Energy, the Environment and the Rational, Strategic & Political Dimensions of Energy Planning

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Mandatory Declaration

This thesis contains no material which has been accepted for the award of any other higher degree or graduate diploma in any tertiary institution. To the best of the author's knowledge and belief, the thesis contains no material previously published or written by another person, except when due reference is made in the text.

Signed ....

David Harries
November 1996

To the memory of my parents.

Abstract

Concern over the costs of energy production and use has led to persistent demands for greater policy emphasis on energy conservation. Many researchers have supported these calls and a considerable amount of technical and social research has been undertaken with the intention of advancing this option. Despite this research effort, reliance on energy conservation has remained low and intermittent in many countries and regions. This study explores the reasons for this limited impact of technical and social energy conservation research on energy policy and planning.

Terms and concepts central to the energy debate are defined and discussed. The rejection of demands to reduce energy use is explained in terms of policy constraints and the contradictions in policy goals contained in the arguments upon which these demands are based. The demand for interventionary strategies aimed at increasing the efficiency of energy use are explained separately in terms of political resistance to demand reduction policies and the nature of energy policy making and planning.

The empirical heart of the study is made up of three case studies which are used to illustrate the arguments developed in the theoretical discussion. The history and ongoing debate over electricity planning in Tasmania is first examined. The underlying reasons behind the rapid expansion of electricity supply, and the rejection of energy conservation as a means of reducing the pace of the state's electricity supply construction programme are analysed. The recent history of electricity planning in the state is then used to explain continued low reliance on energy conservation in the aftermath of electricity planning reform. The effectiveness of two household sector energy conservation strategies are then assessed. An experiment involving the monitoring of the impacts of an information campaign on household energy use, and laboratory testing of the performance and energy consumption of refrigerators, are described. The results of these experiments are discussed in terms of the support they lend to the theoretical arguments and their policy relevance.

It is argued that those who demand energy conservation as a social imperative are frustrated and perplexed due to their failure to understand the complexities of energy issues and what these demands run up against, on the one hand, and to a clash between what is socially and instrumentally rational, on the other. The frustration and perplexity of scientific researchers is explained in terms of differences in disciplinary modes of thinking, to the dominance of scientists in debate over energy policy and energy conservation, and to a schism within the literature on energy policy whereby political explanations tend to be omitted from the mainstream debate.

Using a distinction between high, moderate and low energy conservation strategies, and the idea of threshold effects between these different levels of energy conservation, the reasons for the rejection of energy conservation as a policy option are summarised. The limited impact of technical and social energy conservation research is then explained in terms of these arguments. The overall conclusion reached is that although it is theoretically possible to use scientific research to persuade energy planners to adopt rational demand reduction strategies, in practice, the substantial resources required render it very difficult to do so. Serious planning commitment to energy conservation therefore requires *a priori* change at the political level, the resources necessary for useful scientific research being made available only after policy makers decide to increase emphasis on energy conservation. Contemporary energy policy reform, however, has tended to be forced by economically rational imperatives rather than environmental concerns.

Acknowledgements

When I embarked on this thesis, I was unaware how difficult a road it was going to be and I am indebted to the many individuals who provided advice, encouragement, assistance and gingerbread along the way. It was my supervisor, Associate Professor John Todd from the Centre for Environmental Studies at the University of Tasmania, who suggested the topic of energy conservation and who respected my decision to take a more winding and less trod path in tackling the subject, even though this added greatly to his task as supervisor. Despite his unsustainable teaching, supervisory and research loads, he remained always fully committed to this project. Without his advice, encouragement, patience, friendship and full support, the end of the road would not have been reached.

The process of writing this thesis involved making the transition from the physical sciences and technology to the social, political and economic areas. This was encouraged and facilitated by the interdisciplinary natures of the Centre for Environmental Studies and the Department of Geography and Environmental Studies at the University of Tasmania in which I was enrolled. Two economic geographers, Dr Peter Wilde and Dr Shirley Grosvenor, were particularly instrumental in assisting me in making that transition. Dr Shirley Grosvenor also provided the gingerbread.

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The chapter on energy conservation information campaigns in the study is based on a research project led by Professor Todd of the University of Tasmania and Dr Ian Thomas from the Royal Melbourne Institute of Technology. I gratefully acknowledge their invitation to assist with that project and permission to reproduce a condensed version of that research report in this study.

At the familial level, the disparity between fraternal and sororal support could not have been sharper: my brothers offered distractions while my sisters offered help. I wish to thank my sister, Anne Scarr, who made time amidst her heavy family and work commitments to assist with proofreading and cartography, and my intrepid sister, Maria Harries, from the Department of Social Psychology at the University of Western Australia, who took time off from her own Ph.D. and her hectic academic and extra-academic schedules to offer critical comments on various chapters.

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Finally, I would like to acknowledge the works of two authors who's satirical accounts of academic politics and life as a postgraduate student helped me to survive both. David Lodge's *The British Museum is Falling Down* and Tom Wear's *The Madding of Danial O'Hooligan* should be required reading for all postgraduate research students.

CONTENTS

Chapter Four: Energy Efficiency: the Non-Adoption of a Rational Option

PART II - CASE STUDIES

Chapter Five: Tasmania: A Case Study of Electricity Planning - Part 1

Chapter Six: Tasmania: A Case Study of Electricity Planning - Part 2

List of Figures & Maps

Chapter Eight

List of Tables

Chapter Two

Chapter Seven

Chapter Eight

Chapter One

Introduction

"Would you tell me, please, which way I ought to go from here?"
"That depends a good deal on where you want to get to", said the Cat.
"I don't much care where ... ", said Alice.
"Then it doesn't matter which way you go", said the Cat.
" ... so long as I get *somewhere*", Alice added as an explanation.
"Oh, you're sure to do that," said the Cat, "if only you walk long enough".
— Lewis Carroll (1896) *Alice in Wonderland.*

Another book on energy requires apology more than introduction.
— W.D. Nordhaus (1979) *The Efficient Use of Energy Resources.* Yale University Press, London: p. xv.

1.1 Setting a Course

This study asks why energy conservation is not adopted as a policy option at a rate many consider to be more socially and economically rational, and why there exist such large disparities, in both place and time, in this regard. For the reader to understand why this study chose to ask the above questions and the subsequent line of argument taken in answering them, it is necessary to begin in an unorthodox manner by telling it the way it happened: how the initial problem that prompted the thesis was the perceived low policy priority assigned to energy conservation; the subsequent divergence of opinion over the capacity of social and technical scientific research to alter this state of affairs; and how the 'real' problem came to be seen as an inadequate understanding of the underlying reasons behind the low policy emphasis on energy conservation. In this case, the dead-ends themselves came to be the subject of the thesis. Through this account of the processes behind the study's evolution and the reasons for the change in tack along the way, the reader will be more able to understand the approach taken by, and the arguments developed in, the study. The introductory section of this chapter is therefore used to set the course for the study by briefly relating the story of its origin before discussing at greater length its aims, explaining the methodological approach, and outlining its structure.

1.2 The Origins of the Study

The study's genesis in 1990 coincided with the sexagenary of Tasmania's (for a brief description of Tasmania see Box 1 on the following page) public electricity authority, the Hydro-Electric Commission (HEC). The Commission had just traded-in its traditional crest, encircled with the proud motto, *Vis abundans nec unquam deficiens*[1], for a more modern and stylized logo, *sans motto*. This change turned out to be timely as the Commission's anniversary was marked by the firing of the State's second 120 MW[2] stand-by[3] oil-fired generating unit and a reliance on non-hydro sources to meet 11% of the State's electricity requirements. An extended period of low rainfall had severely reduced the hydro-electric system's ability to meet demand and for the first time in the its history, a substantial portion of the State's electricity needs were generated from a source other than hydro-electricity (HEC 1990a: 41, HEC 1991: 45). Debate on energy policy was coloured by the common perception of a serious electricity *deficiens*!

This graphic demonstration of the vulnerability of the State's predominantly hydro system to the vagaries of the weather, moreover, occurred at a time that lent the occasion amplified significance and more than a touch of irony. After two decades of being mothballed, the State's back-up oil-fired power plant was fired not only the in midst of major economic downturn in the State but also renewed outbreak of war in the

BOX 1

The fact that this study began in Tasmania is not critical to the point being made here. The State is used, however, as one of the three case studies presented to support the arguments subsequently developed. The characteristics of the State are therefore given in greater detail in the introduction to that case study in Section 5.1.

Tasmania is the smallest and southernmost Australian state. In the words of Mikes (1968: 138), it 'seceded' geographically from the mainland over 40,000 years ago and is the only island state in the federation. Roughly heart-shaped, its area (63,325 square kilometers) is very close to that of Sri Lanka or the Republic of Ireland. Tasmania is dwarfed by the Australian mainland, its land area being about one third that of the next smallest state, Victoria. Situated between the latitudes of 42 °S and 43 °30'S, the island lies in the path of the northern tip of the 'Roaring Forties', the westerly airstream over the Southern Ocean. Annual average rainfall on the west coast ranges from 1500 to 3000 mm. There is a strong gradation in rainfall from west to east with annual average rainfall in areas east of the Central Plateau as low as 500 mm. The elevation of the Central Plateau and western ranges is between 1000 and 1200 m above sea level and this relatively high rainfall and tropical relief provides natural potential for hydro-electric development.

A dual Westminster system exists in Australia, with political responsibility shared between the Commonwealth and states. The latter are responsible for, among other things, planning and development of their own energy resources.

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[1] The latin motto translates as *Abundant energy without deficiency.*

[2] A list of energy units and their symbols is provided at the end of the study.

[3] A wide variety of terms are used in this study. A small number of important terms are defined in Chapter Two. All other terms which the reader may not be familiar with are defined in the glossary provided at the end of the thesis. Terms included in the glossary are underlined the first time that they appear in the text of the thesis.

Middle East and a rapid, albeit brief, price rise of oil on the world market. While the temporary rise in the price of oil significantly inflated the Commission's fuel bill, it was the coincidence of this need for back-up thermal power with the demise of a long-standing policy of hydro-industrialization in the State that lent the firing of the back-up power station its real poignancy.

For over three decades the largest portion of the State's capital works programme had been committed to a continuous series of hydro-electric projects of ever increasing magnitude to the extent that the word 'power' in Tasmania had eventually come to be regarded by some as synonymous with the name of the State's public electricity authority (Turnbull 1981, Thompson 1981, McQueen 1982, Lowe 1984). Administration of the State and that of 'the Hydro' came to be seen by many as 'virtually indistinguishable' (Orchison 1994). The goal of the hydro-industrialization policy was simple enough - the promotion of industrial development and presumed concomitant generation of employment within the State underpinned by the provision of cheap hydro-electric power to industry. Absorbing as it did, however, so much of the State's scarce capital resources, the appeal of the policy began to atrophy around the late 1960s. Conflict between hydro-electric development and demand for preservation of natural areas had become the greatest source of public questioning of the policy by the early 1970s. Continued State government adherence to the policy in the face of this criticism led ultimately to political upheaval and community division on a grand scale with a finalé that saw a Premier deposed, a State government toppled and a political spill-over into the national political arena (Thompson 1981, Lowe 1984, Selwell 1987, Rosenthal & Russ 1988, O'Riordan 1989, Smith & Handmer 1991, Tighe 1992). The Federal government intervened by using its constitutional powers in the area of External Affairs to halt construction of a highly contentious hydro-electric project involving the flooding of the Franklin River. The Tasmanian government mounted an unsuccessful legal challenge and on the 1st July 1983 a full bench of the High Court ruled by a single vote in favour of the Federal government (Coper 1983, Sornarajah 1983, Wilcox 1983). With that ruling, the options for exploiting the most of the remaining large scale hydro-electric potential in the State were foreclosed and a colourful chapter in Tasmania's socio-political history was brought to an end. Thus by 1990, as the last of its hydro-electric projects was nearing completion, the State was witnessing the twilight of an energy era that had spanned over three quarters of a century and Tasmania's energy planners were left wondering, like Alice in Wonderland, which way to go from here.

This hiatus in energy policy in the early 1990s acted as a fillip for the State's newly formed Department of Resources and Energy to bring forward the process of weighing up the pros and cons of its various options. The three options vying for ultimate sanction as the State's next energy source, in order of apparent Departmental preference, were (i) a submarine cable (Basslink) connecting the State's electricity grid with those of the south eastern Australian states which were fed, predominantly, by coal-fired power stations, (ii) the development of a natural gas field in the strait between the mainland and Tasmania with a view to constructing a gas-fired thermal generating plant in the State, and (iii) the construction of a coal-fired thermal generating plant supplied by the State's limited indigenous coal resources. The resort to the oil-fired stand-by thermal plant at Bell Bay in Tasmania therefore provided a preview of what was being proposed as a new era in the State, the generation of electricity from the combustion of fossil fuels. It was an energy strategy, however, that collided with increasing international concern over the need to reduce greenhouse gas emissions.

Concern over the enhanced greenhouse effect, the possibility that increasing atmospheric concentrations of carbon dioxide and other greenhouse gases would lead to climate change, was catapulted from a long-term position in policy limbo to being an issue at the centre of the international policy arena in the latter half of the late 1980s. It was, in fact, the third in a series of environmental issues truly global in scope that surfaced around that period, the other two being the potential of even a limited nuclear exchange to result in catastrophic cooling of the Earth's surface (Ehrlich *et al.* 1984) and the scientific evidence of significant depletion of tropospheric ozone (Roan 1989). While the greenhouse problem was a scientifically complex one, with feedback effects such as the impact of warming on cloud formation not fully understood, scientific consensus that the problem was real and that something needed to be done appeared to be steadily growing. Even Britain's archconservative Prime Minister, Margaret Thatcher, had described it as 'an experiment too great to risk', leading one major newspaper editor in that country to declare that there would be much rejoicing in the stratosphere for this one repentant sinner (Olstead 1993: 12).

A series of attempts to reach multilateral agreements to drastically curb greenhouse gas emissions, particularly between the more developed nations, had therefore been set in train. The Toronto Protocol of 1988 had called on developed nations to reduce carbon dioxide emissions to 20% below 1988 levels by the year 2005. Although key players had initially demurred on the uncertainties surrounding the extent, regional differences and ultimate consequences of climatic change, by 1991 twenty nations, including Australia, had entered a voluntary pact to meet the Toronto target despite the absence of any international treaty (Sinclair 1991).

The implications of this 'mother of environmental scares' (Wildavsky 1992: xv) for future levels of fossil fuel use were profound. Carbon dioxide was considered the most significant of the greenhouse gases, accounting for approximately 55% of anthropogenic global greenhouse radiative forcing (Cline 1991: 906) and the combustion of fossil fuels accounted for approximately 85% of these global carbon dioxide emissions (ANZEC 1990: 34). Furthermore, the two sectors that accounted for the greatest part of the fossil fuel combustion were the transport and electricity generation sectors. In Australia, for example, carbon dioxide had been identified as accounting for 45% of total national greenhouse gas emissions. Of the various sectors of the economy, the energy sector was identified as the largest contributor to total greenhouse gas emissions, accounting for 43% of total emissions, 44.7% of which was produced from the combustion of coal. Nearly all of this coal was used to generate electricity (ANZEC 1990: 33-34). Energy was therefore seen to be the key to the solution of the greenhouse problem (Benarde 1992: viii) and electricity generation the major target of any attempt to meet international commitments to reduce greenhouse gas emissions.

Tasmania's intention to embark on a course of increased generation of electricity from fossil fuels at this juncture in time was therefore discordant with both international attempts to reduce greenhouse gas emissions and a national commitment. As such it had about it a disconcerting ring of Hardin's (1968) *Tragedy of the Commons* as it was premised on the belief that its contribution would go unnoticed. Herein lay an irony.

By the late 1980s there were two popular views prevalent in the environmental literature. The first was that the global community was in need of crossing a perceptual threshold in order to avert eco-catastrophe (McKibben 1989, Brown *et al.* 1989, Lovins 1989a, 1991, Eden 1993). The second was that there were clear signs that such a rapid shift in attitude in this direction was occurring. The burgeoning social phenomenon, the modern environment movement was, to its proponents at least, of such a scale that it was variously ascribed the status of revolution (Nicholson 1970, Reich 1970, Lewis 1973, Damman 1984, Brown 1988, Merchant 1989, Harrison 1992), a turning point (Mesarovic & Pestel 1974; Inglehart 1977; Capra 1983), a U-turn (Goldsmith 1988), a green shift (Pearce *et al.* 1989) and a historical discontinuity (Caldwell 1990). To more neutral observers it represented 'one of the most important social movements of our time' (Tester 1994: 1320, Nisbet 1982: 101-7).

The irony in Tasmania's contemplated launch into a fossil fuel electricity generation era had to do with the State's reputation as a leader of beneficial environmental change. Controversy over a proposal to flood Lake Pedder in Tasmania's rugged southwest wilderness for hydro-electric storage in the late 1960s was broadly credited with having seeded the modern Antipodean environmental movement (Dunphy 1972, Knoppes 1987, Smith & Handmer 1991) and to have given rise to the world's first environmental political party, the United Tasmania Group in 1972 (Flanagan 1990). This reputation of being at the vanguard of environmental politics was enhanced a decade later with the re-eruption of this dams versus wilderness controversy which developed into Australia's environmental *cause celebré* (Tighe 1992: 124). Since that time, environmental issues had remained firmly on the boil in the State (Hay 1987: 4). In 1989, environmentalists won the balance of power in the State's House of Assembly (Larmour

1990, Hay & Eckersley 1993) and the Tasmanian environmental movement gained the reputation as being, in the tactical, organisational and philosophical senses, at the vanguard of world environmental politics (Hay 1988). Tasmania was described by some writers as 'one of the few places in the world' where environmental issues had been 'successfully politicised' (Grosvenor *et al.* 1993: 4) and as a green socio-political laboratory (Hay & Haward 1988: 439). The local green movement considered itself to be at the centre of world attention (Pybus & Flanagan 1990) and the State to be 'at the leading edge' of not just green politics but also sustainable economics (Lowe 1990a: 87). This portrait of the State as an environmental leader was therefore out of kilter with its plans to begin generating electricity from fossil fuels at this point in time.

The response of the environmental lobby to the convergence of the above issues was predictable. Todd (1991) argued that Tasmania was strategically located in place and time to embark on an ecologically sustainable energy course which would establish it as an 'energy role model'. Similarly, Mills (1991a) injected into the debate an argued proposal for Tasmania to become the nation's first 'solar state'. Wind energy proposals, had previously been advanced as an economically viable and particularly suitable energy option for Tasmania given its favourable wind patterns and the compatibility of the wind option with its hydro-electric generating system (Blakers & Outhred 1983, Blakers 1987). These wind energy proposals were now dusted off and re-advanced (Diesendorf 1990, Lowe 1990a).

Central to the above sustainable energy proposals was the notion that the State's requirements for energy could be reduced to the point that they could be met with renewable energy technologies (RETs)[4] alone. This followed a long tradition within the general energy debate in which renewable energy and energy conservation were advanced in tandem as two components of the one strategy (Blackburn 1987, National Institute of Economic and Industry Research 1990, Brower 1990, Boyle 1992, Pears & Versluis 1993) that tended to be 'riveted' together (Gibbs 1991: 10). Along with this revival of interest in renewable energy throughout the world, therefore, was a parallel revival of interest in energy conservation.

This new wave of interest in energy conservation sweeping the globe had come in revamped form. Gone were the admonitions for leaving lights on in empty rooms and the avuncular chidings for use of the clothes drier instead of the clothes line. In their stead came an appeal more exculpating to the ego: energy was still being wasted, but the culprit was now projected as the inefficient energy-using appliance rather than the apathetic individual. Geriatric hot water systems and antiquated TV sets were now

[4] A list of abbreviations used in the study is provided at the end of the thesis in which the terms they represent are given.

portrayed as the energy gluttons rather than those who used them. Pogo the Clown's '*We have met the enemy and it is us*', oft used as a rubric in texts on energy conservation, was applicable no more. The enemy was now the appliance and the remedy more palatable, requiring neither a change in lifestyle nor a reduction in comfort but a simple replacement of the offending appliance. Just as the traditional incandescent globe had established itself as a hieroglyph of bright new ideas, the compact fluorescent lamp (CFL) was now adopted as the symbol of energy efficiency. To the most ardent preachers of this new gospel of energy efficiency, the rate at which the theoretical potential for increasing the efficiency of energy use was increasing represented a change of epochal significance (Lovins 1987, Flavin & Durning 1988).

All research starts by choosing an entry point into a specific subject area (Resnick & Wolff 1987: 25). In this case it was the convergence of these ideas and events – the gap in Tasmania's energy policy, the contradiction between the energy strategies being contemplated by the State's energy policy decision makers and the increasing concern over the greenhouse issue, the rift between these conventional energy supply expansion strategies and the local environmental movements's argument that the State was strategically placed to serve as a sustainable energy role model, and the revival of interest in energy conservation – that combined to give rise to the simple suggestion from which this thesis grew. This was that it was timely in place and time to 'do something on energy conservation' and that the most logical focus of this effort was the household sector. The entry point was the ideas that energy conservation was a socially and ecologically desirable policy option and that research on household energy conservation could play a useful role in advancing this option in Tasmania. The research was unabashedly mission-orientated, its ultimate goal being to inform policy on the questions of the scope for household sector energy conservation and how this could be achieved. The author, however, entered this subject area *tabula rasa* and the first step was to begin searching the voluminous literature on household energy conservation as a means of developing a more specific proposal.

Rather than firming up a thesis proposal, however, this reading had the effect of sabotaging it. Instead of producing a clear idea of what would actually constitute a useful contribution to the debate, this preliminary reading distilled serious reservations over the policy relevance of much of this orthodox technical and social household sector energy conservation research. The attempt to find a research topic also involved discussions with a number of individuals with an academic or professional interest in energy conservation[5]. The initial suggestion was that the statement that there existed significant scope for reducing household sector requirements for reticulated energy in Tasmania could be adopted as a working hypothesis. The idea was to test this hypothesis by using literature on energy efficient equipment together with local data on energy use to construct an assessment of the extent to which household energy requirements for reticulated electricity in Tasmania could be reduced. A further suggestion was that it would be useful to develop an environmentally optimal energy strategy for Tasmania. Yet another was that a survey could be used together with field inspections to compare reported with actual levels of thermal insulation in Tasmanian households. That these suggestions had merit was demonstrated by the fact that numerous researchers had followed such lines of inquiry over the years. Nonetheless, all of these suggestions met with reservations that could be neither articulated nor dispelled. Like annoying blowflies, they buzzed around overhead, refusing to either land or go away.

As an aside to mulling over ideas for a thesis, the author began to work on two independent projects. One was a demonstration programme of energy efficient equipment which aimed to show that the potential for reducing energy use through increasing the efficiency of energy use was not theoretical but real. The work involved the measurement of the energy consumption of an efficient refrigerator and comparing this to the energy consumption of conventional models. The second of these asides was a research project in which the author was invited to assist and which involved the monitoring of the effectiveness of a household energy conservation information programme.

Both reading and discussions on further ideas for a research project were continued. The author's rejection of proposals involving the construction of energy proposals based on technical energy efficiency assessments saw these discussions turn toward the idea of undertaking a household survey as a means of determining why households did *not* adopt energy conservation measures available to them or to assess the scope for household sector energy conservation. Again the author demurred, checked by reservations. While deliberating over these, however, Tasmania's energy situation began to change.

The drought eased and the State's thermal power station was mothballed once again, removing the sense of urgency over energy issues. The imminent commissioning of the latest of the State's hydro-electric projects further diluted the intensity of debate over energy policy in the State and further weakened the appeal of doing something on energy conservation. Then came the *coup de grâce* for the research proposal to do something on household sector energy conservation in Tasmania. Comalco Bell Bay

[5] The author consulted a number of individuals during this early stage of the thesis. Initial discussions were held with his supervisor, Associate Professor John Todd. Subsequent discussions were held with Dr Peter Wilde and Professor Kirkpatrick , both from the Department of Geography and Environmental Studies at the University of Tasmania, Dr Mark Diesendorf with the Australian Conservation Foundation, Dr David Crossley from the Demand Management Unit of the Electricity Commission of New South Wales (ELCOM), Dr Hugh Outhred from the Engineering Department of the University of New South Wales, Graeme Wathen from the Department of Industry, Manufacturing and Technology in Melbourne, and Mr Alan Pears, an energy efficiency consultant from Melbourne.

Ltd, an aluminium smelting company located at Bell Bay adjacent to the stand-by thermal power station and the State's largest single electricity consumer had been locked into protracted *in camera* re-negotiation with the Tasmanian Government and the HEC over future electricity prices and security. The heavily indebted HEC argued that the price the company paid for its electricity had to be increased. The company countered with the argument that aluminium smelting was highly competitive and that the price the company paid for electricity greatly affected its international competitiveness. The company therefore demanded that new arrangements be found which would provide it with a guarantee of low electricity prices over the longer term. An acceptable arrangement could not be reached and the company announced that it intended to wind down its Tasmanian operations over the period of the remainder of its existing electricity contract which expired in 2001. To add credence to its threat the company permanently closed down its number one potline, immediately reducing its need for electricity by 60 MW. As the company accounted for approximately 27% of the total electricity consumed in the State, its departure would increase the idle capacity to one third of total generating capacity. It therefore represented a potentially embarrassing crisis for the HEC. For research on electricity conservation in Tasmania, however, it represented a crisis of irrelevance.

The initial problem that had given rise to the suggestions for the thesis, the shortage of electricity in that state, was now a totally inverted one. The case for accelerating the adoption of household sector energy conservation in Tasmania was weakened further by the fact that the price Australian householders paid for electricity was reported to be low in comparison to those paid by householders in many other industrialised countries (Electricity Council [UK] 1988)[6] while Tasmanian householders reportedly paid a lower price for electricity than did their mainland counterparts (*The Mercury* 5 July 1993: 9). The threat of considerable overcapacity had therefore made Tasmania something of a topsy-turvy land in which seeking to explain why householders *did* take-up energy conservation appeared a more logical question the usual research question of why they *did not*. All in all, Tasmania looked to be barren territory for research into energy conservation and this situation looked set to last for some time to come. I Tasmania, electricity conservation had become a non-issue and since few researchers who demand social usefulness as a criteria for their work deliberately venture into the nether world of non-issues (Crenson 1971: 4), it was now the author rather than the State's energy planners who appeared to be wondering where to go from here.

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[6] The Electricity Council [UK] comparison of the price of domestic electricity based on 1988 prices estimated that Australia ranked fifth lowest of twenty selected industrialised countries. This comparison was made using the cost of 3300 kWh of electricity on the standard domestic tariff and included local taxes and VATs.

Perhaps the logical thing to have done at that point would have been to either abandon the topic of energy conservation altogether or to look elsewhere to focus on energy conservation research. Paradoxically, however, it was only once the immediate need for conserving reticulated electricity in the State had been temporarily removed that a potentially useful line of inquiry began to emerge. The reason for this apparent contradiction was that as the momentum of the perceived need for reducing energy dissipated, the reservations held by the author over the various research suggestions began to precipitate out of the confusion and settle, and it was by thinking more deeply about those reservations that ideas began to form as to what research was actually viable and socially useful.

The first of those reservations was an overpowering sense of *déjà vu*. Concern over energy issues and interest in energy conservation appeared to be episodic and we appeared to be asking the same questions as we had been asking on previous occasions.

A second reservation related to the large, and increasing, volume of literature on energy and energy conservation, and the repetitive nature of much of that literature. Not only had the volume of literature on energy conservation increased dramatically since the early 1970s, but it appeared to be characterised, furthermore, by much confusion, on the one hand, and by a readily detectable sense of frustration over the continued low priority assigned to energy conservation in energy policy and planning, on the other.

The third reservation was that it appeared that in attempting to seek the reasons why energy conservation does not happen, much scientific research had focused on the personal level by surveying individuals and householders as the means of searching for potentially fruitful ways to accelerate the adoption of energy conservation measures. The author was unconvinced, however, that the main cause of the rejection of energy conservation as a policy option was located at the individual level.

A final and most important reservation related to the assumptions underlying the research. It has been forcefully argued that the usefulness of much research in general that has been undertaken with the intention of informing policy but has been seriously undermined by the failure on the part of researchers to examine the assumptions underlying their research (Hanson 1993). Hanson's criticism appeared highly applicable to much scientific energy conservation research[7]. Although much scientific energy conservation research had been undertaken as a means of supporting this demand for energy conservation by informing policy makers about the scope for saving energy, policy reliance on energy conservation had remained low and intermittent in many

[7] The term 'scientific energy conservation research' is used in this study as a generic term for technical and social energy conservation research.

countries and regions. It was clear that in many situations, this research had little tangible impact on actual energy policy decision making. At the heart of this scientific research, and the suggestions which prompted this study, were implicit assumptions about how much energy conservation was desirable or necessary, why policy makers did not employ various energy policy instruments to accelerate the rate of take-up of energy conservation, and, therefore, what research would be useful in persuading policy makers to place a greater emphasis on energy conservation. To the author, it was the failure to question these assumptions and appreciate the complexities of the issues involved that lay behind the limited policy impact of this research.

Consideration of these four reservations led to a revision of the direction and aims of the study. It appeared that more technical or social energy conservation research was less needed than to pause and reflect on the causes of this repetition and frustration within the literature and on the apparent failure of scientific research to impact on energy policy and decision making. In this way, the present study was transformed from research *on* energy conservation, to a study *about* the debate over the need for energy conservation and the contribution that scientific energy conservation research makes to that debate.

1.3 Aims and Arguments

The purpose of this study is to offer a critique of scientific energy conservation research *à la* Maslow's (1966) critique of orthodox science by examining the arguments upon which the demands for energy conservation are based and the policy and planning processes. It does not begin with clearly formulated hypotheses that could be objectively tested but merely with a few hunches as to reasons for the particularly low policy emphasis on energy conservation in many countries such as Australia, for the rejection of environmentalist demands for intervention to reduce the demand for energy, and for the limited impact of technical and social energy conservation research on energy policy decision making in such situations. The author therefore decided to begin with these hunches and, borrowing from Dahl & Lindblom (1953: 28), to develop the argument of the thesis as the study proceeded.

The first hunch was that the repetitive nature of technical and social energy conservation research was a direct consequence of the lack of tangible impact this research has often had on policy and decision making. This limited impact on policy, moreover, was considered likely to be itself directly attributable to the fact that this research has been based on an inadequate understanding of why energy conservation has not been adopted as a policy option to a greater degree than it has, or of the reasons for the differences in the degree to which energy conservation has been encouraged over time and between places. One reason for this is that very little is written about those places where energy conservation is given a very low priority in energy policy and planning and this omission means that the low emphasis on energy conservation in such places remains largely unexplained (Gadgil & Sastry 1994: 151).

The second hunch was that those who demand greater reliance on energy conservation and advance energy conservation proposals as alternatives to conventional policy emphasis of expanding the supply of energy, frequently fail to adequately understand the contexts in which their proposals would be implemented, the complexities and many contradictions contained in their demands for reductions in energy use, and the source and nature of the resistance to those demands. It was suspected that it was this failure that led to much of the confusion within the debate over energy conservation.

The aim of the study thus became to explain the rejection of demands for increased emphasis on energy conservation policies, the reasons for the variation in policy emphasis on energy conservation between places and over time, and the particularly low emphasis on energy conservation in some situations. In this way, it was hoped to explain the frustration and repetition that characterised both the environmentalist demand for energy conservation and the scientific energy conservation research literature. It was clear from the outset, however, that any attempt to explain the rejection of demands for greater emphasis on energy conservation would not be straightforward as the debate over energy conservation appeared to be highly confused. The causes for this confusion appeared to be twofold. The first cause appeared to be imprecision in the meaning of terms and concepts employed in the debate. The second cause of this confusion appeared to be the difficulty of agreeing on the answers to three important subquestions central to energy conservation: *why* energy should be conserved?; *how* energy could be conserved?; and, *how much* energy ought to be conserved? The reason that there was little agreement on the answers to these questions, furthermore, is that the issues that they touch on tend to be highly complex.

In embarking on the task of explaining why energy conservation was dismissed as a policy option, the author followed one final hunch: that the adoption or nonadoption of energy conservation as a policy option could not be treated in isolation from the question of the rate of growth of demand for energy and the factors driving that rate of increase in demand. The two issues, the scope for energy conservation and the rate of growth in demand for energy, were felt by the author to be complementary and two sides of the same coin. It was the author's strong suspicion that the dismissal of energy conservation as a policy option had to be understood, not in terms of the absolute number of megajoules or kilowatt hours of energy that could potentially be saved, but in terms of the scope for saving energy *relative to* the projected rate of increase in the demand for energy. The ability to persuade policy makers to adopt energy conservation as a planning option was seen by the author to be closely linked to the rate of growth in energy demand and the capacity to reduce the *rate of growth* in demand for energy. Explaining the rate of growth in the demand for energy, therefore, became quintessential to the study's aim of attempting to explain the rejection of energy conservation as a policy option. Because of this, a secondary aim of this study was to explain the factors behind the rapid rates of increase in demand for energy.

1.4 Methodology

A complete attempt to explain why energy conservation is not relied on to a greater degree than it is would need to incorporate many fields of knowledge that included the technical, behavioural, social, environmental, economic, political, and institutional areas. While an number of writers advocate such an holistic approach as the only means of adequately addressing the complexities of such issues, and environmental issues in particular, to do so would place an unmanageable burden on the research student (Walker 1992: 14). This study therefore makes no pretence of holism but elected instead to adopt an eclectic approach.

This eclectic approach covered a wide range and large amount of literature. This literature was searched using different means and tools which evolved during the course of the study as a consequence of rapid changes in information technology. The initial search was on household energy conservation and Smith *et al.* (1987), in reviewing the literature, had noted its extensive nature and provided a useful summary of the various search devices available, including lists of energy data bases, abstracts and the more important journals. The University of Tasmania Library carried out an initial literature search on household energy use, household energy conservation and household energy efficiency using the *Energyline* and *NTIS* on-line data bases. The author carried out separate literature searches using *Energy Information Abstracts*, *Energy Index*, *Renewable Energy Index* and *Energy Abstracts.*

Once these had been completed, the literature was updated at regular intervals by perusal of the more important journals where these were locally available. A problem with researching in the area of energy conservation and energy policy in Tasmania was that few of the important energy journals were locally available. The University of Tasmania's relatively small library subscribed to very few of the relevant journals, and most of the locally available journals relevant to this study were housed in the Hydro-Electric Commission's library. Accessing these journals was difficult, however, as members of the public have no borrowing rights or access to photocopying equipment at that HEC's library. While visiting the other Australian states, the libraries of several universities and electricity authorities were used by the author to ascertain which journals were important. *Current Contents* was then used to regularly check articles appearing in those journals. The vast majority of material used in this research was obtained through the University of Tasmania Library's inter-library loan service.

The literature on general environmentalism and the environmental debate over energy was obtained in a number of ways. The Centre for Environmental Studies possesses its own resource collection on environmental literature and this information was supplemented by discussions with colleagues researching specific aspects of environmentalism such as environmental philosophy and sustainable development. Searches of the catalogues of major libraries using the internet provided many useful sources of information.

Political scientists working at the University of Tasmania were approached and asked to provided useful initial sources of literature on policy decision making and political theory. The University of Tasmania Library catalogue was then used to extend this reading material. Dr Peter Wilde and Dr Shirley Grosvenor provided useful reference material on social research methodology and realist philosophy of science. Information on theoretical aspects of energy planning, and electricity planning in particular, was more difficult to find. On-line literature searches for the subjects of energy policy and energy planning provided useful references. The main source of this information, however, came from the search for literature on electricity planning in a specific location. Associate Professor Bruce Davis had written widely on the topic and supplied the author with a large number of useful references. Methodologies employed in the research involving the case studies of the effectiveness of behavioural and technical energy conservation measures are described separately in the relevant chapters of this study.

1.5 Plan of the Thesis

This thesis is presented in two parts. To assist the reader, structure of this thesis is outlined graphically in the flow chart in Figure 1.1 This flow chart is used to thread of the argument and how this is connected by the various chapters. PART I covers the conceptual and theoretical components. Before exploring the reasons for the low policy emphasis on energy conservation it is necessary to be clear about what is meant by *energy conservation, energy efficiency* and so on. The need to do so arises from the observation that we tend to think *with* our concepts, not *about* them (Sayer 1992: 35) and this failure has led to much confusion. Chapter 2 is therefore used to look more closely at the important terms and concepts around which the debate rotates and some

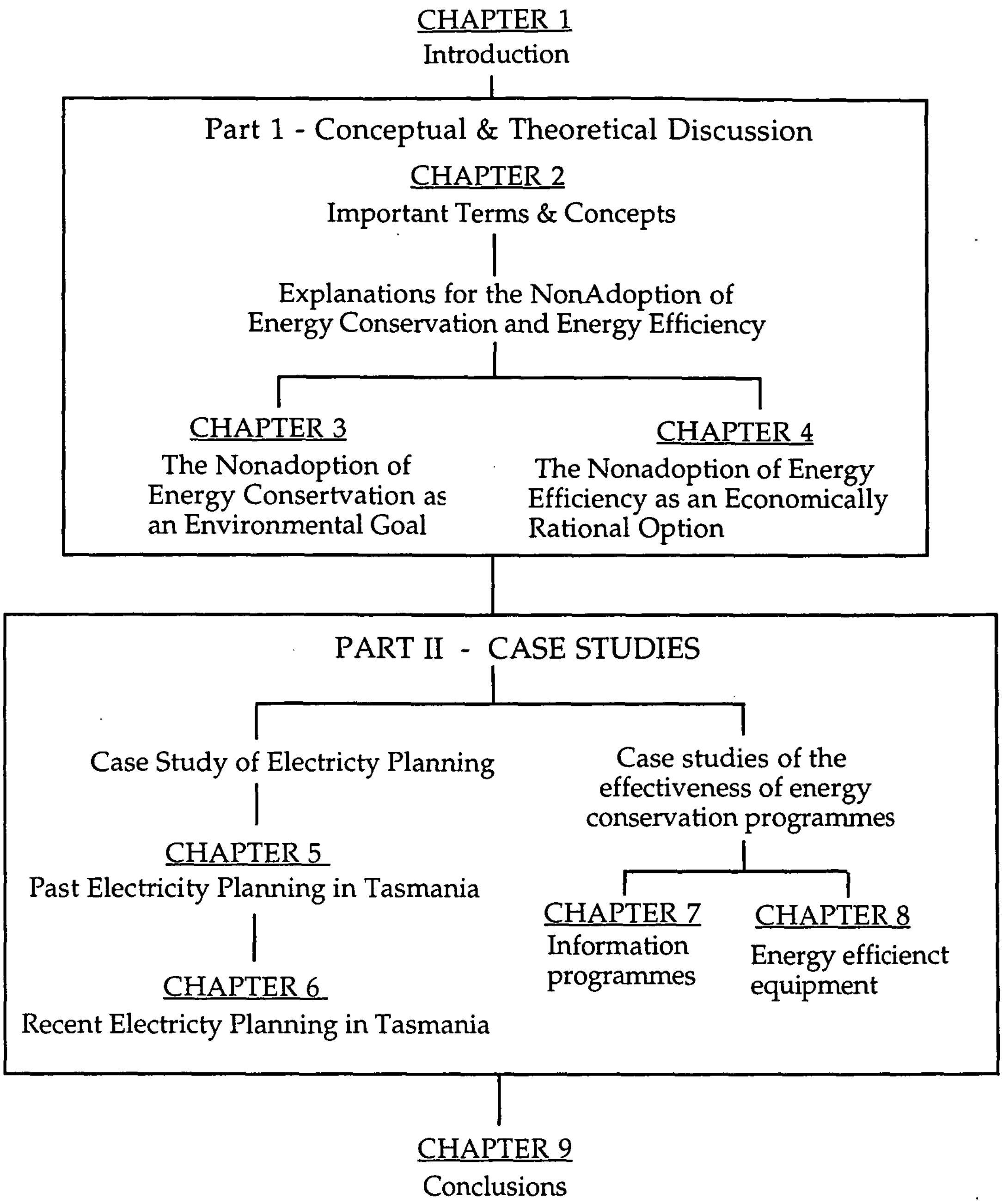

Figure 1.1 Flow chart indicating the structure of the thesis.

of the problems associated with those terms. In the light of those concepts, and using a distinction between different levels of energy conservation, the argument of the thesis is then stated.

Attention turns in Chapters 3 and 4 to explanations for low policy reliance on energy conservation. A two-pronged approach is taken. The ideas and arguments behind environmental demands for energy conservation as an environmental objective are explored. The history of these demands and how they have fluctuated in strength and shifted in nature over time are explored in Chapter 3. The many complexities of the issues and the contradictions associated with the demand for substantial reductions in energy use are discussed. This historical approach is used to show that there has been a lack of consensus over how much energy conservation is needed, to describe the nature of the resistance to demands, and to explain the preference for technical solutions to energy-related problems.

Chapter 4 explores the reasons behind the rejection of proposals to reduce energy use by increasing the technical efficiency of energy use. The history of the debate over energy efficiency is traced to first explain the rejection of radical proposals. Attention then turns to energy planning and to explain the reasons behind the dismissal of more modest proposals for demand reduction proposals. Models of energy and electricity planning used by various authors to explain the outcome of planning decisions in terms of rational planning are described and discussed. The theory of policy decision making is then used to further explain why energy conservation has tended to be assigned a low priority and why planners tend to rely on energy conservation only during certain periods. Finally, this discussion is extended by inclusion of political explanations for policy reliance on continuous and rapid energy supply expansion.

In PART II, three separate case studies are used to support the general and theoretical discussion presented in Part 1. The first of these, presented in Chapters 5 and 6, is an historical account of electricity planning in Tasmania and is used to explain the rejection of energy conservation and the reasons behind the rapid growth in electricity supply in that state. The history of electricity planning in Tasmania is divided into three phases. The early period prior to the debate over energy conservation as a serious energy option provides the historic background to the discussion of planning in subsequent phases and is presented in Appendix 1. Chapter 5 is then used to explain the rejection of energy conservation provides the historic background to the discussion of planning in subsequent phases from the early 1970s to the early 1980s when public criticism of electricity planning escalated. The strategies used to balance supply with demand for electricity during this period of rapid expansion of generating capacity and the way in which this rapid supply construction programme was defended in the face of massive public criticism are described. Chapter 6 provides an account of electricity planning in Tasmania from the early 1980s to the mid-1990s, a period that represented the end of the era of rapid supply expansion and the initiation of electricity planning reform. The more recent debate is followed in order to show that these reforms did not automatically lead to increased reliance on demand reduction strategies but how increased reliance on energy conservation was checked by the legacy of past planning and continued political attempts to maintain control of electricity planning.

The other case studies involve empirical testing of the effectiveness of two energy conservation programmes. These were initially undertaken as asides to this study but were ultimately incorporated into the study because it was realised that they served the dual function of supporting the arguments put forward in the study, and providing a useful bridge in the discussion from the past to the future. The case study presented in Chapter 7 describes a project undertaken to gauge the effectiveness of a household energy conservation information campaign in the city of Brunswick, Victoria, by the Royal Melbourne Institute of Technology (RMIT) in Victoria and the Centre for Environmental Studies at the University of Tasmania. The project compared the impact of two different motivational prompts (saving money and saving the environment) and the results are discussed in terms of their policy relevance and the support that they lend to the theoretical discussion presented in the earlier chapters. The case study in Chapter 8 examines the potential to reduce household sector energy use by increasing the efficiency of energy-using. A laboratory experimental programme designed to test the performance and energy consumption of three refrigerators is described. The results of these tests are discussed in terms of the theoretical discussions about why energy conservation is often rejected as a planning option, resistance to proposals for intervention to rapidly increase the efficiency of energy-using equipment, and the role of mandated energy performance standards (MEPS) as a means of reducing household sector energy use. The implications of these tests are also discussed in terms of the current standard refrigerator test methodology employed in Australia.

The study concludes by returning to the initial questions of why energy conservation proposals have tended to be dismissed and why scientific energy conservation research has been relatively impotent in its attempt to alter this state of affairs. The fundamental causes of the frustration and perplexity of environmentalists and scientists over continued low policy emphasis on energy conservation is discussed in terms of both the way members of these groups think and in terms of their inability to comprehend the complexities of energy issues. The reasons for policy rejection of high, moderate and low energy conservation proposals are reviewed in order to explain why technical and social research have failed to influence policy making. The study concludes with a discussion of the type of scientific energy conservation research that is capable of influencing energy policy making and of the likelihood that this type of research effort will be supported given the current environmental pressures and energy supply sector reforms.

PART I

CONCEPTUAL & THEORETICAL DISCUSSION

If man will begin with certainties, he shall end with doubts; But if he will be content to begin with doubts, he will end with certainties.
— Francis Bacon (1608) *The Advancement of Learning.*

Chapter Two

Definitions and Concepts

'Then you should say what you mean', the March Hare went on.
'I do', Alice hastily replied,
'at least I mean what I say - that's the same thing you know.'
—— Lewis Carroll (1896) *Alice in Wonderland.*

No matter what language one employs ... real life
is too complex for the simplicities of language.
—— Dahl & Lindblom (1953: 26)

2.1 Introduction

The purpose of this chapter is to discuss some of the more important terms, concepts, principles and ideas around which debate on the role of energy conservation in energy policy rotates. It is important to begin this way not only because the eclectic approach adopted in this study requires the use of many terms from a diverse range of areas, but because it serves the useful function of permitting an initial skirmish into some of the considerable confusion that surrounds that debate. And much of that confusion is rooted at the primitive level of definitions. A small number of writers have suggested that it begins with the very fact that energy itself is an elusive concept for which physicists cannot provide a precise definition (Pittas 1979: 5, Sarre 1991: 7). Conceptual fogginess over what energy is, however, would appear in reality to have less to do with this confusion than looseness in the use of terminology. As many of the terms used in the debate are borrowed by disciplines from everyday language, and vice versa, they often posses simultaneously a precise disciplinary meaning and looser common meaning. Energy and energy conservation, moreover, are subjects which span many disciplines, and the terms frequently obtain different nuances in meaning within the various disciplines. Terms such as *fuel*, *power*, *electricity* and *energy* are therefore often used interchangeably, as are *energy conservation*, *energy efficiency* and *demand management*. Siddayao (1986: 4) has argued that the vagueness with which the term energy is used has important ramifications for energy policy debate. Even within debate between professional analysts, the result has been described as one afflicted by the curse of Babel (Hayes 1977: 9) and so ambiguous that it often confounds even the most aware company (Brown *et al.* 1991: 151). This problem is compounded by the occasional attempt to appropriate terms to suit a preferred energy policy option, such as the recent attempt to exclude hydro-electricity as a renewable energy source on the basis of its unacceptably high environmental impacts (Gilchrist 1994: 11). While a glossary of terms is provided at the end of this study, terms more central to this study are discussed at greater length in the following sections.

2.2 Energy Conservation

The term most central to this study, *energy conservation*, means different things to different people. Traditionally, it has been defined as the wise use of energy while environmentalists have often described it loosely as a good idea whose time has come. A more technically precise definition that avoids the issues of why we should conserve energy is that energy conservation is 'the deliberate reduction of energy use from that which it otherwise would have been' (Munasinghe & Schamm 1983: 176) and is taken as the definition of energy conservation for the purposes of this study. The use of the word *deliberate* is important because it distinguishes between those reductions in demand which occur without intervention from those which occur as a consequence of intervention. The level of energy use that 'otherwise would have been' is frequently referred to as the business as usual [bau] level of energy use. A problem that arises, however, is that it is often difficult to determine precisely the level of energy use that would have happened without deliberate effort to reduce energy.

A second problem has been the confusion between the two terms *energy efficiency* and *energy conservation*. Both terms are often used interchangeably and without definition (Saddler 1994: 54). One reason for this is that many of those who advocate a reduction in energy use consider the term *energy conservation* to be popularly associated with curtailment, going without and hardship. Because of this, prominent energy analysts see the term to have 'un-American' connotations and insist on using *energy efficiency* instead (Webb 1995: 34). More recently, a third term, *demand management*, has come into use and is now frequently used synonymously with energy conservation (Kohl 1993: 3). It is important to note, however, that energy conservation, energy efficiency and demand management have important differences in meaning. For this reason, the these terms are discussed at length below.

It is necessary to begin by distinguishing the various ways by which energy use can be reduced or conserved. To do so, the classification system below was developed by the author as existing classification systems were considered inadequate. To discuss this classification system and describe these various means of reducing energy use, the reader is referred to the model of the simple energy using system, S_1, as shown in Figure 2.1. Energy is conserved when the input energy, E_{IN}, is reduced. This can be achieved in the following six ways:

(i) Reducing the demand for energy services (doing less with less): this approach, often referred to as belt-tightening, does not tinker with energy using system, S_1, but merely reduces the level of output, A_{OUT}, in order to reduce the level of input energy, E_{IN}. It is

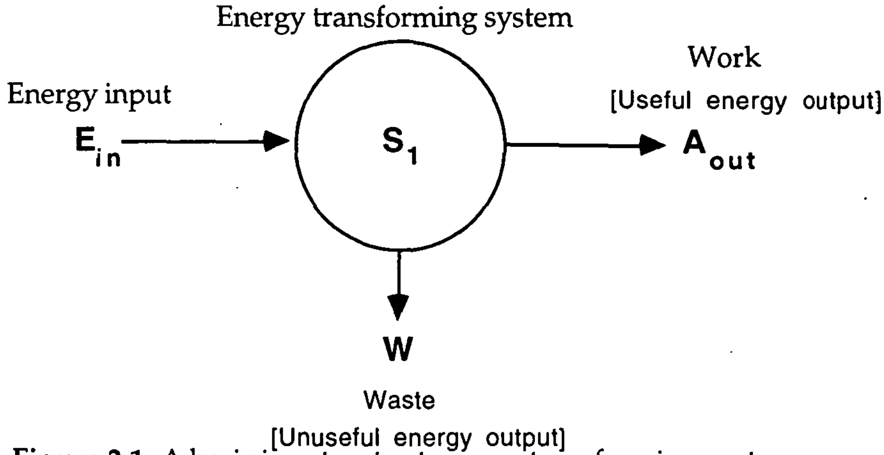

Figure 2.1 A basic input-output energy transforming system.

the simplest way of reducing energy input. A factory, for example, can deliberately reduce its energy input by reducing the amount of goods produced. More plausible examples are the deliberate decisions to reduce the use of a car by riding a bicycle, walking or using public transport, or the lowering of thermostats.

ii) Avoiding unnecessary use of energy (doing the same with less): it is almost trivial that the portion of output energy, A_{OUT}, that is not used to provide a useful service is equivalent to waste. An example of such waste is lights left on in empty rooms such as lecture theatres or offices not in use. Switches controlled by movement detectors are now commonly used to turn lights off in such situations to avoid waste.

(iii) Finding a useful purpose for the waste energy to reduce the energy input of another system, S_2 (using waste): the waste energy, W, from one system, usually heat, can be transferred to where this is needed. The heat expelled from the evaporator of a refrigerator, for example, can be used to reduce the input energy needed to heat the water in a storage tank. Similarly, the waste heat from an industrial process can be either piped to provide central heating in nearby dwellings or can be used to produce steam in order to run a steam turbine to generate electricity.

(iv) Maintaining the energy using system, S_1, in good working order (doing the same with less): this approach attempts to reduce waste output, W, in order to reduce the input energy without altering the level of useful output and without altering the energy using system. Fixing dripping hot water taps, tuning car engines, or repairing broken windows fit into this category.

(v) Fuel switching (doing the same with a different source of energy): the input energy, E_{IN}, can be supplied by another source of energy. This may not save energy *per se*, and may even increase the amount of energy used to provide a service, but it is a means of reducing the use of a specific fuel. An example is the installation of equipment to allow an engine to run on liquefied petroleum gas [LPG] instead of petrol.

(vi) Increasing the technical efficiency of the energy using system (doing the same with less): this can be achieved by either replacing the system with a more efficient one or retrofitting the existing system to increase its energy efficiency. An example of the first is the replacement of an incandescent globe with a compact fluorescent tube. An example of the latter is the installation of loft insulation to increase the thermal performance of a dwelling.

While the above classification system suffers from the usual problem of blurred boundaries, as there are always measures difficult to place into any one category, it is a more comprehensive classification system then those in common use. Energy efficiency is often used rather than energy conservation because it is considered to have a 'better ring to it' (Patterson 1992: 186) and used in this way is loosely taken to mean all of the above means of reducing energy use except (i), reductions in energy services. Using the term energy efficiency in this way, however, is not without problems, the more important of which are discussed below. In this study, energy efficiency is used in the more restricted sense as given in (vi) above ,while energy conservation is used as the generic term for all means of reducing energy use.

2.3 Energy Efficiency

2.3.1 First Law Energy Efficiency

As used in the classification system above, energy efficiency means the 'first law efficiency'. The first law, known as the law of conservation and attributed to Epicarus of the 3rd century BC (Hardin 1991: 50), states simply that nothing can be created out of what does not already exist. The more modern statement of the law of conservation of energy is that in any non-relativistic process occurring within a closed system, the amount of energy remains constant. In terms of Figure 2.2, this means that the sum of the useful work (A_{OUT}) and the waste energy (W) is equal to the input energy (I_{IN}) and the [first law] efficiency, η, with which energy is converted into useful work is defined as the ratio of the output of useful work to the input energy ($\eta = A_{OUT}/I_{IN}$). An oil-fired space heater, for example, has a first law efficiency of about 0.65, a typical domestic refrigerator about 0.60, an incandescent light globe 0.05, and a modern coal-fired-power station approximately 0.40 (Ross & Williams 1982: 530). A heat pump has a first law efficiency of 2 or more. (when $\eta > 1$ it is called the *coefficient of performance* or COP). In transforming the energy into an energy form that provides a function or service, several interconnected systems are often involved. Energy sources (coal, petroleum oil, wood, water in elevated areas) are transformed via a series of energy conversion systems (power station, car, refrigerator, light globe) into a the final form of energy that we desire such as light, motion (kinetic energy), mechanical energy or heat. The first law efficiency of the total energy conversion system shown in Figure 2.2 is the product of the first law efficiencies of each of the component conversion devices.

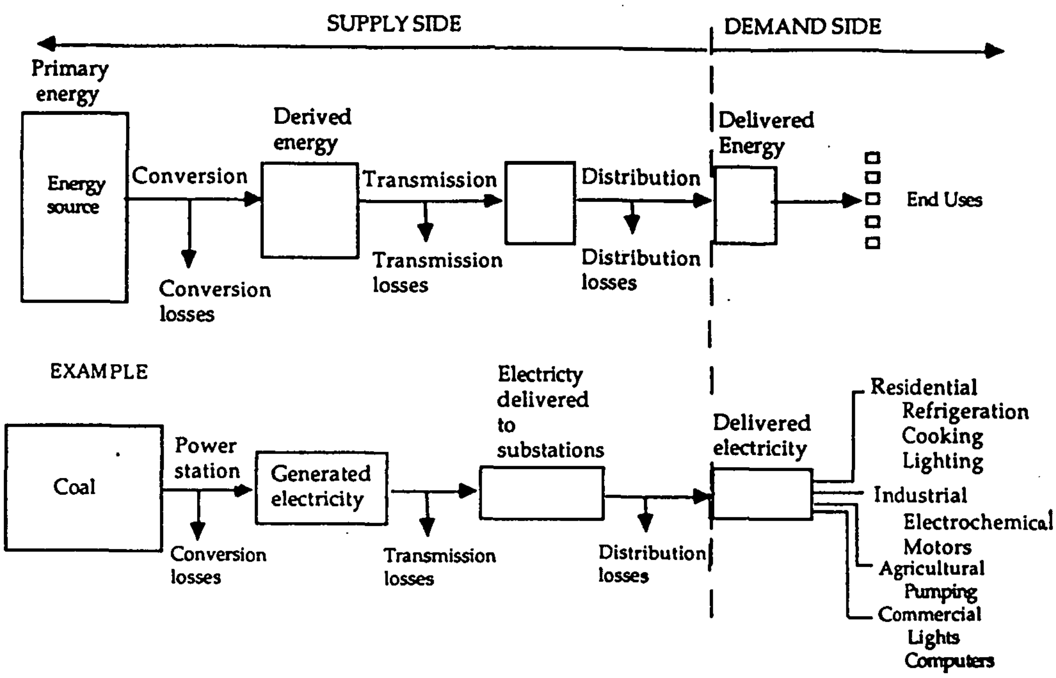

Figure 2.2 An energy conversion chain [Adapted from Kahane 1991: 199].

High first law efficiencies can lead to the false impression that there is little room for improving efficiencies. The calculation of first law efficiencies of complex task where the output is a combination of heat and work, can also be very difficult (Kreider 1978: 224). The maximum value of η, furthermore, is in many cases temperature dependent (Ford *et al.* 1975: 26). For these reasons, first law efficiencies are considered inadequate.

2.3.2 Second Law Efficiency

The second law of thermodynamics is one of the most powerul generalizations made to date (Campbell 1970: 41). It is a deduction concerning heat engines that involves subtle concepts said to be fully understood by very few, including most physical scientists and engineers (Zernike 1973: 2). Non-expert use of the second law to justify policy options or arguments can therefore be dangerous. Such non-expert use, however, is now common as the distinction between the first and second laws is popularly seen as 'crucial' to debate on energy policy (Robinson 1982a: 341). A brief discussion of the second law at this point is therefore necessary. As the author is not an expert on the subject, the reader is referred to authoritative texts for more rigorous discussion of the second law (Holman 1988, Wark 1989, Simonson 1993) or its implications for energy conservation (Berg 1973, Ford *et al.* 1975, Ross & Williams 1982).

The second law states that to convert a quantity of heat into mechanical work, another quantity of heat must undergo a corresponding and compensating change[1]. This means that there is an upper limit to the amount of ordered work than can be produced from disordered thermal energy. The thermodynamic parameter, *available work* (B), is defined as the maximum useful work that can be provided by a system (or fuel) as it proceeds to a specified final state in thermodynamic equilibrium with the surrounding environment. Expressed algebraically, if a quantity of heat, Q_1, is extracted from a resevoir at temperature T_1, at an ambient temperature of T_0, then

$$B = Q_1[1-(T_0/T_1)]$$

The greater the absolute difference between T_1 and T_0, the greater the amount of available work, B. Energy therefore has a 'quality'. While the amount of energy in a closed system remains constant over time, the 'quality' of the energy degrades until an equilibrium state is reached in which there is zero 'available energy' [i.e. energy available to do work] remaining. Without an external source of energy to 'pump' the energy back to high quality form, the usefulness of this energy is irreversibly depleted.

The second law is *task-oriented* and can be used to define 'minimum task energy' (Gibbs 1948). This is one of the most significant implications of the law as it provides an indication of the minimum available work that *must* be used to perform a given task. The second law efficiency, ε, is the ratio of the least available energy that could have been used theoretically to perform a task to the actual available work used to do so:

$$\varepsilon = B_{\text{theoretical minimum}} / B_{\text{actual}}$$

First and second law efficiencies for various types of devices are shown in Table 2.1.

1 For the many other ways of stating the second law, see Campbell (1970: 1088-89).

Table 2.1 First and Second Law Efficiencies for Various Energy Input Source-Work Ouput Combinations [From: Ford *et al.* 1975:Table 2.3, p. 30].

End use \ Source	Work W_{in}	Fuel: Heat of combustion $\lvert\Delta H\rvert$ Available work B	Heat Q_1 from hot reservoir at T_1
Work W_{out}	1. $\eta = W_{out}/W_{in}$ $\epsilon = \eta$ (e.g., electric motor)	2. $\eta = W_{out}/\lvert\Delta H\rvert$ $\epsilon = \frac{W_{out}}{B}$ $(\cong \eta)$ (e.g., power plant)	3. $\eta = W_{out}/Q_1$ $\epsilon = \frac{\eta}{1-(T_0/T_1)}$ (e.g., geothermal plant)
Heat Q_2 added to warm reservoir at T_2	4. $\eta(\mathrm{COP}) = Q_2/W_{in}$ $\epsilon = \eta\left(1-\frac{T_0}{T_2}\right)$ (e.g., electrically driven heat pump)	5. $\eta(\mathrm{COP}) = Q_2/\lvert\Delta H\rvert$ $\epsilon = \frac{Q_2}{B}\left(1-\frac{T_0}{T_2}\right)$ (e.g., engine-driven heat pump)	6. $\eta(\mathrm{COP}) = Q_2/Q_1$ $\epsilon = \eta\frac{1-(T_0/T_2)}{1-(T_0/T_1)}$ (e.g., solar hot water heater)
Heat Q_3 extracted from cool reservoir at T_3	7. $\eta(\mathrm{COP}) = Q_3/W_{in}$ $\epsilon = \eta\left(\frac{T_0}{T_3}-1\right)$ (e.g., electric refrigerator)	8. $\eta(\mathrm{COP}) = Q_3/\lvert\Delta H\rvert$ $\epsilon = \frac{Q_3}{B}\left(\frac{T_0}{T_3}-1\right)$ (e.g., gas powered air conditioner)	9. $\eta(\mathrm{COP}) = Q_3/Q_1$ $\epsilon = \eta\frac{(T_0/T_3)-1}{1-(T_0/T_1)}$ (e.g., absorption refrigerator)

The second law also provides an indication of the theoretical potential for increasing the efficiency with which a specific task is performed and implications for the thermodynamic appropriateness of energy forms for given tasks. Energy conversion processes which use high quality energy (such as fossil fuels or electricity) to produce low quality energy (such as heat below 100°C) have low second law efficiencies. An oil-fired space heater, for example, burns with a flame temperature of about 2027 °C (2300 K) and has a first law efficiency of approximately 0.65 (Munasinghe & Schamm 1983: 182). This suggests that there is some, but not tremendous, scope for improving the efficiency of space heating equipment. However, the second law efficiency of an oil heater used to maintain a temperature of 20 °C (293 K) when the outside temperature is 5 °C (278 K), is:

$$
\begin{aligned}
\varepsilon &= \eta\,(1-T_0/T_1)/(1-T_1/T_2) \\
&= 0.65(1-278/293)/(1-278/2273) \\
&= 0.04
\end{aligned}
$$

The low second law efficiency is the result of a thermodynamic mismatch between the high quality of the energy source (oil) and the low energy quality of the task (low temperature heat). If solar energy at 30 °C (303 K) were used as the source of space heating, then ε would be approximately 0.75. A very low second law efficiency implies that there exists tremendous scope for improving the efficiency with which the task is performed. The second law efficiency of an electric compression-cycle refrigerator, for example, is approximately 0.05 (Ross & Williams 1982: 530). This suggests that while there is limited scope for improving the efficiency of the motor, the efficiency of refrigeration could be vastly improved by other means, such as increasing the insulation, altering the layout of the components, or using a totally different technology.

2.3.3 Non-Technical Meanings of Energy Efficiency

2.3.3.1 The Efficiency of Delivering Energy Services

The usefulness of technical efficiency with which energy is converted into useful work as a guide for energy planning is weakened when the boundaries of the energy-using system under consideration are extended to include the end-user as shown in Figure 2.3. The concept of efficiency then becomes increasingly subjective and unquantifiable as energy is converted into desired ends.

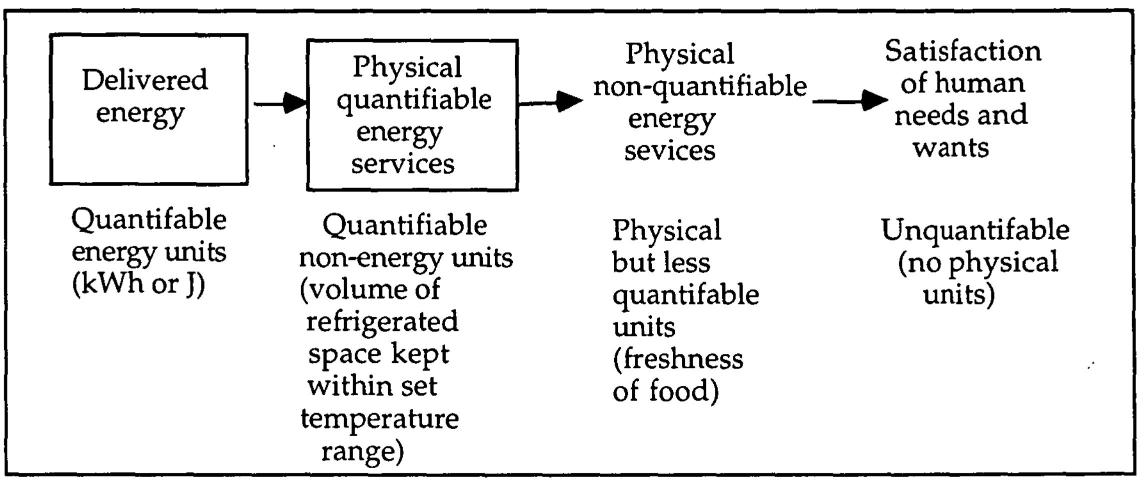

Figure 2.3 The chain of concepts involved in the conversion of delivered energy human satisfaction [Adapted from Nørgård & Christensen 1987: 2].

Delivered energy, precisely measured in kilowatt-hours, is used to produce a service which can also be quantified, although with less precision. For a refrigerator, the convenient measure of the service is the volume of refrigerated space kept below a set temperature, measurable with relatively high degree of accuracy. This is used to provide a physical service, fresh food, which is even less quantifiable. Finally, the fresh food is used to provide satisfaction of human wants, which are not quantifiable in physical terms. While the level of energy services can usually be derived from the stock of appliances and patterns of behaviour determining the use of the appliances, the satisfaction of human needs through the delivery of a service is often difficult to define quantitatively. Consequently, the true efficiency of a technology is hard to define or quantify precisely. The definition of efficiency becomes blurred once we recognise that what we are really rating is the efficiency of providing a service (Nørgård 1989: 6).

2.3.3.2 Economic Efficiency

It has been argued out that the closeness in sound of the two terms *energy efficiency* and *economic efficiency has led to much* confusion in the debate over energy policy (Sutherland 1994: 267). Productive economic efficiency, or *productivity*, is maximised when a given output is produced at the cheapest possible cost, where the input costs are defined by quantity and price (Bannock et al. 1972: 131-32). These input costs are capital, labour and energy (Commoner 1971: 252, Tapp & Watkins 1990: 73), although others would add materials. In the economic sense, overall efficiency can be increased by increasing the efficiency of labour, capital, materials or energy. Economically efficient use of energy, then, is the use of energy that results, in combination with other inputs, in the lowest unit cost of production and in the optimal allocation of resources, assuming efficient pricing of all inputs (IEA 1991a: 44). This economic notion of efficient energy use therefore may result in an *increase* rather than a *decrease* in energy use if the price of energy decreases relative to other inputs into production.

2.4 Demand Side Management

Demand side management (DSM), is defined as manipulation of the way in which customers use their energy (Gellings *et al.* 1992: 2). It involves matching supply-demand of a particular energy source by manipulation of the demand side, as opposed to the supply side, of the equation. It therefore refers to planning decisions made by an energy supply organisation rather than an energy policy adopted by governments. Six generic demand side management strategies available to energy planners have been distinguished (Clinton *et al.* 1986: 127) as described in Figures 2.4 (i) to (vi) below.

Figure 2.4 Demand Side Management Strategies.
[Note: the scale of the horizontal axes in the sketch graphs are not critical and could be diurnal (12 am to 12 am) or over a year]

(i) Valley filling: a common types of demand side management and consists of building up off-peak loads by offering low priced off-peak tariffs to attract users that would otherwise use other fuels and sources of energy. Offering cheap off-peak electricity for storage space heating or water heating, for example, attracts new customers who would have otherwise used gas, solar or wood for those tasks.

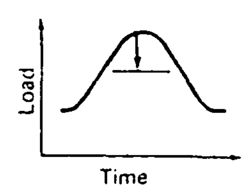

Figure 2.4 (i)

(ii) Peak clipping: the reduction of system peak loads using direct load control. This is usually used where the supplier has direct control over load and is able to switch off and on energy-using equipment. It tends to be used only when peak loads become critical and is rarely used as a demand side management device in the Australian context.

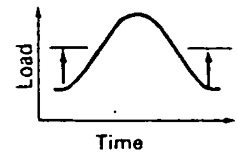

Figure 2.4 (ii)

(iii) Load shifting: involves shifting loads from on-peak to off-peak periods. Popular applications include use of storage water heating, storage space heating, coolness storage and customer load shifts. This does not involve attracting new users but consists simply of shifting the use of existing customers to off-peak times the use of appliances that would have been used during peak periods.

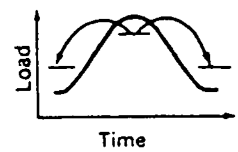

Figure 2.4 (iii)

(iv) Strategic conservation: the reduction in total sales of energy through the use of energy conservation programmes initiated by the energy supplier. Examples include increased thermal insulation to decrease the demand for space heating or cooling energy and the promotion of energy efficiency equipment such as compact fluorescent lamps.

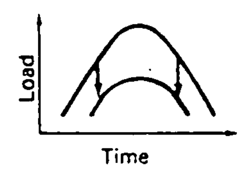

Figure 2.4 (iv)

(v) Strategic load growth: the encouragement of increased sales of energy beyond valley filling. It involves the attempt to capture increased market share of loads that can be, or are, served by competing fuels or energy sources as well as area development, creation of new markets by electrification of tasks traditionally provided by other fuels such as private vehicles.

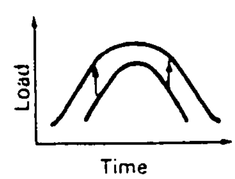

Figure 2.4 (v)

(vi) Flexible load shape: adjustment of the shape of the load curve by offering lower energy prices or other incentives to energy users willing to trade-off reduced reliability of supply. These strategies include interruptible or curtailable loads and individual customer load control devices.

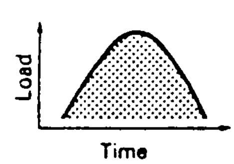

Figure 2.4 (vi)

Demand side management options are planning tools which can be used by an energy supplier to manipulate its load curve to suit its strategic interests. These strategies can either decrease or increase energy use.. Demand management (DM), on the other hand, refers to the broader energy planning strategy of meeting society's future requirements for energy by adjusting the demand for energy, rather than increasing the supply of energy, and is therefore more closely related to a policy goal of conserving energy.

2.5 How Much Energy Conservation?

Discussion about energy conservation as a policy option is bedevilled by the problem of how much energy conservation is desired. For the purposes of this study, a distinction between four broad levels of energy conservation, defined in terms of the reduction in the growth of energy, are defined as follows:

(i) Business-as-usual level of energy use: the level of energy use determined by the 'natural rate' at which the efficiency of energy use increases without public policy intervention. It is a 'zero energy conservation' option as it involves no deliberate attempt on the part of policy makers to reduce energy use. It is the option preferred by adherents of the free market approach in which the appropriate level of energy conservation is determined by market forces alone.

(ii) Low energy conservation: marginal reductions in the rate of growth of energy use below the business-as-usual level. These strategies tend to rely on behavioural instruments which focus on and involve the use of prompts or the provision of information. The household sector is often the main target of these strategies.

(iii) Moderate energy conservation: a reduction in the rate of growth of energy use which does not manage to halt increase in energy use, but is nonetheless significant.

(iv) High energy conservation or aggressive energy conservation: policies and strategies which stabilise the level of energy use (zero energy growth) or reduce levels of energy use in absolute terms. These strategies are seen as the means of achieving the environmentalist preferred energy strategy of a low energy society.

High, moderate and low energy conservation proposals require implementation of the appropriate policies to achieve these reductions and the available policy instruments are discussed below.

2.6 Policy Instruments for Reducing Energy Use

Walker & Large (1975) have classified the various policy approaches to reducing energy use according to whether they rely on psycho-sociological, economic or technological strategies. Lowe (1989: 97), on the other hand, has distinguished between types of policy instruments based on the 'four Es': exhortation, education, enticement and enforcement. Table 2.2 is a matrix which amalgamates these two ways of classifying energy conservation strategies.

BROAD TYPE OF STRATEGY	Exhortation	Education	Enticement	Enforcement
Psycological-sociological	• Mild prompts	• Education re energy-related problems and individual's role in their resolution • Provision of information on how to conserve energy		• Mandated energy performance labels
Economic		• Provision of information on potential monetary savings of energy conservation measures	• Modest increases in energy prices • Incentives such as rebates • Penalties such as taxes	• Substantial increases in energy prices
Technical	• Voluntary agreements with manufacturers to increase the efficiency of products		• Government assistance with research and development of energy conservation equipment	• Regulations such as mandated energy performance standards and building codes

Table 2.2 Classification of approaches and policy instruments designed to reduce energy use.

Where some measures fit into Table 2.1 is a matter of degree. Relatively small increases in energy prices, for example, fall within the ambit of voluntary changes of behaviour for most. Larger increments in price increases represent a shift to virtual enforcement of behaviour change for those without access to capital to reduce energy use without simultaneously curtailing their level of energy services. Environmentalists often advocate the use of aggressive energy conservation policies such as a hefty increase in the price of energy to achieve their demands for reductions in energy use. Anderson (1993: 69), for example, has argued that global levels of energy use need to be significantly reduced and has suggested that this can be achieved by massively increasing the efficiency of energy use. These increases in the efficiency of energy use, he has argued, could be simply achieved by significantly increasing the price of energy. Labelling such a policy an energy efficiency policy, however, is clearly misleading as large increases in energy prices would result not only in increased efficiency of energy use but also reductions in output and levels of energy services. This is but one instance of the confusion between the terms energy conservation and energy efficiency.

2.7 Summary and Restatement of Thesis

Using the concepts of high, moderate and low energy conservation the argument can be stated in the following way. Environmentalists demand high energy conservation policies as a means of reducing the social costs associated with increasing levels of energy use, but these demands meet with widespread resistance. As a retreat to a more achievable objective, environmentalists support the demands for aggressive efficiency of energy efficiency policies, including economic restructuring towards less energy-intensive activities. These demands , however, are also resisted by influential groups with vested private interests in retaining current patterns of economic activity. Environmentalists therefore make a further retreat to more moderate demands for energy conservation based on the economic benefits of demand reduction as a planning option. The rejection of these demands adds to the frustration and perplexity of those who advocate them as they appear to be rational from both the social and the energy supply institution's perspectives, often being referred to as 'win-win' solutions. Technical and social researchers who support the energy conservation option therefore assume that these proposals are rejected for logical reasons and engage in research which attempts to show that moderate energy conservation is a feasible and practical option. This research, however, has had little influence on policy or planning because it fails to understand the reasons why these 'rational' planning options are dismissed by planners and resisted by those with a vested interest in the continued expansion of energy supply. As a last resort, environmentalists and researchers therefore advocate low energy conservation strategies based on the notion that it should at least be possible to implement those low cost and easily achieved reductions in energy use which focus on altering individual behaviour with low intervention strategies such as prompts and the provision of information. These strategies are relied on, however, only intermittently.

The above argument is developed in the following two chapters. Cox & Mair (1989) have argued that explaining what happens in a particular place is difficult as the local and global, necessary and contingent, social and spatial, all merge into one another. The only way to explain decisions in a particular location, they maintained, was to work backwards and forwards between these various levels of abstraction. Rather than working through the above argument in order from high to low energy conservation, the approach taken follows the advice of Cox & Mair. These arguments, furthermore, are linked as the dismissal of demands for high energy conservation serve as a partial explanation of the dismissal of more moderate energy conservation proposals. Similarly, the rejection of the demand for low energy conservation policies can be explained in terms of the rejection of moderate energy conservation proposals.

Chapter Three

Why Conserve Energy?

Some said, 'It might do good'; Others said, 'No!'.
—— John Bunyan (1605) *Pilgrim's Progress.*

3.1 Introduction

It has been said that the arguments for energy conservation are so strong (Ester 1985: 9), irrefutable (Seligman 1985: 135) and well documented that it now suffices to treat these in a perfunctory manner (Dovers 1994a: ix). It is commonly assumed, furthermore, that energy conservation is a logical (Socolow 1977, Schipper & Darmstadter 1978) and uncontroversial energy policy option (Crossley 1980b: 130, Frieden & Baker 1983: 23) and that few are willing to challenge these assertions (Cook 1980: 16). Such uncritical acceptance of the case for energy conservation increases, furthermore, during periods in which energy-related problems acquire the status of a 'crisis': understandably, when it is remembered that the hottest place in Dante's hell was reserved for those who remained neutral in times of crisis. The argument of this chapter, however, is that to begin explaining why energy conservation has tended to be rejected as a policy option it is important to risk Dante's inferno by adopting a more agnostic position by critically analysing the arguments and ideas that lie behind the demand for energy conservation.

The aim of this chapter, therefore, is to show that there is a common view amongst energy conservation advocates and researchers that energy conservation is an uncontentious policy goal, but that when these energy issues are examined more closely they turn out to be complex, messy and confused and that at the deeper level actual debate over these issues is characterised by disagreement rather than consensus. This disagreement is over whether reductions in energy use are desirable or necessary, the extent to which energy use needs to be reduced in one place compared to another, how energy use can be reduced, at what costs, and for benefit to whom. A second argument of this chapter is that advocates of energy conservation frequently fail to fully comprehend the social implications of their reform proposals, on the one hand, and what they are up against in terms of why policy makers stubbornly resist the demand for substantial efforts aimed at reducing energy use, on the other.

This chapter examines the arguments behind the demand for high energy conservation. The quarter from which such demands have been most persistent and insistent has been environmentalism. The arguments upon which environmental demand for high energy conservation are based have been many and varied. To unravel these arguments in a logical manner, the discussion is structured by making use of the four modal propositions of Scholastic Logic: *apodictic* (that energy conservation is a good thing can be readily demonstrated), *imperative* (energy use *must* be reduced), *obligatory* (energy use *ought* to be reduced) and *expedient* (reductions in energy use can benefit non-environmental primary policy objectives).

Structuring the discussion in this way conveniently fits in with a distinction between demands for energy conservation based on social and ecological reasons and the demand for reductions in energy use based cost-effective technical improvements in the efficiency of energy use. The former demands are taken as the subject of this chapter and are concerned with the arguments for reductions in energy use irrespective of the means by which these reductions are achieved. The first three types of logical argument (apodictic, imperative and obligatory) are included within this discussion. The expedient arguments are taken as those which accord with the concept of technically feasible and cost-effective energy efficiency and are discussed in the following chapter. In a crude manner, this distinction also follows the historical evolution of environmentalist demands for reductions in energy use.

The arguments, ideas and values discussed in this and the following chapters have been used to support demands for both large and small reductions in energy use, and to justify much research on energy conservation. The sentiment that household sector energy conservation research is important because it contributes toward the resolution of serious global energy-related problems and is an important part of the transition towards the ultimate goal of a low energy society, for example, has been expressed by many researchers in the field (Crossley 1980a: 480, Ester 1985: 5, Foster & Holmes 1991: 1, Foster & Holmes 1994: 123). A central argument of this study is that although these are the fundamental reasons underlying our concerns and our demands for reductions in energy use, and the reason that many engage in research that can contribute to this goal, proponents of energy conservation are forced to rely on other arguments to support these demands and to justify their research. But a point missed by many is that a large part of the explanation of why energy conservation does not happen arises precisely from the fact that they are forced to make this retreat to more modest demands based on other arguments.

A final point that needs to be made is that the demands for high conservation discussed in this chapter are loosely referred to here as *environmentalist* demands. Environmentalism, however, is as yet neither a unified philosophy nor a coherent ideology but a truncated ideology based a loose bundle of issues (Paehlke 1989: 6). While numerous authors have attempted to classify environmentalists[1] according to their ideologies, philosophies, the nature of their concerns, and so on, there are various problems associated with the attempt to pigeon-hole environmentalists in this manner. The approach adopted in this study follows Sandbach (1980: 22-6) who distinguished between two streams of environmentalism. His first type included scientifically informed individuals who attempted to influence policy making by presenting 'a valid, scientifically argued case based upon ecology and systems analysis' (Sandbach 1980: 22). Others have made the further distinguished between the technocentric and ecocentric strands within this first stream of environmentalism (O'Riordan 1981). Sandbach's second stream of environmentalist was less concerned about the environment and more concerned about social issues and about the compatibility of science and technology with humanistic principles (p. 26).

3.2 Apodictic-Fundamentalist Arguments for Reductions in Energy Use

3.2.1 The Apodictic Status of Energy Conservation

There appear to be two separate ideas behind the notion that energy conservation is a good thing. One is based on the argument that as the production and use of energy is associated with costs or 'bads', lower levels of energy use reduce these bads and is therefore desirable. The other is based on the cultural value that inefficiency is bad. As an aid to discussing the first of these it is useful to refer to the model of the inter-related economic and the environmental systems as shown in Figure 3.1.

Much of the debate over energy conservation has to do with the divergent perspectives on the economic and environmental systems as shown in Figure 3.1. Many environmental theorists consider the environmental system to have non-economic value in its own right or that the economic subsystem is subordinate in importance to the environmental system, as an intact environmental system is a prerequisite for an economic system. Utilitarian economic writers, on the other hand, focus on the economic system and consider the environment to be a subsystem with three economic functions: the provision of resources, the provision of amenity and the absorption of wastes from production and consumption. These three functions are seen to be interconnected since excess wastes (pollution) can result in the loss of both amenity and production. All economic activity, furthermore, impacts to some degree on one or more of these functions. It results in the depletion of natural resources, and the disposal of wastes which have damaging effects on the environment and which reduce amenity. The conservation of

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[1] See Doyle & Kellow (1995: 57) for a discussion of these various typologies.

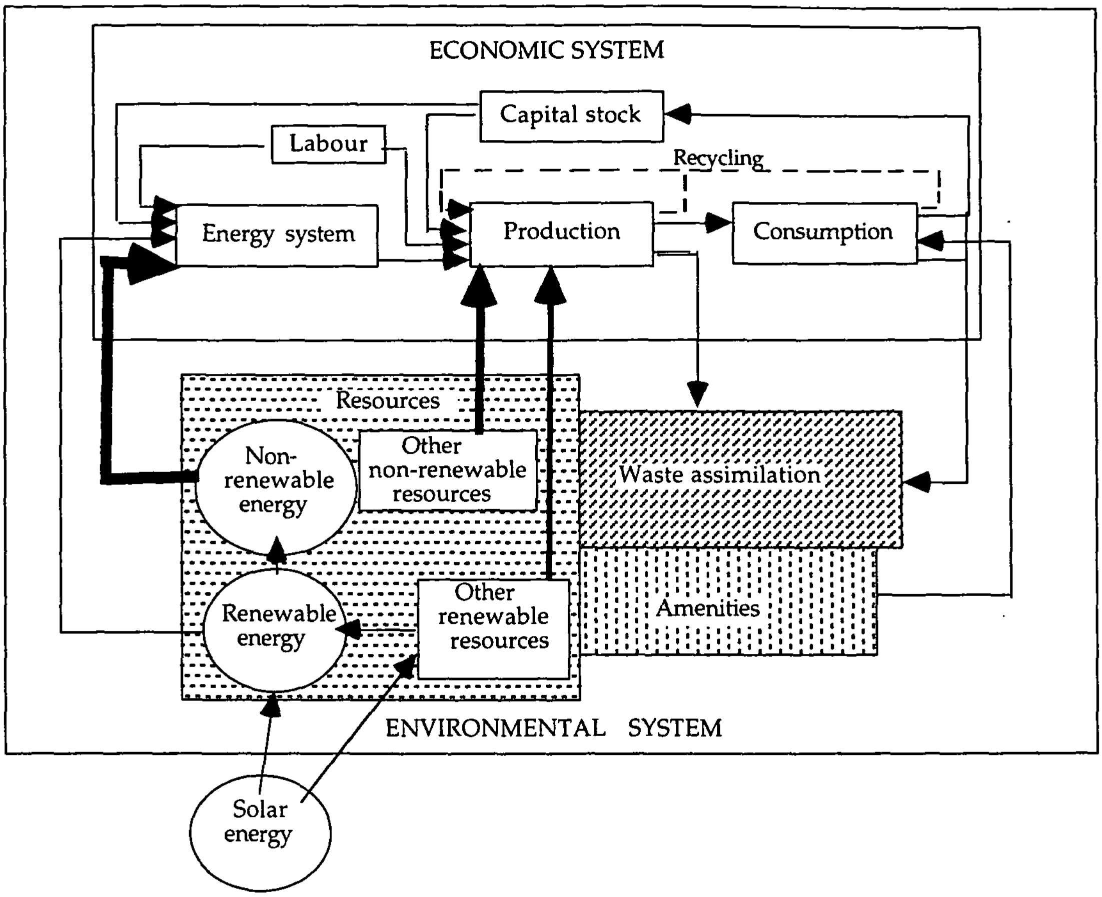

Figure 3.1 A model of the interlinked economic and environmental systems [Adapted from Common (1994: 173)].

resources, including energy, is therefore a good idea from the ecological perspective because a reduction in the rate of resource use leads to a reduction in the impact on these three economic functions. The debate about energy conservation revolves around the importance of energy production and use in the economic system and its role in resource depletion, pollution and loss of amenity. At this level, energy conservation is a means to an end - the reduction of the impacts of energy production and use on these three economic functions.

The first question that needs to be asked is why energy use is seen to be of such importance relative to the consumption of other resources. It is a common assertion in environmental literature that while the conservation of all resources is important, the conservation of energy is of critical importance and most books on environmental issues therefore devote a separate section or chapter to the topic of energy. Examination of this literature suggests that this contention is based on one or more of four arguments and these are briefly discussed below together with comments on the degree to which they provide valid arguments as the basis for policy prescription.

The first argument used to support the notion that energy conservation is of more critical importance relative to other resource and environmental concerns is that energy is a substantively different input resource. This is based on the argument that while other material inputs into the economic system are intersubstitutable - wood can be replaced with steel, steel with aluminium, aluminium with plastic, and so on - there is no substitute for energy (Jacobs 1991: 114). This perception of energy contrasts, however, with the standard economic view in which energy is regarded as just another economic input. To such economists, since energy inputs can be substituted with labour, technology or materials, energy is no different from these other resource inputs (Porter 1982: 89-90). As Common (1994: 174) has pointed out, this incongruence of views cannot be resolved scientifically as it is not a technical question and the debate over energy is thus immediately thrown into the realm of opinions rather than facts.

The second reason given by environmental writers in support of the contention that energy is substantively different from other resources is that the first law of thermodynamics tells us that energy cannot be consumed but only used (Dovers 1994b: 6). The flaw in this argument is that it overlooks the fact that the first and second laws of thermodynamics pertain not only to energy but to all resources. All input materials are degraded rather than consumed. Iron molecules are not consumed but used when iron ore (high entropy) is processed into products such as steel (low entropy) and then used to manufacture cars. As the car rusts, the iron is gradually converted back into a high entropy state. Both energy and materials are therefore degraded rather than consumed.

The third reason given for the greater level of concern over energy use than that of other resources is that energy is a key input resource to all economic activity (Oliver *et al.* 1983; 140), and hence the 'lowest common denominator activity' driving environmental deterioration (Prins & Stamp 1991: 108). As the input resource that props up the 'whole unwieldy edifice' of the modern industrial economic system (Tapp & Watkins 1990: 24), energy use is seen to be at the very heart of environmental problems. What drives the economy must, by definition also be the engine of environmental degradation. The logic of this thinking is that because the industrial economic system has led to much environmental degradation, and because energy is the critical input into the industrial economic system, energy use is therefore one of the most significant environmental problems, if not *the* greatest problem. The level of energy use, and of fossil fuel use in particular, is therefore taken as an indicator of the scale of 'the environmental problem' confronting society (Walker 1991: 22) and as the degree to which the relationship between humanity and nature is dysfunctional (Clarke 1991: 413). The problem with this argument is that while there is a relationship between the level of energy use and the scale of environmental problems caused by energy production and use, it is neither a fixed nor linear relationship. It can lead to the thinking that energy use *per se* is bad rather than the social and ecological impacts of energy use. A variant of this argument, but one that is more specific, is that energy use is not only symptomatic of the level of industrial society's assault on the environment but is in fact the single greatest direct cause of that environmental degradation, along with procreation (Cocks 1992: 127, Cairncross 1993: 111). According to Paehlke (1989: 76) some advocates of aggressive energy conservation premise their demands on the belief that environmental problems are predominantly problems related to energy production and use and that if we solve our energy problems, most other environmental problems will disappear. While it is true that no commercially available form of energy comes free of environmental problems and that many environmental problems are caused by expanding the supply of energy, where energy ranks among serious environmental problems is controversial and varies enormously between places. It has been argued by others, for example, that the real causes of environmental problems are population growth and farming practices and that energy-related problems have been grossly exaggerated (Gray 1993: 156).

The fourth and last argument used to support the contention that energy is substantively different from other resources is theoretically incontestable. It is that energy is different from other inputs because, unlike other inputs, energy cannot be recycled. This argument is thermodynamically irrefutable and the unavoidable consequence of it is that society will ultimately have no option but to rely on renewable (income) energy for all economic activity. But while the argument is irrefutable, its relevance to current policy is very much open to debate.

It can be seen from the outset that behind the environmentalist demand for energy conservation lie very general concepts and ideas which charge the debate but which are not absolutely solid and which are weak in terms of their capacity to influence policy. Two are immediately contestable while the other two are theoretically correct or generally true, but do not necessarily provide a powerful case for energy conservation specific to all locations and at all times.

A second and related question is why environmentalists and energy conservation advocates have tended to place inordinate focus on conserving electricity compared to the conservation of other forms of energy. After the conservation of oil, the conservation of electricity has received greater attention than the conservation of any other form of energy (Harris 1982: 54). With the decline in the price of oil and in concern over oil shortages, the conservation of electricity appears to now receive even greater attention relative to the conservation of other forms of energy.

A number of reasons can be put forward for this emphasis on electricity. First, the production of electricity from fossil fuels involves both conversion and transmission losses. Secondly, electricity is high quality form and therefore involves substantial second law losses when used to perform work that could be achieved with lower quality forms of energy such as low temperature heat. Lovins (1976: 40) estimated that less than 10% of total energy use in the USA required electricity and electricity alone. It is because of these low first and second law efficiencies that electricity has been identified as the energy source with the greatest scope for conservation (Jochem & Gruber 1990: 340, Rosenfeld 1991: 459).

A third reason for focusing on electricity is that fossil fuel-fired power stations are considered significant point sources of pollution and are described by proponents of alternative energy strategies as 'dirty' (Gilchrist 1994: 2). It has been argued, however, that this focus on fossil-fuelled power stations is weakened by the fact that the transport sector has been a far greater source of urban pollution than have coal-fired power stations (Starr 1973: 15). The intractable nature of the latter problem, it has long been asserted, has caused it to be a relatively ignored issue by the environmental movement (Adler 1973: 273, Mittra *et al.* 1995: 46). It is possible that the high visibility of electricity generating power stations lies in part behind the concern over electricity use. Environmentalists have been advised, for example, to exploit this feature as a means of mounting a campaign against the neglected 'coal problem' - the raft of environmental problems surrounding the mining, transport, storage and combustion of coal - on the basis that the neglect of these problems has been due directly to the fact that they lack a convenient symbolic entry point. Power stations, it has been argued, are the most potent symbolic entry points for such a campaign (Martin 1987: 183-4).

Martin's advice was timely as it came just as the greenhouse issue was being elevated as a major political concern at the international level and which saw fossil fuelled power stations identified as the focus for attempts to reduce emissions of these gases. The argument here is that the demand for energy conservation, and electricity conservation in particular, is multilayered and at one level it is informed by general arguments, some of which are of immediate policy relevance whilst others are more theoretical, generalised or symbolic. This is of importance to this discussion because in certain situations these fundamental arguments may be the dominant arguments for energy conservation and the rejection of energy conservation as an option has to be interpreted in that light.

3.2.2 The Apodictic Status of Energy Efficiency

The second fundamental idea behind the notion that energy conservation is a good thing is summed up by the statement made by a character in G.B. Shaw's play *John*

Bull's Other Island. Annoyed by the Irish ways, Broadbent angrily declared that there are only two qualities in this world, efficiency and inefficiency (Shaw 1912: 109). It is a statement that encapsulates the extent to which efficiency enjoys apodictic status in modern society. A number of reasons underlie this status of efficiency as a social value. The first of these is that efficiency is part and parcel of instrumental rationality which has increasingly come to be the driving principle of Western culture since the Enlightenment (Dryzek 1987: 3-4, 1990: 1). It has since come to be the dominant requirement, in theory, of all facets of society, including private business and public administration (Spann 1979: 508).

The second reason is that the elimination of waste quickly came to be seen as a means of maximizing the welfare of the present generation. By eliminating wastage of input resources in the economic process a 'huge deduction from goods and services' could be avoided (Hoover 1921: ix). Efficiency therefore came to be defined by economists as making the best use of resources to ensure that community well-being was maximised (Moran *et al.* 1991: 18). Thirdly, efficiency rapidly became narrowly defined as economic efficiency. The notion behind Fordist assembly line production and Frederich Taylor's time-and-motion studies was that wasted time was wasted money. The economically efficient use of resources thus became an economic imperative so that the efficient conversion and use of energy in production was considered 'scarcely less important' than the development of new resources (Pounds 1954: 122). To sum up, in modern society to be inefficient is to be fundamentally flawed and most individuals like to think of themselves as efficient (Yergin 1979: 136).

It is worth using an example at this point to indicate the extent to which this cultural phenomenon is not (yet) universal. This was demonstrated by a recent study which posited that it ought to be feasible to replace the traditional energy systems of Pacific Island communities with alternative energy systems, thereby allowing these communities to conserve energy by using energy more efficiently and increasing reliance on renewable sources of energy (Norimarna 1992: 276). To the researcher's surprise, however, it was found that this hypothesis had to be rejected, the reason being that unlike Western society where 'no one questioned why efficiency was better than inefficiency', these cultures deliberately chose to subordinate efficiency to other cultural and social goals (Norimarna 1992: 136).

There is a fourth reason why efficiency has come to be regarded as inherently good. The Progressive Conservation Movement in the early twentieth century saw the primary problem associated with resource use to be the degree to which each generation impoverished the natural resource base for following generations. Conservation was therefore seen to be a moral issue and defined as extending the availability of natural resources for use as far into the future as possible. To this end, it preached the gospel of efficiency (Hays 1959: 69). This moral dimension is discussed in relation to aggressive energy conservation in Section 3.5.

The discussion so far has been used to support the case that there is evidence that energy conservation is unchallenged as an environmental goal while energy efficiency is unchallenged as a goal within Western society.

It is important to point out that this apodictic status of energy conservation is not confined to a small group of radical environmentalists or energy conservation enthusiasts but is widely spread throughout the community. A survey designed to unravel the motives behind the take-up of energy conservation measures by Australian householders found that although a significant proportion reported taking up these measures to save money (28%) and to increase comfort (23.4%), 38.7% gave their primary reason as either their belief that saving energy was a good thing, for personal satisfaction or because it represented good housekeeping practices. Only 0.3% reported that they adopted energy conservation for the public good (Crossley *et al.* 1986: 39). While reported motives for taking up energy conservation measures are likely to shift over time as the energy or environmental situation changes, the above survey demonstrated the degree to which energy conservation is accepted as a good thing by a significant number, although still a minority, of individuals.

The following section looks at the evidence that this apodictic status of energy conservation and energy efficiency is transformed within some sections of the community into a fundamentalist belief that aggressive energy conservation is also a good idea.

3.2.3 Energy Conservation Fundamentalism

Cummine (1980: 2) admitted to having begun his study of household energy conservation in Australia as an 'energy conservation fundamentalist', a term he defined as someone who believed that energy conservation was a good idea and therefore something we cannot have enough of. Energy conservation fundamentalism has also been defined as the belief that a reduction in energy use has the capacity to solve all social and economic problems (Saddler 1981: 166) and that energy conservation has value in its own right (Harris 1982: 56). Proponents of aggressive energy conservation policies have been accused of operating from such premises (Maddox 1975: 135, Ingram 1979: 157), as have those who advocated national energy self-sufficiency policies based on grandiose renewable energy, urban redesign or coal liquifaction proposals (Taylor 1982: 122). Similarly, radical environmentalists have been accused of basing their demands for radical environmental policies on a belief that because pollution is bad and cleanliness is good, all pollution must be eliminated irrespective of costs (Wildavsky 1979: 253).

The extension of this argument is that when forced into rational debate, those operating from such a fundamentalist position selectively search for arguments that can be used to support it (Hall 1990: 82). In some instances, environmentalists have been accused of deliberately linking these demands to well known problems in order to facilitate the adoption of their proposed policies. The early attempt to link all cancers to pollution has been cited as a case in point (Maugh 1979: 1364).

The fact that some radical environmentalists or energy conservation enthusiasts hold fundamentalist or quasi-fundamentalist views is not in itself important other than to note that it is likely to result in the demands for energy conservation in some instances which are unsupported by rational argument. It is common to find such evangelistic and uncritical views creeping into attempts at more rational debate on energy issues. In his angry polemic against the Australian electricity supply industry, for example, Gilchrist (1994: 2) stated that fossil fuels ought to be conserved because they are depletable and are therefore 'precious' and referred to energy efficiency engineers as the 'high priests of technology' (Gilchrist 1994: 259). Similarly, solar energy enthusiasts have described their favoured option as 'noble' energy source (Halacy 1973:) and their work as preaching the 'solar energy gospel' (Szokolay 1984: 22). A recent Australian quest for an energy efficient refrigerator explicitly became to some a Holy Grail (Sonneborn 1994: 6), whilst high levels of energy use is compared to the apple that led to prelapsarian Adam's fall from grace (Malpas 1990: 132) and the fact that recycling and pollution reduction equipment requires energy has been interpreted as a Catch-22 so pernicious as to suggest a divine conspiracy to be at work (Jackson 1991: 5, 6).

The maximisation of energy efficiency is an especially strong theme in the literature, and is rooted in the status of the second law of thermodynamics. The eminent physicist, Eddington, once described this Second Law – capitalised to denote the reverence – as holding a special position amongst the laws of nature to the extent that exultation of the Law was not unreasonable (Hardin 1991: 49). In a statement reminiscent of Frederich Taylor's animation when confronted by the inefficient use of time in the work place (Ritzer 1993: 27), energy efficiency expert, Walter Patterson (1991: 118), admits that as a physicist he is 'deeply offended' by thermodynamically inefficient use of energy. Physicist *cum* energy efficiency guru, Amory Lovins, on the other hand is said to be driven by the panacea of an energy efficient society, while placing little importance on how such a transition is affected (Webb 1995: 35). A number of economists charge that such pursuit of energy efficiency is an end in itself, is rampant, and has had a substantial, negative, influence on policy (Brookes 1990: 390, Sutherland 1994: 257).

At this point, it needs to be stated that while there is much evidence that aggressive energy conservation is advanced at least in part from a fundamentalist perspective, modern environmentalism has no monopoly on fundamentalism within the energy debate.

Its predecessor, the early resource (Progressive) conservation movement, was pervaded by a similarly fundamentalist view which valued resources in a narrowly utilitarian manner so that unused resources were defined as wasted. Under this logic, rivers were harnessed to produce electricity on the grounds that to allow water to flow unused to the sea amounted to a crime (Martinez-Alier 1987: 163). Engineers were eulogised as the practical revolutionaries destined to manage society and were seen to be motivated by a shared dream, a vision of a just and humane society (Nye 1990: 161).

There also exists an opposite, but equally fundamentalist perspective which holds that because energy efficiency enjoys such apodictic status, there is no benefit gained from intervening in the market to accelerate the rate at which the efficiency of energy use increases. Economists base this argument on a model of the economic system which was borrowed directly from classical mechanics (Mirowski 1989). In this model, profit maximising producers are considered to interact with atomistic economic persons (formerly economic men), each acting selfishly to maximise their utility. The result, it is posited, is an optimally efficient outcome in the economic sense. As resources become more scarce, a negative feedback loop between producers and consumers automatically ensures that the market switches to less scarce resources and is therefore self-regulating. To these economists, therefore, not only is there nothing new in the notion that it is often cheaper to save a barrel of oil than to produce one, but using energy efficiently has long been an accepted economic objective of both private industry and government (Pounds 1955: 122). Because of this, such economists argue, the efficiency with which energy is used increases automatically and advocates of aggressive energy conservation are therefore advised to stop worrying and to be patient (Maddox 1975: 36). This debate between neoclassical economists and advocates of energy efficiency is taken up at further length in Chapter Four.

This section has shown that the demand for aggressive energy conservation is to some degree premised on the view that aggressive energy conservation is inherently good and that energy conservation is therefore capable of becoming a solution in search of a problem. Committed environmentalists are therefore seen by sceptics to actually desire, perhaps unconsciously, energy problems in order to legitimise their preferred policy options such as mandated solar energy hot water systems (Wildavsky 1979: 396). But while it is unnecessary to ask why policy rejects fundamentalist demands for energy conservation, advocates of energy conservation are frustrated by the apparent willingness of policy to be swayed by the alternative fundamentalist view, that of economic rationalism. It is not possible to state whether demands for aggressive energy conservation are based on fundamentalism or not and the discussion is left at this point. It has been used as a possible explanation of why the issue of energy conservation is so often confused and to point to the possibility that policy rejects the demands for aggressive energy conservation because it is interpreted as fundamentalist rather than rational.

The issue of fundamentalism is briefly revisited at the end of this chapter where alternative explanations are advanced in the light of further discussion. The discussion now turns, however, to demands for energy conservation based on the reasoned arguments for reducing energy use and begin by looking at energy conservation as an imperative.

These imperatives can be divided into those which pertain to the local level and those which relate to the global level (Goodin 1976: 149, Blowers 1984: 304) and the discussion below begins by looking at the local imperatives associated with energy production and use.

3.3 Local Imperatives for Aggressive Energy Conservation

It was argued in Section 3.2.1 that any level of energy use results in both 'goods' and 'bads'. The quintessential question is whether the benefits derived from the use of energy outweigh the costs. Holdren (1992) has argued that since the early 1970s it has been possible to postulate that the costs of energy use have been rising and may now exceed the benefits. He depicted costs and benefits of energy use to be related to the level of energy use as shown in Figure 3.2.

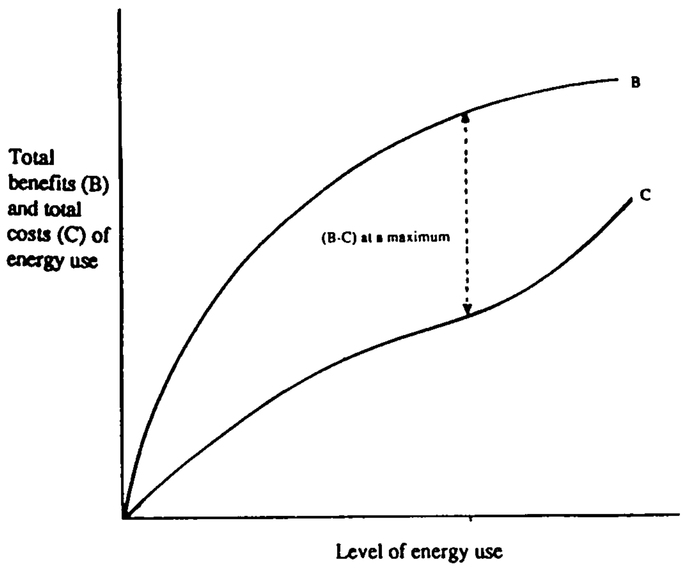

Figure 3.2 The total costs and total benefits of energy use as functions of the total level of energy use as proposed by Holdren (1992: 4).

Holdren assumed that the marginal benefits derived from the use of energy fall with increasing levels of energy use in an exponential fashion (Line A). The relationship between the costs of energy and the level of energy use, on the other hand, he assumed to be sigmoid, with the marginal costs of energy use declining as the level of energy use increased, and to then begin increasing after a certain level of energy use is reached

(Line B). At some level of energy use the slopes of the two lines are the same and the net benefits (total benefits-total costs) is at a maximum. This point Holdren took as the socially optimal level of energy use and the attempt to improve welfare by increasing the supply of energy after this point confronts the law of diminishing returns.

While the sketch graph used by Holdren provides a useful conceptual device around which discussion of energy issues can be rotated, it is nonetheless highly generalised with little empirical support that the relationship between energy use and the costs and benefits are as Holdren assumed. It therefore remains a theoretical tool rather than a practical guide for policy debate. Furthermore, there has long existed a 'rough consensus' within the energy policy debate that at the broadest level energy policy consists of balancing the two conflicting objectives of providing sufficient and reliable low-cost energy to sustain economic growth and maintain standards of living on the one hand, whilst ensuring that the non-economic costs of meeting this energy are kept at acceptably low levels on the other. Energy is not a public issue unless there is a perceived failure to meet one or the other of these broad objectives. But it has also long been recognised that 'this rough consensus ends with a bang' when the debate turns to the selection of criteria for assessing the effectiveness of policy in achieving these two goals (Katz 1971: 131).

The discussion therefore needs to begin by asking what the benefits of energy, and the imperatives behind increasing levels of energy use, are. The benefits derived from energy use can be divided into those which are derived from the personal energy use (such as convenient and rapid personal mobility, warmth, lighting, cold beer in the fridge, and so on) and those derived as a consequence of energy as an input into production (such as the generation of employment, manufactured goods the provision of public infrastructure and services). Increased energy use therefore contributes directly to increased material standard of living and to economic growth. Any demand for a policy of zero energy growth or a reduction in total energy use therefore confronts one or both of these two imperatives.

A halt or reduction in the material standard of living, to be politically acceptable, requires a change in social values and a change from below. Economic growth, on the other hand, is necessary if employment levels are to keep pace with the rise in the labour force and the increase in labour productivity. Any level of economic growth above that will contribute towards an increased standard of living, depending on how it is distributed. Low growth rates produce low interest rates and high unemployment. A growing economy, furthermore, reduces social tensions by permitting income redistribution through welfare, health and education without decreasing the wealth of the rich (Paine & McLean 1991: 10).

The question of economic growth is discussed at greater length in Section 3.4.2 where the debate over whether or not there is a need to end economic growth is taken up. At this point, however, the discussion turns to the costs associated with the production and use of energy.

Support for the argument that the costs of increased energy use outweigh the benefits involves first of all finding an agreed upon means of measuring these costs and benefits. These local costs of energy use can be divided into pollution and loss of amenity and these are discussed separately below.

3.3.1 Local Pollution

Concern over local pollution is not a recent phenomenon but has a long history (Thomas 1983, Pepper 1984, Grove 1995). Air pollution is said to have been the first major environmental issue to capture public attention and a number of theories have been advanced to explain the increased concern at the local level over air pollution in the period immediately after the second world war. The simplest is that the increase in public concern was concomitant with increased levels of air pollution and its impacts on human psychological and physical health. The effects of pollution on the respiratory system were considered to have been particularly pronounced and concerns over these effects were raised throughout industrialised countries during the 1950s and early 1960s (Herber 1965). The inadequacy of this explanation, it has been pointed out, is that in many instances the rise in public concern over pollution was in fact associated with improved air quality (Crenson 1971: 21). It has been argued that this increase in public concern therefore needs to be explained in terms of increased institutional encouragement of such concern and greater political freedom to express their concerns. This accords with the view of more recent social theorists who suggest that the protest generation of the 1960s which saw the rise of the antiwar and modern environmental movements, was a spontaneous occurrence sparked by the sudden perception by ordinary people that they had the ability to contest the power of the large organisations that had towered over them like granite monoliths, and that they had the capacity to shape public affairs (Flacks 1988). The perception dwindled and public protest over environmental issues subsided during the 1970s, according to this thesis, as those large organisations reasserted their authority.

A more complete picture involves a combination of the two views as pollution did increase and become more visible in many urban centres in the post-war period. Smog appeared for the first time in Los Angeles in the late 1940s and major air pollution episodes occurred elsewhere in the following years. In Donara, Pennsylvania, half the town's population of 14,000 became ill in 1948 as a result of air pollution, with 20 fatalities (Freeman *et al.* 1974: 179). It has been postulated these major pollution episodes resulted in a wave of policy reforms in the USA: the Clean Air Act of 1963 (amended in 1970), and the National Environmental Protection Act (NEPA) in 1969. Similarly, the London killer smogs 1952 led to the deaths of 4000 and provided the British Clean Air Society with the weapon to achieve its long-term goal in the form of the Air Act in 1954 (Kellow & Moon 1993: 238). This thesis emphasises the role of the media in drawing the public's attention to pollution incidents such as mercury poisoning in Minimata Bay in 1959, the Torrey Canyon oil spill in the English Channel in 1967, the Santa Barbara oil spill in 1968, and cadmium poisoning in Toyama in 1968.

It is well recognised that the extraction, transport, production and use of energy all result in a large number of local pollution problems. Expanding the supply of energy increases these problems and environmentalists have long held that aggressive energy conservation is a preferable alternative (Swatek 1970, Beckmann 1976, Saddler 1981).

It is possible to quantify in dollar terms many of these social costs caused by local pollution and where this has been attempted it has been shown that these can be very substantial. In the United States, for example, it has been estimated that the social and environmental costs of energy production and use are of the order of US $50 billion (Hubbard 1991), costs which have not been included in the price of energy. These more measurable costs include accelerated corrosion of capital stock such as buildings, the loss of production caused by illness and the loss of agricultural produce caused by impaired soil fertility.

Other costs are more difficult to measure. Illness is often caused by a variety of causes so that apportioning the degree to which any single source of pollution is responsible is often very difficult to determine (Holdren 1992: 32). It is even more difficult, if not impossible, to put a dollar value on other costs such as the loss of human life. Although economists have developed various means of attempting to do so, the contentious nature of such an exercise was recently demonstrated by international reaction to a report on the costs and benefits of global warming commissioned by the International Panel for Climate Change (IPCC). The authors of the report, a team of environmental economists, had based their calculations using estimates of the value of human life ranging from $1.5 million per life in the wealthiest countries to $100,000 per life in the poorest countries (Pearce 1995: 19). The authors subsequently refused to alter the report, maintaining that their methodology was scientifically correct and the attempt to have it altered was based on political correctness. While attempts to value human life at the local level are perhaps less contentious, they nonetheless remain thorny. The argument for aggressive energy conservation as a means of reducing the local costs of pollution therefore confronts an initial question of how to measure these costs.

A further problem associated with the demand that energy use be reduced in order to decrease localised impacts of pollution is that it assumes that there is a high level of public and political concern over these costs. There is, however, no transmission belt that automatically turns social issues into political issues within the public arena, or which automatically places issues of public concerns onto the political agenda (Jones 1984: 57-9, Davis *et al.* 1988: 102). While there is a popular view that problems are translated into political issues if the number of individuals affected is sufficiently large to make it difficult for politicians to ignore (Dubnick & Bardes 1983: 6), this view confuses problems with issues. *Problems* are factual phenomena unrelated to human detection. *Issues*, on the other hand, are expressed demands for government action where present government action or inaction is questioned and may be unrelated to the existence of an actual problem. Far from being politically impelled to respond to problems, however, problems associated with energy use may remain undetected, or may attract little public interest once detected. Not all social problems are acted upon and it often seems to take disasters to prod the political process into corrective action (Anderson *et al.* 1984: 7, Self 1993: 265). Issues which bear little relationship to genuine problems, on the other hand, may suddenly flare up and even if they do attract significant public attention, may not provoke a political response. This, according to Schattschneider (1960: 12), is because the policy universe is finite and issues have to compete for space within it. A model most commonly used to explain whether an issue makes it onto the political agenda or not is the pluralist model of decision making.

The most commonly cited pluralist model of the process of conversion of public issues to political problems is probably that advanced by Downes (1972). To Downes, issues do not get onto the political agenda unless they generate sufficient public support and, furthermore, should they make it onto the political agenda, require prompt attention before they are forced off the agenda again by the arrival of new issues. In Downes' model, many social issues have half-lives and go through a conveyor-belt like issue-attention cycle in which they are pushed onto the agenda by public concern, but once there, are soon eclipsed as public attention shifts to new issues. Policy interest in the original issue gradually fades as public attention to the issue declines, and the issue eventually slips off the policy agenda and into limbo. Public interest in the issue, nonetheless, may remain at a higher level than it was before the initial problem was identified. If this decline in public interest occurred before the problem was adequately dealt with at the policy level, the issue may drop off the policy agenda without being adequately resolved.

An example of such an issue that has had trouble attracting public attention, according to Kellow (1990: 173), has been soil degradation. Although identified as perhaps Australia's most serious environmental problem, soil degradation's low 'sex appeal' as an issue, Kellow argued, rendered it difficult to attract political support for policies aimed at addressing it. Many writers have suggested that the failure to attract public interest to energy-related issues is a consequence of the pedestrian nature of these issues. Even during the second oil crisis in the USA, energy was said to be a subject that put people to sleep (Anonymous 1979: 14). Two anecdotes provide useful means of illustrating that the same is true in contemporary Australia.

The first incident involved the compère of the ABC Radio National's *Drive* programme (Radio National, 3 Nov. 1994) introducing a debate between Dr Mark Diesendorf and Professor Peter Forsyth on the restructuring of the electricity supply industry in Australia, with the comment that although it was an issue guaranteed to leave most listeners glassy-eyed and reaching for their radio dials within minutes, a small number of individuals actually followed the debate. The second anecdote involved a similar comment by the compère of the ABC's *Late Night Live,* Phillip Adams (ABC Radio National, 30 Aug. 1994). Introducing a debate on the Australian government's policy response to greenhouse gas emissions between Dr. Mark Diesendorf (from the Australian National University and Vice President of the Sustainable Energy Industries Council of Australia), Dr Tony Beck (Business Council of Australia) and Gavin Gilchrist (environmental and science journalist with Sydney Morning Herald), Adams apologised to the listener for devoting time to such a boring subject, but quickly added that accusations of a conspiracy on the part of government and industry to undermine Australia's international commitment to reducing greenhouse gas emissions (Gilchrist 1995: 1, 4) had given what was an otherwise mundane topic an interesting twist.

These anecdotes support the argument that some issues fail to find their way onto the political agenda because of low public interest despite the assertion by environmentalists and others that energy-related problems are many and serious. In this regard, energy conservation is a doubly incapacitated option as not only do people find energy issues inherently stuffy, but as a solution to energy-related problems, energy conservation appears to be perceived as *jejuné.* As one writer on the topic bluntly put it, the concrete details of energy conservation are worse than inconvenient: they are boring (Nivola 1986: 6).

The implication is that while environmentalists have consistently advanced aggressive energy conservation as a means of reducing local problems associated with energy use, these problems often fail to be translated into issues and attract low public support. Concern over damage to public health or loss of amenity caused by energy supply expansion, moreover, is likely to reflect the way in which these 'bads' are distributed and on which members of society they impact most heavily. Those whose health is directly at risk from such pollution or whose amenity is impaired by supply expansion programmes are likely to exhibit the greatest levels of concern (Blowers 1984: 305) as people are most concerned with that which immediately effects them. It is maintained by some writers that governments do not respond to pollution problems unless they impact directly on human health (Hall 1992: 82).

There is, however, a long history of such public concern over local pollution (Paehlke 1989: 35-7, Adams 1990: 30-3, Switzer 1994: 3-7) and they are not routinely ignored. Policy makers have taken action to reduce pollution, including the banning of the use of coal within city boundaries, regulation of permissible levels of emissions, the imposition of pollution taxes and the mandating of pollution control equipment. Pollution abatement, however, has tended to rely predominantly on technological and other solutions rather than reducing the level of energy use. Why policy makers rely on these technological solutions, given the derogatory term 'technical fixes' by critics of these solutions, is therefore important as much of the environmentalist demand for aggressive energy conservation is based on dissatisfaction with this approach to resolving energy-related problems. Four different types of technological solutions are described below.

(i) Taller chimney stacks or relocation of energy supply plant

The most simple strategy of reducing the local impacts of pollution caused by the production or conversion of energy is to spread them more diffusely or further afield, thereby removing the 'political problem' but not the emissions. This can be done by re-siting the source of the pollution away from urban areas or building taller chimney stacks. While it may result in damage to the non-urban environments such as wetland ecosystems, or lead to transboundary problems such as reduced soil fertility and forest destruction as in the case of acid rain, these costs have often failed to become political issues unless new and significant problems begin to emerge. Where these problems are transboundary in nature, their resolution, furthermore, has had to rely on the often tortuous process of multilateral negotiations.

(ii) End-of-pipe fixes

End-of-pipe technical fixes such as flue scrubbers and electrostatic precipitators that remove particles and certain gases from emissions from fossil fuel in order to reduce the levels of pollution are a popular technical fix strategy. It is said to have been to date the most favoured response of policy to pollution problems (Jänike 1990: 55). It is also a multi-billion dollar industry dominated at the international level by the German engineering and energy production firm, Siemens (van Lersner 1995: 153).

(iii) Technological innovation which improves existing technology

A third strategy involves technological innovation to render existing technology less polluting. Cleaner coal burning technologies such as pressurised fluidised bed combustion (Pillai 1989) and coke filters (Coghlan 1991), for example, reduce the emissions of sulphur dioxide, nitrogen oxides and particulates. While it is possible to remove carbon dioxide from emissions, it is a costly process and does not overcome the problem of what to do with the carbon dioxide once it is removed.

(iv) Technological innovation which produces new technologies
Technological innovation to produce and commercialise less polluting energy conversion and supply technology continues to be a major strategy used to reduce the impacts of local pollution from energy production and use and are often spin-offs from other areas. The use of nuclear-fission as a means of producing electricity, for example, evolved from military use of the technology, while solar photovoltaic cells were commercialised from the space program. Fuel cells are the most recent attempt at such commercialisation and have been predicted to become the basis of a (AUS1994)$150 to $200 million industry in Australia by soon after the turn of the century (Kestigan 1994). It has been suggested that foremost amongst technical innovations leading to an improved environment in the coming decades will be those in the field of energy generation and conversion (van Lersner 1995: 153).

The reduction of energy use as a means of reducing the impacts of use therefore competes with these four technical fix strategies. To understand why technical fixes are preferred as a means of resolving energy-related problems, they need to be compared with political, economic and social solutions to these problems.

The first of these, the political approach, involves obtaining independent policy advice and increased public participation in decision making which could see energy conservation mandated as an alternative to supply expansion. The demand for such political solutions tends to be driven by public mistrust of organisational decision making procedures and the perceived insensitivity of bureaucracies, technical élites and profit making firms to public needs. It is an approach that is resisted by those who control energy policy and energy decision making and by those who benefit from present arrangements. Governments, moreover, are often reluctant to base public policy on irrational and uninformed public opinion, considering that the issues are too complex and important to be left to nonexpert decision making bodies.

The social approach to resolving energy-related problems, on the other hand, involves the attempt to alter behaviour by changing beliefs and attitudes. This can be achieved using prompts, moral suasion or the provision of information about the nature of energy-related problems and what the individual can do to reduce energy use. While these approaches are politically palatable, their capacity to result in substantial changes in energy use is limited.

Economic strategies involve the use of penalties, incentives and increased energy prices to increase the efficiency of energy production, distribution and use. The problem with this approach, from the political perspective, is that neither energy producers, business or the public will accept this approach if it involves significant increases in the costs of energy or taxes. The attempt by the Conservative government in the U.K. to increase the price of electricity in the U.K. in July 1992 through the introduction of a 17% value added tax (VAT), to be phased in over two years, encountered massive public opposition. The bill was defeated and the government embarrassed when several Conservative politicians crossed the floor and voted against it. The strategy of reducing energy use by increasing prices can also be socially regressive if the price increase is not accompanied with increased transfer payments to those who can least afford to pay more for their energy. Although welfare economists maintain that increasing the price of energy whilst increasing welfare payments to the needy is a far more efficient means of allocating energy than the strategy of providing all users with cheap energy, the risk for low income earners is that these welfare transfers will be reduced over time with the inevitable budget cut backs (Nivola 1986: 13). Incentives to increase the efficiency of energy use, on the other hand, may amount to cross-subsidisation of these high income groups with the financial capacity to take advantages of the incentive programmes.

Technological solutions, on the other hand, rely on engineering expertise to solve energy-related problems and represent a well-established and a politically favoured response to such problems because research and development of technological innovations are strategies with low impacts on individual groups (Hughes *et al.* 1985: 65). They are considered unlikely to arouse emotional commitment one way or the other and therefore enjoy widespread support. The technological strategy therefore tends to be favoured over other strategies which involve exhorting, encouraging, enticing or enforcing reductions in energy use. The other strategies tend to be relied on only when such technical fixes are unavailable or unacceptable.

The environmentalist critique of the 'technical fix' approach, however, is that many technical fixes do not solve the problem at hand but merely shift it elsewhere, or worse, result in the creation of unanticipated problems which can be greater than the initial problem it was intended to resolve. The Aswan Dam has traditionally been cited as the classic case of a technological solution that went wrong and which resulted in massive social, economic and environmental problems (Sandbach 1980: 161). The production of CFCs has become another example of a technological solution with inadvertent consequences. The technology which has become environmentalists *bêté noir*, however, is nuclear fission (Goodin 1992: 161). Not only have environmentalists seen it as the technical fix *par excellence* (Ehrlich & Holdren 1971: 1212) but as the most blatant example of 'reverse adoption' - the deployment of a technology on a commercial scale before the problems associated with it have been resolved. Rather than unanticipated, nuclear power is considered by environmental writers to amount to certain risks in abeyance (Sandbach 1980: 154, Beck 1992: 26). The debate over the risks to public health from nuclear power stations is highly germane to the attempt to explain why policy makers have tended to favour the expansion of supply over the reduction of demand and it is therefore worth concluding this section on local pollution and risks to public health by briefly looking at why policy has relied on this technology and the extent to which it is likely to do so in the future.

The debate over the impacts of nuclear power on human safety and health

Ironically, commercialisation of nuclear fission was motivated in part by the need to overcome public concern associated with pollution created by fossil-fuelled power stations (Spinrad 1973: 183).

Debate over the risks of nuclear energy on human safety and health is characterised by extreme polarisation with various claims and counter-claims so conflicting that it has become a dialectical engagement in which environmentalists attempt to maximise the risks associated with nuclear power while the nuclear lobby attempts to minimise those risks. Environmentalists are accused of using statistics that do not stand up to serious investigation (Petroll 1990: 36), while the industry and governments are accused of being secretive and failing to disclose information on the full impacts of nuclear leakages and accidents. Environmentalists maximise the risks by making holistic assessments which include the risks associated with mining, short and long-term waste storage, terrorist attacks, nuclear proliferation, increased nuclear capacity of rogue nations, and routine radiation leakages as well as major reactor accidents. They are also based on lay assessments of risks which rely on crude rules of thumb and which give greater weight to low probability events with large impacts - such as a nuclear accident - than to constant low level damage - such as that caused by pollution from coal-fired power stations. The risks of a nuclear accident are therefore consistently likened by environmentalists and large sections of the public to those associated with nuclear war (Krupnick *et al.* 1993: 15). The probabilistic assessments of nuclear experts, on the other hand, consistently rate the risks associated with nuclear energy as trivial and small in comparison to those associated with other energy supply technologies such as coal-fired power stations (Beckerman 1975: 75). Experts from the nuclear industry describe their own assessments to be scientific and objective while lay assessments are described as subjective and ill-informed. Such experts consider environmentalist opposition to nuclear power to be even less rational than lay assessments and maintain that it is based on fear of large and complex technologies rather than objective science (Douglas & Wildavsky 1983: 53, Brenton 1994: 117). The nuclear issue is in fact said to be unique in that it is the only environmental issue for which the environmentalists do not have the majority support of the relevant scientific community (Brenton 1994: 115).

Economists have recently suggested that the distinction between lay and expert risks can be accommodated into economic cost benefit analysis. This can be done, it has been argued, by calculating the social costs of nuclear energy on the basis of the psychological anxiety caused by the *perceived* rather than on *objective* assessments of physical damage resulting from a reactor accident. Since people assess the risks of multiple fatalities from disasters differently from individual fatalities, a multiple fatality factor would also have to be included in social costs. The social costs associated with a nuclear accident in the U.K., for example, has been estimated to be approximately 0.000025 c/kWh if based on expert objective risk assessments, but approximately 0.5 c/kWh if based on lay perceptions of risk with a disaster aversion factor included (Pearce 1995: 32). While these assessments are based on many disputable assumptions, including the assumption that each human life is worth $4 million, they do serve to indicate the large difference between expert and lay risk assessments. The usefulness of such attempts to quantify perceived risks of nuclear disasters, however, would only be credible if the perceived risks of disasters associated with gas and petrol storage depots, hydro-electric dams and coal mines were calculated in the same way.

It has been pointed out, however, that lay assessments of the risks associated with nuclear power may not be as subjective and irrational, and expert assessments not quite as objective and accurate, as they at first appear. Expert assessments not only assume that the impacts of radiation on human health are well understood but can omit risks too difficult to quantify such as the probability of human error, material deterioration, failure at the human-mechanical interface, the variability of weather or unanticipated problems during evacuation (Krupnick *et al.* 1993: 17). Lack of consensus, moreover, characterises the debate between expert level with ongoing dispute over the comparative risks of nuclear energy and coal-fired power stations. Analysts who estimate the social costs associated with nuclear energy to be higher than those associated with the use of fossil fuels (Ottinger *et al.* 1990) are contradicted by those who arrive at the opposite conclusion (Hohmeyer 1990, 1992). It has also been found that chemical engineers are less willing to live near nuclear power plants than are nuclear engineers, while nuclear engineers are less willing to live near coal-fired power plants than are chemical engineers, indicating that irrationality due to lack of familiarity operates also at the expert level (Krupnick *et al.* 1993: 17).

The actual level of public support for, or opposition to, increased reliance on nuclear energy is difficult to gauge as both sides of the debate have misused opinion polls to further their cause. Public concern over the risks associated with nuclear energy however, began very early. Although the fire at the Windscale nuclear station in England in 1957 had little immediate impact on public opinion in that country, public opposition succeeded in blocking construction of a nuclear power station within the New York city limits in 1962, giving the anti-nuclear movement an initial impetus (Maddox 1972: 12). Public controversy over nuclear power stations subsided in the USA, however, after the Atomic Energy Commission tightened standards on routine low-level radiation releases (Freeman *et al.* 1974: 178-9). The debate did not pick up again until the mid to late 1970s when the anti-nuclear movement's attention turned to the issues of reactor safety, terrorist theft of fissile material and scepticism over the ability of institutions to manage the long-term problems of reactor decommissioning and waste storage.

The Three Mile Island incident in Pennsylvania in 1979 was pivotal and damaged public confidence in nuclear power in the USA (Pfaltzgraff 1980). It also led to moratoria on further construction of nuclear power plants in a number of countries, beginning with Sweden in 1980 (Lucas 1988: 56). Nonetheless, majority public opinion continued to support expansion of the nuclear energy in those countries with nuclear capacity, but was opposed to the introduction of nuclear power in those countries or states without nuclear generating capacity. In countries such as France and Japan, moreover, the industry continued to 'boom with self-confidence' despite the fact that thousands of riot police were required to quell demonstrators at public hearings over proposals to construct new reactors (Anderson 1984: 357). Despite the view of sober writers that a nuclear catastrophe was almost certain (Sandbach 1980: 157), more Europeans were said to be in favour of nuclear power than were opposed to it. Even some strong advocates of energy conservation in the USA argued against total abandonment of nuclear power technology as it may be needed if the environmental problems associated with fossil fuels prove to be intractable. John Gibbons, co-author of the highly popular book *Energy: the Conservation Revolution*, for example, argued that it would be prudent to rely on nuclear energy to meet a portion of the country's energy needs, even if the price of this nuclear energy was 20% above that of energy produced from coal (Gibbons 1985: 10).

The nuclear industry in the USA, however, was beset by many problems. No new reactors were ordered after 1978 and many orders were cancelled (Pfaltzgraff 1980: 67, Ableson 1987: 73), although construction or planning of nuclear reactors continued with 14.8 GWav of nuclear power capacity under construction at the end of 1987 (Ahearne 1989: Appendix 1, Table 10). A primary cause of the slowdown was the combination of excess generating capacity and declining demand for electricity, added to which were the increasing costs of construction, caused by management and operational problems, and which increased interest rates and led to cost over-runs (Andrews 1990). Delays caused by public opposition to nuclear construction added further to costs. An abundance of coal in many areas of the USA (Ableson 1987: 73) and a shift to smaller gas-fired generating technology as a means of reducing the risks associated with supply expansion further undermined the ability of nuclear industry to compete. In the wake of the Chernobyl accident in 1986, furthermore, it became clear that increased reliance on nuclear fission was unlikely to occur in that USA without a resurgence of broad public and political support (Ahearne 1989: 49).

There is little doubt that the Chernobyl accident in 1986 led to a marked swing in public opinion against nuclear power (European Community 1987: 6, Nuclear Energy Agency 1991: 9). The relevant question now, in the wake of the Chernobyl accident, is to what degree aggressive energy conservation will be pursued rather than increased reliance on nuclear energy? Opponents of nuclear power have interpreted the accident as the last and most devastating in a series of incidents and disclosures about the health hazards of nuclear power, and as so horrendous in terms of damage to human life and health that the industry's credibility was unlikely to recover (Shcherbak 1996) and saw its future to be in serious doubt (Thomas & Berkhout 1992). Proponents of nuclear energy, on the other hand, have claimed that the impacts of the accident have been blown out of all proportion (Brenton 1994: 117). Radiation fallout from the Chernobyl accident on the European Community is estimated to increase the number of thyroid cancers in Europe by about 0.6%, and all cancers by 0.003% over the next half century (European Community 1987: 7). The total damage caused by the Chernobyl accident has been described as far less than that inflicted by other causes of death such as the emissions from coal-fired power stations, vehicle accidents, coal mining or cigarettes which amount in combination to 'thousands of Chernobyls a day' (Lovelock 1988: 173). Nuclear fission technology's most serious problem, its proponents insist, is not public safety or waste disposal but a false public perception of the magnitude and intractability of these problems and the failure of the public to recognise it as both a 'rational choice' and an environmentally acceptable technology (Benarde 1992: 278).

Incidentally, the Chernobyl accident was followed closely by a significant increase in international concern over the ecological and social impacts of heavy reliance of fossil-fuel use and the risks of climatic change caused by increased concentrations of atmospheric greenhouse gases in particular. Proponents of nuclear fission saw in the greenhouse issue the potential to resurrect the industry from its crisis and factions of the environmental movement begrudgingly and cautiously re-examined the nuclear option (Ahearne 1989: 12). Environmental academics abandoned caution and advocated rapid acceleration of nuclear construction as the means of overcoming the greenhouse problem (Benarde 1992: 278). Proponents of nuclear energy did not dispute that unsafe nuclear reactors do exist, especially in Russia, Eastern Europe and most likely also in North Korea and China, and maintained that these reactors should be shutdown as the risk of another Chernobyl is high. They maintained, however, that the fact that reactors in the communist and former communist-bloc countries are unsafe does not amount to an argument against nuclear technology *per se* and that reactors used in the West are far safer and are a vast improvement on coal-fired technologies from the perspectives of both human safety and health and the environment (Gray 1993: 154, Hawley 1995: 96).

The industry's optimism has been buoyed, furthermore, by the fact that public rejection of nuclear power by the public has not been as complete as many environmental writers have contended. A number of referenda in many states in the USA, for example, failed to adopt moratoria on further construction of nuclear plants (Miller 1991: 87). Opinion polls in Finland indicated that apart from the few months immediately after the Chernobyl accident, public support for expansion of nuclear power in that country remained higher than support for expansion supply produced from fossil fuel plants (Silvennoinen 1991: 504).

The nuclear industry, moreover, is pushing on with the design of smaller reactors with passive safety features, such as the PIUS and Geyser reactors, in the hope that public acceptance of the technology can be regained. Although not inherently safe, these new reactor designs are claimed to substantially reduce the risks associated with nuclear fission technology (Holdren 1992b: 27). The nuclear industry's aim, therefore, is not so much to persuade environmentalists and the public to believe that nuclear fission reactors *are* safe but that they *can* be safe (Ahearne 1989: 41). In the meanwhile, the industry will continue to survive by selling reactors to developing countries such as Indonesia, despite the claims by environmentalists that such countries could meet their energy requirements more cheaply by increasing the efficiency of energy use (Keepin & Kats 1988: 541).

The environmentalist argument used to counter the resurgence of interest in nuclear energy is that even if new nuclear reactor designs are safer than the older versions, aggressive energy conservation is an inherently less risky strategy than either fission of fossil fuel technologies: energy conservation cannot produce a Chernobyl-like catastrophe (Cairncross 1993: 111). The assumption that energy conservation is a zero risk strategy, however, has been challenged. The use of urea formaldehyde foam thermal insulation in the early 1980s, for example, resulted in increased incidence of cancers while the rapid shift to wood heaters led to increased deaths from house fires. Had these increased fatalities and illness been caused instead by a nuclear accident, it has been charged, there would have been a public furore (Frieden & Baker 1983b: 445).

The point that the above discussion makes is that despite the many problems associated with the environmentalists most dreaded technical fix option, nuclear fission, the degree to which the public and policy makers are likely to rely on aggressive energy conservation rather than expansion of nuclear energy is not yet clear. Apart from the risks of routine low level radiation emissions and reactor accidents, the industry will have to convince its critics that the problems associated with the storage of nuclear wastes and decommissioning of nuclear reactors can be satisfactorily resolved. Although public opinion has forced governments to scale down, cancel or find alternatives to increased reliance on nuclear energy, this impact has been variable, the success of public opposition being determined largely by the political structure. Public access to courts as a means of questioning the siting of nuclear facilities has been particularly instrumental in those countries such as the USA where governments have been forced to find alternatives to expansion of reliance on nuclear energy, including increased reliance on energy conservation (Rudig 1990). Support for the industry, furthermore, remains higher than many environmentalists have suggested and the assumption that aggressive energy conservation will automatically become a more politically likely option than supply expansion based on nuclear technology is one that needs to be treated with caution. It is probable, however, that another major reactor accident would fatally damage public confidence in the entire industry, and at a minimum force the closure of all nuclear plants of that type (Krupnick *et al.* 1993: 21).

Others consider that even without another accident, the industry is likely to be phased out on the basis of its economic rather than its social and environmental costs. It is commonly maintained by critics of the industry that nowhere has a nuclear plant been installed and operated without substantial public subsidy (Dryzek 1987: 111). Although it has been vehemently denied that nuclear energy has been subsidised from the public purse in France (Carle 1995: 42), the commercial reforms of the U.K. electricity industry revealed the extent of the subsidies in that country and many now express doubts that the U.K. industry can recover from its economic malaise (Rossin 1990: 171).

Health effects of Electromagnetic Radiation

A second and more recent argument for energy conservation has been based on concern over perceived risks to human health from long-term exposure to low levels of electromagnetic radiation, and radiation associated with high voltage power lines in particular.

Public concern over the health effects of long-term exposure to low levels of electromagnetic radiation have increased in recent years. The value of real estate close to high voltage power lines in Australia has dropped from between 5 and 20 percent and many buyers rejecting such homes outright (*The Property Age* 17 April 1996: 3). These concerns have led in some instances to proposals of aggressive energy conservation as an alternative to the need for construction of new power lines (Gibbs 1991), but which have met with limited success to date. They have been dismissed on three counts: (i) that public concern over the health impacts of high voltage power lines is irrational as they are as yet unproven (although not disproved), (ii) that even if proved to be correct the problems caused by such radiation are not likely to be great, and (iii) that the radiation exposure from household appliances and wiring is probably greater in most situations than those from high voltage power lines. The conflicting debate is likely to be protracted for two reasons. First, the epidemiological research required to prove or refute the various claims encounters many problems, not the least of which is finding a suitable control group and knowledge of life histories of exposures to such radiation from various sources. The research to date has therefore tended to be inconclusive. Secondly, if it were established that low levels of electromagnetic radiation do pose a serious threat to public health, it would require fundamental changes to the way in which energy is supplied and delivered (Johnson & Rix 1991: 53-5). The economic implications of this are so substantial that resistance to the need for change without conclusive evidence is guaranteed. Assessment of the health impacts of electromagnetic radiation from high voltage power lines is therefore unlikely to be resolved for some time but until then it is likely that the demand for aggressive energy conservation as a means of reducing these unknown impacts will remain relatively weak.

So far the arguments behind the demands for aggressive energy conservation as a means of addressing public concerns over pollution from energy production and supply, and the reasons why policy makers tend to rely on other solutions to problems, including technical fixes and commercialisation of new technologies, have been examined At this point, the discussion turns to arguments for energy conservation based on the impacts of energy supply infrastructure on amenity, as these issues have often proven less amenable to resolution through technical fixes and have frequently been at the centre of considerable public conflict over energy policy and planning.

3.3.2 Amenity

The production and use of energy frequently impacts on amenity such as the visual impacts on the landscape or the loss of wilderness areas. Many of the arguments above relating to the difficulty of advancing aggressive energy conservation as an energy option to avoid or reduce pollution pertain equally to the issue of amenity. While the debates over the loss of amenity are simplified by the absence of complex assessment of risks to public health, they do share with the pollution issue the problem of measuring the 'bads'.

Environmentalists are often supported in their campaigns against the construction of infrastructure associated with increased energy supply where this impacts on amenity by strong local middle class support arising from a NIMBY (not-in-my-back-yard) or LULU (locally-unwanted-land-uses) syndrome (Blowers 1984: 305). The siting of high voltage power lines, for example, is now the greatest constraint on increasing energy supply in the USA (Grubb *et al.* 1992: 20) and has increasingly become an issue in the Australian context (Natural Resources and Environment Committee 1988: 73). It has recently been shown to have the potential to become the major political obstacle to planned <u>interconnection</u> of the grids of the eastern and southeastern Australian states, the Eastlink proposal between New South Wales and Queensland having developed into a decisive election issue during the 1995 Queensland State election. Opponents of the Eastlink project have argued that it will encourage the use of energy and that the need for the interconnection could be avoided by an aggressive energy conservation policy. The Queensland Labor government was unconvinced and remained committed to the project. This played a decisive role in the government's eventual loss at the polls and the incoming Liberal government quickly floated the idea of a technical fix solution - a submarine cable - as a means of taking the heat out of the issue. It finally appeared as if the idea of interconnection would be jettisoned and that Queensland would build a new coal-fired power station as an alternative means of meeting future requirements.

Energy supply developments which have generated the greatest public opposition, however, have often been those involving the construction of hydro-electric dams. The loss of wilderness, despoliation of areas of natural beauty, and displacement of human settlements caused by hydro-electric projects has often led to greater public opposition than that generated by proposals to construct nuclear power stations (Grubb *et al.* 1992: 20, Brenton 1994: 117). The moratorium on further hydro-electric development in Sweden, for example, predated by a number of years a similar moratorium on further construction of nuclear power in that country (Cairncross 1993: 111). Notable preservationists have argued, further, that if given a choice between the construction of renewable energy systems such as wind farms in areas of scenic value on the one hand, or nuclear energy in non-scenic areas on the other, their preference would be for the latter option (Nash 1979: 26).

Where energy supply expansion has impacted on amenity, public opposition has often been substantial. One reason for this is that unlike the case of pollution, policy has fewer means of resolving these amenity issues. Re-routing proposed power lines, for example, does not solve the problem as it leads to similar problems elsewhere so that the only real strategy available is to compensate landowners for the reduction in the value of their properties caused by such construction. In the USA the issue has become more problematical as those affected have greater ability to mount legal challenges to such planned development. In other situations, such as hydro-electric construction, the only strategies available to policy makers are to re-site the project, to abandon the project and resort to alternative means of expanding the supply of energy, or to adopt a policy of aggressive energy conservation. To succeed in halting energy development projects, public pressure has had to be very substantial. Despite massive public opposition to the construction of a hydro-electric scheme in Tasmania, as discussed in Chapter 5, for example, construction of the dam was not halted until the Federal government intervened. One of the major difficulties faced by such public campaigns is the failure to have many of the 'bads' factored into the project's cost-benefit appraisal.

While owners of land over which high voltage power lines are constructed can be compensated according to the reduction in the property values, the broader public is not compensated for the reduction in aesthetic value to the landscape. With hydro-electric dam construction, the costs in terms of the loss of production caused by the loss of land can be calculated, while the loss of wilderness, or the loss of species of fauna and flora, are not - and cannot - be assigned dollar values and are therefore omitted from the analysis. Environmentalists who oppose such developments are constrained in terms of the type of concerns they are able to bring to the negotiating table as the terms of reference for such negotiations are set not by themselves but by policy makers. Many of the issues most important to them are ruled out as illegitimate and are omitted from the debate (Socolow 1981: 152).

This takes the present discussion back to the issue of 'fundamentalism', in that it is plausible that what is interpreted as a fundamentalist demand for aggressive energy conservation is, at least in part, a product of the inability to advance as arguments for such a policy many things which individuals care most about.

3.3.3 Local Resource Depletion

At the local level, the issue of resource depletion can collide with other issues such as amenity, as when the availability of potential hydro-electric sites outside of wilderness areas are exhausted or when the only remaining coal resources are close to urban settlements. Local depletion issues can also impinge on values such as species conservation. In the Indian province of Kutch, for example, a wildlife sanctuary was halved in size in 1993 to allow for mining of lignite and other minerals, followed in 1995 by the removal of a ban on mining from 40% of the remaining reserve (Kumar 1995). In Australia there have been persistent calls for governments to allow mining in National Parks and although public pressure has prevented such policies being implemented to date, it provides another example of the difficulty of placing values on some of the local costs associated with the production and use of energy .

To conclude this section on local problems associated with energy production and use, it can be stated that although many such problems exist and are often substantial, in only a relatively small number of instances, such parts of the USA and in California in particular, has this led to substantial emphasis on reducing the use of energy as opposed to other solutions or nonsolutions. In many instances, moreover, these problems have not been sufficient to generate public support for aggressive energy conservation. Although specific projects have been halted by public concerns, policy has deployed a range of strategies aimed at reducing the public concern whilst maintaining a policy of expanding the supply of energy. Many of these strategies have displaced the problem in time and place producing problems elsewhere, including transboundary and global problems. It is to these problems that the discussion now turns.

3.4 Global Imperatives

At the global perspective, the two dominant themes of environmentalism have been depletion and pollution (Paehlke 1989: 21). In this section, these global arguments are discussed using a historical perspective in order to show the way in which the themes behind the call for aggressive energy conservation have developed, changed and merged over time. Many contemporary commentators on the issue of energy suggest that energy was not a policy concern until the 1973 'oil shock' led to a fundamental shift in thinking on energy (Crossley 1980a: 363, Saddler 1994: 55). This largely ahistorical approach ignores the overlapping themes that have fuelled the debate over energy and the environment over time and which continue to have a strong bearing on the current debate. The following discussion is developed by taking each theme separately in an attempt to show how the ideas behind aggressive energy conservation and the debate has shifted to become more complex over time.

3.4.1 Global Resource Depletion

At the heart of resource depletion concerns has been the simple axiom that the capacity of a finite planet to provide resources is limited, and secondly, on the simple calculus that the demand for resources is the product of population level and per capita resource use. As the population increases, so too does resource use, a situation which is logically unsustainable as it will ultimately confront these physical resource limits. At a general level, these arguments are intuitively and qualitatively irrefutable and the real debate has been over how close we are to those limits. Moreover, the combination of a geometrically (exponential) increasing population combined with increasing per capita resource use means that society approaches these limits at an accelerating rate, resulting in the exacerbation of concerns over resource scarcity. Such a situation occurred for the first time with the onset of the Industrial Revolution and sparked a debate between pessimists and optimists that has been with us ever since (Kennedy 1993: 5-6).

The first in the 'pessimistic' line of thinkers and the father of quantitative world modelling was the British economist, Thomas Malthus. The thesis of his occasional polemic aimed at his contemporary utopian writers was that food production increased arithmetically (linearly) while human population increased geometrically so that the latter would inevitably outstrip the capacity of the land to produce the food and therefore result in starvation, disease, an increasingly inequitable society and social collapse (Malthus 1798: 70). While the evil day could be put off, the ultimate and unavoidable fate of society was to 'end in shallows and miseries' (Malthus 1798: 112). Malthus' intention was to counter the growing belief of the times in universal progress and prosperity. His book stimulated a ferocious debate that lasted about thirty years. By the end of his life, however, the Rev. Malthus began to have reservations about his own pessimistic thesis as anthropological evidence suggested that primitive societies did not increase in numbers to the point of starvation (Roberts 1987: 103).

The British economist, Jevons (1865), a follower of Malthus, was the first to extend this Malthusian logic to energy when he predicted the demise of Britain as an industrial power once its coal resources were depleted. While other countries lived on their income, Britain, he warned, lived on its capital which would not yield interest because once turned into heat, light or power it disappeared forever into space. Jevons, however, did not advocate eking out coal for as long as possible but accelerated production of wealth (Jevons 1865: 460). Half a century later, the chemist Sir William Ramsay repeated this warning of imminent coal shortages, thereby triggering a search for new energy sources in the U.K. said to be so intensive that no suggestion for harnessing energy, which included wind, solar, ocean and tidal energy systems, was considered too wild to be rejected (Fuchs 1946: 398).

A second idea brought to the depletion debate was that of thermodynamics. To nineteenth century authorities on thermodynamics such as Henry Adams, the availability of low entropy resources was society's critical problem. These economists with a background in physics or the physical sciences claimed that the neoclassical model of the economy as a merry-go-round between producers and consumers was deficient as it failed to take account of the critical thermodynamic role of energy in industrial economic production. They developed their own model, based on extrapolation from the steam engine, in which the economy was portrayed as a one-way, entropy-increasing engine (Martinez-Alier 1987: 127-48). The system was fuelled by a finite reservoir of low entropy natural resources which, once depleted, would mean that modern civilisation would come to an end as abruptly as 'an organ deprived of wind' (Soddy 1928: 12). Economic growth *ad infinitum* based on non-renewable resources was therefore as mythical as a perpetual motion machine. Furthermore, the exhaustion of low entropy resources and their substitution with higher entropy resources would necessarily increase the costs of economic production. The economic maladies of the times were cited as evidence that this process was well advanced (Martinez-Alier 1987: 135).

The primary locus of this resource conservation debate shifted to the USA where the Progressive Conservation Movement championed the wise use of resources via efficient use. While the Movement's initial concern in the late nineteenth century focused on an anticipated timber famine, the Movement quickly extended its concerns to other renewable and non-renewable resources including oil, coal and strategic minerals (Nolan 1958: 50-1). As more deposits of these resources were found over the ensuing decades, anxiety over resource exhaustion gradually subsided, and by 1909 the Movement had temporarily gone into limbo (Rose 1965: 8).

The issue of resource shortages re-emerged after the first world war, principally in relation to the declining self-sufficiency in oil and especially in the USA. The 'expert' consensus amongst geophysicists was that oil imports would need to rise rapidly in the very near term and the question over the degree of oil self-sufficiency became a national preoccupation, generated considerable anxiety within the automobile manufacturing industry, and sparked a move to nationalise the oil industry (Fuchs 1946: 228). The dramatic increase in US oil production in the post-war period, according to Fuchs (1946: 228-9), led most geophysicists to abandon their attempts to estimate how much oil remained undiscovered. One geophysicist who persisted in making such estimates was M. King Hubbert.

The rapid rise in rates of population growth and resource use, and especially oil, in the period after the second world war rekindled the attempt to assess the longevity of fossil fuel resources. M.K. Hubbert was a geophysicist and former 'guiding light' of the small and short-lived Technocracy Inc. movement that emerged in the USA in the early 1930s, and which predicted, among other things, the apocalyptic collapse of the capitalist economic system (Martinez-Alier 1987: 144). He turned his attention in the post-war era to non-renewable energy resources and, using simple bell-shaped resource depletion curves, attempted to estimate the portion of a resource remaining at any one stage in the course of its exploitation. The resultant geological perspective was that industrial society's emancipation from sole dependence on solar energy through the use of fossil fuel represented an unrepeatable "pip" or moment in the total history of time. From this, he concluded, industrial society's position was clearly 'precarious' (Hubbert 1949: 108). Unlike Fuchs (1946: 243), who had enormous faith that science would 'find ways out of trouble' when the oil wells ran dry, Hubbert was pessimistic. Using a notion similar to Ogburn's (1922) notion of social and cultural lag, Hubbert wrote that industrial society continued to plan in an agrarian and prescientific manner and was therefore unlikely to adapt in time to the abrupt decline in availability of fossil fuels (Hubbert 1949: 109). It was, according to Paehlke (1989: 49), probably the first definitive attempt to predict the timing of the end of the oil era.

After the close of the second world war, a number of other writers began to express concerns over resource depletion. Another geologist, Harrison Brown (1954), saw three possible futures for high-energy industrial society. The first, a free industrial society in harmony with its environment, he considered to be an 'extremely low' probability. The second, a stable industrial society controlled by a collectivised, authoritarian state he considered to be more probable. The most likely future, however, he considered to be forced regression to an agrarian society by the inability to avoid war, control population growth or rapidly develop new energy sources before fossil fuels were depleted (Brown 1954: 264-5).

The conflict between natural resource limits and increasing populations led others to see a threatening incapacity to feed the rapidly growing human population (Osborn 1948: 68) and to gloomy Malthusian long-term conclusions for humanity (Darwin 1952)[2]. The limits to not only food production but several other resources were suddenly perceived to be coming into view for the first time (Osborn 1953: 164). The perceived risk to society was that these resource limits would be reached abruptly and unexpectedly, causing great social damage (Ordway 1953: 32). Contradicting these pessimistic writers were optimists with a robust faith in technology such as Fuchs (1946) and Thompson (1957), indicating that the cornucopian versus catastrophist debate began well before it is commonly thought to have.

Oil resources become the 'chips in a postwar global poker game' (Fuchs 1946: 242), and although the Cold War exacerbated concerns over the depletion of all resources, oil was once again of the greatest political and economic import, especially in the USA (Griffith 1968: 18). As a result, the President's Materials Policy Commission was established in 1952 in the USA, followed in the same year by the establishment of an independent organisation with an interest in resource problems, *Resources for the Future*. Japan, being totally reliant on energy imports, began to regulate energy use with the enactment of the 1951 Heat Energy Control Act to reduce the energy intensity of its economy by prescribing efficiency standards for industrial equipment used to produce heat (Dore 1983: 96).

Some of those who feared that fossil fuel depletion was close at hand also believed that there were solutions. Both Osborn (1953) and Brown (1954) believed that either renewable or nuclear energy could fill the vacuum that would be left by the exhaustion of fossil fuels. The early to mid 1950s, therefore, became a period in which the proponents of both of these two options pushed their respective barrows and vied for research resources. Renewable energy advocates argued that the need to make the transition to renewable energy was clearly urgent (Halacy 1957) and managed to briefly re-initiate significant research effort on renewable energy (Resources for the Future 1954). This contrasted with the ambivalence and diversity of opinion regarding the technical feasibility and the costs of energy from nuclear sources. A consultant's

[2] Charles Gaton Darwin (1952), grandson of the renowned biologist Charles Darwin.

report to the Atomic Energy Commission (AEC) on the maximum possible demand for energy to the year 2050 summed up this ambivalence by noting what was commonly seen to be humanity's energy predicament (Putman 1954). Putman's report did not give unqualified support for nuclear energy but rang of an attempt at honest appraisal. It began with the admission that such a forecasting exercise was fraught with dangers and had the capacity without care to degenerate into a parade of prophesies. There was great need, he cautioned, to dismiss extreme claims concerning the technical feasibility and costs of energy from nuclear fission and suggested that the realistic estimate of price of energy from nuclear sources was somewhere between twice the cost to somewhat less than the cost of energy produced from coal (Putman 1954: 247). He stated, moreover, that there was a widely held opinion within the business community that even if the price of energy produced from nuclear fission did turn out to be marginally less than the price of energy produced from coal, most business leaders of the day considered that to be neither terribly exciting, nor sufficient reason to develop nuclear technology (Putman 1954: 3). The tone of Putman's report made it clear that reliance on 'income' energy was the energy option preferred by most, but that society's desire to continue to 'live high' was incompatible with such a strategy and necessitated, with a sense of reluctance, turning to new sources of 'energy capital' (Putman 1954: 247). Putman ended his report with a prescient comment on the potential of continued reliance on fossil fuels to 'derange the natural carbon cycle' and alter the Earth's atmosphere, stating 'We do not know this. We ought to know it ... We should investigate until doubt is removed' (Putman 1954: 459). His final plea was or greater research effort into renewable energy technologies.

The race between renewable and nuclear energy to fill the perceived void in fossil fuels ultimately proved to be a non-contest for another reason. Having spent (US1950)$2 billion on nuclear research during the war, the United States Government had developed a major industry (Knapp 1950: 208) which it continued to foster with post-war orders for naval reactors. In the U.K., a public commission in 1955 called for a policy of energy independence based on major investment in electricity generating infrastructure, triggering major public investment in a commercial nuclear energy programme.

In the USA, General Electric and Westinghouse engaged in heavy <u>loss-leading</u> to create a market for commercial reactors (Layton 1972: 131-3), while the Canadian government's CANDU reactor was developed around the same time as one of that country's few successful attempts at developing a high-value manufacturing domestic and export product (Schrecker 1980: 290). With this aggressive promotion of nuclear energy, together with the discovery of giant oil fields in the Middle East in the mid 1950s that pushed the world oil reserve-to-production ratio to an all time high, concern over energy resources began to subside and is said by some to have slipped into official obscurity around 1960 (Oliver *et al.* 1983: 16). That this was not the case for countries highly reliant on imported oil was demonstrated by the fact that France set maximum levels energy use for household energy-using appliances in 1965 (OECD 1976: 23), whilst Japan put in place a comprehensive energy research policy in the same year (Dore 1983: 96).

A decade later, concern over dwindling resources based on declining grades of mineral resources and the ever larger amounts of cheap energy that would therefore be needed to produce products from these low quality resources was expressed by another geologist (Park 1968: 18-20). World oil use had doubled in the 1950s, however, and oil continued to be seen as the most critical resource problem. Estimates of the amount of oil remaining varied by a factor of two. Hubbert's prediction that USA oil production would peak around 1970 and world oil production around the year 2000 represented the lowest estimate, while McKelvey's assessment represented the upper range in estimates (Park 1968: 183). World oil use doubled again in the 1960s, increasing alarm over its impending exhaustion. Like others before him, Park stated that humanity would be forever grateful to the person who found the means of supplying all of humanity's energy needs by harnessing energy income, but until then, other means would have to be used (Park 1968: 163). Gas and oil discoveries in the conterminous US and its adjacent offshore areas were said to be in decline (Hubbert 1967) and global oil production was projected to fall below expected demand by the early 1980s and peak in mid 1990s (Warman 1971). The most optimistic view was that the actual remaining oil resources were approximately double that estimate (Odell 1973).

The early 1970s was a period in which a number of problems collided. Concern over local pollution from coal-fired power stations in the 1960s had caused a substantial shift from coal to oil-fired electricity generation in many countries (Yergin 1991: 777). The USA had become a net oil importer and oil supplied virtually all transport energy requirements, most home heating needs and much electricity generation in that country. Oil companies had been warning throughout the 1960s of an imminent rise in the price of oil on the world market. In August 1971, fixed exchange rates were abandoned and the US dollar was floated, destabilising oil prices and prompting oil producers, most notably Libya, to pressure for increased oil prices to offset the decline in the value of their oil exports (Hallsworth 1992: 65). This, in turn, led to greater volatility of currency markets and the onset of recession and inflation (Strange 1986). In this uncertain climate, the pessimistic view over the amount of oil remaining prevailed and oil importing countries began to prepare policies aimed at attaining greater self-sufficiency in energy resources. President Nixon, forecasting what lay ahead, announced a policy of national energy self-sufficiency, though actual implementation was delayed (Maddox 1975: 11).

These changes occurred at a time in which the long-term decline in energy intensities of advanced industrialised countries had been temporarily reversed, the most significant causes for this reversal being increased electrification within the industrial sector, a lack of advancement in efficiency improvements of electricity generating systems, and the increased use of personal energy, such as air conditioning and private vehicle use, which had little or no multiplier effect on GNP (Cook 1971: 85, Fowler 1972: 77). The increasing demand for electricity had stretched the capacity of the supply industry to its limits, with blackouts common in many parts of the USA by the early 1970s, and warnings that this 'energy crisis' was set to deepen (Starr 1973: 15). It was also a period in which electricity rates began to rise after a decade of falling real costs of electricity, with bills more than doubling in some states of the USA over the three years from 1971 to 1974 (Freeman *et al.* 1974: 256). A shortage of heating oil in the winter of 1972, apparently the result of US oil policies which encouraged the production of petrol rather than heating oil, added yet another ingredient to what had become a complex energy situation (Hammond *et al.* 1973: v).

This debate over resources also merged with the parallel and closely related debates over the desirability of continued economic growth and the impacts of technologically-induced changes on society. A small number of humanist economists and social critics had been questioning whether the social costs of continued economic growth made it worth the benefits. This cautious debate, well documented by both Arndt (1978) and Huëting (1980), was gradually embraced by the growing debate over environmental issues in which the attack on economic growth was more strident. It reached its peak, however, with the development of computerised world models by systems engineers.

In 1970, the Club of Rome, a group of internationally renowned businessmen, commissioned a team of scientists from the Massachusetts Institute of Technology [MIT] to prepare a report on humanity's predicament. The first attempt was qualitative (Forrester 1971: viii) and suggested that the economy would by necessity stabilize at some time in the future. It was subsequently developed in an enumerated version (Meadows *et al.* 1972) using what was claimed to be the first attempt at a perspective that extended 'far into the future' (p. 19). Their report, *The Limits to Growth*, reached the bleak conclusion that given the trends in population growth, industrialisation, resource depletion and food production, the limits to economic growth would be reached within a century. Continued industrial economic growth was predicted to be checked first by resource limits, especially energy resources, and any attempt to circumvent these checks was automatically doomed as it would exacerbate pollution and therefore fail to avoid eventual collapse of the system (p. 133). The most probable result was projected to be 'rather sudden and uncontrollable decline in both population and industrial capacity' (p. 23). In this view, a steady state economy was no longer merely desirable but also necessary. Although the report had little effect on policy, it received immense publicity and had a major effect in strengthening the view of impending resource limits. It is now history that in October of the year following the publication of *Limits to Growth*, the price of oil on the world market quadrupled as a result of OPEC action.

The oil price rise greatly exacerbated the 'crisis mentality' in relation to not only oil but all energy resources (Paehlke 1989: 53). The immediate impact of the oil price rise on countries varied according to their energy situations, with countries totally dependent on energy imports such as Japan sent into a state of a 'national nervous breakdown' (Dore 1983: 93). Environmentalists have pointed out that the Chinese use a binary ideogram, one danger and the other opportunity, to represent the English word *crisis* (Ehrlich & Ehrlich 1974: 1). They have merely articulated what others already knew and reaction to the oil crisis became a pell-mell of interest groups and organisations who saw an opportunity to peddle their favoured solutions. One of the first to do so in the USA was the Atomic Energy Commission [AEC]. The AEC report, released less than three months after the hike in oil prices, proposed a five-fold strategy for regaining national energy self-sufficiency: increased efficiency of energy use, increased indigenous oil production, substitution of coal and natural gas on a 'massive scale', maximum feasible exploitation of renewable energy sources, and, most importantly, the 'validation' of nuclear energy on a large scale (Ray 1973: 47). Although an accelerated nuclear programme had been dismissed as an energy option in France during the late 1960s and early 1970s on the basis that fission technology was 'not quite economically or technically mature', by 1974 nuclear technology was suddenly assumed to be mature. Electricité de France framed a programme for immediate construction of 5400 MW of nuclear capacity and for construction of a further 6300 MW to begin in the following year (Frost 1991: 250).

During the ensuing debate over energy resources, most environmental writers based their arguments on Hubbert's assessments of non-renewable energy resources (Martinez-Alier 1987: 144) and interpreted the oil price rise as evidence that: (i) the world was entering a period of energy scarcity that promised to be 'very prolonged' (Abrahamson 1973: 186); (ii) that 'Malthus was right in his basic analysis' (Foley 1976: 51); and (iii) that the world was facing an 'unfolding crisis of vast proportions' (Brown 1978: 98). The world's two most pressing problems came to be seen as a rapidly increasing world population and increasing per capita energy use (Robinson 1976). The exhaustion of cheap, low entropy energy was seen to place the industrialised economic system at risk of collapse (Brown 1978: 107). Environmentalists argued that lower-energy society would therefore arrive 'whether people wish it or not' and that the only real question was whether the transition to this low energy 'utopia' would be planned and orderly, or forced and chaotic (Foley 1976: 303).

Australia, being approximately two-thirds self-sufficient in oil and able to regulate the price of domestic oil prices, was sheltered from the rise of oil prices on the world market. Environmentalists nonetheless feared that declining national self-sufficiency in oil, coupled with depleting world oil reserves and increasing concentration of remaining reserves in the hands of an OPEC cartel, contained the seeds for economic chaos (Mula *et al.* 1977, White *et al.* 1978). Moreover, natural gas reserves were considered by these environmentalists to also be on the verge of exhaustion while the costs of coal were regarded to be simultaneously set to escalate abruptly as the richest and most accessible reserves were mined out (White *et al.* 1978: 11). To these writers, resorting to technological solutions that involved increasing the efficiency of energy use amounted to 'meddling' and a form of business-as-usual as it was based on continued production of energy-using products (p. 29). The only real solution, they insisted, was to change the way we live and this demanded radical urban redesign.

The oil price shock had a major impact on policy and energy-using behaviour. Driven by the increase in price and fears of further increases, the shift away from oil and the increase in the efficiency of energy use were accelerated. Governments quickly put in place a battery of energy policy initiatives aimed at reducing dependence on imported oil, including increased domestic oil and gas exploration, accelerated development of alternative energy supply technologies such as nuclear power, and increased exports of other energy resources such as coal and gas to offset the anticipated increases in the costs of imported oil. Environmentalists saw all of these as 'non-solutions', arguing that the oil crisis was symptomatic of a much deeper crisis and that the obvious and only viable long-term solution was to 'turn off the energy to dull labour saving devices' (Brower 1975: xiv). Government's also responded by establishing a number of energy conservation programmes aimed primarily at reducing oil consumption in transport use but also more broadly at reducing energy use in all sectors, and in particular in the household sector. At the individual level, however, much energy conservation effort was driven by the inability to meet the increasing costs of energy and consisted of demand reduction measures, particularly amongst lower income earners.

The second rise in world oil prices in 1979 and early 1980s briefly flamed these energy resource depletion concerns but generally 'failed to ignite public interest' in the USA (Switzer 1994: 125). The cause of the oil price rises have generally been attributed to action on the part of OPEC and that this tactic backfired as the increased oil prices contained the 'seeds of its own destruction' by accelerating fuel switching away from oil, the shift to greater reliance on non-OPEC oil producers, economic restructuring toward less energy-intensive industries, and the take-up of energy conservation (Grubb *et al.* 1992: 15). So great was this economic restructuring and energy conservation effort that by the early 1980s a small number of industrialised economies had increased their economic output while decreasing energy use (Smil 1987: 65). The result was a glut of oil on the world market, a slide in the price of oil and its eventual collapse in 1986 before stabilising around US$15 to $25 per barrel, only marginally above the real pre-1973 price. Further discoveries in the Middle East increased the reserves of oil, the production to reserve ratio increasing from 30 years in 1970 to 44 years in 1990 (Grubb *et al*. 1992: 15). It has been persuasively argued, however that the increased oil prices had little to do with OPEC which actually increased output to compensate for the reduced oil output of Iran and Iraq. The crisis, it has been suggested, was caused rather by the actions of oil refiners and distributors which increased their inventories of oil and in doing so created a false shortage and a price shock (Bohi & Toman 1992: 5). The crash in oil prices in 1986, moreover, was caused when OPEC members decided to abandon regulated oil pricing and allow the price of oil be determined instead by the market, while simultaneously using a new pricing structure based on the delivered costs of oil to the consumer (Bohi & Toman 1992: 7).

Although energy conservation continues to be advanced as a means of extending the availability of depletable energy resources and maximising the long-term security of supply and well-being (IEA 1987: 7), in terms of an environmental imperative, the outlook on non-renewable energy resources, and especially oil, is now more mixed. A number of environmental writers continued to see depletion of oil as 'disturbing' (Gever 1987) and the depletion of fossil fuels in general as an acute problem (Tapp & Watkins 1990: 26, Jacobs 1991: 55), a cause for concern (Dovers 1994b: 4) and a problem closer then generally acknowledged by policy makers (Gilchrist 1994: 12-4).

More optimistic environmental writers have abandoned resource depletion as an argument for energy conservation. They argue that with technological and scientific advancement we may never run out of these fossil fuels or run out at an extremely slow rate (Anderson 1993: 18) and see the current levels of oil production continuing for at least another century (Smil 1987: 57-8, Switzer 1994: 128). The consensus of most oil analysts, however, is that world production of petroleum will peak around 2020 and eventually become almost totally reliant on five Middle Eastern countries (Woodward 1993: 17-20). These analysts dismiss the notion that oil depletion will result in an energy supply crisis as a battery of alternatives to oil exist (Odell 1992, Woodward 1993). Proven reserves of gas have almost doubled over the past decade and the current production-to-reserve ratio for gas now stands at about 60 years with a total energy content approaching that of oil reserves (Grubb *et al.* 1992: 16). Furthermore, there are known to exist vast quantities of coal, heavy oils, methane clathrates and renewable energy sources (Rogner 1989, Odell 1992: 294, Woodward 1993: 23).

Further ahead, technological optimists point to the potential for deuterium-tritium fusion reactors. The amount of energy available from deuterium in the sea has been estimated to be of the order of one million times greater than that stored in the world's coal, oil and gas resources before the industrial revolution (Tapp & Watkins 1990: 14) and proponents of this option express cautious optimism about the prospects of commercialisation by the time the exhaustion forces reliance on fossil fuels to be wound down (Furth 1995). Doubts about the likelihood of commercialisation of deuterium-tritium technology in the face of the apparently intractable nature of the engineering problems associated with it, however, are now common (Holdren 1992b: 45, Hawley 1995: 105). One formidable engineering problem associated with fusion technology is the neutron bombardment which renders the walls of the reactor and containment building brittle and radioactive (Atkinson 1989). A second problem stems from the very high heat fluxes. Superconducting magnets are used to create magnetic fields to hold the high temperature plasma in which the fusion reaction takes place. When these magnets are overheated, the fusion reaction is brought to an end. One rather ambitious solution to this problem has been to replace tritium with helium-3, as this fusion reaction produces protons rather than neutrons and significantly reduces both the irradiation and heat. The problem with the proposal, however, is that helium-3 does not occur naturally on earth and the small amounts produced as a by-product of nuclear weapons programmes would be sufficient to fuel only one full-scale deutrium-helium-3 reactor. The technological optimists who advance this option have therefore suggested quarrying helium-3 from the moon where it is naturally very abundant (Mullins 1995: 35).

Whether or not reductions in energy use are seen as necessary due to a shortage of energy resources is largely determined, therefore, by one's views as to the time frame that is appropriate for policy, the feasibility of various energy options available once the oil wells run dry, and how problematical these energy options are. While there exist real limits to resources on a finite planet, on the available evidence, those limits are currently regarded by many analysts as so remote to be of no sensible policy concern (Brenton 1994: 240).

Depletion of fossil fuels as an argument for reducing energy use is frequently countered by a pervasive technological optimism about the capacity to increase the reserves of fossil fuels through technological development. The dynamic nature of reserves, commonly demonstrated by the use of the <u>McKelvey Box</u>, and their uncertain ultimate size, creates a dilemma for policy. A policy of conserving non-renewable resources could prove to be unwarranted if those resources turn out to be replaceable after all. Ignoring the depletionist argument for aggressive energy conservation, on the other hand, amounts to a gamble that new technology will be developed to facilitate the discovery and extraction of these energy resources. An exponentially increasing scale of resource use is therefore based on a parallel acceleration of technological progress. To the extent that there is no guarantee that it will do so, the stakes of the gamble become higher and the global economic position more precarious (Tisdell 1990: 69).

The 'oil shock' of 1973, and its echo in 1979, that lent so much credence to the idea that humanity was reaching biophysical growth limits, has since been dismissed as events that were predictable, avoidable and unrelated to resource depletion (Arndt 1978: 143, Odell 1992: 284). Many writers concede that these shortages were not the result of the finitudes of natural resources but by 'a jumble of political blunders, negligence, and timidity' (Tapp & Watkins 1990: 58-9). There is also a tendency for contemporary environmentalists to argue that the limits to growth thesis erred in placing too much emphasis on physical resource limits, although environmentalism has not abandoned the depletion argument altogether and it is still common to find resource depletion short-listed as one of the major problems that make up the environmental crisis (Bell, in press: 1). The exhaustion of low entropy resources is said to continue to lurk behind all environmental concerns (Dryzek 1987: 29), fossil fuel depletion continues to be regarded as an acute concern (Jacobs 1991: 51), and energy conservation continues to be advanced as a means of reducing resource shortages (Grubb *et al.* 1992: xviii). These concerns have increasingly been overshadowed, however, by a growing concern over the possible consequences of using these energy resources. Nor are the two problems entirely separate. Regional scarcity of energy resources has compelled countries such as Armenia to rely on unsafe nuclear reactors and many Eastern European and developing countries to rely on polluting coal-fired power stations using low grade coal and minimal emission control technology. The greatest concern, however, is that as non-renewable resources are depleted, humanity will need to rely more and more on renewable resources to meet its needs. As pollution has the capacity to reduce the stock of these renewable resources (Tisdell 1990: 69-70), it is regarded as the more serious long-term energy problem.

3.4.2. Global Pollution

Concern over global pollution was a phenomenon associated with the rise of modern environmentalism in the 1950s and 1960s. There has been much debate over what led to the movement's fundamentally global perspective. One thesis holds that the increase in public awareness of pollution issues led to a generalised concern over pollution (Brenton 1994: 23). Others have suggested that it arose from increased recognition of pollution problems that were truly global in scope, the first of such issues being radioactive fallout from nuclear tests. This view regards physicists such as Robert Oppenheimer to be the true founders of modern environmentalism at the end of the second world war, with their perception that for the first time humanity had developed the technical capacity to destroy itself (Maddox 1972: 12). The international campaign to ban nuclear testing was the first major environmental issue and according to this thesis, gave modern environmentalism its global view from its very inception. To this was added the recognition that many pollution problems were transboundary in nature and that many synthetic chemicals such as DDT were very widely dispersed. Thalidomide, furthermore, provided the evidence to many that such synthetic chemicals could have unforeseen but disastrous consequences on human health (Schumacher 1973: 130).

A third thesis used to explain the global view of environmentalism was the sudden appreciation of the finiteness of the Earth. This conceptual adjustment, referred to as the 'shrinking Earth syndrome', has been attributed to a series of events beginning with second world war which made distant lands not so distant (Knapp 1950: 68), increased globalisation of trade during the 1950s (Arndt 1978: 126) and manned space flight which led to popularisation of Adlai Stephenson's term, 'spaceship Earth' (Roland *et al.* 1965: 210, Caldwell 1990: 35). The release of coloured photographs of the Earth taken during the first manned space flights around the moon, beginning with Apollo 8 in 1968, have also been seen as particularly instrumental in raising concern over 'the Planet' in the late 1960s (Hoyle 1971: 97, Berry 1976: 28).

A fourth and potent explanation, however, was that this global perspective stemmed directly from the pivotal role of ecologists in environmental debate (Paehlke 1989: 21). In the aftermath of the war, it has been argued, many scientists, and especially those trained in the biological sciences, were seeking a more humane and socially relevant application of their discipline to public affairs (Brenton 1994; 24). Ecologists saw pollution as the critical problem and called for a new social movement similar to the Progressive Conservation movement of the late 19th century, but which focused on outputs rather than inputs of the economic system (Commoner 1963: 125). It has since become commonplace to cite the publication of Rachel Carson's (1962) *Silent Spring* as the landmark event that gave rise to the ecologically informed, modern environmental movement (Marcus 1986: 51).

Ecologists brought to the environmental debate two important ideas. One was that the biosphere was a single, large and fragile system, delicately balanced and jeopardised by pollution (Commoner 1963: 118). The second was that pollution resulted in only 'local irritations' up to a threshold level, but that once that critical point was surpassed the damage caused by each unit increase in pollution escalated disproportionately (Commoner 1971: 141). The establishment of the 'International Biological Programme' [IBP] in 1964 and the 'Man and the Biosphere Programme' launched by the International Union of Concerned Scientists [IUCN] in 1968 both added to the global perspective, the aim of the latter programme being to initiate research to deal with the global environmental problems (Adams 1990: 33). Such was the strength of this view that the Secretary General of the United Nations, U Thant, was prompted in 1969 to warn that the world had a decade in which to find cooperative solutions to its three most serious problems: population, pollution and the threat of nuclear war (Adler 1973: 265).

The most basic of these global pollution issues was that of thermal pollution which arose from consideration of the second law of thermodynamics. Since all energy is ultimately converted to heat, the ultimate constraint to economic growth was considered to be the ability of the biosphere to absorb this waste heat from energy use (Caldwell 1972: 100). Another major global pollution problem was considered to be the release of carbon dioxide from the combustion of fossil fuels that could lead to an enhanced greenhouse effect and global warming. Those observing long-term trends in global weather patterns, however, were more concerned by the prospect of a natural cooling of the earth's atmosphere that could see the return of ice age conditions (Ponte 1976).

The most critical of these global environmental pollution problems were identified by the Study of Critical Environmental Problems (SCEP 1970) sponsored by the Massachusetts Institute of Technology. Although the authors of the study made no attempt to rank these problems in order of their seriousness, Smil (1987: 208) has suggested that the order in which they were presented in the summary chapter can be taken as an indication of perceived seriousness. They were, in order, carbon dioxide from the combustion of fossil fuels, particulate matter in the atmosphere, cirrus cloud from jet aircraft, supersonic aircraft in the stratosphere, thermal pollution, DDT and related persistent pesticides, mercury and other toxic heavy metals, oil on the ocean, and excess nutrients in coastal waters.

By 1972 the first wave of modern environmentalism in the USA was at its peak, over 300 hundred books on environmental issues being published in the USA in that year (Nelkin 1977: 408). Some of these became definitive environmental texts. *Small is Beautiful* by Schumacher (1973) brought together three separate streams of thought: the critiques of economic growth by Knapp (1950, 1963), Galbraith (1958a, 1958b) and Mishan (1969, 1970); the critiques of the social impacts of technology by Mumford (1934), Ellul (1964), and Roszak (1969); and the concept of 'intermediate' or 'appropriate technology' which had been increasingly advocated and applied during the 1950s and 1960s as a strategy for Third World development. Political theorists warned that resource scarcity had been omitted from the environmental debate over humanity's future (Falk 1971), renewable energy advocates called for an urgent transition to solar energy (Halacy 1973: 91), thermodynamicist economists re-emerged to advance critiques of the economic system based on the run down of low entropy non-renewable resources (Georgescu-Roegen 1971), while New-Left philosophers reworked their radical critiques of capitalist economic growth (Marcuse 1972).

This rising concern over the environment culminated in two landmark events. The first was the United Nations Conference on the Human Environment held in Stockholm in 1972. The Conference, although focused primarily on the environmental problems of the industrial world, maintained a 'resolutely global' focus (Adams 1990: 36). The second was the publication of *The Limits to Growth* by a group of systems engineers, an attempt to model the prospects for future global economic growth. Although other writers such as Fremlin (1972) advanced global projections that lay somewhere between the optimism of Kahn & Weiner's (1967) and the alarmism of Meadows *et al.* (1972), these received little attention. It was the neoMalthusian qualitative global projections of Ehrlich & Ehrlich (1970) and the attempts at quantitative global modelling by Meadows *et al.* (1972) which galvanised popular attention and dominated the debate.

The qualitative global models were resoundingly attacked by Enzensberger (1974). Writing from a neoMarxist perspective, and without denying that some environmental problems were perilously serious and that ocean and atmospheric pollution were by their very nature global in scope, Enzensberger first attacked the idea that uncontrolled population growth in the Third World represented a global crisis. The attempt to portray it as one, he insisted, served the ideological function of displacing the problems of the wealthy in industrial countries onto the rest of the world by pretending that we are all in one boat. The real problem, he maintained, was not population but inequitable resource use. To avoid confronting this reality, he charged, ecologists retreated to 'factual problems' such as ocean pollution, radioactive pollution, and climate change which were actually, rather than ideologically global in nature. The fact that these were global in nature, however, did not help as ecologists, according to Enzensberger, as their 'hasty global projections' amounted to surrender in the face and size and complexity of the problems which ecology had thrown up (p. 17). Not only were they constructed on the incorrect assumption that the earth was a closed global ecosystem (p. 15), but they were used as a means out of the dilemma ecologists faced when they left biology and attempted to apply their ecological ideas to the social domain despite their 'boundless ignorance of social matters' and ecology's inability to theorize sensibly about society (p. 30). The result, he argued, was not holism but methodological confusion (p. 4). The contrast between ecologists' bleak and dire conclusions and their mild admonitions and appeals to the rationality of their readers was so great, he contended, that one or the other had to be dismissed as implausible. The consequence was that their 'verbal excesses' were 'about as effective as a Sunday sermon' (p. 23) and concluded by pointing out that even the ecologists who warned of eco-catastrophe conceded that many of their own suggestions were 'unrealistic' (Ehrlich & Ehrlich 1970: 322).

The quantitative efforts at global modelling by Meadows *et al.* (1972) were similarly attacked on the grounds that the assumptions upon which this was based were overly simplistic (Cole *et al.* 1975, Passell & Ross 1974). The report's most ardent critics, however, were neoconservative economists who rallied to the defence of continued economic growth (Maddox 1975, Beckerman 1975, Kahn *et al.* 1976, Kahn 1979, Walter 1981). On the question of pollution these economists argued that pollution had nothing to do with economic growth but was a product of the misallocation of resources

(Beckerman 1975: 104). It was on the issue of depletion, however, that economic theory most vigorously differed with the 'limits to growth' thesis. The economic view was that science and technology had the demonstrated capacity to increase the known economic reserves of non-renewable energy inputs and while some resources, especially hydrocarbon non-renewable fuels, were scarcer than others it was always possible to substitute less scarce for more scare resources. As a resource became scarcer, the market and socio-political action provided feedback mechanisms to stabilise the system before a crisis was reached and so ensured that depletion was a smooth process rather than an abrupt and catastrophic event.

The debate was kept alive by the publication of several other attempts at global modelling, the most comprehensive and interdisciplinary of which was the *Global 2000* Report (Barney 1980) produced by several US federal bureaucracies for the President of the USA, Jimmy Carter. The report painted a gloomy picture of the world in the year 2000: more crowded, more polluted and more ecologically precarious. By the year 2000, the report predicted, the world would have suffered massive losses of agricultural soils, forests and species. The report re-ignited the catastrophist versus cornucopian debate and led to the publication of a number of pro-growth responses (Simon 1981, Maurice & Smithson 1984, Repetto 1986). Displaying boundless faith in markets and human ingenuity to overcome problems, economists refuted the *Global 2000* Report, describing its projections as dead wrong. Generalising from a small number of trends in the USA they offered a highly optimistic, but equally unrealistic, global projection for the year 2000 in which the world would be less crowded and the quality of life higher (Simon & Kahn 1984).

The primary intention of *Limits to Growth*, according to one member of the Club of Rome, was to stick pins into governments in order to prod them into action (King 1990: 41). The extent to which it succeeded in doing so is not clear. By the time the report had been published, major changes in policy were already in place or in train in many countries. Environmental departments had been established and numerous pieces of environmental legislation had already been enacted. The impact of *Limits to Growth* on the public sphere, however, is indisputable. It received 'immense publicity' and many individuals are said to have initially taken it as prophecy (Maddox 1972: 287). Even this impact was attenuated by the dramatic rise in oil prices in the following year as environmental debate was quelled and its primary focus was shifted from pollution to energy issues. The increase in price of energy led to reductions in energy use or reductions in growth in energy demand due to stagflation and reduced economic output at the macrolevel, and energy conservation, often involving reductions in energy services, at the individual level. This inflationary period of the post-1973 oil crisis led to both high unemployment and a swift end to a period of unparalleled economic expansion. OPEC had invested its massive profits in Eurodollars, further weakening the US dollar and the world's largest economy (Hallsworth 1992: 65). As someone once put it, when the USA catches a cold, the rest of the world gets pneumonia. With the ensuing stagnation, bankruptcy and unemployment, debate over the desirability of continued economic growth was quelled. The problem for environmentalism was that it had called for zero economic growth in the early 1970s and when the recession gave it to them, most members of society were displeased (Paehlke 1985: 31). This interpretation may be misleading as many economists are sceptical about the extent to which inflation and recession were caused by the increase in oil prices. While increased oil prices may have contributed to inflation, these writers maintain that energy prices actually had little to do with the macroeconomic problems of the 1970s and that monetary authorities rather than OPEC were the cause of the recession (Bohi & Toman 1992: 31).

Many commentators state that public interest in environmental issues declined as a consequence of the rise in oil prices almost as fast as it had risen as pollution was eclipsed by the problems of recession, inflation and unemployment (Cairncross 1993: 34, Brenton 1994: 25). However, this appears to represent an account of environmentalism peculiar to the USA where it was noted to have taken on a particularly virulent and crusading form (Sinclair 1974: 180). Even in the United States it has been suggested that environmental issues continued to 'run strongly', although overshadowed by energy affairs (Smil 1987: 216). In many other places, the decline in public interest in environmental issues was less marked. The antipodean environmental movement, for example, did not emerge as a national phenomenon until 1972 and consolidated throughout the 1970s. In all situations support for environmental issues remained higher than it had been before the 1970s. A 'strong undercurrent of public opinion' giving 'highest priority to environmental protection, energy conservation and restraint in material production and consumption' outlived any issue-attention cycle although failed to translate into the adoption of aggressive energy conservation or a dramatic shift to reliance on renewable energy systems (Strümpel 1983: 193).

This failure to attract greater support was attributed to the non-acceptance by the majority that high levels of employment were possible without economic growth (Paehlke 1985: 31). This realisation, according to Paehlke (1989: 51), saw environmentalist opposition to economic growth peter out in the early 1980s (Paehlke 1990: 51). It simultaneously moved away from 'scientific doomsdayism', re-embracing social issues and problems (Hay 1988: 22). By the early 1980s, many amongst the litany of problems that made up 'the ecological crisis' such as ozone depletion from supersonic jets and the effects of jet condensation trails, had been re-appraised and downgraded from critical global problems to difficult but manageable local or regional degradations, ordinary problems or non-problems (Smil 1987: 217). Smil points out that only one of the critical global problems cited by the SCEP in 1970, carbon dioxide build up in the atmosphere, remained on the list of critical environmental problems as made up by the

Reykjavik Conference, an international environmental meeting held in 1982. The environment versus development debate was described by some commentators as 'largely dead' (Clarke & Timberlake 1982: 23) whilst others have suggested that it had not died but had led to schizophrenic confusion within the environmental movement (O'Riordan 1981).

One branch of environmentalism took a technological and utilitarian tack that was packaged in a manner attractive to materialism (technocentric environmentalism) and which had its antecedents in the conservationist (as opposed to environmentalist) concept of prudent resource use (Owens 1995: 208). It was this line that was adopted by the World Conservation Strategy (IUCN 1980) which maintained that it was not development *per se* that was the root cause of environmental degradation, but the type of development. It was a philosophy subsequently adopted by the more influential Brundtland Report (WCED 1987) which renewed attempts to reconcile development and economic growth. The WCED report played down the prospects of eco-disaster and was firmly cornucopian rather than catastrophist in tone, whilst acknowledging that many environmental problems were grave. Equally grave, however, was the problem of poverty in developing and underdeveloped countries, the only solution to which was rapid economic growth. Juggling two apparently contradictory objectives, the WCED attempted to resolve the paradox by invoking the concept of *sustainable development*, a slippery concept which entailed placing environmental and economic objectives on an equal footing so that development could meet the needs of the present generation without compromising the needs of future generations.

Opposed to this line of argument was a second stream of environmentalism (ecocentric environmentalism) which maintained an ecological emphasis, was unconvinced that economic growth and development were sustainable, and relied heavily on moral arguments as the basis for environmental reform. With renewed warnings of ecological catastrophe, this ecocentric view regained support and the split in the environmental movement widened. Pollution abatement and recycling were dismissed as non-solutions to the environmental crisis as both failed to check growth (Porritt 1984: 37, Irvine & Ponton 1988: 17). The two dominant environmental problems of depletion of stratospheric ozone and tropospheric carbon dioxide transformed the notion of 'the environmental crisis' from an ecological concept to a palpable phenomenon. As the debate increased, the events began to parallel those of the first wave of environmentalism two decades earlier.

The year 1992 became a re-run of 1972. Scientists from two august scientific bodies, including 104 Nobel Laureates, issued statements to the effect that the environmental changes occurring were probably irreversible and could jeopardise the future of the ecosystem. The world was given at most a few decades in which to avert this irreversible and potentially disastrous ecological catastrophe (Meyers 1994). These statements were followed in June of that year by the United Nations Summit on the Environment in Rio de Janeiro and by the revamping of the limits to growth thesis (Meadows *et al.* 1992). In this reworked version, the critical environmental limit on economic activity was not the environment's ability to provide resources but the capacity of the environment to absorb the wastes produced by the economic system, a limit which the authors contended had already been exceeded. Energy was portrayed in *Limits to Growth* (Meadows *et al.* 1972) as the critical resource shortage. Two decades on, it was portrayed in *Beyond the Limits* (Meadows *et al.* 1992) as the critical cause of pollution and the new environmental crisis.

With the re-emergence of the ecocentric stream of environmentalism, the strong anti-growth ethic was revived (Lewis 1992: 2). The greenhouse issue led to the calls for a reduction in energy use in the industrialised countries of about two thirds (Boyden *et al.* 1990) to nine tenths (Trainer *et al.* 1991: 20) from current levels. While ecologists saw an end to economic growth as an ecological imperative, neoMalthusian resource analysts saw continued economic growth as an impossible calculus and look forward to the day when it would be finally laid to rest as a policy objective (Tapp & Watkins 1990: 24). To some the root cause of environmental degradation was the dysfunctional relationship between humanity and nature catalysed by the development of technology and *laissez-faire* capitalism, with the exploitation of fossil fuels representing the principle symbol of this malignancy (Clark 1991: 402). Others perceived the problem to be industrial capitalism's values of competition and materialism and accordingly prepared industrialism's obituary (Kassiola 1990: 29).

What ever the root cause of the environmental crisis is considered to be, there is a dominant view within the environmental literature that policy is failing to respond to this ecological crisis. The two common explanations for this are (i) scepticism over the existence of an environmental crisis and (ii) the constraints imposed by the imperatives of economic growth. These are briefly discussed below.

(i) Scepticism over the existence of an Environmental Crisis

While it is commonly suggested that most policy makers at the top end of strategic policy making remain unconvinced about the existence of a global environmental crisis (Gore 1993: 36, Brenton 1994: 5), many environmentalists maintain that the view that humanity is in trouble is broadly accepted and that the existence of the environmental crisis is now unequivocal. Kassiola (1990: 2), for example, expressed utter surprise when his use of the term 'the ecological crisis' without any attempt at substantiation was subsequently challenged. The important point is how two such disparate views can coexist?

The most straight forward explanation advanced is that this non-belief in the environmental crisis is a form of psychological denial. Using Festinger's (1957) concept of cognitive dissonance and Hirschman's (1982) notion of disappointment avoidance, Kassiola (1990: 23-4) posited that belief in both the feasibility and desirability of economic growth and the existence of an environmental crisis caused by industrialism would lead to dissonance and therefore the need to reject one or the other idea. But because acceptance of the latter would lead to disappointment and would necessitate admitting that past decision making and judgement have been seriously flawed, disappointment and discomfort are avoided by reconstructing reality and denying the latter.

The most obvious example of a similar phenomenon that has been explained by such psychological denial was the response of the Western world to the rise of fascism in the 1930s and 1940s (Camus 1947). This has lead contemporary environmental writers to suggest that the current signs of ecological collapse can be likened to the *krystallnacht*, the first outbreak of public anti-Semitic violence in pre-war Germany before the holocaust (Gore 1993: 271). This denial thesis is supported by well-documented evidence within management theory which shows that a frequent reaction to critical situations is a refusal to accept the facts. Experienced professionals such as pilots and surgeons frequently fail to accept that the situation is real when confronted with a critical situation (Carnino *et al.* 1990: 82-3).

There are two problems with this thesis, however. The first is that if it is a correct interpretation of reality, it does not render the task of convincing sceptics to change their beliefs any easier. Hirschman (1982) concluded that denial of reality continues until the problems increase beyond a threshold point and become clearly manifest. Only then is there a sudden mass conversion to belief in the problem and alarmed over-reaction. This leads to the pessimistic conclusion that environmentalists can do little but repeat themselves while waiting for the evidence of the crisis to become clearer.

The second problem with the thesis is that it can easily be inverted to suggest that belief in an environmental crisis is itself a result of a similar psychological process of denial. That is, the desire for radical policy change leads to the belief in the existence of an environmental crisis (Wildavsky 1979: 396). To avoid dissonance between the belief in such a crisis and the lack of evidence in such a crisis, environmentalists selectively accept some pieces of evidence whilst rejecting or ignoring others.

This introduces a second possible explanation for the refusal of policy makers to believe in the existence of a crisis. This is that politicians and policy makers examine the evidence and conclude that the existence of a crisis is unproven, or at best inconclusive.

At first, this appears absurd. How can environmentalists take the evidence for an environmental crisis to be so obvious and well documented that there is no need to go over the evidence (Kassiola 1990: 3-4, Dovers 1994a: xi) while others consider it to be inconclusive or a fabrication? Dryzek (1987), however, in his case for ecological rational decision making, has put forward the argument that this is precisely what occurs. He argued that for every indicator which can be used to show that our environmental situation is getting worse, there exists another that can be used to show that it is getting better. This point was perhaps best made by the oft-cited wager in 1980 between super-cornucopian economist Julian Simon, and the neoMalthusian ecologist Paul Ehrlich, together with two physicists from the University of California. The bet was whether the real price of five minerals would increase or decrease over a ten year period. We are now often reminded by the modern contrarians that the combined real price of the five minerals in question declined in real terms by 50% over the decade and Ehrlich and his colleagues lost the bet (Mestel 1995). And so it has been with other indicators. Sceptics point to improvements in urban air quality, while environmentalists argue that this has been at the expense of pollution further afield; sceptics point to increased grain production levels, while environmentalists point out that this has been made possible by increased use of fossil fuels, water and fertilizer (Paehlke 1990: 37).

Dryzek's contribution was published in 1987 before the greenhouse issue became a major international concern. Since that time, two things have changed. First, as has been shown, depletion was no longer advanced as the principle limit on economic activity. And secondly, it could be argued that since 1987 the evidence of environmental degradation has become even more compelling in the interim. Many environmentalists would now posit that the existence of a crisis is no longer contestable. With the publication of each new book or article, more bad news on the environmental front is revealed: the possible link of the five massive mammal marine die-off events over the last decade to a subtle, but lethal, effect of chlorine pollutants (Motluk 1995), the loss of 25 billion tonnes of fertile top soil each year (Hawken 1994: 1), a rate of species loss unparalleled since the Cretaceous-Devonian boundary 50 million years ago (Meyers 1994) and the increasing degree to which our species appropriates net global photosynthetic product (Vitousek *et al.* 1986).

Surely now, it would appear safe to suppose that the evidence of an ecological crisis was irrefutable. The fact that the bet between Simon and Ehrlich is being re-proposed, although currently stalled by dispute over the selection of appropriate indicators (Mestel 1995: 5), points to the fact that although the onus of proof appears to be steadily shifting to those who would deny the existence of an environmental crisis, there is as yet no consensus on this point.

The net result of this debate, Dryzek argued, is that although it is clear that ecological problems do exist, and that some ecosystems have already been 'stressed to the point of destruction', at the global level 'it is difficult to gauge how close to the edge we are' (Dryzek 1987: 23). Sceptical or contrarian views on the existence of an environmental crisis, or the extent of the crisis, continue to be commonplace (Duffy 1994, Easterbrook 1995, North 1995). Furthermore, leading environmentalists have admitted to occasional and deliberate over-dramatisation of seriousness of environmental problems, although denying damaging the truth (King 1990: 39, Goldsmith 1995: 43). The sceptics therefore realise what psychologists have been telling us for a very long time, that belief is seldom determined rationally. But what they overlook, as Bertrand Russell pointed out long ago, is that the same is true of disbelief (Russell 1929: 114-5). In their brilliant book, Douglas & Wildavsky (1983) extended this argument to show that risk is in fact a cultural construct.

There are two further points which can be made regarding the failure to persuade politicians of the existence of an environmental crisis. The first is that there have been reverse situations in which policy makers have considered there to be a crisis but have found it difficult to persuade the public that such a crisis exists. In the 1950s, democratically elected governments and their experts were seen to be cognizant of the potential catastrophe while the public were seen to be dangerously conservative and strongly resisted the necessary reforms (Lippman 1954: 23). The contemporary environmentalist thesis reverses this argument and states that the crisis is now identified not by government or its agencies but by independent experts, while *Leviathan* is dangerously conservative, destructively wrong and slow to react. Brenton (1994: 6), however, turns the argument around again, and considers that even if there is consensus within the scientific community over the seriousness of regional or global environmental problems, and there rarely is, multilateral remedial action is slow, not purely because governments are unwilling, but because they are constrained by the domestic political acceptability of such action. In a vicious cycle, governments are checked by public opinion, and public opinion is driven by the economic imperative. Hence we arrive at the modern version in which all participants are aware of the crisis but no one is doing anything (Beck 1992: 25).

The second point is that those advancing the argument that a crisis exists often argue that there are only two policy options available. The choice before society is portrayed as the equivalent of a decisive 'yes or no' decision choice. The traditional metaphor used to describe this situation by those advancing the urgent need for reform has been that of Robert Frost's traveller who is faced with two diverging roads (Lippman 1954: 23, Carson 1962: 52, Lovins 1976). This use of the metaphor is interpreted by sceptics, however, as an attempt to restrict the policy options to only two, a right and a wrong, akin to those relating to the 'either-or' status of constitutional, religious or moral issues.

(ii) <u>The constraint imposed by the imperative for economic growth</u>

The second and related explanation of why policy makers refuse to believe in the existence of an environmental crisis is because to do so would require abandoning dominant policy objectives of industrial capitalism. Many explanations have been put forward to explain policy's stubborn resistance to environmentalist demands to abandon economic growth. A common explanation advanced is that growth is one of the triad of ideologies, along with progress and development, directing modern society (Tapp & Watkins 1990: 24), whilst writers from the Left perceive the paramount function of economic growth to be alleviation of the lot of the 'have nots' without wealth redistribution. Growth-stop would have the undesirable effect of locking in inequitable distribution of wealth and, therefore, producing dissent and antagonism between social groups and business groups which control economic resources (Siebert 1992: 233). Because of this, the argument goes, there is a structural need to maximise economic output which is defined as the production of manufactured goods - ahead of all other objectives (Tindale 1995: 199). Economic growth has therefore been described as 'the political solvent that buys off the discontent of the poor at no cost to the wealthy' (Dryzek 1987: 72) and the main ideological weapon of industrial élites in their attempt to maintain the status quo (Kassiola 1990: 29).

Describing growth as an *ideology*, however, is problematical not only because the term has come to be overburdened with meanings but because it can be used as convenient excuse for avoiding the need to handle more difficult and complex questions. Simeon (1976: 555) therefore distinguished between ideologies, paradigms, dominant ideas and principles and described economic growth as a 'dominant idea'. This position acknowledges that while economic growth is an unchallenged policy objective, this is dictated by a number of formidable pressures on policy makers for the retention of economic growth as a policy objective, including national security and status (Arndt 1978: 151). As Huëting (1980: 15) pointed out, moreover, the cry for economic growth does not come from only industrialists, economists, governments and the rich but also from all those who demand higher incomes and ever increasing values of their investments such as housing.

For these reasons, conservationists concede that economic growth remains a 'political imperative' and 'almost the supreme value of western societies' (Jacobs 1991: xiv, Beck 1992: 45, Self 1993: 206). For the while, and some say for the foreseeable future (Brenton 1994: 239), reduced economic growth will simply not be accepted as an item on the debate over policy agenda and those environmentalists who persist in demanding it, the argument goes, will be doomed to repeating themselves. To Arndt (1978: 153), therefore, the debate cannot be over growth or no growth but needs to be over how much growth and the quality of growth. Governments, he argued, do accept some reductions in economic growth in order to achieve social and environmental goals.

One attempt to overcome the impasse in the debate over the ecological risks of pollution imposed by economic activity has been that decision making should be based on the *precautionary* or *uncertainty principle* which calls for prudence when there is a reasonable risk that an activity could lead to potentially irreversible damage to the environment. It is based on the philosophy that the prophecy of doom is to be given greater heed than the prophecy of bliss as progress and perfection need to be secondary to the primary goals of preservation and protection (Jonas 1984: 26). The problem with the concept is that to advance society will need to take some risks and it leaves unresolved the questions of what level of risks are acceptable and how agreement on what the risks are can be reached. These uncertainties have meant that the precautionary principle has been unable to displace the contemporary principle guiding policy decision making which holds that economic activity should not be constrained for ecological reasons unless there is incontrovertible scientific evidence that such activity would lead to substantial and irreversible damage. The counter-argument is that science is unable to accurately predict the impacts of human activities on the ecosystem. The outcome is that although the precautionary principle is an eminently sensible and uncontentious idea, it is as yet insufficiently well defined and matured as a concept to be of practical use to policy making (O'Riordan & Cameron 1994: 292). It remains as yet an embryonic concept and few senior policy makers have been convinced of its virtue or capacity to serve as the basis of decision making (Haigh 1994: 240-2). It is intimately connected with the moral dimension of the debate over energy conservation and it is to this dimension that the discussion now turns.

3.5 Obligatory Arguments for Energy Conservation

It has been argued that ethical issues render energy policy the most important moral question of our time (Daly 1978: 22), that the most important arguments for energy conservation are ultimately those relating to equity issues (Anderson 1993: 20), and that widespread acceptance of a new environmental ethic based on moral questions constitutes humanity's only hope of avoiding catastrophe (Gore 1993: 295). The moral dimension to the energy debate therefore contains a contradiction, for while it is held to be the most compelling argument for energy conservation, in practice moral arguments appear to have the least capacity to influence either individuals or governments. The difficulty is, however, that all claims on policy tend to dress themselves up as moral issues or as in 'the public interest', even if these arguments are sometimes hypocritical (Self 1993: 265), and many are highly sceptical of what they perceive to be environmentalist attempts to convert political issues into a moral crusades (Luke 1993: 14). This debate is further confounded by the frequent failure to define what is meant by 'moral' or 'the public good' and it is useful to begin with brief definitions.

Goodin (1980) has distinguished between 'prudent morality' or 'enlightened self-interest', 'internalised norms' and 'seriously held principles'. 'Enlightened self-interest' he defined as moral behaviour in anticipation of a pay-off. An appropriate example would be the statement made by Australia's Minister for Resources and Energy that Australia had a moral obligation to develop its energy resources in order to provide the energy and materials for the developing world (Griffiths 1990: iv). 'Internalised norms' Goodin (1980) defined as mere calculations and as such another element of a utility function, something to be satisfied. Caring for one's children would, in Goodin's schemata, constitute an internalised norm. It is possible, according to Dryzek (1987: 153), that energy conservation for the common good can become an internalised norm through social learning via media publicity or exhortation. Only 'seriously held principles', moral beliefs immune to trade-offs and corruption by ordinary self-interested behaviour, were considered by Goodin to constitute genuinely moral behaviour or altruism. This last type of morality also conforms to Hawken's (1993: 136) idea that 'an ethic is not an ethic, and a value is not a value, without some sacrifice for it'. The often used example of genuine altruism is that of patriotic duty in war time (Dryzek 1987: 151, Gore 1993: 269).

A further distinction is made between the 'collective good' or 'public interest' and 'genuinely moral' arguments. The former involve issues which impact on a group of which the individual is a member, while the latter refer to issues which impact on distant others. The most distant others are those in other countries (intragenerational issues) and those not yet born (intertemporal issues). Before looking at the degree to which policy is persuaded by these genuinely moral arguments, the discussion begins at the individual level and the degree to which individuals can be persuaded to alter their energy-using behaviour based on moral considerations.

3.5.1 The Morality of Individual Decision Making

Moral suasion has often been employed to urge its citizens to act in 'the public good', conserving energy being one prominent instance. The degree to which individuals respond to such exhortations based on the public interest has been a matter of debate. It has been argued on the one hand that individual efforts at conserving energy in the 1970s were more than a reaction to higher energy prices but were partially driven by moral principle (Lindblom & Cohen 1979: 18). This view has been contradicted, however, by the many reports which found such attempts at moral suasion to have little impact on behaviour (Peck & Doering 1976, Seligman 1985: 142, Condelli *et al.* 1984). In general, it has been noted that policies which rely on moral suasion as a means of altering individual decision making have not been encouraging (Dryzek 1987: 161), President Carter's attempt to use moral suasion to motivate his nation to conserve energy in 1977, likening the energy crisis to the moral equivalent of war, now held up as notable evidence of the failure of this approach as a means of solving future energy problems. It has been argued, moreover, that individuals are even less likely to be persuaded to conserve energy on arguments based on 'genuinely moral' concerns as distinct from the public interest. There are two rival explanations advanced to explain this, one based on beliefs about human nature, the other based on the nature of modern society.

The first explanation is based on the agnostic view that lifestyle choice is a matter of personal opinion and the belief that humans are selfish. Economists, for example, have argued that the simplest explanation for the failure of individuals to take account of future generations is simply that individuals are unconcerned about the welfare of those remote in either place or time (Huëting 1980: 187). Eminent behavioural psychologist, B.F. Skinner, similarly argued that not even the certainty of a future 'energy crisis' was likely to be very successful in persuading individuals to take-up energy conservation. These problems were not only too remote in time to be of relevance to people, according to Skinner, but they impacted on someone else in the next generation or the generation after that (Yergin 1979: 139). Most individuals, Skinner implied, are selfish, do not base their decisions on moral concerns and subscribe to the philosophy of *après moi le déluge.*

Rational theorists have used this argument to explain serious social problems, such as the depletion of both resources (renewable and non-renewable), traffic congestion, air pollution and crowding in national parks. Their thesis is that individuals confronted with a conflict between the short-term costs and benefits to themselves and the longer-term costs and benefits to society, tend to base their decisions on the former rather than the latter. Since this choice is made collectively, the net result is long-term serious problems. One of the best known arguments based on this reasoning is the *Tragedy of the Commons* thesis as advanced by biologist, Garrett Hardin (1968) in which each individual is seen to seek to extract more than their share from common property resources to the long-term detriment of the group. A similar model was also developed independently from game theory by Olson (1965). In explaining the (il)logic of collective action, Olson reasoned that the self-interested, rational individual would tend to avoid contributing voluntarily toward the collective production of public non-excludable goods, such as clean air or national defence, because such goods are not economically or physically divisible and individuals cannot, therefore, be excluded from their consumption. Rational and self-interested individuals, Olson maintained, would instead elect to 'free ride' on the contributions of others. This 'free-rider effect' has been frequently advanced as the underlying mechanism behind environmental degradation and the cause of the failure of moral suasion to induce individuals to conserve energy (Nivola 1986: 6). Platt (1973) extended the argument to suggest that many problems were the result of 'social traps'. Once a specific social direction is set by a pattern of behaviours, Platt argued, there is no easy way of backing out of these situations even if they begin to prove unpleasant or risky because each individual 'continues to do something for his advantage that is collectively damaging to the group as a whole' (Platt 1973: 641).

There is no denying that selfishness is a powerful force, that remoteness in time and place is likely to impact upon an individual's moral concern, and that peoples' resources are limited and they have many immediate demands on their time, energy and money, including their children's needs. That selfishness is an incomplete explanation is clearly demonstrated, however, by the apparent willingness of large numbers of individuals to volunteer substantial amounts of their personal time, money and effort to altruistic causes. It is therefore important to look at the alternative explanation for the failure of individuals to make choices which are for the collective good.

This rival explanation focuses on the social and cultural milieu in which individual decisions are made and maintains that any realistic view has to recognize that these choices are made within a very weighty structure of social influences. The structure of cities, the social pressures, the demands of modern lifestyles, and the power of markets all effectively dictate what the individual can and cannot do. Many social commentators have subscribed to this theory that individual energy-using behaviour is shaped by structural and cultural constraints so that the amount of energy an individual uses is socially rather than individually determined (Monnier 1983). The outcome is that each is responsible and yet no one is responsible for society's energy problems (Comstock 1974: 359), while the implication is that it is inappropriate to regard energy consumption and conservation behaviour as microlevel behavioural phenomena that can be influenced by specific behavioural changes directed at individuals and that it can only be changed by altering the structure and values of society as a whole (Dholakia *et al.* 1983: 246).

The important corollary of this second explanation is that those energy conservation strategies which rely solely on altering individual attitudes and values are likely to be relatively ineffectual since such policy approaches ignore the root cause of the problem. These collectively made 'prior commitments' are so culturally grounded that few recognise them as choices at all and they are routinely depicted as needs rather than wants (Redclift 1992: 35). As the central feature of capitalism is the simultaneous production of commodities and the 'needs' for those commodities, the individual wage-earner is unable to differentiate between 'real' and 'artificial' needs so that moral appeals for people to reduce their needs within a system that is based on creating needs is, in this view, not only absurd and useless but is also cynical (Enzensberger 1974: 29). In this view, even if individuals are morally motivated to reduce energy use, their ability to give expression to such concerns is limited.

A philosophical critique of modern society based on a Weberian analysis, however, suggests that individuals are even unlikely to be morally motivated to reduce energy use. The argument is not that moral behaviour is limited by human nature, but because morality is an impotent construct within modern society. Morality, it is argued, is a premodern construct based on proximity and is woefully inadequate for dealing with today's issues (Bauman 1995: 217). Modernity's process of rationalisation and its encouragement of the idea of the individual as sovereign destroys social relations, reduces society to an externality and constructs a reality which excludes the moral dimension. Individuals, therefore, have no choice but to be instrumentally rational in a morally impotent society (Poole 1991: 143). Morality becomes a question of not 'how do I want to live?' but of 'what ought I do?', a restriction on life rather than a guide to it (Poole 1991: 141). The only vestiges of a true morality remaining in modern capitalism are those attached to the concept of the family and the nation. Individuals will make sacrifices as a *parents* or as *Australians* that they would not otherwise do as only in such situations are certain activities both duties as well as components of the individual's well-being (Poole 1991: 135).

This debate over the degree to which individual action is based on self-interest rather than altruism or the public good is taken up again in Chapter 7 where the comparative ability of energy conservation information programmes to motivate individual householders to save energy on the basis of reducing energy bills and on the call to protect the environment are compared. At this point, however, the important point is that irrespective of which school of thought one is more closely aligned to, all predict that moral arguments will have relatively low power to alter behaviour at the individual level. The discussion therefore now turns to the question of the degree to which policy makers rather than individuals can be persuaded to act on the basis of such moral arguments.

3.5.2 The Morality of Political Decision Making

If rational decision making theory is correct in its premise that individuals are selfish and will not act for the common good when there is a conflict between their short-term individual interests and society's longer-term interests, it suggests that we ought to be even more pessimistic about the capacity to persuade policy makers to adopt aggressive energy conservation on the basis of moral arguments. The traditional view of politics is a highly pragmatic one in which moral merely means that which is popular (Cicero 45 BC) and that in politics statesmen cannot afford the luxury of acting by the standards of private morality as the stakes are too high (Machiavelli 1640). While such sentiments are likely to represent a cynical extreme, the persistent contemporary critique of green political theory is that decision-making within existing political structures is overly mechanistic and inadequately incorporates moral issues (Martinez-Alier 1991: 126, Weale 1992: 27). There is also good reason to believe that as a consequence of the globalisation of markets, governments are becoming more, rather than less, pragmatic as they are hobbled by the international money market. Bill Hayden, Australia's former Governor General, and the one time leader of the political party traditionally aligned with the Left, the Australian Labor Party, recently expressed the view that with internationalisation of the economy had come the end of ideology in politics. The capacity of national governments to fund social programmes, he maintained, were severely restricted by the market as the ambitions of liberal idealism were now tempered by national economic self-interest (*The Australian* 5 Sept. 1995: 1, 6).

From this pessimistic note, the discussion now looks at the degree to which governments do in fact act on moral principle in terms of energy issues. Energy can be considered a (genuinely) moral issue on three accounts: (i) many energy supply construction projects have longer than normal planning horizons due to their long lead times and their greater impact on future generations than conventional planning decisions, (ii) the exhaustibility of fossil fuels, and (iii) the long-term environmental impacts of energy use. Each of these is discussed separately.

3.5.2.1 Discount Rates and Intergenerational Issues

The standard economic approach has long held that policy is capable of resolving the issue of optimal allocation of resources between generations by employing appropriate social discount rates in public project appraisals (Kellow 1982: 7). Because of this, some commentators tend to be highly sceptical about environmentalist use of moral arguments as the basis for demands for policy reform and alternative policy options. Such commentators maintain that many intergenerational issues are resolvable without resorting to such moral arguments and dismiss moral arguments based on notions of 'the Planet' or 'Nature' as not only politically ineffective but as dishonest attempts to turn political issues into moral blacks and whites (Kellow & Moon 1993: 241). It needs to be remembered, however, that moral arguments are employed by all sides in policy debate. Free marketeers, for example, consistently oppose government intervention in the market on the grounds that it violates basic individual freedoms. Kellow & Moon's argument, however, is that intragenerational issues can be resolved by placing economic values on natural assets and by selection of an appropriate social discount rate in cost-benefit analyses. The lower the discount rate employed, the greater weighting placed on the future costs and benefits. Low discount rates in the analysis of timber operations, for example, favour longer rotation periods between harvesting. The use of discount rates, can, however, present environmentalists with a dilemma. The use of low discount rates in electricity planning, for example, favours capital intensive energy options such as wind farms in which the costs are made during the initial construction phase, and mitigates against options with lower upfront cost but a stream of costs over time, such as coal-fired power stations. High discount rates are therefore seen by energy conservation enthusiasts to be the greatest barrier to renewable energy systems (Pears & Versluis 1993: Section C: 5). Low discount rates, however, also favour options such as hydro-electric dam construction and nuclear power over coal-fired power stations. Low discount rates, furthermore, contain another contradiction for environmentalists in that they could increase the overall demand for materials. A problem for environmentalists, therefore, is that there is no one discount rate that consistently favours their preferred options.

Debate about the shortcomings of cost benefit analysis, moreover, is considerable. Whether monetary values can be placed on intangible factors such as the effects of oil spills on marine life or the effects of radiation on public health is contestable and critics of cost benefit analysis maintain that such attempts are based on arbitrary values and guesses as valuations placed on many costs can only be subjective or no more than rule of thumb guesstimates (Davis *et al.* 1988: 111). Placing monetary values on such costs therefore gives these analyses the appearance but not the substance of rationality. Economic analysts parry with the argument that whilst imperfect, there is no viable alternative to cost benefit analyses (Ableson 1979: 57) and that their use is likely to improve decision-making as the benefits of preservation are unlikely to be so high as to be above valuation (Harris 1982: 63). Whilst the attempt to place a value on natural assets and the use of social discount rating continues to be defended as capable of dealing with moral issues, there has been a growing critique of the capacity of standard economics to do so (Martinez-Alier 1987, Costanza 1992, Hodgson 1993). Traditionally conservative economists, moreover, have conceded that the view from within the economics profession is that there is a need for a 'new economics' which will take greater account of human values and the needs of future generations (Felmingham 1995). The debate is ongoing but from the above it can be seen that there is a dominant view within policy making circles that the moral issues of equitable resource allocation between generations involved in energy project appraisal can be adequately resolved by selection of an appropriate discount rate. To this way of thinking, once the appropriate discount rate is used in energy project appraisal, determination of the appropriate level of energy conservation can be rationally determined without the need to consider moral issues.

3.5.2.2 The Exhaustibility of Non-Renewable Energy Sources

The moral implications of the inherent exhaustibility of fossil fuels are twofold. The first involves the question of how such depletable resources should be shared between members of the current generation, while the second involves the issue of how these resources should be shared between current and future generations. Taking the first question, the gap between per capita resource use in rich and poor countries is so blatantly large that the moral case for a more a more equitable distribution of resources between countries is incontrovertible. A persistent environmentalist demand has been a drastic reduction in the use of energy and other resources in developed countries in order to make room for those in developing countries to increase theirs (Glasser 1977: 19, Tapp & Watkins 1990: 27, Anderson 1993: 23, Goodland 1992: 3, Dovers 1994c: 42). Such a demand strikes a resonant chord not only with environmentalists but everyone, for as Enzensberger (1974: 15) tersely put it, 'who wouldn't be taken in by such global brotherliness'.

The environmentalist demand is based largely on the argument that if the ultimate objective is more or less equal per capita levels of resource use, the physical limit to the amount of energy available dictates that the developed world will have to reduce its levels of per capita energy use since if all individuals in the world used energy at a rate of those in the USA today, world energy use would treble. If the increased populations are factored in, furthermore, total world energy use would be seven times higher in 2050 than today's levels. This impossible calculus means that without reducing per capita energy use in industrialised countries there is no feasible way of achieving equality in levels of energy use (Tapp & Watkins 1990: 23, Dovers 1994c: 42).

In the face of this inequality, waste of energy is broadly perceived to be immoral (Ester 1985: 5). The Australian engineering fraternity (Institute of Engineers 1977: 187), for example, described the inefficient use of energy in industrialised countries in the face of the glaring disparity in per capita energy use between rich and poor countries as irresponsible and gross indulgence. The problem is, however, that increasing the efficiency of energy use in energy-intensive countries on its own does nothing to materially assist those in poor countries. Radical environmental demand for reducing energy use in industrialised countries as a means of achieving a more equitable sharing of energy resources between industrialised and developing countries, furthermore, runs up against the disturbing reality that whilst the inequitable use of energy is indisputably a serious issue, energy use is not the only resource characterised by such gross disparities. Deficiencies of the most basic resource, food, has proved a tragic and largely unresolved problem. Currently, about 1 billion people in the world are starving, between 50 to 60 million die from malnutrition each year, and five billion live below the poverty line (Smith 1994: 70). In the face of this inequity, those in wealthy countries are rarely willing to commit more than 1% of GNP on development aid and regard themselves as entitled to sell commodities at the highest possible prices or keep scarce minerals in the ground although these are needed by less developed countries. The reality appears to be that international obligations usually correlate with rights rather than welfare (Miller 1989: 723). Nor can the cause of this predicament be loaded onto governments alone, as their constituencies are equally unwilling to allow their governments to devote more than these relatively small amounts on aid and governments find it hard to attract majorities for self-sacrificing policies (Stretton 1976: 286).

While intragenerational issues are real and serious, and as an argument for energy conservation are entirely legitimate, they are therefore problematical. Concern over inequitable resource use between rich and poor countries is likely to be motivated not purely by moral concerns but, at least in part, by concern over the international tensions created by these disparities. The international means of putting into effect proposals for more equitable sharing of resources via economic cooperation based on enlightened self-interest (Independent Commission on International Development Issues 1980), however, have been elusive due to the lack of the necessary political and economic structures in place (Corbridge 1986: 122). It is for this reason that the Less Developed Countries (LDCs) as a group have turned to other means. The 'Group of 77', a bloc of non-aligned LDCs, have made their willingness to cooperate with the industrialised world's environmental and other concerns contingent upon the commitment of the industrialised nations to assist them in their development objectives. Rather than being driven by a moral sense, industrialised countries may, therefore, be forced to act to reduce regional and global pollution and put into effect greater equity in resource use as part of a planetary bargain (Dahlberg *et al.* 1985: 135). The Earth Summit in Rio de Janeiro in 1992 failed to extract any transfer of capital or technology to the poorer countries as a means of improving the lot of the poor in those countries or reducing the environmental impacts of their development programmes. The Malaysian Minister for Primary Industry was therefore provoked to declare that his country was poor and needed to rely on production of timber from native forests to better the lot of the Malaysian people. If the developed world wanted to protect those forests, he declared, then they would have to pay for them (North 1995: 296). Although many environmentalists demand that the industrialised world reduce its greenhouse gas emissions for moral reasons, such reductions may well be driven ultimately by enlightened self-interest rather than genuinely moral concerns. In terms of the capacity of the moral arguments over the equitable distribution of resources between developed and developing countries, therefore, it appears that while it is a legitimate demand, it is unlikely on its own to be successful in altering policy. There appears, as yet, to be no evidence that policy makers accept that the goal of equal levels of per capita energy use at a global level constitutes the basis of decision making at the local level.

The second argument for energy conservation based on the exhaustibility of fossil fuels is that of intertemporal equity of resource use. Contemporary advocates of aggressive energy conservation continue to define conservation in the tradition of the resource conservation movement as 'essentially an ethic involving the long-term management of resources for the benefit of mankind' (Tapp & Watkins 1990: 74). During the 1970s, environmentalist argued that scarce energy resources, and particularly oil, should be left in the ground for future generations. It was quickly noted, however, that sharing resources with future generations bumped into the problem of how many generations the resource was to be shared with. To divide a resource equally between *all* future generations reduces each generation's share to virtually zero, and although this was said to be no more absurd an idea than that one or two generations have a right to deplete an entire resource (Daly 1978: 22), it left an awkward question unanswered. It was argued, furthermore, that the hard political reality was that governments were unlikely to elect to leave scarce resources such as oil in the ground for future generations when it was a cheaper source of energy than alternatives and that any policy designed to do so would be highly unpopular (Stretton 1976: 286). Many economists argued, furthermore, that it is by no means certain that such sacrifices made by the members of the current generation in the interests of their descendants would be appreciated by the intended beneficiaries since technological advancement could render the conserved fuels plentiful relative to demand and, therefore, relatively lowly valued (Edwards & Thorpe 1978: 34).

Basing the case for energy conservation on the moral need to share resources between generations strikes yet another awkward question. Georgescu-Roegen (1976: xviii) stated quite emphatically that a steady state economy at even present levels would be unsustainable and insisted that world population levels would have to be reduced to levels that could be sustained on organic agricultural practices. But as Tisdell (1990: 61-2) points out, this raises a major philosophical issue as it leaves humanity with a choice of three general paths of development: (i) exponential growth, collapse and possible extinction, (ii) a steady state at existing population levels which puts off eventual collapse and may not avoid eventual resource exhaustion, or (iii) a steady reduction of population levels and economic activity so as to tremendously extend the survival period of the human race. The argument about sustainable resource use therefore effectively comes down to a debate involving the distribution of human population over time.

3.5.2.3 Long-term Environmental Impacts of Energy Use

There is a commonplace view that environmental concern is primarily a concern about the consequences of present actions on future generations and that in the absence of concern for future generations, the environmental movement would lose much of its drive (Cameron 1989: 57). The 'new energy crisis', it is maintained, is substantively different from the 'old energy crisis' precisely because the intragenerational impacts of energy use can no longer be shrugged off lightly (Schipper & Meyers 1992: 54). The issue, like that of intragenerational equity discussed above, is based on a widespread intuitive judgment that future generations have moral standing of some sort. At a philosophical level, this equivalence is apparent as there is very little difference in our obligations to future generations and our obligations of those in need in other countries as distance and time and distance in place are equivalent (Attfield 1991: 90).

The difficult question in attempting to base decision making on the future is how far into the future needs to be considered. The further into the future, the more uncertain the impacts associated with present actions become. It has been argued that it is difficult enough to care about those in the present in distant countries, let alone to concern ourselves with those not yet born so that consideration of the impacts of our present actions should be limited to the foreseeable future only, this being defined as the lifetimes of our children and grandchildren (Passmore 1974: 54). It is nonetheless clear that even very distant generations will require as a minimum a functional biosphere in order to meet certain basic needs (Attfield 1991: 91).

The issue of the long-term environmental impacts of our activities has become more critical in recent years as the signs of irreversible global environmental change become more visible and worrisome, on the one hand, and have the potential to deepen as economic activity is accelerated in the attempt to raise the well-being of those in developing countries, on the other. The concept advanced as the means of balancing these inherently conflicting goals and steering a path that avoids a clash between inter and intragenerational issues is sustainable development and it is a pertinent point at which to end this discussion on the arguments for energy conservation as it encapsulates many of the problems discussed in this chapter and leads directly into the discussion of energy efficiency in the following chapter.

3.5.2.4 Sustainable Development

Sustainable development is a concept that has been around in various forms for some time and like energy conservation is uncontentious in principle, a 'good thing'. Definition of the term, and the means of how to put it into practice, however, have been elusive

(Adams 1990: 24). Many consider that the word *development* was tricky enough, a Trojan horse of a term into which one can pack anything one likes (Frank 1987: 232). These writers consider that its juxtaposition with *sustainable* has merely produced a term that is useful precisely because it is imprecise (Redclift 1992: 40).

Many questions hover uncomfortably over the question of sustainable development, the primary one being whether it is possible. James Lovelock once stated that he gave more credence to the notion that a goat could become a gardener than to the notion that humans could become stewards of the planet. Optimists place their faith in international treaties and technology. One of the few areas of relative agreement is that it will involve very substantial increases in the efficiency of energy use and shifts in the technologies used to produce this energy. But achieving that will require mechanisms such as regulation and pricing, the political acceptance for which remains uncertain. Moreover, it is not yet clear whether these devices will be adequate or whether substantial changes in our material standards of living and behaviour, such as giving up driving cars, will be also be necessary.

The more difficult question is whether sustainable development will be a truly global strategy. The greenhouse issue represents an acid test to such commitment and present indications are not promising with an impasse over how to convince developing countries to agree to reduce their emissions. While industrialised countries have historically contributed most to increased concentrations of these gases and remain the major emitters today, the rate at which developing countries and newly industrialising countries are increasing their emissions means that any effort on the part of industrialised countries to reduce their own emissions will be swamped by the increase in the those from the developing world. Without agreement from the developing countries, stabilization of greenhouse gases will not be possible. But these countries do not see their contributions as the cause of the problem and are focused on what they perceive as more pressing internal problems (Cairncross 1994). They are unlikely to be willing to reach agreements to cut their emissions unless those agreements are based on per capita emissions and unless the industrialised world is willing to transfer the technologies and capital necessary for their development programmes to continue unabated. Industrialised countries, however, have proved reluctant to do so and are likely to support carbon-taxes only if they, rather than an international body, retain control of the revenue raised from those taxes (Redclift 1992: 40).

Another important question revolving around the issue of sustainable development returns our discussion to the definition of the concept. For, as Susan Owens (1995: 208) has put it, sustainable development defined narrowly as material well-being and survival is merely an extension of the ideas embodied within those of the resource conservation movement and if applied in that sense then 'future generations could look forward to a safe and sanitised, but aesthetically and culturally sterile environment'. To such writers, sustainable development defined globally and in its broadest sense will not be possible without each of us questioning our material needs and wants, and will therefore require radical restructuring of our economic and social institutions which shape and drive those wants (Redclift 1992: 42, Owens 1995: 213).

3.6 Summary & Discussion

This chapter has approached energy conservation from the environmentalist perspective and has unravelled the arguments behind the environmentalist demands for energy conservation in order to understand why they have been ignored. Four explanations have been found for the rejection of these demands.

The first of these explanations is that although energy conservation is often assumed to be an uncontentious policy objective, in reality many awkward questions lie behind the idea and that the issues are so complex that there is little consensus on the question of what the appropriate level of energy conservation should be. Demands for high energy conservation based on the fundamentalist notion that energy conservation is a good thing and something we cannot have enough of are simply ignored as they are seen to have little relevance for rational policy debate.

The second explanation for the dismissal of these demands for energy conservation is that the arguments upon which they are based are considered ill-informed and irrational. Environmentalist opposition to supply expansion is put down as irrational fear of unfamiliar or large and complex technologies, unscientific assessments of risks, or unproven evidence of energy-related problems. Policy makers are dismissive or sceptical about demands for reductions in energy use based on theoretical, general and global arguments which shift over time. Concern over these environmental issues is seen to be episodic, this fluctuation being attributed to an increase in perceived, rather than actual, risks (Douglas & Wildavsky 1983: 10). These demands are considered to be buoyed, furthermore, by the concepts of the 'energy-crisis' or the 'environmental crisis', concepts referred to in the realist school of the philosophy of science as 'chaotic abstractions' (Sayer 1992: 53). These abstractions are constructed by improperly bundling together separate entities that cannot simply be grouped together to form a single entity the way that atoms can be put together to form a molecule. They are therefore interpreted by critics as homogenising agents which falsely smooth out the differences between a range of environmental and social problems from one place to another and which confuse rather than aid debate.

While environmental writers tend to explain this scepticism in terms of denial on the part of policy makers, a third explanation for the rejection of these demands for high energy conservation is that there exist structural constraints on policy making. Even if problems such as the well-being of those less well off in developing countries or those not yet born are accepted as real and serious, democratically elected governments are severely constrained in what they can and cannot do by their electorates. Without change in individual values that results in a reduction in material wants, material standards of living and levels of consumption, those problems are not readily resolvable by government. While the likelihood that individual values will change is hotly debated, those who consider individual values to be shaped largely by our economic and social institutions suggest that without radical transformation of those institutions such a shift in individual values is unlikely.

The final grounds upon which these demands for high energy conservation are dismissed are that the arguments upon which they are based are considered to be deliberately exaggerated or fabricated. Demands for high energy conservation are regarded as ambit claims designed to achieve more moderate energy conservation goals, such as widespread adoption of solar domestic hot water systems, increased reliance on public transport, or urban redesign. The risks of eco-catastrophe are considered by critics of environmentalism to be deliberately overstated, while moral arguments about nature or the plight of distant others are considered to be used merely to achieve here and now human wants (Beckmann 1976: 167, Wildavsky 1979. 396, Wildavsky 1992: ix). That environmentalists have to resort to such tactics in order to achieve their more modest demands has been attributed to the fact that in the absence of other mechanisms, such as the withdrawal of labour supply, the environmental movement's most effective weapon in their attempt to bring about reform is to maximise the perceived electoral ramifications of not meeting those demands (Bergmann 1993). This is achieved by maximising the perceived risks associated with technologies such as nuclear fission and with pollution generated through the production and use of energy in general. Exaggerations and overdramatisation may well also be, in part, an attempt to counter their opponents' attempts to minimise those perceived risks.

This raises the question of why these more moderate demands for energy conservation are dismissed by policy makers and leads into the following chapter on energy efficiency. There is, however, another explanation that can be advanced for the need to overdramatise and exaggerate environmental problems. This chapter has focused primarily on those arguments for energy conservation associated with the scientific stream of environmentalism. The concerns behind the second brand of environmentalism distinguished by Sandbach (1980: 26), that stream concerned with the social or humanitarian impacts of technology and science, have been touched on but have not been the dominant part of the discussion. The need to exaggerate risks and overdramatise problems, and even energy conservation fundamentalism, could also be explained in terms of an inability to bring to formal debate on energy policy many of those social or humanitarian issues. For what is 'rational' in modern society, has virtually come to mean that which is instrumentally rational (Poole 1991: 67). What is instrumental rational, furthermore, has been largely appropriated to mean that which is economically rational. Formal energy policy debate is therefore restricted to the instrumentally and economically 'rational' planes in which nothing is sacred, all is profane, everything can be costed, and risks can be assessed objectively using scientific probabilistic techniques. Emotive and social issues such as how much wilderness we ought to leave, what aspects of nature should be retained, how to combat the alienation created by a society that revolves around cars and highways, what level of perceived risk we want to accept, and what sort of society we want to live in and pass on to our children, are all described by some as 'less dramatic' environmental causes (Dahlberg *et al.* 1985: 77). To others, they are neither irrelevant nor secondary, but all-important (Beck 1992: 28). They have not been the central focus of this chapter precisely because they are not included in formal debate over policy issues. The boundaries of such debate are circumscribed not by environmentalist, but by policy makers and the former are forced to debate on their opponents' terms and in their opponents' language, and to use the particular rather than the general (Socolow 1981: 152). The environmental impact assessment (EIA) process, for example, has been criticised as an inherently weak tool because of the highly circumscribed role that it plays in decision making. EIAs are typically used to merely examine *how* a specific development project should occur rather than *whether* or *where* such development should take place (Sadler 1994: 4). The important conclusion that can be drawn from this is that in retreating to more moderate demands for energy conservation based on energy efficiency, energy conservation as an option loses much of its puff as environmentalists are forced to leave behind much of what is most important to them (Owens 1995: 213). The dismissal of demands for high energy conservation therefore go a long way to explaining why more modest demands for energy conservation are also dismissed. For in making the retreat to these more moderate demands for reducing energy use based on 'rational' arguments, the passion that drives environmental campaigns is lost and much of the intensity of environmental debate dissipated (Tindale 1995: 205). The extent to which important goals can be achieved becomes dependent on the degree to which they can be accommodated through such instrumentally and economically rational arguments.

Environmentalists therefore not only have to debate using the terms and language of the dominant discourse, but are also forced to support more moderate demands for energy conservation as a retreat to more achievable objectives. As a consequence of these compromises, their demands are often inconsistent and contradictory. To argue for sustainable development on the basis of moral arguments on the one hand, for example, while advancing energy efficiency as a means of increasing the competitiveness of the national economy on the other, are potentially contradictory since increased competitiveness of our own economy could deprive developing countries of income.

This chapter has also been used to partially explain the disparity in policy emphasis on energy conservation between countries and regions. It has been shown that moderate energy conservation policies have been implemented as national strategic or economic imperatives. In certain situations, moderate energy conservation policies have also been adopted at the local level as a consequence of local opposition, rational or otherwise, to supply expansion proposals. This has occurred particularly in parts of the United States of America (McConnon 1986: 217, Lees 1995: 196). Such public opposition to siting of supply expansion projects has been most successful in forcing policy makers to adopt moderate energy conservation policies where the judicial system permits individual members of the public to challenge the legality of supply expansion proposals. Elsewhere, the ability to persuade policy makers to adopt moderate energy conservation has been less successful and policy has continued to rely almost exclusively on expanding the supply of energy while using technical fixes to resolve or reduce energy-related problems.

The study now follows this retreat away from the demand for aggressive energy conservation based on social and ecological concerns to more moderate demand for reductions in energy use based on the economically rational arguments and technical fixes. The following chapter examines the demands for energy efficiency and attempts to explain why these 'rational' demands also tend to be dismissed as policy options as a means of reducing the need for expansion of energy supply.

Chapter Four

Energy Efficiency: the Non-Adoption of a Rational Option

Between the idea
And the reality
Between the motion
And the act
Falls the shadow
—— T.S. Eliot (1925) *The Hollowmen.*

4.1 Introduction

Those who advance energy policy proposals based on increasing the efficiency of energy use consider the benefits of their proposals to be both multiple (Lovins & Hirst 1989: 39) and obvious (Blackburn 1987: x). Included amongst these perceived advantages, moreover, are economic benefits, and because of this, energy efficiency is considered to be a 'spherically sensible' strategy - an energy option which is rational no matter from what perspective it is looked at (Socolow 1991: 535).

Energy efficiency advocates are therefore perplexed by the fact that many individuals, energy supply organisations and policy makers tend to overlook the available and substantial scope for cost-effectively reducing energy requirements by increasing the efficiency of energy use. Why individuals overlook the available cost-effective energy efficiency measures has been something of a mystery to such writers , who ask, 'Why, if energy conservation is so simple, logical and cheap, is more energy conservation not taken up?' (Sathaye & Gadgil 1992: 163).

Equally perplexing and frustrating to advocates of energy efficiency is the fact that energy efficiency is also rejected by energy suppliers when it would appear to make good business sense, since the incremental costs of increasing energy supply are significantly greater than average costs of existing electricity supply (White 1981: 4546).

These energy efficiency proposals are also considered to be economically rational from a social perspective:

> All experts agree that our society can save about half of the energy we are using without any loss in the quality of life ... When the experts make these predictions, they are making them on the basis of the technical knowledge that is available today. Most importantly they are making the statement that many of these conservation investments are economically justifiable and would pay for themselves in a few years ... Why then is there not more conservation? (Seligman 1985: 135)

Advocates of aggressive energy efficiency policies have often seen the theoretical practical implications of increasing the efficiency of energy use in terms of the reduced need for investment in added generating capacity as a potent means of advancing this option:

> One 20 W compact fluorescent lamp gives the same energy service - illumination - as one 100 W incandescent bulb. Ten million 100 W incandescent bulbs require 1000 MW of power station to light them. Ten million 20 W compact fluorescent lamps requires only 200 MW of power station to light them. The choice before society is obvious. (Patterson 1992: 186)

Given these seemingly substantial economic benefits of energy efficiency strategies on top of the perceived urgent need to reduce the social and ecological costs of energy production and use (Mestrovic 1992: 331, Gilchrist 1994: 1, Dovers 1994a: xi), these policy proposals are considered by those who advance them to be 'realistic' and like Keynesian economics, apolitical and equally palatable to political parties and administrations of all persuasions (Paehlke 1989: 31). To such individuals, the failure on the part of energy policy makers to adopt these economically rational proposals is therefore both difficult to comprehend and frustrating (Grubb *et al.* 1992: xvii).

Their inability to influence policy makers has led to the portrayal of the debate over energy policy as one neatly delineated between just two camps, with advocates of aggressive energy efficiency (demand-siders) in one camp, and the 'energy establishment' (supply-siders) in the other. Energy efficiency advocates describe their own camp as made up of a small and disorganised, but altruistic and determined band of independent experts and their supporters (Moskovitz 1992: 399). These experts, who tend to be trained in the physical sciences and physics in particular, doggedly persist in offering what they reckon to be sensible and unbiased policy advice based on socially and economically rational principles. Their opponents in the 'energy establishment's' camp are seen to be typically economists, engineers and politicians, who inexplicably and persistently refuse to listen to the sensible advice being offered them (Nørgård & Christensen 1987: 3-6, Gilchrist 1994: 278).

The ongoing debate between these two camps is likened by advocates of energy efficiency as a frustrating, one-sided affair, akin to the attempt to engage in dialogue with the deaf. They produce techno-economic analyses of the potential for reducing energy use via energy efficiency, plot trends in energy use that show how much energy has been saved by energy efficiency and how much more could be saved, and describe the policies available to policy makers to increase the efficiency of energy use. As these efforts are to little avail, and not understanding why their seemingly 'sensible' proposals are dismissed, energy efficiency experts rework their analyses 'once more' in the hope that repetition will eventually pay dividends where rational debate has failed (Blackburn 1987: xi).

The aim of this chapter is to explain why policy makers seem not to have been listening to these demands for reducing the requirements for energy by increasing the efficiency of energy use. The discussion begins by examining the various sociological or general models advanced to explain the rapid growth of energy systems and of energy supply technologies in particular. Working downward from the general and most ambitious energy efficiency proposals to more specific and modest proposals by looking at the history of the development of the energy efficiency concept, the discussion turns to the rejection of more modest energy efficiency proposals by examining the planning and policy decision making processes, focusing particularly on electricity planning. The reason for this focus on electricity is that while the critique that energy policy making has relied on expansion of supply and the rejection of energy conservation is common to all energy types (Saddler 1981: 4), electricity planning has been most closely associated with both rapid growth of energy systems and public conflict, and has been described as the most virulent form of 'growthmania' (Daly 1973).

4.2 Sociological Explanations of the Growth of Energy Systems

4.2.1 Technological Determinism

Technological determinism has been described as the single most influential theory about the relationship between society and technology (MacKenzie & Wajcman 1985: 2). The thesis has received a good deal of support form social writers such as Ellul (1964), Rosak (1969) and Reich (1970) who have portrayed technology as malevolent and anarchic and who have portrayed social, environmental and economic change to be a consequence of technological development. Technological determinism, furthermore, has come to constitute the most common sociological explanation of the growth of technological systems and, by implication, the main sociological theory advanced to explain the non-adoption of energy conservation as an option.

The technological determinism thesis posits simply that technology is an independent factor over which society has little or no influence. It is the thesis that technological change is the most important source of change in society and that technology is not simply a tool used by society, but something which impinges on society from outside. As Grundmann (1991: 109) points out, technological determinism is the technological parallel of the Marxist economic concept of *alienation*[1] and posits that technology

[1] Marx defined 'alienation' as the process in which the results of human action become independent from their producers and cannot be re-appropriated because the process retroacts on the producers in a detrimental way (Grundmann 1991: 109).

'works behind people's backs' . Those who espouse this theory deny that technologies are social constructions and posit, in its most extreme form, that technology is autonomous.

The most thorough attempt to date at undermining the notion that technologies are neutral has been that advanced by Langdon Winner (1977) in his *Autonomous Technology*. Winner extended the 'technics-out-of-control' theme to develop his 'reverse adaption' thesis. In Winner's view, a specific technology is selected initially as a means of achieving a task with a desired social end. On completion of this task, however, the technology 'refuses to go gently into that goodnight' (Winner 1977: 25) and spontaneously sets in train a series of social transformations which lead eventually to a reversal of the ends and means. The original tool, the technology, effectively takes control of society and creates its own operational imperatives. While the original purpose of the technology was to provide important social ends, the ends become crucial to the survival of the system and are pursued regardless of whether they have any further objective value to society or not (Winner 1977: 247). The thesis holds that once the technology's original use-by date has expired, the technological system develops under its own volition and becomes increasingly unresponsive, inflexible and rigid. In the end, technology shapes the needs of society rather than passively responding to consumer demand. To do this, the technological system has to ensure that there exists a happy coincidence between social needs and what the system is able to produce (Winner 1977: 146). Advertising, product design and tariff structures are therefore mobilized to this end, moulding individual wants to match technological output. Winner used this thesis to explain, amongst other phenomena, the rapid expansion of energy supply systems.

Winner conceded that there was a political dimension to the growth of technological systems and relied heavily on Galbraith's (1972) concept of 'technostructures' controlled by a cadre of technical élites. Winner replaced Galbraith's concept of 'technical élites' with his own theory of 'technological politics' in which who was nominally in control of the technology was irrelevant as in reality no one was in control. Whoever was in command of the system would be forced, according to Winner, to take more or less the same steps with regard to the maintenance and growth of technological means (1977: 263-4).

Few outside sociology, including this author, accept the technological determinism thesis and dismiss it as anthropomorphism of technological systems. While the rapid growth of technological systems does give the outward impression that the technological system is closed and uninfluenced by external events, technological determinism overlooks the fact that high growth rates of technological systems are politically driven. Examples of technologies which have not been taken up or which have been resisted, and the differential impacts of a technology in different situations have been used to show that the thesis does not stand up to critical review and is too simple an explanation of the relationship between society and technology (MacKenzie & Wajcman 1985: 6). The technology-out-of control thesis is therefore useful as a overall description, but has little explanatory or predictive power and is therefore rejected by the author as a suitable explanation of policy reliance on continued expansion of energy supply and dismissal of energy conservation as a means of reducing the need for further supply.

4.2.2 System Trajectory Thesis

The trajectory thesis maintains that once large technological, economic or social systems are set on a particular course, they continue along that trajectory because they are able to resist attempts at changes in direction. Various mechanistic and biological metaphors have been employed to describe the mechanisms behind this resistance. Thorsten Veblen (1899) considered the problem to be social institutions which were prone to 'institutional inertia'. In his *The Theory of the Leisure Class*, Veblen argued that unless otherwise compelled by circumstances, human behaviour and thought was habitual and that this routinised behaviour had a cumulative and self-reinforcing effect at the institutional level; increasing resistance to innovation and reform. He wrote:

> These institutions which have so been handed down, these habits of thought, points of view, mental attitudes and aptitudes, or what not, are therefore themselves a conservative factor. This is the social factor of social inertia, psychological inertia, conservatism. (Veblen 1899; 190-1, cited in Hodgson 1993: 131)

Ogburn (1922) used the metaphor *cultural lag* to convey a similar idea that social institutions are slow to adapt to their changing environment, becoming institutional anachronisms out of synchronisation with the needs of the new era. His metaphor was subsequently borrowed by many other writers, including Hubbert (1949: 109) and Odum (1969: 403).

Yet other writers on technological development have resorted to biological metaphors. Giovanni Dosi (1984) used the biological analogy of evolution to describe his model of technological development in which technologies were likened to species influenced by an environment comprised of the economic, political and institutional systems. To Dosi (1984: 20), these environmental forces shaped technology by selecting the initial direction of mutation (setting the technological paradigm) and then selecting among the mutations (by *ex poste* trial and error).

Hodgson (1993) has recently adapted another evolutionary metaphor to describe the process by which large systems become locked into certain paths of development and are resistant to attempts to alter their paths of development. The tendency of species to evolve characteristics which then set the evolutionary development of the species on a course and excluded other paths, even though some of these other evolutionary paths are possibly more efficient or desirable, was referred to by the biologist Conrad Waddington (1957) as *chreodic development*[2]. This tendency of *chreods* to stabilise on one course of development through time was attributed by biologists in part to the evolution of hierarchical control sequences in the genotype (Hodgson 1993: 257).

According to Hodgson, a number of researchers interested in the process of technical innovation and change argued during the 1980s that technological systems developed hierarchical control sequences and behaved very similar to a chreod. Once a technological 'paradigm' was selected early on in the development of a technology, these writers maintained, the technical system evolved in a relatively fixed path of development and it appeared to become increasingly difficult for the system to deviate from this trajectory. Technological lock-in was said to have occurred. A good example was the motor car. Once the internal combustion motor was chosen in preference to steam, gas or electric vehicles, the course of development was set. Furthermore, once the private motor vehicle was chosen, it set the course for the development of transport systems which then became difficult to alter even after the problems with overdependence on private vehicles became apparent. Other examples cited by Hodgson of technological lock-in in the face of alternatives that in hindsight appear to have been better were standard typewriter keyboards, standard railway line gauges and VHS video cassettes (Hodgson 1993: 257). The concept of chreodic development applied equally well, according to Hodgson, to industrial, economic and institutional systems.

Hodgson explained the behaviour of chreods in terms of positive feedback effects which freeze an attribute or structure in place and make subsequent amendment difficult, even if the original development was not perfect. The advantages of alternative patterns of development destabilise the system by acting to pull it off its stable trajectory but are effectively countered by a strong hierarchical controlling influence that steers the system back onto the original course. The inherent danger of this type of development, Hodgson concluded, was that the stability of the system may lead over time to ossification as prolonged periods of habits of thought and action decrease the ability to respond to a changing environment and steer the chreod towards catastrophe. A regional economic system, for example, Hodgson suggested could be decimated by an inability to anticipate the entry of more vigorous competitors from outside.

The policy implications of chreodic development, according to Hodgson, are clear. In the case of energy systems, for example, attempts at small adjustments to alter the

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[2] Waddington 's term, chreod, was from the Greek *chre* = fated and *hodos* = path.

course of the development of the system toward increased adoption of innovative or different technologies will tend to fail as the hierarchically controlled chreod is too able to counter these small perpetrations and pull the system back to its original course. The only viable way of effecting a transition to a more optimal choice of energy technologies is, therefore, a planned and abrupt change of tack rather than piecemeal and gradualistic change in direction.

As with the technological determinism thesis, the concept of technological trajectory has been dismissed on the grounds that it omits an understanding of the causes of technological momentum. Historian of large energy systems, Ted Hughes (1987: 77) has debunked the technological trajectory thesis, arguing that the momentum of energy systems is purely an artefact of the durability of their physical components and the inability of energy generation and supply organisations to rapidly divest themselves of such components. While it is possible to reduce some 'momentum' through measures such as retrenching workers, it is not possible to abruptly divest debt or infrastructure.

Critics of the technological trajectory thesis accepted the argument that the choice of one technology may have far reaching ramifications in terms of predetermining subsequent technological choices. The decision to develop a nationally interconnected grid, they suggested, may bias the future system towards the construction of large centralised energy systems such as nuclear power stations, whilst locally independent grids would favour small renewable systems. They maintained, however, that these original choices were not neutral but part of an inherently political process (MacKenzie & Wajcman 1985: 7).

Historical instances of broken trajectories have also been used to argue that the trajectory thesis was not good at predicting the development of technological systems. Disruptions to oil supplies in the 1970s, increased environmental concern in the 1960s, and the diminishing potential to increase the technical efficiencies of conventional energy supply systems, all challenged the assumptions of unstoppable technological momentum or chreodic development. Countless systems have reached a point of stasis, declined and disappeared (Hughes 1987: 80). The British electricity system, for example, underwent substantial changes during the first world war. Prior to the war, the British electricity supply system was based on local government political boundaries. To increase load factors[3] and the efficiency of fuel use, Parliament overrode local government and forced interconnection of the multiple grids. Increased technical efficiency continued to be assigned a high priority in post-war reconstruction and the tradition in local government control of electricity supply was permanently terminated.

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[3] Load factor is the ratio of average to peak load, or the ratio of the average load to the generating capacity of a system.

To Hughes (1983), the development of technologies was driven by economic imperatives rather than compelled by technology acting separately. Because technologies are inextricably a part of society and the economic enterprise, Hughes (1983: 80) argued, they are open to competition, and are therefore forced to change. The more closely the economy of a country is linked to international markets, the greater the pressure exerted on that country by technical change outside a country.

The apparent tendency of energy systems to become less controllable and to steer a course independent of human agency as they get larger and gather momentum has sufficient semblance of truth to render the notions of autonomous technology and chreodic development attractive. The authors of *A Time to Choose* came close to articulating such a view in stating that modern energy systems were not shaped by social choice but were allowed to 'drift' (Freeman *et al.* 1974: 3).

While useful heuritsic aids, the concepts of technological determinism and the trajectory theses ignore the structural mechanisms and contingent events that shape technologies and cause 'lock-in' to occur. The second world war, for example, is said to have been a war of motion and an event that gave huge impetus to the shift from rail to road transport (Yergin 1991: 382). While technological trajectory models, such as Hodgson's chreodic development, provide a useful metaphor of what occurs at the systems level, they offer little by way of explanation of how vested interests shape the initial decisions and behind the resistance to change. An example of a more complete understanding was Ruth Cowan's (1985) account of the processes that led to the dominance of compression cycle over absorption technology in refrigeration manufacturing.

Describing how the refrigerator got its hum, Cowan described the embryonic domestic refrigerator manufacturing industry in the USA and recounted how gas absorption and electric compression refrigerator technologies were initially developed independently by various small companies in the early years of the present century. Many technical experts regarded the absorption system to be the superior technology, and the absorption option also had many advantages from the consumer's perspective since it involved fewer moving parts, was less prone to breakdown, was easier to maintain, had lower operating costs and was virtually silent (Cowan 1985: 211). Gas, moreover, was in more widespread use than electricity at the time, and this, Cowan argued, ought to have given the absorption refrigeration industry a head start. Two decisive factors, however, steered the industry resolutely toward the compression option.

The first, and most important, was the entry of large manufacturing firms into the industry and their subsequent decisions to develop compression refrigerators. General Electric purchased the Kelvinator Co. in 1916 and three years later General Motors purchased Frigidaire. Refrigeration was a relatively minor activity for these companies and their subsequent decisions to develop compression technology were made purely on the basis that this technology married with their broader interests rather than on what was optimal from the community's interests. General Electric's decision was particularly instrumental and was a direct consequence of the fact that the company not only manufactured refrigerators, but also sold electricity. According to Cowan, the company made a conscious decision to pursue air-cooled rather than water-cooled condensers as the former required greater electricity use (Cowan 1985: 209).

Once these large US companies invested heavily in the development of compression technology, the smaller and undercapitalised companies such as Electrolux-Serval in Sweden, were unable to match the rate of innovation made in the laboratories of these larger companies and lost the race. As a consequence of both of these factors, the industry became locked into compression technology despite the fact that it was never demonstrated that it was the optimal technology from the users' point of view but purely on what suited the interests of business (Cowan 1985: 214). Many other technologies destined for the domestic market, she concluded, met with a similar fate. Cowan argued that neither the decision by Hoover and Apex to manufacture portable rather than centralised and technically preferred vacuum cleaners, nor Maytag's patent on the agitator and vertically rotated drum for washing machines, were based on these being the preferable technologies from a social perspective, but on the profitability for the company. They nonetheless critically shaped the development of these appliances over the ensuing half a century.

Cowan's account therefore provides a deeper explanation of why technological lock-in tends to occur. Most importantly, her account illustrated that technological development is the consequence of deliberate decisions made by planners and that the momentum of a technology has to be understood in terms of planning and political economy. Initial and deliberate decisions by key players have a very significant impact on the future development of the technology. Technological lock-in occurs, according to Cowan, because influential players have the effective power to pull other players into line. The technological determinism and technological trajectory theses, according to Cowan, were coarse as they did not explain why technological systems grow in the way that they do and why technological lock-in often occurs.

The discussion therefore turns to energy planning and energy policy decision making to provide more complete explanations for the growth of energy systems and the rejection of energy efficiency proposals. This discussion begins by tracing the historical development of energy efficiency proposals to show how these proposals have developed over time. The reasons for the dismissal of the more ambitious proposals are dealt with along the way, leaving the explanations of the rejection of more moderate energy efficiency proposals for subsequent sections.

4.3 The Historical Development of Energy Efficiency Proposals

4.3.1 Energy Efficiency as a Means of Conserving Resources

With the outbreak of renewed concern over energy-related issues in the late 1960s and early 1970s, those in the hard sciences, and physics in particular, quickly brought their skills and training to bear on the problem. In the USA, the American Physical Society joined the effort to seek solutions to the nation's energy problems by devoting its summer school - held a few months before the first oil price rises - to exploring the feasibility of increasing the efficiency of end-use equipment more thoroughly (Socolow 1985: 20). These physical scientists adopted one of two approaches.

One group approached the problem from first principles, looking for both more efficient processes and a means of increasing the efficiency of existing processes. Their approach was resolutely apolitical and focused purely on adjustment of end-use technologies rather than transforming society or altering the behaviour of end-users (Ford *et al.* 1975: 5). These technologists and physicists represented unreconstructed resource conservationists, merely shifting the focus of the wise use philosophy to the outputs and end-uses rather than the inputs of the energy system. Their efforts were stimulated primarily by concerns over energy shortages and their work pointed to considerable savings that could be achieved through technical improvements in energy-using equipment.

One report to the President of the USA, based on techno-engineering analysis, calculated that a redesign of household appliances could reduce household sector energy use by 3.7% over an eight year period (Executive Office of the President and the Office of Emergency Preparedness 1973: 23). Other reports were bolder and were based on what was theoretically possible. A federal US agency reported that it would be possible to approximately halve space heating requirements in the USA with low-cost weatherisation measures. It also claimed that it was technically feasible to produce 40 mpg cars at no extra costs to the consumer and without compromising comfort, performance or safety (US Federal Power Commission 1971). In 1972, an independent analyst, John Needy, calculated the very substantial savings in energy and household expenditure on energy that would be achieved with a hypothetical overnight replacement of the entire stock of US domestic refrigerators with the most efficient then available on the market (cited in Clark 1974: 189). This hypothetical assessment of the technical potential for saving energy and household expenditure on energy, although crude, has been a potent means of putting forward the case for the energy efficiency option and continues to be employed by researchers such as Herring (1992) who recently used the example of the technical potential for increasing the efficiency of household refrigeration energy use in the United Kingdom to argue for policy forms in that country.

4.3.2 Energy Efficiency as an Environmental Goal

The second stream of physical scientists working on energy-related problems was pioneered by a small number of physicists concerned about the attendant social and long-term environmental problems of high energy use. These physicists, such as John Holdren and Dean Abrahamson, were closer in philosophy to modern environmentalism and their writings were often aligned to the environmental movement (Abrahamson 1970, 1973, Holdren & Ehrlich 1971, Holdren & Herrera 1971). They did not limit themselves to analyses of end-use technology, but made broader critiques of energy policy based on the various problems created by the inefficient use of energy in industrial society.

This second strand of physical scientists were inspired particularly by the views of biologist Barry Commoner (1971) who served as the bridge between ecologically informed environmentalism and the search for technological solutions to environmental problems. Contradicting many leading environmentalists of the day, Commoner declared that economic growth was 'a popular whipping boy in certain ecological circles' (1971: 141) and that the solution to environmental problems required neither a reduction in living standards nor a reduction in population, but replacement of faulty technology (1971: 178-9). He was one of the first leaders of the environmental movement to advance aggressive energy efficiency proposals as a solution to environmental problems (Commoner 1976).

4.3.3 Low Energy Growth Proposals

This more radical and ambitious 'technical fix' vision based on the search for solutions to the deeper and broader social and environmental problems associated with modern society's high levels of energy use, was articulated for the first time by a pioneering report produced for the Ford Foundation in 1974. The study of US energy policy was initiated in early 1971 at a cost of (US1971) $2 million, and was the first energy modelling exercise based on a scenario analysis. In their final report, the authors described as feasible, a Low Energy Growth (LEG) scenario in which the rate of growth of US energy use over the remainder of the century was more than halved 'without requiring fundamental changes in the structure of the economy' or 'major sacrifices in real income growth' (Freeman *et al.* 1974: 511)[4]. The authors added that under an even more ambitious Zero Energy Growth (ZEG) scenario, which amounted to a restructuring of the economy but only minor lifestyle changes, energy use in the USA could be levelled off sometime before the year 2000.

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[4] Of the twelve authors of the report, only one, Ross Williams, was a physicist.

The Ford Foundation report included comments by the various members of the advisory board which ranged between two extreme views. At one extreme, it was described as too apologetic and defensive in tone and to have not gone far enough, as evidenced by its failure to recommend the total abandonment of nuclear fission technology (Freeman *et al.* 1974: 356). At the other extreme, many of the report's assumptions were contested, its objectivity challenged, and its view of the electricity supply industry dismissed as biased (Freeman *et al.* 1974: 353).

Early critics described the energy debate as polarised between two groups of hard-liners: neoconservative advocates of a business-as-usual approach, and 'eco-nuts' who advocated low energy growth proposals (Chapman 1975: 215). The latter, Chapman argued, were based on legitimate concerns over the ecological risks associated high levels of energy use and social costs of centralised energy systems based on large technologies, such as the breakdown of communities, the loss of community self-sufficiency, and the loss of skills and job satisfaction. He nonetheless dismissed their proposals as highly unrealistic, as they created more problems than they attempted to resolve. The major consequence of rapid reductions in energy use, he maintained, would be massive unemployment (Chapman 1975: 205). These low energy growth proposals, according to Chapman, were theoretical rather than practical, as they were premised on numerous assumptions, including the assumption that a shift to more labour intensive economic activity was beneficial. Chapman maintained that in doing so, they ignored the fact that people did not desire monotonous and hard physical work, and that a shift to more labour intensive modes of production would increase production costs. Unilateral adoption of such a strategy would therefore damage the economy's competitiveness. Low energy growth, he suggested, was a laudable, but long-term goal.

4.3.4 The Soft Energy Path

At about this same time as the Ford Foundation report was under way, a small number of apostate nuclear physicists, seeking greater social relevance in their work, abandoned nuclear research and went to work for the anti-nuclear movement (Webb 1995: 33). One of these renegade nuclear physicists, Amory Lovins, amalgamated the Ford Foundation study's technical fix and ZEG proposals together with the ideas of various social critics, such as Clarke's (1974) 'soft technologies', Illich's (1973: 21) 'convivial tools' and Dickson's (1974) 'appropriate technologies', to produce a 'soft energy path (SEP) proposal (Lovins 1976, 1977). Lovins was particularly influenced by the ideas of Schumacher who had described 'nuclear economics' as the example *par excellence* of 'economics as if people did not matter' and declared that what was needed was 'technology with a human face' (Schumacher 1973: 136). By blending technical assessments with these social ideas, Lovins was able to make his radical soft energy path option sound feasible. His proposal was based on two strategies: greatly increased efficiency of energy-using equipment (the technical fix component), and rapid deployment of 'soft technologies'. The latter Lovins defined as technologies which were relatively simple from the user's point of view (though these could be technically sophisticated)[5], matched in scale and in energy quality to end-use, and which relied on renewable energy resources (Lovins 1978: 478)[6].

A central feature of the SEP was the argument that very few end-use tasks actually required electricity and that the efficiency (second law) of energy use would be greatly increased if other sources of energy were used. Although his idea of a SEP relied on technology, it was not a purely technical fix solution but an amalgam of technical fixes and radical social change to commutarian social structures. Lovins (1977) also claimed that the soft and hard energy paths were mutually exclusive, an assertion based on the arguments that continued commitment to the hard energy path would starve the soft energy path of resources, would bring about changes in social values that would inhibit the ability to develop soft technologies, and would create political and institutional impediments to development of soft technologies.

The SEP was developed primarily as an alternative to the deployment of nuclear fission technology. By making radical change in energy systems sound relatively easy, it struck a chord around the world and triggered the production of a small wave of qualitative SEP analyses in number of other countries (Secretariat for the Future 1977, Strümpel 1979). The concept was also quickly embraced by mainstream environmentalism (Paehlke 1989: 30), a consequence, according to Denton Morrison (1980: 280), of its capacity to provide environmentalism of the 1970s with an escape route out of the anti-everything corner that it had painted itself into.

There is little doubt that Lovins' work had a major impact on both public debate over energy policy and, in certain situations, on policy itself. The reasons for this have been discussed by Greenberger & Hogan (1987). These authors analysed the most important reports on energy policy and strategies undertaken on the USA over the decade 1973 to 1982, in order to account for the disparate impacts of these reports on the public debate and on policy. Using two groups of energy analysts and researchers (traditionalists

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[5] As an example of technology that was simple to use from the user's perspective, Lovin's cited the pocket calculator. Soft technologies were technologies which individuals could adapt to their lives and use as tools, rather than machines which ran their lives (Lovins 1978: 478)

[6] Soft technologies were not required to be environmentally benign and although they tended to be, this was 'probably derivative rather than essential to the definition' (Lovins 1978: 478).

and reformists) together with a control group, they found that the perceived quality of the research was inversely related to its perceived impact. Rather than a case of professionally done analysis attracting attention and being used by policy makers, these researchers found that the highest quality analyses obtained the lowest acceptance and had the lowest impact on policy. Lovins' analysis on the soft energy path (1977) was ranked the lowest quality research by both the traditionalists and the control groups, yet was rated to have the highest impact on public opinion and policy by all three groups (Greenberger & Hogan 1987: 251). One of the major determinants of a report's impacts on energy policy, they concluded, was not the quality of the research but its timing. Lovins' treatise on the soft energy path, they argued, was published just as public concern over nuclear proliferation was increased by the news that India had detonated a nuclear device, and just as a new U.S. president, unencumbered with an entrenched energy policy, entered the White House.

The SEP was broadly criticised by commentators from across the political spectrum. Conservative energy analysts attacked the idea on the basis that its potential political and social ramifications had not been addressed (Rossin 1980: 58). If it did not work, and resulted in shortages of electricity, rationing would have to be introduced by 'strong government', therefore exacerbating just what its proponents hoped to avoid (Rossin 1980: 59). Rossin argued that not only was the SEP based on the false belief that the philosophies of decentralisation and self-sufficiency were universally beneficial, but that it could not occur without substantial subsidisation to overcome the market power of the electricity companies. In reality, he maintained, it was difficult enough to get the public to agree to increased energy prices, let alone increased prices based on philosophical arguments. Because of this, the proposal was predicated on a shift in social values and attitudes (Rossin 1980: 60).

While the conservative attack on the SEP concept was relatively weak, the concept was more resoundingly criticised by political economists as utopian. Lovins' depiction of two mutually exclusive energy paths based on soft and hard technologies was dismissed as crude technological determinism (Sandbach 1980: 161) and its basic logic flawed, as there was nothing to prevent soft technologies being developed in a way which maintained private control and central planning. Many 'hard' technologies were considered indispensable, furthermore, for making work and life more satisfying and enjoyable (Martin 1978). Political economists considered, further, that the SEP's fundamental desiderata, such as decentralisation and self-sufficiency, collided with the basic logic of industrialism (Martin 1978: 12, Sandbach 1980: 159). Nuclear power and coal-fired energy systems, these political economists argued, were technologies favoured by advanced industrial capitalism because they served to centralise control over investment and production, to keep the decisions in the hands of the employers, and maintain passive consumerism (Martin 1978). From the perspective of political economy, technological choice is not based on technical assessments and rational debate and policy making, but is strongly influenced by the social relations of production which favour centralised, large energy conversion technologies (Sandbach 1980: 162-3) The main weakness of the SEP, these writers suggested, was its underestimation of the power and interests of the nuclear, coal and oil industries (Sandbach 1980: 161). The adoption of decentralised energy systems by a significant portion of people, these writers argued, would therefore require a fundamental redistribution of economic and political power (Berman 1988: 83).

Lovins agreed that hell was likely to freeze over before a significant shift in social values to lower material standards of living occurred, but rejected the argument that his SEP proposal was either predicated on such a shift in social values or ran counter to the logic of capitalism. Sounding like Adam Smith reborn as an environmentalist, he advanced his 'Neo-Capitalist Manifesto' (Lovins 1978) in which he maintained that the modifications to the economic structure required to put the soft energy path in place were minor, and that the SEP was not anti-capitalist since reliance on soft technologies was simply a cheaper option for energy utilities as well as society. Lovins argued that rather than being anti-capitalist, all that was required to start the soft energy trajectory was to get government out of energy policy, and leave energy decision making to the market (Lovins 1980: 35).

While debate over the soft energy path waned in the early 1980s, the less radical energy policy reform proposals based on increasing the technical efficiency of energy use began to make real advances.

4.3.5 Making Energy Efficiency More Persuasive

By the mid-1970s, the boldest energy efficiency experts were claiming that it was technically feasible to save approximately 50% of US energy use through cost-effective energy conservation measures, and that these measures could be put in place over a 15 year period (Ross & Williams 1976). It was suggested by Socolow (1977: 239-40), moreover, that due to the similarity in the structures of industrial countries, the scope for reducing energy use in other industrial economies was also close to 50%.

Policy makers nonetheless remained resolutely behind a strategy of increasing the supply of energy, despite the evidence in the form of technical analyses that there existed considerable scope for reducing the demand for energy. Unable to account for this stubborn resistance to their elegantly simple and logical proposals, these energy efficiency advocates gravitated towards Ludwig Wittgenstein's maxim that 'at the end of reasons comes persuasion' (1949: 81). What energy efficiency proposals required was improved packaging. To sell the product, recalcitrant policy makers needed to be persuaded that energy efficiency was a virtual source of energy and therefore a legitimate means of meeting society's energy requirements. To this end, an attempt was made to make energy efficiency more real by referring to it as 'conservation energy' (Yergin 1979: 136) and by comparing energy conservation to 'drilling for oil and gas' in houses' (Ross & Williams 1980: 24-36) or constructing 'mini hydro-electric generators in the corner of every home' (Wright & Baines 1986: 5). Far more persuasive tools, however, came with the construction of energy conservation supply curves and the development of the associated least-cost planning (LCP) methodology.

Energy supply curves are economic-engineering tools constructed by ranking available energy sources according to their assessed unit costs of production (vertical axis) and the quantity of energy available (horizontal axis). These stepped functions are used to compare various energy sources on an equal basis and thereby assist the energy decision maker to select the optimal energy option or mix of options capable of meeting predicted increases in the demand for energy. Energy efficiency analysts adapted this tool to their cause by working upwards from end-uses, fuel by fuel, and subsector by subsector, to produce 'energy conservation supply curves' which indicated how much energy could be saved together with the unit cost of the 'saved energy' from each measure. By adapting a conventional planning tool in this way, energy conservationists hoped to render utility planning more congruent with social cost-benefit determinations. The first detailed energy conservation supply curve analysis was undertaken for the Californian residential sector in 1978-79 (Wright *et al.* 1981) and was followed by a similar calculation for the entire US residential sector (Solar Energy Research Institute 1981), the U.K. (Leach *et al.* 1979) and New Zealand (Wright & Baines 1986).

The least-cost planning concept was developed by a team of economists from the Energy Productivity Centre of the Mellon Institute in the USA (Sant *et al.* 1979) and immediately attracted considerable attention. It added to the energy conservation supply curve concept by requiring, first, that planning for future energy requirements should take as its fundamental principle that all energy sources, including 'conservation energy', should be compared on the same basis, and secondly, that the least expensive option from society's perspective should be utilised first. Only after the least-costly option had been exploited to its fullest potential should the next least expensive option be utilised. By using such a methodology, Sant *et al.* (1979) showed that residential demand for energy in the USA in the year 2000 could be reduced by 28%, and total energy use by 6% compared to the official forecasts for that year. It represented the first non-government quantified attempt to prepare such energy projections by econometric modelling based on the decisions of end-users. While the report's conclusions were dismissed by policy makers on the grounds that many of the assumptions upon which it was based did not stand up under scrutiny, it nonetheless had a substantial and enduring impact on energy planning[7]. It popularised the economists' idea that energy was an intermediary good and that energy users had use only for the services that energy provided, not for energy *per se*. The report also implanted into the broader debate the rationality of the least-cost planning methodology which was quickly adopted by the Bonneville Power Authority in North West USA (Lee 1991). Over the course of the 1980s, its was adopted as a planning methodology by a number of electricity utilities and regulatory bodies throughout the USA (Clinton *et al.* 1986: 122).

A third tactic employed to increase the attractiveness of the aggressive energy efficiency option to policy makers was to argue that investment in energy efficiency and renewable energy created more jobs than did the equivalent investment in expanding conventional energy supply (Grossman & Daneker 1979, Brooks & Paehlke 1980, Kazis & Grossman 1982, Buttel *et al.* 1984). This attempt, however, fared less well then did least-cost methodology and supply curve analyses. It proved difficult to persuade policy makers that the energy conservation schemes, where jobs came to an end once houses were insulated, were the equivalent of energy supply construction schemes which provided not only once-off construction jobs, but encouraged development and led to further growth in manufacturing and longer-term employment (Nordlund & Robson 1980: 6). Similarly, while it was estimated by some that investment in renewable energy generated three to four times the direct employment than investment in the equivalent conventional energy supply, these jobs were considered in the main to be low-skilled and poorly paid (Nordlund & Robson 1980: 66). More importantly, as Owens (1995: 211) has pointed out, these comparisons of the macroeconomic effects of conventional energy supply expansion schemes and clean, low-impact energy efficiency and renewable energy strategies in terms of employment creation, overlooked the important point that what creates political pressure and tension in representative democracies is not concern about jobs in general but concern about *these* jobs in *this* locality.

The first least-cost modelling had been presented, not as a forecast of what would happen, but as a demonstration of what could happen if government deregulated energy prices and the price of energy was allowed to increase to reflect its true costs. This theoretical debate was rapidly overtaken by events when President Carter deregulated energy prices in the same year the Mellon Institute published its report. Deregulation was followed soon after by the second round of oil price rises and the combined effect was a rapid reduction in the growth of energy demand in the USA. Total primary energy use in 1987 was below the Ford Foundation's (Freeman *et al.* 1974) ZEG projection for that year. To proponents of aggressive energy efficiency, there could be no more concrete demonstration that their aggressive energy efficiency

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[7] Sant *et al* (1979) assumed, for example, that energy consumers made energy choices based on an implicit discount rate of 5%.

proposals were realistic. Much of the reduction in the growth of energy use was attributed to an increase in the efficiency of energy use (Brower 1990: 12), allowing proponents of aggressive energy efficiency to argue that whilst a rapid increase in the efficiency of energy use had been dismissed by policy makers as an option, it had happened 'anyway' (Blackburn 1987: 6). The accelerated reduction in the energy intensity of the economies of the USA and a small number of other industrialised countries was taken as evidence, furthermore, that similar reductions in the energy intensity were possible in other countries (Chandler *et al.* 1988)

The development of the least-cost concept coupled with the rise in oil prices stimulated a wave of books, particularly in the USA, advocating aggressive energy efficiency as the solution to energy-related problems (Leach *et al.* 1979, Kendall & Nadis 1980, Sorenson 1980, Gibbons & Chandler 1981, Ross & Williams 1981, Solar Energy Research Institute 1981, Lovins 1981, Oliver *et al.* 1983, National Audubon Society 1984). The production of energy efficiency assessments became a cottage industry and whilst interest in the concept of the SEP went into decline, the attention of most analysts, including Lovins, was increasingly focused on the more mundane but achievable solution of increasing the technical efficiency of energy end-use.

Proponents of the aggressive energy efficiency option continued to believe that a major obstacle they faced was convincing policy makers that the 'saved energy' obtained from increasing the efficiency of end-use was a virtual source of energy. They continued to look for persuasive devices to overcome this resistance and when the word 'negawatt' appeared as a typographical error in a local utility planning document, it was quickly seized upon by energy efficiency enthusiasts as the unit for their virtual energy source (Webb 1995: 35).

Growing environmental concerns in the mid to late-1980s led to another wave of publications on energy efficiency. The World Commission on Environment and Development described energy efficiency as 'the cutting edge' of sustainable energy policies (WCED 1987: 14). Those who argued that energy production and use was responsible for the most serious environmental problems (Lovins & Lovins 1989: 2) also argued that, by a happy coincidence, these were problems for which a ready solution happened to be at hand.

The estimates of the potential to produce 'negawatts' continued to increase over time. Blackburn (1987) estimated an 'overnight' substitution of the most efficient energy-using equipment on the market would reduce US energy use by one third, while increased energy efficiency in tandem with the deployment of renewable energy systems could reduce the nation's energy use to about 20% of existing levels early in the new century without any reduction in lifestyle. Lovins estimated that about 50% of energy in industrialised countries could be saved at zero net cost, and that much of this could be saved at a cost of less than 1c/kWh, and probably closer to 0.6c/kWh (Lovins 1989a: 306), claiming that this figure was based on analyses using exhaustively documented technical data (Lovins 1989a: 301). Using the most advanced cost-effective technologies and a near-perfect equipment maintenance regime, he further suggested, it would be possible to reduce electricity use in the USA by 75% and that:

> ... if we simply pursue the narrowest of economic interests, the energy problem has already been solved by new technologies - primarily for more efficient end-use, secondarily for more efficient conversion and sustainable supply. (Lovins 1990: 193)

Like their ecologist counterparts, the physicists who advance aggressive energy efficiency as a solution maintained that a global perspective was required. Socolow (1985: 18) likened the level of energy use to the distinction between classical mechanics and relativity. At low levels of energy use, Socolow suggested, a local perspective sufficed, while a planetary perspective was required for high levels of energy use. Lovins (1989a: 305), on the other hand, based his case for a planetary perspective on the 'round Earth hypothesis', the limited supply of non-renewable resources and the environment's capacity to absorb pollution. To Holdren (1992b: 1), a global view was required when discussing energy policy issues because of the uniformity of the nature of the constraints on further supply expansion in all countries and regions, and because the world as a whole had entered the era of more costly energy.

As the environmental problems once again took on a global character, so too did the energy efficiency assessments. The International Energy Agency (IEA) estimated that energy demand in OECD countries could be reduced by 25% by the year 2000 using known and cost-effective technologies (IEA 1987). Goldemberg *et al.* (1987) calculated that the use of efficient energy-using technologies could reduce energy use in industrialised countries by approximately 50% by the year 2020 while increasing economic growth by 50 to 100%. The authors further estimated that global energy requirements in the year 2020 could be met with 11 TW of primary energy, only 1 TW more than the 1980 level of global energy use and far lower than the 20 to 40 TW projected for that year by conventional forecasts. Schipper & Meyers (1992: 68) also estimated that the energy intensities of OECD countries could be decreased on average by almost 50% by the year 2010 compared to where the trends appeared to be pointing. By the late 1980s, the assertion that is was possible to halve energy requirements through the deployment of cost-effective energy efficient technologies had become relatively common. The WCED (1987: 14) claimed that many modern appliances could be designed to deliver the same energy services with as little as half the primary energy input needed by their conventional counterparts. This was a view reiterated by other commentators (Geller 1985: 4, Lönnroth 1989: 775) and has increasingly come to be adopted within the reports of government advisory bodies (ASTEC 1994: 15).

From this brief history of the energy efficiency debate, a number of important points can be made. The first is the estimates of the scope for energy efficiency have tended to increase significantly over time. The most optimistic technical estimates made in the 1970s suggested that a 40% to 50% reduction in energy use was technically possible and cost-effective. The most optimistic current estimates suggest that energy use can be reduced by 75% to 90% (Pears & Versluis 1993: Section 2: 8).

The second point that can be made is that the rate at which energy intensity has been reduced over the past two decades has varied between countries, and between states within countries. The literature is therefore replete with contradictory views over the degree to which energy efficiency is actually occurring. On one hand, the rate of increase in energy efficiency in the USA has been described as little noticed but astonishing, more so because it has occurred with minimal direct policy intervention (Lovins 1989a 311). Yet others lament the slow rate of increase in energy efficiency in the USA since the mid-1980s, a phenomenon attributed to consumer indifference (Schipper & Ketoff 1990: 538). The energy efficiency gap, furthermore, is said to remain large for every form of energy in virtually every regions and in all sectors (Jochem & Gruber 1990: 340). When the global picture is viewed, moreover, the trends are said to be heading in the opposite direction to what those who advance aggressive energy efficiency maintain is desirable or possible (Schipper 1995).

The third point to be made is rather than adopt anti-business, anti-capitalist and anti-growth positions, energy efficiency proposals have relied heavily on the argument that energy efficiency is able to reduce the costs of energy supply to industry and thereby increasing national competitive advantage and create new employment opportunities (Toyne 1991: 42). The development of an industry manufacturing energy efficient products and renewable energy technologies are advanced as a means of boosting export income (Saddler 1990).

The final point is that the refusal of policy makers to adopt energy efficiency proposals as an alternative to expansion of supply has perplexed those who advance those proposals. This rejection has been interpreted, furthermore, as an inability on the part of the 'energy establishment' to make the quantum leap to demand-side thinking (Kohl 1993: 3). The key to facilitating the necessary transition to demand side thinking, it has been assumed, has been seen to employ devices that will persuade policy makers that 'saved energy' is equivalent to increasing the supply of energy. The latest example of such an attempt has been the construction of an 'energy efficiency McKelvey diagram'. This has been used to demonstrate that the 'economic reserves' of 'saved energy' can be altered by investment in technology and an increase in the price of energy in exactly the same way that the economic reserves of conventional energy sources are influenced by these factors (Pears & Versluis 1993, Section 2, pp. 9-11).

Despite these attempts at increasing the persuasive power of the case for aggressive energy efficiency, policy makers in many situations have continued to overlook this option and the discussion now turns to the explanation of why these proposals have been dismissed. It begins by looking at the debate over the need for public policies aimed at rapidly reducing energy intensity of the economy before moving downward to the reasons for the reliance on supply expansion and the dismissal of energy conservation within energy planning at the more local level.

4.4 Proposals to Rapidly Reduce National Energy Intensity

Debate over the need for policy intervention to accelerate the reduction in the energy intensity of the economy has been protracted, with energy efficiency advocates maintaining that reducing energy intensity should be the overall goal of energy policy (Saddler 1981: 53). The rejection of these demands for policy intervention has been based on a 'quasi-law' (Kraus 1987: 266) or 0 mistaken belief by policy makers that there exists a *causal* relationship between energy use and economic growth that flows from the former to the latter so that an increase in energy use is erroneously perceived to be a *necessary* condition for economic growth.

It is true that economists and economic geographers writing in the Long Boom of the 1950s and 1960s noted the correlation between certain measures of well-being (personal income levels) and energy use and that it was deduced from this that the level of energy was one of the important attributes of economic growth (Odell 1963: 72, Schurr 1963: 116, Manners 1964: 16, Larson 1968: 1). The fact that economic growth and growth in energy use have historically marched in 'eerie synchrony', and that the ratio between the two was amazingly constant over two decades after the close of the second world war is thought to have further contributed to the idea that the two parameters were causally related (Socolow 1985: 15-16).

While energy efficiency analysts considered such a belief that energy use caused economic growth was understandable prior to 1973, continued adherence to this belief, they maintained, became increasing irrational after that date for two reasons. First, techno-economic energy efficiency analyses pointed to the existence of substantial theoretical potential for increasing the efficiency of energy use (Penner 1979: 917). Secondly, the energy intensities of a small number of advanced industrialised economies[8] was significantly reduced, and for a brief period energy use actually fell while economic

[8] Energy use actually declined whilst economic output increased in Denmark, Japan, Sweden and the USA over the four year period 1979 to 1983.

output increased, in the aftermath of the second round of oil price rises in the late 1970s and early 1980s. Energy efficiency advocates interpreted this reduction in energy intensity as concrete proof that their proposals were practical rather than theoretical. The fact that the energy intensities of many other countries did not decline by similar amounts was explained by advocates of energy efficiency in terms of an irrational refusal to accept this 'proof' (Hughes *et al.* 1985: 109, Socolow 1985: 15). This argument continues to be used today as the explanation for the rejection of aggressive energy efficiency proposals (Pears & Versluis 1993: Section E: 9).

Statements made by influential decision makers to the effect that relationship between energy use and economic growth is fixed, have been used as evidence that policy making is based on such a misconception about the relationship between these two parameters. Such statements were said to be relatively uncommon prior to the early 1970s (Abrahamson 1973: 193, Chapman 1975: 117). The Ford Foundation's report (Freeman *et al.* 1974), however, led to heated debate in which a number of influential decision makers commented on the nature of this relationship (Saddler 1981: 75). One such individual was Donald Burnham, Chairman of the Westinghouse Corporation and member of the Ford Foundation study's advisory board. Burnham contested the assertion made by the authors of the report that energy use and GNP were not inextricably linked and could be uncoupled, maintaining that there existed a wealth of data to indicate that they were indeed linked (D. Burnham in Freeman *et al.* 1974: 367). Similar comments continue to be made. The Australian government's premier economic forecasting body, the Australian Bureau of Agricultural and Resource Economics [ABARE] recently maintained that the trends continued to reaffirm 'the importance that economic growth has for energy consumption growth' (Bush *et al.* 1989: 3).

While these statements appear to provide strong evidence of such a belief in an inextricable link between energy use and economic growth, there are reasons for doubting whether such comments were intended to suggest that it was theoretically impossible to increase economic output whilst decreasing energy use. A more plausible interpretation of these comments is that these individuals believed that dramatic reductions in energy intensity were undesirable rather than impossible. It appears to have been well accepted, for example, that the relationship between energy use and GNP was 'far from a one-to-one correlation' and that both parameters varied both over time and between places (Cook 1971: 87, Chapman 1975: 119). The Australia Institute of Engineers stated explicitly that the nation's energy intensity would continue to decline as a result of structural changes, energy conservation and energy substitution and that the rate of this decline would be determined largely by the price of energy (Institute of Engineers of Australia 1977: 11).

That individuals such as Burnham maintained that it was not possible to alter the relationship between energy use and economic output, was in fact undermined by the fact that Burnham, in making his statement, used a scatterplot showing that this relationship varied from one year to the next, and that this change could be substantial. His graph (Figure 4.1) showed energy use in the USA to fall by over 7% in 1949 with no concomitant reduction in economic growth, and decreased in 1952 by 1% while economic growth increased by 3% (Burnham, in Freeman *et al.* 1974: 168). That Burnham believed an increase in economic growth *necessitated* an equal growth in energy use, or that there existed an immutable relationship between energy use and economic growth, is therefore difficult to accept. It is clear, however, that such individuals considered rapid and substantial changes in this relationship to be either less possible or undesirable, or both.

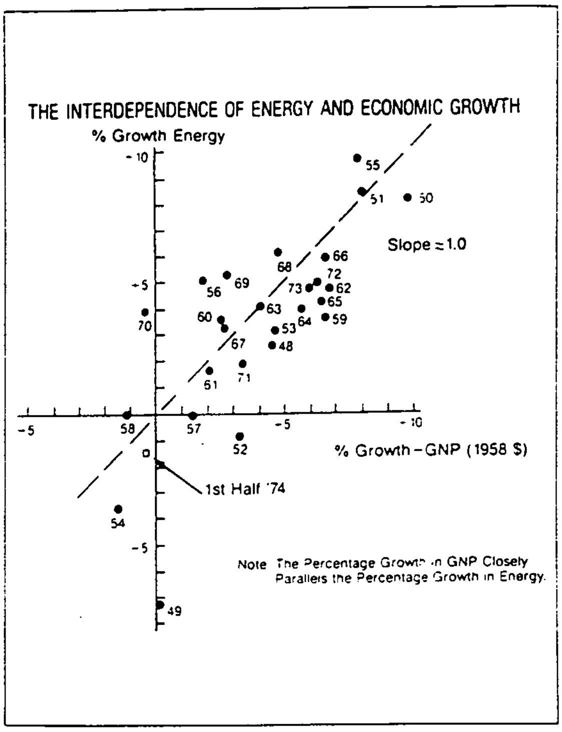


Figure 4.1 The scatterplot of energy use and economic output in the USA, 1948 to 1973, used by Burnham (Freeman et al. 1974: 168) to indicate that energy use and economic growth were linked.

That individuals such as Burnham believed that relationship between energy use and economic growth could not be rapidly altered in theory is also highly unlikely, given that it is undeniable that an economy based on low energy-intensive activities, such as manufacturing cigarettes or computers, would use less energy than an economy based on energy-intensive economic activity, such as aluminium smelting. Saddler (1981: 76) argued that because this argument was irrefutable, statements such as those made by Burnham were 'fatuous' and clearly served the ideological function of protecting the vested interests of energy-intensive industries and an ideological commitment to reliance on market mechanisms rather than government intervention to determine the structure of the economy.

While Saddler's neoMarxist interpretation has a certain amount of validity, it is not without problems. An alternative explanation for the refusal of policy makers to intervene to dramatically alter the structure of the economy is that abrupt and dramatic shifts could not be made without causing 'severe economic dislocation' (Cook 1971: 88). This view was advanced not only by conservative industry leaders but by independent energy conservationists such as Peter Chapman who wrote:

> It is just about impossible for a modern industrial society suddenly to change any trend - all changes must be gradual. In fact the more slowly the change is made, the less disruptive will be its effects. (Chapman 1975: 112)

Rapid restructuring of the economy requires changes in the nature of employment, retraining of the workforce, changes in places of living, and so on. If these changes occur too rapidly, they have the potential to inflict considerable hardship. Resistance to such demands therefore extends beyond the immediate interests of industry alone and includes governments, workers, their families, and secondary businesses reliant on energy-intensive industries. Redevelopment of energy-intensive industries to render them more efficient is therefore a socially and politically more palatable option than a rapid winding down of energy-intensive industries and their replacement with less energy-intensive modes of production. But even this investment in redevelopment of the existing structure of economy can be a slow process as the durability of energy-using equipment dictates replacement over decades (Schipper & Darmstadter 1978: 44). The irony here is that a rapid reduction in energy intensity requires a high rate of economic growth: the faster the economy grows, the greater the opportunity to reduce the energy intensity of the economy.

The debate over the potential or desirability of reducing the energy intensity of the economy has often omitted the crucial question of how these reductions in energy intensity can be, and have been, achieved. Introducing this question raises a number of difficult issues. Energy intensity can be decreased by increasing the efficiency of energy supply; curtailing nonproductive energy use (in the economic sense) such as private transport or space conditioning, fuel switching, and restructuring economic activity to shift from energy-intensive activities such as aluminium production to less energy-intensive activities such as tourism and other services. Approximately a quarter of the reduction in OECD energy use from projected energy use levels between 1973 and 1988 has been attributed to curtailment and behavioural change (lower thermostats, greater use of public transport, etc.). Another one third has been estimated to have resulted from structural shifts between different sectors of the economy (less aluminium production, more computers and so on). The remaining 40 to 45% has been attributed to an increase in the technical efficiency of energy use (Saddler 1994: 51-2).

These figures, however, conceal a number of possible complexities. Structural shifts can be achieved by displacing energy-intensive manufacturing off shore, and to developing countries in particular. Increased technical efficiency of energy use can also result in no net reduction in energy use if the gain in energy efficiency is offset by increased output. The attempt to attribute causes to the reductions in energy use and energy intensities, furthermore, can be complex and figures can be misleading. Included in the category of increased technical efficiency of energy use, for example, are often changes such as structural shifts within sectors of the economy, such as the production of higher value added aluminium products rather than low value products. Such changes are in reality disguised structural shifts rather than increased technical efficiency improvements but are difficult to segregate out from aggregate data. Included in technical increases in efficiency, moreover, are supply side efficiency improvements and the impacts of changes in fuel mix. It has been pointed out, for example, that the 'decoupling' of energy use and economic growth in the USA between 1973 and 1987 was limited largely to a decoupling of petroleum use from economic growth and that the intensity of other energy types actually increased. Electricity use in particular remained highly correlated with economic growth and at a global level the relationship remained extremely close to 1:1 (Ahearne 1989: 1-2). In countries such as the USA in which sectorial energy intensity declined approximately 25% between 1973 and 1987, electricity use as a portion of total energy use increased (Preston 1995: 50). Estimates of improvements in energy efficiency based on the decrease in energy intensity, furthermore, can overlook the fact that an increase in the price of commodities such as cars can decrease energy intensity without altering energy efficiency.

This leaves largely unexplained why some countries have managed to restructure their economies and decrease their energy intensities significantly while others have not, and why in some countries, such as Australia, economic development continues to rely on attracting energy-intensive industries (ASTEC 1994: 15). While the answer to this question is complex, a small number factors appear to have been particularly important.

The first has to do with the degree to which the economy is reliant on energy imports, and oil in particular. Prior to the rise in the price of oil in the 1970s, Denmark, the Netherlands and Japan were all highly dependant on oil imports and hence moved quickly to reduce the oil intensity of their economies as the vulnerability of their situation became clear (this shift involved not only substitution away from oil, but also energy conservation). These countries moved quickly to reduce the risks to their economies of further oil price rises. The USA was not only a net oil importer but a superpower. Oil was therefore an energy source of great strategic importance to the USA and the government moved to reduce reliance on imports for strategic reasons. The substantial decrease in the energy intensity in the USA was also partially a consequence of the higher per capita energy use base that country started from.

The second, and related factor, is that of the price of energy. Where energy prices have been high, such as in Japan and Italy, the replacement of energy-intensive equipment processes has occurred at a more rapid rate than it has in countries where energy prices are relatively low, such as Canada and Australia.

The third reason has to do with the relationship between government and business, a relationship which is said to vary substantially from one country to another. Economic adjustment can follow either a 'business-led', laissez-faire or 'negotiated' model in which government, business and labour cooperate in policy development and implementation to varying degrees. In many Scandinavian and continental European countries, and particularly in France and Japan, there exists a strong and mutually supportive government-business relationship in which the state actively intervenes in the affairs of, and supports, business. Economic adjustment in countries such as France and Japan is described by political scientists as 'state-led' with collaboration between business and government in which an active state role is welcomed by business. In contrast, the relationship in Anglo-American countries is one in which politics and the economy have been traditionally separated. In such circumstances, the state's role in the economy is described as 'weak', making it difficult to implement a concerted approach to economic problems (Bell & Wanna 1992a: 10-12). This traditional relationship between government and business, and between politics and the economy in countries such as Australia, for example, makes many would-be policy solutions to problems politically infeasible (Bell & Wanna 1992a: 11).

In summary, the debate over energy intensity is therefore divided between those who demand rapid reductions in energy intensity, but who fail to understand the social and economic implications of their reform proposals, and neoconservative economists, who consider a public policy of intervening to reduce the energy intensity of the economy to be about as rational as reducing the 'custard intensity' of the economy (Sutherland 1994: 260). The reasons for the differences in the reductions in energy intensity between countries, such as energy prices, political cultures and variations in the relationship between business and government have often been overlooked. While the sensible position appears to be somewhere between the two extremes, it is clear that the pace of change in this direction has tended to be undesirably slow in many situations.

So far, technological determinism and the technological trajectory theses have been dismissed in this study as adequate explanations of the growth of energy systems, while the reasons that policy makers reject demands for radical restructuring of either society or the economy in the name of reducing reliance on large energy conversion technologies or the energy intensity of the economy have been covered. The discussion now turns to more moderate energy efficiency proposals and the reasons why these are dismissed in many situations. Examination of these more moderate demands requires an adjustment of focus to the energy planning and decision making processes. Three basic models of policy decision making can be identified within the literature, rational strategic and political, all three of which are idealised abstractions of reality. The discussion begins with the first of these models, rational planning and decision making.

4.5 Rational Energy Planning

To access the degree to which the growth of energy systems and the rejection of energy conservation can be accounted for as products of rational planning, the theory of rational decision making needs to be first discussed.

4.5.1 Policy Decision Making Theory: The Rational-Analytical Model

Rational decision making is commonly referred to in the literature as rational-comprehensive, rational-analytical or synoptic decision making model. It has been advanced as not only the best way to make decisions, but also as a description of how decisions are actually made. The presumption of the model is that planning decisions are the result of purposive choices made on the basis of pre-existing and consistent goals, and is the policy decision making analogue of the economist's rational utility-maximising individual. Policy makers are assumed to establish precisely defined goals and then make a thorough search for solutions and carry out a complete analysis of each of these, taking every factor into account. It assumes that a problem can be specified and separated from its social context and that a single optimal solution to that problem can be logically determined by the following ordered sequence of steps: (i) identification of goals; (ii) translation of goals into more specific objectives; (iii) ranking of these objectives in order of priority; (iv) examination of the alternative means of achieving each objective and the costs and benefits of each; (v) examination of the feasibility of the various options and the extent to which they would add to or detract from other important values; (vi) selection of one option on the basis of costs and benefits; (vii) the implementation of the chosen option; and (viii) monitoring of the performance of the policy option to ensure that it leads to the expected result (Doyle & Kellow 1995: 138). It is therefore ambitious, confident and comprehensive in its approach and aspires to scientifically or analytically 'correct' solutions.

A problem with the rational-analytical decision making model is the very significant demands it places on the decision making process - in much the same way as an holistic approach places an unmanageable burden on the researcher. The requirement of rational policy decision making for unambiguous information, time and resources to carry out the necessary analyses, and a complete and consistent way of ordering preferences, are more than most decision making processes have access to. The rational-analytical model is therefore limited in its application to resolution of only the most simple and straightforward issues.

Energy policy has been regarded as one such issue that can be managed using the rational-analytical model, particularly where the choice of energy options is assumed to be made on the basis of narrowly defined engineering and economic parameters. The energy options are considered to be sufficiently few to be comprehensively assessed and compared, and the selection of the optimal option can be capable of being determined analytically using empirically constructed demand forecasts and the application of standard cost-benefit analyses. Energy efficiency experts also implicitly adopt such a position in advancing aggressive energy efficiency on the basis of their techno-economic analysis of the cost-effectiveness criteria. In the following section, the degree to which rational energy planning provides an explanation of the growth of energy systems and the rejection of energy conservation proposals is examined.

4.5.2 The Growth of Energy Supply Systems under Rational Planning

Where planning is based on a narrow economic criteria, the strong tendency of planners to rely on expanding the energy supply system and to dismiss energy efficiency proposals can be explained in terms of the drive to increase system load factor and system reliability. The rejection of energy conservation proposals can also be explained within rational planning where the scope for reducing the demand for energy is perceived by planners to be limited.

4.5.2.1 The drive to increase system load factor

Large discrepancies between average <u>load</u> and system generating capacity, or between average and peak loads, increase average unit costs. Load factor was a concept developed specifically by the electricity supply industry late in the nineteenth century as a direct consequence of the inability to store electricity (Hughes 1987: 73). High load factors are desired because generating capacity is not determined by the average load, but by the maximum load during the cycle. From the engineering perspective it is therefore desirable to smooth out the load profile to ensure that system generating capacity is used to the maximum. The goals of minimising the ratio between average to peak (diurnal or annual) loads, and creating high and stable base to maximize use of generating capacity are both important to managers. The relative importance of these goals varies from one situation to another. Where the system is based predominantly hydro-electric generation, peak load factors are less critical as additional generating capacity can be brought on line relatively quickly. The attempt to increase load factors, Hughes maintained, has been the primary drive behind the historic growth of capital intensive technological systems in capitalist interest-calculating societies.

The two 'elegant solutions' to the problem of low load factors, according to Hughes, have traditionally been interconnection of neighbouring energy systems, and the construction of new supply capacity. Interconnecting neighbouring distribution systems achieves a better overall spread of customer type. Electricity utilities have pursued interconnection to spread the load over a diverse range of sectors such as industrial, small business, transport and residential sectors. Increasing the supply of energy within a separate energy grid, on the other hand, can increase load factors if the increase in supply is used to attract new customers with relatively stable loads.

Over the past one and a half decades, an increasing number of utilities have also attempted to increase load factors by encouraging existing customers to shift loads to off-peak periods or finding new customers for off-peak demands (discussed in Section 2.4.) It is for this reason that most demand side management programmes adopted by utilities to date have consisted primarily of peak shifting, valley filling or peak clipping strategies rather than load reduction (Geller 1989: 741).

This desire to increase load factor through the dual strategies of reducing peak load and building up off-peak load explains the lack of utility encouragement of energy conservation measures. Advocates of energy conservation and renewable energy, for example, have often criticised the lack of energy utility encouragement solar hot water systems which they consider to be the most mature of the renewable energy technologies and to have been economically competitive with conventional energy supply systems for quite some time. This has been interpreted as evidence that managers of energy supply have a 'hostile attitude' towards renewable energy technologies (Diesendorf 1994a: 12-17, Gilchrist 1994: 278, Lowe 1994: 206). But while renewable energy enthusiasts and energy conservationists consider low off-peak tariffs which reduce the cost-effectiveness of solar water heating perverse, energy suppliers see low off-peak tariffs simply as a means of deferring the need for further peaking capacity. The fact that low off-peak electricity tariffs reduce the cost-effectiveness of solar hot water systems is, to managers of electricity supply organisations, no different from the fact that off-peak tariffs also compete with other fuels such as gas.

Electricity utilities actually have a double incentive to discourage the use of solar hot water systems if these are used in a way that increases system load factor (Gibbs 1991: 15). The adoption of solar hot water systems can reduce total load. Owners of solar hot water systems who boost their solar systems with the general electricity tariff and draw off most of their hot water in the early evening, add to the evening peak load. For this reason, electricity authorities have tended to restricted electric boosting of solar hot water systems to off-peak tariffs. There is therefore a contradiction contained in the criticism of low off-peak tariffs. Energy efficiency proposals are often advanced as a means of deferring costly investment energy supply expansion programmes (Lovins & Hirst 1989: 34). The most costly supply systems are those associated with the expansion of peak load capacity and energy conservation measures which reduce peak load are therefore advanced as particularly cost-effective from a social perspective (Lewis *et al.* 1987: 1). The use of cheap off-peak tariffs to reduce peak load in order to defer the need for investment in new supply, however, also undermines the cost-effectiveness of conservation measures.

In a similar manner, renewable energy enthusiasts have objected to proposals for interconnecting grids on the grounds that interconnection increases the supply of cheap energy and thereby reduces local reliance on renewable energy technologies (Diesendorf 1994b: 156). Where interconnection is seen as a means of reducing the need for further construction of conventional supply infrastructure, however, factions of the environmental movements have supported interconnection proposals (Kohl 1993: 25).

Behind these contradictions lie not only fundamentalist notions about energy conservation being a good thing, but a failure to understand when load reduction is in the interests of the utility, and how much energy conservation is possible. The first of these questions will be momentarily put aside and addressed in Section 4.6, while the issue of how much energy conservation is being referred to is discussed in Section 4.5.2.3.

4.5.2.2 The need to increase system reliability

Growth of energy supply systems can also be explained in terms of rational planning attempts to increase system reliability. The interconnection of grids may reduce uncertainty over system capacity to meet demand if the interconnected systems are based on different supply technologies or fuels. By increasing the diversity of the energy system, a shortage of one fuel could be partially overcome by temporary increased reliance other fuels. Alternatively, the construction of new energy generation capacity based on different fuels within an independent energy system serves the same function. By interconnecting a grid supplied by hydro-electricity with another supplied by coal-fired power stations, the overall efficiency of the system can be increased with the hydro-electric facilities used to provide peak loads and the thermal plant used to provide a steady base load. The costs of energy are also decreased as the need for <u>reserve plant margin</u> is also reduced. Reducing the costs of energy in this way, however, also reduces the cost-effectiveness of energy conservation measures.

4.5.2.3 A perception of limited scope for reducing demand

The dismissal of aggressive energy conservation proposals can also be explained under rational planning where planners perceive the scope for reducing demand to be relatively limited. Tension over energy policy arises in this area when the perceptions as to the scope for reducing demand differ and it is worth considering the causes of these differences in perception.

Central to this debate is the concept of *barriers* to energy conservation. The term 'barriers' is a physical metaphor originally employed in psychology to explain resistance to individual mobility between social groups (Lewin 1936). From psychology it was borrowed by consumer research, where it was used to label the causes for limits on the market penetration of new products (Woods 1981: 153). The term *barriers* is now in widespread use in many fields, including that of energy conservation. As an explanation of the what causes the gap between the potential to reduce energy use and actual levels of energy conservation, however, the term can be problematical. Without empirical attempts to identify the actual nature of these causes, the term is tautological as it amounts to tacit acceptance of the hypothesis that high adoption rates are expected, and then postulates the existence of barriers as a secondary hypothesis in order to account for the fact that the predictions of the first hypothesis are not observed.

There is, furthermore, a strong tendency on the part of those who use the term barrier to treat it as an explanation rather than a metaphor. Sayer (1992) has discussed at length the potential problems that such displacement of metaphors can lead to in research and used diffusion theory as an example. Diffusion theory, he argued, takes as its fundamental premise that the expected diffusion of technical innovations can be modelled on the basis of the diffusion of pathogens, whilst ignoring the fundamental differences between pathogens and technical innovations (Sayer 1992: 53). The temptation to label as a barrier anything which retards the increase in energy efficiency is therefore fraught with risks and has the potential to lead to much confusion in analysis (Sawhill & Cotton 1986: 9). The confusion would probably be significantly reduced if the term *barriers* to energy conservation was avoided and the term *reasons* for low adoption rates of energy conservation measures were used instead.

The different perceptions over the scope for energy conservation is further complicated by the fact that there are several interpretations of the optimal level of energy efficiency (Jaffe & Stavins 1994). This difference in meaning has been at the root of the often heated debate between economists and technical energy efficiency experts (Brookes 1990, 1992, Grubb 1992, Jaffe & Stavins 1994, Sheraga 1994, Sutherland 1994). To understanding the difference in perceptions of these two groups it is necessary to understand the economists' distinction between *barriers* (or *market barriers), market failures* and *non-market failures.* While economists dismiss the notion of barriers to energy efficiency as a myth (Sioshansi 1991), economists generally define market barriers as those factors that cause the gap between what is technically cost-effective and what occurs in practice. Unlike energy efficiency experts, however, economists maintain that many market barriers are normal characteristics of a well-functioning market. To the economist, the diffusion of technologies such as solar hot water systems tends to be a gradual process by nature and the existence of an energy efficiency gap is therefore a natural and expected phenomenon rather than a mystery or a problem (Jaffe & Stavins 1994: 804). Policy intervention to overcome market barriers to increase the rate at which energy conservation measures are adopted, according to economists, may or may not be warranted (Brookes 1991, Sutherland 1994). Sutherland (1994: 267), for example, described falling electricity prices as a market barrier to the increased adoption of solar hot water systems. But it does not logically follow, he argued, that policy makers should attempt to increase the adoption rate of solar hot water systems. Some market barriers, however, do warrant public policy intervention to overcome them and these are referred to by economists as *market failures* (Jaffe & Stavins 1994: 805).

What constitutes market failures, however, is not always clear. Because the available theoretical models of how markets work are relatively crude, only relatively large deviations between what is expected from a rational economic perspective and what actually happens in practice are taken as substantive evidence of market failure (Hinchey *et al.* 1991: 8). Potential sources of market failure commonly identified include lack of information and a split in the incentive between those who purchase energy equipment and those who pay their running costs. Intervention to overcome these market failures, economists argue, may be justified.

Economists also recognize *non-market failures* which retard the rate of adoption of energy efficiency measures. These non-market failures are caused by such considerations as the uncertainty of future energy prices, the uncertainty about the actual savings from energy technologies and the irreversible nature of energy efficiency investment decisions. All of these make consumers cautious about investing in energy efficiency. Energy performance, furthermore, is not the only basis on which purchase decisions are made as size, features, brand, reliability and maintenance service are all factors used by consumers in making such decisions. One colleague recently reported to the author that he selected a new refrigerator on the basis of the door handle. Another colleague selected his new refrigerator on the basis of the rapidity with which it would cool down beer. Compact fluorescent lights provide another example of purchasers basing their decisions on factors other than energy efficiency. While CFLs are more cost-effective than incandescent globes in many situations, individuals may decide against purchasing them on the basis of the risks of breakage, the hue of the light, or their non-instantaneous full luminosity. To economists, such behaviour cannot be dismissed as irrational.

Not all energy efficient equipment, furthermore, is economically efficient for all users. Heap pumps, for example, are more economically efficient than electric resistance heater where space heating requirements are substantial. For those who heat only small areas, or who use space heating equipment only rarely, less technically efficient electric resistance heaters may be the more economically rational option.

From the above discussion, it is apparent that there exist differences in opinion as to what constitutes the optimal level of energy efficiency. Jaffe & Stavins (1994) defined the 'hypothetical technical potential' for energy efficiency as the level of energy efficiency achieved by an overnight substitution of the existing stock of energy-using equipment with the most technically efficient available. These authors then defined the 'technologist's optimal level', as the level that could be achieved by removing all 'market barriers' to energy efficiency irrespective of their nature or difficulty of doing so. They then defined the 'economists' optimal level' as the level of energy efficiency achieved by eliminating all market failures for which it was cost-effective to do so. The socially optimal level of energy efficiency Jaffe & Stavins argued, was a totally separate issue and revolved around the debate over the degree to which the social costs of energy production and use should be internalised. The reasons why policy makers resist demands for including the full social costs of energy in energy prices were discussed in the previous chapter. Jaffe & Stavins' useful schemata of the relationship between these various definitions of the optimal level of energy efficiency is reproduced in Figure 4.2 [Note: the various levels of energy efficiency shown in Figure 4.2 have been arbitrarily chosen and are not meant to indicate precision in potential].

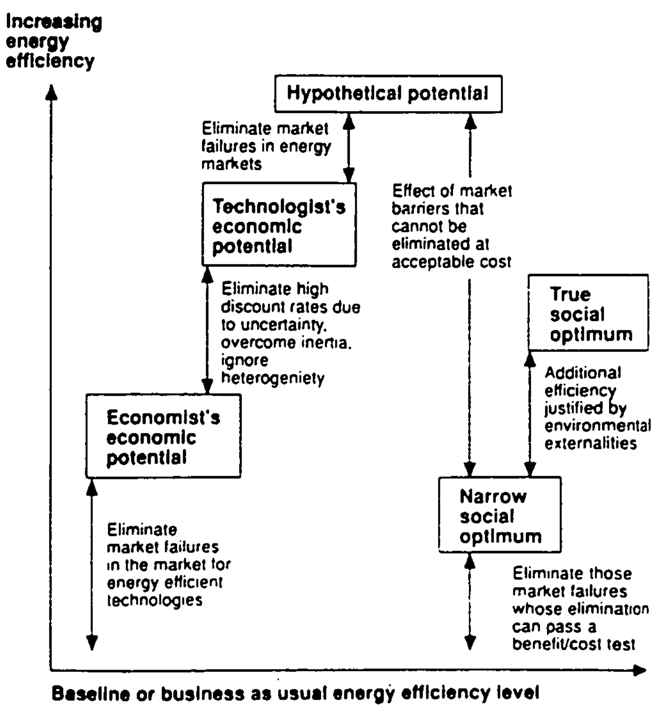


Figure 4.2 The distinction between the technically, economically and socially optimal levels of energy efficiency [from Jaffe & Stavins 1994: 808].

For reasons discussed above, policy makers are likely to perceive the scope for reducing energy use through energy efficiency to be more limited than do proponents of aggressive energy efficiency. The more marginal the perceived capacity of energy conservation to defer supply expansion, the lower its attraction as a planning option. Energy efficiency improvements that are able to defer the need for another nuclear power station, coal-fired power station or large hydro-electric scheme for only a short period also fail to excite environmentalists.

Interest in energy conservation as a planning option on the part of an energy supply organisation will be limited unless the perceived scope for energy conservation is above a certain threshold. Here, the practical planning definition of energy conservation given by Lee (1991: 337), as the capacity to rein in some of the slack in the energy system during periods of hardship or stress, is perhaps more important than the precise, technical definition of energy conservation given in Section 2.2. Lee's definition infers that for policy makers to have an interest in energy conservation, the scope of energy conservation has to be seen as sufficient to provide a meaningful solution to a planning problem. If the scope for reducing energy use is modest, permanently attempting to maximise the efficiency of energy use is not considered worthwhile or realistic and energy planners could be bothered expending effort to reduce energy use only when the problems associated with energy supply problems are pressing. In this view, the behaviour of energy supply organisations is akin to that of the individuals who is aware that there is a large gap under the back door through which heat escapes but who could not be bothered doing anything about it until prompted by a sudden rise in the price of energy or an exceptionally cold snap. Where the scope for reducing demand is perceived to be limited, planning interest in energy conservation is therefore a matter of timing.

Planners may also decide to defer reliance on energy conservation even where the perceived scope for reducing demand is considered significant. If for example, the expansion of electricity supply is financed with low interest government loans, it may be rational from the energy supply bureaucracy's perspective to continue the expansion programme in order to ensure that the gain from these low interest loans is maximised while they are available. Energy conservation would then be allowed to build up over time with energy conservation programmes kept in abeyance until the scope for energy conservation reaches a threshold level or until the situation dictates that the time is right for this slack in the system to be tapped.

The above sections have attempted to explain the growth of energy systems and the dismissal of energy conservation as a planning option from the perspective of narrow engineering and economic management goals. It has been shown that the growth of energy supply systems and the rejection of demands for energy conservation policies can be partially explained as the consequences of rational planning narrowly defined. It is less possible to explain very rapid rates of growth in the energy supply system for the rejection of energy conservation where the perceived scope for reducing demand is substantial. There are also many theoretical problems associated with the rational-analytical policy decision making model which lead to the need to look at alternative decision making models for energy policy decision making.

A serious problem with the rational decision making model is that it may not be possible to identify all options, problems may not be clearly defined, and there may be conflict over values and goals. The technical information available may be either woefully deficient and therefore ignored, or so comprehensive that it is beyond the ability of policy makers to appreciate its significance (Walker 1994: 186). An attempt at truly comprehensive-rational decision making would place extraordinarily large demands on the decision making process in that it assumes that goals can be specified and agreed upon, and that it is possible to rationally evaluate a number of means of achieving these goals. Yet, as Canfield & Siemenski (1975: 324-5) argued, 'nowhere is the problem of multiple goals more troublesome than in the area of energy'. Policy makers, they argued, struggle to balance and harmonise the often conflicting objectives of assuring reliable supplies at the lowest possible cost while trying to protect the environment, minimise energy imports and prevent gross inequities in the system. Attempting to convince policy makers that these conflicting goals can best be achieved by means other than greatly expanding energy use, Canfield & Siemenski argued, can be difficult.

If these problems in the rational-analytical model result in short-cuts in decision making, the claim to comprehensive rationality is immediately compromised. At the practical level, the major problem with the model is the time constraints on decision making. Time is often of the essence and the decision making process therefore needs to be hurried. Speeding up analyses, however, dramatically drives up the costs of analysis. A fully rational-comprehensive search for the best possible solution, therefore, would be a recipe for paralysis. Policy makers would therefore tend to weigh up the likelihood that an informed guess would arrive at the same answer more quickly and demand a lot less in the way of resources than rational planning. Another likely consequence of the short availability of time is that if information upon which a particular option is based is seriously questioned by any party, even if it were the optimal decision in reality, that option is quickly abandoned in the rush to reach a decision in the time available (Kellow & Doyle 1995: 232).

A further problem with the analytical approach has to do with the way information is presented to decision makers. Georges Pompidou, the President of France in the 1970s, once stated that there were three ways to ruin. While the most enjoyable road to ruin, according to Pompidou, was to chase after women, and the fastest was to gamble, the most certain way to ruin, he asserted, was to follow the advice of experts (Cane 1981: 1). Policy makers often have a healthy scepticism over the accuracy and completeness of information supplied by 'experts' which is seen to be biased to varying degrees as experts are not impartial participants in the debate but carpetbaggers peddling favoured options. Individuals, specialised organisations and interest groups are able to selectively choose, withhold and distort the information they advance in order to further their goals (Kellow & Moon 1993: 138-9). This presents decision makers with the difficult task of deciding which source of information is the more reliable.

The above problems have been broadly considered by many policy analysts to render the comprehensive-rational or rational-analytical model so problematical that its use in decision making is severely restricted. While many consider that decisions over small, well-defined issues such as energy policy making are amenable to resolution through the use of such analytical or quasi-analytical tools as cost-benefit analyses and environmental impact statements, there is virtual consensus amongst policy analysts that most policy decision making conforms in reality to something closer to the alternative strategic decision making model.

Rational planning is therefore able to partially explain the growth of energy systems and the dismissal of some energy conservation proposals. It is also able to explain why peak load demand management strategies have tended to be in more common use than overall load reduction strategies. What is clear from this discussion is that for energy conservation to be adopted as an planning option, the perceived scope for reducing the demand for energy needs to be significant. Secondly, the value of energy conservation from a planning perspective is only useful when planners are contemplating the means of meeting demand for energy beyond the output of the existing supply system. The discussion has to turn to the second decision making model, that of strategic decision making, and the degree to which growth in the energy supply system and the rejection of energy conservation proposals can be explained using this model.

4.6 Strategic Energy Planning

Policy decision making under the strategic model is more limited in its intellectual aspirations than is the rational-analytical model. It assumes that people cannot master all of their problems and are forced to rely on simplifying devices such as trial and error or rules of thumb, or to fall back on routinised and habitual responses to certain categories of problems. Policy making is therefore a more cautious, steady-as-she-goes approach that accepts that whilst rational decision making would be ideal in theory, the practical constraints on rational-decision making rule it out as a real option. At the very best, rationality is considered to be 'bounded' and decision makers choose the first course of action that will do rather than searching for the one which is optimal (Simon 1957).

Lindblom (1959) considered that most policy decision making was more pragmatic and less rational than even the bounded rationality thesis posited. Policy decision making, he argued, was deeply conservative and based on looking for the most familiar solutions. In its most basic form, he argued, it was disjointed and incrementalist and did not seek optimal or 'satisficing' solutions, but merely tended to ask what decision was made last time and whether it had worked. If this does not satisfy the requirements, the next most familiar is tried, and so on, policy makers constantly looking for marginal alterations rather than brave innovations. In this model, the evolution of policy is a slow process that involves a series of incremental steps rather than a discontinuous process characterised by small quantum shifts in direction. The advantage of this approach, according to those who advance it as a prescription for policy making, is that it provides a simple and practical way of dealing with uncertainty. Most importantly, it is a flexible approach as it allows policy decisions, in theory at least, to be quickly reversed once mistakes are recognised, and other options tried.

In contrast to the rational-analytical decision making model, policy making in the strategic-incremental model sets relatively simple goals, ignores most social values and does not attempt to rank those that are considered. Rather than steered by the ends, it chooses between ends and means simultaneously and is guided by the pragmatic notions that means are more readily agreed upon than goals and that the test of a good policy is not whether it is rational but by how acceptable it is to all engaged in the debate. Its strength, therefore, is seen to be its essentially democratic nature as the final decision is seen to be arrived at via an iterative process of haggling between all parties engaged in the debate. As a result of this process, referred to by Lindblom as *partisan mutual adjustment*, the ultimate compromise reached never strays too far from the consensual position. The notion of partisan mutual adjustment is related to the pluralist model of political conflict resolution, the thesis that conflict over policy is resolved through a zero-sum game in which all interest groups have equal access to political process and which thus guarantees the stability of the system. In the pluralist model, the function of the government is simply to act as a scorekeeper or referee in a debate between all interested groups (Kellow 1986: 13).

This pluralistic decision making process can, however, result in decisions which are irrational from the social perspective. If each interest group gains support for their proposal by trading consent for other proposals, then the sum of the policies agreed upon can be undesirable to the majority. This can occur, according to Dahl & Lindblom (1953: 339), where there is little interest in, or analysis of, the general consequences of the policy proposals in terms of long-term economic consequences, government expenditures or taxation levels. To this list could now be added localised or long-term environmental consequences.

The logic of incremental-strategic decision making is, above all else, that of damage limitation (Collingridge & Reeves 1986: 148). It considers the time interval in which a decision has to be reached to be critically brief and the outcomes of bold policies unpredictable, thus forcing policy makers to chose the safest rather than the optimal policy. The safest decision is taken to be that which makes marginal adjustments to existing policies. Strategic policy decision making is extremely conservative, its primary aim being to ensure that policy mistakes are kept within tolerable limits. By making small incremental steps, it is able to accommodate change and avoid serious, lasting mistakes. The policy maker is therefore less concerned with arriving at the 'correct' policy than with being able to avoid big mistakes and with being able to correct any mistakes that are made. It therefore places a high premium on corrigible decisions, those which can be relatively easily corrected at low costs. Rather than assign a heroic role to technical and scientific analysis, decision making in the strategic model is based on the philosophy of moving with one's eyes wide open rather than on the pretence that it is based on scientific analysis. This mode of decision making has therefore been described by its proponents as 'knowingly muddling with some skill' (Lindblom 1979: 319).

While rational-analytical decision making enjoys considerable esteem, and 'planning' is seen as the most desirable approach to policy, such approaches are regarded by proponents of the incrementalist-strategic school to be in reality an abstract activity engaged in by engineers, economists and scientists trained in analytical methods but who overlook the role of social interaction in policy making. In truth, adherents to the strategic model argue, policy decision making relies on technical and cost-benefit analyses merely as an aid and policy decision making is never totally analytical. In polyarchies, declared Lindblom, planning and policy making 'are always - without exception - strategic, although there are many attempts at synopsis' (Lindblom 1977: 314).

The strategic model of policy making has the power to explain the deeply conservative nature of past energy policy decision making. As such, it provides an immediate explanation of the rejection of radical demands for policy reform such as the low energy growth and zero energy growth strategies advanced by the Ford Foundation (Freeman *et al.* 1974), and the soft energy path advanced by Lovins (1976). It also explains the lack of policy response to environmental demands for the inclusion of social costs in the price of energy (Walker 1994: 196).

The incrementalist approach explains what many policy analysts have seen as the *ad hoc* nature of policy decision making and most policy analysts have concurred that the incrementalist model of policy making provides a more accurate description of actual policy decision making than does the rational decision making model. As a prescription of what *should* happen, however, it has offended those who consider a more rational decision making process to be desirable. Strategic decision making has also been criticised as inappropriate for decisions which are essentially irreversible. A small number of policy analysts therefore developed hybrid decision making models with features of both the comprehensive-analytical and the incrementalist-strategic models.

Dror (1968) advanced his own two-staged policy decision making. The first stage employed a rational-analytical approach in which policy objectives were clarified and major alternatives were surveyed. Once this process was completed, policy makers then decided whether greater benefits would accrue by advancing incrementally or through bolder innovation. Etzioni (1967) developed a similar two-stepped model of decision making, the 'mixed scanning' model, in which broad policy goals were established using a synoptic approach, omitting the details in order to obtain greater breadth. Once these broad goals had been rationally decided upon, the specific details were chosen through an incremental process.

Neither Dror's nor Etzioni's hybrid models gained wide support (Davis *et al.* 1988: 114). Their many critics pointed out that neither were able to state unequivocally at what point decision making should flip from a synoptic to an incrementalist approach as the boundaries between the general and the particular aspects of decision making were often vague. These hybrid models were further criticised on the grounds that even if only one stage of the decision making relied on a synoptic approach, it still placed unrealistic demands on decision making. Many therefore dismissed these hybrid models as afflicted by the weaknesses of both the synoptic and the strategic models.

While Etzioni's mixed scanning model was criticised on the grounds that it could not resolve the problem of multiple and conflicting policy goals, Etzioni maintained that his model was applicable to at least those decisions which involved a single goal such as how best to meet society's future energy requirements. Rational planning, he argued, should be able to apply standard analytical techniques to assist in the choice of the optimal energy option and the selection of the optimal size of a energy supply projects. This was particularly the case where these decision were based on narrow economic and engineering criteria (Davis *et al.* 1988: 115).

There have been two models of electricity planning advanced to explain the energy supply construction cycle which have seen energy planning as a combination of rational and strategic decision making (Collingridge 1980, Puiseux 1987). In both cases, energy policy decision making is assumed to be basically a rational process, but is ultimately forced to adopt a more strategic approach because of the inability to accurately predict future demand. These two models of energy planning are discussed individually below.

4.6.1 Rational Planning Under Uncertainty

David Collingridge (1980) devised a model of the planning of essential goods and services, such as energy, based on the principles of Bayesian rational decision making theory. While technical experts are said to be obsessed with forecasting methodology and numbers (Hogwood & Gunn 1984: 128), to Collingridge, policy makers were more sceptical about the ability to accurately predict demand and therefore used forecasts merely as devices used to assist policy making by allowing the implications of policy decisions to be explored. He dismissed as erroneous the conventional view that planning attempted to match supply to an accurate forecast of demand and argued instead that the primary requirement of energy planning was to avoid shortages potentially damaging to economic growth. He therefore concurred with those political analysts who maintained that the task of policy makers was not to eliminate risks of decision making, but to suggest hedges against those risks (Quade 1982: 278).

The danger inherent in planning based on forecasting is that the planning decisions lead to the changes in demand in a way that makes forecasts self-fulfilling prophecies. The tendency for this to occur in regard to the energy, Collingridge maintained, was due to two important constraints on planning. Having accepted a forecast, he argued, the rational energy decision would be to chose the option which produced this amount of energy at the cheapest cost. But this had to be balanced, he argued, against the possibility that the technology chosen would fail to perform adequately and result in energy shortages. To avoid such risks, Collingridge posited, policy makers preferred tried-and tested rather than the cheapest technologies. Planning, in his view, consisted of first selecting the most reliable technology and then attempting to minimise costs by constructing large units to capture economies of scale. Reliance on large technologies to capture economies of scale, however, rendered the expansion of energy supply lumpy. This introduced the second constraint on planning as it created large surpluses of cheap energy. The laws of supply and demand therefore came into play and ensured that consumers adjusted their demand to match output. In this way, the forecast for energy demand became self-fulfilling and the original planning decision appeared to be justified (Collingridge 1980: 85).

Planning for essential goods and services, according to Collingridge, thus became a vicious circle. With self-fulfilment of the forecasts, the gap between demand and supply was once again closed and planning began anew. But as the previous planning decision had driven up demand, construction of the next supply system had to be scaled up yet again. In this way, Collingridge saw planning as being locked into the proven technology and ever increasing scale of construction. The inherent contradiction contained in this process was that the strategy of hedging against shortages induced by plant failure resulted in reliance on ever increasing scale of construction which, in turn, increased the risk of oversupply. This hedging cycle continued, Collingridge presciently posited, until the demand for the energy was saturated and consumers could not longer absorb the excess. The inevitable result was therefore an oversupply crisis, the greater the scale of the excess the more expensive it would be and the longer it would take to correct.

Collingridge's explanation of the rejection of energy conservation as a planning option has to be understood in terms of where he perceived energy conservation to fit into the planning cycle. To Collingridge, energy conservation and supply expansion could not be deployed in parallel but only in series. The reason for this was that growth in energy supply was lumpy and once new supply came on line, energy conservation was no longer in the strategic interests of the energy supplier. The supplier, having borrowed to construct new capacity, was debt-driven and therefore engaged in load growth as a means of maximising revenue income. Only when this spare capacity had been soaked up did demand reduction as a means of deferring the need for further investment in supply again become a potentially useful option for the energy supplier.

The pertinent question then became why energy conservation was not adopted once the gap between supply and demand was narrowed. Collingridge argued that the rejection of energy conservation was a product of the uncertainties associated with the capacity of energy conservation programmes to reduce energy demand. By the time the stage in the planning cycle was reached where demand was approaching supply, he suggested, a decision had to be made as to whether to begin construction of the next supply expansion project or to rely on energy conservation to reduce demand. The long lead times of supply expansion projects, however, meant that a decision had to be made quickly to avoid possible shortages. Lack of experience in managing demand for energy, however, mitigated against reliance on the adoption of demand reduction strategies as it was not possible to know precisely how much, or how rapidly, energy could be saved. The combination of the planning priority on avoiding shortages and the uncertainties associated with the capacity of energy conservation programmes to reduce demand, according to Collingridge, led to rejection of the energy conservation option. In the rush to reach a decision in time, energy conservation option was jettisoned. Collingridge's depiction of the energy planning process is provided in Figure 4.3.

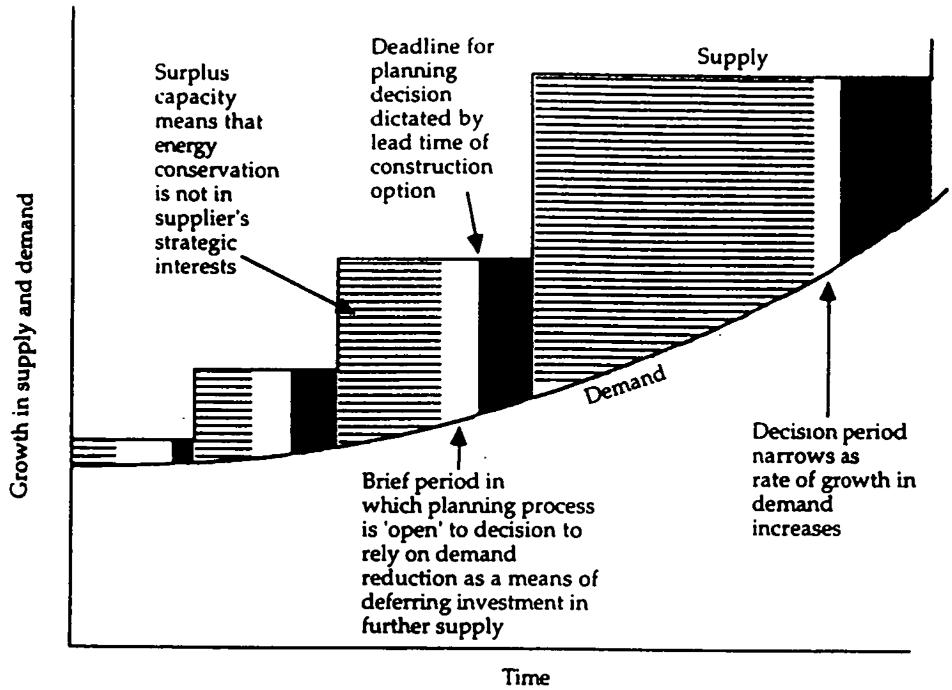


Figure 4.3 A stylised sketch of the factors that drive energy planning under uncertainty as advanced by Collingridge (1980) [Author's own sketch].

Collingridge's model lends support to this author's initial hunch that the rejection of energy conservation as an option is connected to the rate at which the supply of energy increased. Although Collingridge did not discuss whether energy conservation was more or less likely to be adopted depending on whether the demand growth was high or low, his model suggests that energy conservation is more likely to be adopted as a planning option if growth in demand is relatively low. The reason is simply that if demand growth is rapid, the period in which to make a decision is shorter and the risks of supply shortages caused by the failure of energy conservation programmes to meet the demand are increased. With low growth in demand, on the other hand, there is more time to put energy conservation programmes in place. With low rate of growth in demand, the risks of disruption to economic growth if energy conservation programmes fail to produce the expected savings are also lower as there is more time in which to correct the decision by bring forward the construction programme.

The Collingridge model, however, is weakened by assumption that new energy utilities become locked into a particular technology because of the attendant risks of relying on less tried and tested technologies. There is not one, but a number of tried and tested technologies available including gas, coal, nuclear, hydro-electric. The energy supply industry, furthermore, relies on <u>spinning</u> and <u>stationary</u> <u>reserve</u> plant to hedge against the risks of shortages caused by technical failure. As an explanation of technological lock-in, therefore, avoidance of shortages caused by technical failure is not completely solid. Lock-in is more likely to be caused by a desire to rely on locally available sources of energy and the comparative costs of different sources of energy. As an explanation for the rejection of energy conservation, Collingridge's model appears to be credible. A more complete explanation of the tendency for policy to rely on large supply expansion technologies and for the phenomenon of overgrowth of energy supply is that provided by Puiseux.

4.6.2 Risk Asymmetry in Rational Energy Planning

Louis Puiseux (1987), an econometric modeller with Electricité de France (EdF), argued that planners had to work with the knowledge that forecasts are necessarily inaccurate. They therefore had to work with probabilities and the critical decision they faced was whether to err on the side of over or under-supply. The consequences of aiming too high were over-investment which tied up scarce resources in the form of costly idle capacity that was not producing income. This served to increase the average unit price of energy produced by the system. The consequences of aiming too low, on the other hand, were the inconvenience to consumers and the damage that shortages would inflict on the economy. These risks were not symmetrical from the planners perspective as the prospect of blackouts or rationing in the middle of winter when the demand for electricity was highest, or of increasing unemployment due to a slowing of industrial expansion, were potential political nightmares that planners and politicians could ill-afford:

> One can ... imagine the sweat breaking out on the forehead of politicians when the possibility of a shut-down of factories and shivering householders is evoked, and all this punishment for their stinginess seven or eight years earlier when they failed to allocate the required financial means. (Puiseux 1987: 197)

This perceived asymmetry in the risks associated with the two alternative planning options, Puiseux argued, lead planners to systematically adopted high load forecasts[9]. The inherent risk in this strategy was the potential for overgrowth in supply and a serious imbalance between supply and demand. To minimise these risks, Puiseux suggested abandoning the strategy of constructing generating units of ever increasing size which was driven by the attempt to capture economies of scale, but increased lead times and, therefore, the planning period. This, in turn, increased the uncertainties over future demand and, therefore, the risks of oversupply. The rational alternative, according

[9] Puiseux acknowledged that the concept of asymmetrical risks in forecasts as an explanation for policy preference for high load forecasts was first advanced by Bergougnoux (1982) [Bergougnoux J (1982) *La Prévision de la Demande d'Electricité*. Paper presented at the Colloquium Futuribles, Avignon, 20 December].

to Puiseux, was to proceed more incrementally with smaller-scaled and lower capital cost generating units. Although this would increase the unit costs of energy by foregoing economies of scale, this disadvantage would be offset, Puiseux asserted, by the reduction in risks of oversupply and costly idle capacity as lead times would more closely match to those of industrial expansion projects. It was a strategy that involved treading a finer line between supply and demand, with the risks of shortages constantly greater should growth in demand suddenly accelerate unexpectedly. The ability to bring on new generating capacity in a shorter period of time, however, reduced these risks.

To Puiseux, the real problem was the systematic bias in planning for oversupply and related risks of overcapacity rather than low planning emphasis on energy conservation *per se*. Nort does reliance on a more incremental supply expansion programme, based on smaller-scaled and lower capital cost technologies necessarily render active demand reduction a more attractive planning strategy from the perspective of energy suppliers. Collingridge's explanation of the rejection of the energy conservation option in terms of the short planning decision times, the uncertainties over the capacity of energy conservation to reduce demand, and the primary planning objective of avoiding shortages, all remain unaltered. In one way, Puiseux's suggestion of reliance on smaller-scaled generating units could serve to reduce the attractiveness of energy conservation as a planning option. Many writers maintain that the primary value of energy conservation to planners is the financial savings obtained form deferral of the need for costly investment in supply infrastructure. The actual value of energy conservation from the perspective of planners, however, may be the capacity to reduce the financial risks associated with further investment in capacity expansion, risks associated with a failure of the expected increase in demand to materialise. If this were the case, and it appears likely that it would be in many situations, then reducing the size of the increments in capacity expansion would reduce these financial risks and, therefore, the attractiveness of energy conservation as a strategy. This argument was supported by Lucas & Papaconstantinou (1982) who used a probabilistic model that integrated the uncertainties associated with supply side outages, of demand, and of the costs of outages. They concluded high uncertainty favoured smaller-scaled and less capital intensive energy supply options but large planning margins.

Three important points need to be made here. First, planning as described by both Collingridge and Puiseux places a premium on security of supply. This injects into the rational planning process a large subjective element as energy security is not something that can be objectively measured but is 'a comfort level' that varies according to many factors. What is valued in expanding supply is not the energy itself but the *perception* of security associated with that level of supply (IEA 1991a: 44). Energy supply organisations, business and governments tend to value energy security more highly than do individuals.

Secondly, conventional rational energy planning as portrayed by Pusieux is client-based. It assumes that existing clients will expand their needs for energy and that new clients will arrive in response in more or less the same way that they have done to date. It consists of forecasting the *likely* increase in demand and then producing enough energy to meet the predicted increase. Demand then rises is response, reversing cause and effect as the policy decision to increase supply has the effect of increasing demand as the events that will influence future demand for energy are policy-determined or policy-influenced variables (Robinson 1982a: 629). So much has been written about the inaccuracies of such predictive forecasting attempts in the 1970s and 1980s based on extrapolation that there is no need to use yet another graph to demonstrate these inaccuracies. One response has been the attempt to improve the reliability of forecasting by using more sophisticated econometric models and the use of conditional 'if-then' clauses to make the uncertainties in the assumptions explicit. Forecasting based on trend analyses attempts to determine where we seem to be heading. It is an inherently conservative process as the lack of historcial data on unconventional energy options such as energy conservation automatically means that projections of likely increased reliance on these options will understate their true potential (Robinson 1982b: 228). Another approach has been the development of end-use or bottom-up analyses that more closely mimic energy consumption processes (Bartels 1988: 113). While these bottom-up approaches permit a better evaluation of energy conservation potential (Robinson 1982a: 628) it has been argued that attempting to improve the fidelity and accuracy of forecasting models will not resolve the fundamental problems associated such a planning approach and that the real problem is the attempt to predict what is *likely* rather than what is *desirable*. Such individuals advocate the use of end-use analyses in conjunction with 'backcasting' to explore the feasibility of various energy future scenarios (Robinson 1982a, 1982b, 1982c, 1988, 1990). Such an approach, however, deviates from the traditional client-based mode of energy planning. Rather than attempting to estimate what future clients may need by way of energy, it asks what more can be squeezed out of existing energy supply and use systems. This turns traditional planning on its head as any future increase in energy requirements have to be accommodated within this boundary. Such a way of planning is foreign to most energy planning organisations (Schrecker 1980: 27).

The third important point is that advocates of aggressive energy efficiency proposals have overlooked the risk asymmetry between under and oversupply. Such experts have quite rightly maintained that the risks associated with supply-side strategies are real and potentially serious. Drought, for example,is a perennial uncertainty associated with hydro-electric schemes. Engineering errors such as miscalculation of evaporation effects on hydro-impoundments, as in thre case of the Aswan dam (Sandbach 1980: 139), mean that long term generating output is less than anticipated. These experts insist, moreover, that supply and demand uncertainties are approximately equal:

> The estimates of the size and costs of conserved energy are not inherently more or less uncertain than those of conventional supply. (Wright & Baines 1986: 6)

Such statementss indicate a failure to comprehend tthat planners treat the risks of under and oversupply differently. Even if the risks of conservation and energy supply were considered to be more or less equal in degree, planners would still consider them to be substantially different in their consequences and place greater weight on the uncertainties that could result in supply shortages than on other uncertainties.

Collingridge's and Puiseux's explanations for the rejection of energy conservation as a policy option in electricity planning have been given tacit support within the literature. It is commonly accepted that agencies responsible for electricity planning will tend to err on the side of security and overproduction as managers of these agencies stand to be severely censured if the generating system subsequently proves unable to meet demand (Wilde 1978: 213). A recent interpretation of the reasons behind the undermining of demand management in electricity planning in the Australian context (Chatfield *et al.* 1992) also lent support to these explanations. The choice of large scale electricity generating units, these authors argued, avoids shortages but is a gamble as planning forecasts that are too high result in large surplus capacities. These risks are amplified by the fact that the choice of large generating units required the construction of large reserve plant generating units, since the generating capacity of reserve plant is related to the size of the generating units in use. Once the new large plant come on line, their argument went, energy demand management conflicts with the strategic interests of the utility. Until the rise in demand catches up with the increased capacity of the system, there is little incentive for the utility to engage in demand management. But at that point, the authors added, the long lead times for new plant construction necessitates a quick decision and the lack of utility experience in demand management strongly mitigates against its deployment as an option (Chatfield *et al.* 1992: 164).

As the above-mentioned authors were the managers of the demand management programmes in Australia's largest electricity authorities, it is evident that the Collingridge model has much support from within the electricity supply industry itself. Collingridge's explanation, and that of Chatfield *et al.*, may have erred, however, by overstating the period for which energy conservation is in the strategic interests of the energy supplier. The conventional view supporting the Collingridge model is that planning interest in energy conservation does not die off until the new generating plant is commissioned. In reality, the attraction of energy conservation to the energy supplier may dissipate well before the new plant comes on line. For once construction loans have been arranged and contractual commitments associated with the construction of new supply projects have been entered into, the energy supplier is committed to the supply rather than the conservation strategy (Natural Resources and Environment Committee 1988: 21-2).

The argument that expansion of energy supply represents the less risky option, moreover, continues to be advanced as a 'rational' argument for further supply side construction. In Finland, it has been argued that whilst energy conservation is an obvious component of the Finnish greenhouse gas reduction strategy, it is necessary to hedge against the uncertainty associated with energy conservation (Silvennoinen 1991: 508). The perceived risks of relying on energy conservation alone were curtly summed up by Silvennoinen in the following way:

> To the extent that energy savings are prone to be based on wishful thinking, the power producer is faced with a situation where capacity shortages can be avoided only by installing whatever kind of capacity can be built at short notice. In regard to the situation in Finland this means that overly wishful plans for savings and so-called negawatts eventually turn out to be coal-fired megawatts. (Silvennoinen 1991: 505)

To avoid the risk of increased carbon dioxide emissions from these coal-fired megawatts, Silvennoinen advocated the construction of a fifth nuclear power station.

That uncertainty over the scope, timing and costs of energy conservation leads to reliance on supply-side options was recently given tacit support by the Australian Institute of Engineers. When a recent Australian Bureau of Statistics [ABS] national survey of household energy conservation effort found that only 50% of Australian households had insulated their ceilings, the President of the Queensland Branch of the Institute of Engineers of Australia responded on national radio by arguing that the energy supply industry could not be accused of needlessly increasing the supply of electricity when even those opposed to the construction of new power stations did not attempt to conserve energy (ABC Radio National, *National News*, 25 October 1995).

Central to this rational explanation for the rejection of aggressive energy conservation as an option are the assumptions that energy savings from energy conservation programmes are difficult to predict and that only by implementing such programmes can their actual effects be assessed (Natural Resources and Environment Committee 1988: 21) and that those who advance energy conservation tend to overstate these savings (Atkins & Evans 1992: 143). It is this assumption that has led to 'extensive and often heated' debate, with energy efficiency advocates annoyed by the persistent claims that their proposals are unrealistic (Pears & Versluis 1993, Section 2: 8). It is therefore useful to look at what are considered by various writers to be the more important causes for this uncertainty. These are described below.

(i) Lack of an adequate baseline data on energy end-use

It may be unclear what portion of energy consumption is used for a particular end-use within a particular sector. If, for example, no definitive information is available on how much energy is used by household refrigerators, then it is immediately difficult to gauge how much energy could be saved by implementing an energy conservation programme designed to increase the efficiency of household sector refrigeration. Lewis *et al.* (1987: 11) alluded to this problem when they noted that estimates of total annual household sector refrigeration energy use in Victoria given in the literature varied from 5% to 17% of total annual household sector electricity use.

(ii) Uncertainty about the take-up rates of energy conservation measures

It has been argued that household sector levels of energy use are relatively fixed by the nature of the stock of energy-using equipment in use. As this equipment is not replaced simply when a more efficient version arrives on the market but at the end of its useful life, improvements in energy efficiency do not occur overnight but gradually over a ten to fifteen year period, householders exhibit low short-term demand elasticities (Sioshansi 1991: 231). The average life of appliances and energy-using equipment, furthermore, is not known with any precision. The author was informed by the Australian Consumers' Association that the Association was unable to make either a general or informed statement about the expected life of appliances (Sandra Leach, personal communication, October 1991). Energy efficiency advocates, however, contend that this assumption that a rapid take-up is not possible is in fact erroneous and that a rapid take-up is 'certainly possible' (Pears & Versluis 1993:, Section 2: 14).

(iii) Administrative complexities

The difficulty of encouraging energy users to take-up energy conservation measures renders this option administratively far more difficult and less straightforward than the option of increasing supply (Reddy 1991: 955). Programmes to promote the more efficient use of energy are inherently more difficult to implement than those organised to sell electricity, gas or oil. The marketing of energy conservation is considered to be relatively complicated as the markets for energy services are complex and dynamic. Energy conservation planning therefore involves a wide range of novel marketing problems (Williams 1989: 834-6). Proponents of aggressive energy efficiency proposals have been criticised for neglecting to appreciate this difference (National Institute of Economic and Industry Research 1990: 15). These difficulties are exacerbated, moreover, by a lack of experienced technical and managerial skills required for their formulation and implementation (Reddy 1991: 957). Support for the case that a rapid take-up of energy conservation is possible is premised on a faith that while the take-up of energy conservation is obstructed by market 'imperfections', demand siders are 'smart enough to understand the mechanisms needed to overcome them' (Gilchrist 1994: 278).

(iv) The 'take-back' effect at the microlevel

Individuals and firms that take-up energy efficiency measures do not always use these increased efficiencies to reduce energy use but often use part of the gains in efficiency to increase the output of energy services. Khazzoom (1987, 1989) used the example of the motor car to make this point. This argument has been countered on the grounds that people do not use other energy-using equipment in the same way that they use cars and there is only limited scope for off-setting the increased energy efficiency of a refrigerator by leaving the door open, or TV set by watching more television. For many end-uses such as refrigeration, however, increases in the energy efficiency have not always translated into decreased average household refrigeration energy usedue to a trend towards larger refrigerators, two-door models with separate refrigeration and freezing compartments, and extra features such as automatic defrosting (Geller 1991: 21, Schipper & Meyers 1992: 53). Herendeen & Jacobs (1982) therefore assumed in their end-use forecast for household energy use that energy use would increase despite efficiency improvements.

This argument has been supported by the finding that the dominant motive behind the installation of insulation has been to improve thermal comfort rather than to save money (Kerby 1985). The term 'take-back' in this case is a misnomer as there was never any intention on the part of the individual to save energy. Similarly, while microwave ovens have the technical potential to reduce the energy requirements for cooking by approximately 50% (IEA 1991: 115) and over half of Australian households own microwave ovens, it has been found that very few householders use these for other than reheating leftover meals (ACA 1992: 14). Such effects render it difficult to estimate energy savings as they depend not only on the operation of the technologies but also on the behaviour of the people who use them. Stern *et al.* (1987: 351-2) warned against estimating energy savings from new technologies without comprehensive field trials. Engineering estimates were inadequate, these authors argued, because energy-efficient technologies consume less energy, but also free income that can be spent on other uses, some of which are likely to use energy (Stern *et al.* 1987: 351-2). Quantifying the possible impacts of energy conservation on electricity demand is therefore 'a rather subjective exercise' (Johnson & Rix 1991: 64).

Poulsen & Forrest used this arguemnt (1988: 337) in expressing scepticism over the merits of energy efficiency codes for new buildings and financial incentives to improve the energy efficiency of the existing dwelling stock. Building codes, they argued, often had the effect of making increased power use more affordable rather than promoting conservation. Brookes (1990) has taken the argument further in positing that the proportion of average household income spent on energy has historically remained amazingly fixed, suggesting that the level of expenditure on personal energy use remains relatively unchanged while the efficiency of energy use changes.

(v) The 'take-back' effect at the macrolevel

Many economists have taken issue with the assumption that an increase in the efficiency of energy use at the microlevel will result in reduction in energy use at the macrolevel equivalent to the sum of these microlevel savings. They argue that it has been well-documented that increased energy efficiency at the microlevel does not necessarily translate into macrolevel energy savings as an increase in the efficiency of energy use effectively decreases the unit costs of using that energy, with the result that demand adjusts accordingly. In its submission to the Inquiry into the health effects of electromagnetic radiation (Gibbs 1991), the Australian Electricity Supply Association, for example, stated that demand management had the theoretical potential to reduce industrial expenditure on energy by up to 20% in the long-term. The Association added, however, that there was no evidence to indicate whether these potential monetary savings would result in reduced consumption as they could 'equally make electricity more competitive and so lead to its increasing its share of the total industrial energy market' (Gibbs 1991: 11). Economists also have questioned whether improvements in technical energy efficiency at the microlevel would translate into equivalent reductions in energy use at the macrolevel (Sheraga 1994: 267). Whilst energy efficiency advocates have claimed that the goal of energy conservation policy is to reduce the energy efficiency of the economy (Saddler 1981: 71), the more extreme economists claim that by increasing the efficiency, the demand for energy would be increased and that they have serious doubts whether energy efficiency has any relevance for energy policy at all (Sutherland 1994: 267).

(vi) Technological uncertainties

Experts on all sides are considered prone to exaggerate the claims made of their favoured technologies. The early claims of proselytizers of nuclear fission are now legendary. It has been suggested by Khallizad & Bernard, however, that the claims made by contemporary renewable energy enthusiasts are amazing carbon copies of those earlier pro-nuclear claims (cited in Smil 1987: 87). Of the claims that renewable energy has the capacity to rapidly displace oil or fossil fuel, one energy analyst remarked that he only wished that this were 'a lesser fiction than oil depletion and the economic viability of nuclear fission' (Odell 1992: 292). There is reputed to be a similar scepticism held by many over the technical potential of end-use energy efficiency measures (Schipper & Meyers 1992: 55). Inaccuracies in techno-economic analyses, furthermore, are said to give rise to uncertainties over the economic benefits of these energy efficiency measures and resistance to their adoption (Jochem & Hohmeyer 1992: 219). Jones *et al.* (1991: 33) have claimed that market failure such as lack of awareness of the benefits of energy conservation measures is unlikely to be a full explanation of why individual firms and householders take-up cost-effective energy conservation measures. They hypothesised, instead, that not all the energy efficiency measures cited in the literature were in reality as cost-effective as these analyses assumed them to be. They suggested that a first priority was to test this alternative hypothesis by testing the validity of the claims made in the literature. This question of the technical uncertainties associated with energy efficiency assessments is examined more closely in Chapter Eight in which energy performance tests on domestic refrigerators and the results of these tests are discussed.

There is said to be, furthermore, 'strong disagreement' between energy efficiency advocates themselves as to the cost-effectiveness of energy efficiency measures (Pears & Versluis 1993, Section 2: 9). Inconsistent methodologies, lack of awareness by some energy efficiency experts, the technical scope of some measures, and the use of 'simplistic methodologies' are all considered to this lie behind this disagreement . According to many economists, furthermore, the affects of DSM programmes are multiple and varied. They can alter the costs of electricity (up or down), can effect system reliability, and can lead to changes in the quantity and quality of energy services provided. Energy conservation policies also involve equity issues as they may effectively transfer income from participants to nonparticipants. All of these issues and uncertainties render the estimation of the economic benefits of DSM 'more complicated than the mere comparison of the expense of 'negawatts' with the cost of megawatts' (Hobbs 1990: 86).

Pears & Versluis (1993, Section E, p. 11), concede that it is not possible to be precise about the cost of saved energy or about the cost of energy produced from alternative systems but insist that despite these uncertainties there remains a clear economic justification for 'a serious commitment' to these options. They charge, moreover, that policy makers have consistently underestimated the technical scope for increased energy efficiency.

It has been argued that these uncertainties associated with conservation programmes means that although a large number of energy conservation programmes have been undertaken, especially in the USA, these energy conservation initiatives have not been in place long enough to allow planners to understand how effective they are (Prindle 1991). It is still unclear, it has been argued, what the impact will be on the balance in electricity planning between construction of supply and energy conservation. The unpredictable nature of the potential, timing and persistence of energy conservation together with the uncertain costs of energy conservation programmes and their high uncertainties, are seen by planners as added complications to what is an already difficult task of planning in which mistakes can be long-lasting and expensive. Planners concede that energy conservation programmes could turn out to be more effective than predicted, but their major concern is that they could also turn out to be less effective (Hemphill & Meyers 1986: 137). Despite the occasional claims that there has been a revolution in the adoption of DSM, scepticism within the US electric utility industry over the capacity of DSM to serve as a resource for utility planners remains high. Commonwealth Edison delightedly ran advertisements in 1988 stating that 'The 16,138,000 kilowatt-hours you weren't supposed to need until 2005 were supplied last Tuesday with the help of two new power plants we weren't supposed to need until

2005' (cited in Ahearne 1989: 15). It has been maintained that while the size, reliability and longevity of DSM resources remains uncertain, this scepticism is justified (Prindle (1991: 205).

(vii) Energy inefficiency as a buffer against short-term energy shortages
Before leaving the topic of rational planning under uncertainty, one further explanation of why energy conservation is not adopted as a policy option can be advanced. Electricity planning under uncertainty has been shown to involve the attempt to find strategies to cope with uncertainties in relation to long-range future demand. According to Collingridge and Puiseux, the major strategy employed is to err on the side of over- rather than under-supply, a strategy which can lead to overgrowth of supply. But there are also shorter-term and unpredictable shortages associated with the supply and demand that lead to problems in matching demand with supply. Needle peaking, for example, is an unusually high peak within normal peak loads. It can be caused by such things as atypically harsh weather. To cope with such events, utilities can enter into interpretability clauses with large consumers of electricity so that the sudden increase in demand in one sector can be met by temporarily interrupting supply elsewhere.

Of interest here, however, are unanticipated temporary supply shortages or demand increases of longer duration - weeks or months. These could be caused by a number of factors including plant failure, or prolonged periods of atypically harsh weather conditions. The usual strategy for coping with these shortages is to rely on reserve plant. In some instances, furthermore, the problem could be caused by reductions in fuel supplies due to strikes in coal mines or, in the case of hydro-electric systems, droughts. In such cases, it may be in the interests of the energy supplier to use the slack in the demand side of the system - the scope for temporary energy conservation - as a buffer against short-term shortages. In this way, the energy supplier could use inefficient energy use as a means of reining in some of the slack during temporary shortages, and increasing the slack in the system by encouraging energy use once the shortage was over.

The proceeding sections of this chapter have attempted to cast a wide net in order to pull in as many plausible rational explanations for the low priority given to energy conservation as a planning option in situations such as Australia. The aim has been to provide a description of, rather than a prescription for, policy making. One conclusion that flows from these explanations is that once the rate of growth of energy supply exceeds a certain threshold, energy conservation is effectively undermined as an option. With rapid expansion of energy supply, incorporating energy conservation into the planning process becomes more difficult. The question of what drives the expansion of energy systems is therefore critical to the explanation of why energy conservation is overlooked as an option.

A number of factors driving the growth of energy supply have been examined. To many commentators, however, these explanations of the low priority given to energy conservation within energy planning are inadequate. This school of thought considers that lack of action in terms of energy conservation on the part of utilities or governments cannot be adequately explained in terms of insufficient information or uncertainty as there has been a vast amount of research and demonstration effort already undertaken in this field to date, especially in the USA. This is taken to mean that the 'element that is missing is not information but action' (Senate Standing Committee on Industry, Science and Technology 1991: 7) and that 'conservation deserves more action from governments and electricity authorities than has been carried out so far' (Rosenthal & Russ 1988: 284).

The rate of expansion of energy supply, it is argued, cannot be explained purely in terms of rational or strategic planning as these explanations fail to account for the fact that electricity planning has often led to the construction of generating units larger in scale than what has been economically efficient (Harris 1982: 55). Muddling through, on the other hand, is above all else, designed to avoid grand mistakes and hence should, in theory, lead to a predominance of prudent over obviously flawed decisions. In this view, rational and strategic planning models fail to explain the preponderance of what have proved to be injudicious decisions in the form of massive overcapacities throughout the industrialised world during the 1980s and early 1990s and which strongly suggest that energy planning has been based on something other than *ad hoc* pragmatism. In this view, essential to understanding why energy conservation is rejected as an option is an understanding of what determines the scale of the supply expansion projects. The Collingridge thesis, that it is driven purely by consideration of economies of scale combined with a progressive ratchetting up of demand, does not adequately explain past overgrowth of energy systems and the widespread occurrence of massive overcapacities in electricity generation throughout the industrialised world in the late 1980s and early 1990s. Other explanations are therefore seen to be required to explain this phenomenon and the associated rejection of energy conservation as an energy planning option. The discussion now turns to those explanations.

4.7 Political Decision Making

Political decisions have been defined as those made on the basis of preferences of actors without regard to the public interest (Pfeffer 1981: 22). According to Pfeffer, many of those not schooled in political science find it difficult to accept political explanations and tend to fall back on rational decision making models as explanations of the rejection of energy conservation as an option. Hughes (1987), for example, argued that such explanations could be invoked to explain policy decisions to expand energy supply only if this expansion programme could not be explained as the outcome of rational decision making. The problem with this position, in Pfeffer's view, was that whether a decision was made on the basis of rational or political decision making processes cannot be divined from the decision outcome since any outcome can be consistent with rational choices (Pfeffer 1981: 21).

It has been argued, however, that in the case of energy planning, and electricity planning in particular, planning outcomes have not suggested a rational decision making as they have clearly 'left much to be desired', even in terms of what is economically rational (McColl 1976: 148). It is therefore necessary to look at political decision making as an explanation of the rate of growth of energy systems and the rejection of energy conservation. The first step in this process is to extend the theory of energy policy decision making by looking at élitist policy decision making and non-decision making.

4.7.1 Elitist Policy Decision Making and Non-Decision Making Theory

Whilst Lindblom's description of policy decision making as pragmatic and strategic muddling was broadly accepted as a descriptive model of decision making, it was denounced by many policy analysts as 'nothing but a handy excuse to avoid more difficult explanations' (Downey 1987: 31) and a perverse normative model of decision making (Goodin 1982: 19). Incrementalism was regarded as inimical to policy reform and dismissed by those seeking such reform as an ideological reinforcement of the pro-inertia and anti-innovation forces prevalent in all human organisations.

Lindblom's incrementalist-strategic model was also criticised as a description of policy decision making, its major defect considered to be its pluralist-like assumption that all interest groups had equal power to advance their case. These pluralist explanations of which issues get on to the political agenda, and which do not, and of the way in which issues subsequently slip off the policy agenda as public interest in the issues subsides, were discussed in Section 3.3.1. An alternative explanation of which issues do and do not get onto the policy agenda posits that influential actors and decision makers have the political ability to prevent certain problems from becoming issues through the process of 'politically informed neglect' (Crenson 1971: 184) or are played down or nipped in the bud before they become fully fledged political issues. Some groups are seen to be more able to promote their interests and determine the outcomes of policy decision making than are ordinary citizens. In the most extreme form, the dominant values and the power of influential groups have the capacity to effectively keep certain grievances from developing into full-fledged issues so that there is no call for policy decisions (Bachrach & Baratz 1962, 1963, Crenson 1971).

Which issues make it onto the finite policy agenda is, in this model, governed by the law of limited numbers and the mobilization of bias. Each group attempts to keep its issues on the finite agenda space by keeping competing issues off. Some issues are thereby organised *into* politics while others are organised *out* (Schattschneider 1960: 71). Policy proposals are therefore adopted or rejected not on the basis of their social rationality or analytical rigour, but on the basis of political power and preference (Walker 1994: 197).

While not shifting from his position that policy is *always* strategic and usually incrementalist, Charles Lindblom agreed that actual policy decision making was fundamentally flawed and conformed to the political decision making model. 'I have failed to communicate', he wrote, '... just how bad I think policy analysis and policy making are, even under the best of circumstances' (Lindblom 1979: 517). While maintaining that incrementalism was the theoretical optimal mode of decision making, it failed because it was undermined by the privileged positions of some interest groups *vis-a-vis* others in the policy making process (Lindblom 1977: 168). To Lindblom, the pluralist model was a 'lie' as the participants in policy debate did not represent the interests and values of society, but the *dominant* interests and values (Lindblom 1979: 523). The more important the decision, he argued, the less representative was participation in decision making. Debate over grand issues, such as the distribution of wealth, corporate prerogative and the distribution of political power were simply organised off the political agenda. Policy, declared Lindblom, was not only strategic: it was *too* strategic (1979: 520). And this, he added, 'could put us on road to ecological collapse' (1977: 347).

Those influential groups with an interest in continued and rapid expansion of energy supply, and which are therefore likely to oppose, overtly or tacitly, proposals for greater reliance on demand reduction strategies, are discussed in the following section.

4.7.2 Political Support for Rapid Growth of Energy Supply

Governments are sometimes assumed by those who advance aggressive energy efficiency and renewable energy options to be ideal purposive agents in control of policy and governed by an overarching goal of improvement of the community's standard of living (Berrill *et al.* 1991: 10). As energy efficiency and renewable energy reduce the social and economic costs of energy, it logically follows, to such writers, that these options should be adopted. Governments, however, are fragmented and more complex, with one government bureaucracy often working at cross-purposes to another. The relationship between government, society, business and bureaucracy is also not as simple as many advocates of energy conservation assume.

Some political analysts depict the state (political system) within liberal capitalist societies as poised between the business (economic system) and social spheres (social system). This relationship together with their interrelationships to the energy system is shown in Figure 4.4 below in which the state is seen as precariously juggling the two key functions of assisting business accumulate capital and maintaining legitimacy.

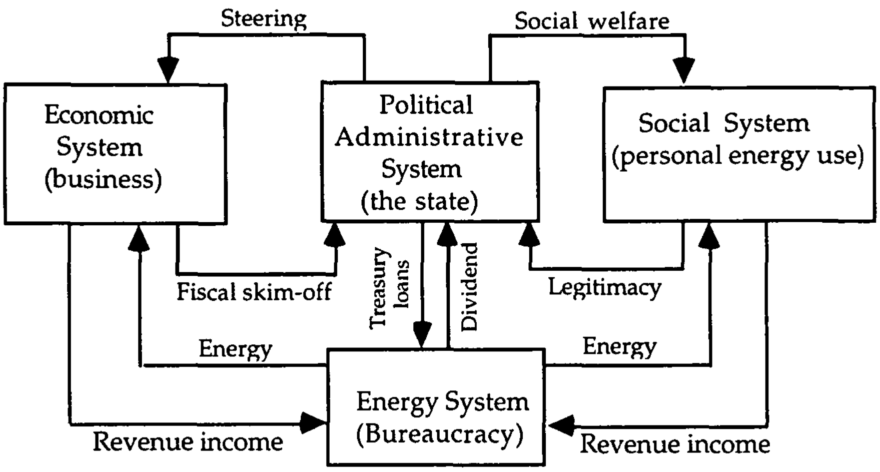


Figure 4.4 The adapted Habermas/O'Conner/Offe model of the relationship between the state, business and society [adapted from Pusey 1991: 197] to which the energy system has been added.

Capital accumulation is increased by assisting business through tax relief, the provision of infrastructure and a trained workforce. As business requires stability, a major role of government is to provide a controlled, secure, entrepreneurial climate in which financial risks can be taken (Galbraith 1972: 90). Legitimation, on the other hand, is maintained by expenditure on public welfare (O'Conner 1973, Offe 1975, Habermas 1979). Balancing these two functions is seen by these writers as a delicate task. Too much attention to encouraging business at the expense of ignoring the needs of the community, many of which are created by the expansion of the economic activity, risks public unrest. Too much expenditure on public welfare and services and insufficient attention to maintaining economic stability and growth, on the other hand, results in a fall in government revenue. This forces the state to engage in an austerity drive and cut back on services and welfare which, in turn, results in reduced popularity, electoral backlash and a reversal of the policies. The attempt to resolve these tensions is therefore seen to create, alternatively, fiscal and legitimation crises. As a result, the state's role in the economy oscillates between *laissez-faire* minimalism and socialist intervention.

The interests of each of the three spheres - business, the state and the energy bureaucracy - in continued and rapid energy supply expansion programmes, and the political influence each of these spheres has on policy making are discussed in more detail below by taking each of these separately.

4.7.2.1 The state's role in energy policy

<u>The Impotent State</u>

A small number of political economists have perceived capitalist economies to be based to a high degree on energy-intensive manufacturing industries and a policy emphasis on conservation as being inimical to the economic viability of major corporations (Walker & Large 1975: 470). Such writers have argued that energy policy within a capitalist system is determined primarily by the interests of industry and that the state is therefore relatively impotent in regard to developing meaningful energy policies. Other writers have disagreed and have argued instead that the business community is too fragmented and divided to dictate energy policy in such a way. To such writers, the state does not increase energy supply for the interests of specific businesses but as a general means of increasing economic growth (Caldwell & Woolley 1976: 117).

Many governments, however, have subsidised energy-intensive industry as a means of gaining legitimisation. The contradiction inherent in this approach is that these industries most aggressively mechanise and displace labour. This process results in a cycle in which further investment in energy supply has to be made, to accelerate growth so as to take-up the displaced labour, or to provide welfare and retraining assistance to displaced workers. Either way, the fiscal crisis of the state is deepened (O'Conner 1973). Because of this, the latitude of the state to deal with energy problems is severely constrained and it therefore continues to rely on continued expansion of supply (Caldwell & Woolley 1976).

<u>The State as Developer</u>

An alternative view of the relationship between the state and business is that it is a complex and two-way influence, with public spending tending to accommodate the needs of business (Galbraith 1972: 316). This is as equally true in business-led, laissez-faire economies such as Germany as it is in state-led economies such as France and Japan. In its most extreme form, governments use resources and public investment in infrastructure such as energy supply as a means of encouraging capital to invest and is referred to as developmentalism.

Governments have both indirectly encouraged economic development to varying degrees by investing in research and infrastructure and directly by investing in resource development projects. The degree to which Australian state governments have intervened directly in economic development has historically been inordinately high in comparison to other capitalist democracies. This has been attributed to their colonial origins and the 'tyranny of distance' from world markets which forced state governments to strategically intervene by mobilising resources to attract 'much needed' foreign capital (Davis *et al.* 1988: 15). Australian state governments have provided significant infrastructure in the form of railways, ports, power generation and have offered generous concessionary resource agreements in order to attract such capital investment. As a consequence, Australian was branded by capitalists such as Henry Ford as a socialist country. To neoMarxist writers, however, this intervention has not constituted socialism but 'corporate socialism', the true intention of which has been to provide the necessary conditions for private firms to make large profits (Saddler 1981: 115). According to Saddler, business has been content to allow governments to take on the marginally profitable or unprofitable undertakings, such as railways and electricity supply, as it freed them to invest in more profitable ventures. By nationalising their electricity industries, Saddler argued, the Australian state governments were not acting against capital, but for it.

The 'ideology of development' or 'developmentalism' (Saddler 1981: 4) has been much more potent at the state than the federal level in the Australian context. The reasons for this has to do with the Constitutional arrangements of the Australian federation which give the states little control over macroeconomic policy while barring them from raising income from bounties or tariffs. With few other avenues available to them for generating employment, the states turn to the one thing they own: their natural resources. Resource development provides both revenue and highly visible jobs and is therefore seen as a vote-catching strategy. 'It is this political calculus', according to Kellow (1986: 13), 'which encourages the developmentalist ideology in the [Australian] states'.

4.7.2.2 The power of business

The power of business resides in its monopoly over capital investment decisions. Restriction on energy supplies could seriously damage economic growth as businesses do not just appear. Any business contemplating setting up a new plant asks some fundamental questions about the costs of energy and energy security. If they do not like the answers they receive, they look elsewhere (Rossin 1980: 61).

Business confidence can be damaged with policies that impact negatively on profits. Regulations to protect the environment, increased taxes to pay for environmental repair programmes, reduced public spending on infrastructure such as rails, ports and electricity, or substantial increases in electricity prices, are all viewed as detrimental to business interests. Reduced business interests, furthermore, could trigger economic downturn (Dryzek 1995: 294).

While proponents of aggressive energy efficiency are adamant that their option would generate as many or more jobs, and would provide a greater economic growth than would an increase in the supply of energy (Gilchrist 1994: 227-8), the fact remains that the political clout of advocates of the aggressive energy efficiency option is seriously diminished by the fact that it is not energy efficiency advocates who control the means of production and wealth which generate employment. They therefore tend to be less well represented within the policy debate than those who do command such factors (Kellow & Moon 1993: 248).

Firms which are a major source of direct or indirect employment within regional communities, furthermore, are in a particularly strong position. The economies of localities dominated by such industries are considered by some writers to be effectively held hostage to this power of large business (Schrecker 1990: 160-171). In such cases, overt threats on the part of industry to decamp are usually unnecessary within the capitalist system as both local communities and governments are well aware of the economic ramifications of industrial disinvestment (Bell & Wanna 1992b: 268). The corporate executive thus becomes, in Lindblom's (1979: 178) words, ' a public official in the market system'.

Many writers have argued that this relationship between the three spheres is extremely lopsided and the state's ability to address social issues is restricted by its dependency on a well-performing business sector. If business performance falters, the state's capacity to tax business to run the state apparatus is reduced. This reduction in the state's capacity in turn weakens its legitimacy. Business therefore enjoys a privileged position in the policy debate, and this seriously undermines government's ability to resolve serious problems such as environmental degradation and energy shortages. 'The private corporation, wrote Lindblom, 'has rights that the citizen does not; they are taller and richer persons than the rest of us dwarfs' and because of this, much would-be effective regulatory decisions are blocked (Lindblom 1979: 520). In this view of politics, 'public interest is less important than private profit' (Walker 1992b: 251), governments are severely checked in what they can do as any action which threatens private profit is opposed by business (Dryzek 1987: 84) and the social sphere is effectively reduced to that of a 'generic externality' (Pusey 1991: 10).

In market-driven economic systems, therefore, governments are seen by many political writers to be checked in their attempts to adopt 'seemingly desirable policies such as energy conservation or environmental protection' where these threaten to undercut business profits (Lindblom 1977: 347). In the USA, President Carter is said to have recognised that energy conservation was in the national interest but was aware that any attempt by his administration to introduce policies encouraging conservation of oil would be resisted by Congress due to the power and influence of the oil companies (Dahlberg *et al.* 1985: 39). Manufacturers successfully opposed even relatively mild environmental regulations such as container deposit legislation for years because it increased handling costs and reduced output of nonreturnable products (Dahlberg *et al.* 1985: 53). Business is less resistant to the introduction of environmental regulations where it is possible to pass on the costs of these measures such as pollution control devices on vehicles onto customers without impairing its competitiveness.

A pertinent example of business exercising such a veto power in regard to energy conservation policies would be the opposition of manufacturers of energy-using equipment to mandated minimum energy performance standards where the imposed standards require expensive retooling or substantially increased research and development of new designs or a loss of competitive edge. If the appliances produced by local manufacturers are less energy efficient than those of imported models, as is the case with refrigerators in the United Kingdom (Herring 1992), local businesses are likely to put up strong resistance to the introduction of mandated energy efficiency standards which their models could not meet but which their imported competitors could. Governments are likely to be swayed by such pressure, moreover, if the introduction of mandated standards threatens local jobs.

The threat of standards to the appliance manufacturing industry, however, may be not so much the initial standards themselves as the fear that standards, once in place, would be rapidly ratchetted upwards. Regulatory bureaucracies are not necessarily captured by the industry they are designed to regulate and can become the driving force behind rapidly tighter standards (Jones 1975: 41). Whitegoods manufacturers in the USA have complained bitterly that once the National Appliance Energy Conservation Act (1987) was introduced, the US Department of Energy rapidly increased the minimum standards (Weizeorick 1991: 526).

4.7.2.3 The public energy supply bureaucracy

Bureaucracies behave in characteristic ways and with well-documented pathologies (Presthus 1962). In particular, the tendency for self-aggrandisement to become the dominant bureaucratic goal is a well-worn path in political theory (Self 1993: 35). While Hughes (1989: 69) was sceptical about the role that organisational empire-building has played in electricity planning, others have suggested that the desire for bureaucratic growth has played a relatively important (McColl 1976: 52), or even dominant (Saddler 1981: 76) role within the Australian context. The drive for organisational growth has also been perceived as the dominant motivating factor driving supply expansion elsewhere (Freeman *et al.* 1974: 85, Hughes *et al.* 1985: 109-10).

There is little mystery as to why bureaucracies pursue such growth. Just as governments find the management of the state an easier task with an expanding economy than they would under static economy, bureaucracies operate as organisations most smoothly when they are growing or maintaining their size. Institutions such as electricty supply authorities, and their executives, are rewarded for pursuing high growth activities and punished for pursuing low growth activities (Robinson 1982: 235). But it is also a consequence of the characteristic ways in which bureaucracies operate. Large organisations tend to be extremely conservative (Maslow 1966: 34) and develop bureaucratic ideologies which engender organisational rigidity and ossification. Through this process they become resistant to innovation (Blau & Meyer 1971) and reluctant to take on alternative ideas or follow new paths as long as they continue to be rewarded for meeting the established milestones set out for them (Nader & Milleron 1979: 955). If the milestones are to produce electricity at the cheapest possible unit cost, they continue to do so until this charter is altered. But they also tend to prefer to set their own charters than have their charters dictated to them (Crenson 1971: 36). Because of this, bureaucracies tend to follow routine behaviour rather than problem solving and are robust and resistant to change. In Lindblom's words, they possess 'strong fingers, no thumbs' (Lindblom 1977: 76-89).

Organisational structure also plays a role. As career maximizers, bureaucrats are loyal to the goals of the organisation (Presthus 1962: 16). The process of induction into a profession, furthermore, leaves an indelible imprint on the mind set of the individual - engineers think like engineers, economists think like economists. Because of this, engineers find it difficult to think in terms of altering demand as the traditional engineering approach is to work on the load end of the equation. A bureaucracy in which the dominant section is run by engineers will therefore develop an engineering culture that determines the organisations outlook (Nader & Milleron 1979: 959). For such organisations, grand engineering supply expansion projects such as large dams, nuclear power plants, or wind farms are a more appealing option than the attempt to decrease energy use through the encouragement of lots of small and relatively drab measures such as constructing pelmets over windows, insulating attic spaces, or replacing refrigerators with more energy efficient models.

Because bureaucracies are inherently conservative, once they have established an expertise in a certain field lock-in results from a preference to stick with tried and proven programmes closest to existing ones. Bureaucrats seek incremental change (Pfeffer

1981: 22) and seek it for their own perceived interests (Douglas & Wildavsky 1983: 52). They are optimistic because they need to be in order to fulfil their expansionist plans, and this optimism colours their forecasts (Robinson 1982: 234-5). They have an inability to see the unexpected, will not readily take political risks on board, tend to deny failure, resist external program evaluation and hold on to incomplete or inappropriate theories in the face of manifest failure. Bureaucratic planning failure can therefore be perpetuated to the point where it becomes spectacular (Dryzek 1987: 101).

Given these bureaucratic pathologies, the relevant question is the extent to which bureaucracies, rather than their political masters, control policy making processes. There is no one answer to this question as the interplay between bureaucracy and government is complex. Dahl & Lindblom (1953: 341) argued that political control of bureaucracies requires fine balance. Too much political direction and influence, those authors suggested, would undermine the bureaucracy's ability to make discretionary judgements that is indispensable if rational decisions are to be made about complex technical questions. Too little political control, on the other hand, damages the democratic process. It has been suggested that this political-bureaucratic relationship can fit any one of five different models. At one extreme, the bureaucrats are portrayed as being in control by virtue of their expertise and knowledge - the *Yes, Minister!* model[10]. At the other extreme, politics is portrayed as being in command of the bureaucracy. Such extremes have been descibed as rare and actual relationships as being intermediate between the two, and to range from cooperative to conflictual (Self 1993: 35).

The relationship is complicated further, however, by the strong tendency of bureaucracies to be secretive. Such secrecy in electricity planning in the Australian context was noted by McColl (1976: 149). Saddler (1981: 115) was more trenchant and attacked the tactics of Australian energy bureaucracies as 'secretive, devious and dogmatic'. Crowley has recently used evidence of such secretive bureaucratic behaviour as empirical support for her somewhat tautological thesis that 'ecopolitical demands are constrained by the material interests of capital' (Crowley 1994: 12). Yet Max Weber long ago told us that it would be surprising if bureaucracies did not behave in this way:

> Every bureaucracy seeks to increase the superiority of the professionally informed by keeping their knowledge and intentions secret. Bureaucratic administration always tends to be administration of 'secret sessions': in so far as it can, it hides its knowledge and action from criticism. (Weber 1952: 233)

[10] *Yes, Minister!* was a popular television series produced by the B.B.C in England which satirised political decision making based on the public choice model.

4.7.2.4 A convergence of interests

It is clear that various possible combinations and permutations of mutual interests in expanding the supply of energy and opposing aggressive energy conservation exist. The relationship between bureaucracy and government in decision making can considerably tip the scales in favour of the bureaucracy by the closely interwoven interests between resource bureaucracies and their industrial clients. Such a common interest is seen to potentially create a formidable counterweight to the 'nominal' decision making capacity of the state (Jänike 1990: 13). The State may also support industrial and bureaucratic interests in expanding the supply of energy as part of its developmentalist policies.

There are also many other influential individuals and groups who could have an interest in expanding the supply of energy. Politicians obtain electoral benefits from providing jobs in their electorates through energy supply construction programmes or attracting new industries. Secondary industries supplying construction equipment and material, and small service businesses advantaged by the general increase in economic activity generated by investment in supply expansion and in further industrial expansion, are also likely to support such policies. Trade unions whose members are employed in energy supply construction and industrial expansion projects are also likely to support continued energy supply construction programmes.

With the outlook of political decision making, the earlier discussion on energy planning can now be revised to incorporate some of these important ideas to see how political and bureaucratic decision making modify energy planning.

4.7.2.5 Technocratic planning

One of the first to note the important ways in which the characteristics of both large energy conversion technologies and large bureaucracies interact to alter planning was the economist, J.K. Galbraith. According to Galbraith (1972), industrial development which relied on sophisticated technologies were characterised by certain features which dictated that manner in which development proceeded. The development of large technological systems, he argued, was driven by the technical imperative of achieving economies of scale to minimise unit production costs. Increasing the scale, however, made them capital intensive and increased the lead times, committing the organisation to inflexible and large resources, a specialised work force, and a highly developed organisation: they became technocracies. Above all, such technical development required planning because the commitment to large amounts of capital long before production came on line was problematical and conflicted with the ability to predict demand over long lead times. To overcome this uncertainty, according to Galbraith, demand had to be shaped:

> ... the system, if it accommodates man's wants, also and increasingly accommodates men to its needs. And it must. This latter accommodation is no trivial exercise in salesmanship. It is deeply organic. High technology and heavy capital use cannot be subordinate to the ebb and flow of market demand. They require planning; it is the essence of planning that public behaviour be made predictable - that it be subject to control (Galbraith 1972: 317).

In contrast to Collingridge's model of rational planning under uncertainty in which demand passively self-adjusted to supply as dictated by the laws of supply and demand, in the Galbraithian technocracy model, an élite corps of technocrats make investment decisions involving large requirements for capital. Demand was then actively manipulated to ensure 'that what is ultimately foreseen eventuates in fact' (Galbraith 1972: 35). Investment risks are reduced by the use of mechanisms such as advertising and tariff structures, to control demand.

The Galbraithian technocracy thesis has been given support from a proponent of the French nuclear energy generation programme. Carle (1995: 32) attributed the success of that programme directly to the persistence of political support for the programme and the political ability to deflect or quash public criticism that would slow the pace of construction. This was critical, according to Carle, because continuity was the key to success in the planning of large technologies such as nuclear power supply. Given the large time constraints involved in nuclear planning (up to eight years), any hiccups in the otherwise smooth planning process had a dramatic effect on costs. Continuity of the construction programme, moreover, meant constant workload for suppliers and thereby further reduced costs. Disruption to construction once begun, what's more, had a paralysing effect on the whole nuclear programme, as it added greatly to construction costs and eroded the economic advantages of the nuclear option. There was no better example or evidence of the severity of the impacts of public questioning of nuclear power construction, Carle suggested, than the United States. Once construction of a nuclear plant was started, it therefore became critical that it was continued not only for the sake of that plant, but for the entire ongoing nuclear programme.

Kellow (1986, 1996) considered that the construction of electricity generating technologies was substantively different from the development of other technologies in two ways and that this required the Galbraithian model to be adjusted. The first of these differences, according Kellow, was that in pursuing economies of scale in order to decrease electricity production costs, construction lead times became inordinately long. This critically exacerbated the problems associated with inflexible commitments to large amounts of capital. Planning was therefore more essential in electricity generating then it was in other types of technological developments. The second difference between electricity generation developments and other technical developments pointed out by Kellow, was the need to maximise plant output over both the long and short-runs. The reason for this was, as has already been seen, that electricity could not be effectively stored (Hughes 1983). The goal of electricity planning therefore became to maximise plant output over both the long and the short-terms (Kellow 1986: 3).

Kellow then used the 'bureaucratic politics' model to argue that empire-building technocrats constructed forecasts that matched their organisational ambitions. Maximising the forecast demand and then selling the surplus meant more construction activity and organisational maintenance and expansion (Kellow 1986: 5). When the predicted demand for electricity failed to materialise, the excess output was sold cheaply in order to generate income and service the debts. In this way, the forecasts became self-fulfilling not, as Collingridge (1980) would have it, as a result of the laws of supply and demand, but by the active creation of markets using cheap supplies of energy. The main beneficiaries of this process were by necessity energy-intensive industries with the ability to take-up large blocks of electricity. Once the electricity supplier was committed to construction of new supply, they were saddled with the excess capacity and thus became 'encumbered vendors' (Kellow 1986: 4). With shorter lead times than those of electricity generation projects, energy-intensive industries such as aluminium smelting firms were therefore able to take-up the cheap electricity on a buyer's market. This relationship between electricity suppliers and industry was not parasitic but symbiotic as the addition of a large bulk load customer aided the utility by providing a guaranteed customer and therefore assisted with debt servicing. The main advantage of these bulk users, from the energy supplier's perspective, however, was that they also provided a relatively stable load and therefore helped smooth out the daily load by reducing the relative proportion of variable peak loads on the system.

To Kellow, this convergence of private and public sector interests may have been an elegant solution to management problems and an optimal outcome in a narrow economic-engineering sense, but it was neither socially nor economically rational in a broader sense. Such planning, Kellow argued, placed 'undue power in the hands of the technocracy' and 'posed a serious threat to democratic decision making' (Kellow 1986: 4). While it was an arrangement which benefited the energy supplier and large energy-intensive industries, it did not necessarily involve forcing politicians to move in directions they did not want to take' (1986: 14).

Kellow therefore concurred with the common environmentalist critique of electricity planning in arguing that bureaucratic aggrandisement was the driving force behind the preference of large-scale energy projects and the distortion of forecasts. In doing so, he debunked the 'technological determinism' thesis as an explanation for the increasing scale of energy generating systems and the widespread overcapacities of energy suppliers.

The problem, according to Kellow, was not technology but technocracy. It was the people who made the technological choices that ultimately created the problems. Writing before Puiseux (1987) had put forward the case for small-scaled capacity expansion programmes, Kellow maintained that the technological determinism thesis was undermined by the fact that there was no reason why small scale technologies could not be deployed, and their short lead times in fact increased the rationality of these technologies as they decreased the lumpiness of both debt and supply output. They were dismissed, according to Kellow, not because they were technically unsuitable or not economically viable, but because they did not suit the interests of individuals and organisations. The rate and shape of technological growth was not determined by technology itself, but by the individuals making technological choices (Kellow 1986: 4).

4.8 Summary and Conclusions

This chapter has briefly traced the evolution of the aggressive energy efficiency proposals before looking at various models and theories that can be advanced to account for the energy efficiency advocate's grievance that policy makers seem not to be listening to their demands. This historical account showed that radical zero energy growth scenarios such as Lovins' SEP relying on major social and economic structural changes gained considerable support were gradually abandoned and purely technical energy efficiency alternatives took their place. The essential source of frustration appears to be that the proponents of aggressive energy efficiency considered their option to be not only socially desirable but also economically rational. Advocates of aggressive energy efficiency, on the other hand, perceived their proposals to be politically neutral and, therefore, realistic. It has been argued in this chapter that the related questions of why energy systems tend to grow and why policy makers tend to favour expansion of supply over energy conservation can be answered from a number of perspectives. These explanations range from the systems approach of technological determinism to the 'analytically rational', strategic and political perspectives. From a systems model approach, it was seen that all large systems are prone to inertia and therefore afflicted by a substantial incongruence between the direction they are heading and what is socially optimal. The technological deterministic model provides a useful description of the behaviour of large technological systems, but its central thesis that society is relatively incapable of taking command and that change in this regard usually arrives only after the problems created by technological expansion reach crisis proportions is unappealing to those seeking immediate policy reforms. Which of these explanations applies in a particular circumstance will obviously have great bearing on the nature of research that will be useful in accelerating the take-up of energy conservation. Theoretical research which attempts to show that there exists significant technical cost-effective scope for increasing the efficiency of energy use is liable to have little impact on energy policy where it needs to be explained, for example, in terms of political or ideological explanations. Historically, the growth of systems has been driven by the search for elegant engineering and management solutions. This raises the question of why energy efficiency, also an elegant engineering-management solution has tended to be rejected. By looking at decision making theory, it was shown that 'rational' decision making is forced to retreat to strategic incrementalism in order to minimise risks of under-supply and this has been used to explain the phenomenon of widespread overcapacities. An alternative explanation is that these overcapacities have been the consequence of decision making shaped by those influential groups with an interest in continued expansion of supply and which therefore support the incrementalist approach and are able to use uncertainties surrounding energy issues to ensure that policy remains incrementalist in nature.

There is unlikely to be one correct model that can explain why energy efficiency tends to be rejected as an energy option in a particular place. Certainly no model can explain the outcomes of energy policy and planning in all places and at all times. There is a sufficient uniformity in energy-related problems, however, to suggest that similar causal mechanisms have been at play in many locations and that those places in which policy has lagged in embracing energy conservation, the mechanisms or reasons for policy's tendency to reject energy conservation as an option are likely to be structurally similar. The following two chapters examine a case study of the growth of energy systems and the rejection of energy conservation as an option in favour of the expansion of energy supply. This case study is used to access the applicability of the various explanations for the growth of energy systems and the tendency of policy makers to reject energy conservation in one particular situation in which the adoption of energy conservation as a policy option has been laggard.

PART II

CASE STUDIES

Come, come, of words enough we've bandied;
'Tis time that deeds were now begun.

—— Johann Wolfgang von Goethe (1770-1831) *Faust.*

Chapter Five

Tasmania: A Case Study of Electricity Planning - Part 1

'It's a Little Anxious', he said to himself, 'to be a Very Small Creature Entirely Surrounded by Water'
— A.A. Milne (1926) *Winnie-the-Pooh*

5.1 Introduction

5.1.1 Tasmania as a Case Study

The purpose of this chapter is to illustrate the way in which the rate of growth in energy supply, and the nature of resistance to energy conservation proposals as a means of reducing the rate of growth in supply, are determined by a blend of rational, strategic and political decision making. The degree to which these three factors determine policy outcomes differs between one place and another. As Davis *et al.* (1988: 5) have pointed out, all attempts to explain policy decisions are ultimately limited and are specific to a particular location. While this may be a nuisance for policy analysts, these authors added, it is something that has to be accepted. There are, however, groups of countries or regions in which the outcomes of energy policy decision making have been remarkably similar. Not only has the phenomenon of overgrowth in energy supply been extremely widespread (Patterson 1992: 188, Jaffe & Stavins 1994: 806), but in a number of instances, overgrowth of energy supply has been particularly pronounced. Tasmania is one such region in which the rate of growth of electricity supply has been rapid, and policy emphasis on energy conservation has been relatively low. Tasmania is therefore used in this and the following chapters as a case study of low emphasis on energy conservation in electricity planning with a view to illustrating the reasons for this rapid rate of growth in energy supply and the low priority given to energy conservation in planning. But while Tasmania represents an extreme case in terms of the low policy emphasis on energy conservation and rapid expansion of supply, Platt (1988: 13) has noted that such extreme cases studies serve a valuable function in research where they are able to uncover explanations and to illustrate points that are difficult to uncover or demonstrate in more normal contexts. In this regard, Tasmania represents a highly appropriate case study of electricity planning because it has a number of other attributes which add substantially to its usefulness in studying politics and society.

Tasmania has been regarded by many writers as almost unique in its ability to explore and explain political and social issues. As a small island community, it provides a closed and manageable natural research unit and many researchers have made use of this feature. Economic geographers used the State to construct the first complete input-output energy analysis of an entire economic region (Larson 1968). Small island communities, furthermore, have been seen as microcosms of the larger world where events are more observable and decisions more readily explained. MacLean (1972), in his study of the process of cultural disintegration on St Kilda, noted that such island communities provide natural laboratories for studying social phenomena. In small states such as Tasmania, policy decision making is more readily explained as it is thrown into greater relief. As Humphrey McQueen (1982: 105) sardonically put it, while there is probably no less rottenness and repression in Tasmania than exists in the larger Australian states, in Tasmania it can be recognised walking down the main street.

Tasmania is also an interesting case study of electricity planning and energy conservation as it has been the Australian state in which public conflict over electricity planning has been most pronounced. That this has been the case has to do with the fact that conflict over electricity planning in the State was precipitated by proposals to construct hydro-electric schemes in wilderness areas. As discussed in Section 3.5.5, hydro-electric construction has been associated with greater conflict than has any other form of energy supply construction programmes, largely because of the limited availability of technological fixes to reduce the social and environmental costs associated with hydro-electric development. This inability to reach compromise over wilderness issues gives them an either-or like quality akin to those associated with moral and constitutional issues. It has been suggested that as a consequence of environmental conflict over hydro-electric development in Tasmania, nowhere in the world has a community been so intensively subjected to the environment versus development debate (Hay and Haward 1987: 92). As a result of this, Tasmania was the first Australian state in which aggressive energy conservation proposals were seriously advanced as a means of deferring specific energy supply expansion projects, and in which moderate energy conservation proposals were first adopted as government policy.

Finally, Tasmania's capacity to serve as a valuable case study of electricity planning is further increased by the relative lack of complexity of the Tasmanian energy system. Hydro-electricity has been by far the major source of electricity on the island to date. Like many other places in which electricity is supplied predominantly by a single technology, electricity planning in the State therefore provides a case study of technological lock-in and its causes. The alternatives to electricity in Tasmania, furthermore, are also limited as natural gas has not been made available. Other sources of energy, such as oil and wood, fall outside the ambit of Government energy policy, and because of this, electricity planning in Tasmania has historically been a relatively uncluttered affair. Tasmania is a useful case study, therefore, because electricity planning in this small island at the end of the world[1], run by what Dr Norm Sanders called 'a rinky dink parliament'[2], is more readily understood than it is in the larger world. Furthermore, although electricity planning in the State has involved construction of 'dinky little hydro-electric schemes' compared to the very large schemes constructed in other parts of the world, it has led to a scale of public conflict unprecedented in Australia. It was because of the scale of this conflict that planning was opened up to public scrutiny, and as a result, the politics of electricity planning in the State is relatively well-documented. Insights into the reasons behind the rapid scale of supply expansion and the rejection of energy conservation as a means of reducing that rate of growth in supply are therefore more discernable in Tasmania than they are in many other places. As means of explaining the rate of expansion of electricity generating capacity, and low policy reliance on energy conservation, Tasmania represents an extreme, and, therefore, an extremely useful, case study.

5.1.2 Three Historical Phases of Electricity Planning in Tasmania

It has been argued that in order to understand why certain policies prevail over others, it is critical to understand the historical context of the policy in question (Anderson *et al.* 1984: 10-11). In this view, past energy policy and the historical development of the relevant organisational structures are significant determinants of present policy and largely define the parameters of possible policy reform in the present era. The reason for this is that the strategic nature of policy decision making dictates that energy policy reforms are likely to occur in small steps, the more disjointed and incremental the policy decision making process, the slower the pace of change. For the purposes of this study, it was considered convenient to distinguish three broad historical phases in the historical development of electricity planning in Tasmania.

The first of these three stages is taken to be the period from the initial development of an electricity supply industry in the State, until the first major outbreak of public questioning of electricity planning in the mid 1960s. This period illustrates the initial impetus behind State involvement in electricity supply, and the ways in which electricity policy altered. The public electricity authority's changing role in planning over the period is also illustrated. The events that occurred and decisions made during that

[1] This term is borrowed from MacLean (1972: 2) who described his case study, the Outer Hebridean island of St Kilda, as a small island at the end of the world.

[2] Dr Norm Sanders, a migrant from California who became Tasmania's first green representative of the House of Assembly, described himself as member of a rinky dink parliament (cited in Green 1984: 152).

early phase are important to this discussion as they gave energy policy in the State a momentum that carried through to subsequent stages. Planning failure in the form of large excess capacity was not a feature of electricity planning during that early era, and energy conservation was not raised as a policy option. The momentum of electricity planning built up during that period, however, was critical to the eventual oversupply of electricity and the rejection of energy conservation as a policy option in subsequent phases. It has been appended, therefore, as a separate section at the end of the study (Appendix I).

The second evolutionary phase of electricity planning in Tasmania described in this study covers the period during which the legacy of early energy planning decisions began to result in the overgrowth of electricity supply and the threat of considerable surplus generating capacity. It also covers the public conflict and political turmoil generated by further proposals to expand the supply of electricity. This period from the early 1970s to the early 1980s is the subject of the present chapter, which focuses on the debate over the capacity to slow both the accelerating demand for electricity and the energy supply construction programme, by using energy conservation programmes and policies. The chapter describes electricity planning in Tasmania in order to illustrate the factors that lead to overgrowth in electricity supply, and the response of policy makers to environmentalists' demands for energy conservation as a means of slowing down the supply construction programme. The subsequent attempts to reform electricity planning in the State, the degree to which energy conservation has been adopted as a policy option and the way in which energy conservation programmes have been implemented are the subject of the following chapter. To begin, a brief description of Tasmania, and a summary of the early hydro-electric development in the State follow.

5.2 Description of Tasmania

5.2.1 Political Economy

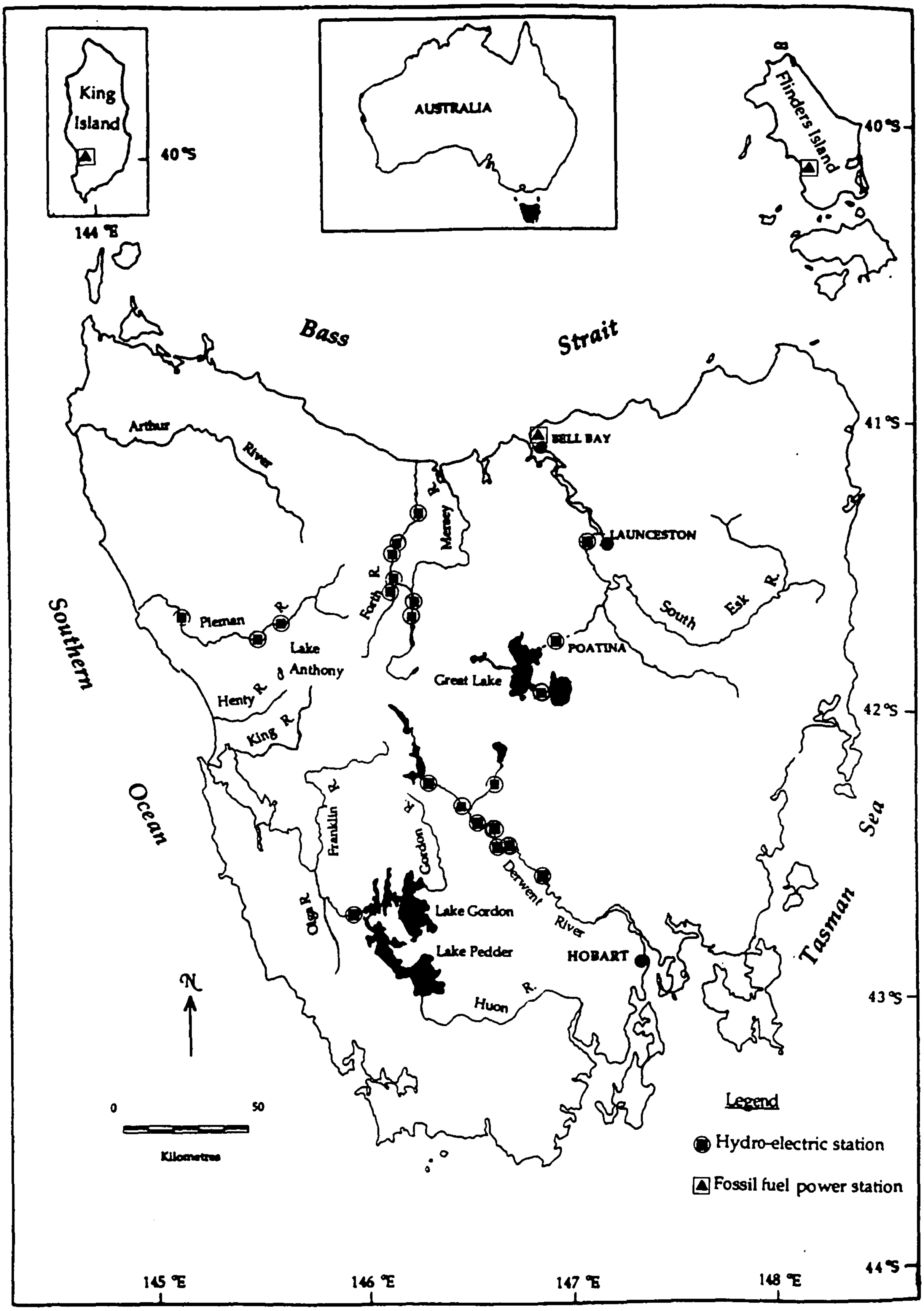
Australia was once facetiously described as a country lying in the Southern Ocean whose economic development had been severely retarded by an unfortunate dispute between geographers as to whether it was an island or a continent (Bierce 1906). Had Bierce described Tasmania as an island lying in the Southern Ocean whose economic development had been retarded by a similar dispute as to whether it was an island or a state, his statement would have been closer to the truth. For as Australia's smallest, poorest and only island state, Tasmania has not only shared in Australia's traditional economic problem - the 'tyranny of distance' from European and North American markets (Blainey 1966) - but has had to contend with its own problems. The greatest of these problems has been the constraint on economic development imposed by what has come to be referred to as the 'tyranny of Bass Strait', the 300 km stretch of water that separates the island state from the Australian mainland (see Map 5.1).

The island's small and highly decentralised population, and the persistent outmigration from the State, have contributed further to its economic problems. With a current population of less than half a million, the island's small domestic market is fragmented into three separate economic units which are often more closely linked to Victoria's capital, Melbourne, than they are to each other (Grosvenor *et al.* 1993: 5). The State's economy is dominated by a small number of large firms with boardrooms interstate and whose economic positions are vulnerable to fluctuations in commodity prices. Due to its peripheral location, the Australian economy is said to bear many structural similarities with the economies of less developed countries (Drake & Nieuwenhuysen 1988: 7). This similarity is particularly marked in the case of the Tasmanian economy (Felmingham & Rutherford 1989: 416) which is more export orientated than any of the mainland states and is based predominantly on low value-added mineral concentrates, forest products, processed metals and agricultural produce. In many respects, the State's economic structure and problems bear a close similarity to those of the Canadian Atlantic maritime provinces as described by Burrill & McKay (1991), though these problems are less extreme than the similar problems caused the small size and peripheral location of small Pacific island nation states discussed by Hughes (1990).

These combined problems, often referred to collectively as 'the Tasmanian problem' (Callaghan 1977: 34), have meant that the State has never enjoyed the rates of economic growth and development achieved by its mainland counterparts. It has traditionally had the highest rates of unemployment, the highest youth unemployment, and the lowest economic growth of all the Australian states. The greatest source of revenue for the State has been Commonwealth grants, with over fifty per cent of State revenue coming from that source in 1989 (Grosvenor *et al.* 1993;15). With less than 3% of the nation's population, Tasmania receives 3.5% of Commonwealth grants, or $250 million over and above the amount of Commonwealth revenue collected from the State.

5.2.2 Political system

Apart from its economic backwardness, Tasmania is characterised by a slow pace of change and a deeply conservative community. Only on occasion have the State's captains of industry or political leaders demonstrated a willingness to experiment boldly, the two examples most pertinent to this study being its ambitious programme of hydro-industrialisation and the creation of its unique Hare-Clark voting system (Bowman 1979: 210). With a budget equivalent to that of a small county in the USA,



Map 5.1 Tasmania with place names mentioned in text and hydro-electric and fossil fuel-power stations either in service or planned by the early 1970s.

or a large local city council on mainland Australia, Tasmania is governed by a bicameral parliament consisting of a total of 54 elected members. The lower house, the House of Assembly, is the house of universal suffrage and is made up of thirty five members elected under the Hare-Clark proportional voting system, reputed to be the most democratic in the world (Newman 1992). The upper house, the Legislative Council, by contrast, is made up of nineteen members elected under a highly undemocratic voting system strongly biased in favour of property owners and non-urban voters (Newman 1977). The Legislative Council, while protected from all its members ever having to go to the polls simultaneously, has the constitutional power to force the Government to the polls (Kellow 1996: 47). This disparity in the democratic nature of the voting systems for two houses of the Tasmanian parliament has been instrumental in determining the course of electricity planning in the State.

5.3 A Summary of Early Electricity Planning in Tasmania

A comprehensive account of the history of electricity planning in Tasmania is given in Appendix I and only the most salient features of that story have been extracted to construct the summary below.

Public involvement in the production of electricity in Tasmania began in the early years of the twentieth century with the development of a private hydro-electric scheme on the Central Plateau designed to supply the electricity required to by a separate prospective zinc processing firm. When the venture collapsed, the State took over the task of construction to avoid losing the chance of developing a zinc processing industry. The Hydro-Electric Department was established in 1914 and staffed by the management of the collapsed company, providing a close association between energy-intensive industry and the public electricity authority from the Department's inception (Tighe 1992: 128).

Public development of the State's hydro-electric resources was immediately viewed by the new department as a means of promoting economic development by attracting energy-intensive industry. It was seen by Government as one of a small number of measures used in attempting to attract capital to the State.

The powers of the public electricity authority were gradually extended, first to ensure that development of the State's electricity supply system was coordinated. In 1929 the Hydro-Electric Department was abolished and the Hydro-Electric Commission (HEC) installed in its place with wide ranging monopoly over the production, distribution and sale of electricity in the State.

This vision of accelerated economic growth based on energy-intensive industrial development supplied with cheap hydro-electricity, failed to materialise. In the period before the second world war, development of the State's hydro-electric resources proceeded at a slow pace. Funded by low interest Commonwealth loans, it was used largely a means of providing employment relief. Over the thirty year period from 1920 to 1950, the demand for electricity in the State doubled.

With the close of the war, the policy of hydro-industrialisation was accelerated. Two footloose energy-intensive industries, an aluminium smelting firm (Comalco Bell Bay) and a producer of ferro-manganese alloys (Temco), established in the State in the 1950s and 1960s respectively. Largely as a consequence of the expansion of these two firms, the demand for electricity in Tasmania quadrupled in the two decades from 1950 to 1970. Further power was handed to the HEC. The 1944 HEC Act removed the Commission from Ministerial control. While the Minister for the HEC was answerable to parliament for the activities of the Commission, the Commission was not answerable to the Minister but to parliament. By the 1950s it had become the most powerful bureaucracy in the State and the public electricity authority with the most extensive powers in Australia with complete control over the planning, construction, generation, transmission, distribution and sale of electricity in the State.

Hydro-industrialisation in the post-war period became an entrenched policy to the extent that it has been labelled a 'deep-rooted ideology' (Hay 1987: 4). To label it as such, however, glosses over the reasons behind the dogmatic adherence to a policy of rapid construction of hydro-electric schemes. For a community faced with severe economic disadvantages and struggling to achieve the population and economic growth rates of the wealthier mainland states, it represented a pragmatic means of creating regional employment and economic growth. For successive State governments, it was both an electorally successful means of retaining power and a means of regaining control of the State's destiny. It was propelled, furthermore, by a structural relationship between the Commonwealth and the states which left the latter with few means other than resource development to create new jobs and symbols of progress.

Nor would it be entirely accurate to describe hydro-industrialisation as a hegemonic vision, as some have done, since the policy was not without its critics and detractors. Rather, hydro-industrialisation during the post-war period can be regarded as policy dogma in a political climate in which energy policy was controlled by a small number of highly influential decision makers. By the late 1950s, the policy of continued construction of hydro-electric schemes was steered by four individuals: the Premier, Eric Reece, his deputy, Roy Fagan, the HEC Chief Commissioner, Allan Knight, and the State's Under Treasurer, Kenneth Binns.

Conflict over electricity planning erupted again in the mid 1960s when the HEC, having exhausted all other potential sites, turned to the rivers in the State's rugged South West wilderness areas to further expand the supply of electricity. An environmental campaign to prevent the inundation of Lake Pedder National Park in the State's remote south west wilderness as part of the Middle Gordon scheme was thwarted by the secrecy of the planning process on the part of the HEC and the Premier. The HEC's managers were also able to use their monopoly on technical expertise to persuade the uninformed and politically powerful Legislative Councillors that further expansion of electricity supply was needed, that hydro-electric development remained the cheapest supply option, and that there existed no satisfactory technical or economic means of reducing the scale of the scheme in order to avoid flooding Lake Pedder. Drought-induced electricity shortages in the late 1960s added considerable weight to the Commission's arguments. Drought had the capacity to severely damage the State's reputation as a reliable supplier of electricity to existing and potential industrial clients and, therefore, economic growth. As such, it was regarded by policy makers as something to be avoided at all costs. The Middle Gordon scheme was hurriedly sanctioned by parliament together with construction of a 120 MW oil-fired power station as a further drought protection measure.

Despite the political power of its proponents, opposition to the hydro-electric scheme increased during the construction of the Pedder Scheme, and in the ensuing debate the Commonwealth intervened by holding an independent enquiry into the issue. The HEC and the State's politicians were increasingly required to provide *a posteriori* justification for their decision to proceed with the scheme. The debate's initial focus on wilderness versus development issues was extended in this debate, furthermore, to include cost comparisons of hydro-electricity and thermal options. Also increasingly questioned were the economic and employment benefits of continued expansion of electricity supply to provide the electricity for the expansion plans of energy-intensive industries while those industries were shedding jobs at a faster rate than could be offset by their expansion programmes.

The Lake Pedder controversy set the seeds for further public conflict over hydro-electric development during the Franklin River controversy a decade later. Electricity planning during the interval between the Lake Pedder and Franklin River controversies was also instrumental in shaping subsequent opposition to further hydro-electric development.

5.4 Electricity Planning in the Aftermath of the Lake Pedder Controversy

In 1970, during the midst of the conflict over the flooding of Lake Pedder, the HEC submitted to parliament a proposal to construct the 230 MWav Pieman scheme at a cost of $139 million[3] that would increase the total generating capacity of the State's electricity system to 1087 MW. Without immediate commencement, the Commission argued, the State would face a shortage of electricity by the early 1980s (HEC 1970:18). The Commission also argued for, and was granted, funding to build a second 120 MW oil-fired generating unit at Bell Bay as further measure against drought proofing. Added to the latter proposal was the argument that it would provide a low capital cost contingency for meeting any unanticipated increase in demand for electricity before the controversial Middle Gordon hydro-electric scheme was completed (HEC 1970). As there were no indications that such demand for this electrical energy would materialise, it represented a deviation from the Commission's just-in-time policy and a shift towards planning for spare capacity (Kellow 1996: 51).

The HEC's decision to begin planning for spare capacity to meet unanticipated increases in demand occurred, however, just as the drought eased. Growth in the demand for electricity, furthermore, slowed as world commodity prices fell and the Tasmanian economy went into recession. Industries which had previously indicated that they would require substantial additions to their loads put off their expansion programmes. Apart from an export woodchip industry with a small load, no new industries arrived in the State and demand for electricity actually fell between 1967 and 1972.

With a decreasing rate of growth in demand and the easing of the drought, the HEC began to promote electricity use once again. This action was justified on the grounds of the benefits it provided. Building up off-peak load, according to the HEC, reduced the overall unit price of electricity and contributed to the State's economic well-being as expenditure on electricity rather than oil or gas meant that the revenue remained within the State. As the main Australian manufacturer of off-peak electric heaters was based in Tasmania, the promotion of off-peak heating further assisted the State's economy. Increasing residential electricity sales, the Commission added, was also a means of maintaining the Commission's revenue income during periods of reduced income major industrial sales (HEC 1972: 2).

The promotion of electricity while simultaneously arguing the need for the Pieman scheme and a second oil-fired generator, led to criticism from the environmental lobby.

[3] Implicit in the HEC's proposals to Parliament was that construction costs were estimates based on pre-feasibility studies and that more accurate estimates of costs could not be obtained until a full feasibility studies was undertaken. As full feasibility studies were costly, these could not be undertaken until parliamentary approval for the scheme was granted. The convention adopted was for the HEC to advise parliament of any major revisions in the estimated construction cost as a result of the more complete analysis. The Commission also revised its costs estimates in the light of changed circumstances (strikes, price hikes in the costs of materials, etc.) and changes in either Government or the Commissions construction policy (e.g. deceleration of construction as a consequence of a fall in the growth in demand).

Environmentalists had hoped that the fall in growth for electricity demand would permit a temporary halt to the construction of the Middle Gordon scheme and allow further examination of the possibility of saving Lake Pedder. The HEC's Chief Commissioner dismissed these calls on the grounds that the slow-down in demand for electricity was likely to be a temporary phenomenon:

> The Commission's plans of development relate to a ten year period. Surplus power *now* has only small relevance to the needs in the years ahead. Temporary variations in the demand for power have frequently been experienced in the past, but the demand has always caught up over subsequent periods. However, even if a very pessimistic rate of growth of demand is assumed to continue over the next five to ten years, the whole of the inflow of the Gordon and Pedder storages will be required to meet the load forecast. (HEC 1972: 22)

Knight's assessment of the situation was fully supported by the Premier, Eric Reece. The Premier's view of electricity planning amounted to a virtual article of faith that demand would continue to increase much as it had done in the past and that supply therefore had to be increased. Rather than cautiously err on the side of over supply as suggested by Collingridge (1980) or Puiseux (1987), Reece's view of electricity planning was a far cruder 'what did we do last time' process:

> We have got to keep developing. There have been times in my experience when the power need has doubled in a period of ten years here, so there will always be growth. (Reece, quoted in Green 1984: 30)

Embarking on a new strategy of planning for spare capacity just at a time that growth in demand was falling presented the HEC with a problem. Although independent economists were arguing that the thermal option was the cheaper option for Tasmania (Davidson 1972), the HEC insisted that hydro-electricity remained the cheaper option. It was well known to economists, however, that a slower rate of growth made the thermal option even more attractive as the higher capital costs and the longer lead times of the hydro-electric option meant that revenue to pay off the construction loans was delayed and the interest accruing on the loan increased. Critical to this debate was the length of time it took after construction of a hydro-electric scheme to fully utilise the full generation capacity of the system. Delays on increased loads impacted on the economics of hydro-electric schemes far more than they did on thermal plants. The economics of hydro-electric construction were summed up by a World Bank discussion paper in the following manner:

> The maximum rate of return is obtained, of course, on the extreme and convenient assumption that the load grows fast enough to make possible the full utilisation of the dam's capacity immediately on its completion (van der Tak 1966: 52).

To the problem of a slow-down in growth of demand for electricity in Tasmania, the HEC was able to find a convenient solution that allowed the Commission to turn this 'extreme and convenient assumption' into near reality. Conveniently for the HEC, the decline in the rate of growth in demand meant that the increase in demand could be met with electricity produced from the Middle Gordon scheme rather than the oil-fired power station. Once approval was obtained to construct the Pieman scheme and a second 120 MW oil-fired generating unit, the HEC announced that the starting date of the Pieman scheme would be deferred (HEC 1972: 1). The Commission immediately entered into contracts to provide the aluminium smelting firm, Comalco, with an additional 44 MW block of electricity from the Middle Gordon Scheme (Block E). On a buyer's market, the price paid by the company was fixed at 0.35 c/kWh for the first three years and 0.4 c/kWh for the following four years, buffering the firm from the effects of inflation (Kellow 1986: 9). Four years later, the HEC entered into a second long-term contract with Comalco to provide a further 40 MW (Block F) from the Middle Gordon scheme at 0.52 c/kWh, with no escalation until 1975. Although the cost of producing electricity from the Middle Gordon scheme was higher than the costs of producing electricity from earlier schemes (Wilde 1978: 225), the unit price Comalco paid for the electricity from the Middle Gordon scheme was lower than its contract unit price for the blocks of power it obtained from those earlier schemes (TWS 1984: 14).

The company also won a concession from the Government to alter the escalation clause of all of its contracts to reduce the variation in its prices by 0.02 c/kWh per seven units in variation of the HEC's Operation Cost Index (the previous contracts had varied prices by 0.02 c/kWh per five units of variation in the HEC's Operation Cost Index). This minimised the effects of real wage increases and further protected the company from the effects of inflation. The Government further reduced the contract price for Block F by 4% until the end of 1978. The purpose of the rebate was, according to the Commission, to encourage growth in demand at times when it suited the Commission's operations (Kellow 1986: 9). Comalco entered into the contracts to expand at a time when rising inflation had brought to a halt plans by a consortium, of which Comalco was a major partner, to construct a huge smelter at Boyne Island in Queensland (Wilde 1978: 212). As Kellow pointed out, while inflation over the 1970s paid the HEC's interest bills and eroded the value of its outstanding loans, the benefits of this were not passed on to its customers evenly but were effectively used to subsidise Comalco. These contracts, Kellow argued, were strong indications of a Galbraithian buyer's market. But it was not a case of a technocratic political model in which bureaucracy and industry colluded behind the backs of politicians, as politicians were involved in these generous contractual agreements (Kellow 1986: 9).

By 1979, industry accounted for two thirds of electricity consumption in the State, the two footloose firms, Comalco (199 MW) and Temco (61 MW), accounting for approximately two thirds of the industrial load.

5.5 The Franklin River Controversy

5.5.1 The Lead-Up to the Franklin River Controversy

Following the Lake Pedder debacle, environmentalists were immediately anxious about further plans to construct hydro-electric schemes in the State's South West. Of particular concern was the Franklin River. At a press conference in March 1974, the HEC Commissioner indicated that the Commission was investigating construction of a dam that would involve the Franklin River but that no firm decisions had been made. The statement sent a wave of concern through both the environmental movement and the Government. The Labor Party had been considerably damaged by the Pedder affair, and many of its rank and file members had resigned. It was therefore keen to avoid further conflict over electricity planning and the Commissioner's assumption that the decision over the State's next energy expansion option would be made without reference to Government therefore perturbed several Labor politicians (Lowe 1984: 49).

As the HEC was planning its next proposal to parliament, doubts over the wisdom of continued hydro-electric development in the State were growing. The myth that hydro-industrialisation was a cure-all for the State's economic problems was becoming increasing apparent. Manufacturing sector employment had peaked in 1971 at 32,000. By 1979 it had fallen to 28,000. Declining industrial electricity prices on the mainland as a result of the economies of scale achieved through the construction of large coal-fired power stations further reduced the prospect of attracting new industries to the State. The possibility of already established industries rationalising and closing down their Tasmanian operations added to the concerns of policy makers in the State (Wilde 1975: 304). Those sceptical about the likelihood of attracting new energy-intensive industries to the State had good reasons. No new energy-intensive industries had established in the Tasmania since the early 1960s and growth of industrial load in Tasmania had been virtually restricted to the expansion programmes of the already established industries. One reason for this was that unlike the situation in other states where the price of electricity was averaged over all existing plants, in Tasmania the price major industries paid for electricity was tied to the historical cost of the scheme from which it was nominally produced. Those contracts linked to earlier schemes were therefore the cheapest and any new industries would have to purchase blocks from the newest schemes at a higher price. This acted as a large disincentive for new energy-intensive industries to locate in the State.

A Commonwealth government Inquiry into Tasmania's structural economic and unemployment problems (Callaghan 1977) found that not one of these established industries was contemplating expansion. The policy of hydro-industrialisation, Callaghan concluded, had 'permitted the expansion of some sectors of the Tasmanian economy (but) has now run its course' (Callaghan 1977: 75). Independent analysts had also suggested that it was difficult to see how the HEC's projections of an average of 2.7% p.a. increase in Major Industrial load and 5.5% p.a. growth in retail load could come about (Wilde 1978: 213).

On top of this were increasing concerns over the costs of further hydro-electric construction. As growth in demand for electricity declined throughout the 1970s, work on the Pieman scheme had been slowed to avoid surplus capacity. This deceleration of the construction had led to a blow-out in the costs of the scheme as it meant that interest on the loans would be increased and revenue income to repay the loans deferred. In 1978 the HEC approached Parliament with a request for approval to increase borrowings for the scheme from the original $139 million (1970 dollars) to $400 million (1978 dollars) (Wilde 1978: 224).

This increasing pessimism over the prospects of attracting new energy-intensive industries to the State contrasted, however, with the buoyant economic optimism in Canberra over the prospects of attracting energy-intensive industries to Australia. The Liberal Prime Minister, Malcolm Fraser, was a staunch supporter of both conservation and development. On the latter score, his vision was to lead Australia into a new era in which it could take a role in world affairs and to this end had no ideological objection to public sector intervention in the economy despite espousing *laissez-faire* economic philosophies. Public expenditure on national development projects was seen by Fraser in much the same way as wartime Labor Prime Minister , Billy Hughes, had used public finance to undertake the Snowy Mountain hydro-electric scheme (Kelly 1989: 90). With Fraser's support, the Loans Council not only approved, but solicited infrastructure loans, the majority of these loans being for electricity generation projects (Kelly 1989: 91). Fraser's vision was bolstered further by the 1979 OPEC oil price rises as they led to the belief that OECD member countries would shift away from oil and move their energy-intensive industries, especially aluminium smelting offshore. For Australia, the OPEC oil price rise was interpreted as a potential bonanza in the form of increased coal and gas exports and rapid expansion of the energy-intensive manufacturing sector.

5.5.2 Labor's Attempts at Electricity Planning Reform

It was within this economic and political environment that a young reformist Labor Premier, Doug Lowe, came to power in 1977. The avidly pro-hydro Premier, Eric Reece, had been forced to retire in 1975 by disaffected Pedder supporters within the ALP who succeeded in setting a new 65 year age limit for endorsed ALP candidates. With the retirement of Sir Allan Knight as HEC Commissioner in the following year, the pro-hydro forces had lost their two staunchest allies. Lowe immediately set to attempting to rein in the powers of the HEC and regaining government control of electricity planning. His attempt to place the HEC under limited Ministerial control was opposed, however, by both the HEC and the Legislative Council (Kellow 1996: 41). The relationship between the Minister for Energy, Andrew Lohrey, and the Commission quickly became unworkable, forcing Lowe to take on the energy portfolio himself. The dumping of the Minister led to calls from the Opposition for an inquiry into the electricity planning and the HEC, and for a thorough investigation of all energy options before further hydro-electric construction in the Lower Gordon area proceeded (Wilde 1978: 224).

Despite opposition from the HEC, the Lowe administration established two independent energy advisory bodies. An Energy Advisory Council was created in late 1978, followed by a small Directorate of Energy within the Premier's Department in February 1979. Although the Government negotiated with the Legislative Councillors over the nature and extent of the reforms, the Legislative Council used the Bill to embarrass the Government, stating that the HEC deserved better treatment (Herr & Davis 1982: 10). The HEC Chief Commissioner served as a reluctant member on the Energy Advisory Council (Lowe 1984: 119). The purview of the HEC was widened to require the Commission to investigate all energy sources in the State upon the request of its Minister. Lowe accordingly instructed the HEC Commissioner to prepare a report on all the State's future energy options, making it clear that the HEC could not assume that its preferred option would be accepted by the Government (Kellow 1996: 42).

Coincidentally, the HEC announced early in 1979 that the No. 1 oil-fired unit at the Bell Bay power station would be brought into service for the first time to offset possible shortages from low rainfall. Reliance on the stand-by power station was to increase over the course of the following years, peaking in 1982/83 when it was used to produce over 5% of the total electricity generated in the State (HEC 1984). In October of the same year (1979), the Commission tabled its report on the Gordon River Power Development (Stage II) with a load projection to the year 2000. The report recommended an immediate start to construction of a dam on the Lower Gordon River approximately 1 km downstream from its confluence with the Franklin River (the 'Gordon-below-Franklin' or 'GbF' dam). It was to be the first in a series of dams in an integrated scheme that was to include further dams on the Gordon, King and Franklin Rivers at an estimated cost of $1.36 billion and a maximum generating capacity of 296 MW. The <u>assessed long-term average energy output</u> (ALTAEO) of the Gordon-below-Franklin dam, 172 MWav, represented a 15.8% increase in the output of the State's generating system. Alternatives to the Gordon-below-Franklin scheme were included in the report, but all were treated in a shallow manner and dismissed as too costly. The Premier later wrote that the report to fall well short of what he had requested (Lowe 1984: 121).

Lowe's response was to open up the debate to the public and order independent submissions and a report from the Directorate of Energy and the Department of the Environment, neither of which could match the resources of the HEC. Rumours that the HEC was interfering in the preparation of these reports were given support when it was revealed that the Mines Department had substantially redrafted its submission according to the requirements of the HEC (Herr & Davis 1982: 8, Weinstein 1982, 16). When the Department of the Environment released its report, the HEC threatened to take legal action over its contents (Cockburn 1982).

Wishing to avoid political conflict over the decision, Lowe proposed that the State's next power option be considered by a Joint House of Parliament Committee which would then make a recommendation to parliament. The Liberal Opposition, however, preferred to capitalise on a rare opportunity to differ from the government on a major policy issue and to appear decisive and strong compared to a vacillating government. The Opposition Accordingly once again abandoned its misgivings over hydro-industrialisation and the HEC and rejected Lowe's proposal.. The Government was thereby forced to make a unilateral decision.

Concerned that the government might adopt an option other than its preferred Gordon-below-Franklin scheme, the HEC lobbied the members of the Legislative Council to set up their own Select Committee into the State's future power options.

5.5.3 Aggressive Energy Conservation Proposals

Energy conservation was not seriously advanced by the environmentalist lobby during the Lake Pedder debate as the problem was seen to be hydro-industrialisation rather than wasted energy use. It was suggested, however that growth in retail load could be curbed if the HEC desisted from promoting the use of electricity (Hean 1972: 105). By the time the Hydro-Electric Commission presented its next construction proposal to Parliament in 1979 energy conservation was quickly adopted as the main plank of environmentalist counter-proposals to further hydro-electric construction. The environmental lobby had learnt that it could not afford to allow parliament to decide the fate of the Franklin river solely on the choice of the two conflicting philosophies of wilderness preservation and development and that it needed to put forward alternatives to the HEC's proposals for meeting the State's future energy requirements (Newstead 1980: 22).

The Australian Conservation Foundation (ACF) argued that the goal of energy policy should be to steadily reduce the rate of growth of energy demand to zero, citing Sweden as an example of a place where this goal had been successfully achieved (Hill

1980: 80). The ACF advocated that short-term energy requirements be met by a combination of non-grid energy supply systems, such as solar hot water collectors and wood heaters, smaller-scaled hydro-electric schemes outside the South West wilderness area, and the use of wood waste as a fuel for centralised electricity generation. The main policy instrument advanced by conservationists to reduce demand for electricity, was to increase the price of electricity to its long-term marginal cost of production. Citing from evidence given to the Newport Review panel in Victoria by Californian experts, it was argued that the energy conservation could reduce load in a region such as Victoria or Tasmania by approximately 5%, equivalent to two years growth in forecast demand. This, the ACF argued, would defer the need for construction on a new electricity supply project for two years (Hill 1980: 87). If the community proved unwilling to restrain demand to levels that could be met with these 'small' energy supply options, it was argued, a coal-fired thermal station could be built (Hill 1980: 86).

The main function of energy conservation was to delay the decision over the choice of energy supply options, thereby allowing time to mount a more sustained attack against the real problem – continued rapid expansion of electricity supply and the expansion of energy-intensive industry. By stalling the decision, it was hoped that the debate could be redirected to a more thorough assessment of the State's future energy requirements and of the how those energy requirements could best be met (Jones 1980: 93). Environmentalists derogatorily described State energy policy as a vacuum that was filled by the first option that came along, which was invariably another hydro-electric scheme pushed by the HEC. As no other energy option was subjected to thorough analysis, the HEC's hydro-electric development proposal became policy without first establishing if more electricity was actually needed. This process, environmentalists charged, was the reason that Tasmania had failed to rely on energy conservation to the degree that many other countries had, despite the fact that the strategy of increasing the supply of subsidised energy was a 'thoroughly discredited' job creation strategy as the energy-intensive companies in Tasmania used more electricity but employed fewer people than they did 30 years previously (Jones 1980: 104).

The most aggressive proposal for using energy conservation as a means of deferring the need for investment in new electricity supply was that advanced by the Tasmanian Conservation Trust (Harwood & Hartley 1980). The Trust's report drew on the small number of energy efficiency supply curve analyses produced overseas (Leach *et al.* 1979) to argue that increasing the efficiency of energy use represented a least-cost option for meeting increased energy requirements in Tasmania. The report took the increasingly standard environmentalist line that the policy of hydro-industrialisation ought to be abandoned on the basis of the high public investment per job created through this means, and the high risk of saddling the State with considerable idle capacity and large debts should the anticipated industrial expansion not eventuate (Harwood & Hartley 1980: 60, Saddler *et al.* 1980: 39). The fact that the HEC's 1970 forecasts proved to be inaccurate was used as evidence that these risks were real.

Having argued that expansion of electricity supply to encourage energy-intensive industrial expansion could no longer be justified on the basis of employment generation, Harwood & Hartley (1980) then argued that growth in demand for electricity without an increase in industrial load would be sufficiently low to permit it to be met by increasing the efficiency of energy use. To achieve increases in efficiency, the authors advocated a number of policies, including mandated energy efficiency standards and dwelling thermal performance levels. These policies were justified on the grounds that the benefits were so great that regulation to ensure they occurred was justified (Harwood & Hartley 1980: 28). As an example of these savings, it was stated that for an extra capital cost of $20-30 the electricity consumption of refrigerators could be reduced by 37-40% and that the reduction in electricity bills would mean that these were paid back in less than three years (1980: 27). The authors assumed that a variety of economic instruments would be used to increase the adoption of wood heaters, solar collectors and heat pumps to preset levels. By 1995, the authors believed, solar hot water systems could be installed on over 20% of dwellings, compared to a 1980 level of less than 1% of dwellings (1980: 24). Public investment in electric generating capacity could be further reduced, the authors contended, by using industrial cogeneration to meet 20% of the pulp and paper manufacturing industry's electricity requirements. Their end-use analysis suggested that if an aggressive energy conservation and cogeneration policies were adopted, the demand for electricity in 1995 could be reduced to 1105 MW compared to the HEC's mid-range estimate of 1388 MW[4], allowing the decision to construct further generating capacity to be deferred for fifteen years (1980: 39). The authors conceded that their forecast would eventuate automatically, but only if their recommended policies were put into effect (1980: 15).

The environmental lobby immediately supported Harwood & Hartley's energy efficiency proposal, while maintaining that many of Harwood & Hartley's estimates of the scope for reducing energy use in the State were in fact too conservative (Thompson 1981: 117, Weinstein 1982: 14). By scrapping Comalco's antiquated and inefficient Bell Bay smelter and redeveloping it to bring the smelter up to world best efficiency standards, it was argued, the firm's load could be reduced from 237 MW to 180 MW. It was also maintained that the portion of the pulp and paper industry's electricity requirements met by cogeneration could be increased from 20% to 100% (Thompson 1981: 120). In the unlikely event that these strategies did not negate the need for further supply expansion, increased demand could be more cost-effectively met, environmentalists

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[4] Average load in 1980 was approximately 900 MW.

maintained, by wind and solar energy technologies than with hydro-electric or thermal power. Others went further and argued that not only should the policy of energy supply expansion to provide energy-intensive industries with more electricity be abandoned, but that the energy-intensive industries in the State were likely to decamp. Tasmania's hydro-electric system was seen to be rapidly becoming too small to compete with the large aluminium smelters being constructed elsewhere, supplied by very large hydro-electric or coal-fired power stations. Comalco's Bell Bay plant, it was asserted, would therefore inevitably close down, probably when the joint-venture refinery at Boyne Island in Queensland in which Comalco was a partner began production in 1982 (Sanders 1980: 53). To provide employment in the place of hydro-electric construction and energy-intensive manufacturing industries, conservationists advocated development of cottage industries, ecotourism and small-scaled, value-added manufacturing such as PV cells, wood heaters and heat pumps (Sanders 1980: 18). Environmentalists argued, moreover, that going on past escalations in the costs of hydro-electricity construction projects, the final cost of the GbF scheme was likely to be twice the figure suggested by the HEC. This, it was argued, made energy conservation, cogeneration and renewable energy even more economically rational options.

Harwood & Hartley's estimates of the scope for energy conservation contrasted sharply with the estimates for saving energy made by the HEC. The Commission's estimates of the possible effects of energy conservation programmes, which were included in its own lower band forecast, was that there existed the potential to save 109 MW of electricity in the retail sector through energy conservation measures over the period 1979 to 2000 (HEC 1979, Appendix II: 15). But as the HEC also estimated that electrical space heating load over that period would increase by 94 MW as a consequence of a shift from oil to electricity for space heating, the total potential for reducing energy use in the retail sector was estimated to be only 15 MW over the 21 year period. Electricity was used for heating in approximately 12% of Tasmanian homes (Wilde 1978: 223) and econometric models had predicted that as oil prices rose householders would switch to electricity in preference to wood heaters (Fleming 1979). Any increase in the efficiency of major industrial sector energy use, the Commission argued, would be taken up as increased output rather than reduced energy use. The HEC's overall conclusion was that while there existed scope for saving electricity, it was unrealistic to assume that energy conservation would produce anything but a small and temporary diminution in the rate of growth in electricity demand (HEC 1979, Appendix II: 8-9).

Harwood & Hartley's (1980) proposal was also dismissed by independent energy policy experts. The Directorate of Energy commissioned resource planning expert, Professor John Burton from the University of New England in NSW to prepare its own critique of the HEC's report and to recommend energy options. Professor Burton described Harwood & Hartley's contribution as 'useful', but rejected it as a prescription for policy on account of the large number of assumptions upon which it was based. Its authors, Professor Burton maintained, had little knowledge on energy matters and bore no responsibility should their estimates of the scope for energy conservation prove highly inflated and result in supply shortages (Burton 1980: Section 3: 45). Not only was Harwood & Hartley's proposal based on numerous technical and cost-effectiveness assumptions, but many of its recommendations were considered by Burton to be unpopular and politically infeasible (Burton 1980: Section 3: 56).

It was in regard to the HEC's load forecasts, however, Professor Burton reserved his most damning comments. To predict growth in retail load the Commission had assumed that growth would continue until 1985 at a rate of 2.95% p.a. as it had done over the past half a decade, whereupon it was assumed to gradually return to its earlier, much higher rate of growth rate of 5.5% p.a.. Burton maintained that the HEC put forward no solid justification for these assumptions. The methodology employed by the HEC to estimate growth in industrial load, Burton considered to be even harder to justify. The Commission had arrived at a forecast of probable future industrial load by surveying major industries and obtaining their estimates of anticipated future electricity requirements in the event that the electricity was available at commercially acceptable prices. As a forecasting methodology it was doubly flawed. The companies were not contractually bound to these estimates, and the estimates were made without consideration of what the actual price of electricity would be. If the HEC's survey of major industries was used, industrial load would increase by 506 MW in 21 years. Over half of this forecast increase in demand (228 MW) would be from one firm, Temco.

The HEC considered an average rate of industrial load growth of 20 MW p.a. unlikely and arbitrarily halved the forecast rate of industrial load growth to about 10 MW per annum. When this was combined with the projected retail load, the result was a projection of total load growth that dovetailed perfectly in timing and output with the Commission's preferred Gordon-below-Franklin scheme. Professor Burton politely suggested that it was tempting to conclude that the Commission's forecast was strongly influenced, if not governed, by what its preferred hydro-electric option could supply (Burton 1980: Section 3: 64).

The Coordination Committee on Future Power Development (1980) accordingly dismissed Harwood & Hartley's aggressive energy efficiency proposal outright, describing it as essentially subjective. The report argued that the lack of research into the demand for energy in the State and the consequent poor information base on energy end-use data, mitigated against the political feasibility of such an untested option. It was pointed out that the estimates of energy savings and the cost-effectiveness of these measures varied substantially across all end-uses and energy conservation measures, from solar hot water systems to dishwashers. The government was ethically bound, the Committee argued, to have a better understanding of the impacts of energy conservation measures before imposing it on the community through regulations (Coordination Committee on Future Power Development 1980: 155). The Committee therefore advised the Government to adopt an energy conservation programme with all urgency but claimed that this would be insufficient to negate the need for expansion of the system (Coordination Committee on Future Power Development 1980: 6).

The Coordination Committee's strategy for undermining the HEC's argument for the Gordon-below-Franklin scheme was the reverse of the environmental lobby's. Accusing the HEC of arbitrarily reducing projected industrial load growth to match its hydro-electric option, the Coordination Committee estimated industrial load growth to be significantly higher than assumed by the HEC. As this demand forecast could not be met with a hydro-electric scheme with a lead time of over ten years, the Coordination Committee argued, it necessitated immediate construction of a 200 MW coal-fired power station, followed by construction of the smaller dam on the Gordon just above its junction with the Olga River (See Map 5.1). The Gordon-above-Olga scheme was the HEC's second favoured option and had the advantage of avoiding inundation of the Franklin River.

5.5.4 Political Support for the Hydro-Electric Option

As the debate moved into the public sphere, the pro-hydro forces organised on an unprecedented scale and the Government came under pressure from several fronts at once. At the instigation of the Hobart Chamber of Industries, thirteen of the major industries in the State formed a working party which commissioned a public relations firm to steer public opinion towards the HEC's preferred option and also hired a professional lobbyist to take their case to politicians (Lowe 1984: 110). HEC employees also formed their own organisation, the Hydro-Employees Action Team (HEAT), to protect the jobs of the HEC's construction workforce by publicly campaigning for the Gordon-below-Franklin scheme. Kellow has argued that since HEC employees were forbidden by law from making public statements concerning the HEC, HEAT enjoyed at least the tacit approval of the HEC as the Commission did not censure their activities (Kellow 1996: 44). Most damaging to the Government, however, was the formation of a pro-HEC lobby group, the Association of Consumers of Electricity (ACE). Its membership included former Liberal and Labor Premiers, Sir Angus Bethune and Eric Reece, as well as the ex-HEC Commissioner, Sir Allan Knight.

5.5.5 Moderate Energy Conservation as a Compromise Strategy

On the 8th of July, 1980, Cabinet met to consider the options. Both the HEC's integrated hydro-electric scheme and the all-thermal option were immediately rejected. The thermal option was rejected as the HEC was able to easily convince the members of Cabinet that electricity produced from coal would be more expensive than electricity produced from hydro-electric sources. But while the HEC insisted that hydro-electricity continued to represent the cheaper option, independent economic analysis again suggested that coal had become competitive with further hydro-electric construction by the early 1970s (McColl 1976). The government's acceptance of the HEC's cost estimates was made in the face of growing concerns over the blowout in the costs of the incomplete Pieman scheme.

A number of possible contributing factors to the Government's acceptance of the HEC's stance can be suggested. Primarily, politicians found themselves dealing with complex economic and technical issues which they did not fully understand. They therefore had to decide which expert advice to accept, that of the HEC, or that used by the Coordination Committee. The choice of the former was probably based on 'the Devil you know' principle, together with the more dominant presence of the HEC in the debate. This advice, however, was subsequently shown to be seriously deficient (Kellow 1982, Saddler 1982). Critiques of the HEC's comparative cost estimation methodology pointed out that these comparisons were not based on the normal tools of project evaluation but relied on undiscounted cost streams and ignored the cost implications of small errors in forecasting. The HEC's cost comparisons were also shown to be based on economic costs analysis of the Gordon-below Franklin scheme in isolation from, rather than as a component of, the entire State's integrated electricity generating system. The discount rate employed by the HEC was lower than was normal for public project appraisal, the efficiency of modern thermal power stations was understated by the HEC analysis, and while the costs of the thermal option included the costs of land, no attempt was made to place a cost on the loss of wilderness or other values in the hydro-electric option. The costs of coal were also inflated in the HEC analysis at a rate of 8% p.a. compared to an inflation rate of 6% p.a. for all other inputs. Independent analysts also claimed that the HEC understated the capital costs of the hydro-electric option. Alternative independent analysis using more conventional economic appraisal techniques found the thermal option to be 'significantly cheaper than the hydro alternative to meet the HEC's forecast load growth to the year 2000 except under then unlikely circumstances of a 2 % p.a. escalation in the price of coal' (Kellow 1982: 10).

Politicians were unable to make similar criticisms of the HEC's cost comparison methodology. Although some early critiques pointed out the deficiencies of the HEC's comparative cost methodology (Hill 1980), by the time more comprehensive comparative cost evaluations were produced by independent investigators, the Government had committed itself to the hydro alternative. Cabinet's support for the hydro-electric option may also have been based on a strong desire to believe that hydro-electricity was cheaper than coal simply because the implications of believing otherwise were far-reaching. It was clear that Tasmania could not produce electricity from coal at prices competitive with the large mainland coal-fired power stations. Reliance on coal would mean that the State had no advantage over the mainland states in electricity generation. If coal were the cheaper option, moreover, it would require a decision with high political costs in the from of retrenchment of the hydro-electric construction workforce.

Given that much of the pressure on the government came from HEC employees and trade unions, employment implications were of paramount importance in reaching a decision (Kellow 1996: 42). When the HEC admitted that the Gordon-above-Olga scheme would be more labour-intensive than the Gordon-below-Franklin scheme, Lowe believed that it provided a compromise that would offer both the HEC's construction workforce and the environmental lobby their major goals. Cabinet's final decision was to proceed with the 120 MW Gordon-above-Olga scheme. As the output of the compromise option was 52 MW less than the HEC's preferred option, Cabinet adopted a moderate energy conservation package designed to reduce growth in retail load by 60 MW over one decade. As a further measure to ensure security in the supply of cheap electricity, the conversion of the Bell Bay stand-by oil-fired power station to coal was also adopted as part of Cabinet's energy strategy. Cabinet took its compromise energy proposal to parliament confident that it would be accepted as it avoided both the need to flood the Franklin River and the need to retrench HEC workers.

To lend credibility to its energy conservation proposal, the Government needed to be seen to be able to achieve its target of a 60 MW reduction in electricity demand. A semi-autonomous Energy Management Centre was established within the HEC to promote energy conservation (Sioshansi 1990, Section 4: 7). The Energy Advisory Council was also instructed to appoint a working party to prepare legislation that would alter the State's building codes to mandate minimum thermal performance standards for new dwellings. The Working Party, headed by Graeme Wathen, handed its report to the government and the legislation to put the new regulations into effect was tabled in Parliament in late 1981 (Working Party on Thermal Insulation of New Dwellings 1981: 1). To add to the visibility of its energy conservation efforts, the Government also established the Tasmanian Energy Research Council (TERC) which made available grants for research on energy conservation. A research team from the University of Tasmania quickly took advantage of this new source of research funding and applied for an $86,500 to undertake a comprehensive survey of Tasmanian households with a view to developing a sophisticated econometric model of household sector energy use and thereby improve forecasting of future demand (Challen *et al.* 1983). The University Research Team applied for the funding using the argument that the greatest problem for overall electricity planning in the State was the uncertainty associated with future retail sector demand, of which the household sector was the largest component. According to the University research team':

> Relative uncertainty about demands imposed on all energy sources by the domestic sector makes it difficult to plan the provision of energy supply for the other sectors even where long-term contractual arrangements give some certainty to the estimation of future demand in those sectors. (Challen *et al.* 1983: 1-2)

This view conflicted with the those such as Professor Burton who considered the uncertainty associated with forecasts of major industrial load to be far greater than those associated with forecasts of retail sector load. The research aim to develop a model which could include the effects of saturation levels and increased end-use energy efficiency, and so 'enable the prediction of the likely effects of government policy initiatives in the conservation area' (Challen *et al.* 1983: 2), however, appeared to be potentially useful.

5.5.6 Political Resistance to Alternative Energy Strategies

The major weakness of the government's energy proposal was seen to be that the estimated cost of electricity produced by the Gordon-above-Olga scheme of 1.6 c/kWh was 0.2 c/kWh higher than the estimated cost of electricity produced by the HEC's preferred Gordon-below-Franklin scheme. It was estimated by the HEC that this price differential would cost the State in the vicinity of $3 million p.a. (Newstead 1980: 25). The government maintained that this was a fallacious argument as although its compromise would increase the unit cost of electricity, total expenditure on electricity would not be increased as demand for electricity would be reduced through its moderate energy conservation programme. Critical to the government's energy policy strategy, therefore, was its ability to convince its critics that the energy conservation programmes would result in the 60 MW electricity savings assumed by the government.

The Government's compromise option was passed in the House of Assembly but was rejected by the pro-hydro lobby and by conservationists. The seven-member Legislative Council Select Committee on Future Power Developments held hearings *in camera*, denying access to environmental groups whilst giving free access to HEC and industry representatives. The Managers of the HEC provided the Committee with reports not supplied to the Government (Bates 1983: 3), an action the Commission justified on the grounds that the Commission was responsible to Parliament rather than to the government of the day, and merely worked to ensure that parliament was fully informed (Cockburn

1982). The Commission, furthermore, continued to produce load projections that took no account of the Government's estimates of the scope for energy conservation and publicly warned that electricity tariffs would rise unless the Gordon-below-Franklin Scheme went ahead (Thompson 1981: 21).

The recommendations of the Legislative Council Select Committee report tabled in early 1981 surprised few as five of its members had expressed their support for the HEC option before hearings began (Bates 1983: 2). The Committee reasoned that the State could not afford to jeopardise its economic future by adopting anything but the energy option that provided electricity at the lowest unit price. In an unprecedented move the Legislative Council altered the wording of the Government's Bill by deleting 'Gordon-above-Olga', inserting 'Gordon-below-Franklin' in its place and recommending immediate start on construction. The government refused to accept the Legislative Council's amended Bill and a Conference of Managers consisting of members of both houses of Parliament was formed to break the impasse. The Conference of Managers remained deadlocked throughout 1981.

In the absence of any other constitutional mechanism for resolving the impasse, Lowe took the debate into the public arena (Herr & Davis 1982: 8), relying on the fact that opinion polls had consistently shown majority public support for saving the Franklin River (Lowe 1984: 110). Under the criticisms from the HEAT, ACE, the major industries and the HEC, the resolve of a number of Labor parliamentarians began to weaken. When the government also came under attack from its traditional support base, the trade union movement, the rift within the Government's own ranks widened. Large unions had close connections with the Commission and these unions brought their considerable influence within the ALP to alter Government policy and undermine the Premier's position. At an ALP State Council meeting in early July 1980, a union attempt to commit the Government to the Gordon-below-Franklin scheme was defeated but a motion to put the issue to a referendum was passed (Kellow 1996: 44). The result was an unsuccessful challenge to Lowe's leadership and a reshuffling of his Cabinet. A junior member of Cabinet, and a supporter of the Gordon-above-Olga option, Julian Amos was given the Energy portfolio. Within days of gaining the energy portfolio, Amos switched to the pro-hydro camp (Lowe 1984: 148). His first official duty was to announce a 13.6% increase in retail sector electricity tariffs. The new Minister attempted to link the increase in electricity charges to the Government's energy conservation policy by simultaneously replacing the declining block general retail tariff with a flat rate tariff (*The Mercury* 31 July 1981: 1-2).

Union support for the Gordon-below-Franklin scheme was not absolute. The Public Service Union commissioned the doyen on matters economic in Tasmania, Dr Bruce Felmingham from the Department of Economics at the University of Tasmania, to put forward its case that expenditure on public administration created more income and jobs than did expenditure on hydro-electric construction (Felmingham 1982). Felmingham produced a report damning further hydro-electric construction and the policy of hydro-industrialisation. Comalco, he claimed, paid less than the marginal cost of supply for the electricity it received and that while the firm attempted to justify this subsidy on the basis of the contribution the company made to the direct and indirect employment in the State, this argument was readily undermined by the fact that hydro-industrialisation was an excessively costly job creation strategy. Politicians, Felmingham stated, had ignored a number of the reports which had indicated that hydro-industrialisation had already run its course in the State and should be laid to rest (Felmingham 1982: 25).

Nor was business support for continued hydro-electric development complete. A group of small businesses formed their own association opposed to the Lower Gordon scheme and commissioned international economist and energy consultant, Shann Turnbull, to prepare an independent report on the State's future energy options. The 'Turnbull report', released in September 1981, foreshadowed more recent reforms of the electricity supply industry by advocating that the HEC be split into generating, distribution and retail units, and that the HEC's monopoly be broken by allowing private generators to compete (Turnbull 1981). The report proposed that generators bid to supply a central distributor, an Energy Efficiency Office (EEO), with bulk electricity which would be resold in bulk to independent retailers. The function of the EEO would be to act as a regulator and ensure that electricity was used efficiently. Like other independent economists, Turnbull was also of the opinion that the cost of thermally produced electricity would be less than that produced from hydro-schemes and recommended construction of a coal-fired power station rather than further hydro-electric development.

Turnbull's recommendations were publicly supported by the Minister for National Parks and Wildlife, Andrew Lohrey. On the insistence of Amos, Lohrey was sacked (Lowe 1984: 154). Just before his sacking, Lohrey made a request to the Prime Minister to nominate South West Tasmania for inclusion on UNESCO's World Heritage List. The request initially went unnoticed amid the political turmoil but was to be of paramount significance to the eventual outcome[5]. With Lohrey's sacking, Lowe lost his support and on 11 November 1981 was toppled. An HEC spokesperson publicly stated that the Premier had been properly dismissed for failing to heed the advice of its bureaucracies and there was a common perception that the HEC had played a direct role in the Premier's fall (Cockburn 1982, Hay 1987: 5). To political analysts Herr & Davis (1982:

[5] Lowe (1984: 165) stated that he personally sent the request. According to another member of Cabinet at the time, however, it was Andrew Lohrey who sent the request and did so without consulting Cabinet. It was this action, the author was told, that led to the initial push from the pro-HEC faction within Cabinet for Lohrey's sacking (Bob Graham, personal communication, December 1995).

7), however, this was a too literal interpretation and understated the subtlety of the HEC's involvement.

The new Labor Government abandoned Lowe's energy strategy and Lowe resigned from the Party to sit as an independent. The referendum was held on the future power option, giving the public the choice of only two options: the Government's Gordon-above-Olga scheme, or the HEC's Gordon-below-Franklin scheme. The Government did not campaign for its own option, which received only 8% of the vote. The HEC's option polled 47%. Almost one third of all voters chose neither option but elected instead to write 'No Dams' across their ballot papers. When Labor Whip, Mary Willey, followed Lowe by resigning and sitting as an independent, the Government lost its majority and parliament was immediately prorogued by Lowe's successor for three months to defer the inevitable vote of no confidence. While in recess, the new Labor administration adopted the Gordon-below-Franklin scheme as policy on the grounds that it was the option that had received the greatest support in the referendum.

The new Labor administration set about dismantling Lowe's electricity planning reforms. The Energy Advisory Council was abolished and the Directorate of Energy was replaced with a small Energy Policy Unit within the Premier's Department. Interestingly, the energy conservation programme put in place by the Lowe administration was retained. The Energy Policy Unit was asked to produce an Energy Policy statement reaffirming the Government's commitment to energy conservation (Government of Tasmania: 1982a: 27-8). The government used the statement to declare that it had set a goal of reducing government sector energy (not electricity) use by 20%, and that a broad range of energy conservation policies would be used to encourage household sector energy conservation. It was announced that the legislation mandating thermal performance standards codes for new dwellings would be introduced as soon as Parliament resumed.

An updated and extended version of the Policy statement was used to justify the government's support for the Gordon-below-Franklin Scheme on the basis of the greater economic and social benefits the option provided during the construction phase. It gave the function of the energy conservation programmes as the tailoring of demand to supply during the long construction time of the dam (Government of Tasmania 1982b: 71). This ignored the fact that the Pieman scheme would be commissioned in the interim period and left unanswered why such energy conservation policies were seen as necessary when the Gordon-below-Franklin scheme was defended by the HEC using a forecast that was not contingent upon moderate energy conservation efforts.

As soon as Parliament resumed the Government fell, and the Liberals were swept to power in March 1982 under their new leader, Robin Gray. The Bill approving the Gordon-below-Franklin Scheme passed both Houses of Parliament and the Deputy

Premier was sent off to Paris to dissuade the UNESCO Committee from including South West Tasmania on the World Heritage List. With a federal election approaching, the Liberal Prime Minister offered the Tasmanian government $500 million to construct an 800 MW coal-fired power station instead of the Gordon-below-Franklin dam. Gray dismissed the offer out of hand (Green 1984: 197).

During the course of the Franklin River, dispute three industrial firms operating in the State had permanently closed their doors. One of these, the Carbide works at Electrona had been propped up by the Government by the purchase of $12 million shares in the company which it then resold to the company for $1. To save the jobs of the company's 180 workers, its contract electricity price was reduced to a fraction of a cent per unit. In 1980 the company folded and reneged on its take-or-pay electricity contract (Tasmanian Wilderness Society 1984: 15). None of these closures appeared to have any impact on the question of the accuracy of load forecasts and the associated risk that there would be excess capacity when the Gordon-below-Franklin Scheme was completed.

5.5.7 Renewed Debate over Electricity Planning and Energy Conservation

The environmental lobby took its campaign to the federal sphere and persuaded the Australian Democrats in the Senate to establish a Senate Select Committee of Inquiry on South West Tasmania. The Senate Inquiry permitted a more thorough examination of all issues, including load forecasts, comparative costs of the energy options and the scope for energy conservation. Both Weinstein (1982) and Kellow (1996) have noted the further insights into the electricity planning in Tasmania obtained during the course of the Inquiry, and especially the responses of the HEC's Chief Commissioner to questions from the Select Committee of Inquiry.

When asked by the Committee if he would advise the Tasmanian Parliament to approve construction of a hydro-electric scheme in the absence of palpable evidence of any increase in demand for electricity, HEC Chief Commissioner, Russell Ashton, stated that his advice to the Parliament would be that expansion of supply would be prudent, even in the absence of firm increase in demand (Weinstein 1982: 16). This answer surprised the Committee members, who then asked the Chief Commissioner whether he considered that the attempt to project demand based on all of the HEC's analysis of data was irrelevant. To this the Chief Commissioner replied:

> In many ways I think it is. I would say about the general load again, for instance, that may be we are out in our estimates of general load; may be we can achieve better results with conservation than we assume and that will drop the general load down a bit. But all that does is give us a little bit more for industry, and it is a mighty valuable thing to have. I do not see any problems about it (Senate Select Committee of Inquiry on South West Tasmania 1982a: 3275).

The HEC's Chief Commissioner had previously described forecasting as more of an art than a science, an analytical method which relied heavily on experience and judgement (Newstead 1980: 22). His response to the Senate Select Committee of Inquiry illustrated that in the Commission's art of forecasting, the scope for retail sector energy conservation was deemed to be not only uncertain, but largely irrelevant.

The Senate Select Committee concluded that it was not possible to arrive at any absolute position on the comparative costs of energy supply options as there existed no consensus on likely future interest rates, discount rates, or future fuel costs. To resolve these issues, more investigation was needed (Australian Parliament 1982b: 220). On the question of forecasts, the Committee was equally ambivalent. The environmental lobby suggested that the retail load in Tasmania in the year 2000 would be around 700 MW, well below the HEC's upper band estimate for that year of 1,100 MW. The HEC's justification for its retail load projections the Committee considered 'incomplete and in some cases erroneous' (Australian Parliament 1982b: 61) While the HEC assumed a 5.95 % p.a. increase in retail load to 1984, reducing to 3.95 % after 1987, environmentalists assumed a 2 % p.a. growth in retail load. The disparity between the highest and the lowest load projections for the year 2000 submitted to the Committee was 436.2 MW (Australian Parliament 1982b: 75). Given that actual retail demand in 1979 was 293 MW, this range in forecasts was considered exceptionally large (Australian Parliament 1982b: 88). The Committee found a similar disparity in the forecasts of major industrial loads. Its own survey of Tasmanian firms found that plans to increase demand before the mid 1980s were tentative and that no company had any firm plans to increase demand beyond that date. This conflicted with the HEC's assessment of the situation.

In his submission to the Senate Inquiry, independent energy consultant, Dr John Todd, suggested that the HEC's load projections were too high, that demand could be further reduced with energy conservation, and that any increase in demand for electricity to the year 2000 could therefore be met using renewable energy technologies. Dr Todd maintained that it would be more than possible to increase the efficiency of energy use in Tasmania by 1.8% p.a. over the following decade. As this would amounting to the 180 MW reduction in electricity demand over the decade - equivalent to the output of the Gordon-below-Franklin scheme - energy efficiency could be used , according to Dr Todd, to defer the decision over which energy supply option was in the best interests of the State until the early 1990s. When pressed by the Senate Committee members for substantiation of this opinion, Todd expressed surprise, claiming that such scope for energy conservation was simply accepted everywhere else (Senate Select Committee 1982a: 1222). Asked whether increased energy efficiency was likely to result in increased output rather than reduced energy use, Dr Todd claimed that in his experience as an energy consultant to small to medium-sized industries, this was not the case.

That there existed significant, though not as dramatic scope for electricity conservation, was also argued by the Commonwealth's Department of National Development and Energy (DNDE). In its submission to the Senate Inquiry, the DNDE claimed that it would be possible to save 780 GWh of electricity p.a. in Tasmania by the year 2000, reducing the HEC's projected load growth for the year by one third. The Department estimated 80% of this scope for energy conservation to be in the industrial and commercial sectors, with the other 20% in the household sector.

These claims were hotly contested by the Department of Industrial Development of Tasmania (DIDT), the predecessor of the Tasmanian Development Authority. According to the DIDT, assessment of the scope for energy efficiency in the industrial sector required specialist skills and detailed local knowledge. The Authority gave its own best assessment of such scope for conserving energy in Tasmania as 85 GWh p.a. by the year 2000, most of this scope for energy efficiency being in the industrial and commercial sectors. Such energy efficiency, the DIDT asserted, was likely to be taken up as increased output rather than a decrease in electricity use. The DIDT claimed, on the other hand, that the scope for household sector electricity conservation was frequently over-estimated.. It was argued that householders who used electric space heating had been encouraged by the HEC's Customer Advisory Service to insulate their dwellings for over two decades, and were therefore likely to have disproportionately higher rates of insulation. Increased insulation, it was argued further, was more likely to result in increased thermal comfort levels rather than in decreased electricity use. As the price of oil rose, moreover, it was asserted that there would be an increasing switch to electric space heating. In regard to the potential to reduce household sector electricity use in other end-uses such as lighting and refrigeration, the DIDT was totally dismissive (Department of Industrial Development of Tasmania: 1982: 74). The real scope for industrial cogeneration, the Authority also suggested, was a fraction of that claimed by conservationists and the DNDE. In the DIDT's estimation, the actual scope for electricity savings was a mere 22 GWh per annum.. In arriving at this figure, the DIDT made the extraordinary statement that higher estimates of the scope for electricity conservation assumed that Government policy would be revised (Department of Industrial Development of Tasmania 1982: 87), implying that it was necessary to ensure that sufficient supply of energy was available in case government energy conservation programmes were not put in place. The DIDT in essence advocated expanding supply as a hedge, not only against the limited uncertain scope for energy conservation, but also against uncertainties of policy implementation. It amounted, in effect, to an extreme form of Collingridge's (1980) hedging circle.

Faced with these conflicting views and forecasts, the Committee commissioned the McLachlan Group to independently critique the forecasts and to prepare an independent load projection. The McLachlan Group considered the HEC's forecast band to be too narrow and substantially increased the upper band and reduced the lower forecast band. The Senate Committee of Inquiry Committee considered the forecast prepared by McLachlan Group to be the most reliable and noted that if the McLachlan Group's lower band forecast was accepted as the basis for planning, no supply expansion would be needed before the year 2000. If, on the other hand, the Group's upper band was used as the basis for planning, hydro-electric development could not meet the required load increase in time (Senate Standing Committee of Inquiry on South West Tasmania 1982b: 219-20). In view of the large uncertainties, the Senate Select Committee of Inquiry considered the most prudent option to be a 'just-in-time' construction programme using small-scale supply expansion projects with short lead times, while investigating all other options, including the scope for reducing demand with a comprehensive energy conservation programme, and research to improve demand modelling (Senate Standing Committee of Inquiry on South West Tasmania 1982b: 221).

5.6 Federal Intervention

In March 1983, the Labor Party gained office at the federal level, coming to power promising to halt construction of the Gordon-below-Franklin scheme using Commonwealth constitutional powers to protect areas on UNESCO's World Heritage List. A challenge by the Gray government in the High Court narrowly failed when the full bench of the High Court ruled by a 4 to 3 majority, on 1st July 1983 in favour of the Commonwealth, and the Gordon-below-Franklin dam was abandoned (Bates 1983: 11). Federal intervention to override states in order to achieve important environmental goals became known within Australia as 'the Tasmanian solution' (Lowe 1994a: 325).

The HEC quickly prepared a report on alternative hydro-electric schemes outside the South West and revised its load projections – upwards! Comalco, which had previously indicated that it would probably require an extra 60 MW by 1990 and no further load thereafter, now indicated that it would probably require a further 250 MW by the year 2000. In all other respects the HEC considered that its 1979 load projection remained accurate, and on the basis of this, recommended immediate start to the King (68 MW) and Anthony-Henty (44 MW) schemes at an estimated cost of $605 million. Under the federal compensation package, the costs of the electricity from the schemes was to be subsidised to bring it down to the equivalent of the cost of electricity from the abandoned Gordon-below-Franklin scheme. The Federal government also entered into a commitment to subsidise the State to make up the 60 MW difference in the output between the abandoned Gordon-below-Franklin scheme and the alternative King and Anthony-Henty schemes, should the demand for the extra electricity materialise.

5.7 Conclusions

As a consequence of their State's intractable economic problems, Tasmanian policy makers traditionally placed singular importance on the potential economic benefits of electricity supply expansion projects. Social costs were given little consideration and supply expansion options were judged purely on the basis of achieving the lowest unit cost of electricity possible. Policy makers relied on the expertise of the electricity supply bureaucracy for advice as to both the likely increase in demand and the cheapest means of meeting those future electricity requirements. The electricity bureaucracy's supply expansion proposals were uncritically accepted. Where questioning of these proposals did occur at the State level, questioning was superficial, as politicians lacked the technical or economic ability to challenge the bureaucracy and were unwilling to demonstrate their inadequacy. The bureaucracy was therefore given a free rein in deciding the likely rate of growth in demand for electricity and the optimal means of meeting this increase in demand. Rather than technology being out-of-control, it was a case of a bureaucracy being in control.

This mode of electricity planning collided with changing social attitudes and the demand for a shift in the balance between development and environmental protection. Both government and the energy bureaucracy resisted the demands to slow down the hydro-electric construction programme for environmental reasons and bureaucratic secrecy in electricity planning, and direct intervention in the democratic process were politically tolerated, but publicly resented.

Although political concern over the degree of bureaucratic control of electricity planning in the State surfaced soon after the rate of expansion of electricity supply began to accelerate, industry rather than the bureaucracy was the ultimate arbiter of the rate of expansion throughout the 1950s and early 1960s. If the bureaucracy's construction programme was not synchronised with industrial expansion programmes, industry demanded that the hydro-electric construction programme be accelerated. By end of that decade, however, industrial demand was slowing and the expansion of electricity supply was increasingly based on planning for surplus capacity as a contingency for unanticipated growth in demand. According to Collingridge (1980), inherent in such a shift in planning was the risk of an oversupply crisis. Collingridge failed to see how an oversupply crisis could be averted by entering into contractual agreements with energy-intensive industry to take up the spare capacity at low rates, should the demand for the extra electricity fail to materialise. The speed with which the electricity bureaucracy entered into such agreements suggested, however, that the rate of electricity supply expansion increasingly came to be based on what was optimal from the electricity supplier's perspective. Kellow (1986: 13) pointed out that while politicians supported this arrangement and participated in the negotiations, it did not follow the classical corporatist model of policy decision making, in which 'strong' government negotiates with peak industrial bodies. Rather, it was a case of 'weak' government negotiating with individual companies.

The political attempt to regain control of electricity planning during the Franklin River episode was resisted by the bureaucracy and conservative politicians. Political reformers attempted to include consideration of changing social values and attitudes. An attempt was also made to reduce the rate of electricity supply expansion to a level that more closely matched the public interest. These attempts were frustrated by the collective power of the bureaucracy and pressure groups, including trade unions and energy-intensive industries, with a vested interest in continued expansion of hydro-electric construction at a maximum rate. The rift between government, and the bureaucracy and industry during this controversy, permitted the influence of these pressure groups on policy and planning to be more clearly seen. The reformist government was undermined by the combination of the conservativeness of the pro-development Legislative Council and the political expedience of individual politicians who exploited the dispute as a means of acquiring political power. Though more subtle than its earlier intervention in the democratic process to undermine the environmentalist campaign to halt the flooding of Lake Pedder, the bureaucracy worked to undermine the government once the latter sought a change in direction. Ultimately, the bureaucracy was defeated by a Federal government more removed from the imperatives of economic policy making at the local level, and by a single vote in the High Court.

Environmentalists' proposals to alter the State's economic direction by abandoning the policy of hydro-industrialisation, can be considered to be completely analytical and rational. They were supported by sober and independent economic reports which argued that the policy of hydro-industrialisation had run its course (Callaghan 1977). Along with aggressive energy conservation proposals, these proposals were rejected by policy makers on both sides of the debate, and this rejection can be seen as a consequence of the strategic nature of policy making. Despite all the problems it created and the limited benefits it provided, without an alternative vision, Tasmanian policy makers were unwilling to radically alter policy direction. But without abandoning the policy of hydro-industrialisation, aggressive energy conservation proposals could not avoid the need for further expansion of electricity supply. Energy policy debate therefore remained centred on the question of economies of scale to produce electricity at the lowest unit cost. Energy conservation alone could not meet the environmentalists' demands.

The moderate energy conservation proposal adopted by the Government, on the other hand, was estimated to save 60 MW of electricity in the retail sector over a ten year period. It therefore neatly made up the difference between the outputs of the HEC's preferred option (the 180 MW Gordon-below-Franklin scheme) and the Lowe

Government's preferred option (the 120 MW Gordon-above-Olga) scheme. How could the Government be sure that its energy conservation programme would make up the 60 MW when there had been little or no assessment of the impacts of these programmes? The simple answer is that how much or how little energy the energy conservation programmes actually saved, was not critical from the Government's perspective. Unable to challenge the HEC's forecast, the function of the moderate energy conservation programme was purely to provide the Government with the political means of arguing that this forecast load could be met with an alternative strategy.

The Government's compromise energy strategy had three fundamental weaknesses that opponents were able to exploit. First, although the Gordon-above-Olga provided temporary job security, it opened the door for the hydro-electric construction programme to be terminated after completion of the dam. Trade unions and HEC employees preferred to keep the HEC in control of electricity planning for long-term job security.

Secondly, although the Government's energy conservation programme was moderate compared to the programmes being adopted at the time by a small number of Northern European and North American countries, it represented a bold step for Tasmania. No government in Australia had proposed reducing the demand for electricity on such a scale. But while the Government was willing to adopt an energy conservation package despite the large uncertainties over the energy savings that would be achieved, its opponents were able to exploit those uncertainties in their attempts to resist policy reform. The risks of those energy conservation measures not translating into reduced demand, and thereby leading to shortages and reduced economic growth, were used to undermine the alternative energy strategy.

Thirdly, from the environmentalist perspective, this moderate energy conservation package was of limited value if it was unable to avoid further construction of hydro-electric schemes in the South West.

The outcome of the Franklin River dispute left the Liberal government and the HEC with a smaller hydro-electric construction programme than they had supported, together with an energy conservation programme that they had not supported. The way in which those energy conservation programmes inherited by the Government were implemented are discussed in the following chapter. Also described are the changes introduced in the attempt to place electricity planning on a more rational basis, the resistance to those attempts, and the outcomes in terms of policy emphasis on energy conservation.

Chapter Six

Tasmania: A Case Study of Electricity Planning - Part 2

> History teaches us that men and nations behave wisely
> once they have exhausted all other alternatives.
> — Abba Ebam, Israeli Foreign Minister, 1970.
> Quoted in *The Cassell Dictionary of Cynical Quotations*. Cassell, London.

6.1 Introduction

In this chapter, the case study of electricity planning in Tasmania is extended to cover the more recent period. This is necessary because the political conflict created by the technocratic style of electricity planning eventually led to the introduction of planning reforms. As the financial problems created by the technocratic planning described in the previous chapter became more pressing, the pace of those reforms accelerated. It was when factors outside the state came into play, however, that the reform process rapidly gained momentum and underwent a substantial shift in direction. The important question from the perspective of this study is to what extent those reforms resulted in, or are likely to result in, a greater reliance on energy conservation as a planning option.

Energy planning in the State following the Franklin River dispute is in fact more difficult to explain than it is in the period prior to, or during, that conflict for a number of reasons. One reason for is that electricity planning in the State after the Franklin River dispute became a lower key affair, relatively devoid of the public conflict. As a result, there has been less written on electricity planning in the State during in this more recent period and it is less well understood. The issue of electricity planning in the State, furthermore, became more complex during the 1980s and 1990s as the ongoing planning reforms introduced were the consequence of an interplay of number of pressures.

To discuss electricity planning in Tasmania the post-Franklin era, the period from 1983 to mid 1996 is divided into three separate stages. The first of these was the period immediately following the forced abandonment of the Gordon-below-Franklin scheme up to the late 1980s, when shortages re-ignited debate over the State's next power option. Explaining the low priority on energy conservation during that time is relatively straight forward as it was primarily the product of the planning decision to continue with hydro-electric development. The changes to electricity planning made during that time nonetheless had considerable bearing on policy in the subsequent stages.

During the second stage, from the late 1980s to the early 1992, there arose the perception that energy conservation needed to become an important component of both State and Federal policy. A number of energy conservation programmes were put into place, some of which were more effective and enduring than others.

The final stage discussed covers the period from 1992 to mid 1996. During that time, debate over reform of the electricity supply industry and energy policy intensified, leading to tension between those groups attempting to retain political control over electricity planning in order to encourage industrial expansion, those groups seeking to place electricity planning on a more economically rational footing, and the environmental lobby which demanded both economically rational and democratic planning reforms which increased public participation and which would ensure that energy conservation became the linchpin of energy policy and planning in the State.

6.2 The Legacy of Past Electricity Planning in the post-Franklin Era

6.2.1 The Inability to Halt further Hydro-Electric Construction

Once a substitute for the Gordon-below-Franklin had been decided upon, a small number of attempts were made to persuade the policy makers to abandon construction of the King and Anthony-Henty Schemes using economic arguments. Blakers & Outhred (1983) continued to criticise hydro-electric construction and the HEC forecasts upon which this strategy of meeting future electricity was based. The cost of electricity produced from wind energy systems, these engineers maintained, would be approximately 6 c/kWh, well below 11 c/kW they estimated to be the cost of electricity produced from the King and Anthony-Henty schemes. As wind turbines could be added in small increments, reliance on wind would effectively reduce the forecasting horizon to eighteen months or so, and would reduce the risks of oversupply resulting from inaccurate forecasting.

Although not advanced as an alternative to the King River scheme, another wind energy proposal offered insights into the continued resistance to proposals for reforming electricity planning in the State. In January 1983, a group of private individuals sought approval to finance, install, operate and maintain two 55 kW wind generators on King Island as a commercial operation. Their intention was to demonstrate the feasibility of wind energy systems for the State. A company, Tasmanian Wind Enterprises (TWE), was formed and took to the Government a proposal to sell approximately 200 to 600 MWh of electricity p.a. to the HEC. The Commission's diesel generating system on the island produced electricity at an estimated cost of 11 to 12 c/kWh, but as the Commission was required by legislation to charge residents on the island the same rate as customers on the Tasmanian mainland, the King Island system ran at a loss. The operating loss for the 1981/82 year was $627,248.

The TWE group argued that to make a reasonable return on their investment, the price would need to be approximately 10.5 c/kWh (*The Examiner* 15 Feb., 1983). The group finally accepted a price of 9 c/kWh on the condition that the Commission cooperate with TWE in assessing the true value of electricity over the first twelve months of operation. The TWE group argued, however, that as its proposal was a high risk venture, the most appropriate method would be to index the price of electricity to the price of diesel. This also appeared to be fair method as it was directly related to the HEC's own costs of producing electricity on the island. The HEC insisted that the electricity be indexed to the price of electricity on the Tasmanian mainland (Private Letter, Dr John Greenhill of TWE to the Secretary of the HEC dated 7 December 1983). After protracted discussions, agreement could not be reached and the venture was abandoned.

While the King Island wind energy proposal was a practical proposal in that it had no immediate ramifications for overall electricity planning in the State, the Tasmanian Wilderness Society engaged in a more ambitious attempt to halt construction of the King and Anthony-Henty schemes well after work on the King scheme had started. Adapting the title of Pardy *et al.*'s (1979) critique of the hydro-electric development in Papua New Guinea[1], the Tasmanian Wilderness Society's *Overpowering Tasmania* (TWS 1984) demanded that the King and Anthony-Henty schemes be abandoned on the grounds that the electricity was not needed and that continued hydro-electric construction would serve merely to aggravate the HEC's already considerable debt. The report did little other than reiterate the by then well-rehearsed argument that past HEC forecasting had proven to be inaccurate and that current HEC forecasts were

therefore likely to similarly over-optimistic, and that investment in hydro-electric development had failed to produce adequate returns to the State in terms of employment. Using the same arguments as Harwood & Hartley (1980) and other writers, the TWS report maintained that increasing the supply of electricity to provide for the expansion plans of energy-intensive industries such as a Comalco and Temco was an expensive means of creating employment. A single sentence was devoted to the assertion that if

[1] Pardy R, Parsons M, Siemon D & Wigglesworth A (1979) *Purari: Overpowering PNG.* International Development Action Group, Fitzroy, Victoria.

hydro-industrialisation was abandoned, increased retail sector energy requirements could be cost-effectively met through energy efficiency policies. The report made no impact on policy debate.

A third attempt to halt the hydro-electric schemes was made a year later. In 1985, a petrogeologist, John Davidson, discovered natural gas deposits in the already well investigated Yolla Basin in Bass Strait. Davidson lobbied politicians, arguing that bringing natural gas ashore would result in far greater economic benefits for the State than would further hydro-electric construction (John Davisdon, personal communication, Dec. 1993).

While the abovementioned attempts to derail the King and Anthony-Henty schemes could perhaps be described as rational in the economic sense, in the political sense they could only be described as extremely ambitious. After the Gordon-below-Franklin scheme had been blocked by the Federal government, public interest in the Tasmanian energy issue rapidly dissipated and little support could be mustered to extend the acrimony and community division. Furthermore, once the alternative schemes had been started, contracts signed, and loans negotiated, the prospects of halting construction became more and more difficult. The attempt by the Wilderness Society in 1984 to halt further dam construction well after construction on the King River scheme had begun, using well-rehearsed and, in places, relatively speculative arguments, was particularly quixotic. Thirdly, and most importantly, no amount of evidence that other options were technically feasible or cheaper was likely to dissuade a Premier who had ridden to power on the basis of support for continued hydro-electric construction and decisive leadership. The failure of TWE attempt to use wind generators to enter the electricity supply market, on the other hand, indicated the determination of the public energy bureaucracy to retain control over electricity planning and its monopoly as the sole electricity supplier in the State.

6.2.2 The Demise of Labor's Energy Conservation Programmes

The Liberal government and the HEC had inherited a small number of energy conservation initiatives from the Lowe administration which they had opposed and which they maintained were unlikely to achieve the energy savings assumed by the Lowe government. According to Collingridge's (1980) interpretation of the supply construction cycle, however, once a decision has been made to start on a new supply expansion project, energy conservation is no longer in the mid-term strategic interests of the electricity supplier and planning interest in energy conservation is deferred until demand once again catches up with supply. The problem for the HEC was that the energy conservation policies and programmes it inherited had the clear potential to conflict with the need to increase electricity consumption once the Pieman scheme came on-line. Collingridge (1980) also assumed that the scale of supply construction cycle increased in order to capture greater and greater economies of scale, and that as the size of the new supply systems increased, the risks of an oversupply crisis also increased due to the eventual saturation of the demand for electricity. Collingridge's model did not strictly apply to the Tasmanian situation, however, for a number reasons. In the case of the largest scheme constructed, the Middle Gordon scheme[2], an oversupply crisis was avoided by selling large blocks of cheap electricity to an electricity-intensive industry. The potential for an oversupply crisis with the commissioning of the slightly smaller 230 MWav Pieman scheme was nonetheless real as a consequence of other factors. Increased public scrutiny of electricity planning as a consequence of the Franklin River dispute rendered it more difficult to dispose of any surplus from the Pieman scheme by entering into contracts with energy-intensive industries at subsidised prices. If the HEC's forecasts proved to be accurate, on the other hand, then its King and Anthony-Henty schemes would not be capable of meeting demand by the late 1990s and either a new supply of energy would need to be found or energy conservation programmes would be required to tailor demand to existing supply.

Rather than put these policies and programmes on hold until there was another shortage, the Liberal government set about dismantling the energy conservation policies put in place by the Labor government. The legislation mandating thermal energy performance standards for new dwellings was one of the first pieces of legislation debated when parliament resumed and was defeated by the Liberal government. The Energy Policy Unit was disbanded and responsibility for energy planning returned to the HEC. A Planning and Public Affairs Group (PPAG) was created within the HEC and charged with the responsibility of the planning of all energy sources in the State. The Energy Management Centre continued to promote substitution away from oil and encourage energy conservation and the HEC undertook minimal pilot testing of solar hot water systems in the HEC's laboratories and on five houses on King Island (HEC 1984: 9).

The field work for the University of Tasmania's $86,500 household energy use survey funded by the Lowe administration had been completed and the raw data published (Challen *et al.* 1983: 1). It eventually became clear that the research was not going to be used to develop an econometric model of household sector electricity demand. The reason for abandoning the project was never made clear, but according to the leader of the project, Mr Don Challen, the research was terminated due to an oversight. The

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2 The hydro-electric scheme with the greatest generating capacity in the State was the Poatina scheme (300 MWav). As the Poatina scheme involed the decommissioning of the Waddamana power station, the largest scheme in terms the additidional generating capacity provided was the Middle Gordon scheme (288 MWav).

initial intention had been to obtain information on household oil use for space heating for the year 1982 once those households that used oil for that purpose had been identified in the survey. A failure to collect this information, according to Mr Challen, undermined the usefulness of the data for modelling purposes (Mr Don Challen, personal communication, Dec. 1991). This does not appear to be a complete explanation, however, as econometric modelling had been frequently carried out with far less precise data than was available to the research team. It appears more likely that interest in the research waned as energy conservation lost its political appeal and that this contributed both to the failure to follow up with the collection of oil use, and the failure to use the available data to construct an econometric model.

By the early 1980s, it was clear that the expected resource boom from the OPEC oil price rise had in fact turned out to be a recession. Industrial load growth had actually fallen 1% between 1979 and 1983. To offset this, electricity tariffs were increased 15% in February 1983. The costs of the Pieman scheme had blown out and in Novemeber 1984 the Pieman Bill was amended to increase authorised expenditure from the original $139 million (1970 dollars)[3] to $681 million (1984 dollars). The new reformist Federal Labor government had inherited a badly performing and heavily indebted economy and embarked on a programme of sweeping microeconomic reform to increase the country's competitiveness. One of the first measures introduced by the Hawke government was to place a ceiling on Loans Council borrowings, forcing the HEC to increase internal revenue raising and to rely on semi-government external borrowings at higher interest rates to complete the construction of the Pieman scheme and finance construction of the King and Anthony-Henty schemes.

In 1986, the No.1 unit at the Bell Bay oil-fired power station, which had been in use since the beginning of the Franklin River dispute, was shut down. Industrial load growth had been slower than anticipated while the forecast rate of growth of the general load growth was reduced from the HEC's 1983 forecast of 3.5 % p.a. to 1.53% per annum. The HEC argued that the slower rate of growth in demand would allow further hydro-electric development would proceed ahead of construction of a coal-fired power station (HEC 1987: 17). This new forecast continued to be based on the assumption that householders would switch from oil heating to electricity rather than wood heaters (Islam 1985), despite the evidence to the contrary in the form of a substantial shift to wood heating. The HEC's generating capacity was also set to

[3] Both the HEC and the Australian Bureau of Statistics advised the author that there is no readily available inflator with which to convert estimated hydro-electric construction costs in Tasmania in 1970 to 1984 dollars which would permit a direct comparison of the HEC's original and revised cost estimates. An appropriate index would need to include the inflation in the costs of both labour and materials specific to dam construction, and to weight these appropriately.

increase when the Pieman scheme was commissioned and a third 144 MW generator had been installed in the Middle Gordon scheme to increase peak load capacity. The Director of HEC's PPAG, Bill Gaskell, declared that many energy conservation measures had become uneconomic (HEC 1986: 16) and the HEC embarked on a $190,000 campaign to encourage electricity use (Knibbs 1987: 44).

6.2.3 Reform of Electricity Planning under the Liberal Government

The Liberal Party had risen to power in Tasmania by supporting the HEC's formula for electricity planning based on economies of scale and continued development of the State's hydro-electric resources. It was therefore opposed to the style of reforms of electricity planning put in place by its predecessor and the creation of independent energy planning and advisory bodies. Despite this, the Liberal Government under Gray proved able to achieve what the Labor Party in terms of reining in the control of the HEC's Power Engineering Branch over electricity planning. A dominant character, Gray was unwilling to be dictated to by government bureaucracy and put into effect the Carter recommendations of the public sector administration reforms initiated by the Lowe administration (Cartland 1981). The HEC Act was amended in 1985 to place the HEC under ministerial control and to create the positions of four government appointed Associate HEC Commissioners. This was followed by removing decision making over the Commission's financial borrowings. The HEC had taken out its semi-government loans to finance the King scheme in Swiss francs and when the Swiss currency devalued in 1986, the interest rates on the HEC's loans increased from 11.7% to 14.05% over a short period. Management of the HEC's external borrowings was quickly taken out of the HEC's control and handed over to Tascorp, a newly created body of economic experts within the Tasmanian Development Authority (TDA).

When the HEC Chief Commissioner's contract expired in February 1987, it was not renewed. The HEC Act was again amended to abolish the position of Chief Commissioner, replacing it with the two separate positions of Chief Executive and Chairman, both whom served on an HEC Board with four government-appointed Commissioners. To increase managerial experience of the Board, Brian Gibson, ex-Managing Director and then Director of Australian Newsprint Mills (ANM), one of the major industries in the State, was appointed Chairman of the HEC. An outsider with a wealth of managerial experience in international companies, Graeme Longbottom, was appointed Chief Executive. With these moves, HEC's Power Engineering Branch lost its control of the organisation. Under this new management, the policy of commercialising the HEC to turn it into a profit-oriented business was accelerated. To this end, a Marketing Group was established within the HEC to identify and meet customer needs (Sioshansi 1990, Section 4: 5).

6.3 Supply Shortages and Revived Interest in Energy Conservation

6.3.1 Electricity Planning Reforms under the Labor-Green Accord

In May 1989 the Liberal government lost power when five Greens were elected to the House of Assembly and held the balance of power. The Greens entered into an accord with the Labor Party and the latter formed a minority government (Larmour 1990). Ironically, the issue which had initially created the environmental movement in the State, electricity planning, was at the time at the back of the policy agenda and was not included as part of the Accord agreement (Davis 1992: 119). The new Labor government accelerated the pace of reform of electricity planning in the State by creating a Department of Resources and Energy with the function of providing advice to government on all aspects of energy policy. The Secretary of this new Department was a Commissioner of the HEC.

At the national level, however, awkward questions were being asked about the debts of the Australian state electricity authorities and the Treasurer, Paul Keating, had instructed the Industry Assistance Commission (IAC) to investigate the electricity supply industry. The IAC's report revealed that the HEC's profit to loss ratio in 1987/88 of -24.2% was the worst of any Australian electricity authority. The HEC's reserve plant margin of 74.5% compared with world standard practice of 20% (IAC 1989: 6). The Commonwealth government instructed the Commission to hold a full Inquiry into the Australian electricity supply industry.

One of the first tasks of the new Department of Resources and Energy in Tasmania was to commission an international consultant to undertake a review of HEC tariffs. The consultant's report, acknowledged that the HEC had managed to provide Tasmanians with relatively cheap electricity, but was highly critical of the HEC's use of historic rather than replacement costing, and the lack of regulation over HEC contracts with major industries (Bartels 1990: 13). HEC's tariffs, the consultant noted further, bore little relation to actual costs. The HEC simply used its monopoly power to reduce prices for those consumers sensitive to electricity price while increasing prices for those less sensitive to price. Industrial users were price sensitive and a small increase in the price of electricity would lead to a substantial shift from electricity to other energy sources in the industrial sector. Small businesses and the household sectors, on the other hand, could use only electricity for many end-uses such as lighting and were price insensitive. A substantial increase in retail electricity prices would not result in a major reduction in electricity use.

6.3.2 Recession and Further Commercialisation of the HEC

The minority Labor government's term in office was dogged by two major crises. The first was the State's chronic economic position. A report released by the mainland group, the Evatt Research Foundation (1989), had shown the State's financial position to be precarious. Six months later, the USA based financial group, Moody's, down-graded the State's credit rating from a top (Aaa) to a third ranking (Aa3). All other Australian states continued to received a top ranking (Aaa) except Victoria which was dropped to a second ranking (Aa2). The Labor government introduced a series of austerity measures, including sweeping public sector retrenchments and closures of small country schools to reduce State's debts. The State Authorities Management Sector Act of 1990 was introduced, requiring State government income-producing instrumentalities to pay tax equivalents and a dividend to State Treasury. This placed further strains on the HEC's financial position and stimulated the Commission to move more quickly towards commercialisation in order to increase profitability and performance. The Commission seized on the first wave of public service retrenchment offers to massively reduce its workforce. The Commission also adopted the Standard Australian Accounting Practice which was based on asset replacement costing. This resulted in an additional $50 million depreciation costs which meant that the HEC could not afford to pay a dividend and a 5% levy was imposed on the bills of all classes of customers to pay the dividend to Treasury.

6.3.3 Electricity Shortages and Environmental Concern over Energy Use

On top of this came drought. For the first time in the State's history, both 120 MW oil-fired stand-by generators were fired and 11% of total electricity in the 1990-91 year was generated from the oil-fired generating station. Coinciding with the rise in oil prices induced by the Gulf War, the cost of fuel oil was $12.8 million in 1989-90 and increased to $53.6 million in the following year. The Dean of Economics at the University of Tasmania, temporarily forgetting that he had joined the chorus denouncing the Gordon-below-Franklin Dam during that dispute as uneconomic[4], blamed the environmentalists who had blocked the dam for the electricity shortages and the need to rely on the stand-by generators (Felmingham 1990: 2). His argument was not only inconsistent, but overlooked the fact that even if construction of the dam had gone ahead it would not have been completed in time to alleviate the need for reliance on the oil-fired generators. It also overlooked the fact that the oil-fired generators were simply

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[4] See Section 5.5.6.

being used for the purpose for which they had been built and that a hydro-electric system was prone to drought-related shortages.

The crisis mentality associated with the use of the oil-fired generators was exacerbated by the fact that the drought coincided with the rise of political concern over the greenhouse issue. Not only were Tasmanians increasing their greenhouse gas emissions, but they were paying a small fortune to do so. The result of these combined factors was a resurgence of interest in energy conservation. Pasminco-EZ (formerly Electrolytic Zinc Co.) approached the HEC with a proposal to alter its take-or-pay contract to allow the company to reduce its total contractual load if it undertook measures to reduce energy use by increasing efficiency. The company claimed that a 15% to 20% reduction in its energy demand would avert the need to use the Bell Bay generators (*The Mercury* 19 August 1993: 1). A Demand Side Management working group was established within the HEC, but without permanent staff and with nominal organisational support its contribution to planning was tokenistic (Sioshansi 1990, Section 4: 6). The Department of Resources and Energy was instructed to commission a consultant's report on the scope for energy efficiency. The report, *An Energy Efficient Blueprint for Tasmania,* described Tasmania as an 'energy efficiency gold mine' and the Tasmanian community highly supportive of the energy efficiency strategy compared to consumers in the USA, while energy conservation legislation lagged behind that of many other places (Sioshansi 1990: Section 2: 6). Sioshansi's report made 107 recommendations, including reorganisation of the HEC to ensure that demand side management was supported by a permanent office and was made an integral part of planning. Dr Sioshansi also recommended that legislation to mandate thermal performance standards for new dwellings be re-introduced. It would be possible, Dr Sioshansi suggested, to reduce electricity use by 1% p.a. over a fifteen-year period.

Following the SECV's lead, the HEC moved towards more openness in its decision making. In late October, the Commission held its inaugural Annual General Meeting to which the general public were invited. At the meeting the HEC General Manager made it abundantly clear that the cost of producing electricity from hydro-electric construction in Tasmania was no longer cost-competitive with mainland electricity producers. The cost of electricity produced from the Pieman scheme (5.9 c/kWh) was on average 44% higher than the unit cost of electricity produced from new coal-fired power stations in other states, while the unit cost of electricity produced from the King and Anthony-Henty schemes (8 c/kWh)[5] was estimated to be almost double the cost of electricity produced by mainland thermal plants. This meant, according to the HEC General Manager, that

[5] The true cost of electricity from the King and Anthony-Henty schemes was closer to 11 c/kWh if the Commonwealth contribution to the scheme's capital costs was included (Blakers 1995: 117).

Tasmania would need to find an alternative to further hydro-electric development in order to produce energy at a price competitive with prices on the mainland. By the Commission's own reckoning, there existed the potential to save somewhere between 10 and 100 MW of electricity at a cost below the marginal cost of expanding supply

The HEC also released at the Annual General Meeting a new load forecast which estimated that demand for electricity would increase between 1990 and 2015 at a rate of 1.3% to 2.2% p.a.. This compared with a rate of over 3.5% p.a. predicted by the HEC's 1983 forecast. The Minister for Energy announced at the meeting that the Government intended to introduce a number of energy conservation programmes, including annual energy efficiency awards (Weldon 1991). The government also resurrected the Energy Advisory Council. While applauding the move, environmentalists were disgruntled over the lack of community representation on the Board whose membership was made up of the General Manager of Comalco, HEC management, and representatives of the Tasmanian Development Authority (TDA), the trade union movement, and other industries. Environmental groups, consumer organisations, smaller industries and small businesses were unrepresented.

The HEC gave all the indications that it would take energy conservation seriously and was the only other electricity authority in Australia apart from the SECV to place increased emphasis on DSM as a planning option during the period (Johnson & Rix 1991: 3). The HEC declared, in fact, that its intention was to be the national energy efficiency leader among Australian electricity authorities (HEC 1991a: 17). A Demand Management Unit was established within the HEC which hurriedly identified 30 MW of economically viable energy savings in the State, including $5 million p.a. savings at Pasminco-EZ and $1 million p.a. at Comalco (HEC 1991a: 18). Tasmanian householders were treated to multiple energy conservation campaigns.

Many responses to the energy shortages and the renewed enthusiasm for increasing the efficiency of energy-use were rushed and ill-thoughtout, or served merely as symbolic gestures. The office of the Federal member for the Hobart seat of Denison, for example, hurriedly distributed to all households in the electorate with poorly produced photocopies

of an out-of-date mainland energy conservation brochures. Most of the initiatives deployed by the HEC, furthermore, were of a type that could be easily terminated should the occasion demand it. These efforts included highly visible energy conservation competitions - with electric appliances offered as prizes - and the preparation, in conjunction with ABC Radio, of booklets on energy efficient cooking based on public suggestions and ideas (HEC 1990b). A large part of the HEC's campaign consisted of exhorting its customers to 'switch on wisely' and to this end the HEC's Energy Advisory Service began encouraging customers to use the appliance energy efficiency labels that had previously gone unmentioned. These labels had appeared on new equipment retailed in the State as an unintended consequence of decisions made in Victoria and NSW rather than decisions made by the Tasmanian government or the HEC. Once the governments of those larger mainland states introduced mandatory labelling, distributors made the administrative decision to label all appliances sold within Australia. The smaller states such as Tasmania therefore inherited a default energy labelling programme. With the drought, the HEC was able to piggyback on this programme.

As a demonstration of this commitment to DSM and energy efficiency, the HEC removed the regulations barring customers with solar hot water systems from boosting these with the continuous hot water tariff[6]. The impact of this change in regulations, however, was very small since solar hot water systems were installed on approximately only 0.5% of Tasmanian houses. Most of these, furthermore, were likely to remain on the off-peak tariff since solar contribution of solar hot water systems is maximised, and the electric boosting minimised, if most of the hot water draw-off occurs in the morning and electric boosting occurs at night. The Commission also began small-scale pilot testing of demand side management strategies. The impact on energy demand from replacing incandescent globes with compact fluorescent lamps was investigated on King Island, while the energy savings achieved from installing insulation was monitored using 100 electrically heated homes in Launceston. The results of these pilot programmes were never released publicly.

Not all demand side management strategies are purely load reduction strategies as some are double-sided and can be used to increase market share when the time dictates. One of the recommendations made by the energy efficiency consultant was to encourage the replacement of electric resistance space heaters with energy efficient electric heat pumps (Sioshansi 1990, Section 7: 8). Other independent analysts also pointed to the substantial scope for increasing the efficiency of residential sector energy use in Tasmania

by switching from wood to electricity for space heating (Wilkenfield 1990: 405, Wilson *et al.* 1993: 34). The promotion of electric heat pumps therefore had the potential to lead to not only a switching from electric resistance heaters but to also increase the market share of electricity by competing with other energy sources for space heating. Sutherland (1996: 369) has recently made the claim that many utility DSM programmes undertaken in the USA during the 1980s were conservation programmes in name only and that they were in reality disguised marketing programmes. The degree to which the HEC's promotion of heat pumps was a means of reducing energy demand by increasing

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[6] The continuous hot water tariff rate was 6.47 c/kWh. Prior to the change in the regulations, customers with solar hot water systems could connect these to only the off-peak tariff (4.44 c/kWh) or the normal household tariff (9.09 c/kWh).

the efficiency of energy use and the degree to which it was a means of increasing market share was, therefore, a question of balance. When the HEC embarked on a $250,000 advertising campaign promoting electric heat pumps, it raised the ire of wood heating manufacturers and distributers who saw the balance as heavily tipped in favour of increasing electricity's market share.

The promotion of energy efficiency came not only from the HEC but also from the Federal government as a consequence of the public and political pressure for action to curb Australia's greenhouse gas emissions. The Federal government, as part of its greenhouse response strategy, prepared an information booklet on energy efficiency in conjunction with the Australian Consumers' Association, copies of which were distributed to every household in Australia (Australian Government & Australian Consumers' Association 1991).

Another boost to Tasmania's energy efficiency drive also came as part of the national greenhouse response strategy. The Federal government announced that it would jointly fund a national Integrated Energy Management Centre (IEMC) which would encourage and trial energy efficiency programmes for all fuels in all sectors of the economy and serve as a demonstration for similar projects around the country. Submissions of interest were called for and Tasmania's submission was accepted, largely on the basis of the manageability of preparing and assessing energy conservation programmes in a small location. The IEMC was set up in Hobart's northern suburbs as a semi-autonomous body with a two-year funding from the Commonwealth and staffed by personnel seconded from the HEC.

6.4 Renewed Pressure for Increased Electricity Supply

6.4.1 The End of the Drought

By mid 1991, the drought had eased and the Bell Bay power station was again shut down. The King River scheme was due to come on-line in early 1992. Industrial load growth had been slow due to the recession and forecasts had been revised downward. By October 1991 the government's interest in energy conservation was waning. An Inter-Departmental report on the State's future energy options stated that although energy conservation was an important component of energy policy, energy conservation programmes had to be thoroughly assessed before being implemented and their timing needed to be consistent with the State's major policy objectives (Inter-Departmental Committee 1991: 38). The main interest of the government turned to which source of energy to use to meet future energy requirements.

Inter-Departmental Committee report (1991) suggested that a new supply of energy would be required in the near-term and indicated that the government was considering all options including a coal-fired power station using local coal, further hydro-electric development and wind energy. An option that received much attention was Basslink, a proposal to connect the Tasmanian and South East mainland grids with a submarine cable. This option had been looked at on every occasion the State's future energy needs had been contemplated since the mid 1960s. It had been persistently opposed by the HEC on the grounds that a cable would result in importing electricity from the mainland and exporting jobs from Tasmania. Policy makers had also preferred to maintain the State's energy independence to ensure security of supply. The HEC had also dismissed the idea that a cable would allow Tasmania to profit from exporting high cost hydro-electric peaking power while importing low-cost base load imports from mainland coal-fired stations. The main flaw with the proposal, according to the HEC's Director of Planning and Public Affairs, Bill Gaskell, was that without the Gordon-below-Franklin scheme Tasmania's hydro-electric system lacked the necessary downstream storage to allow off-peak pumping of water back up stream for re-use. Without such facilities, Gaskell maintained, the ability to sell peaking power to the mainland would be too limited to be profitable. It was argued further that neither of Tasmania's two existing storage hydro-electric schemes, the Poatina and Middle Gordon schemes, had the capacity to serve entirely as peak load generating systems. It was argued that in the case of the Poatina scheme, constant use to generate peak load for the mainland would result in flooding of farming areas downstream. Gaskell maintained that sustained use of the Middle Gordon scheme to serve the same function, on the other hand, would cause considerable erosion and other environmental problems on the lower Gordon River (Knibbs 1987: 46). Despite these arguments, the cable proposal was lent a new lease of life in the early 1990s as a result of the growing debate over restructuring of the Australian electricity supply industry.

6.4.2 National Reform of the Electricity Supply Industry

The Industry Commission's report on the electricity supply industry requested by the Treasurer, Paul Keating, was tabled in federal Parliament in May 1991. The report recommended sweeping structural reforms of the industry in order to increase its economic performance and thereby contribute to reduce the costs of electricity to the manufacturing sector and thereby enhance national competitiveness. The Industry Commission estimated that national economic output could be increased by $2.2 billion p.a. through competitive market reform of the electricity supply industry and advocated breaking up the state-owned public electricity monopolies by ring-fencing these into commercial business units within the existing public authority, or by breaking up the functions of the authorities and selling these as separate businesses (Industry Commission 1991a). According to the Industry Commission, institutional barriers to energy which represented the greatest obstacle to energy conservation and increased efficiency of energy use and removing these institutional barriers would result in both economic and environmental benefits. Critical to the Commission's proposal to create a competitive market for electricity and gas was the need for open access to the networks (high voltage transmission lines or gas pipelines) between energy producers.

The electricity supply industry tentatively concurred with the general thrust of the report and in July 1991 a National Grid Management Council (NGMC) was set up to encourage and coordinate the most economic and environmentally sound electricity supply industry in the eastern and southeastern States. In 1991 Paul Keating became Prime Minister and the vision of a national grid gained added momentum as it accorded with his 'One Nation' policy plan. As part of that policy package, the Commonwealth offered to contribute up to $100 million towards the Basslink option. A pre-feasibility study was undertaken and estimated that a 390 MW cable would cost $550 million and provide a net benefit to Victoria and Tasmania of $1.17 billion over a 24 year period (SECV & HEC 1991a). These benefits included reduced need for oil at the Bell Bay station in Tasmania and the ability to defer investment in additional supply capacity in Victoria beyond 1989. A full feasibility study followed and the estimate of the net present value of the cable using a 10% discount rate to be substantially reduced at $310 million. This reduction in the net present value was due largely to the reduced load forecasts produced in the interim by both the SECV and the HEC (SECV & HEC 1991b).

6.4.3 The Decision over Tasmania's Next Energy Option

The Tasmanian Development Authority's preferred option was to bring natural gas ashore. A consortium (Tasgas) consisting of the HEC, Comalco Bell Bay Ltd and the Tasmanian government was formed to investigate the feasibility of the gas option. The consortium estimated that if natural gas could be brought ashore from the Yolla Field in Bass Strait at $4/GJ, and if the minimum size of a gas-fired power station built was 150 MW, it would be possible to produce electricity at 4 to 6c/kWh. Tasgas formed a joint venture with the exploration firm Sagasco to undertake a $40 million drilling programme to firm up the gas resource.

As consideration of the next energy option continued, the HEC was undergoing further structural and philosophical change. The national electric supply industry reform debate gave added momentum to the HEC's new drive towards commercialisation. Following the Industry Commission report, the HEC produced its *Blueprint for the Future* (HEC 1991b) in which it outlined its plans to restructure as a commercial body by ring-fencing into six separate profit-making business units by March 1992. An unanticipated consequence of this was a weakening of the relationship between the HEC and its traditional ally, its major industrial clients.

6.4.4 Tension between Industry and the HEC over Reforms

Driving the debate on energy planning in Tasmania was a single firm, Comalco Bell Bay Ltd. The entry of eastern European aluminium manufacturers into the world market in 1989 had led to a glut in aluminium and a slump in price. The small, old and inefficient Tasmanian smelter began to run at a loss of approximately $30,000 per day. The company commissioned a $1 million feasibility study of the investment strategies open to it and was presented with three options: The first was a total redevelopment of the plant to best world practice at a cost between $0.6 and $1 billion. The firm claimed this option would and require an additional 150 MW of electricity. The second option was a partial upgrade of the plant to extend its life by 15 to 20 years and meet new environmental standards planned for introduction in July 1994. The estimated cost of the partial upgrade was estimated to be between $200 million and $300 million. The last option open to the company was to make no further investment in the plant and permanently shut down the smelter when its existing contract for electricity expired in the year 2001. The company publicly announced that its preferred choice was the first of the above, total redevelopment, but warned that it would not commit itself to that option unless guaranteed a long-term contract for electricity at a price sufficiently low to allow it to remain competitive.

Negotiations between the HEC and Comalco over a new contract price began in late 1991. Simultaneously, Comalco's Tiwai Point plant in New Zealand and the Boyne island smelter, in which Comalco had a 30% stake, were negotiating similar price contracts and conditions for investment in redevelopment. Comalco Bell Bay's parent company, CRA, insisted that all three investments could not be undertaken concurrently and that unless an agreement on a new electricity contract was reached in Tasmania before the decision to proceed with investment in New Zealand and Queensland, the Tasmanian redevelopment decision would be deferred for a number of years. The company set July 1992 as the deadline for a decision.

Although no official figures were ever released, it was commonly believed that in its negotiations with Comalco, the HEC demanded a 100% increase in the contractual price the company paid for its electricity be increased, from 1.7 c/kWh to 3.4 c/kWh. Comalco Bell Bay Ltd was believed to unwilling to pay more than 2.0 c/kWh (*The Mercury* 29 July 1993: 6).

As the debate dragged on, Comalco's bargaining position strengthened. Sagasco, the joint venture partner in the natural gas project, threatened to pull out of the $40 million drilling programme unless the Tasgas consortium could guarantee a minimum market for the gas of 20 PJ per annum. Tasmanian Development and Resources estimated that an 8 PJ p.a. market for gas could be created by encouraging susbstitution from fuel oil, distillate and LPG in the industrial sector located in the north of the State. The only way that a 20 MJ p.a. market could be created therefore was to construct a gas-fired power station of a size that would use the extra 12 PJ of gas. This worked out to be 150 MW. The catch was that under its just-in-time policy, the now commercialised HEC was unwilling to commit itself to construction of such a large gas-fired plant without a firm market for the electricity. While Comalco Bell Bay Ltd expressed an interest in a new contract for an additional large increment in electricity, it was the only firm to do so. The aluminium smelting firm, furthermore, was unwilling to commit itself to this expansion unless it was guaranteed long-term security of supply at a sufficiently low price. The impasse could not be broken and Sagasco withdrew from the venture (Energy Council of Tasmania 1994: 52).

Next to collapse was the wind option. Early in 1992, the two separate firms independently investigating the feasibility of constructing privately-owned wind farms in the State reported to the government that their estimated costs of producing electricity from wind ranged between 9 c/kWh and 11 c/kWh. As the quoted price was well above the estimated costs of electricity from either a submarine cable or gas, the government abandoned its interest in developing wind energy.

6.4.5 Collapse of the Labor-Green Accord and the Return of Power to the HEC

The prospects of further construction of hydro-electricity were dismissed not by government but by the HEC itself. In early 1992, the minority Labor government fell out with the Greens and called an early election with the hope that of gain a majority in its own right. Both Liberal and Labor produced energy policy statements during the course of the election which included further hydro-electric developments in the State. The HEC remained silent on the issue. Together with the Commission's previous statement that it considered the hydro-electric option to be no longer cost-competitive with electricity producers in the Australian mainland states, this silence strongly suggesting that with the transformation of the HEC to commercial organisation the vestiges of enthusiasm for hydro-industrialisation lingered as a political rather than bureaucratic vision.

The Labor government's strategy in calling an early election backfired. Campaigning on the need for stable government, the Liberal Party regained government on the 18th of February 1992. Following the report of a Royal Commission into a political bribery scandal (Royal Commission into the Attempt to Bribe a Member of the House of Assembly 1991), the former Liberal leader, Robin Gray, had been replaced as leader of the Liberal Party by Ray Groom. As Deputy Premier, Gray retained both his old Energy portfolio and his leadership ambitions. Under Gray, the HEC regained much of the control over energy planning it had lost under the Labor government. The Department of Resources and Energy was abolished. The ten-member Energy Advisory Council was replaced with a three-member Advisory Council and supported by an Office of Energy Planning and Conservation with a staff of two. Gray also exempted major industrial consumers from the 5% surcharge on electricity which the HEC had introduced for all customer classes as the means of providing the government with the dividend it now demanded. The Liberals, however, like their Labor predecessors, had no plausible energy policy and were unable to develop one while Comalco continued to hold the key to energy decision making in the State.

6.4.6 Pressure for Privatisation of Public Electricity Generating Assets

As the HEC rapidly moved towards a more commercial business-like enterprise with the aim of becoming more profitable, its negotiations with Comalco became deadlocked. Increased profitability, warned the Commission, would not be possible without progressively increasing revenues and this would need to include increases in contract prices paid by major industries (HEC 1991a: 4). Industry's reaction was surprise as it had assumed that the purpose of commercialisation was to reduce the costs of energy to the manufacturing sector. Individual industries claimed that they could not afford to increase electricity prices. The debate was inflamed by the release of the 'Curran Report', the report of the Independent Commission of Review of Tasmania's Public Sector Finances (1992).

In handing down its findings, the Independent Commission of Review recommended a series of economic rationalist policies to cut public sector spending and debt, including large-scale retrenchments and public asset sales. Among these was the sale of a 300 MW block of the HEC's generating system and construction of the Basslink cable as a private venture. The Independent Commission of Review's recommendations provided Comalco with another bargaining lever and came at a time in which the HEC's position in its negotiations with Comalco was becoming more difficult.

Growth in electricity sales had been slower than forecast and surplus capacity was set to increase with the imminent commissioning of the King River scheme. Faced with this surplus, two promotional campaigns had been initiated by the HEC to increase electricity's share of the space heating market. A clever and effective *Smoke gets in Your Eyes* media campaign extolled the environmental virtues of electric heating compared to wood heaters. The 'Hydroheat' campaign reduced the electricity rate for electric space heaters with a rating of 3.5 kW or more to the cheap continuous hot-water tariff as a means of increasing the market penetration of heat pumps. It was subsequently extended to include all electric space heating equipment rated above 3.5 kW.

Negotiations between Comalco and the HEC became more complicated when, in September 1992, the Government announced that it would be phasing out all Ministerial exemptions to the Environmental Protection Act by mid 1994 when a new Bill would be introduced. Comalco had two such exemptions, one permitting the company to emit 4.75 kg of fluoride into the atmosphere per tonne of aluminium produced[7]. The other exemption permitted the firm to release liquid waste containing cyanide into the Tamar River. Comalco responded to the government's announcement with the claim that as its operation at Bell Bay was already unprofitable it could not afford to invest in pollution control equipment except as part of its full redevelopment option. It put further pressure on the negotiations over the firm's new contract electricity price and price security. The company, frustrated by the deadlock in the negotiations, demanded that the only means by which it could achieve sovereign risk protection was through the acquisition of public generating assets. The contemporary discussion over whether to introduce a national carbon tax may well have contributed to the company's desire to acquire hydro-electric assets.

The company's proposal to buy part of the HEC's generating assets caused a great deal of consternation within both the Tasmanian community and other industry members. The concern of other industries was that a partial sale of HEC assets to Comalco would reduce the efficiency of the overall system and increase costs to the HEC's other customers. It was also clear that the scheme that Comalco sought was the 300 MW Poatina Scheme. That scheme was originally constructed to meet the firm's expanding demand and had been paid off. It was also a storage scheme and could provide

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[7] This was four times the level of emissions per tonne of aluminium permitted in the mainland states.

protection against drought. Comalco indicated that unless an agreement on the sale of assets was reached in the near future it would shelve its redevelopment plans and close the plant in the year 2001.

As all other schemes apart from the Middle Gordon scheme were run-of-river schemes, the sale of the Poatina scheme would greatly reduce the overall efficiency of the remaining generating system, decrease the ability to protect other customers from drought-induced shortages and increase the need to rely on the thermal back-up generators. The demand to acquire generating assets was therefore of considerable concern to the HEC's other customers. The manager of Australian Newsprint Mills (ANM) opposed to the sale and voluntarily offered to increase his firm's contract electricity price to 3.4 c/kwh.

The HEC also opposed the sale of assets, arguing that the State's generating system needed to be operated as an integrated whole and that fragmentation into separate generating systems would substantially reduce its overall efficiency. To defuse the pressure for asset sales, and supported by the Minister for Energy, Robin Gray, the Commission maintained that the price that Comalco paid for its electricity was so low that should the firm close, a new market for only a part of its 237 MW load would need to be found to make up the shortfall in revenue. This, the Commission argued, could be achieved by increasing its share of the electric space heating market (*The Mercury* 12 Nov. 1993: 5). Comalco responded by announcing it would withdraw from the negotiations with the HEC unless a sale of HEC assets was on the agenda.

The Premier overrode the HEC and initiated direct government negotiations with Comalco over the partial sale of HEC assets. The HEC retaliated by taking a line previously adopted by the environmental lobby and commissioning a confidential economic analysis of the impacts of Comalco's closure on the State. The report indicated that the impacts of Comalco's closure would not be as severe as generally believed and that it could even provide a net economic benefit for the State (Centre for Regional and Economic Analysis 1993: 16). The HEC's bargaining position, however, continued to be eroded. A glut of aluminium on the world market caused by the entry of eastern European producers forced the global industry to agree to cut world aluminium production by 12%. Tasmania's antiquated and inefficient aluminium smelter was a logical place to begin production cuts. Comalco Bell Bay Ltd closed its No. 2 potline and reduced its load by 60 MW, further increasing the HEC's nominal surplus. One hundred and fifty workers were retrenched (*The Mercury* 5 February 1993: 1).

When, in mid 1993, the government announced that a sale of assets to Comalco was imminent, it failed to anticipate the public backlash. Newspaper editorials, environmental groups and unions joined in the chorus of protest. The Government stonewalled, dismissing calls for a referendum. As Comalco's $650 million redevelopment was vital for economic growth in the State, the Government argued, the sale of generating assets was essential. The traditional supporters of the HEC, including the ex-Labor Premier Reece, ex-HEC Commissioner Ashton, and HEC employees were joined by Labor and Green members of Parliament, and environmental groups at a public meeting which unanimously passed a motion condemning any sale of HEC assets. Consensus among this odd assortment of bedfellows was nonetheless limited and a second motion put up by environmentalists opposing the sale of subsidised electricity to Comalco was resoundingly defeated (*Weekend Australian* 26-27 July 1993: 10). Other industries also put pressure on the government to abandon the sale of HEC assets. ANM suspended its own $120 million expansion programme and warned that it would wind down its own operations in the State if the asset sale went ahead. The proposal to sell part of the HEC's generating assets also made clear a split that existed within the Liberal government. The Minister for Energy, Robin Gray, wrote to all HEC staff declaring his opposition to the sale of HEC assets. He also espoused the view that the loss of Comalco would not represent a severe economic cost to the State (*The Saturday Mercury* 3 July 1993: 5).

With little public support for the sale of HEC assets even in the Bass electorate in which Comalco's Bell Bay smelting operation was located, the government backed down and in mid-1993 announced that the sale of HEC assets was no longer an option. The low, but undisclosed, offer made by Comalco was given as the reason for its decision[8]. Comalco retaliated by announcing that its withdrawal from the negotiations and its intentions to begin winding down its operations. To give weight to its threat, the firm retrenched 80 workers. Unmoved, the Government insisted that asset sales were permanently off the agenda. To entice the firm back to the negotiating table, the Government indicate a willingness to limit its demand for a price increase in the firm's contract price to 150% of the previous price (*The Mercury* 19 August 1993: 3). This offer would have taken the contract price to approximately 2.5 c/kWh.

With the closure of Comalco's potline in February 1993, the HEC's nominal excess capacity increased. Commissioning of the 44 MW Anthony-Henty Scheme was set to increase total spare capacity to 130 MW. Comalco's threat to close, if made good, would increase total spare capacity 350 MW, one third of total hydro-electric capacity and double the output of the abandoned Gordon-below-Franklin Scheme. Comalco rejected the Government's offer of a reduced increase in the contract price for electricity.

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[8] It was believed that Comalco's offer was $350 million while the scheme in question had been valued at $700 million (*The Mercury* 29 July 1993: 1).

6.4.7 Environmentalist Proposals for Electricity Planning Reform

Buoyed by the level of public opposition to the sale of HEC generating assets, the environmental movement sought to exploit the rift between the HEC and Comalco to promote its preferred version of planning reform. The Social, Economic, Ecological and Cultural Alliance (SEECA), formed in 1993 as an attempt to form a link between the Left faction within the Labor Party and the Greens, advanced a proposal for restructuring the State's electricity supply industry (Kohl 1993) that was a virtual copy of the earlier proposal advanced by Turnbull (1981). Many of SEECA's recommendations, furthermore, were economically rationalist and conformed to those put forward by the Industry Commission report (1991a). The Alliance's proposal included fragmentation of the HEC into a single electricity generation body and multiple retail entities, and the creation of a new regulatory body, the Public Utilities Board (PUB), with representation of community and environmental groups. The clear underlying intentions of the proposal were to emasculate the HEC, to break the strong nexus between the HEC and major industries, and to rupture the political decision making process that had given the HEC virtual monopoly control over electricity planning in the State. By increasing competition and by making electricity planning more democratic, it was hoped to slow down the supply construction programme and to install energy conservation as the mainstay of public energy policy.

SEECA realised that its presumed virtues of competitive reform of the industry were likely to remain academic while the HEC possessed a large surplus of generating capacity. With a large excess generating capacity, the HEC's low short-run marginal costs of supply would undermine the viability of any potential electricity supply competitor. One solution was to split the HEC into separate generating units. As this would play into the hands of Comalco Bell Bay Ltd's attempt to purchase part of the HEC's generating assets, pivotal to the SEECA proposal was an alternative means of disposing of the HEC's surplus without fragmenting the hydro-electric system. The Alliance therefore demanded that the proposal to connect the State's grid with Victoria's proceed. The underlying assumption used by SEECA to support its demand was that a submarine cable would create a market for peaking power and allow the State to receive a high price for the electricity it produced from its hydro-electric system, while buying back cheap base-load power from the mainland coal-fired electricity producers. Echoing the Industry Commission (1991a) report, SEECA argued that the cable would defer the need for expansion of generating capacity in both Victoria and Tasmania and was a potential 'big bang' efficiency measure, would reduce greenhouse gas emissions, and was therefore a moral necessity (Kohl 1993: 23).

To sell its proposal, SEECA ran a high profile public campaign while demanding that the issue of electricity policy be taken to the public arena through government sponsored public symposia. It was greatly assisted in this demand by the publication of a scathing critique of past electricity planning in the State in the national electricity magazine, *Electricity Week* (Beatty 1994).

The *Electricity Week* article was a condensed version of an article published later in the year in an academic environmental journal (Blakers 1994). Dr Andrew Blakers, an engineer from the Australian National University, accused the HEC of squandering $350 million dam compensation money, and of wrecking the State's economy by frenzied and unnecessary dam construction. This construction programme, Blakers charged, had been based on forecasts which had proven to be highly inaccurate, while the forecasts advanced by environmental lobby were shown to have been remarkably accurate. The costs of electricity from the unneeded King and Anthony-Schemes, the article contended, had left the State with a massive overcapacity and had contributed to 44% of the State's crippling debt. The article created a wave of questions and recriminations in Parliament, the Greens and the environmental movement calling for a Royal Commission into past HEC forecasting (*The Mercury* 9 March 1994: 9). As Premier at the time those planning decisions were made, Gray was the focus of these attacks. He defended his decision to proceed with the King and Anthony-Henty Schemes on the grounds that all the expert advice he had been given at the time indicated that the extra electricity would be required. More importantly, he added, 2300 families needed an income.

The Minister for Energy and the HEC also came under attack from the Parliamentary Standing Committee of Public Accounts (Parliament of Tasmania 1994). The Committee was asked to report on the HEC in response to the protracted negotiations between Comalco and the HEC and by the high level of opposition to the Government's proposal to sell HEC assets. Its report was highly critical of the degree to which the Commission's commercialisation had brought it into conflict with its major industrial clients. Healing this rift between the HEC and the major industries was seen by the Committee as imperative to avoid damaging the prospects for economic growth. The Committee was also perturbed about the declining public support for hydro-industrialisation and dismissed the claim that major industries received subsidised electricity as unsubstantiated (Parliament of Tasmania 1994: 24). Whether the price these industries paid for the electricity was cost reflective or not, the Committee argued, was irrelevant as the reality was that these industries paid what the market would bear. Any attempt to increase their contractual prices would undermine industrial investment in the State and put economic growth at risk. The Committee accused the HEC of having little understanding of the imperatives of industry and therefore recommended that members of Tasmanian Development Resources (TDR)[9], with their close relationships

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[9] The Tasmanian Development Resources (TDR) was formerly the Tasmanian Development Authority (TDA).

with industry, serve as HEC Commissioners (Parliament of Tasmania 1994: 21). The Commission's commercialisation, according to the powerful parliamentary committee, had gone too far and the Government had lost control of the its energy bureaucracy. Plans to fully corporatise the Commission, the Committee argued, ought to be abandoned. The Committee also dismissed the Commission's assumption that it could find new customers to make up the shortfall of revenue if the aluminium smelter closed. It was recommended that the HEC's revenue income should be increased by raising household and commercial tariffs rather than the prices paid by major industries (Parliament of Tasmania: 25).

The besieged Minister for Energy conceded to SEECA's demands for public consultation and ordered his Office of Energy Planning and Conservation to prepare a discussion paper on future electricity options in the State ready for a public seminar in May. The discussion paper outlined the national electricity supply industry reforms which would require the HEC's monopoly powers to be ended and a more competitive industry structure established. While privatisation at some stage in the future was not ruled out, the discussion paper followed Gray's line that, if Comalco closed, the HEC would be able to use the electricity to attract new industries and markets (Energy Council of Tasmania 1994: 11). This discussion paper outlined the various energy options available to the State government and the problems and estimated costs associated with these options, noting that there existed about a 25 MW potential to save energy at a cost of 2 to 5 c/kwh (Energy Council of Tasmania 1994. 25). SEECA interpreted the gesture as evidence of interest in its proposals for energy policy reform, restructuring the HEC and the Basslink option (*The Examiner* 4 April 1994 1).

On the eve of the seminar a confidential report commissioned by the HEC's Corporate Business unit in 1993 was leaked to the media. The report, prepared by the International firm, Merril Lynch, estimated that the HEC's revenue from its major industrial clients to be approximately $130 million p.a.[10] and that this income from the sale of electricity to its major industrial clients fell short of costs by $200 million p.a. It was not possible, the consulting firm claimed, to make up this shortfall by increasing retail tariffs alone (*The Mercury* 7 May 1994: 1)..

At the seminar, various speakers put forward their respective energy options for meeting the State's future energy requirements. The Managing Director of the Integrated Energy Management Centre (IEMC), Dr Peter Davis, indicated that although there was a potential to save between 20% to 25% of the energy used in the State, the IEMC was

[10] HEC revenue raised from retail sector sales (2,958.7 GWh) in 1993 was $293 million, while the revenue raised form bulk contracts with major industries (5.224.5 GWh) was $127.9 million.

out on a bureaucratic limb while electricity conservation programmes conflicted with the HEC's current commercial interests (Davis 1994: 4). Dr Davis suggested, however, that through the actions by the Australian and New Zealand Minerals and Energy Council, such as its pressure for the introduction of national Minimum Energy Performance Standards (MEPS) for household appliances, the efficiency of energy use in the State was likely to be increased irrespective of HEC or State policies (Davis 1994: 3).

6.4.8 Rejection of Environmental Reform Proposals & Energy Conservation

On the day following the seminar, Gray dismissed the Basslink proposal as too risky. With the reforms of the national electricity supply industry and the major restructuring of the Victorian electricity industry by the Liberal government in Victoria, Gray maintained that the situation had become too confused and volatile to permit an assessment of the impacts of the cable option in Tasmania (*The Mercury* 9 May 1994: 4). Under the National Grid Protocol adopted by all state governments except Tasmania, generators would compete on to supply customers with loads above 30 MW, decreasing to 10 MW by mid 1996. The major concern of the HEC and the Tasmanian government was that reform of the Victorian electricity supply industry would lower the price of electricity produced in that state, in which case interconnection would result in Victorian producers engaging in 'cherry-picking' – taking the HEC's high-paying customers whilst leaving it with its low-paying customers. SEECA's demand for the Basslink option and restructuring of the electricity supply industry in the State were dismissed as ill-thoughtout. The Alliance continued to press, nonetheless, for it electricity planning reforms.

To undermine Comalco's demand to purchase HEC assets, ANM signed a contract to pay 3.4 c/kwh for its electricity. The Managing Director of Pasminco-EZ publicly applauded the deal (*The Mercury* 28 June 1994: 6). The Chairman of Comalco Bell Bay Ltd's parent company, CRA Ltd, merely reiterated that unless an agreement could be reached that would protect Comalco from sovereign risk of price increases, the Bell Bay smelter would be closed.

Without warning, and with the Minister for Energy out of the country, the HEC announced on 8 July 1994 the introduction of a new retail tariff structure which included a new transmission tax of $109.50 p.a., to be increased to $219 p.a. in 1996. Together with the supply charge householders in 1995/96 would pay $350 p.a. on top of electricity charges. The new 'pole tax', the HEC argued, would be offset by a reduction in electricity rates so that the average householder would pay only a 2.5% net increase in 1995. The 'Hydroheat' tariff would be reduced from 6.99 c/kWh to 6.20 c/kWh in 1994/95, and to 5.5 c/kWh in 1995/96. The new HEC cost structure was clearly designed to encourage electricity use and was highly regressive, increasing the bills of low electricity users and decreasing those of high electricity users.

For those who had attempted to establish a wind energy generating company in the state, or who had quixotically attempted to persuade the then Premier, Robin Gray, to abandon the King River scheme in the early 1980s, it suddenly appeared as if their monster was indeed turning to windmills. Returning from the USA, the Minister for Energy, declared that the next new energy generation project in Tasmania could be a wind farm. There was, however, a caveat attached to the wind option. Gray defended the restructured tariff charges, arguing that there was little point in encouraging energy conservation whilst there was an excess of electricity generating capacity. He described the State's three energy scenarios as being (i) the closure of Comalco's aluminium smelter with a resultant large spare capacity and no need for energy conservation, (ii) the redeveloped of Comalco, which would necessitate the need for a large increase in generating capacity which would make energy conservation irrelevant, and (iii) the retention of Comalco's smelter without redevelopment. Energy conservation and wind energy, the Minister stated, would only be relevant in the last of the above scenarios and provided, furthermore, that growth in demand for electricity from other sectors remained low (*The Mercury* 25 July 1994: 5).

The new Environmental Management and Pollution Control Bill 1994 was passed in July. Comalco reiterated that it would close before 2001 when its electricity contract expired if it was forced to comply with the Bill, claiming that it had no incentive to invest $200 million in pollution control when it was running at a loss of $20 million p.a. (*The Mercury* 4 September 1993: 7).

By the time the second public symposium on future electricity options in the State was held, in November 1994, the situation had altered. In February 1994, the Council of Australian Governments (COAG) had agreed in principle to the national competition policy as set out by the 'Hilmer report' (Independent Commission of Inquiry into National Competition Strategy 1993). The report recommended that all government business enterprises came under the Commonwealth Trade Practices Act to end their monopolies. It was an ironical situation in which a Labor Prime Minister extolled the virtues of the free market to reluctant, and mainly Liberal, state Premiers. Only Tasmania demurred, uncertain of how the reforms would impact on the financial position of the HEC. In August 1994, COAG agreed to a package of specific national competition measures including the introduction of state legislation to remove the monopoly powers of the electricity supply authorities. The focus of the Public Symposium in Tasmania was therefore narrowed to discussion of the implications of these reforms for Tasmania. The Government insisted that because of Tasmania's small size, and because of the need to operate the hydro-electric generating system as an integrated unit, SEECA's proposal of fragmenting the HEC into separate and multiple generation and distribution units was not feasible.

Disgruntled over the public consultation process, and with both their demand for the Basslink option and their proposed restructuring of the HEC rejected, SEECA members joined other environmental groups in their call to drain and restore Lake Pedder. The proposal had quietly built up momentum over a considerable period and, in late 1994, environmentalists saw the time as right. The Lake Pedder 2000 group was formed and publicly launched its proposal to drain the Lake by the Year 2000. With a surplus capacity of 150 MW that was likely increase to 350 MW when Comalco decamped, the environmental lobby argued, the 65 MW that the Pedder impoundment contributed to the HEC's generating system was no longer required. It was seen as an opportunity to achieve a major environmental goal without even the need to advance energy conservation proposals. Although debunked as a hare-brained idea by local Labor and Liberal politicians, the Federal Minister for the Environment took the proposal seriously and requested the House of Representatives Standing Committee on the Environment investigate the feasibility of draining the Pedder impoundment (House of Representatives Standing Committee on Environment, Recreation and the Arts 1995). In its evidence to the Inquiry, the Managing Director of Comalco Bell Bay Ltd claimed that draining Lake Pedder would reduce the capacity of the State's generation system to avoid drought-induced shortages and rationing, would undermine investment confidence in the State, and would jeopardise his company's $650 million redevelopment plans (*The Mercury* 28 March 1995: 1). The House of Representatives Standing Committee ultimately recommended against draining the impoundment on the grounds that there was no surplus electric generating capacity in the State.

To counter declining public support for hydro-industrialisation and the growing public and political support for re-orientation of economic policies towards encouragement of small business as a substitute for large industries, eleven of the State's largest industries formed a industry body, the Major Employers Group. The Group commissioned a team of economists to assess the importance of their industries to the State's economy (Felmingham *et al.* 1995). The report asserted that industrial load would increase by up to 100 MW by the year 2003 and that, together with growth in retail load, this would require commencement of construction of additional generating capacity in the near-term. In making this statement, it was assumed that Comalco would redevelop (Felmingham *et al*. 1995: 44). The report stated that full redevelopment of the Bell Bay smelter, would require an additional 50 MW demand for electricity, one third of the increase in load suggested when the redevelopment option was first announced. The clear message of the report conflicted with earlier claims that the policy of hydro-industrialisation ought to be buried (Felmingham 1982) and argued instead that the

State's economic well-being was still inextricably linked to that of a small number of large industries. Although the contributions made by these industries to the State's employment and economy was declining, it was argued, the industries remained the core of the State's economy and could not be neglected. Releasing the report, the authors claimed that failure to encourage development of these industries would result in their closure and reduce the State's economy to that of a Third World Country (*The Mercury* 17 March 1995: 2). The conclusion that could be drawn was that energy policy in particular continued to be governed primarily by the needs of those industries.

That these industries had good reason to be concerned over their weakening grip on State economic policy was demonstrated by a second report commissioned by the Major Employers Group. The second, unreleased, report surveyed public acceptance of major industries and found that the number of Tasmanians who thought that these industries were holding back economic development in the State (39.2%) was slightly higher than the number that thought that these firms were assisting the State's economy (35.6%). The report also found that only 10% of Tasmanians considered these large companies to be the most important sector of the State's economy, and that two-thirds of Tasmanians did not believe that the HEC achieved the right balance in what it charged householders and what it charged industry (Volpato 1995)[11].

6.4.9 Capitulation to the Federal Government's Reform Agenda

To entice the Tasmanian government to follow the lead of other state governments by putting the national competition reforms into effect, the Federal government provided the State with an extra $8 million in Commonwealth grants, conditional upon legislation to corporatise the HEC and remove its monopoly powers being in place by July 1995. On the 29 June, the HEC Act was replaced with the Hydro-Electric Corporation Act. Accordingly, the HEC's planning functions were removed and vested in an independent Office of Energy Planning. The HEC's regulatory functions were also removed and invested in an independent Office of the Regulator. While regulation of the new Corporation's tariffs was assigned to an Oversight Commission, bulk electricity contracts with major industries remained outside the purview of the regulator, indicating that the intention of the reforms of electricity supply industry were not to create a truly competitive electricity market.

With these changes, Comalco's bargaining position had been undermined. Its sister plant in New Zealand had failed to persuade the New Zealand government to sell part

[11] The author of the report, Richard Volpato, retained the rights to the data and kindly provided the author with the above information.

of its hydro-electric generating assets. The firm had nevertheless proceeded with its $320 million redevelopment. The New Zealand-based smelting firm, furthermore, had entered into a new electricity contract with N.Z. Electcorp at an increased price (*The Australian Financial Review* 9 Dec. 1994: 8). The Tasmanian based smelting-firm, Comalco Bell Bay Ltd, also signed a new nineteen-year electricity contract with the Hydro-Electric Corporation and committed itself to a $200 million upgrade (*The Mercury* 13 November 1995: 1). As a consequence of the partial upgrade, the company planned to reduce its workforce by another 20%. Its new power contract, furthermore, was for 250 MW, an increase of only 13 MW above its previous contract. The company also did an about turn by agreeing to comply with the new environmental regulations despite its previous claims that it could not afford to do so without undertaking the full $650 million redevelopment option.

6.4.10 Prospects for Reduced Growth in Demand & Energy Conservation

By the mid 1990s, the attempt to increase electricity sales by obtaining a greater share of the domestic space heating market was beginning to show signs of putting stress on the distribution system, and disruptions to electricity supply had become more common by the mid 1990s. The HEC was forced to spend $10 million on upgrading Launceston's electricity distribution system. Growth in demand nonetheless looked set to remain low and as the aluminium smelter had not taken up the redevelopment option, the HEC was left with considerable surplus generating capacity. Energy conservation was not in the short-term interests of the new Corporation. The slow rate of growth in demand, however, meant that there was little risk of shortages and no urgent need to plan for supply expansion. This meant that not only would energy conservation programmes were better able to meet future load requirements and defer the need for new capacity for longer, but that there was ample time, with a bit of foresight, to plan for energy conservation in the future with this extended planning horizon. Proponent of the energy conservation option therefore appeared to have grounds for hope about the future prospects for an increased emphasis on energy conservation in planning. In this regard, however, the final comments made by the Minister for Energy before resigning from parliament in late November 1995 were pertinent. Gray claimed that there were good prospects for rapid industrial expansion in the State but that these would be lost without increasing the supply of energy. He urged the government to quickly begin construction of a new energy supply option (*The Examiner* 24 November 1995: 1). For those keen to see greater emphasis placed on encouragement of energy conservation, it was a case of *plus ça change, plus c'est la même chose.*

Gray's parting words captured the essence of Tasmania's problem. Despite the persistent misgivings about the social and economic benefits of the strategy of expanding energy supply to encourage industrial expansion, Tasmanian politicians remained focused predominately on opportunities for industrial development. Gray's final message was a reminder that although electricity planning in the State could no longer be described as technocratic, energy planning nonetheless remained a client-based strategy. Large blocks of energy continued to be made available in order to attract potential investors on the basis of noncommittal expressions of interest. It indicated the perennial ambivalence towards energy conservation at the political level in that while demand reduction strategies were not opposed *per se*, these strategies remained an aside to what was perceived to be the real purpose of energy policy: ensuring that sufficient surplus capacity was always at hand lest opportunities for industrial investment were lost. Although the political emasculation of the HEC's Power Engineering Branch had brought to an end the phenomenon of 'reverse adaption' as described by Kellow (1986, 1996), the supply construction cycle remained intact and was now driven by Tasmanian Development and Resources (TDR). While that mentality remained, the prospects for increased reliance on demand reduction strategies appeared remote.

As this study drew to a close, the debate over electricity tariffs continued against the backdrop of the fact that the proportional increase in electricity tariffs in Tasmania from 1991 to 1996 was larger than the increase in any other Australian state. By 1996, Tasmanian households paid a higher unit price for general tariff electricity than did households in Queensland or New South Wales, and paid a higher unit off-peak price higher than did households in all other states except Western Australia. Commercial and small business consumers, moreover, paid a higher unit electricity price than their counterparts in any other state, and double that paid by commercial consumers in New South Wales and Queensland (Government Prices Oversight Commission 1996: 11-13). The first task of the new regulator, the Government Prices Oversight Commission, was to hold an inquiry into HEC tariffs and prices. Predictably, the Greens and Labor opposition called for the scrapping of the electorally unpopular network charge and the introduction of a tariff structure that would be likely to encourage energy conservation (*The Mercury* 9 May 1996: 6). These calls ignored the fact that any adjustment of retail tariffs to encourage electricity conservation would be countered by the HEC while the Corporation still held a substantial surplus generating capacity. More importantly, they ignored the fact that while tariff restructuring could be used to encourage retail sector energy conservation, its impact on overall energy use would be limited while industrial electricity contact prices remained beyond the ambit of public debate, and while the priority of both Liberal and Labor parties was to attract capital using the State's natural resource base as the lure.

6.5 Conclusions

Tasmania has been used as a case study of electricity planning to show that it is not possible to explain the rate of expansion of energy supply or the degree of emphasis ascribed in electricity planning to conserving energy without understanding who controls electricity planning and for what purpose. The Franklin River controversy represented the beginnings of a major shift in control of electricity planning in Tasmania. The Lowe administration had confronted the HEC head on and attempted to reduce the organisation's influence over planning by creating new energy policy bureaucracies. This attempt was successfully countered by the HEC and the Legislative Council and only marginal reforms were put in place. In the aftermath of public and political conflict over electricity planning in Tasmania in the early 1980s, the Liberal government under Gray took a different approach and reformed the HEC from within. Rather than create independent energy bureaucracies or increase public participation in policy formulation, under Gray, the power and influence of the Commission's Power Engineering Branch was usurped by a new group of business managers under whose control the organisation was run along the lines of a private business.

This set up a duel between the factions wanted the HEC to retain political control of electricity planning in order to foster industrial expansion, and those who supported the new economically rationalist agenda. Business at first supported those reforms, assuming that the outcomes that would naturally flow from them would be lower electricity prices to industry. Only when business realised that the reforms would in fact increase the price of electricity to industry did the reform process fragment the previous harmony between industry, the electricity supply organisation and politicians. The economic rationalists eventually won the day, supported by political rivalry and intervention by an economically rationalist Federal Labor government. At the end of the day it was no longer an engineering corps which controlled electric planning in the interests of the organisation and its industrial clients, but a leaner and meaner commercial business operation with a narrow economically rational agenda. It was not parliament, but the market.

Debate over energy conservation during this period of reform was like a background tune that came to the fore only briefly during intermittent lulls in the major score. The reasons for this continued low emphasis on energy conservation were the conflicting prospects faced by planners. The legacy of past technocratic planning together with the slow-down of the growth in demand for electricity in the State presented planners, on the one hand, with the prospect of an enduring and serious energy supply crisis. If this eventuated, as environmentalists argued it would, then it would render energy conservation irrelevant as a planning option in the short to mid-term. The alternative prospect was the loss of industrial expansion opportunities due to an incapacity to expand energy supply in time to meet the needs of prospective industrial clients. It was the rapidity with which debate over energy planning oscillated between these two diametrically opposed concerns that made energy conservation difficult to accommodate within electricity planning in the State. While decision makers remained optimistic about the prospects of industrial expansion and the associated need for rapid supply augmentation projects, energy conservation was relegated a low priority as a planning option. The reforms put in place meant that energy planning had become more economically rational and that a just-in-time policy was again adopted. While further hydro-electric schemes were abandoned as a planning option, the minimum size of the mooted gas-fired power station (150 MW) was dictated not by demand but by the minimum size of a market that would making the venture profitable for the developer. Although smaller than the Poatina, Middle Gordon and Pieman hydro-electric schemes, a 150 MW gas-fired power station was larger than the combined output of the King and Anthony-Henty schemes. Hence Puiseux's (1987) proposal that the risks of oversupply be minimised by reducing the lead times and scale of new generating capacity to match those of industrial user was only partially possible. Planning, furthermore, remained a client-based affair in which the planners scrambled to ensure that sufficient energy was available to prospective industries. While the move to economically rational planning therefore served to avoid the risks of overgrowth of electricity supply with the creation of costly large excess capacity, these reforms did not increase the likelihood that planning would place greater priority on energy conservation. While policy makers continued to desire as rapid growth in demand as possible, electricity planning continued to consist of a cycle between load growth as a means of reducing excess capacity and decisions over capacity expansion to meet future requirements. The decision period between these phases of the cycle remained short and this mitigated against increased reliance on energy conservation

Critics of past electricity planning in the State were quick to seize on these prospects of an expensive large excess of generating capacity as proof that their low growth forecasts had been accurate while the HEC's forecasts had been disastrously optimistic. Those recriminations overlooked the fact that the deviation between projected and actual demand was caused not only by over-optimistic forecasting on the part of the HEC but also by the many changes that occurred during the interim period such as the changes in State and Federal governments and policies. The imposition of a ceiling on Commonwealth loans, for example, increased the price of electricity from uncompleted schemes and this is likely to have influenced industrial demand. Increased public scrutiny of electricity planning in the aftermath of the Lake Pedder and Franklin River controversies was increased further once the Greens held the balance of power in parliament and eroded the Commission's ability to engage in 'reverse adaption' by disposing of large blocks of excess electricity by entering into contracts with industry at subsidised prices, thereby further reducing the rate of growth in demand. More importantly, as a consequence of the reforms of electricity planning and the structure of the electricity supply industry, the relationship between the HEC and its industrial clients was substantially altered. The Commission itself demanded higher prices for electricity from its industrial clients, further slowing growth in electricity sales to industry and the demand by industry for acquisition of public electricity generating assets.

The environmental demand for increased public participation, radical restructuring of the electricity supply industry and regulation to ensure that energy used efficiently went almost unnoticed. While the environmentalist's long-term demand that energy planning be based on a more rational footing had been achieved, environmentalists mistakenly thought that the rift between the HEC and its industrial clients would lead to increased environmental consideration in planning and increased representation of community and environmental groups. The Minister conceded to environmentalists demands for public seminars to open the debate to the public, but these seminars were used merely to defuse the debate and to deflect the environmentalist own proposals for the organisational restructuring of the electricity supply industry.

Energy conservation became an option that was constantly held up as desirable, but one which needed to be applied in practice only when the time was right. The time was rarely right and was confined to periods of sudden shortages or heightened environmental concern. Many of these drought-induced energy conservation efforts tended to be symbolic or superficial. Others were potentially more long-lasting. The IEMC was established and energy savings in industry, the government sector, and particularly in schools, were actively encouraged. There was less focus on the household sector due to the requirement that the IEMC was to eventually become a self-funding organisation. As household sector energy conservation was not profitable, minimal efforts were expended in encouraging energy conservation in that area. As the electricity shortage in the State eased and public concern over the greenhouse issue waned during the early 1990s, however, the IEMC found itself out on a bureaucratic limb, its organisational goals in direct conflict with those of the HEC. The Centre's future is now uncertain and at the time of writing is being debated by the new Liberal State[12] and Federal governments. The IEMC's instigator and Managing Director, Dr Peter Davis, took up a senior position as the HEC's marketing manager and immediately turned his considerable entrepreneurial skills to the task of increasing electricity sales, a task that had the capacity to undermine alternative energy options. A project aimed at using methane from the Hobart City Council's landfill operation failed to materialise as prospective clients for the 2 MW of energy, including the Royal Hobart Hospital, were offered incentives by the HEC's

[12] In early March 1996, the Liberal government lost its outright majority and the Greens again held the balance of power in the Tasmanian House of Assembly. The Liberals remained in power as a minority government.

marketing division to continue to be use electricity supplied by the HEC (*The Saturday Mercury* 22 June 1996: 9). To Dr Davis it was all healthy competition that forced the HEC to improve its services to customers.

With the partial move towards a market-led energy supply industry, the degree to which electricity conservation is adopted in the future in Tasmania remains uncertain. It has been argued that unregulated energy supply industry has little interest in encouraging customers to reduce energy use (Moskovitz 1992: 399) and that the degree to which energy conservation will be pursued in a competitive market environment has been seriously overstated (Moskovitz & Austin 1993: 3). This view has been lent support by evidence on the ground (Cocklin 1993, Mittra *et al.* 1995: 45, ANZMEC 1995: 38). The weaknesses in terms of achieving optimal environmental and social outcomes have been discussed by numerous writers (Dietz & Vollebergh 1988: 53, Haavelmo & Hansen 1992, Self 1993: 276). The need for a regulatory energy in order to substantially increase the efficiency of energy use or reduce the demand for energy has also been argued by such writers as Saddler (1981: 166), Johnson & Rix (1991: 64), Roberts *et al.* (1991:19-20), Kinrade (1992, 1995a), Cairncross (1993: 63) and Lowe (1994a: 208-9, 1994b: 326-7). The degree to which energy conservation is accelerated is therefore likely to depend on the extent to which the industry is regulated to ensure that energy use is maximised and energy waste minimised.

What will happen in terms of energy conservation in Tasmania as a consequence of the reforms put in place is not yet clear. Some maintain that the adoption of energy conservation in Tasmania may accelerate even without regulations to mandate DSM or energy performance standards. As it became clear to the environmental movement that its demands for increased regulation of the electricity supply industry and increased public participation in electricity planning were unlikely to be met, this belief that the efficiency of energy use in Tasmania would increase in Tasmania despite a continued lack of encouragement by either the HEC or the Government became more common (Porsch & Sharples 1993: 28). It was a view premised partially on the assumption that IEMC would remain actively involved in the encouragement of energy conservation in the State, and partially on the belief that decisions made at the national level would impinge on energy use in Tasmania. The combined result of these two factors was seen to be that the State would be involuntarily caught in an energy conservation 'slipstream effect'. A case in point was the default energy labelling programme that eventuated when the NSW and Victorian governments unilaterally imposed a requirement for labelling. For administrative ease, appliance manufacturers and distributors placed labels to appliances retailed in all of the Australian states so that the smaller states effectively acquired labelling schemes. A similar involuntary change occurred when the NSW government unilaterally introduce unleaded petrol. It did so only after it failed to reach agreement with other states to introduce unleaded petrol as a uniform national policy measure. The view that the Federal government would introduce policies aimed at increasing the efficiency of energy use as part of its commitment to reducing greenhouse emissions was therefore seen as a way in which the rate of increase in efficiency end-use in Tasmania would be exogenously determined. Finally, an increase in the rate of adopt of energy conservation was considered by such individuals to be likely to occur as public concern over environmental issues such as the greenhouse effect increased. As a consequence of a shift in attitudes, it was assumed that individuals would alter their energy-using decisions, especially if this was encouraged by government. The degree to which such strategies, if adopted, are likely result in reductions, and the likelihood that they will be implemented, are the subject of the following chapters.

Chapter Seven

The Effectiveness of Public Information Campaigns

> In order to save the environment, massive human behaviour change is necessary and this is urgent. Raising environmental awareness and fostering more positive attitudes may encourage greater environmental friendliness.
>
> — Prof. Margaret Prior (1994: 94)

> ... savings for households might appeal to the 'piggy bank' that is in us all.
>
> — Nader & Milleron (1979: 958)

7.1 Introduction

From an examination of past electricty planning in a particular location, the study now turns to an examination of the effectiveness of specific energy conservation strategies. The case studies presented in this and the following chapter critically examine the potential effectivness of two such strategies in order to assess their potential effctiveness and to tease out the more important difficulties that could be encountered in their implemenation. This is used to provide further support for the arguments presented so far that energy conservation proposals are often resisted by exploring the reasons for such resistance. This also allows the discussion to be steered from what has occurred in the past what could possibly happen in the future. Such critical examination of the effectiveness of energy conservation strategies is important since the degree to which energy conservation will be pursued voluntarily in a reformed competitive electricity supply industry in the absence of regulatory structure is not yet clear. The case study of reform in the previous chapter showed that within a replacement cost pricing policy, it is possible that electricity use will continue to be encouraged. It also showed that the theory that market solutions are effective is unlikely to even be put to the test until the legacy of large surplus capacities are overcome. In those cases where the energy is supplied from fossil fuels, overcapacity will result in conflict between the short-term commercial interests of the utility and the longer-term need to reduce electricity use for social reasons. In such situations, intervention is likely to be required to achieve an outcome that advances the public interest. This will mean that either a regulatory structure is put in place which actively promotes or mandates utility energy conservation programmes or that the interventionist measures employed work in opposition to electricity or energy utility efforts to encourage increased energy use. Much of the debate will therefore be over whether there will be a need to mandate Least-Cost Planning and the implementation of demand management strategies, or whether reliance on market forces through such mechanisms as the development of a strong and independent energy service industry will suffice will be set by the effectiveness of energy conservation programmes in reducing energy use and the extent to which the benefits flowing from these programmes outweigh their costs. The effectiveness of these strategies is critical since, as discussed in section 4.6 , while the socially optimal level of energy efficiency remains narrowly defined, electricity utilities are unlikely to be required to implement demand management programmes that are not in their commercial interests or energy conservation programmes that have not been proven to be cost-effective (Industry Commission 1991b: 202). While advocates of market solutions argue that the effect of pricing energy at its real cost will automatically ensure that energy is used efficiently, advocates of a more interventionist approach counter with the argument that markets, and energy markets in particular, are so lopsided that until energy prices reflect the full social costs, including pollution costs, the level of energy use will remain higher than that defined narrowly by the cost-effectiveness criterion.

This raises the questions of what instruments are likely to be employed by government to encourage reductions in energy use and how effective these various policy instruments are likely to be. Two policy instruments particularly favoured by the conservation lobby are, as discussed in Section 2.4, pricing and regulatory approaches. Conservationists have long argued that energy prices need to be increased to reflect full social costs of energy production and use and pollution taxes are recognised as one means of achieving this. The idea of a carbon-tax was taken to the Federal Labor Cabinet in December 1994 by the Federal Minister for the Environment, Senator John Faulkner. The proposed levy would have netted $900 million over three years (*The Age* 12 December 1994:1). As well as reducing natural greenhouse gas emissions, the tax was advanced as a means of improving the national Balance of Payments figures before the next federal election and allowing greater expenditure on various other environmental problems. Most importantly it would have saved the Minister the embarrassment of arriving at the Berlin round of negotiations on the climate change treaty in the following March empty-handed. The tax was opposed, however, by the finance and development Ministers on the basis of a 'Catch-22' . For a carbon-tax to have any significant effect on the level of greenhouse gas emissions, it was argued, it would need to be set at a relatively high rate. A substantial tax would be both inflationary and damage the competitive positions of Australian export industries. Senator Faulkner went empty-handed to Berlin and the Federal government opted to rely on other measures to reduce greenhouse gas emissions. A variety of measures have been used to date, including initial funding of a national Integrated Energy Management Centre (IEMC) in Tasmania, the provision of relatively low interest loans for solar hot water systems, and dissemination of energy conservation information. A second policy approach favoured by proponents of energy conservation is the regulatory approach. Mandated energy efficiency standards (MEPS) for household appliances and the use of building codes which mandate thermal performance standards for dwellings have been mooted. Assessing the effectiveness of any such policy instruments is clearly important for a number of reasons, not least of which is the fact that, as discussed in Chapter Four, much of the failure to adopt energy conservation policies to date has been attributed to the uncertainty over the impact that such energy conservation measures will have. The focus of this study, therefore, moves to the issue of the effectiveness of specific energy conservation measures. In this and the following chapters, the effectiveness of two such policy instruments are examined. These two instruments studied are commonly perceived as lying at opposite ends of the spectrum in terms of both their effectiveness and their contentiousness. This chapter takes as a case a study behavioural conservation strategy involving the dissemination of public information. Although a low energy conservation strategy, it is a politically palatable and safe instrument. As such, the reality is that it is likely to be relied on and that it is therefore worth examining the effectiveness of such a strategy and this can be maximised. In the following chapter, the more contentious, but potentially more effective, instrument of regulated minimum performance standards for energy-using equipmment is examined.

The 'soft' strategies of information and education campaigns were the most prevalent means by which utilities, governments and community organisations attempted to encourage householders to reduce energy use during the 1970s and early 1980s (Clinton *et al.* 1986: 101). The rise in concern over the greenhouse effect has seen a second wave of books, booklets, posters and other material produced by electricity utilities, private television networks, individual writers, environmental community groups and state and federal government departments, all urging individuals to save energy and offering advice on ways by which this can be achieved. Environmental writer, Gavin Gilchrist (1994), for example, ended his polemic on the Australian electricity industry with a six-paged addendum in which he listed the various ways by which householder could save energy in the home by using lids on saucepans whilst cooking, replacing incandescent globes with compact fluorescent lamps, and so on. The Federal government, in association with the Australian Consumers' Association, prepared a more comprehensive booklet on energy efficiency which was distributed to every Australian household in late 1991 (Australian Government & Australian Consumers' Association 1991). And the HEC, in association with the Tasmanian Environment Centre, produced a 'Be an Energy Saver' poster'.

It therefore appears likely that information campaigns will continue to represent a major component of any government strategy to reduce household sector energy use in Australia in order to reduce the social impacts of energy use, this attempt at public education relying on both the publication of such material and on regulation which requires manufacturers of energy-using equipment to display estimates of energy consumption and relative energy efficiency on their products. It is also likely that in the event that energy utilities do adopt demand management programmes, that these will include such information campaigns. One reason for this is that those who advocate a free market approach to the allocation of energy resources and resolution to energy-related problems tend to consider the provision of information to be the most, and in many instances the only, useful or legitimate form of government intervention in the energy market (Industry Commission 1991b: 188). For these reasons it is useful to consider the effectiveness of the dissemination of information as an energy conservation strategy. In this chapter, the literature on information strategies is briefly reviewed and their perceived effectiveness and the theoretical means of maximising their effectiveness is discussed. A specific energy conservation information campaign undertaken in the Victorian city of Brunswick is then reviewed in order to assess the effectiveness of an information campaign designed in the light of these theoretical considerations.

7.2 The Value of Energy Conservation Information Campaigns

Energy conservation information campaigns have been the staple approach to increase the take-up of energy conservation measures. Much of this material, moreover, has remained unchanged over the course of two decades. Both Holliman (1974: 128-30) and Elkington & Hailes (1989: 182-201), for example, included in their books remarkably similar lists of useful ways that readers could save energy. Governments, energy suppliers and community organisations have tended to rely on such dissemination of information to encourage energy conservation for a number or reasons. One of the most obvious reasons is that they provide a relatively inexpensive means of reaching large sections of the community (Senate Standing Committee on Industry, Science and Technology 1991: 43). If they are effective they therefore represent a cheap and easy victory and a potentially valuable policy tool (Griffin 1986: 219). From an administrator's perspective, they also have the advantage of being highly flexible, with the capacity to be started and stopped at short notice (Crossley 1979b: 41), while from a political perspective they are both unintrusive and highly visible. They are therefore highly palatable to the public compared to other strategies such as enforcement or pricing mechanisms (Crossley *et al.* 1986: 96), and have the political advantage of providing a highly visible means by which politicians or bureaucracies can be seen to be doing something to encourage energy conservation. The critical question, however, is just how effective, or ineffective, public information strategies are. On this score, there are two diametrically opposed schools of thought. One is that such information strategies have little or no effect and amount to tinkering. The other is that when properly constructed and designed, the combination of exhortation and education used in public information campaigns can be effective and therefore constitutes an important, if not essential, part of a total energy conservation policy.

This disparity of opinion over the usefulness of public information campaigns can be attributed to a number of causes, including the vagueness of the label 'information campaign'. The types of strategies included under this umbrella term range from very general and broadly dispersed material to site-specific or equipment-specific information. Poor design has also been found to be the reason many information campaigns fail to result in either increased energy conservation behaviour or reductions in energy use (Clinton *et al.* 1986: 137). Differences in opinion over the effectiveness of energy conservation information strategies are also likely to be related to the fact that evaluation of the effectiveness of those programmes is difficult and evaluation is either rarely undertaken or is superficial (Clinton *et al.* 1986: 138, Schipper & Meyers 1992: 209). A recent comprehensive review of household sector energy information campaigns in Australia undertaken for the Commonwealth government (SRC International Pty Ltd & Artcraft Research 1994), found that of the 127 programmes undertaken in Australia between 1990 and 1994, an attempt was made to evaluate only one third. Approximately one third of these, moreover, involved very informal evaluation methodologies and no evaluation costs were available for one third of those programmes formally evaluated. Not one programme was comprehensively evaluated and very few programmes attempted to assess how much energy had been saved as a result of the programme, whether the programme was cost-effective, or whether the impacts of the programme were likely to be persistent (SRC International Pty Ltd & Artwork Research 1994, Section 1: 3-4). A major reason for the low attempt at evaluation is that thorough assessments of effectiveness can be arduous and resource consuming (Schipper & Meyers 1992: 209). Another reason, however, is that many information campaigns have not been designed to reduce energy use but merely to increase awareness of the issues (Crossley 1979b: 50), so that accurate evaluation of the effects of such campaigns would serve little purpose.

The results of the research on the impacts of energy conservation information strategies have been mixed. Much early research found that the provision of information on its own had a negligible effect on either energy-using behaviour or levels of energy use (Milstein 1976, Olsen and Goodnight 1977). This conflicted with the view that the major cause of the nonadoption of energy conservation was that individual energy users were either not motivated or uninformed and that this could be corrected with information campaigns. To this group of researchers, information campaigns could, in theory, have an effect and are an important component of any broader approach which includes behavioural and regulatory strategies (Ester 1985: 96, Crossley *et al.* 1986: 53, Lewis *et al.* 1987: 72). There are a number of possible explanations to account for the apparent ineffectiveness of many past energy conservation information programmes.

One possible cause of the relative ineffectiveness of energy conservation campaigns is that the theoretical assumptions upon which they are based are invalid. A central assumption has been that the provision of information designed to increase awareness of energy-related problems will alter attitudes, and that this in turn will lead to a change in behaviour. Many researchers who have endeavoured to find ways to increase the take-up of energy conservation by this means have been puzzled, therefore, by the consistent finding that individuals with pro-conservation behaviour are little, if any, more likely to adopt energy conservation measures than those with without such positive attitudes towards energy conservation (Crossley 1982: 160, Lewis *et al.* 1987: 43). Yet this finding is not surprising when viewed against the background of similar research findings about the relationship between attitude and behaviour in fields other than energy conservation (Cook & Berrenberg 1981: 81). Social science, moreover, has consistently shown that the existence of such a gap between attitude and behaviour is the norm rather than the exception (La Pierre 1934) and this led many early writers to suggest that from a purely theoretical perspective there were good reasons for scepticism about the effectiveness of appeals to consumers to conserve energy. One such commentator stated that:

> If designers of these public persuasion programs had first examined the extensive social science literature on the linkage between attitudes and behaviour ... they might have selected other strategies ... as there is little clear evidence that attitudes can be predictably changed by cognitive appeals, or that if they are changed that they will have any predictable influence on behaviour. (Olsen 1978: 97)

This is consistent with research evidence which indicates strongly that changing people's attitudes does not necessarily alter behaviour and that attitudes towards energy conservation are very weak predictors of energy-using behaviour (Condelli *et al.* 1984: 490, Ester 1985: 34). One social science researcher has surmised that personality is likely to be a better predictor of conserving behaviour than are attitudes towards conservation (Brandstätter 1993: 475). The existence of a correlation between personality and energy conservation behaviour, however, has little policy relevance.

Another important underlying assumption of energy conservation information campaigns is that the gap between what is possible by way of energy conservation and what actually happens is attributable to an information deficit. This assumption has been supported by research which has shown that many individuals are not very knowledgeable about the factors that contribute to energy use or what actions they can take to reduce energy use (Cunningham & Lopreato 1977, Tashchian & Slama 1985, Crossley 1980a, Lewis *et al.* 1987). This literature indicates that people lack awareness of the individual and social benefits of energy conservation and of what they can do as individuals to reduce energy use (Crossley 1983: 540). A survey of 2000 households in Victoria undertaken by the SECV (1992: 32), for example, found that 90% of householders could not estimate the electricity consumed by their refrigerator. Recent research, furthermore, suggests that this situation is true of environmental issues in general (Prior

1994). Further support has come from studies which have also shown that households which have adopted a larger number of energy conservation measures have also received more information from government agencies or electricity suppliers (Brown & Macey 1985: 50), suggesting that the energy information literature may have a causal effect on behaviour. It has also been found that low-income and elderly groups tend to take up fewer energy conservation measures and also rely on more limited and parochial sources of information (Brown & Rollinson 1985: 298).

The counter-argument is that, although lack of information or poor attitude towards energy conservation may be important causes of the failure to take up energy conservation measures, there exists a large number of other constraints on behaviour other than lack of information or poor attitude. Crossley (1983: 581), found that in only a small number of instances could the non-adoption of energy conservation measures be attributed solely to an information deficit or to negative attitudes towards energy conservation. Again, however , the evidence is not conclusive as other researchers have found a lack of information to be the single greatest cause for the non-adoption of household energy conservation measures (Brög *et al.* 1984: 303). The disparity in the conclusions of the two studies can perhaps be best explained by the differences in the methodological approaches. Crossley's Australian research employed an in-depth qualitative survey using a small, non-random sample while that of Brög and his colleagues relied on a very large random sample of German households and used a comprehensive and multiple quantitative approach together with a household audit. Yet other commentators maintain that the ineffectiveness of public information strategies should not be surprising when the high effort-to-savings ratio of even low-cost energy conservation measures is considered. Nonadoption of apparently cost-effective energy conservation measures in this view is attributed to apathy or indifference rather than ignorance, an apathy induced by the fact that the amount of savings provided by each energy conservation measure is trivial compared to total household expenditure (Cook 1980: 21, Reddy 1991: 945). Other researchers have pointed to energy conservation's pedestrian nature and have suggested that this is a major cause of the non-adoption of energy conservation by individual energy users. The argument goes that low levels of adoption of energy conservation measures occur despite general high acceptance of its value and need and, furthermore, that this is attributable at least in part to the lack of appeal. Support for this explanation has come from a survey of Hawaiian residential consumers which concluded that energy conservation lacked 'romantic appeal' *vis-a-vis* other environmental issues because unlike 'water, trees and baby mammals, the concept of saving energy cannot be seen, felt or heard' (Ward Research 1991: 27). The inability of energy conservation to conjure up 'concrete' and 'tangible' images such as those evoked by the more romantic environmental issues undermined its capacity to provoke actual public engagement in energy conservation behaviour (p. 9). The report concluded that energy conservation, by definition, faces challenges relative to image association and the way people relate to it (p. 27). One respondent, it was reported, agreed that energy conservation was important but confessed to being apathetic and unable to get excited about the issue (p. 16).

Some researchers have taken the argument a step further in arguing that the original premise of energy conservation information campaigns is incorrect in that individuals do not in fact waste energy and that increasing energy use is not a behavioural but a purely technical issue (Aldershot & Kanis 1984: iv). To these writers, urging householders to limit the amount of time that refrigerator doors are opened, not to use washing machines and clothes dryers unless fully loaded, or not to place warm food in refrigerators is of very limited practical value in reducing energy use. Yet other research has found that the differences in the way refrigerators are used accounts for a substantial portion of the differences in refrigeration energy use of identical models of refrigerators (Pedersen & Lawætz 1989: 4).

The argument that not all the information supplied to energy users in energy conservation material has been accurate was lent support by a test carried out by the Australian Consumers' Association (ACA). One almost standard item in such material has been the advice to householders to use clothes driers only with full loads. This advice appears to have been based on commonsense and on the fact that it accords with advice given to householders concerning the use of dishwashers and washing machines. Yet when ACA (1992: 16) put it to the test, it was found that a clothes drier with half a load used half of the energy when used with a full load. This is consistent with the results of Woodson (1976: 130) who measured the energy consumption of six machines under various loads and found that operating the clothes dryers with less than half loads decreased the energy efficiency of the clothes dryer but that the efficiency losses were reduced for loads greater than 50% of full capacity and that for some machines there was little difference in efficiency for full and half loads.

This dispute over the effectiveness of such campaigns is reflected in the debate over appliance energy performance labelling. It is the contention of those who advocate the use of appliance labels that they have had an effect on energy use and energy efficiency levels (Industry Commission 1991a: 201). According to one estimate, the energy efficiency of new domestic refrigerators has increased by 15% in NSW in the two years after labels were first introduced into that state in 1987 (SECV & DITR 1989c: 5). Others have estimated that the improvement in efficiency of refrigerators has been as much as 30% (Pears & Brotherton 1990: 51) while the recent disappearance of 'one star' appliance models from the Australian market has been advanced as evidence of the impact of labelling (Senate Standing Committee on Industry, Science and Technology 1991: 113). This assumed effectiveness of the Australian labelling programme stands in stark contrast to the belief that the effects of labelling in other countries has been very limited (Griffin

1986: 231, Schipper & Meyers 1992: 210) and the claim by the Demand Management Marketing Unit (1994: 38) in Victoria that the benefits of labelling are as yet largely unconfirmed and that more thorough research is required. One possible explanation for this contradiction is that increased efficiency of refrigerators in Australia may have been due to causes other than labelling. The personal opinion of the Director of the Australian Consumers' Association (ACA), Mr Norm Crothers, is that factors such as changes in refrigeration manufacturing practices in Australia introduced between the mid 1970s to the mid 1980s, especially the use of rigid polystyrene foam, were made purely for engineering and economic reasons but had the spin-off effect of increasing energy efficiency. The introduction of labels just happened to be coincidental with these other changes.

A similar increase in the efficiency of other appliances, especially dishwashers, occurred, according to Crothers, because these are often brand-engineered and the firms involved switched to another product (Mr Norm Crothers, personal communication, January 1992). The cause of the increase in the energy efficiency of dishwashers, on the other hand has been attributed directly to the introduction of appliance performance labelling by the Executive Director of the Australian Electronics and Electrical Manufacturers' Association (AEEMA), Mr Bob Adams. Unlike their imported counterparts, Australian made dishwashers prior to the late 1980s had no cold wash cycle. This did not affect sales, according to Mr Adams, as Australian consumers did not use a cold water wash cycle. With the introduction of labelling, however, imported dishwashers received the highest performance rating because they had such a cycle and Australian manufacturers were therefore forced to retool at considerable cost to produce models with cold wash cycles. Hence the labelling programme resulted directly in an increase in the efficiency of dishwashers sold on the Australian market. According to Mr Adams, however, it is doubtful that this led to any energy savings as there is no evidence that Australian households used these cold wash cycles.

While the impact of labelling on actual energy use may in this instance be contentious, it does suggest that manufacturers at least regard the labels to have sufficient potential to alter consumer purchasing behaviour to warrant retooling. This is further supported by the comment made by the Executive Director of Australia's largest whitegoods manufacturer, EMAIL Australia, that Australian refrigeration manufacturers dramatically increased the efficiency of their products in the late 1980s in response to both the introduction of energy performance labels and the strong shift in consumer preference to energy efficient products (Toone 1991: 5).

Against this mixed body of opinion, many social researchers and others have insisted that a major limitation of energy conservation campaigns has had to do with their design and that well-designed programmes are likely to be more effective (Crossley

1980c: 299, Byrne *et al.* 1985: 9, Ester 1985: 9, Lewis *et al.* 1987: 109, Senate Standing Committee on Industry, Science and Technology 1991: 45, Foster & Holmes 1994: 130). While the provision of information, on its own, is unlikely to have a very large effect on household energy use, these commentators posit that there remains real scope to reduce energy use via such a strategy and that information strategies are therefore potentially valuable. The two important questions are that of what constitutes a well-designed information strategy and, secondly, the criteria by which the effectiveness of such campaigns need to be assessed. The latter question is tackled first.

There are various ways by which the effectiveness of energy information campaigns can be judged. A common approach has been to ascertain the degree to which it has induced an increase in the take-up of energy conservation measures. The weakness of this approach, however, is that it has been found that success in inducing householders to take up energy conservation frequently has very little effect on levels of use (Crossley 1981: 30, Brown & Macey 1985: 50). Crossley (1981), for example, found that households which reported adopting energy conservation measures used only slightly less energy than other households which reported that energy conservation measures had not been adopted. Reported adoption of energy conservation is therefore a poor measure of effectiveness, as are commonly used measures such as householders' ability to recall the content of the material (Coltrane *et al.* 1986: 140). The assessment of the effectiveness of such campaigns therefore requires that actual changes in energy use levels induced by the provision of information be measured. Accurately monitoring changes in energy use levels requires that the energy use of sufficiently large numbers of households is monitored, that energy use is adjusted to account for changes in weather conditions and that a control group is used against which the changes can be gauged (Ester 1985: 9). Katzev & Johnson (1983: 282) add that great care is needed to ensure that the control group is not influenced by the experiment since even apparently innocuous influences have been shown to have an impact on the electricity use of the control group. Attention now turns to the issue of the design of information material.

7.3 Design of Energy Information Campaigns

From the above discussion and from the relevant literature it is possible to list the important attributes of a well-designed information campaign. First, there is virtual consensus that to be effective, energy conservation campaigns should aim at altering behaviour rather than merely attempting to alter attitudes (Lewis *et al.* 1987: 97). To this end they should rely on not only the rationale for conserving energy but should also provide information about what the individual can do to save energy (Clinton *et al.* 1986: 137, Crossley *et al.* 1986: 96). Communication theory suggests that a well-designed information campaign would need to provide specific behavioural advice on what individuals can do as well as prompts based on the social and individual benefits of conserving energy (van Raaj & Verhallen 1983: 58, Crossley *et al.* 1986: 96).

Features of the information material considered paramount are that it be vivid and eye-catching and able hold the individual's attention (Anderson & Claxton 1982: 163, Yates & Aronson 1983: 440), that the source of information is perceived as credible (Nader & Milleron 1979: 958, Cook & Berrenberg 1981: 74, Coltrane *et al.* 1986: 134,), that the information be comprehensive and specially tailored to the target group (Ester 1985: 10), and that the emphasis of the material be on actually saving energy rather than simply altering attitudes (Lewis *et al.* 1987: 98). It needs to be made clear that the actions recommended do not involve sacrifice or loss of comfort (Byrne *et al.* 1985: 94), that the information provided be useful, reliable and accurate, and that prompts to conserve energy and to conserve money relate to measures with relatively short payback periods (Costanza *et al.* 1986: 525). It has also been noted for energy conservation campaigns to be effective they must be persuasive. As a primary measure of persuasiveness is its salience to the individual (Cook & Berrenberg 1981: 78), it is therefore necessary to discuss the motivation behind individual adoption of energy conservation. The two motives of particular interest in this study are those of saving money and protecting the environment, largely because these are seen as the primary motives for conserving energy from the individual and societal perspectives, respectively.

7.4 Motives for Conserving Energy

One of the most important salient features of material is its underlying motivation of the prompt. During the energy crises, many information campaigns stressed the benefits of energy conservation in terms of the public good and therefore appealed to consumers' altruism. As discussed in Section 3.7.1, behavioural theory suggests that prompts based on self-interest may be a stronger motivator than altruism, and that in situations where the choice is action which is in the individual's short-term interests and against the long-term interests of society, individuals will tend to choose the former (Olson 1965). Urging individuals to conserve energy for the public good is problematical for other reasons. As Liek & Kolman (1978) argued, even if individuals are convinced that saving energy contributes towards the collective good, it may still be rational from their perspective to continue to use high amounts of energy rather than invest time, effort and money into reducing energy use. They may, for example, consider that saving energy is futile if it simply results in others using more energy and to therefore play the 'I will if you do' game.

Around the late 1970s and early 1980s, opinion within the energy conservation research literature began to shift to favour the argument that saving money might be a more potent motivator of energy conservation than civic responsibility (Anderson & Claxton 1982: 164). If this thesis was correct, it had major implications for the design of energy conservation information campaigns as it would mean that energy conservation material that failed to adequately incorporate potential monetary savings would have low salience and limited effect on behaviour. The two goals, saving money and furthering the collective good, are not necessarily in conflict and energy conservation campaigns have increasingly attempted to reduce the negative social consequences of energy use by informing individuals about what is in their own monetary interests (Anderson & Claxton 1982:164). If a consumer buys an energy efficient refrigerator on the basis of his/her desire to minimise life cycle costs, it has exactly the same environmental impact had the same purchase decision been based on the desire to reduce the environmental impacts of personal energy use. Behavioural theory, and many observers, simply consider the former to be the stronger motivator and that energy conservation programmes should therefore rely on the 'what's in it for me' motive rather than the 'do the right thing' motive.

It is clear, however, that monetary savings are not the whole story (Becker & Seligman 1981: 2). Individuals behave both as self-interested consumers who make their welfare preferences on the basis of an instrumentally rational calculus (*homo economicus*), and as members of a social group who can be persuaded to base their preferences on consideration of what is in the collective best interests (*homo civilus*). It is also obvious that these two beings can come into conflict where the interests of the individual are not congruent with the interests of the group (Sagoff 1988: 8). Under such circumstances, rational behaviour theory predicts that *homo economicus* will dominate and individuals will tend to behave in ways which provide individual short-term benefits at the expense of the long-term collective good (Olson 1965). As discussed in Section 3.3.4 this has been cited as a major mechanism behind environmental degradation. Because of this, it is clearly important that information campaigns attempting to reduce energy use based on the appeal to reduce the environmental impacts of energy use avoid advocating energy conservation measures which involve sacrifices such as reduced comfort or inconvenience. What is of interest here, is whether the appeal to consumers' self-interest (saving money) is stronger, weaker or on a par with the appeal to individual's sense of social responsibility (environmental protection) in terms of encouraging the take-up of energy conservation measures.

Much of the literature has assumed that saving money is the primary motivation behind individual energy conservation (Milstein 1976, Perlman & Warren 1977, Cunningham & Lopreato 1977, Gottlieb & Matre 1976). Perlman & Warren (1977), for example, found that a majority of respondents to their survey reported conserving energy because it saved money rather than from a sense of civic duty or belief that the energy crisis was real. One plausible explanation for this is that individuals perceive the potential of energy conservation to reduce household energy bills as significant while not being convinced that household sector energy conservation can make a significant contribution to solving society's overall energy problems. Since the household sector accounts for a relatively small portion of total energy use, it has been argued further, even if substantial energy conservation were to occur in this sector it would have only a modest impact on total energy requirements and individuals therefore find it difficult to be motivated to conserve for the public good (Humphrey & Buttel 1982: 178). This argument is supported by research undertaken in the mid 1980s in which it was found that householders reported that saving money was their primary reason for both energy conservation measures already adopted and for intended adoption of energy conservation measures. Far fewer respondents reported that their reason for saving energy is for the public good or to conserve resources (Crossley *et al.* 1986: 33-34, Foster & Holmes 1991: 4, Foster & Holmes 1994: 127). Interestingly, the difference does not appear to have been always large and to have varied from one measure to the next. Crossley *et al.* (1986: 73), for example found that almost 50% of households took up space heating conservation measures to increase comfort or convenience, 17.7% to save money, 15.7% to save resources and 0.5% for the public good. For water heating the respective values were 16.8% to increase comfort and convenience, 27% to save money, 14.6% to conserve resources and 0% for the public good. This compares with the results of more recent social research based on diffusion theory in Queensland where it was found that 45% of new home builders who installed solar hot water systems reported that they did so to save money, while 21% reported that their main reason for installing the system was to conserve resources (Foster & Homes 1991: 4). For ceiling insulation, 64% reported that the motive for installation was comfort, 13% for structural reasons and only 7% to save money. The results indicated that motives behind energy conserving behaviour varies from one measure to the next. They are also likely to be differences between places and fluctuate over time. The finding that individuals conserve energy to save money rather than from a sense of civic duty may be related to the fact the research was undertaken at a time that a belief in an energy crisis was low. Whether a current belief in the need to reduce energy use in order to limit global climatic change is a more likely to stimulate householders to conserve energy than was the 'oil crisis', for example, has not been adequately tested but is a question that has implications for the design of energy conservation information campaigns.

The questions asked in this section of the study are how effective well-designed energy conservation information campaigns are, and whether campaigns based on prompts to conserve money (self-interest) are more or less effective than campaigns based on prompts to protect the environment (collective good). While few would dispute that saving energy remains an important motive behind the take-up of energy conservation, many researchers have maintained that saving money must be the main message of the energy conservation material (Ester 1985: 87). This has been challenged by Joerges (1983: 87) who has argued that with the gradual decline in world energy prices over the early 1980s, energy conservation strategies were required to place increasing emphasis on non-economic motives. There have been few attempts, however, to test this assertion. One project which attempted to compare the effectiveness of information campaigns based on these two motives is reviewed in the remainder of this chapter. The research (Thomas *et al.* 1993) was undertaken with a grant provided by the Energy Research and Development Corporation (Project No. 1425) by a small team led by Dr Ian Thomas from the Royal Melbourne Institute of Technology (RMIT) and Dr John Todd from the Centre for Environmental Studies at the University of Tasmania with the assistance of Karen Blakemore and the author of the present study.

7.5 Review of the Brunswick Energy Conservation Project

The Brunswick energy conservation project undertaken jointly by the RMIT and the University of Tasmania involved the dissemination of energy conservation leaflets to households in the city of Brunswick, a small city approximately 11 km^2 in area and with a 1990 population of approximately 18,000. The city, which is located approximately five kilometres north of the Central Business District of Victoria's capital city, Melbourne, has traditionally had a high proportion of low-income and migrant households and a large number of low-rise apartments, although gentrification of the city began in the early 1980s (Prosser 1984: 4). There were two major reasons for selection of the city. The first was that the Brunswick City Council at the time the study was undertaken owned its own municipal electricity distribution system, the Brunswick Electricity Supply Department (BESD). The BESD, along with a number of other municipal electricity distributors in the Melbourne area, purchased electricity in bulk from the State Electricity Commission of Victoria (SECV) and resold the electricity to its own rate payers. The philosophy of the Brunswick Council was to operate the distribution system to the benefit of the community rather than purely as a source of revenue and the local electricity department had a strong commitment to keeping ratepayers bills as low as possible. To this end, the BESD actively encouraged energy conservation and was therefore likely to be considered a highly credible source of information on energy conservation. The second reason for the selection of Brunswick City for the study was the offer of cooperation from the BESD which supplied the necessary records of electricity use for blocks of households. This allowed the impacts of the pamphlets on electricity use to be monitored.

The aim of the project was to design two energy conservation pamphlets, one prompting householders to conserve energy in order to save money, the other prompting householders to conserve energy to protect the environment. Both pamphlets were designed according to the concepts discussed in Section 7.3 above and consisted of a folded A3 sheet with a title ('Save Energy to Save Money' or 'Save Energy to Save the Environment') and appropriate graphics on the cover with more detailed discussion on the benefits of conserving energy on the inside folds. A wall-chart was constructed on the reverse of the pamphlets, containing 70 separate household energy conservation measures classified by task (hot water, lighting, etc.) and by either their cost-effectiveness ('Save Money') or how much energy they were likely to save (Environment). In all other ways the two pamphlet designs were kept as similar as possible. To increase the longevity of the pamphlets, householders were encouraged to hang the checklist on a wall. Brief descriptions of the pamphlets messages were also given in five non-English languages and householders were encouraged to seek further advice and information. Contact addresses and phone numbers of a number of various agencies including the Brunswick Electricity Supply Department were provided. Copies of the pamphlets have been inserted into the pocket on the inside of the back cover of this thesis. The pamphlets were sealed in envelopes and mailed to approximately 2,200 households in the first week of November, 1990. Approximately half these households received the 'Save Money' pamphlet and the other half the 'Environment' pamphlet. A third group of about 1100 households received neither pamphlets and served as the control.

Records of electricity use were made available for clusters of households rather than individual households to ensure confidentiality. The BESD recorded electricity consumption on a rotating bimonthly basis and records from Sep/Oct 1986 onward including the three bimonthly billing periods following the distribution of the pamphlets. The selection of households in the three groups, nominally referred to as the 'Save Money', 'Environment' and 'Control' groups, was achieved non-randomly by dividing all Brunswick households into 'blocks' using census collector districts. Each census block comprised between 100 to 120 households. Those blocks of households for which BESD electricity records had the highest incidence of continuous supply records (low changes of ownership) over the previous four years were selected for use in the study. Socioeconomic data from 1986 Australian Bureau of Statistics census data was then used to sort blocks of households into groups of 10 blocks, ensuring that each group was made up from a similar range of blocks according to age distributions, ethnicity, household income and educational qualifications. In total, approximately 20% of the city's population was involved in the monitoring project.

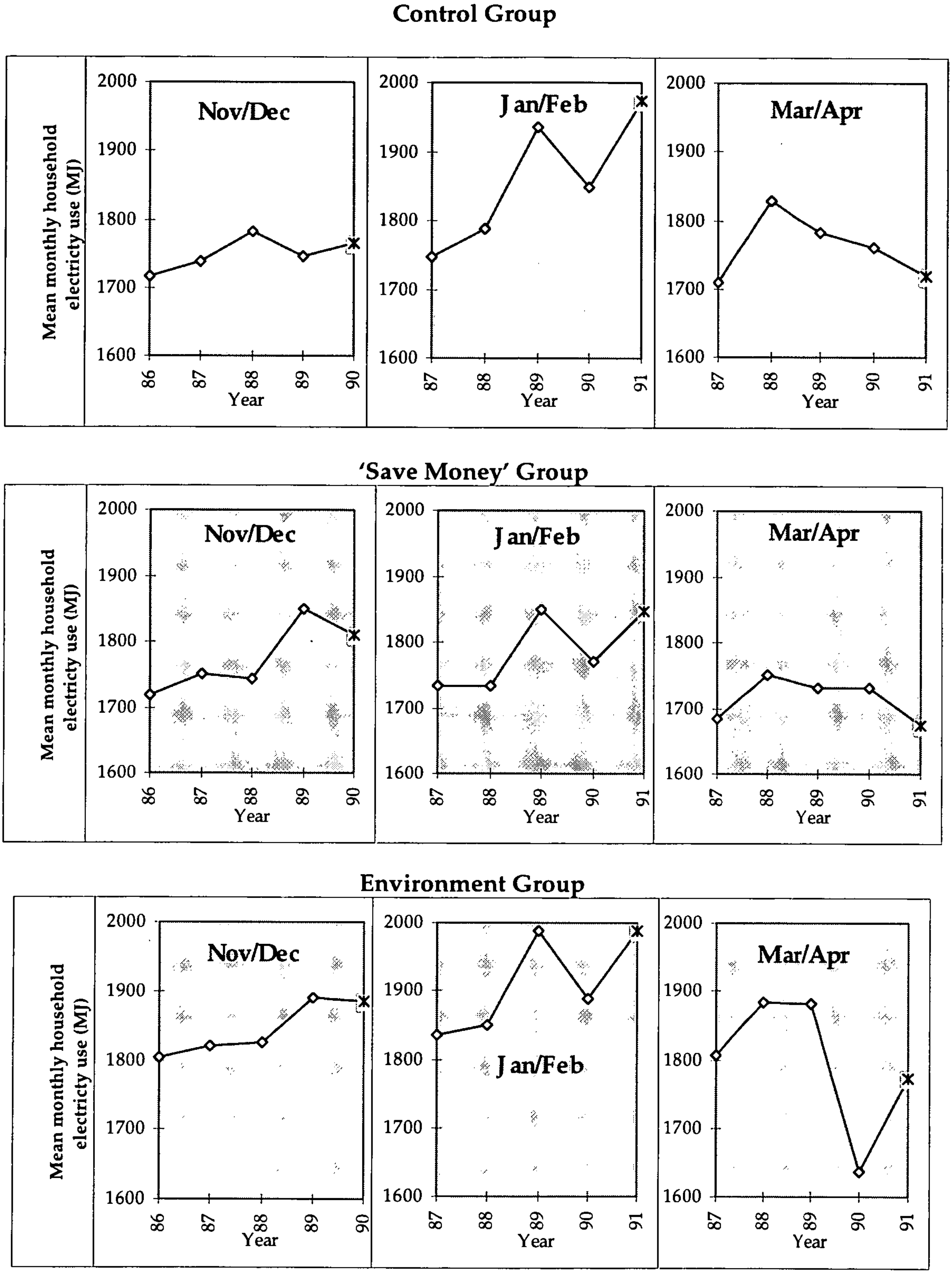
Total bimonthly household electricity use for each block was used to calculate mean household electricity use per block. This data was then used to calculate mean bimonthly electricity use for each of the three groups. While this aggregation guaranteed confidentiality for households, it rendered the data coarse. It also meant that standard deviations could not be calculated. All electricity use data was converted to megajoules (MJ) so that direct comparisons could be made with gas. Gas use data obtained from the Gas and Fuel Corporation of Victoria (GFCV) was more restricted, covering only 10 bimonthly billing periods for the 'Save Money' and 'Environment' groups prior to the delivery of the pamphlet (from Apr/Mar 1989), and only eight bimonthly billing periods for the Control group, as well as the three bimonthly billing periods after the pamphlet was distributed. Monthly average data on evaporation, barometric pressure, rainfall, relative humidity, hours of sunshine, and minimum and maximum daily temperatures were obtained for the Melbourne area from the Bureau of Meteorology.

7.6 Results of the Brunswick Study

Due to the nature of the sample selection process, neither parametric nor nonparametric data analysis could be used. Instead, simple graphical analysis was employed to gauge whether the dissemination of the conservation material had resulted in a change in electricity or gas use. This visual inspection of the data indicated a tendency for mean household electricity use in all groups to increase over the winter and spring months with a small increasing trend in the summer and autumn months over the period March/April 1987 to March/April 1991. A similar trend in mean household gas use for all groups was observed over the more limited period for which gas records were available (March/April 1989 to March/April 1991). As expected, examination of records of mean monthly maximum and minimum temperatures indicated that these trends could be partially explained by the average minimum and maximum temperatures, although no other meteorological factors appeared to be related to changes in mean household electricity or gas use.

To determine the effects of the pamphlets on electricity use, mean household electricity use for the three billing periods Nov/Dec, Jan/Feb and Mar/Apr were plotted for each of the three group for the years 1986/87 to 1990/91 (Figure 7.1). In each case, the last point in the series represents mean household electricity use in the two-monthly billing periods following the distribution of the pamphlets. The other points in the series represents the electricity use in the same two-monthly billing period in previous years. It can be seen from Figure 7.1 that mean household electricity use in the Control group displayed a tendency to increase over the years in Nov/Dec and Jan/Feb, but decrease in the Mar/Apr. A very similar pattern was observed in the 'Save Money' group. In the 'Environment' group , however, mean household electricity use for the Nov/Dec and Jan/Mar periods followed a similar patterns to those in the Control group, but mean

Figure 7.1 Mean monthly household electricty use 1986/87 to 1990/91 for each of the three billing periods (Nov/Dec), (Jan/Feb) and (Mar/Apr).



Note 1: The last point in each series (marked X) represents average household electricty use for the group in the same billing period after the distribution of the pamphlets.

Note 2: To ensure confidentiality, the BESD supplied only aggregated data on electricty use for blocks of 100 to 120 households. Each point on the above graphs represents the average of ten such groups. Because the data was received in such an aggregated form, it was not possible to indicate standard errors on the line graphs.

household electricity use in Mar/Apr 1990 was 13% lower than it was for the same period in the previous year. This was not a trend shown in the other two groups. Electricity use in the Control group for the Mar/Apr 1990 period was, by contrast, only 1.1% lower than it was in the Mar/Apr 1989 period. As there was no explanation for this relatively large decline in mean household electricity use for the 'Environment' group, it suggested a relatively high level of 'noise' in the data.

Changes in mean household gas use were compared for Nov/Dec, Jan/Feb and Mar/Apr for the limited period that data was available (Figure 7.2). Again the trends between the groups were similar except for the inordinately large rise in mean household gas use for the 'Environment' group in the Mar/Apr period in 1991 compared to the same period in 1990. This suggested that any changes induced by the pamphlets was of the same order as the 'noise' in the data.

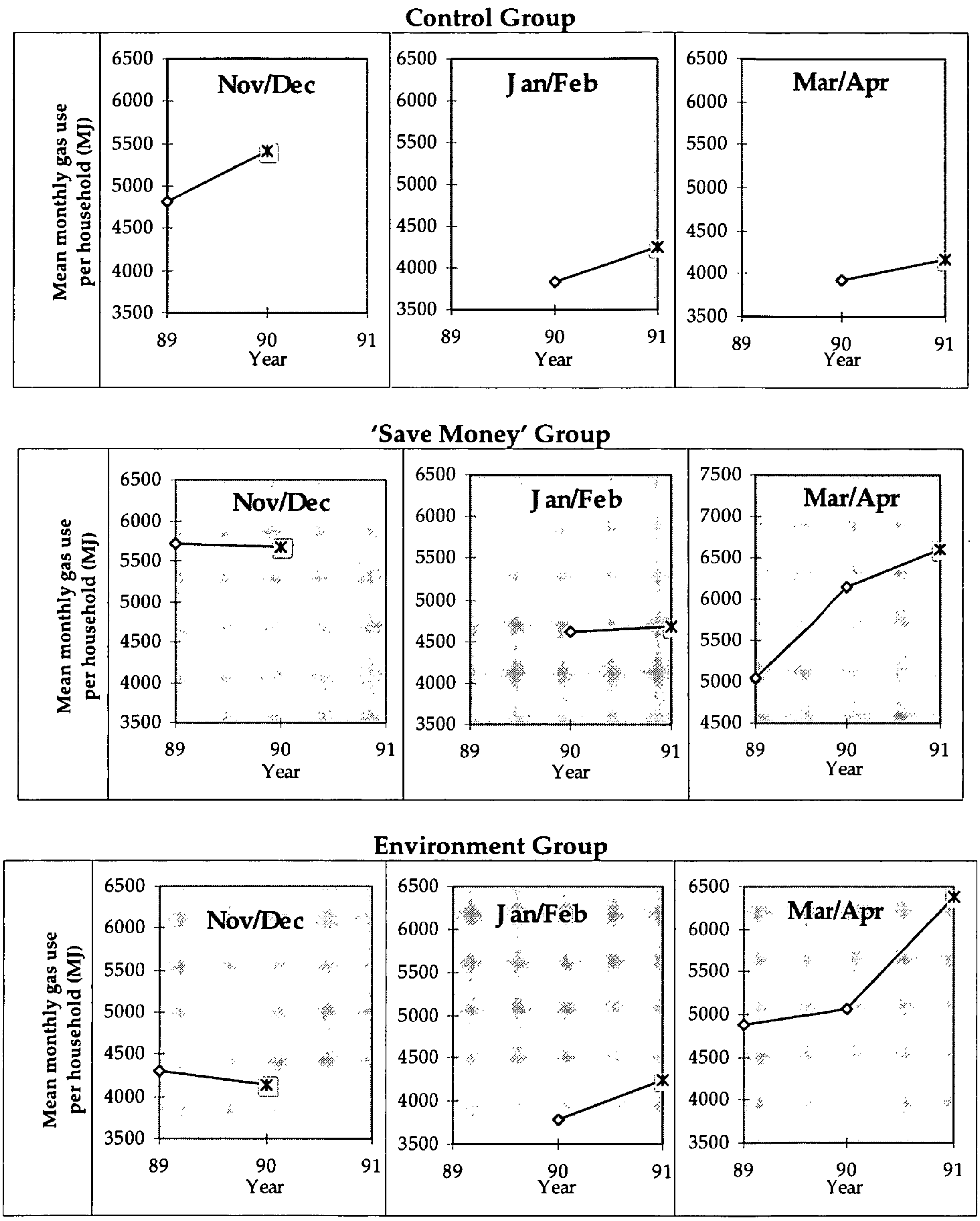
To smooth out the fluctuations in mean household electricity use for each billing period over the four years prior to the distribution of the pamphlet, these were added and an average calculated. The percent change in mean household electricity use in each of the three billing periods following the distribution of the pamphlet from the corresponding average of the previous years was calculated for each of the three groups. The percent changes in the 'Save Money' group and the 'Environment' group relative to the percent change in the Control group were then calculated. A similar calculation was made for the percentage changes in gas use from the same period in the preceding year. The results are shown in Table 7.1 and Figure 7.3 (a and b).

Table 7.1

The change (%) in mean electricity and gas use per household in the three bimonthly billing periods following distribution of the energy conservation pamphlets compared to the average electricity and gas use in the same period in previous years and relative to the percent change in the Control group for the same period.

	Months	Environment Group	Save Money Group
	Nov/De	-1.0%	-1.0%
Electricty	Jan/Feb	-2.6%	-3.6%
	Mar/Ap	-1.1%	-0.1%
	Nov/De	-10.1%	-6.3%
Gas	Jan/Feb	+1.0%	-9.3%
	Mar/Ap	+13.8%	-4.9%

Figure 7.2 Mean monthly gas use per household 1988/89 to 1990/91 for each of the three billing periods (Nov/Dec), (Jan/Feb) and (Mar/Apr).



Note 1: The last point in each series (marked X) represents average household gas use for the group in the same billing period after the distribution of the pamphlets.

Note 2: To ensure confidentiality, information on gas use was aggregated for blocks of 100 to 120 households. Each point on the above graphs represents the average of ten such groups. Because the data was received in such an aggregated form, it was not possible to indicate standard errors on the line graphs.

Figure 7.3a Percent change in mean household electricity use from same billing period in previous years relative to percent change in Control group.

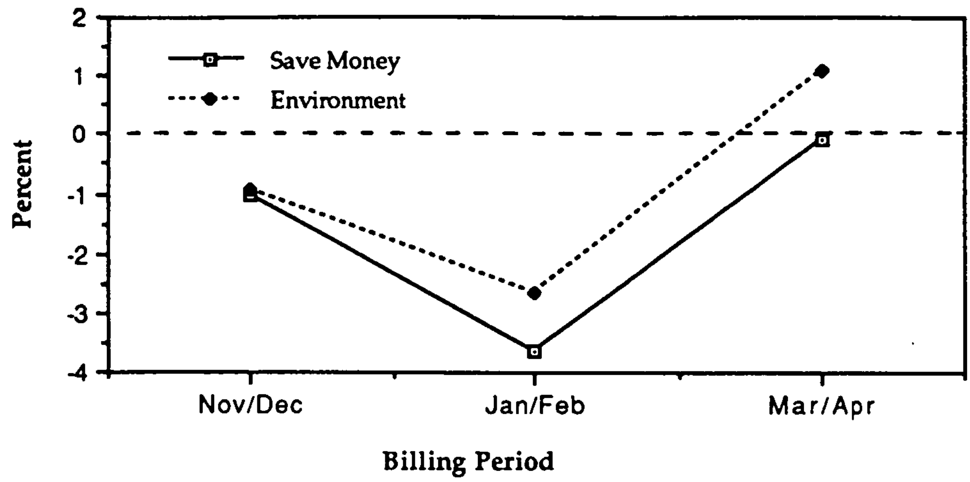
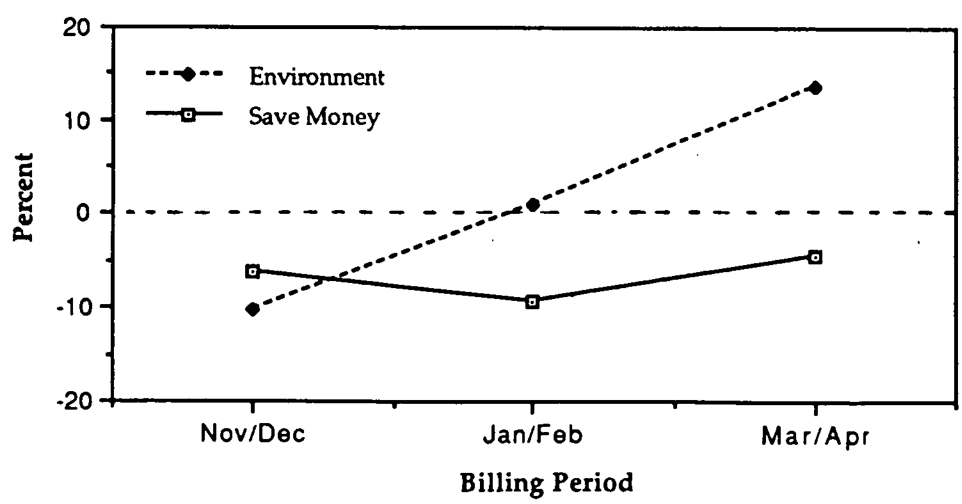


Figure 7.3a Percent change in mean household gas use from same billing period in previous years relative to percent change in Control group.



The impact that the pamphlets had on mean household electricity and gas use can be gleaned from these figures. In both the 'Save Money' and 'Environment' groups, electricity use decreased by approximately 1% relative to the Control group in the Nov/Dec billing period immediately following the distribution of the leaflet. In the following two months (Jan/Feb), mean household electricity use in both groups relative to the Control group decreased further, and by the Mar/Apr period, the differences between the two groups and the Control group had disappeared. This suggests that the pamphlets had a small impact on electricity use but that this was relatively short-lived. It should be noted here that these results differ slightly from the original results of Thomas *et al.* (1993: 46) which were based on comparisons of electricity and gas use in the period following distribution of the pamphlets with only the preceding year rather than the average of the four preceding years. This showed the effects of the pamphlet on electricity use to be smaller but more persistent than the method used in this study.

The data in Table 7.1 on changes in mean household gas use, indicate that the pamphlets had an initial impact for both the 'Save Money' and 'Environment' groups, but that while this effect was persistent for the 'Save Money' group the effect was short lived for the 'Environment' group. The 'Environment' group actually increased gas use in the Mar/Apr billing period by a greater margin from the same period in the preceding year than did the Control group. It is possible that the shorter-term gas savings in the 'Environment' group compared to the 'Save Money' group was due to differences in the types of measures that householders in 'Environment' and 'Save Money' groups adopted in response to the information leaflet. However, this would not explain why the 'Environment' group subsequently increased gas use relative to the Control, nor the size of this relative increase (13.8%). The coarseness of the data, together with the lack of feedback from individual householders, meant that the differences in changes in gas use between the 'Environment' and Save Energy groups in the period following the distribution of the pamphlets could not be adequately explained but suggested that the scale of the changes induced by the pamphlets was of the same order as the 'noise' or natural fluctuations in energy use of the groups over time.

7.7 Discussion of Results and Conclusions

The results of the Brunswick energy conservation study are mixed. They suggest first that provided certain conditions are met, even the 'soft' energy conservation strategy of broad dissemination of information leaflets may be have a significant and relatively durable impact on household sector use for some fuels and some end-uses. Two of these conditions are that the material be well-designed and that the perception of genuine interest on the part of the energy supplier to encourage energy conservation.

Secondly, the results of the Brunswick project suggest that the prompts based on self-interest (save money) or the collective good (save the environment) were of approximately equally potency. Although the electricity savings resulting from the energy conservation campaign described in this study were relatively small, they were significant when remembered that most past energy conservation campaigns have found such electricity savings difficult to achieve. It has to be remembered, however, that the project was undertaken under an atmosphere of heightened concern over environmental issues. While the impacts on electricty use were similar in the short-term for both types of prompt, however, the prompt to save energy based on self-interest had a more durable effect. This differential impact may have been related to the differences in the types of energy conservation measures undertaken by householders in response to the pamphlets.

The differences in the impacts of the pamphlets on gas use and electricty use were not surprising. Earlier research noted the tendancy for conservation pamphlets to have a greater impact on gas use than electricity use where the former is used for space heating purposes. The explanation offered for this was that significant changes in space heating energy use can be achieved without replacing equipment, whereas the same is not true of most non-heating electricity end-uses (Ester 1985: 143). The differences in the longevity of the two prompts on gas use, however, are less readily explained. Again, the explanation may be that the prompts led to differences in the nature of the energy conservation measures adopted by the two groups. Those prompted to reduce energy use in order to protect the environment, for example, may have tended to reduce energy use through behavioural adjustments such as lowering thermostats, while those urged to use energy more efficiently in order to save money may have tended to invest in more permanent energy efficiency measures, such as thermal insulation. If so, the implication for the design of future energy conservation information material would be to emphasise more permanent energy conservation measures, especially in relation to space heating. Further research would be required to assess the accuracy of this explanation.

The lower durability of gas savings prompted by the appeal to conserve energy in order to protect the environment, compared to the prompt based on the money saving potential of energy conservation, lent support to the common contention that saving money is the most powerful motivator of energy conservation behaviour. But while early research concluded that it was not possible to encourage individuals to conserve for the public good (Milstein 1976: 9), the results of the study did not support the view that encouraging individuals to conserve energy in the name of the public interest has no role within information strategies. The similarity in the effects of the two prompts, saving money and protecting the environment, on both electricity use and on the effects on gas use in the period immediately after the dissemination of the information, suggest that prompts to conserve energy for the public good can be of similar effectiveness as prompts to save energy to save money. A possible reason for the difference between the findings of earlier research and those of the Brunswick study in this regard may be related to disparate definitions of *the public interest*. When it is remembered that the attempt to encourage individuals to reduce energy use in order to conserve resources or avoid potential future shortages runs up against the uncertainty over technological change and discovery of new resources, the limited success of these efforts is less of a mystery. The fact that environmental problems such as the greenhouse warming are proximate also has an important bearing on the issue. It also needs to be remembered that it is not possible to separate out genuinely moral issues from self-interest. In the case of the greenhouse issues, this is exacerbated as the greenhouse issue has been confused in public mind with ozone depletion which has immediate implications for the current generation.

The results of this Brunswick project are nonetheless supported by those of Ester (1985) who monitored the effects of comprehensive and carefully prepared energy conservation booklets on 400 Netherland households and followed the experiment up with in-depth surveys. One of his conclusions was that his initial hypothesis that a belief in the personal consequences of energy conservation would influence energy conservation behaviour to a greater extent than would beliefs about the social consequences of energy use had to be rejected. The two beliefs, Ester found, contributed about equally to the intentions to save energy.

It is necessary to temper the above discussion, however, by acknowledging some of the more important limitations of the Brunswick conservation study. Apart from the coarseness of the aggregated energy use data and the lack of feedback from individual householders as to which of the conservation measures they adopted, one of the important limitations of the study was the restricted six-month period over which household energy use was monitored subsequent to the distribution of the pamphlets due to restrictions on available funds. An extended period of post-experiment monitoring would have enabled more definitive conclusions about the longevity of the impact of the pamphlets to be reached, and on gas use in particular. A second limitation of the study, as pointed out by Thomas *et al.* (1993: 17), was the inability to control information received by households. Because of the close proximity of households in the three groups to each other, householders may have shared information, particularly via word of mouth, and this could have diluted the effects of the pamphlets. It is possible that the Control group was influenced by the pamphlet in this manner. All households, furthermore, were likely to come into contact with other energy conservation material over the six month period following distribution of the leaflet and this would have had a further dilution effect on the impacts of the leaflets. In designing the leaflets, it was considered important for credible material to refer householders to further sources of information and contact addresses were supplied on the leaflet. It is known that at least some householders acted on this advice and contacted the BESD requesting further information. Secondary material obtained from either the BESD or other sources may have been based on a prompt different to that of the leaflet received by householders and this may have had a further dilution of the differential impacts of the two pamphlets. Bearing in mind the above limitations of the study, two conclusions of relevance to policy makers can be drawn from this chapter. The first is that while the motivation to save money is likely to remain an important motive behind the take-up of energy conservation under normal circumstances, the importance of monetary savings relative to other considerations may decline at other times. The desire to protect the environment is one such motive. The results of the empirical study discussed in this chapter have not lent unqualified support to the Olsonsian (1965) thesis that individuals tend to base their decisions on short-term self-interest at the expense of the longer-term collective good. The significance of this for those assigned the task of designing energy conservation information material is that it will be important to recognise such shifts in public attitudes when they occur.

The second, and more significant, conclusion that can be drawn from the study is that even a relatively low-level energy conservation campaign can have an effect on household energy use, especially on space heating energy use. This finding is inconsistent with that of Ester (1985) who found that a well-designed but far more comprehensive energy conservation information booklet than used in the Brunswick study resulted in only a relatively small, albeit relatively persistent, reduction in household energy use. This difference is likely to be related to the shift in both the nature of public concerns over energy-related issues and the level of those concerns in the Netherlands in 1984 and in Victoria in 1990. Nonetheless, it is also clear that both the Brunswick project and Ester's study, information campaigns were less effective and less permanent when it came to electricity use. In all, it can be concluded that while such information strategies offer utilities and governments a relatively cheap means of encouraging reductions in energy use, it is clear that the dissemination of public education material will be able to serve at best as a complement to rather than an alternative to more effective and less palatable measures. On their own, the value of such strategies to policy makers is likely to remain largely symbolic. Any serious attempt to reduce the negative social consequences of energy use or to reduce the growth of energy use for strategic planning purposes will need to rely predominantly on other, more effective, strategies.

Not surprisingly, more sophisticated information strategies have been found to be more effective than the broad dissemination of public information on how and why to conserve. As discussed in Section 7.2, there is considerable debate over the effectiveness of mandated appliance energy performance labelling. Household energy audits, on the other hand, have been found to result in greater energy savings, although the proportion of householders interested in energy audits has been found to be low even where generous financial assistance has been offered to carry out the recommended retrofits (Seligman 1985: 143). Similarly, while the provision of information on building energy performance has been found to be effective in inducing home buyers to pay more for a house with energy saving features (Horawitz & Haeri 1990, Brown 1993), it is likely that stronger measures will be required to significantly reduce energy household sector energy use. Although a low conservation strategy, the dissemination of information has been used by governments and energy supply organisations in the past and in the absence of a regulated energy market in which energy suppliers are required to pursue energy conservation as part of a Least Cost Planning strategy, it is likely that this strategy will continue to be relied on in the future.

Chapter Eight

The Performance of Energy Efficient Equipment

As in manufacturing so in science - retooling is an extravagance to be reserved for the occasion that demands it. The significance of crises is the indication they provide that an occasion for retooling has arrived.

——— Thomas Kuhn (1970) *The Structure of Scientific Revolutions*, 2nd edn. University of Chicago Press, Chicago, Illinois: 76.

We have assumed very moderate targets for increased appliance efficiency in Tasmania ... We believe that the economic case for these targets is so strong that they should be mandatory.

—— Harwood & Hartley (1980) *An Energy Efficient Future for Tasmania*. Tasmanian Conservation Trust, Hobart, Tasmania: 28.

8.1 Introduction

The third case study examined in this study shifts from the behaviour of individuals to the performance of energy-using equipment. As discussed in Chapter 4, it has long been recognised that there exists significant theoretical technical scope for improving the efficiency of energy-using equipment. Such improvements in the technical efficiency of energy use are commonly hailed by many as the unproblematic cure for a host of risks associated with energy production, transmission and use (Hinchliffe 1995: 93). These gains in efficiency are regarded by such individuals as either so cost-effective or so socially desirable, or both, that policy instruments which mandate increased efficiency are warranted. Demands for government intervention in the form of mandated minimum energy performance standards (MEPS) are likely to increase in the absence of regulations requiring the energy supply industry to adopt Least-Cost Planning methods and to engage in demand management programmes as the industry moves towards a competitive energy market. It has been advanced as a low cost (Clinton *et al.* 1986: 137) and highly effective means of achieving significant and enduring energy efficiency improvements in the residential sector as it bypasses the complexities of individual and market behaviour and simply outlaws the inefficient use of energy (SECV & DITR 1989b: 5, Meyers 1994: 86). Environmental organisations such as the Australian Conservation Foundation have therefore urged the federal government to introduce mandated minimum energy performance standards, especially in the lead-up to the Berlin round of international negotiations on global climate change in March 1995 (Kinrade 1995b).

Mandated energy efficiency standards are regarded by some as a logical extension of the energy labelling (SECV & DITR 1989a: 9) and demands for their introduction have been based on several arguments. First, individuals do not have the incentives to reduce energy use to socially optimal levels while the costs of energy to the individual are less than the social costs of energy use. Regulation is regarded as the most effective means of addressing this discrepancy (Hamblin & Vineyard 1985: 75).

Secondly, it has been argued that if the mandated standards are set at levels which are cost-effective from the perspective of the individual, it is then difficult to mount an ethical case against their introduction (Harwood & Hartley 1980: 28, Griffin 1986: 228, Wright & Baines 1986: 172). If minimum energy efficiency standards are set at the cost-effective level, the imposition of minimum energy efficiency standards then represent a socially costless, or a 'no regrets', environmental policy as it is able to meet environmental goals whilst producing a net economic benefit, or at least resulting in no net economic costs (Pugsley & Olejniczak 1994). One of the first attempts at estimating the benefits of increasing the efficiency of household appliances in Australia estimated that by increasing the energy efficiency of appliances, the average household in Victoria could save between $80 and $120 p.a. by the mid 1990s and that the SECV could save approximately $80 million by deferring the need to expand supply capacity (DITR 1986). The Ecological Sustainable Development Working Groups subsequently maintained that the introduction of MEPS for all major domestic appliances was clearly justified on social, environmental and economic grounds (Lowe 1994: 201). A more recent report commissioned by federal and state government departments in Australia recommended that conservative national performance standards be set for refrigerators, freezers, clothes dryers and electric water heaters and estimated that the imposition of these standards in 1996 would reduce national greenhouse gas emissions by 12% and save Australian consumers $575 million by the year 2007 (George Wilkenfield & Associates 1993: 232).

A third argument, and one considered the most potent by many, is that MEPS are the only effective means of overcoming the market failure caused by the common split between the purchaser and the user of energy-using equipment (Gilchrist 1994: 234). Without such a policy instrument, it is argued, landlords have little incentive to take payback criteria into account when purchasing hot water systems, refrigerators, or other energy-using durables since their tenants will reap the benefits. Those responsible for purchasing energy-using equipment but who do not have the responsibility for paying the running costs, therefore, will tend to base their purchase decisions on first costs rather than energy efficiency. The welfare of renters and others who have are unable to control the efficiency of the energy-using equipment they use and are hence frequently forced to use inefficient appliances and equipment is therefore put forward as a strong argument for the imposition of minimum standards (Gilchrist 1994: 236).

Proposals to introduce MEPS have been opposed and criticised on a number of grounds. While voluntary standards have already been introduced in Australia, compared to labelling, the use of mandated energy performance standards is considered to be a more effective (Schipper & Meyers 1992: 211) but more contentious (Wright & Baines 19986: 179) strategy for reducing energy use. The Australian appliance manufacturing industry has been vehemently opposed to the introduction of MEPS and a proposal involving the joint introduction of MEPS by all states was abandoned at the eleventh hour when the Victorian Liberal government unexpectedly withdrew its support (Lowe 1994: 43). The Federal government also decided against unilateral introduction of regulations, persuaded by industry to accept instead voluntary standards by which industry agreed to meet self-imposed energy performance. Such set-backs are seen by some commentators as temporary and the introduction of MEPS in Australia as ultimately inevitable (Walsh & Kerby 1990: 397, Walsh 1992: 621). This view appears to be based largely on the fact that mandated standards have been introduced in the USA and a small number of other countries, and on the growing push for MEPS within other countries, or regions such as the European Economic Community, for the introduction of mandated energy performance standards (Schipper & Meyers 1992: 272).

Appliance manufacturers justify their more a cautious approach on the grounds that it is essential that technological innovations be introduced in a strategic, step-by-step process since the ramifications of product failure are immense (Kanis *et al.* 1982: 13), a point that technical energy efficiency advocates commonly fail to understand. To put products onto the market before being thoroughly tested represents an unacceptable risk to the manufacturer (Weizeorick 1991). Evacuated panels, for example, have frequently been cited by energy efficiency experts as an innovation that is already available and which could be used to substantially increase the energy efficiency of refrigerators. The industry, however, maintains that refrigeration manufacturers have been slow to incorporate these into commercial refrigerator designs until more is known about their long-term performance (McMahon 1991: 530, Weizeorick 1991: 526) and that a panel that holds its vacuum for the life of the refrigerators has not yet been developed (Toone 1991: 4). The process of product planning from concept design to commercialisation, furthermore, typically involves long lead times and having seen energy prices increase sharply, only to decline again. Many manufacturers are therefore reluctant to place too much focus on designs which increase energy efficiency at the expense of other features. Manufacturers may also adopt the strategy of holding back the inclusion of some ready to be commercialised energy efficient design features until the market is judged to be ripe (Schipper & Meyers 1992: 309).

The introduction of mandated energy efficiency standards is also opposed on the grounds that the concomitant testing programmes are likely to be costly, and because they ignore community preferences and are therefore unethical (Industry Commission

1991b: 198). Opposition to mandated standards is more qualified by those who consider them unethical only if imposed without prior adequate establishment of their cost-effectiveness (Burton 1980: 155). Treadwell (1993: 90), however, has avoided the ethical arguments but has pointed out the many potential practical problems associated with setting standards. These include the fact that energy-using equipment is subject to differing levels and patterns of use under various circumstances, the variation in climatic conditions under which it operates, and the fact that inefficient energy-using equipment may be the most economically efficient option for low use applications so that their removal from the market may in fact be economically inappropriate in some cases.

A major cause of resistance to such proposals has therefore been the lack of reliable information over the impacts that such a measure would have on levels of energy use. Accurate information on the energy consumption of energy-using equipment is therefore a prerequisite for the policies of both labelling and MEPS. This chapter therefore presents a case study of the capacity of technical energy efficiency improvements in one appliance. It is used to assess the degree to which those technical improvements are likely to lead to actual reductions in energy use by measuring the energy consumption of an appliance under laboratory conditions. In this way it allows discussion of the degree to which the uncertainties surrounding aggressive energy efficiency proposals as discussed in Chapter Four are real and a fundamental reason for the rejection of those energy efficiency proposals as a planning option. As Jochem & Hohmeyer (1992: 219) have noted, uncertainty over the economic benefits of energy conservation measures in particular leads to resistance to the adoption of these measures. This was supported in the case study in Chapter Five where it was shown that uncertainty over the energy saving potential of both moderate and aggressive energy efficiency proposals was used as an argument for rejecting those options in Tasmania. This chapter takes the argument further by actually measuring the energy consumption of one commonly advanced technical energy efficiency measure in order to assess the accuracy of the estimates of the energy savings potential associated with that measure as a further means of supporting the argument that this uncertainty is real and is the underlying cause of much of the resistance to energy conservation proposals.

The appliance chosen for testing in this project was the domestic refrigerator. There were a number of reasons for selecting this appliance. First, the refrigerator is often cited as a prime example of a technology for which the energy efficiency can be increased dramatically using available, simple and cost-effective technological changes. The theoretical technical opportunities for reducing the energy requirements of electric compression household refrigerators have been well-documented. The coefficient of performance (COP) of a refrigerator is the ratio of the cooling load or heat removed, Q, to the electricity used, E. Another way of stating this is that the COP is the carnot efficiency, η_c, multiplied by the theoretical maximum value of the COP, ε_{max}, which is defined by the second law of thermodynamics. Expressed algebraically,

$$\text{COP} = \eta_c \times \varepsilon_{max}$$

where $\varepsilon_{max} = T_0/(T_1-T_0)$ and T_0 is the evaporator temperature (Kelvin) and T_1 is the condenser temperature (Kelvin). The electricity consumption, E, is therefore given by

$$E = Q/(\eta_c \times \varepsilon_{max}) = Q/[\eta_c \times T_0/(T_1-T_0)]$$

This means that the electricity consumption of a refrigerator can be reduced in one of three basic ways:

(i) by reducing the cooling load, Q, (by reducing the heat transmission through walls, doors and seals, by increasing the insulation thickness, or by using better insulation materials);
(ii) increasing the carnot efficiency, η_c (by increasing the efficiency of components such as electric motors, fans and compressors); and
(iii) increasing the carnot factor (T_1-T_0) (by increasing the heat transfer surface areas of the evaporator and condenser).

Engineering estimates of the energy savings to be gained from these, and other technical changes such as dual compressors for refrigerator/freezer models are now common (A.D. Little Inc. 1977, Hoskins & Hirst 1977, Craig 1981, Guldbrandsen & Nørgård 1986, Pedersen 1987, Turiel & Levine 1989). It has been claimed, for example, that by increasing the efficiency of refrigerator fan motors and compressors, and by adding extra insulation and a second condenser, refrigeration energy consumption could be reduced by 80% at a cost of less than (US1989)2 c/kWh of saved electricity (Katz 1989). An implication drawn from of this is that if developing countries built highly efficient refrigerators based on these improvements rather than inefficient refrigerators based on current technology, the <u>avoided energy supply</u> would amount to 42 GW and the <u>avoided costs</u> of investment in fossil fuel plants would be $77 billion, or $189 billion in nuclear plant. The cost of increasing the energy efficiency of refrigerators, by comparison, would be between $5.5 billion to $12.5 billion and would also avoid 23 million tonnes of carbon dioxide emissions p.a. at a displacement cost one tenth of the cost of doing the same with nuclear power and in a shorter time.

Refrigerators have also been at the centre of debate because the rate at which manufacturers have increased the energy efficiency of refrigerators has varied between countries by a factor of up to three (IEA 1991b: 115). Denmark, Germany and Japan have been the leaders in this regard (Herring 1992). As a consequence, the average specific energy consumption of refrigerators now often varies between countries by substantial margins. The low correlation between the cost and energy efficiency of various models of refrigerators has also led to particular interest on this appliance (Patterson 1991: 104).

Refrigerators are also considered to be the main household appliance for which mandated energy performance standards are applicable, along with freezers and hot water cylinders, the reason being that the performance of these appliances is largely independent of consumer behaviour (Wright & Baines 1986: 179). During the recent unsuccessful bid to introduce national MEPS in Australia, the four appliances initially considered suitable for inclusion in the programme were refrigerators, freezers, clothes dryers and hot water storage systems. Clothes dryers were eventually deleted from the list on the grounds that the overall energy savings achieved by increasing energy efficiency of these appliances would be relatively small. Manufacturers of hot water systems argued successfully for the deletion of these from the list to which MEPS would apply on the grounds that the enforcement of increased energy efficiency would increase the price of the units and damage the export of Australian manufactured hot water storage systems. This left only refrigerators and freezers as the only appliances for which MEPS were seriously considered an option in Australia. A further reason for focusing on refrigerators is that the technical potential to increase the energy efficiency of refrigerators and freezers is considered to be inordinately large compared to most other appliances (Kanis *et al.* 1982: 12, Aldershot & Kanis 1984: iii, National Institute of Economic and Industry Research 1990: 12) and because this increase in energy efficiency can be achieved using simple and tried-and-tested technologies that could be repaid in less than two years (Kanis *et al.* 1982: 12, Pedersen & Lawætz 1989). But while refrigerators represent a technology for which there exists significant technical scope for increasing energy efficiency and for which the setting of standards is considered to be particularly applicable, devising accurate standard performance and energy consumption tests for refrigerators is not straight forward (Hellmann-Tuitert & Kanis 1983: 242). Selecting standard test conditions which represent those under which the average refrigerator is used is also difficult, since owners have considerable latitude in terms of refrigerator thermostat settings, the ambient temperatures of the environment in which the refrigerator is located, the food loading behaviours, and door opening schedules. For these reasons, the research programme described in the following sections of this chapter attempted to measure the performance and energy consumption of refrigerators in order to comment on the appropriateness and the accuracy of this information and the implications in terms of appliance labelling and the introduction of MEPS.

8.2 Methodology

The tests followed the requirements of the Australian test standard as set out in AS 1430-1986 (Standards Association of Australia 1986) and more recently in AS-2575.2-1989 /NZS 6205.2-1989 (Standards Australia and Standards Association of New Zealand 1989). All references in the following text concerning the Australian Standard test requirements refer to these two documents. The size and design of the constant temperature room followed that used by Stockwell (1987). The room had external dimensions of 3200 x 1900 x 2500 mm and was constructed in a small annex (dimensions = 3690 x 3990 x 3220 mm) to the Environmental Studies Laboratory in the basement of the Chemistry Department's building at the University of Tasmania's Sandy Bay campus and the layout of the room is shown in Figure 8.1. These dimensions were designed to permit simultaneous testing of three refrigerators. Construction used a frame (20 x 50 mm softwood) to which 3 mm ply was glued and nailed on the walls and roof and 17 mm ply used on the floor. Polystyrene foam (25 mm thick) was glued to the entire outer surface and all gaps were sealed to ensure that the room was airtight. A constant temperature was achieved by connecting a 1500 W oil-filled electric column heater controlled by an Omron ESC5 temperature-controlled relay switch which turned the heater on when the room temperature fell to a preset level, and off again once the temperature reached 1^0 C above that preset level. An initial test run in which the temperature of the constant temperature room was maintained at 32 ^{0}C for over 200 hours showed that heat was lost from the constant temperature room at a rate of approximately 40 W/ ^{0}C temperature difference between the temperature of the constant temperature room and the temperature of the small annex in which it was housed.

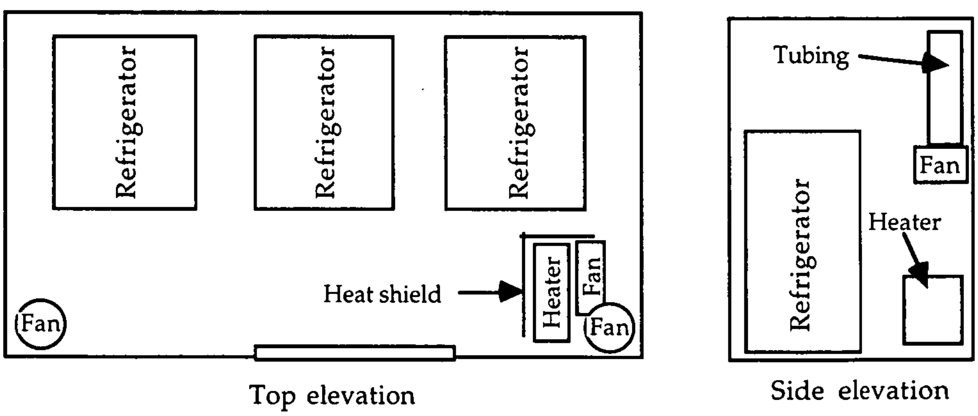


Figure 8.1 Layout of constant temperature room.

To maintain an even temperature within the constant temperature room and a vertical temperature gradient below 1 ^{0}C/m as required by the Australian Standard test methodology as set out in Appendix B of AS 1430-1986 (Standards Association of Australia 1986) and AS-2575.2-1989 /NZS 6205.2-1989 (Standards Australia and Standards Association of New Zealand 1989), air within the room was circulated using an electric Mistral fan to force air over the heater. Two small variable speed Muffin electric fans built into the ends of 760 mm lengths of 100 mm diameter tubing were also used to circulate air in the room. The intakes of these tubes were placed 125 mm from the ceiling in the corners of the constant temperature room opposite the refrigerators and their speeds controlled by rheostat switches. To prevent radiant heat from affecting the refrigerators, and to reduce the velocity of air in the vicinity of the refrigerators to less than 0.25 m/sec as required by the AS-1430 standard, the heater and fan heater was shielded from the refrigerators. To ensure that the conditions in the room met the test criteria specified in AS-1430, a series of tests recorded temperatures at various heights and at various positions within the room over a 24 hour period whilst maintaining air temperature in the test room at 32 ^{0}C. Air velocities were measured using an Airflow LCA 6000 anemometer. From this series of tests it was found that to minimise temperature fluctuations in the constant temperature room, only one refrigerator could be tested at a time. The results indicated that the maximum temperature difference between ceiling and floor temperatures was 2.77 ^{0}C, giving a maximum vertical temperature gradient of 1.1 ^{0}C/m, slightly greater than the 1 ^{0}C/m maximum temperature gradient permitted under standard test conditions.

Temperatures were measured at 5 second intervals using T-type thermocouples and recorded using a Datataker DT 100 datalogger which was down-loaded *in situ* onto a PC using PC-Talk software so that temperatures could be read directly on the PC monitor during the course of the tests. Temperature data was subsequently converted to the Excel spreadsheet programme to plot the changes in temperature over the course of the test and carry out the calculations. Thermocouples used to measure air temperatures were shielded by inserting them into 15 mm diameter PVC T-Junctions painted matt black to reduce the effects of radiation. Thermocouples used to measure the temperatures inside refrigerators were soldered into 50 mm lengths of 19 mm diameter solid copper rod with a thermal capacity equivalent to approximately 11.7 g of water (the Australian Standard test method specifies that thermal masses should be between the equivalent of 10 g and 20 g of water). The copper rods served as heat sinks and were designed to simulate the temperature changes in food stored in the refrigerator compartment. Attaching the thermocouples to the rods smoothed the fluctuation in recorded temperatures inside the refrigerator compartments. The 12 copper rods used in the tests varied in weight by less than 0.5 g and subsequent calibration tests showed this difference to have a negligible effect on temperature measurements.

Electricity use was measured using Sangamo HMT watthour meters[1]. These were calibrated by connecting them to a precisely known load, drawing approximately 1 kW for 24 hours. The results indicated that the meters readings were accurate to ± 0.5%. Since the voltage of the electricity supply was stable to only within 1%, however, the accuracy of energy consumption readings was ±1.5%.

The accuracy of visual readings from the watthour meters was ±16.5 Wh. To improve the accuracy of electricity use measurements, a second PC in conjunction with equipment

[1] These are the standard meters used by the HEC to measure retail electricity use.

and software developed by the Fijian Electricity Supply Unit to monitor and record diurnal changes in household electricity use, was used. This equipment consisted of a camera lens which focused light reflected off the rim of the watthour meter wheel onto a photo-sensitive transducer. The circuit was broken once per revolution of the wheel by a thin black mark on the rim of the wheel and in this way the software programme recorded the cumulative energy use (number of revolutions) and the time at which the watthour meter stopped and started. As the watthour meter wheels revolved at a rate of 600 revolutions per kWh, this system allowed electricity consumption to be read to within ±1.67 watthours. In calculating the potential errors of electricity consumption readings, this was added to the ±1.5% accuracy of the watthour meters.

Thermocouples were used as the temperature measuring devices due to their low cost and robustness, and because the Datataker used had been pre-wired to use thermocouples for an earlier research project. A further attribute of thermocouples is their capacity to retain calibration as this is purely a characteristic of the metals used. Australian Standards (AS-1430 1986, Appendix II, p. 26), furthermore, specifically indicated that thermocouples were an appropriate device. T-type thermocouples were used on the basis of their response curves over the temperature range - 20 ^{0}C to 50 ^{0}C. A number of temperature measurement problems, however, were encountered. The cause of an initial temperature reading error was found to be moisture condensing on the copper rods inside the refrigerator cabinets during off-phases of the refrigeration cycle. The moisture created a grounding loop and led to an error in the Datataker calibration. To overcome this problem, the copper rods were sealed in prophylactics and the test programme restarted. A second, and more subtle and erratic temperature measuring error was subsequently discovered once the testing programme had been restarted. Refrigerator compartment temperatures as measured by the Datataker occasionally appeared to be lower than expected and were therefore checked using an independent KM 3012 battery operated, nonrecording temperature measuring device with a K-type thermocouple. The results indicated that refrigerator compartment temperatures recorded by the Datataker drifted intermittently and erratically from true temperatures by from one to four Celsius during the 'on' cycle, returning to true temperature during the 'off' cycles. Attempting to eliminate the problem by running both the Datataker and PC on batteries to avoid grounding loops, and by replacing the T-type thermocouples with K-type thermocouples failed to correct the problem. It was subsequently discovered that electromagnetic interference with electronic equipment was a perennial problem in the Chemistry building due to a variety of very large sources of electromagnetic radiation. Shielding of both leads and the Datataker to reduce electromagnetic interference reduced, but failed to completely overcome, the problem.

As measurement of temperature using thermocouples relied on the fact that the voltage created at the thermocouple's bimetallic junction was proportional to its temperature, and this voltage was susceptible to electromagnetic interference, the attempt to use thermocouples was finally abandoned. Stockwell (1988) had reported using thermistors to measure refrigeration temperatures and as these devices relied on temperature-induced changes in resistance rather than voltage they would not be affected by the electomagnetic fields. Using thermistors in conjunction with a Campbells datalogger, a series of temperatures recording trials was carried out. The Campbells dataloggers operated off a 12 volt battery and recorded onto audiocassettes which were then down-loaded onto a PC and converted into ASCI II and then reconverted to the Excel programme. While this was found to provide more reliable temperature measurements, the recording process proved cumbersome and had the disadvantage of not allowing temperatures to be read during the course of the test. A convenient solution to the problem was found by a colleague, Mr Chris Ashworth, from the Department of Physics at the University of Tasmania. Temperature recording equipment constructed for the Physics Department's upper atmospheric physics programme used AD590s as the temperature measuring device. These integrated circuit temperature transducers produced a current proportional to temperature and therefore gave temperature readings unaffected by electromagnetic radiation. A series of temperature measurements were run using the Physics Department's equipment and found to be accurate and reliable. The Datataker was therefore rewired to use AD590 semiconductors. For convenience, the AD590s were connected to trim pots so that the temperatures recorded could be zeroed by calibrating them in a water bath. The AD590s, however, could not be soldered into the copper blocks and another method had to be found of ensuring good thermal contact with the copper blocks. The method similar to that described by Unwin (1980: 15) was used in which the AD590s and the end 100 mm of the leads were sealed using heat-shrink tubing and then inserted into 0.635 mm diameter and 20 mm deep holes drilled in the top of the copper rods. Heat-conducting putty was used to ensure good thermal conductivity between the copper and the AD590 and the holes were sealed using silicon.

The AS 1430-1986 standard test procedure required that temperature measuring devices have an accuracy of at least ±0.5 ^{0}C. The AD590s had a nominal accuracy given by the manufacturer of ±1 ^{0}C and a linearity of ±0.5 ^{0}C over the temperature range. Using a Haake D8 waterbath with a capacity to maintain a constant temperature to within ±0.1 ^{0}C together with a submerged mercury in glass thermometer with a NATA certified accuracy of ±0.15 ^{0}C and with the ability to be read to 0.01 ^{0}C, the AD590s were calibrated over the temperature range 0 ^{0}C to 50 ^{0}C and found to be accurate to within ±0.15 ^{0}C. Trim pots were used to adjust the temperatures measured by all AD590s in a distilled water-ice bath in a thermos flask to 0.00 ^{0}C. Periodic recalibration during the refrigerator performance testing programme indicated that the devices held their accuracy to within ±0.14 ^{0}C. This meant that measurements of the difference in temperature between the test room and the refrigeration cabinets were accurate to within 0.28 ^{0}C.

In order to achieve an ambient test temperature of 10 ^{0}C, a 5 kW Misibushi room air-conditioner was used to reduce the room air temperature of the annex in which the constant temperature room was housed. Windows in the annex were covered with 25 mm thick sheets of polystyrene foam to reduce heat transfer from the windows. The room air conditioner was able to reduce the air temperature in the annex by a maximum of five degrees below the temperature of the surrounding environment, so that refrigerator performance tests at an ambient temperature of 10 ^{0}C could not be carried out during warm weather and had to be deferred until later in the year. As the room temperature in the Environmental Studies Laboratory to which the annex was connected was maintained close to 23 ^{0}C during the day by the building's central heating system, it was not possible to maintain a constant temperature of 10 ^{0}C during the day and tests had to be carried out overnight when the central heating system was switched off. This meant that the duration these tests at an ambient temperature of 10 ^{0}C was limited to less than 12 hours rather than the minimum of 16 hours as required by AS-1430 standards. For this reason the results of the tests carried out at an ambient temperature of 10 ^{0}C are less reliable than those carried out at higher ambient temperatures.

The above discussion of the methodology serves as a warning that measuring refrigeration cabinet temperatures can be difficult and that without careful attention the accuracy of these measurements may be doubtful. The difficulty of controlling the test room temperature is also an issue that needs to be taken into account in discussion of the accuracy of refrigeration energy consumption and performance tests.

8.3 Results and Discussion

Three refrigerators were tested over the course of the research project. Because one of the aims of the project was to assess the accuracy of technical assessments of the capacity to reduce energy use with available technology and equipment, the first refrigerator chosen for testing was a highly efficient one. A small energy efficient refrigerator designed at the Physics III Laboratory of the Technical University of Denmark in Lund was produced by the Danish appliance manufacturer, Brdr. Gram A/S, beginning in late 1988 (Pedersen & Lawætz 1989: 5). The Gram LER 200 is a small, 200 litre Class 1 refrigerator[2] and with a reported annual energy consumption, based on both laboratory testing and in field measurements of about 90 kWh p.a., reputed to be one third that of the average consumption of similar models of refrigerators on the market

[2] The Australian Standard AS 1430 sets out a system for classifying refrigerators. Class 1 refrigerators are those which have no freezing compartment so that the entire storage volume comprises a fresh food compartment. Refrigerators are also categorised according to storage volume.

in Denmark at the time (Nørgård 1989: 135). Common reference in the Australian literature to an energy efficient European refrigerator that used 90 kWh p.a. (Greene 1990: 28) suggested that the LER was the most efficient conventional Class 1 refrigerator on the international market and this was supported by reference in the international literature that the world's most efficient refrigerator used 90 kWh p.a. (IEA 1991: 113). The design of the LER involved two major changes. The first was an increase in thickness of the polyurethane insulation level of insulation to 7 cm, which allowed down-sizing of the compressor and motor. The second was an improved cooling system by increasing the surface areas of the condenser and evaporator, and by improving compressor efficiency. These design changes are discussed at length by Heebøll *et al.* (1985). Most other low energy refrigerators available on the international market, such as the US made 420 litre Sunfrost, estimated to use 200 kWh p.a. (Mills 1991b:8), were not cost-effective options in Australia and were therefore not considered[3]. As Gram Bdr did not market refrigerators in Australia, a Gram LER 200 was imported from Denmark for this research project.

For comparative purposes, the most efficient Class 1 refrigerator on the Australian market was also obtained for testing. Based on SECV information, this was the Australian manufactured 330 litre Kelvinator CS 334. Attempting to accurately compare the energy efficiency of different models of refrigerators is problematical because each model varies in terms of features and utilities. To overcome this the energy intensity of the refrigerator is used. The <u>specific energy consumption</u> [SEC], defined as the energy use per unit of volume of refrigeration storage space, is often used as proxy of comparative energy efficiency (Herring 1992: 72). Energy efficiency, however, is volume dependant since the ratio of a refrigerator's surface area to internal volume decreases as volume increases. Because the volume of the Kelvinator CS 334 was two thirds again that of Gram LER 200, their specific energy consumptions were not directly comparable. For this reason, a popular but less efficient Class 1 refrigerator sold on the Australian market with a volume as close as possible to that of the LER was also selected for testing in this study. This was the 190 litre New Zealand manufactured Fisher & Paykel 190 C. The relevant details of the three refrigerators tested are given in Table 8.1 below.

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[3] The 12 volt DC Sunfrost retailed by Real Goods Inc. (USA) is reputed to be the most efficienct electric refrigerator in the world and was used in the University of Sydney's Applied Physics Department's demonstration programme of the technical potential to minimise household reticulated energy requirements (Mills 1991b). Because of the thick insulation used, however, they are relatively large refrigerators. Theyare also relatively expensive, a Sunfrost with the same internal dimensions as the Gram LER retailing for about three times the price as the Gram LER.

Table 8.1 Details of refrigerators used in study

	Kelvinator CS 334	Fisher & Paykel C190	Gram LER 200
Storage volume (litres)	330	192	200
Energy consumption indiacted on label (kWh/year)	490	460	90 (no label)
Star rating	5	3	n/a

8.4 Performance and Energy Consumption Tests

As well as the measurement of refrigerator energy consumption, the standard test involves two performance tests. To meet the Australian standards and receive an energy performance label, refrigerators need to perform adequately over the temperature range 10 °C to 43 °C, and meet the requirements of the 'pull down' test which measures the capacity of the refrigerator to reduce its internal temperature from a set ambient temperature within a specified time interval.

The refrigerators tested were of a similar design with a front crisper at the bottom of the fresh-food compartment. Temperature measurements were made at positions conforming as closely as possible to positions given in Appendix C of the AS 1430 (Standards Association of Australia 1986). The three measurment positions were on the central axis of the fresh-food compartment as shown in Figure 8. 2. The average temperature at each position was calculated as the mean temperature at that point over a number of complete operating cycles. Average compartment temperature, Tav, was then calculated as the average of these temperatures, Tav = $\Sigma(T_1 + T_2 + T_3)/3$.

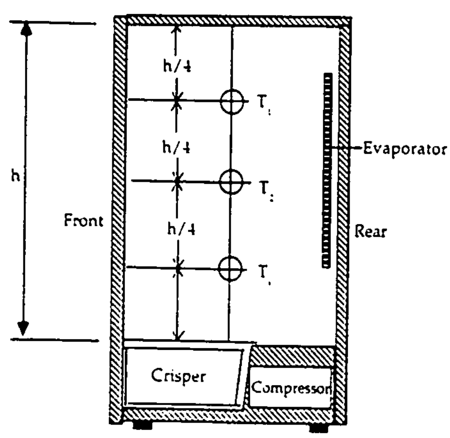


Figure 8.2 Air temperature measuring points of fresh-food compartments

For refrigerators to meet the Australian AS 1430 test standard requirements and carry an approved energy performance label they need to be able to perform adequately under Australian conditions. The two stipulated performance criteria are (i) the capacity to pull the compartment temperature down from 43 ^{0}C to 8 ^{0}C within six hours, and (ii) the ability to keep food cool while operating within a range of temperatures. Class 1 refrigerators are required to be able to maintain the temperature of stored food between 0.5 ^{0}C and 6.0 ^{0}C at ambient temperatures of 10 ^{0}C, 21 ^{0}C, 32 ^{0}C and 43 ^{0}C. The first of these tests was carried out as a separate test and the results are given in Section 8.4.1 below. The set of second performance tests was conducted simultaneously with energy consumption measurements and the results are discussed in Section 8.4.2.

8.4.1 Pull-Down Test

The 'pull-down' test is a simple test which involves leaving the door of the refrigerator open at an ambient temperature of 43 ^{0}C until its internal temperature has reached equilibrium with that ambient temperature. With the thermostat of the refrigerator set at its coldest setting, the door of the refrigerator is then closed and the unit switched on and the time taken for the average internal temperature to reach 8 ^{0}C is measured. To meet Australian standards, the pull-down time must be no longer than six hours. The pull-down test is therefore essentially a test of the compressor capacity. The results of the tests conducted on the three refrigerators are shown in Table 8.2.

Table 8.2 Pull-down times

	Kelvinator CS 334	Fischer & Paykel C 190	Gram LER 200
Time for refrigerator to pull down cabinet temperature from 43 to 8 degrees Celsius	3.83 hours	3.17 hours	> 6 hours

The results of the pull-down test indicated that while the Kelvinator CS 334 and Fisher & Paykel C 190 were able to cool the average compartment temperature from 43 ^{0}C to 8 ^{0}C in a time well within the limit set by the Australian standard, the Gram LER 200 was unable to meet this condition. After 3.87 hours, the average compartment temperature of the Gram stabilised at 10.1 ^{0}C with the compressor on almost all of the time.

As down-sizing of the compressor was a deliberate energy efficient design feature of the Gram LER 200, and the pull-down test is primarily a measure of the refrigerator's compressor capacity, this energy efficiency design feature of the Gram militate's against that refrigerator's performance as measured by the pull-down test. The purpose of the rapid pull-down requirement is to ensure that refrigerators sold in Australia have the capacity to cool quickly, since refrigerators in many parts of Australia operate at high ambient temperatures. Toone (1991: 4) put it in a way that most Australians would understand in stating that a refrigerator that did not cool down beer quickly on a hot day wouldn't last long in the average Australian household. The initial temperature of 43 ^{0}C in the pull-down test, however, has little relevance for temperate areas of Australia and indicates the problems associated with using a single standard over a very wide range of climatic conditions such as occur in Australia. The choice of a lower pull-down temperature of 8 ^{0}C and the maximum pull-down period of six hours, furthermore, appear to have been arbitrarily set. The draw-down temperature of 8 ^{0}C as the internal temperature, for example, contrasts with the 6 ^{0}C maximum average internal temperature stipulated for other refrigerator performance tests. There also appears to be little basis for choosing a six-hour maximum pull-down time rather than, say a 4 hour or 8 hour pull-down period. For these reasons, the pull-down test was repeated using an ambient temperature of 32 ^{0}C, which is closer to the maximum temperatures in more temperature regions of Australia, and an internal temperature of 6 ^{0}C, which is consistent with the maximum average internal temperature used in other Australian standard refrigerator performance tests. Under these conditions, the Gram LER 200 pulled the average cabinet temperature down to 6 ^{0}C in 2.37 hours. The Kelvinator CS 334 and the Fisher & Paykel C 190 reduced their compartment temperatures by the required increment in 2.125 hours and 1.75 hours respectively. It is interesting to note the similarity in the pull-down times of the Kelvinator and the Gram under these altered requirements.

Apart from the arbitrary nature of the parameters of the pull-down test set in the Australian standard and the suitability of a single standard based on the harshest climatic conditions, there is reason to question its relevance relative to other measures not required by the standard. A more important measure of refrigerator performance than the time it took a new refrigerator to cool down to 8 ^{0}C when first switched on, for example, would appear to be its capacity to keep food cool during interruptions to the electricity supply. Because this appeared to be a more sensible performance measure, the time it took for the average compartment temperature to increase from 3.0 to 21 ^{0}C at an ambient temperature of 32 ^{0}C[4] was therefore measured. This test of the reverse measure of performance could be termed the 'drift-up' test and is essentially a measure of the performance of the refrigerator's thermal insulation. As expected, the results indicated that when this reverse performance measure was used, the Gram, due to its greater thermal insulation, outperformed the Kelvinator and the Fisher & Paykel by a

[4] An upper temperature of 21 ^{0}C rather than 32 ^{0}C was chosen as the basis for the test because of the length of time that would be required to reach equilibrium with the ambient temperature.

substantial margin. It took almost twice as long for the Gram's compartment temperature to increase to 20 ^{0}C (4 hours) as it did those of the Kelvinator (2.6 hours) and the Fisher Paykel (2.65 hours). The Gram was therefore better equipped to be able to maintain food at a cooler temperature during brief interruptions to the electricity supply - assuming refrigerator doors were not opened.

A second point that needs to be made is that all three refrigerators were able to maintain an average compartment temperature between 0.5 ^{0}C and 6.0 ^{0}C and therefore satisfied the Australian standard test requirements. This came as a surprise as the Gram LER 200 had not been able to meet the criteria stipulated in the pull-down test but had stabilised its average compartment temperature at just over 10 ^{0}C after 2.5 hours with the compressor on virtually all the time. It was therefore expected that the Gram would not be able to achieve a stable average compartment temperature lower than 6 ^{0}C at an ambient temperature of 43 ^{0}C. It was found, however, that if the Gram LER was operated continuously on its coldest thermostat setting for a long period, its compartment temperature was gradually lowered and that after approximately 72 hours it stabilised at around 2.4 ^{0}C as shown in Figure 8.3.

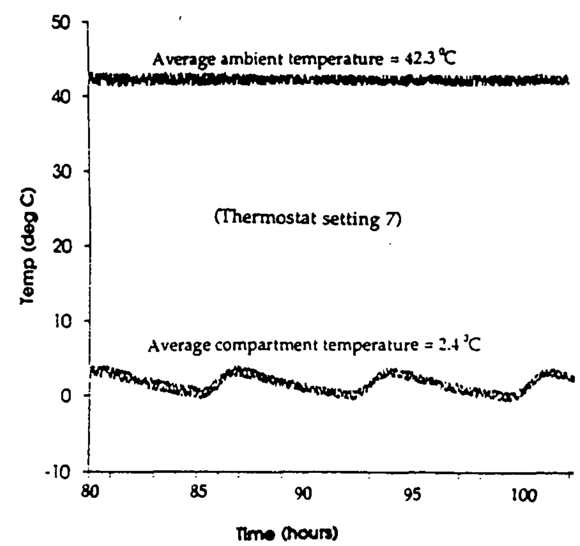


Figure 8.3 Average compartment temperature of Gram LER 200 after 80 hours at an ambient test temperature of 43 ^{0}C.

8.4.2 Energy Consumption Measurements

The most updated method for determining the energy consumption of refrigerators under standard test conditions is given in Appendix B of AS 257.2-1989 (Standards Australia & Standards Association of New Zealand 1989: 12-13). The standard test procedure is similar to that used in the USA which uses a closed-door test (an unloaded fresh food compartment and no door openings) at an ambient temperature of 32 ^{0}C and an average temperature of the fresh food compartment of 3 ^{0}C. This method is assumed to simulate energy consumption under normal operating conditions (an average ambient temperature of 21.5 ^{0}C) using a higher ambient temperature to compensate for the lack of door openings. As a matter of interest, refrigerator energy consumption was also measured at all ambient temperatures of 43 ^{0}C, 32 ^{0}C, 21 ^{0}C and 10 ^{0}C during the course of the performance tests.

Recording of electricity use began once refrigerators reached thermal equilibrium, defined as the position reached when the average internal temperature fluctuated by no more than 0.5 ^{0}C over a cycle for a period of at least two cycles. Energy use was recorded over an even number of 'on' and 'off' cycles, the starting and ending points for recording taken as either the 'on' or 'off' points in the cycle. In the standard test procedure, energy consumption per 24 hours is determined by recording energy consumption for the lesser of either 16 hours or until at least 1 kWh of electricity had been used. To increase the accuracy of the energy consumption data in the present study, wherever possible energy consumption was recorded over a minimum period of 72 hours.

Energy consumption per 24 hours for an average refrigeration compartment temperature of 3 ^{0}C was found at each ambient temperature by setting the refrigerator's thermostat at its mid-point, measuring the energy consumed and calculating the average compartment temperature. The thermostat setting was then adjusted up or down depending on whether the calculated average compartment temperature in the first test was higher or lower than 3 ^{0}C and energy consumption and average compartment temperature re-determined. This process was continued so that energy consumption per 24 hours was found for a range of average compartment temperatures at a particular ambient temperature. The two average compartment temperatures closest to 3 ^{0}C were then used to interpolate (or extrapolate if one of the average temperature readings was sufficiently close to 3 ^{0}C) from this data to find the energy consumption at an average compartment temperature of 3 ^{0}C at the particular ambient setting. The calculation of energy consumption at an average compartment temperature of 3 ^{0}C for each of the ambient test temperatures by this means is shown in Appendix II. This information was condensed and annual energy consumption and annual standard energy consumption (using energy consumption per 200 litres of storage space) for each of the four ambient temperatures are shown in Figures 8.4 and 8.5 respectively. Errors in energy consumption resulting from the 0.28 ^{0}C temperature reading accuracy of the AD590s were also calculated from the graphs in Appendix II and added to errors in kWh readings.

The results of measurements the refrigerator energy consumption tests undertaken in this study indicate that there exists genuine scope for increasing the energy efficiency of refrigerators in Australia using available, tried-and tested design changes. As shown in Figures 8.4 and 8.5, the Gram LER 200 used approximately 200 kWh p.a. less electricity than the, Fisher & Paykel C 190 at ambient tests of both 32 ^{0}C or 21 ^{0}C. As the Fisher

Figure 8.4 Refrigeration electricity use per year at four ambient test room temperatures.

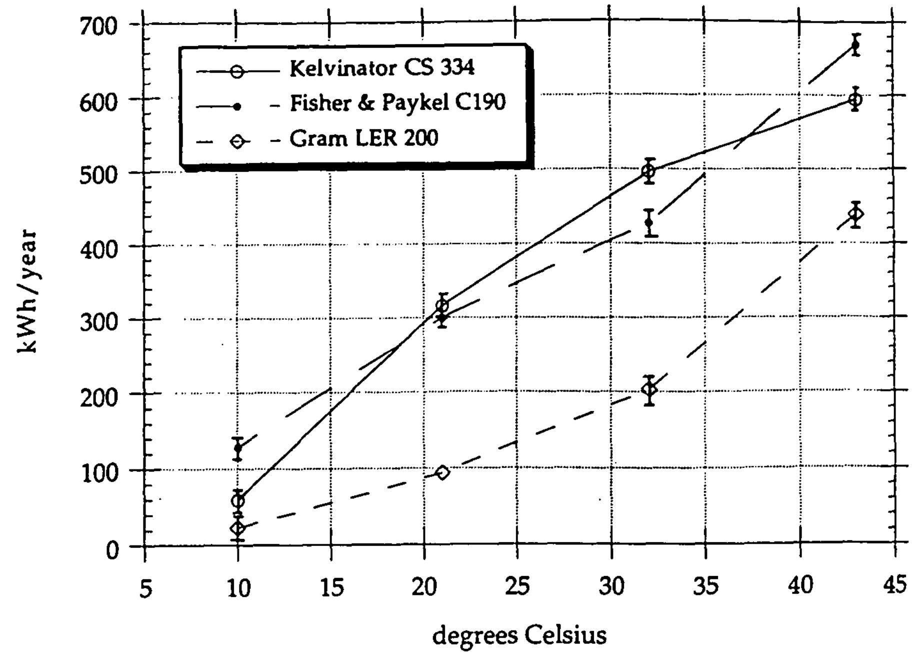
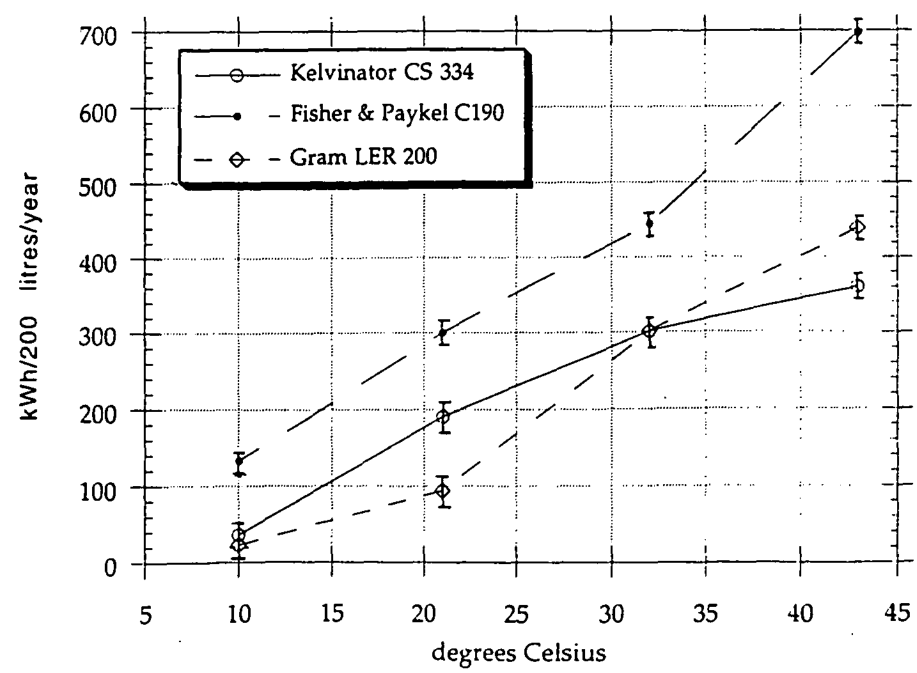


Figure 8.5 Refrigeration electricity use per 200 litres storage volume per year at four ambient test room temperatures.



& Paykel is the same size and class as the LER 200 and is in the middle of the range in terms of efficiency of refrigerators of its size and class on the Australian market, it suggests that potential for increasing the energy efficiency of refrigeration in Australia is significant. Furthermore, as the purchase costs of the two refrigerators were comparable[5], these improvements would appear to be cost-effective.

Since the measurements of refrigeration energy consumption for labelling purposes in Australia are taken as those measured at an ambient test temperature of 32 ^{0}C, the results of the energy consumption tests carried out at that ambient test temperature are summarised in Table 8.3. The information in Table 8.3 indicates a number of things, the most evident of which is that the annual energy consumption of the Gram LER as measured under standard test conditions in Australia is double that reported in the literature. This difference is attributable to the differences in the European and Australian standard test methodologies, the former using an ambient temperature of 25 ^{0}C and an average refrigerator compartment temperature of 5 ^{0}C (Pedersen & Lawætz 1989: 11, Nørgård 1989: 131, Toone 1991: 5, Crothers 1991: 5). From Figure 8.4 it can be seen that the European standard test conditions would appear to be equivalent to an ambient test temperature of 21 ^{0}C and a refrigeration compartment temperature of 3 ^{0}C since the annual energy consumption of the Gram LER at that point is very close to that given in the literature. The difference between the energy consumption of the LER under Australian and European standard test conditions supports the argument that caution is needed in basing estimates of the energy saving potential of energy efficient technologies from information given in the literature untested under local conditions.

Table 8.3 Energy consumption with an ambient temperature of 32 ^{0}C and an average compartment temperature of 3 ^{0}C.

	Kelvinator CS 334	Fisher & Paykel C 190	Gram LER 200
Energy consumption per 24 hour (kWh/24 hr)	1.359	1.17	0.5565
Energy consumption per year (kWh/year)	496	427	203
Energy consumption per 200 litres per year (kWh/200 l/year)	301	401	203

The second point that emerges from Table 8.3 is that whilst the energy consumption of the Kelvinator CS 334 measured in this study was very close to the energy consumption

5 The purchase cost of the Gram LER 200 excluding freight from Denmark was very similar to the costs of the Fisher & Paykel C 190.

figure given on its label (490 kWh p.a.), the energy consumption of the Fisher & Paykel C 190 was 7% below that shown on its label. This difference was outside the error range of the energy consumption measurements in this study and suggest that the information on the labels is not always accurate. This is supported by the results of energy consumption tests carried out by the Australian Consumers' Association [ACA] (1992: 16) in which it was found that the annual energy consumption of some refrigerators measured under Australian standard test conditions deviated substantially from that claimed by their manufacturers. The annual energy consumption as determined by ACA's test was usually found to be lower than that given by the manufacturer. Of the refrigerators tested by the ACA, the one for which the variance between the manufacturer's estimate of energy consumption and the ACA's own estimate was greatest was the Fisher & Paykel P 120J, a 120 litre bar refrigerator. This refrigerator was found by ACA to have an annual energy consumption as determined by the standard test of 235 kWh, 27% less than the 320 kWh p.a. energy given by the manufacturer and indicated on its label. From the point of view of the labelling programme, it could be argued that if labels are to be used to provide consumers with information relating to energy use then it is of vital importance that this information be accurate. It is clear from this test and those of the ACA that currently this is not always the case.

The issue of the accuracy of the information contained on energy performance labels runs into a greater problem, however, in terms the validity of tests results carried out under Australian standard test conditions for many locations. Comprehensive energy consumption measurements of over two hundred Gram LER 200s in households in Denmark established that the energy consumption of the Gram LER as measured by the European standard test was very close to actual average annual energy consumption in households in that country (Pedersen & Lawætz 1989: 25). Refrigeration energy consumption in Australia is obviously likely to be higher, all other things being equal, than in northern Europe due to the hotter climate in Australia and it is possible that the Australian standard test simulates relatively accurately refrigeration energy consumption in the average Australian home, although there appears to be limited research data available with which to support this contention. The Australian standard test is similar to that used in the USA and Stewart (1985: 3) did find on the basis of limited field testing that actual refrigeration energy, as measured in households in Missouri, was relatively close to the estimates obtained in the laboratory under US standard test conditions. It is nonetheless apparent that the accuracy of estimates of annual refrigeration energy consumption based on this method will decrease as one moves away from an 'average' Australian climate. The information on energy consumption borne on appliance energy labels in Australia, for example, would appear to have little meaning in Tasmania which may well more closely approximate conditions in northern Europe than those in New South Wales. Thermal comfort levels in Tasmanian homes have long been noted to be low relative to their mainland counterparts (Larson 1968: 34) and although this difference is likely to have been reduced since Larson made his study, the proportion of households in Tasmania that are centrally heated remains relatively small (Chandler *et al.* 1983b: 3). Many householders in Tasmania, furthermore, heat living areas and close off unheated areas of the house (Coldicutt *et al.* 1986: 9). For this reason, the average ambient temperature in the typical Tasmanian household in areas where refrigerators are installed is likely to be well below the 21.5 ^{0}C assumed by the Australian standard test. As one colleague quipped, in Tasmania you go to the kitchen on a cold winter's morning, open the refrigerator door and let the warm air out.

The present method of dealing with this variation in annual energy consumption of the same equipment over a range of climates and different household environments, is that energy labels carried by appliances in Australia bear a caveat, *writ small,* which advises consumers that the appliance's actual energy consumption is dependant upon where they live and how they use the appliance. This means that in many situations energy labels serve purely as a guide to relative energy efficiency and are of little assistance in terms of informing buyers of absolute cost-effectiveness. This problem becomes even more thorny, however, in the case of national mandated energy performance standards [MEPS] should these be introduced. In setting a standard on the basis of cost-effectiveness, the difficult question will be that of 'cost-effective for whom?'. Setting a standard that is cost-effective for an average household in Sydney may eliminate cost-effective options for households in colder climates such as Tasmania.

A further issue concerning the applicability of refrigeration energy consumption as determined by the current Australian standard test method is the degree to which this closed door test which uses an elevated ambient test temperature to compensate for the lack of door openings will become less accurate as the efficiency of refrigerators increases over time. As the energy efficiency of refrigerator is raised by increasing insulation in the panels, the impact of door openings on energy use increases relative to other losses. It has been suggested by a number of writers that the validity of the closed-door test method will decrease over time as a result of the increasing relative importance of door openings on energy use (Stewart 1985: 5, Nørgård 1989: 331).

8.5 Summary and Conclusions

The conclusions drawn from the results of the refrigeration tests discussed in this chapter need to be qualified in terms of the limitations of the research. The fact that the refrigerators studied were Class 1 refrigerators with no freezer compartment means that the results cannot be extended to refrigerators or refrigeration energy use in general as the portion of Australian households which currently use such refrigerators is relatively small, although increasing over recent years as the market share of twin refrigerator/freezer sets has grown. A second limitation of the research is the fact that only one refrigerator of each model was tested. It is known that individual refrigerators of same brand and model can vary in electricity consumption under standard test conditions (Stockwell 1988: 26). The inability to maintain an ambient test room temperature constant to within ±0.5 ^{0}C with the heating control equipment available also added to the potential error of the results[6].

The two conclusions can be drawn from this chapter. The first is that this scope is real, although not as significant as often assumed. The Gram used less than half of the energy of the Fisher & Paykel C 190 when tested under Australian standard conditions, and the Kelvinator CS 334 used about 50% more than the Gram when corrected for size. It would therefore be possible to build a well-designed refrigerator the same size as the Kelvinator CS 334 which used approximately two-thirds the energy. As the absolute differences in standard energy consumption (energy use per 200 litres p.a.) were the same whether tested at an ambient temperature of 32 ^{0}C or 21 ^{0}C, this conclusion remains valid over a relatively wide range of climatic conditions. This demonstrates that there exists significant technical capacity to reduce household refrigeration energy requirements in Australia by inclusion of the features of the Gram LER into their design. The major constraint is the inability of such energy efficient refrigerators to meet the requirements of the existing pull down test criteria based on the harshest climatic conditions experienced in many parts of Australia. The inability of energy efficient refrigerators such as the Gram LER to meet such performance criteria and the assumption that energy consumption is the only criterion of importance have been cited as the fundamental flaws in the common assertion that there exists significant scope for increasing the efficiency of Australian refrigerators. The Executive Director of Australia's largest appliance manufacturer, EMAIL Australia Ltd, R.C. Toone, has argued that an energy efficient refrigerator that cannot rapidly cool down beer on a hot day is about as marketable in Australia as a fuel efficient car that can not go up steep hills. When performance is factored into the equation, according to Mr Toone, Australian made refrigerators are already highly efficient (Toone 1991: 5). It needs to be remembered, however, that appliance manufacturers in the USA protested against the introduction of mandated efficiency standards in that country using similar arguments, yet managed to meet the stringent standards imposed by the US Department of Energy (Weizeorick 1991).

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[6] A means of reducing the fluctuation in ambient temperature was devised during the course of the testing programme using a two-circuit, 240 volt Moeller 22E relay to switch on a small electric heat source equivalent to the heat output of the refrigerator during its 'off' cycles and to switch it off again during the 'refrigerator's on' cycles to achieve a relatively even heat output. Unfortunately, the switching device was not constructed in time for the tests included in this study.

The second conclusion that can be drawn from the chapter is that although the harsh climate over much of Australia militates against the argument that refrigerators can be designed to reduce energy use by very substantial amounts, the technical scope for reducing refrigeration energy use in temperate regions of Australia, and in Tasmanian in particular, remain real. The potential savings to the individual represented by the Gram compared to the Fisher & Paykel are of the order of $20 p.a. (in 1996 dollars), assuming an electricity tariff of 10c/kWh. This compares well with the assumption made by the first assessment of the scope for energy efficiency in Tasmania that electricity consumption of refrigerators could be decreased by 37% to 40% at an extra capital cost of $20 to $30 (in 1980 dollars) (Harwood & Hartley 1980: 27). It is a claim that rests, however, on the argument that refrigerators retailed in temperate regions of Australia should not have to perform under the harshest climatic conditions in the country. The proposal to reduce the refrigeration energy requirements in temperate regions of Australia therefore rests on the feasibility of producing energy efficient refrigerators suited only to that region. In this regard, the perspective of the Australian whitegoods manufacturing industry is critical.

The Australian whitegoods industry has been described as economically undersized, production rates being well below the 500,000 units p.a. considered by overseas experience as a minimum efficient scale (Linge 1979: 194). These small production runs are the primary reason for the lack of experimentation and why Australian manufacturers piggy-back off the innovations by their parent companies in other countries (Harries 1965: 125). This problem has been compounded by the highly competitive nature of the industry which has led to the production of a wider range of products available to Australian consumers than in comparable countries (Department of Industry and Commerce 1978: 10). Saturation in the market for many whitegoods after the mid to late 1970s led manufacturers in Australia to increase replacement rates by introducing new models with labour saving features, improved performance and reduced running costs (Bureau of Industry Economics 1983: 35). This had the double effect of further lowering production runs and delaying retooling as the longevity of manufacturing equipment used to produce these whitegoods is determined predominantly by total production. For economic reasons, the Australian whitegoods industry is unlikely to favour yet greater diversity of products such as separate models for different climatic zones that would further reduce production runs. The prospects for such low energy refrigerators becoming available in temperate regions of Australia will depend therefore on either the emergence of new companies producing refrigerators specifically for this region, or on the import of low energy refrigerators from overseas. However, caution over the likely success of any such venture under existing conditions is warranted.

Australian import tariffs for overseas manufactured refrigerators has decreased over the past two decades from over 25% to around 7%, and will decline further in the future. One of the greatest constraints faced by importers, however, is the need to comply with Australian standards in order to receive an accredited label. Unless these standards are altered, low energy refrigerators that cannot meet these performance criteria will find it difficult to gain entry into the Australian market. An interesting case study can be used here to make the point. Toshiba refrigerators have been noted for their energy efficiency relative to other models, the most efficient Toshiba refrigerator retailed on the USA market using one third as much energy as the average refrigerator of the same class and size (Lovins 1985: 24). Toshiba, however, withdrew its refrigerators from the Australian market in the late 1980s. The reason given to this author was that the company considered the Australian standard to be unrealistic as it meant redesigning their refrigerators to perform over the whole range of climatic conditions in the country (General Manager, Toshiba Australia Ltd, personal communication, Oct. 1991). The introduction of labelling in this instance removed energy efficient refrigerators from the Australian market by forcing out models which operated efficiently in temperate climates but which did not perform to Australian standards in hotter climates and thus served to eliminate a competitor to local manufacturers. The small number of local firms controlling the Australian market renders it easier to agree to standards which advantage local industry at the expense of potential competitors since consensus among local manufacturers is more likely when the number of players is small. Massive rationalisation of the Australian whitegoods industry in the period after the second world war allowed producers to increase production rates and decrease unit prices, but resulted in an industry structure described as a tightly differentiated oligopoly (Harries 1965: 138). The number of firms which control the industry has steadily declined and today four firms account for an 80% share of the Australian market. These firms have a considerable input into the setting of standards as they are well-represented on the committees which set the relevant standards. Unlike representatives from other organisations on these committees, moreover, representatives from appliance manufacturing industries regularly attend committee meetings. It is possible that the standards introduced have tended to deliberately favour locally manufactured products and discriminate against import rivals. The apparent arbitrariness and limited relevance of some of the criteria of performance standards, such as those used as the basis of the pull-down test, and the absence of some apparently sensible performance measures, such as the ability to keep food cool for longer periods during interruptions to the power supply or to allow refrigerators to be used with off-peak electricity, lend support to such a hypothesis.

Even if the Australian standards were altered to approve refrigerators that performed adequately in temperate regions but not hot climates, the ability of new firms to gain significant market is questionable. Past attempts to break into the Australian refrigerator market by even large companies such as Hoover, which already dominate other areas of the Australian whitegoods market such as washing machines, failed (Harries 1965: 123). While this has been attributed to brand loyalty, in reality it is more complex than simply a question of gaining public acceptance. In most countries, a small number of distributors account for a very large proportion of total sales of whitegoods and new brands have to first gain the confidence of these distributors (Mesdag 1983: 52). The New Zealand firm, Fisher & Paykel, has managed to capture a 14% share of the Australian refrigerator market and an 18% share of the Australian freezer market in five years (*The Australian Financial Review* 1 January 1995: 13) and this indicates that the capacity to gain entry to the Australian refrigeration market as import tariffs have been has increased. The failure of European firms to retail energy efficient refrigerators on the Australian market on two separate occasions to date (Mr Bob Adams, personal communication, Executive Director, AEEMA, October 1991), however, suggests that it nonetheless remains difficult.

In conclusion, although the refrigerator testing programme discussed in this chapter confirmed the existence of significant technical scope for reducing refrigeration energy requirements in temperate regions of Australia with available and cost-effective technology. Until there is a sufficient increase in either the public concern over the social costs of energy use or the importance of running costs among Australian consumers, however, it is likely that manufacturers will move to produce climate-specific models and it is likely that refrigerators sold on the Australian market will continue to be designed to perform under the full range of climatic conditions. It is therefore unlikely that the demonstrated cost-effective technical potential to increase the efficiency of refrigeration energy use in temperate regions will be rapidly translated into reality and the efficiency of refrigerators sold in such regions is likely to continue to be determined instead by those factors which determine the rate at which the refrigeration energy efficiency increases in Australia as a whole, whether this be competition from overseas products, changes in consumer preferences, or the introduction of national mandated energy performance standards.

As to the impact of national MEPS on household sector energy requirements, if and when these are introduced in Australia, it can be concluded from the above discussion that this will obviously depend on the level at which they are set. To the extent that the function of MEPS is to remove the most inefficient products from the market, it would appear that to be effective they would need to be set at more than a minimum since many one-star products have already disappeared from the market, a phenomenon that has been ascribed by some to a consequence of the labelling programme. The function of MEPS, therefore, would be to rapidly force up the energy efficiencies of products sold on the market by progressively raising the minimum standards. What emerges from this research, however, is that unless these minimum standards are set differentially for different regions of the country they will fail to capture much of the cost-effective technical energy savings that are technically possible.

Chapter Nine

Synthesis

> Someone, somewhere, sometime, ended a book with a conclusion. This idea has its drawbacks, but it became a custom, and as Plutarch remarked, 'we are more sensible of what is done against custom than against nature'.
>
> — Fairfield Osborn (1953) *Our Plundered Planet*: Little & Brown, London: 151.

9.1 Introduction

In attempting to write a concluding chapter, the study comes full circle as it confronts the same problem that was encountered in the introduction and which was the reason why the study began with what may have appeared to some as a circuitous account of the origin of the study. That account was necessary because a truly interdisciplinary study confronts the very real problem of the considerable gulfs between the ways in which different people interpret the world. This entire study has rotated around the considerable discrepancies over both the perceived causes of the frequent low priority assigned to energy conservation in energy planning and how policy reliance on energy conservation can be increased. In attempting to conclude this study, those differences in paradigms resurface because they are also associated with expectations as to how such a study should conclude. At one end of the spectrum, those who operate from a technically optimistic paradigm will regard a study such as this to have no value unless it offers practical solutions to the problem at hand, namely the low emphasis of energy conservation in energy policy and planning. They will therefore expect nothing less than a set of firm recommendations typical of technical reports, together with a set of concrete guidelines as to how such practical recommendation can be put into effect. It may be possible to conclude from this study, for example, that to increase planning emphasis on energy conservation it is necessary to improve communication between different experts by adopting a multidisciplinary approach to energy planning with social scientists, technical experts, political scientists, economists and engineers working together. Such recommendations, however, have now been reiterated on so many occasions that to do so once more is unwarranted. In some cases, furthermore, the various policies and policy instruments potentially useful in accelerating the uptake of energy conservation have been so thoroughly canvassed that to repeat them would risk mere pastiche[1]. The point that this study has attempted to make is that such

[1] See, for example, Schipper & Meyers (1992), Chapter 11 (pp. 305-27) and Chapter 12 (pp.

recommendations ahve been advanced repeatedly but have more often than not been disregarded by policy makers. While Chapters Five and Six were used to illustrate how these recommendations or proposals have been routinely ignored in a particular case, this has been the common experience in most other situations. The intent of this study, therefore, has not been on reaching the end to once again reiterate those recommendations. Instead, its aim has been to reach a better understanding of why those recommendations have not been heeded by policy makers, what must happen before policy makers start to listen to such advice, and what role scientific research can, and cannot, play in this endeavour. The attempt reach such an understanding has required an eclectic approach involving a variety of arguments. The purpose of this final chapter, therefore, is nring those arguments together to present a more coherent summary and to discuss their implications for scientific energy conservation research. It begins by first examining more closely the causes of the frustration and repetition so evident within the literature on energy conservation because such an understanding goes a long way toward understanding the reasons for the low policy emphasis on energy conservation.

9.2 The Causes of Perplexity and Frustration

An assumption of this research has been that the root cause of the perplexity of scientific energy conservation researchers and environmentalists is that they inadequately take into account the economic, social and political contexts in which their energy conservation proposals would be implemented. That they fail to do so is not altogether surprising as the question of why there is not more energy conservation is a riddle with no single answer, and attempting to find the answers leads into a complex conceptual maze involving interconnected political, legal, economic, socio-psychological, and technical themes, many of which seem to lead to dead-ends. At the heart of the issue, furthermore, is the need to understand why policy makers continue to rely on supply expansion and it has been shown in this study that understanding why policy makers make the decisions that they do is not easy.

Superimposed on this complexity is the fact that the degree to which policy makers rely on energy conservation is not uniform in either place or time. A contributing factor to the failure to understand why energy conservation is adopted in some regions or countries while it happens in others is a bias within the energy conservation literature which focuses to a very high degree on those case studies where policy emphasis on energy conservation is comparatively high. The explanation for this, according to two energy analysts, is that those cases where energy conservation is assigned low priority

328-52).

as a policy option, or where energy conservation programmes are tried but to little avail, are not written up or published in the energy conservation literature as there is considered to be nothing to write about (Gadgil & Sastry 1994: 151). This bias, the argument goes, leads to the misconception that energy conservation has been an important component of energy policy in most countries and regions of the world.

Another contributing factor to the failure to understand why energy conservation is not adopted to a greater degree is the tendency to overlook the differences between countries. Kellow (1996: 170) has argued that overgrowth of public electricity supply based on the provision of large blocks of subsidised electricity to industrial clients (reverse adaption), can be explained in terms of strong support for distributive politics favouring development. This provides one explanation for lack of interest in energy conservation in particular situations. Other differences between countries and regions also exist and account for variation in policy emphasis on energy conservation. Differences in the costs of energy, the perceived need at the policy making level for reductions in energy use as strategic or economic national goals have been important determinants of the level of policy emphasis on energy conservation. Differences in the scale of local opposition to supply expansion proposals and in the political, administrative and legal ability of individuals and community pressure groups to question energy planning decisions also account for differences in the degree of policy reliance on energy conservation. But these differences alone cannot explain which governments do and which do not place importance on energy conservation. Nigel Lucas (1985) has written a comparative account of national energy conservation policies in Western Europe and found that many of the differences in the degree to which governments intervened to reduce energy use had to be explained in terms of political culture. There was no easy way, Lucas suggested, to explain Italian energy or energy conservation policies.

Variations in the degree to which energy conservation is adopted as a policy option at the regional and local levels cannot be explained purely in terms of the level of public opposition to supply expansion proposals. Throughout the 1980s and early 1990s, for example, Victoria was the sole Australian state to make a sustained and serious policy and research commitment to reducing the demand for electricity. While that policy commitment was initiated by a state government with a traditional leaning towards the Left, this difference in policy interest in conserving energy between the Australian states could not be explained in terms of differences in the political philosophy of the major parties since Labor governments in other states were as lax in their commitment to energy conservation as their conservative counterparts. Rather, it appears that differences in policy commitment to energy conservation at the state level also needs to be explained in part in terms of the social context and the unpredictable arrival on the political scene of dominant individuals willing and able to push through energy policy reforms within those contexts. Policy reform, however, is a two-way process and policy interest in energy conservation often appears to be fickle. Energy policy is characterised by long periods of sole reliance on supply expansion strategies punctuated by brief periods of increased attention to energy conservation.

The ultimate cause of the frustration of those who advocate energy conservation, however, has to do with both a clash of values and paradigms, with differences in rationalities or in the way that individuals *think*. Environmentalists interpret what is rational in terms of what appears to be ecologically sensible and socially important but operate in a world where rationality has come to mean instrumentally rational, and instrumentally rational has largely come to mean that which is economically rational. In an instrumentally rational world, environmentalists are doomed to being frustrated because they are forced to be instrumentally rational in the pursuit of their ends, but as a result must fail to reach those ends most crucial to them (Poole 1991: 143).

Scientifically trained energy efficiency analysts, on the other hand, base their demands for reducing energy use on instrumentally and economically rational arguments and therefore perceive these proposals to be 'spherically sensible' (Socolow 1991: 573). They and their supporters are therefore doubly frustrated and perplexed when these apparently 'rational' demands are also resisted. This perplexity has been due in part to professional modes of thinking (Nader & Milleron 1979: 957-8) and to the mistaken belief that cost-effective technical energy efficiency and economic efficiency are the same thing. As a result, much contemporary debate over energy policy has consisted of an ongoing squabble between technical energy efficiency analysts and conservative economists (Hinchliffe 1995). But this perplexity has also been caused by the fact that physical scientists are first and foremost 'problem solvers' who look for elegantly simple solutions and explanations (Maslow 1966: 122). They are trained to think logically and assume that all others do likewise. They look for the 'correct' answers and find it difficult to engage in debate characterised by contradictory views and opinions (Ruedisili & Firebaugh 1975: i). Physicists in particular are trained to think in such a way (Barrow 1992: 12) and, as shown in Chapter Four, it has been physicists who have spearheaded the demands for aggressive energy efficiency policies. Such analysts overlook the fact that energy use is not purely a technical issue and that problems are therefore rarely simple and solutions rarely elegant.

The real cause of frustration of both energy efficiency experts, however, is their failure to understand the nature and scale of the resistance to their proposals and the fact that policy decision making is often governed not by what is economically rational but by what is in the political interests of influential individuals, organisations and groups rather than by what is in the public interest - however that is defined. It is the separation between the political analysis of energy policy on the one hand, and the economic and technical analysis on the other, that is most apparent within the literature.

For while the energy *literati* boldly elevates the status of energy policy to that of a new discipline (Huntington *et al.* 1994: 795), their conception of what constitutes energy policy analysis is often extremely narrow. One group of energy efficiency experts, for example, has asserted that this new discipline amounts to simple techno-economic energy efficiency analyses (Lovins *et al.* 1989: 12). As a result, debate over energy policy is conducted by different groups with their own, separate bodies of literature. Journals such as *Energy Policy* have been set up for one audience, and the pages of such journals are dominated by the analysis of past trends in energy use, estimates of the potential of various energy options to meet future energy needs, assessments of the ability of energy efficiency or nuclear energy to reduce greenhouse gas emissions or reliance on imported fuels, and so on. Political analyses offering explanations of why certain policies are, or are not, adopted, attract another audience and are written up in political journals. This schism within the literature between these two schools has contributed greatly towards the sense of frustration that pervades the energy conservation literature because it reflects in part a failure to understand why energy conservation is not relied on as a policy option to a greater degree than it is and the apparent limited capacity of scientific energy conservation research to change this.

9.3 The Failure of Energy Conservation Research to Influence Policy

To explain the low priority given to energy conservation, this study has used a three-tiered approach. Briefly reviewing each of these is a useful first step in explaining the limited impact of scientific energy conservation on energy policy and decision making.

The explanation for the low priority given to energy conservation in this study began with the most potent arguments for energy conservation, those associated with the demand for radical reductions in energy use to halt growth in energy use or reduce energy use in absolute terms. The arguments upon which these demands have been based were shown to be routinely dismissed by policy makers as unrealistic, unproven or irrational. They are often interpreted as ruses used to prod governments into action in the form of more modest energy conservation policies as a means of ameliorating more immediate and local energy-related problems, problems which policy makers generally consider best resolved through the use of technological fixes.

Environmental writers commonly explain the rejection of these demands in terms of psychological denial on the part of policy makers, a denial induced by an unwillingness to abandon economic growth. The fact remains that resistance to abandoning economic growth is near-universal While economic growth remains a dominant social and political objective, the capacity to reduce energy use is limited. For energy use to be dramatically reduced, energy prices would need to increased sharply or draconian regulation imposed, or both. While it has been argued in Chapter Four of this study that the capacity for political decision making by which unpopular decisions are foisted onto an unwilling public is real, it was also argued in Chapter Two that there are limits to the degree to which democratically elected governments are able to introduce unpopular policies such as those which would substantial increase in the price of energy. This means that reductions in energy use which involve a reduction of economic growth would require resolution of a difficult chicken-and-egg problem: as democratically elected governments are constrained in many areas by what their electorates permit, policies such as major increases in the price of energy would have to await a major change from below in the form of a spontaneous shift in societal values and a reduction in wants and material standard of living.

Although mathematical simulation based on game theory has lent theoretical support to the notion that such abrupt and unexpected social change is possible (Glance & Huberman 1994), most policy makers and commentators curtly dismiss the idea that people will voluntarily choose a lower material standard of living as a remote possibility (Rooke 1995: ii). A number of proponents of energy conservation, however, insist that a reduction in material wants and standard of living is not only desirable or necessary, but maintain that social values are constantly evolving and that changes in social values which result in a shift to acceptance of a lower material standard of living is not altogether out of the question (Pears 1990: 448). Social theorists have gone further in arguing that a change in societal values to reduced material wants is entirely feasible (Huëting 1980: 187). More optimistic commentators interpret changes in public attitudes toward smoking and harsher penalties for drink drivers as signs that such shift in social attitudes may be possible (Fells & Horlock 1995:213), while the most optimistic interpret such signs as evidence that a fundamental shift in social values is already under way (Lowe 1990b: 224). In a similar vein, it has been suggested that there are hopeful signs that the transport systems of Australian cities are about to 'flip' into a radically more energy efficient mode (Newman 1994: 101).

It needs to be remembered, however, that suggestions that a spontaneous shift in societal attitudes is just around the corner is part of an optimistic paradigm and have consistently been made over the past two and a half decades. The oil crises of the 1970s and early 1980s led to a belief that such 'a Kuhnian paradigm shift' (Kuhn 1970) in societal attitudes towards energy had in fact occurred (Crossley 1980a: 452). This led subsequently to a search for 'barriers to energy conservation' to explain the low evidence of any substantial change in energy-using behaviour, the hypothesis being that while attitudes had changed, something prevented this shift in attitudes from being translated into action (Crossley 1983). In-depth qualitative social research, however, found little empirical support for the original supposition that there had been any shift of substance in public attitudes towards energy (Kerby & Phillips 1983). More recent observers have also debunked suggestions that there exists evidence that a fundamental shift in values may be occurring, and insist that there is as yet no evidence that people are willing to forego their high material standards of living (Luke 1993: 141, Mittra *et al.* 1995: 45). In this view, growth in energy use is not a separate issue, but a part of the total growth ethic.

The argument that alteration of social values is difficult is supported by those who consider social values and attitudes to be shaped within the framework of very hefty social and economic influences. Such observers are therefore dubious about the prospects for major changes in social values occurring in the absence of prior institutional change. Our current institutions, and the values they shape, are seen by such observers, moreover, to be the root cause of the frustration and repetition that pervades not only energy conservation research and other attempts at environmental policy reform, but society in general. To such writers, what this system of values has achieved:

> ... is not satisfaction, but frustration; not creativity and repose, but endless repetition, punctuated with occasional satiation. (Poole 1991: 142)

Energy efficiency experts and disciples of the 'new economics', such as Michael Jacobs (1991) and Victor Anderson (1993), have attempted to get around the dominance of economic growth as a social objective by arguing that it is possible to substantially reduce energy use without reducing material standards of living. Rapid increases in the technical efficiency of energy use and an overhaul of the economy to shift to less energy-intensive modes of production, are seen as the means of having our cake and eating it as energy use can be massively reduced without damaging economic growth. Most advocates of aggressive energy efficiency nonetheless concede that radical restructuring of the economy and the implementation of all energy efficiency measures are likely to be insufficient to reduce energy use to sustainable levels whilst the global human population and material standards of living in developing countries continue to increase. Increased technological efficiency may also be inadequate because of a strong tendency for increased energy efficiency to be offset by increased output in market economies while social attitudes remain unchanged (Jacobs 1991: 56, Holdren 1992a: 45, 1992b: 167, Anderson 1993: 20).

It was shown in Chapter Four, however, that the structural relationship between business and government makes adoption of such aggressive energy efficiency proposals difficult. By encouraging the perception that the costs of industrial closure will be very high, in terms of both reduced employment opportunities and the state's revenue base, and therefore the popularity of governments, business is able to put up strong resistance to policies and policy changes potentially damaging to its profits. Although environmental issues are now commonly perceived to be permanently on the policy agenda and less radical environmental groups are perceived as having acquired insider status and greater access to policy makers (Papadakis 1994, Papadakis & Moore 1994), a number of policy analysts point to this strong structural relationship between government and business to warn against interpreting increased environmental concern at the policy level as a harbinger of radical or permanent change (Miller 1989: 330, Jänike 1990: 4, Beck 1992: 25, Dryzek 1995: 298).

There are, therefore, good reasons for being sceptical about the environmentalist claim that energy use can be substantially and rapidly reduced by either altering individual values or by dramatically increasing the technical efficiency of energy use and overhauling the economy. Such claims need to be considered in the light of Sandbach's (1980: 169), question: 'What good does it do to recommend a remedy when the cause of the problem is our social and economic structures themselves?'. When this rhetorical question is borne in mind, the repetitious nature of environmentalist demands for very substantial reductions in energy use that impinge on levels of growth is more understandable. In an economic system structurally dependant on growth, a political system structurally dependent on the health of the economy, and individual values shaped by the social and economic systems, environmentalists are doomed to repeating themselves (Beck 1995: 1). Scientific researchers, furthermore, repeat themselves because while they attempt to contribute towards the resolution of environmental problems with a single-mindedness and passion, their efforts have been to little avail because those efforts have ignored sociological and political realities. But without consideration of the distribution and structure of power and prevailing norms, such debates are 'either meaningless or absurd, and probably both' (Beck 1992: 25).

Energy conservationists therefore retreat to moderate energy conservation proposals on the grounds that although a compromise, they are still capable of achieving important environmental and social goals, such as reducing pollution levels from what they otherwise would have been. The rejection of these moderate proposals by polcy makers, however, needs to be explained in a number of ways. First, if they cannot resolve the problems raised in the high energy conservation discourse, then they immediately loses much of their appeal. If conservation is not able to permanently halt construction of energy supply construction programmes, then while it may be economically rational and may contribute to important environmental and social goals, it can only defer the need for further construction but does not provide an alternative vision. The gains achieved by these moderate energy conservation strategies, moreover, are eventually offset by growth in demand (Jacobs 1991: 56, Anderson 1993: 20). From an environmental perspective, they are temporary measures only. This inability of moderate energy conservation to provide either a complete or permanent solution to energy related problems reduces the political salience of moderate energy conservation demands and the economic rationale for moderate energy conservation becomes more important.

Secondly, explaining why scientific research which points to the scope for moderate and economically rational reductions in energy use has been ignored requires looking at the assumptions underlying that research about why energy conservation policies are not adopted. A number of possible assumptions can be canvassed. One possible implicit assumption is that policy makers have a latent interest in placing greater reliance on demand reduction strategies but are prevented from translating this into action because they suffer from an information deficit. Under this assumption, energy conservation research would be seen as one vehicle able to fill this information gap. The assumption that policy makers are interested in energy conservation and are actively seeking practical information on how it can be put into place has been shown in this study, however, to be clearly contestable in many situations. In such situations, the demand for 'rational' reductions in energy demand has been actively resisted by organisations with a vested interest in continued expansion of rates which suit organisational interests. These organisations, furthermore, have been aided in this stratagem both by governments keen to maintain control over energy policy in order to ensure security of energy supply and to advance statist development policies of a scale that was not possible at the time under private ownership of electricity supply. They have also been supported by large industrial users of energy which reap the benefits in terms of cheap, and often subsidised, energy. Under this strategy, economically rational energy policy has been overridden by political goals.

A second possible implicit assumption of scientific energy conservation research that could be put forward is that even if planners are uninterested in learning about economically rational demand reduction options in the strategic interests of the energy supplier, research which points to substantial scope for saving energy at a cost below the marginal cost of supply would be difficult to ignore. The perceived role of scientific energy conservation research then becomes to either inform policy makers actively seeking information on how to reduce energy use, or to embarrass more recalcitrant policy makers into placing greater reliance on energy conservation. This argument is not easily refuted and, if accepted, suggests that the explanation for the failure of scientific research to alter policy must therefore rest with the research itself. Two possible shortcomings of this research can be suggested.

The first has to do with the strategic nature of policy making and the requirements of planners. Due to the strategic nature of policy making, policy makers require unambiguous and precise information before committing themselves to policy reforms. In the case of energy conservation, this means that research is perceived as useful by policy makers only if it offers accurate information about the amount of energy that could be saved, the cost of saved energy, and the permanence of those energy savings, and so on. What many scientific researchers have failed to understand is that they are not competing with supply side options on an equal footing but, because of the perceived asymmetry in risks associated with supply side and demand side strategies, they need to provide particularly accurate and unequivocal information about the potential for saving energy. These requirements for precision are amplified by the fact that those interest groups which resist proposals to slow down the supply construction programme are able to use uncertainties regarding both demand and the scope for conservation strategies to great effect. While scientific energy conservation research has sought the type of information required by planners, the information it has actually provided has been too ambiguous and imprecise to be of use to planners.

The second possible shortcoming of the research is that while it has attempted to assess the 'real scope for energy conservation' (Lewis *et al.* 1987: 1), the methodologies employed have provided information of little value to planners. Quantitative survey instruments have been used on numerous occasions to collect reams of 'hard' factual data on physical dwelling characteristics and socioeconomic, demographic and attitudinal variables which are then used to calculate correlates of household sector energy use or to construct models of household energy use. The value of this information to policy makers and planners interested in finding effective ways of reducing the demand for energy has been variable. As discussed in Chapter Seven, the attempts to explain energy use in terms of attitudinal variables has been uninspiring, a result which does not surprise many social theorists. The large surveys that employ extensive, as opposed to intensive[2], methodologies suffer many other problems. The considerable requirements involved in ensuring that the sample is random and representative, and in ensuring that the survey instrument is reliable and valid, are so substantial that the mechanistic aspects of these surveys tend to quickly dominate the research process with the result that getting the survey done becomes the end goal and researchers quickly loose sight of the original research question (Adams 1990: 25). Worse, many costly social surveys have been rendered of little value because they have failed to ask the right questions (Hardin 1991: 48). Although the funding for the large household energy conservation survey undertaken in Tasmania in the early 1980s (Challen *et al.* 1983), was provided largely for political reasons rather than as part of a serious effort to reduce electricity use, it was nonetheless a potentially useful piece of research. It was abandoned once the political relevance of energy conservation dissipated and the funding for the research began to dry up. This loss of political interest, in turn, probably led to the failure to collect data on oil use for space heating that would have been desirable in terms of the construction of an econometric model of household sector

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[2] Extensive survey methodologies rely on statistical sampling techniques and survey instruments which require respondents to answer predetermined questions, often by selecting from a narrow range of given response options. Intensive survey methodologies, on the other hand, use in-depth techniques which are less structured and allow the respondent to answer in their own terms and which permit the researcher to probe more deeply as the interview unfolds.

demand for energy and the termination of the project before an econometric model was produced.

At the epistemological level, many commentators question the ability of social research based on positivist methodologies to cope with the messy vitality of social systems (Sayer 1992: 32). Critics of these approaches maintain that they are borrowed from the natural sciences and while they are able to point to correlations and attempt to predict behaviour, they are ill-equipped to determine the causal factors of that behaviour or deal with the task of understanding human behaviour such as why individuals do, or do not, invest time, money and effort in energy conserving activities. Without such understanding, such writers argue, we are unlikely to be develop effective ways of altering their behaviour (Sawhill & Cotton 1986: 16). The dilemma for social scientists is that while intensive survey methodologies provide a more powerful tool for understanding the behaviour of energy users, the conclusions reached by such research often has little immediate policy relevance. Good examples of such research were the content analysis of group discussions by Kerby & Phillips (1983) and the non-random, small-scale, in-depth surveys carried out David Crossley in Australia in the early 1980s. Crossly's research stands as one of the few attempts at empirical identification of 'barriers' to energy conservation but reached the conclusion that not only did there appear to exist a large number of *types* of barriers to individual energy conservation, but that many of these barriers appeared likely to be highly resistant to removal (Crossley 1983: 545).

The policy relevance of much social research has been relatively weak. It has been used to suggest, for example, that the use of *all* policy levers - exhortation, education, enticement and enforcement - would probably avhieve meaningful reductions in household energy conservation measures (Crossley 1980: 299, Lewis *et al.* 1987: 109). Social research has also been used to point out that a combination of information campaigns and minimum insulation standards could increase the number of households with thermal insulation (Foster & Holmes 1994: 135). While these conclusion may be valid, they are relatively self-evident and do little to render policy makers more informed in terms of how much energy will be saved, at what cost, or how permanent these savings are likely to be, and so on.

This criticism that scientific energy conservation research aimed at advancing moderate energy conservation as an option has failed to deliver information useful to policy makers and planners has been lent tacit support from one prominent Australian energy supply organisation. The Gas and Fuel Corporation of Victoria (GFCV) has stated that despite massive research effort on household sector energy conservation undertaken over the past two decades, energy planners still have little to go by when attempting to assess the practical worth of energy conservation proposals (GFCV 1990b: 2). On a less formal level, the argument that scientific energy conservation research has failed to inform planners has been supported by the expressed opinion of one energy planner attending a workshop on household sector energy conservation in Victoria. This individual maintained that in his opinion, the only useful piece of research on household sector energy conservation undertaken in Australia to date was the Brunswick research project as described and discussed in Chapter Seven of this study[3]. This criticism of scientific energy conservation research suggests that even where policy makers have been open to the idea of increasing reliance on demand reduction strategies, the scientific research has to a very real extent not provided the requisite information to allow them to do so.

The rejection of moderate energy conservation proposals can therefore be explained in terms of political resistance to such strategies and the strategic nature of policy making. The limited impact of scientific research to alter policy in this regard can be explained by asking, 'What good does it do to recommend well-documented policies and policy instruments potentially useful in reducing energy use without addressing the uncertainties associated with these policies and policy instruments when it is precisely those uncertainties that prevent their adoption?'

From the above, it is clear that to a very real degree, technical and social energy conservation researchers repeat themselves because they tend to define 'the problem' in terms of what their disciplinary tools are capable of solving. In this regard, they have behaved not so very differently from the energy supply organisations at which they have levelled Maslow's famous aphorism, that if all you have is a hammer then it is amazing how everything begins to look like a nail (Harwood & Hartley 1980, Lovins & Lovins 1981). Those who advocate energy conservation explain the propensity of energy supply organisations to rely on continued construction of favoured technologies as a consequence of professional myopia. Scientific energy conservation researchers, however, have also tended to define the problem - low policy emphasis on energy conservation - in terms of what their technical analyses and social surveying skills can manage.

This leaves the question of why, when it is known that at least *some* scope for energy conservation exists, though of uncertain or limited extent, low-cost instruments such as prompts and information strategies are not more often employed to encourage energy conservation. The Brunswick energy conservation project discussed in Chapter Seven of this study (Thomas *et al.* 1993), as well as other research, has shown that even relatively simple strategies, if well designed, are capable of reducing household sector demand energy use by a measurable extent.

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[3] This information was relayed to the author by his supervisor, Dr John Todd, who attended that workshop.

Much energy conservation research that has pointed to relatively small reductions in energy use has been based on the vague notion that energy conservation is an uncontentious goal and that any reduction in energy use is therefore worthwhile. This view appears to have been particularly strong during periods of high concern over energy issues and the crisis mentality that something must be done and almost anything will be useful has been prevalent. An implicit assumption appears to have been that although more meaningful energy conservation strategies are resisted, low conservation strategies are likely to meet with low resistance so that these, at least, ought to be achievable.

It has been shown in this study that when the scope for energy conservation is uncertain, energy conservation tends to be overlooked as a planning option and that this is due to the fact that energy supply expansion is lumpy and that this is particularly acute in the case of reticulated electricity supply. Once the gap between supply and demand has been reduced, planners have a brief period in which to decide whether to quickly commit themselves to a new supply expansion project or to defer the need for investment in capacity expansion by reducing demand. It has been seen that planners are concerned primarily with avoiding shortages and so dismiss the latter option if the scope for energy conservation is uncertain. Other levers, such as deceleration or acceleration of the current supply construction programme are likely to be used instead as the primary means for balancing supply and demand. If the scope for energy conservation is uncertain *and* low, then obviously it will be even less likely to be relied on as a planning option in such situations.

Where the scope for energy conservation is relatively certain *but* is also relatively small, energy conservation is rejected because of the planning bias for load forecasts to err on the side of oversupply rather than undersupply. In this case, energy conservation is rejected because of a threshold effect and the uncertainties associated with projected growth in total demand. Low potential for energy conservation provides an ability to defer the need for capacity expansion by a short period only, the length of this period being determined by the projected load growth. Where the projected rate of growth in demand is high, energy conservation will be able to defer the need for capacity expansion by a very brief period and the advantages of doings so are swamped by the large uncertainties over total load growth. Low but certain scope for conserving energy is therefore overlooked in the rush to ensure that the next supply expansion programme is started in time to avoid possible shortages. Where energy suppliers are keen to commit decision makers to an early start of the next construction project in order to ensure continuity of the construction programme, the scope for using low energy conservation strategies to defer the start to further capacity expansion is even more likely to be overlooked.

The case study of electricity planning in Tasmania discussed in Chapter Six showed that this threshold is not necessarily very small. In the early 1990s, the HEC's own demand management unit identified 20 MW of potential energy savings achievable at a cost below the marginal cost of supply (Energy Council of Tasmania 1994: 32). While 20 MW is a small amount of electricity in a large system, in the case of Tasmania where the projected increase in demand was estimated to be of the order of 200 MW over ten years it amounted to approximately one year's growth in demand and, therefore, the capacity to defer the construction of supply augmentation projects by approximately one year. This scope for conserving energy looked set to be ignored, however, in the rush to develop a new increment in generating capacity in order to encourage industrial expansion.

Where the scope for energy conservation is limited and uncertain it is therefore relied on merely as a last resort strategy to assist planners balancing supply and demand in times of hardship or stress induced by drought or other problems. It is also relied on during periods of heightened concern over energy issues when low energy conservation strategies are often employed for public consumption, are used as a first resort strategy by providing policy makers with symbolic gestures to imply that something is being done about the problem. Politicians, furthermore, are quick to seize on energy conservation strategies that focus on the individual and the household as these provide the means for displacing the perceived locus of the energy-related problem and relieving politicians of the need to rely on less popular strategies. Such strategies portray the problem as the personal use of energy and the solution, therefore, to rest with the individual.

The non-adoption of low energy conservation strategies therefore has to be explained in terms of both the uncertainty associated with the scope for energy conservation and its limited scope. While the failure of much energy conservation research to reduce the uncertainty associated with energy conservation programmes has already been noted, the reasons why this research has tended to point to only limited scope for reducing energy use have not been addressed. One reason appears to have been that researchers have focused inordinately on the personal level and on the scope for household sector energy conservation in particular rather than on the transport, commercial and industrial sectors (Anderson & McDougall 1980, Crossley *et al.* 1986: 1).

Numerous reasons have been used by writers and researchers to justify their selection of the household sector as the focus of their research, some of which are convincing, many less so. It has been claimed for example that the household sector is important because household sector energy use is particularly inefficient (Crossley *et al.* 1986: 1) and that this is due to the fact that householders are less informed and less rational than firms (Savitz & Hirst 1986: 98). This claim has been contested by those who have studied the reasons for the non-adoption of energy conservation within the commercial sector (de Camio 1993). Others have cited the relatively large portion of total household expenditure comprised by energy bills as the reason why the household sector is important (Department of Minerals and Energy 1984: 4). The problem with this argument is that those for whom the costs of energy are a burden do not have the access to capital to increase the efficiency of their energy-using equipment and have relatively little discretionary ability to reduce energy use by curtailing energy services (Joerges 1979, Bradshaw & Harris 1983, Bradshaw and Hutton 1983). Yet others have argued that since all energy is ultimately used by individuals, encouraging individuals to conserve energy plays an important role in changing values (Pears 1990: 447). The household sector has been as the easiest place to attempt to alter individual attitudes (Monnier 1983: 197, Crossley 1983: 533).

More pragmatic arguments used to justify a focus on the household sector have included the argument that household sector energy conservation is important because if household sector energy use is reduced there will be more energy available for other uses (Lewis et al. 1987: 6), and the costs of supplying and distributing energy to the household sector are inordinately high (Lewis *et al.* 1987: 1, DPIE 1990a: 10). Yet others have maintained that other sectors are equally or more important but are more difficult to target (Becker & Seligman 1981: 2, Crossley *et al.* 1986: 6) and that more is known about energy use and energy-using equipment in the household sector than in other sectors (Pears and Versluis 1993, Section 8: 43). Yet others critics of this inordinate research focus on the household sector have suggested that the reasons for it have more to do with the symbolic importance of the household sector (Weizeorick 1991: 257), a sentiment echoed by those who perceive the disproportionately high focus on household sector in recycling programmes as serving the same purpose (Horton 1995: 16).

However valid or invalid these reasons, the point is that the household sector is not the only important sector in which to look for reducing the demand for energy. The author concurs with the argument that while all sectors are important, the household sector is only one sector and in some cases may be relatively less important than other sectors (Aldershot & Kanis 1984: 1). Encouraging responsible individual energy use is only useful as part of an overall effort involving governments, industry, commerce and individuals. Both researchers and governments, however, have tended in the past to focus primarily on individuals and the household sector (Crossley 1979a: 57, Tonn & Berry 1985: 1243). Those pushing government initiatives to encourage or enforce household sector energy conservation claim that they expected these programmes to be subsequently extended to other sectors of the economy and were disappointed when this did not occur (Hirst 1986: 235). This emphasis on the household sector has contributed to the perception that the scope for energy conservation is limited.

In summary, low energy conservation strategies are ignored because they are easy to ignore. They do little to resolve energy-related problems at hand and are dismissed as tinkering. In normal circumstances, furthermore, planners find it easier to rely on other strategies to balance supply and demand and overlook low energy conservation strategies. The rejection of low energy conservation strategies can therefore be explained by asking simply, 'What good does it do?'

The relevant question arising from this critique of energy conservation research is what constitutes useful scientific energy conservation research? To answer this, it is necessary to ask what information planners require before energy conservation is relied on as a rational demand reduction strategy and the discussion now turns to that question.

9.4 Energy Conservation Research and Strategic Planning

From the above discussion it is clear that a serious commitment to energy conservation as a strategic planning tool requires two things. First, political resistance to a slow-down of the supply expansion programme needs to be overcome so that electricity planning is based on what is economically rational from the social perspective rather than on what is in the political interests of individual politicians, bureaucracies and bulk energy users. Secondly, it has been shown that even energy planning based on an economically rational footing continues to be biased towards oversupply rather than undersupply, and energy conservation is ignored unless the uncertainties associated with energy conservation option are reduced. What is also required to achieve economically rational reductions in energy use that are in the strategic interests of the energy supplier and the energy uses - the much touted 'win-win solution' - is research that demonstrates accurately and unambiguously the amount of energy savings available and the costs of achieving those savings in a specific place at a specific time. Research is therefore needed which allows planners to accurately predict the outcome of various energy conservation options and programmes.

A variety of research is potentially useful. Technical research which assesses the performance of energy saving equipment, both in the laboratory and *in situ* and research which provides detailed base-line data, and especially longitudinal data, of sectorial energy end-uses, are both useful. Both improve the capacity of planners to model the likely impacts of energy conservation policies on demand. Most required of all is pilot testing of energy conservation programmes that permit the effectiveness of these programmes to be gauged in terms of their capacity to reduce demand in a particular place and at a particular time.

But in pointing to these types of research activities that are required, a serious dilemma emerges. Large pilot programmes, laboratory and *in situ* testing of equipment on a large scale, and the collection of accurate and disaggregated end-use data all require substantial resources. While the research undertaken in Chapter Eight of this study was used, in part, to point to a type of research that may be useful, the resources required for useful research are generally of an order or two larger than what that project involved. Independent institutions can, and occasionally do, undertake research of this scale. The School of Architecture from the University of Melbourne undertook a monitoring programme of the energy use in public housing in Tasmania in the mid 1980s (Coldicutt *et al.* 1986). A team of researchers from the University of Tasmania surveyed a representative sample (1.2%) of Tasmanian households in the early 1980s with a view to obtaining sufficiently detailed data to permit accurate econometric modelling of household sector energy use (Challen *et al.* 1983). The Department of Industry, Technology and Resources was instrumental in pushing for greater reliance on demand management strategies in Victoria and undertook a very large survey of households in that state with a view to modelling household energy use and energy conservation behaviour (Lewis *et al.* 1987). The RMIT and the University of Tasmania combined to monitor the impacts of an energy conservation information programme (Thomas *et al.* 1993), and the Applied Physics Department of the University of Sydney has been actively demonstrating the capacity of non-grid solar energy supply systems in combination with energy efficiency household equipment to reduce household sector reticulated energy requirements (Mills 1991a). For a variety of reasons, however, not all of these research efforts have provided planners with information that render reliance on demand reduction strategies more feasible or likely. The research by the Applied Physics Department examined the technical rather than the economic potential for reducing energy use. The monitoring of energy use in public houses in Tasmania was undertaken at a time that the State government and the HEC were actively seeking to expand the supply of electricity. The large survey of Tasmanian households was abandoned once political interest in energy conservation evaporated and as the research funds dried up.

The dilemma, therefore, is that the organisations in the best position to undertake the research necessary for reducing the uncertainty associated with the impacts of various demand reduction strategies are the energy supply organisations themselves. These organisations have access to the necessary resources, are better placed to collect base-line end-use data, and are more aware of what information is actually required. Energy supply organisations such as the HEC have periodically engaged in collection of end-use base-line data for marketing purposes. In the early 1990s, for example, the HEC's Marketing Division, used data loggers to record the instantaneous load of a random sample of 200 all-electric households at the half hourly intervals over a period of one year. The information was collected, however, mainly for marketing purposes and did not disaggregate the various end-uses within households. Such information, furthermore, tends not to be publicly released. The HEC also briefly undertook limited pilot testing of energy conservation measures in the early 1990s during a brief period of heightened concern over the social costs of energy use and the economic costs of hydro-electric shortages. The impacts on electricity use of a programme of replacing incandescent lights with compact fluorescent lamps on King Island, and of installing insulation in 100 households in Launceston, were both monitored. The temporary nature of those pilot testing programmes, and their small scale compared to what is actually required in order to ascertain the true scope for reducing demand, however, can be gleaned by comparing them to the $50 million demand side management (DSM) programme initiated by the Kirner Labor government in Victoria in the late 1980s (SECV 1992).

There are a number of conclusions that can therefore be reached at this stage concerning waht has to happen before policy makers and planners are persuaded to increase reliance on energy conservation. The first is that planning needs to be open and accountable, and removed from the control of those experts or politicians whose interests are served by rapid growth in energy supply. Secondly, the information supplied by research needs to be unequivocal, it needs to point to worthwhile levels of energy savings, and it needs to be precise and accurate. As the agancies most capable of undertaking this research are the energy suppliers themselves, this means that for energy supply organisations to undertake the necessary research, these institutions either have to arrive at the conclusion that DSM is in their strategic interests, or be required to adopt DSM strategies. The history of DSM to date, however, has shown that the latter tends to be the case and that adoption of DSM strategies therefore requires *a priori* change at the political level. Such political change, where it has occurred, has tended to be driven by either economic imperatives or the political need to avoid public dissent over energy policy and planning from spilling over into the political arena with damaging consequences. As the current restructuring of the energy supply industry towards a market-led energy sector has been driven predominantly by rising costs energy as a result of past planning failure and the political need to find an alternative to raising energy prices further (Orchison 1996: 38), the relevant question at this stage is to what degree this restructuring is congruent with the changes discussed above that are required before energy conservation is adopted as a policy option.

9.5 Energy Conservation in a Competitive Market

Many writers have maintained that economic rationalism and environmental goals can, and do sometimes overlap. For this reason, most environmentalists have embraced the competitive energy market reforms in Australia and elsewhere as a step in the right direction. The assumption has been that in a more competitive electricity market will mean an end to the technocratic style of planning that has led to the overgrowth of electricity supply and planning failure in the form of massive overcapacities. There are, the argument goes, two reasons why this should be so.

First, historic overgrowth of electricity supply relied on a policy of supplying subsidised electricity to large industrial clients. In a truly market-driven electricity supply industry there are likely to remain incentives to subsidise large energy-intensive industries, but the rate of growth in demand for electricity should be reduced if the market supports increased prices and if the process of 'reverse adaption' is abandoned. Moreover, an interconnected transmission system, which is seen as essential to the creation of a competitive electricity market, would allow more efficient use of the entire system. To this extent, competitive market reforms should result in energy being conserved since a few power stations that would have otherwise been built would not be. It is interesting to note that local environmental opposition to the proposed interconnection of the Queensland and New South Wales' grids led to the announcement by the incoming conservative state government in Queensland that a new coal-fired power station would be built as an alternative to interconnection.

The second assumption behind the push toward a more competitive electricity supply industry is that energy suppliers operating in a competitive market are more risk averse than are vertically integrated energy generators and suppliers operating under monopolistic conditions, and more risk averse than public monopolies protected by government guarantees. A major advantage of competitive market reforms, from the environmentalists' perspective, is that such risk averse energy suppliers are less likely to rely on large, capital-intensive electricity supply technologies, such as nuclear power plants and large hydro-electric schemes, but are more likely to minimise financial risks by relying on lower cost and smaller scale technologies with shorter lead-times. Deregulation and the competitive market reforms have therefore led to a 'dash to gas' and rapid deployment of gas turbine electricity generation systems (Fells & Horlock 1995: 206). Resorting to smaller scale and lower capital cost expansion options, Puiseux (1987) pointed out, permits a closer matching of the lead times of industrial and electricity supply expansion and should, in theory, reduce the risks of very large overcapacities and the search for a market for the spare capacity which has so often rendered the construction of electricity supply a virtual end in itself rather than a means to an end. It was with understandable concern, therefore, that Kellow (1996: 177) recently pointed out that the two most notable examples of privatisation of power stations in Australia over recent years (the Queensland governments sale of its Gladstone Power station and the Victorian government's sale of Loy Yang B power station) have both relied on government guaranteed purchase of electricity. The Tasmanian case study in Chapter Six indicated that developers of Bass Strait gas reserves also wanted such guarantees from the Tasmanian government. Government willingness to go down the competitive market road has therefore been checked by the political desire to protect energy-intensive industries perceived to be critical to economic growth.

While truly competitive market reforms have been interpreted by many environmentalists as positive change, these reforms also have the capacity to drive up energy use. These reforms have been driven primarily by the desire to reduce the costs of electricity to manufacturers as a means of increasing their capacity to compete with their competitors overseas and basic economics suggests that reductions in the price of electricity leads to an increase in the demand for electricity. For this reason, a small number of environmentalists have adopted a more ambivalent stance in regard to these reforms (Diesendorf 1994, 1996).

The shift from public to private control of energy planning also has implications for the degree to which energy suppliers rely on DSM to meet future requirements in energy. Under a market-led system, reliance on DSM could be reduced. The reason for this is that while the risk averse nature of markets leads to reduced reliance on capital intensive energy generation technologies, high risk aversion also reduces planning horizons but without reducing planning margins (Lucas & Papaconstantinou 1982). Private energy supply industry, or publicly owned energy suppliers asked to behave as private companies, have shorter planning horizons than do governments or public energy supply monopolies. But in order to reduce the rate of growth of the supply expansion programme, pilot testing of demand management programmes on a large scale is necessary. This pilot testing needs to be carried out well before the gap between supply and demand is narrowed and pressure mounts to quickly expand supply to avoid future shortages. It therefore needs to be undertaken at a time when there still exists considerable surplus capacity and when it is in the short-term strategic interests of the electricity supplier to pursue load growth rather than engage in demand reduction. This clash between long-term requirements for planning and short-term interests of businesses means that competitive commercial energy suppliers are less likely than public energy authorities to engage in the long-range planning necessary for DSM. An indication of the weaker emphasis on DSM with the move to a competitive market was the premature termination of the $50 million Victorian demand management programme and the scuttling of the Demand Management Unit in that state in the early 1990s. The Victoria Liberal government has pursued competitive market reforms and privatisation of the electricity supply industry more aggressively than have other state governments in Australia. In doing so, it made the abrupt transition from the state with the most ambitious DSM programme in place to the state with one of the lowest priorities on DSM and Victorian generators have begun aggressive marketing of electricity within Victoria and neighbouring states.

The shift towards a competitive market model may have a further downside from the environmental perspective. The shorter planning horizons of competitive suppliers means that DSM programmes adopted may tend to focus primarily on those measures which can produce short-term reductions in energy use. Measures such as the replacement of incandescent light globes with compact fluorescent lamps and retrofitting that involves stuffing insulation into the ceilings of the existing stock of houses have been common DSM approaches, while measures aimed at increasing the efficiency of more durable energy-using equipment such as the design of housing have tended to fall outside the ambit of DSM. This represents a serious shortcoming to those who consider that the most potent argument for increasing the efficiency of energy use is the moral need to ensure that we do not lumber the next generation with inefficient equipment which they cannot change in a hurry should they encounter energy problems (Rosenfeld 1991: 459).

The shorter planning horizons of competitive energy suppliers may also have implications for the adoption of renewable energy technologies as shorter planning horizons does not foster experimentation with less tried and tested technologies. Although renewable energy has been subsidised within the framework of a market-led energy supply industry in Britain (Fells & Horlock 1995: 212), this has been an inadvertent consequence of the need to protect the nuclear energy industry by introduction of a Non Fossil Fuel Obligation levy. As renewable energy technologies (RETs) are also alternatives to fossil fuel, investors in renewable technologies were able to demand similar subsidies funded from the levy. The levy, however, is due to be phased out in the near future (Jackson 1996: 125). There are two reasons why greater experimentation with renewable technologies is important. One is the ability of renewable energy technologies to reduce the environmental impacts of conventional energy systems, such as reducing greenhouse gas emissions and other pollutants. The other is that it is in our strategic interests to do so. History has shown that without such subsidisation of less tried and tested technologies, lock-in quickly occurs and produces robust rather than resilient energy systems. Robust systems have little ability to cope with unexpected problems. The are built on uniformity and, like the Titanic, are built to withstand known problems but have little capacity to deal with the unexpected. Resilience, on the other hand, is the capacity to bounce back, to cope with unanticipated problems, and is built on flexibility and diversity. The virtues of resilient energy systems based on diversity and flexibility, compared to robust energy systems based on a narrow range of large and centralised technologies, have been well debated (Douglas & Wildavsky 1983: 196-7, Jänike 1990: 60-2). Dryzek (1987: 53-4) has similarly expounded the ecological and social virtues of resilient as opposed to robust political systems. Industrial society has built its energy systems to a very high degree on fossil fuel technologies and is now confronted with the dilemma of how to reduce reliance on these fuels. Collingridge (1980) saw technological lock-in to be the result of the rational planning which focused only on minimising the risks of supply shortages which could damage economic growth, but which was blind to the economic risks of oversupply. His explanation was limited both because it failed to acknowledge the other risks attendant upon continued reliance on a single energy conversion technology and because it failed to see that technological lock-in was largely the result of political rather than rational decision making. If reliance on renewable energy technology systems is to be significantly increased, economic rationalism will have to be abandoned and renewable energy technologies will need to be subsidised.

Another serious downside to the shift to a competitive market, from the social perspective, is that it has been associated in many instances with a reduced public input into electricity planning and policy formulation. It is well known that policy and planning are more likely to result in socially desirable outcomes when public involvement in the those processes is increased (Crossley 1983: 545) and has been increasingly applied in the USA and Canada (Ducsik 1986, Henderson 1986). Although limited, the mechanisms for public consultation in electricity planning in Victoria put in place by the Cain Labor government in the early 1980s, and which were subsequently extended by the Kirner administration (SECV & DITR 1989c), were hailed as instrumental in bringing about electricity planning reform in that state during the 1980s (Pears 1990: 449-50). Those mechanisms for public consultation, however, were dissolved along with the demand management programmes and the Demand Management Unit by the incoming Kennett Liberal administration. Public participation in electricity planning and energy policy in Tasmania has remained extremely limited. In 1990, the HEC briefly adopted a type of 'Glastnost', offering an open invitation to the public to attend its only annual public general meeting, but reversed its decision in the following year. The public symposia on electricity planning held in Tasmania in 1994 appear to have been designed for public consumption rather than as a *bone fide* attempt to consult with the public on the direction and detail of policy reform. At the global level, it has been argued that competitive electricity market reforms may have dashed the anti-nuclear lobby's hopes for an early phase out of nuclear power in countries such as Sweden. Politically imposed moratoria on further construction of nuclear power in such countries are now likely to be abandoned and the decisions as to how to meet future energy requirements left to private investors rather than the government (Midtunn 1996: 63).

The above arguments, and the history of DSM in the United States of America and other countries, suggests that DSM tends not to be adopted in a market-led energy supply industry unless energy suppliers are regulated to ensure that energy conservation programmes are deployed and that energy users are encouraged to conserve energy. But this history has also shown that DSM programmes on their own are unlikely to result in significant reductions in energy use. The spread of DSM in Canada and Western over recent years has been described by energy conservation proponents as a revolution (Flavin & Lenssen 1994). Ironically, just as this has occurred, interest on the part of both utilities and regulators in the USA has rapidly ebbed (Sioshansi 1996: 284). The declining interest in DSM in the USA has been the result of sustained criticism by economists of the economic benefits of those programmes (Joskow & Marron 1992), the equity of mandated DSM programmes (Sioshansi 1991), and of the overall economic efficiency of these programmes (Sutherland 1991, 1994). Most of all, it has been a consequence of increasing utility disdain for DSM programmes and the shift towards a market-led energy supply industry (Gellings 1996: 288). The common perception among energy utilities in the USA is that DSM programmes marginally increase the costs of supply, and are therefore no longer in the interest of the energy suppliers. The DSM programmes undertaken in the USA, furthermore, have for the most part involved shifting time of use as a means of reducing peak loads, or increasing off peak loads, and have been beneficial from the utility's perspective but had relatively little impact on overall demand for electricity (Clinton *et al.* 1986: 126). DSM programmes undertaken in Australia to date have predominantly served the same purpose (Saddler 1994: 54). Despite the large expenditures on DSM in the United States of America and the large number of utilities involved, the largest slice of this effort has been undertaken by a very small number of utilities which account for the bulk of total expenditure on DSM programmes.

One common approach to overcoming the shortcomings of DSM programmes has been to require energy suppliers to use Least-Cost planning (LCP) or <u>integrated resource planning</u> (IRP) methodologies. Even this regulation, however, is not a panacea as there is no elegant and totally effective regulatory system and many demand reduction programmes adopted by utilities in the United States of America under the Least-Cost Planning approach have been poorly designed and implemented (Clinton *et al.* 1986: 123).

An alternative approach many analysts consider to hold considerable promise is to foster a healthy energy service industry to compete with the energy supply industry (Clinton *et al.* 1986: 137, Roberts *et al.* 1991:125-6, Keating 1996: 321, Chamberlin & Herman 1996: 328-9). This solution has recently been adopted by the Australian National Grid Management Council (1995) as its preferred means of encouraging DSM and energy efficiency within the context of a market-led energy supply industry in Australia. The degree to which a small and fragmented embryonic energy service industry dealing in the sale, installation and financing of energy efficiency equipment, would be able to effectively compete against the already established energy supply industry with massive capital assets and cash flows, and with significant market power, remains unanswered.

There exists, therefore, a large body of opinion which suggests that significant reductions in energy use are unlikely to result from a simple shift to simple market-led strategies.

Diesendorf (1996), for example, has argued that these reforms will not result in reductions in energy use. In doing so he has put advanced his own proposals for 'reforming the reforms', but notes that these proposals are resisted by many of the most powerful stakeholders in the process. The argument that the introduction of competititive market reforms alone will not result in reductions in energy use is also supported by the recent experience in the United Kingdom where light-handed regulation of a competitive market has not only failed to reduce energy use but has produced considerable surplus capacity (Mittra *et al.* 1994: 45, Lees 1995: 196, Fells & Horlock 1995: 213). In summing up his historical treatise on the Electricté de France, historian Robert Frost (1991: 252) has written that nationalisation of the industry following the second world war overturned an entire trajectory of political thought because the behaviour of the new publicly owned bureaucracy was so little different from the behaviour of the private firms that it replaced. Those who now see 'liberalisation' of the market as a revolution (Patterson 1992: 188, Flavin & Lenssen 1994: 1042) tend to overlook his point. Without regulation that makes the pursuit of energy conservation profitable for the electricity supply industry and expanding sales of electricity unprofitable (Moskovitz 1992: 399), this change is likely to be, to a very real degree, revisionist rather than reformist in character.

It is too early to tell what is likely to happen within the Australian context in relation to energy conservation. There are signs that energy supply industry is moving closer to embracing demand side management and Least-Cost Planning philosophies. The National Grid Management Council (1995: 11) has cautiously accepted in principle a number of regulatory measures. These include cost reflective pricing, mandated energy performance standards of energy-using equipment, the decoupling of profits from volume of electricity sales by price capping, the use of integrated resource planning, mandatory DSM programmes, and the demand bidding in wholesale electricity. Whether the measures will be introduced by Australian governments in the near to mid-term, however, appears doubtful. Both the new federal government and a number of state governments are evangelists of the free market and are keen to 'sell off the family silver' (Davis 1995: 256) and pass on to the private sector as much policy decision making as possible. Within this context, meaningful regulation of the Australian electricity supply industry does not appear likely in the short-term.

This inability of even a regulated market to result in substantial reductions in energy use has led many environmental writers conclude that measures beyond regulation of the energy supply industry which mandate DSM and Least-Cost Planning will be necessary to reduce energy use to sustainable levels. These individuals look for discontinuities that will allow us, or force us, to break with the patterns of the past. They look hopefully to international concern over energy-related environmental problems, and climatic change in particular, as an issue that will force government action on this front. Many see the greenhouse issue as having the clear potential to turn the slow pace of reform around and force rapid change from above. How likely, and how soon, international agreement can be reached on reducing emissions of greenhouse gases, however, is unclear. On the optimistic side, through the incrementally slow process of increased scientific assessment of the risks, the onus of proof has shifted away from those who consider the enhanced greenhouse effect to be a risk that requires immediate and concerted action, to those who hold that it may not be and advise waiting for the elusive scientific proof (Anonymous 1995: 198). Even those scientists who consider that reductions in greenhouse gases are required, however, continue to disagree over what constitutes the most rational greenhouse gas stabilization strategy. One member of the Intergovernmental Panel on Climate Change (IPCC), climatologist Tom Wigley, together with two economists, has recently advocated refraining from active intervention to reduce emissions for approximately three decades. The argument advanced by these authors is that new energy technologies will be commercialised over the next thirty years and that by waiting until these technologies are available and then rapidly putting these in place, it will be possible to substantially reduce emissions without damaging national economies (Wigley *et al*. 1996). Whilst unpopular amongst other members of the IPCC seeking to convince governments that drastic and immediate action is required, it is likely to be an argument popular with many governments.

Within the Australian context at least, there appears room for pessimism on the question of how quickly governments are likely to act to reduce greenhouse gas emissions. Although Australia was embarrassed at the Berlin Framework Convention on climate change in March 1995 with figures which showed it to be the highest per capita greenhouse gas emitter in the world (Hamilton 1994, Steering Committee of the Climate Change Study 1995: 61-2), cheap energy continues to be seen as one of the few areas where Australia has a competitive advantage, and both federal and state governments continue to pursue a policy of attracting energy-intensive industry (ATSEC 1994: 15). The degree to which the Australian government will introduce measures to reduce energy use is therefore likely to depend on the ability of the international community agreement to reach agreement on reducing greenhouse gas emissions. Despite environmentalist demands for a serious national commitment to greenhouse gas emission on moral grounds (Kinrade 1995b), the structural constraints on government suggest that moves in this direction are likely to continue at a snail's pace. While countries whose economies are highly dependent on fossil fuel use, such as Australia, are likely to come under increasing pressure from countries whose economies are less dependent on fossil fuel use, especially the Eurpoean countries, to reduce greenhouse gas emissions they are likely to continue insisting that reducing greenhouse gas emissions would disproportionately damage the their economies. They are also likely to argue that any efforts on their part to reduce greenhouse gas emissions would have a negligible impact on global greenhouse gas emissions while developing countries such as China are rapidly increasing their greenhouse gas emissions and are exempt from greenhouse reduction targets. Not only is the electricity supply industry in such countries likely to resist moves for early retirement of fossil fuel-based generation infrastructure, but in Australia's case, coal is the nation's single greatest export income earner. This makes it even less likely that the Australian government will move quickly to support international efforts to significantly reduce greenhouse gas emissions.

The fragmented nature of political responsibility in federal political systems such as Australia further slows the pace of reform, with state governments likely to remain unwilling to adopt 'no regrets' policy measures until convinced that the costs of *not* adopting them are higher than the costs of doing so. While optimists maintain that the history of international agreements suggests that such agreement will eventually be reached (Christie 1990, Brenton 1994, Wensley 1994), less optimistic observers point out that the only truly international environmental treaty in place to date has been the phasing out of CFCs and that the motives behind the CFC treaty were radically different from those at play behind a treaty designed to stabilise atmospheric concentrations of greenhouse gases. To the extent that reaching international agreement on greenhouse gas reductions will involve agreement to reduce economic growth, these writers imply, reaching them will make the process behind the strategic arms limitations treaty (SALT) and the international treaty phasing out CFCs look like child's play (de Freitas 1991, Sinclair 1991, Wildavsky 1992).

9.6 A Conclusion

The gist of the above discussion is likely to displease many. To the technological optimists they will be too pessimistic. To such individuals, the purpose of research is to find solutions rather than to merely point to the reasons why change may be difficult. Admittedly, much is uncertain and, with a bit of luck, their optimism may yet prove to be justified. Governments may suddenly introduce regulations to significantly curb the rate of growth in energy use and to increase the efficiency of energy use. Those governments presently dragging their feet on the issue of reducing greenhouse gas emissions may bow to pressure and introduce greenhouse gas reduction measures, regulations and laws. In the process, they may significantly reduce the rate of growth of energy use, increase the efficiency of energy use and reliance on renewable energy systems. The limited competitive market reforms put in place may prove to be more effective in reducing energy use than suggested above. The important point, however, is that it would be dangerous to assume that this will be the case.

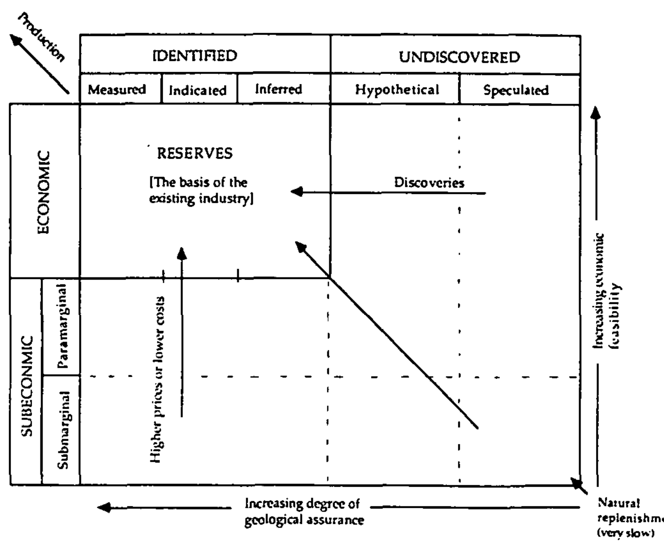
Returning to the issue of the utility of scientific energy conservation research, from the preceding discussion, the only thing that appears relatively certain is that debate over the need to reduce energy will be ongoing. It will be ongoing because the fundamental frictions created by continued increase of energy use - the ecological health of the planet, moral issues, social values such as aesthetics, and debate about the sort of society we want to live in - will not go away. It will also be ongoing because of the structural impediments that retard the pace of social and environmental reforms. Because of this, technical and social energy conservation research will continue to be used in the attempt to inform policy makers about how energy can be conserved and by pointing to policies and policy instruments potentially useful in achieving that goal. What this study suggests is that throughout thats process it will be worth bearing in mind Herbert Spencer's (1879: vii) advice that 'only by varied reiteration can alien conceptions be forced on reluctant minds'. For it is hard to avoid the conclusion that the function of much technical and social energy conservation research undertaken to date has been the political one of raising the normative appeal of energy conservation as an option rather than as a genuine attempt to increase our understanding and knowledge. The major conclusion that can be drawn from this study, however, is that in order to serve a socially useful function, this energy conservation research needs to be coupled with a good sense of what really needs to be done. If the aim of the research is to influence policy, then it is axiomatic that political and sociological questions need to occupy a much more central position in these analyses. For this research to be effective, the rational, strategic and political dimensions of energy planning need to be understood. This means that the behaviour of energy institutions and the regulatory framework in which they operate, the policy making and planning processes, and the complexities of environmental problems, individual energy use and political systems all need to be comprehended. Until that is done, these efforts will continue to produce more repetition and frustration then they will useful policy guidance or reform.

Glossary

AD590	An integrated temperature transducer produced by the Analogue Devices Inc. (USA) with a linear current output of 1 μA/K over the temperature range -55 ^{0}C to +150 ^{0}C.
assessed long-term average energy output	The estimated average annual output of a scheme based on historical hyrdological data. There may be large fluctuations in actual annual output from one year to the next as a consequence of fluctuations in rainfall.
Australian Standard	A voluntary national standard code or specification prepared by means of a consensus process under the auspices of Standards Australia.
avoided costs	Costs that can be avoided by investing in a particular option, e.g. investment in energy conservation can result in avoiding the cost of operating a supply plant.
avoided energy supply	Energy which does not need to be supplied as a result of energy conservation or demand-side measures.
brand engineering	the process whereby a manufacturer purchases some products manufactuered by another firm but applies its own brand name to the product. Two firms will often exchange products in this way, reducing the investment in manufaturing equipment of both.
cogeneration	The co-production of electricity and heat in an industruial process.
cost-effective	An option is cost-effective if it can achieve the same result at a lower cost.
demand	Requirements for energy.
demand management	Meeting society's energy requirments by reducing the demand for energy.
demand side management	The systematic planning and implementation of energy utility services designed to influence customer use of energy in ways that will produce desired changes in the utility's load.
delivered energy	The amount of energy avialable at the point of end use.
derived energy	Energy produced directly or indirectly by conversion processes from primary energy sources.
end-use energy	The energy consumed by a particular market segment or company for a particular task (e.g. electricity for refrigeration, gas for space heating).
end-use energy efficiency	The ratio of energy used to provide a service (e.g. lighting) compared with the level of service (e.g lumens of light).energy Commonly defined as the capcity to perform work or provide heat.

energy audit	An examination of an energy system to assess the most appropriate sources of energy to use and opportunities for efficiency improvements.
energy intensity	The amount of energy used to produce a unit of economic output. Usually measured as the ratio of total primary energy requirements (Joules) to GNP (measured in constant dollars). Confusion associated with this term arises because it is sometimes defined as the *change* in energy use per *change* in GNP, a parameter which can be either positive or negative.
footloose	A term used to in economic and industrial geography to describe industries which do not need to locate in close proximity to the source of raw materials and are therefore not tied to a specific geographical location.
fossil fuels	Naturally occurring , exhaustible and finite energy resources which are of fossil origon (e.g. crude oil, brown coal, black coal, natural gas).
fuel	Originally '*material for the fireplace*'. Material whose energy content can be mobilized where and when it is desired for use. (Note: Some commentators limit the concept of fuel to only those forms of energy which are commercially tradeable. Others include electricity in their definition of fuel although it cannot yet be commercially stored in bulk).
greenhouse effect	Shortwave incoming solar radiation is absorbed by the Earth's surface and re-emitted as shortwave (infra red) radiation, some of which is absorbed by certain gases in the lower atmosphere. This cause the lower atmosphere to warm up relative to the upper atmosphere and is referred to as the (natural) greenhouse effect. The e*nhanced g*reenhouse effect refers the effects of anthropogenic increases in the concentrations of greenhouse gases in the lower atmosphere.
greenhouse gas	Greenhouse gases are those chemicals in the lower atmosphere which absorb long wavelength radiation from radiated from the Earth's surface. The most important greenhouse gases are carbon dioxide, methane, CFCs, oxides of nitrogen, ozone and water vapour.
Integrated Resource Planning (IRP)	An approach to electricity planning that involves integrating supply and demand curves to allow examination of the effects of supply costs on demand.
interconnection	The connection between two or more transmission grids. It is used to allow transfers of electricty sales from one regioon to another or to share reserve plant margin.
intermediary good	An economic term meaning goods, such as steel or energy, which are used in the production of other goods rather than for final consumption.
Least-Cost Planning	Electricity planning based on meeting increased requirements for energy by the lowest cost means of meeting energy requirements before more costly measures are adopted.
loss leading	the process of selling at a loss, often with fixed interest vendor finance, in the early stages of developing a new market or increasing the market share of a new product.

load	Instantaneous demand for electric power.
load factor	The ratio (percent) of the average load to peak load of an energy supply system. It can also be the ratio of the average load to the generating capacity of a system. In this study, the former meaning is used.
major industries	In Tasmania, major industries are those firms supplied by the HEC with electricty through long-term negotiated bulk contracts rather than through standard electricty tariffs.
marginal cost	The additional cost that a producer incurs by producing an additional unit of output (e.g. the cost of producing an additional kWh of electricity). Short run marginal costs and long run marginal costs will be different.
McKelvey box	A matrix which distinguishes between the mineral *resources* and *reserves* and their dynamic nature (see diagram below). The size of resource is a function of changes scientific and technical development and economic costs of extraction and resource prices.



ozone	A molecule consisting of three atoms of oxygen.
photovoltaic (PV)	The technology which allows sunlight to be converted directly inbto electricity by means of a semiconductor which has been processed to form a solar cell.
potline	A series of pots in which alumina is electrolytically reduced to produce metal aluminium
power	The rate at which energy is supplied or work is performed.
primary energy	Energy obtained from a source which is in its "least refined", captured or useable form.
radiative forcing	Refers to the absorption of infra red radiation re-emited from the Earth by gases in the lower atmosphere, thereby increasing the temperature of the Earth's surface.
renewable energy	Energy obtained from sources which are naturally regenerated (includes hydro, solar, wind, tidal, wave, geothermal).

reserve plant	An excess of electricty generating capacity designed to ensure the reliable supply in the event of a sudden breakdown of part of the generating system. It usually consists of spinning reserve and stationary reserve.
reserve plant margin	The ratio of excess generating capacity to actual demand.
retail load	The demand for electricty from all sectors other than the major industrial (MI) load in Tasmania (often also referred to as general load).
retrofit	The modication of existing building shells, vehicles, appliances and other energy using equipment to render them more efficient in their use of energy (e.g. installation of insulation, weathersealing of doors and windows, and modification of vehicle engines.).
ring-fencing	Separation of a public energy authority into separate business units that independently
social costs	The costs to society rather than the individual, company or agency. The two can be different due to externalities (e.g. atmospheric or water polltion) and additional costs to government or other parts of society.
specific energy consumption	The energy used by a refrigerator per unit volume of refrigerated space over a given interval and under standard test conditions.
spinning reserve	Generating plant that is activated ready for rapid connection to the grid to meet sudden increase in demand or unexpected generating losses.
stand-by	Generating plant designed to cover unexpected outages or sudden increased load.[4]
stationary reserve	Generating plant held in reserve , often with an output equal to the second largest unit in the operating , which can be brought into service in one to three minutes
thermistor	A contraction for *thermally sensitive resistors*. Semiconducting materials characterised by a high and temperature-dependent electrical resistance inversely related to absolute temperature.
thermocouple	A temperature measuring device consisting of two different types of wire spot welded at the measuring tip. The volatge produced at the bimetallic junction is temperature dependent. T-type thermocouples consist of copper and constantan wires. K-type thermocouples consist of nickel-chromium and nickel-aluminium wires.
weatherisation	A term used in the USA for those energy conservation measures involving changes to dwellings and used to reduce household space heating requirements. These include fitting of storm windows, draught-proofing, double glazing of windows and installation of thermal insulation.

Abbreviations

ABARE	Australian Bureauy of Agricultural and Resource Economics.
ABC	Australian Broadcasting Commission.
ABS	Australian Bureau of Statistics.
ACA	Australain Consumers' Association.
ACE	Association of Consumers of Electricty.
ACF	Australian Conservation Foundation.
ACT	Australian Capital Territory.
AD590	An integrated temperature transducer produced by the Analogue Devices Inc. (USA) (see Glossary for technical details).
AEC	Atomic Energy Commission (USA).
AEEMA	Australian Electronics and Electrical Manufacturers' Association Ltd.
AGPS	Australian Government Publishing Service.
AIP	American Institue of Physics.
ALP	Australian Labor Party.
ALTAEO	assessed long-term average energy output.
ANM	Australian Newsprint Mills.
ANZEC	Australian and New Zealand Environment Council.
ANZMEC	Australian and New Zealand Minerals and Energy Council.
ANZSES	Australian and New Zealand Solar Energy Society.
ATSEC	Australian Science and Technology Council.
BESD	Brunswick Electricity Supply Department.
BHP	Broken Hill Proprietry Ltd.
CFC	chlorofluorocarbon
CFL	compact flourescent lamp
COAG	Commonwealth Heads of Australian Governments consisting of the Prim Minister and the state premiers.
CPI	Consumer Price Index.
CAR	Conzinc RoiTinto Australia Ltd.
CREA	Centre for Regional and Economic Analysis at the University of Tasmania.

CSO	Community service obligation. The requiremet on energy authorities to subsidise classes of energy users such as rural customers or low income households through cross-subsidies.
DNDE	Department of National Development and Energy.
DIDT	Department of Industrial Development,Tasmania – the precursor to the Tasmanian Development Authority.
DITR	Department of Industry, Technology and Resources.
DM	Demand Management.
DPIE	Department of Primary Industries and Energy.
DSM	Demand Side Management.
EdF	Electricité de France.
EEO	Energy Efficiency Office.
ESAA	Electricty Supply Association of Australia.
GaO	Gordon-above-Olga dam.
GbF	Gordon-below-Franklin dam.
GFCV	Gas and Fuel Corporation of Victoria.
GNP	Gross Natioinal Product.
HEAT	Hydro-Employees Action Team.
HEC	Hydro-Electric Commission of Tasmania.
HED	Hydro-Electric Department.
IAC	Industry Assistance Commission.
IC	Industry Commission.
IEA	International Energy Association.
IEMC	Integrated Energy Management Centre.
IPCC	Intergovernmental Panel on Climate Change.
IRP	Integrated Resource Planning.
IUCN	International Union for Conservation of Nature and Natural Resources.
LPAC	Lake Pedder Action Committee.
LCP	least-cost planning.
LDC	less developed country.
LEG	low energy growth.
LER	low energy refrigerator.

LPG	liquid petroleum gas.
LULU	locally-unwanted-land-uses.
MEPS	mandated energy performance standards.
NATA	National Association for Testing Authorities
NIMBY	not-in-my-backyard.
NSW	New South Wales.
NZS	New Zealand Standards.
OECD	Organisation for Economic Cooperative Development.
OPEC	Organisation of Petrolium Exporting Countries.
PPAG	Policy and Public Affairs Group (HEC).
PUB	Public Utilities Board.
PV	photovoltaic.
PVC	polyvinylchloride.
RET	renewable energy technologies.
RMIT	Royal Melbourne Institute of Technology.
SABH	South Australian Breweries Holdings Ltd, a major Australian manufactuer of whitegoods. Recently underwent a name changes to Southcorp Holdings Ltd and took control of Hoover Australia.
SALT	Strategic Arms Limitation Treaty.
SECV	State Electricty Commission of Victoria.
SEP	soft energy path.
SEECA	Social Economic, Ecological and Cultral Alliance.
TDA	Tasmanian Development Authority.
TDR	Tasmania Devlopment and Resources – formerly the TDA.
TWE	Tasmanian Wind Enterprises.
TWS	Tasmanian Wilderness Society.
UNESCO	United Nations Education, Scientific and Cultural Organisation.
UTG	United Tasmania Group.
VAT	valued added tax.
WCED	World Commission on Environment and Development.
ZEG	zero energy growth.

Units and Symbols

Basic energy units

Joule (J)	The basic unit of energy in the metric and SI systems.
Watt (W)	Basic unit of power = a rate of energy supply or use of 1 Joule per second
Horsepower (h.p.)	The old Imperial unit of power (1h.p. = 746 W)
kilowatthour (kWh)	One thousand watthours, the unit of electrical energy used for retail billing purposes. It is the equivalent to the amount of electrical energy used by a 1 kW electric radiator for a period of one hour (1 kWh = 3.6 MJ)
megawatt average (MWav)	The average power generated by a power station, load on the system, or the demand of a large consumer over a certain period. For example, a power station may have a maxiumum generating output of 1000 MW. If its expected average operational time over one year is 75%, then its expected average annual output is 750 MW.

Larger Units and SI Prefixes

Units such as the Exajoule, Gigawatt of kilojoule can be calculated form the table below which defines these prefixes

Prefix	SI Symbol	Exponent form	Multiplier
Exa	E	10^{18}	1 000 000 000 000 000 000
Tera	T	10^{12}	1 000 000 000 0000
Giga	G	10^{9}	1 000 000 000
Mega	M	10^{6}	1 000 000
kilo	k	10^{3}	1 000

1 kilowatt (kW)	=	1000 Watts	1 kilojoule (kJ)	=	1000 Joules
1 Megawatt (MW)	=	1000 kilowatts	1 Megajoule(MJ)	=	1000 kilojoules
1 Gigawatt (GW)	=	1000 Megawatts	1 Gigajoule (GJ)	=	1000 Megajoule
1 Terawatt (TW)	=	1000 Gigawatts	1 Terajoule (TJ)	=	1000 Gigjoule
			1 Exajoule (EJ)	=	1000 Terajoule

The typical modern nuclear power plant has an output of about 1.3 GW installed capacity. Modern coal-fired power stations consist of generating units of about 600 MW output capacity each.

References

Ableson P H (1987) Science and Technology Affecting Demand for Materials and Energy. *In* McClaren D J & Skinner B J (eds) *Resources and World Development.* John Wiley & Sons, New York, New York.

Abrahamson D (1973) Energy Technology: Status and Needs. *Ambio* **2**, 6: 186-195.

Abrahamson D E (1970) *The Environmental Cost of Electric Power.* Scientists' Institute for Public Information, New York, New York.

A.D. Little Inc. (1977) *Study to Produce More Efficient Refrigerators and Water Heaters.* A.D.Little Inc., Cambridge, Massachusetts.

Adams W M (1990) *Green Development: Environment and Sustainability in the Third World.* Routledge, London.

Adler C A (1973) *Ecological Fantasies: Death from Falling Watermelons.* Green Eagle Press, New York, New York.

Ahearne J F (1989) *Will Nuclear Power Recover in a Greenhouse?* Resources for the Future Discussion Paper ENR89-06. Resources for the Future, Washington, D.C.

Aldershoff D E & Kanis H (1984) *Huishoudelijk Elekticiteitsverbruik Besparing door Techniek en Gedrag,* SWOKA Research Report No.10. Instituut voor Consumentenonderzoek [SWOKA], The Hague, Netherlands.

Anderson A (1984) Japanese Nuclear Power. *Nature* **310**, 5976: 357.

Anderson C D & McDougall G H (1980) *Consumer Energy Research: An Annotated Bibliography.* Behavioural Energy Research Group, University of British Columbia, Vancouver, British Columbia.

Anderson C D & Claxton J D (1982) Barriers to Consumer Choice of Energy Efficient Products. *Journal of Consumer Research* **9**, 9: 163-170.

Anderson J E, Brady D W, Bullock C S & Stewart J (1984) *Public Policy and Politics in America,* 2nd edn. Brooks/Cole, Monterey, California.

Anderson V (1993) *Energy Efficiency Policies.* Routledge, London.

Andrews C J (1990) The Electric Utilities are Shifting Risk to their Customers: A New Reason for Investing in Conservation. *ASHRAE Transactions,* **96**, : 266-275.

Anonymous (1979) Motivating the Troops for the Energy War. *Psychology Today* **12**, 11: 14.

Anonymous (1995) Editorial. *Nature* **371**, 6550: 198.

Arndt H W (1978) *The Rise and Fall of Economic Growth: A Study in Contemporary Thought.* Longman Chesire, Melbourne, Victoria.

Atkins A & Evans D (1992) *The Demand for Demand Management.* Book of Proceedings, Vol. 1, First National Demand Management Conference, 'Focus for the Future': 140-156.

Atkinson A (1989) The Environmental Impact of Fusion Power. *Energy Policy* **17**, 3: 277-83.

Attfield R (1991) *The Ethics of Environmental Concern,* 2nd edn. Basil Blackwell, London.

Australian and New Zealand Environment Council (1990) *Towards a National Greenhouse Strategy for Australia.* Australian Government Publishing Service, Canberra, Australian Capital Territory.

Australian and New Zealand Minerals and Energy Council (1995) *Least Cost Energy Services for Australia.* ANZMEC Report No. 95.03: Vol. 1. Australian and New Zealand Minerals and Energy Council.

Australian Consumers' Association (1992) Why Waste Energy? *Choice* **33**, 5: 12-6.

Australian Government & Australian Consumers' Association (1991) *The Energy Guide.* Australian Government Publishing Service, Canberra, Australian Capital Territory.

Australian Institute of Energy (1991) *The Marketing Challenge for the 1990's - Energy Efficiency for the Residential Sector. Adelaide, July 1991: Conference Papers.* School of Marketing, University of South Australia, Adelaide, South Australia.

Australian Science and Technology Council [ASTEC] (1994) *Energy Research and Technology in Australia.* Australian Science and Technology Council Occasional Paper No. 28. Australian Government Publishing Service, Canberra, Australian Capital Territory.

Bachrach P & Baratz M S (1962) Two Faces of Power. *American Political Science Review* **56**: 947-52.

Bachrach P & Baratz M S (1963) Decisions and Nondecisions: An Analytical Framework. *American Political Science Review* **57**: 632-42.

Bannock G, Baxter R E & Rees R (1972) *The Penguin Dictionary of Economics.* Harmondsworth, England.

Barney G O (1980) *The Global 2000 Report to the President of the U.S.: Entering the 21st Century.* Pergamon Press, New York New York.

Barrow J D (1992) *Theories of Everything.* Vintage, London.

Bartels R (1988) Residential End-Use Electricty Forecasting. *In* McColl G (ed.) *Electricty Generation Planning in an Uncertain Environment.* Centre for Applied Economic Research, University of New South Wales, Kensington, New South Wales; Chapt. 9: 113-22.

Bartels C (1990) *A Review of the Tariff Policies and Procedures of the Tasmanian Hydro-Electric Commission. Stage One: Situation Analysis. A Report to the Tariff Steering Committee.* Tellus Institute, Boston.

Bates G M (1983) The Aftermath of Lake Pedder. *In* Sornarajah M (ed.) *The South West Dam Dispute: The Legal and Political Issues.* University of Tasmania, Sandy Bay, Tasmania.

Bauman Z (1995) *Postmodern Ethics,* 3rd printing. Basil Blackwell, Oxford, England.

Baumgartner T & Midttun A (1987) Energy Forecasting: Science, Art, Politics. *In* Baumgartner T & Midttun A (eds) *The Politics of Energy Forecasting: A Comparative Study of Energy Forecasting in Western Europe and North America.* Clarendon press, Oxford, England; Chapt. 1: 3-10.

Beatty B (1993) Comment: Tas. Hydro-Strategy Pigeons Come Home to Roost. *Electricity Week* **13**, 13: 2-4.

Beck U (1992) *Risk Society: Towards a New Modernity.* Sage, London. [First published in German in 1992 by Suhurkamp Verlag, Frankfurt. Translated by Mark Ritter].

Beck U (1995) *Ecological Enlightenment: Essays on the Politics of the Risk Society.* Humanities Press, Atlantic Highlands, New Jersey.[First published in German in 1991 by Suhurkamp Verlag, Frankfurt. Translated by Mark Ritter].

Becker L & Seligman C (1981) Welcome to the Energy Crisis. *Journal of Social Issues* **37**, 2: 1-7.

Beckerman W (1975) *Two Cheers for the Affluent Society: A Spirited Defence of Economic Growth.* St. Martin's Press, New York, New York.

Beckmann P (1976) *The Health Hazards of Not Going Nuclear.* Golem Press, Boulder, Colorado.

Bell S & Wanna J (1992a) Introduction - Approaches, Issues and Themes. *In* Bell S & Wanna J (eds) *Business-Government Relations in Australia.* Harcourt Brace Jovanovich, Sydney, New South Wales: 3-14.

Bell S & Wanna J (1992b) Power, Interaction and Restructuring: Concluding Comments. *In* Bell S & Wanna J (eds) *Business-Government Relations in Australia.* Harcourt Brace Jovanovich, Sydney, New South Wales; Chapt. 25: 267-73.

Bell S (in press) A Fly in the Ointment: Business and Environmental Politics. *Chain Reaction.*

Benarde M A (1992) *Global Warning ... Global Warming.* John Wiley & Sons, New York, New York.

Berg C A (1973) Energy Conservation Through Effective Utilization. *Science* **181**, 4095:128-37.

Bergmann V (1993) *Power and Protest: Movements for Change in Australian Society.* Allen and Unwin, Sydney, New South Wales.

Berman M (1988) *All that is Solid Melts into Air: the Experience of Modernity* [2nd printing]. Penguin, London.

Berrill T, Clark P, Foster J, Koerner R, Monsour P, Sale R & Willrath H (1991) *Energy Policy for Queensland: Prospects for Renewable Energy Technologies.* Energy Policy Group, Queensland Branch of the Australian and New Zealand Solar Energy Society, Brisbane, Queensland.

Berry A (1976) *The Next Ten Thousand Years: A Vision of Man's Future in the Universe.* Coronet Books, Bungay, England.

Bierce A (1906) *The Cynic's Word Book.* [Reprinted as *The Enlarged Devil's Dictionary* in 1967 by Penguin, Harmondsworth, England].

Black W Z & Hartley J G (1985) *Thermodynamics.* Harper & Row, New York, New York.

Blackburn J O (1987) *The Renewable Energy Alternative: How the United States and the World can Prosper without Nuclear Energy or Coal.* Duke University Press, Durham, North Carolina.

Blainey G (1966) *The Tyranny of Distance: How Distance Shaped Australia's History.* Macmillan, South Melbourne, Victoria.

Blakers A & Outhred H (1983) *Wind Energy for Tasmania - a Discussion Paper.* University of New South Wales, Kensington, New South Wales.

Blakers A (1987) *Wind Energy in Tasmania.* Paper presented at the Australian and New Zealand Solar Energy Society Conference, Australian National University, Canberra, Australian Capital Territory, 26-28 November.

Blakers A (1994) Hydro-Electricity in Tasmania Revisited. *Australian Journal of Environmental Management* **1**, 2: 110-20.

Blau P M & Meyer M W (1971) *Bureaucracy in Modern Society,* 2nd edn. Random House, New York, New York.

Blowers A (1984) *Something in the Air: Corporate Power and the Environment.* Harper & Row, London.

Bohi D R & Toman M A (1992) *Energy Security Externalities and Policy.* Resources for the Future Discussion Paper ENR 92-05, Resources for the Future, Washington, D.C.

Bowman M (1979) *Australian Approaches to Environmental Management: The Response of State Planning.* Environmental Law Reform Group, University of Tasmania, Hobart, Tasmania.

Boyden S (1990) Towards an Ecologically Sustainable Society: Australia's Opportunity. *In* Hocking B (ed.) *Australia Towards 2000.* Macmillan Press, Basingstoke, England: 183-197.

Boyden S, Dovers S & Shirlow M (1990) *Our Biosphere under Threat: Ecological Realities and Australia's Opportunities.* Oxford University Press, Melbourne.

Boyle S (1992) *Towards a Fossil Free Energy Future.* Greenpeace International, Amsterdam.

Bradshaw J & Harris T (eds) (1983) *Energy and Social Policy.* Routledge & Kegan Paul, London.

Bradshaw J & Hutton S (1983) Social Policy Options and Fuel Poverty. *Journal of Economic Psychology* **3**: 249-266.

Brandstätter H (1993) Should Economic Theory care about Personality Structure? *Journal of Economic Psychology,* **14**, 3: 473-494.

Brenton T (1994) *The Greening of Machiavelli: The Evolution of International Environmental Politics.* Earthscan, London.

Brög W, Iblher P & Mettler-Meibom B (1984) Energy Conservation Potentials for German Households. *In* Morrison B & Kempton W (eds) *Families and Energy: Coping with Uncertainty: Conference Proceedings.* Institute for Family and Child Studies, College of Human Ecology, Michigan State University, Ann Arbor, Michigan.

Brookes L G (1990) The Greenhouse Effect: The Fallacies of the Energy Efficiency Solution. *Energy Policy* **18**, 2: 199-201.

Brookes L G (1992) Forum. Energy Efficiency and Economic Fallacies: A Reply. *Energy Policy,* **20**, 5: 390-392.

Brooks D B & Paehlke R (1980) Canada: A Soft Path in a Hard Country. *Canadian Public Policy* **6**: 444-53.

Brower D R (1975) Foreword. *In* Lovins A B & Price J H (eds) *Non-Nuclear Futures: The Case for an Ethical Energy Strategy*: xiii-xv.

Brower M (1990) *Cool Energy: The Renewable Solution to Global Warming. A Report by the Union of Concerned Scientists*. The Union of Concerned Scientists, Cambridge, Massachusetts.

Brown H (1954) *The Challenge of Man's Future.* Viking Press, New York, New York.

Brown L R (1978) *The Twenty Ninth Day: Accommodating Human Needs and Numbers to the Earth's Resources.* W.W. Norton & Co., New York, New York.

Brown L R, Flavin C & Postel S (1989) A World at Risk. *In* Brown L R, Durning A, Flavin C, Heise L, Jacobson J, Postel S, Reyner M, Shea C P & Starke L (eds) *State of the World.* A Worldwatch Institute Report on Progress Towards a Sustainable Society. W.W. Norton & Co., New York, New York.

Brown L R, Flavin C & Postel S (1991) Saving the Planet: How to Shape an Environmentally Sustainable Economy. W.W. Norton & Co., New York, New York.

Brown M & Macey S M (1985) Evaluating the Impacts of Two Energy Conservation Programmes in a Mid-Western City. *Applied Geography* **5**, 1: 39-53.

Brown M A & Rollinson P A (1985) Residential Energy Consumption in Low Income and Elderly Households. *Energy Systems and Policy* **9**, 3: 271-301.

Brown M A (1993) The Effectiveness of Codes and Marketing in Promoting Energy -Efficient Home Construction. *Energy Policy* **21**, 4: 391-402.

Brown R (1988) Our Place is Between the Forest and the Machines. *Habitat* **16**, 4: 7.

Bureau of Industry Economics (1983) *Structural Adjustment in the Australian Whitegoods Industry.* Bureau of Industry Economics Research Report No. 12. Bureau of Industry Economics, Australian Government Publishing Service, Canberra, Australian Capital Territory.

Burrill G & McKay I (1987) Introduction. *In* Burrill G & McKay I (eds) *People Resources and Power.* Acadiensis Press, Fredericton, New Brunswick.

Burton J R (1980) *Prospects for Future Power development in Tasmania: A Critical Appraisal.* Report to the Directorate of Energy, Premier's Office, Hobart, Tasmania.

Bush S, Leonard M, Bowen B, Jones B Donaldson K & Trieu L H (1993) *Energy Demand and Supply Projections Australia 1992-93 to 2004-05.* Australian Bureau of Agricultural and Resource Economics Research Report 93.2, Australian Bureau of Agricultural and Resource Economics, Canberra, Australian Capital Territory.

Buttel F H, Geder C C & Wiswall I W (1984) *Labor and the Environment.* Greenwood Press, Westport, Connecticut.

Byrne J, Rich D, Tannian F X & Wang Y (1985) Rethinking the Household Energy Crisis: The Role of Information in Household Energy Conservation. *In* Byrne J, Schulz D A & Sussman M B (eds) *Families in the Energy Transition.* The Haworth Press, New York, New York: 83-113.

Cairncross F (1993) *Costing the Earth: the Challenge for Governments, the Opportunities for Business.* Harvard Business School Press, Boston, Massachusetts.

Cairncross F (1994) Environmental Pragmatism. *Foreign Policy,* No. 95: 35-50.

Caldwell L K (1972) *In Defence of the Earth: International Protection of the Biosphere.* Indiana University Press, Bloomington, Indiana.

Caldwell L K (1990) *Between Two Worlds: Science, the Environmental Movement and Policy Change.* Cambridge University Press, Cambridge, New York.

Caldwell M B & Woolley J T (1976) Energy Policy and the Capitalist State. *In* Hammarlund J R & Lindberg L N (eds) *The Political Economy of Energy Policy.* Institute for Environmental Studies, University of Wisconsin, Madison, Wisconsin.

Callaghan B (1977) *Inquiry into the Structure of Industry and the Employment Situation in Tasmania.* Australian Government Publishing Service, Canberra, Australian Capital Territory.

Cameron J R (1989) Do Future Generations Matter? *In* Dower N (ed.) *Ethics and the Environmental Responsibility.* Avesbury, Aldershot, England; Chapt. 4: 57-78.

Campbell J A (1970) *Chemical Systems: Energetics, Dynamics, Structure.* W.H.Freeman & Co., San Francisco, California.

Camus A (1947) *The Plague.* [Published by Penguin, Harmondsworth, England in 1954, 12th edn. 1972].

Cane R F (1981) *Our Energy Situation and the Flight from Reality.* University of Tasmania Occasional Paper No. 31, University of Tasmania, Hobart, Tasmania.

Canfield M & Siemenski A E (1975) If You're So Smart, Why Ain't You Rich? - An Analysis of Impediments to Implementing Energy Conservation in the United States. *Public Administration Review* **35**, 4: 322-27.

Capra F (1983) *The Turning Point: Science, Society and the Rising Culture.* Flamingo (Fontana), London.

Carle R (1995) French Energy Policy. *In* Rooke D, Fells I & Horlock J (eds) *Energy for the Future.* E & F N Spon for the Royal Society, London; Chapt 3. 35-48.

Carnino A, Nicolet J & Wanner J (1990) *Man and Risks: Technology and Human Risk Prevention.* Marcel Dekker, New York, New York. [Translated by S. Norman].

Carson R (1962) *Silent Spring.* Houghton-Mifflin, New York, New York.

Cartland G (1981) *Report on Phase II of the Review of Tasmanian Government Administration.* Government of Tasmania, Hobart, Tasmania.

Centre for Regional and Economic Analysis [CREA] (1993) *The Tasmanian Economy in 2009-10 under two Electricity-Consumption Scenarios: Report produced for the Hydro-Electric Commission.* Centre for Regional and Economic Analysis, University of Tasmania, Sandy Bay, Tasmania.

Challen D W, Finney, A J, Gunn, P A, Rutherford R P & Wilde P D (1983) *Tasmanian Domestic Energy Demand Project,* Report Nos 1-6 Tasmanian Energy Research Committee, Hobart, Tasmania.

Chamberlin J H & Herman P M (1996) How Much DSM is Really There? *Energy Policy* **24**, 4: 323-30.

Chandler W U, Geller H S & Ledbetter M R (1988) *Energy Efficiency: A New Agenda.* American Council for an Energy Efficient Economy, Washington, D.C.

Chapman P (1975) *Fuel's Paradise: Energy Options for Britain.* Penguin, Harmondsworth, England.

Chatfield M, Crossley D, Gallaugher J & Stobie M (1992) Barriers in Electricity Utilities to the Development of Demand Management. *In* ESAA (1994) *1st National Demand Management Conference: Book of Proceedings.* E Supply Association of Australia, Canberra, Australian Capital Territory: 157-66.

Christie E (1990) The Greenhouse Gases and Environmental Law. *Environmental and Planning Law Journal* 7, 2: 114-26.

Cicero (45 BC) *De Finibus Bonorum et Malorem.* [Reprinted in 1930 by Heinman London, 2nd edn. 1951. Translated by H. Rackhman].

Clark J (1981) The Search for Natural Limits to Growth. *In* de Neufville J I (ed.) *The Land Use Policy Debate in the United States.* Plenum Press, New York, New York; Chapt. 5: 65-82.

Clark M E (1991) Rethinking Ecological And Economic Education: A Gestalt Shift. *In* Costanza R (ed.) *Ecological Economics: The Science and Management of Sustainability.* Columbia University Press, New York, New York; Chapt. 26: 400-415.

Clark W (1974) Energy for Survival. Anchor Books, Garden City, New York.

Clarke R (1974) *Some Utopian Characteristics of Soft Technology.* Centre for Biotechnic Research and Development, London.

Clarke R & Timberlake L (1982) *Stockholm Plus Ten: Promises, Promises - The Decade Since the UN Environment Conference.* Earthscan, London.

Cline (1990) Scientific Basis for Greenhouse Effect. *The Economic Journal* **101**, 407: 904-19.

Clinton J, Geller H & Hirst E (1986) Review of Government and Utility Conservation Programmes. *Annual Review of Energy* **11**: 95-142.

Cockburn M (1982) The Great Hydro-Power Falls from Grace. *The Sydney Morning Herald* 1 Feb. 1982: 5.

Cocklin C (1993) Anatomy of a Future Energy Crisis: Restructuring and the Energy Sector in New Zealand. *Energy Policy* **21**, 6: 881-91.

Cocks D (1992) *Use with Care: Managing Australia's Natural Resources in the Twenty First Century.* University of New South Wales Press, Kensington, New South Wales.

Coghlan A (1991) Coke with Pores Cleans Emissions from the Dirtiest Coal. *New Scientist* **130**, 1772: 21.

Coldicutt A B, Coldicutt E B, Isaacs A & Moshini F (1986) *Energy Requirements and User Satisfaction in Tasmanian Public Housing. Australian Housing Research Grant Report No. 106.* Australian Housing Research Council, Dickson, Australian Capital Territory.

Cole H S, Freeman C, Jahoda M & Pavitt K L (1975) *Models of Doom: A Critique of the Limits to Growth.* Universe Books, New York, New York.

Collingridge D & Reeve C (1986) *Science Speaks to Power: The Role of Experts in Policy Making.* Frances Printer Pub., London.

Collingridge D (1980) *The Social Control of Technology.* St. Martin's Press, London.

Coltrane S, Archer D & Aronson E (1986) The Social and Psychological Foundations of Successful Energy Conservation Programme. *Energy Policy* **14**, 4, 1986: 134-48.

Common M (1994) Economic Policies for Sustainable Energy Use. *In* Dovers S (ed.) *Sustainable Energy Systems: Pathways to a Sustainable Energy Reform.* Cambridge University Press, Cambridge, England. Chapt. 8: 171-193.

Commoner B (1963) *Science and Survival.* The Viking Press, New York, New York. Reprinted as 'To Survive on Earth' in Disch R (ed.) *The Ecological Conscience: Values for Survival* . Prentice Hall, Englewood Cliffs, New Jersey: 118-125.

Commoner B (1971) *The Closing Circle.* Alfred A. Knopf, New York, New York.

Commoner B (1976) *The Poverty of Power: Energy and the Economic Crisis.* Alfred A. Knopf, New York, New York.

Comstock R W (1974) Energy Crisis: Fact or Fiction? *In* Yannacone V J (ed.) *Energy Crisis: Danger or Opportunity.* West Publishing, St. Paul, Minnesota; Chapt. 9: 343-359.

Condelli L, Archer D, Aronson E, Curbow B, McLeod B, Pettigrew T. White L & YatesS (1984) Improving Utility Conservation Programs: Outcomes, Interventions and Evaluations. *Energy* **9**: 485-495.

Cook E (1971) The Flow of Energy in an Industrial Society. Scientific American Inc. (1971) *Energy and Power.* W.H. Freeman, San Francisco, California: Chapt. 7: 83-91.

Cook P E (1980) *Energy Conservation: A Closer Look: A Study of the Political and Social Significance of Energy Conservation.* Unpublished Master of Environmental Science thesis, Monash University, Clayton, Victoria.

Cook S W & Berrenberg J L (1981) Approaches to Encouraging Conservation Behaviour: A Review and Conceptual Framework. *Journal of Social Issues* **37**, 2: 73-107.

Coordination Committee on Future Power Development (1980) *Report to the Premier.* Coordination Committee of Future Power Development, Hobart, Tasmania.

Coper M (1983) *The Franklin Dam Case.* Butterworths, Sydney, New South Wales.

Corbridge S E (1986) Interdependent Development? Problems of Aggregation and Implementation in the Brandt Report. *Applied Geography* **2**: 253-65.

Costanza M, Archer D, Aronson E & Pettigrew T (1986) Energy Conservation Behaviour: the Difficult Path from Information to Action. *American Psychologist* **41**, 5: 521-28.

Costanza R (ed.) *Ecological Economics: The Science and Management of Sustainability.* Columbia University Press, New York, New York.

Cowan R S (1985) How the Refrigerator got its Hum. *In* MacKenzie D & Wajcman J (eds) *The Social Shaping of Technology: How the Refrigerator got its Hum.* Open University Press, Milton Keynes, England; Chapt. 15: 202-18.

Cox K & Mair A (1989) Levels of Abstraction in Locality Studies. *Antipode* **21**, 7: 121-32.

Crabb P (1991) Paying for Water: There Are No Free Drinks! *Australian Geographer*, **22**, 2: 126-8.

Craig P P (1981) Technical Issues Relating to End-Use Management: Refrigerators. *Energy Systems and Policy* **5**, 4: 243-56.

Crenson M A (1971) *The Un-Politics of Air Pollution: A Study of Non-Decision Making in the Cities.* Johns Hopkins Press, Baltimore, Maryland.

Crossley D J (1979a) The Role of Popularization Campaigns in Energy Conservation. *Energy Policy,* 7: 57-68.

Crossley D J (1979b) *Energy Use and Human Lifestyle.* Australian Environmental Studies Working Paper 7/79, School of Australian Environmental Studies, Griffith University, Brisbane, Queensland.

Crossley D J (1980a) *Social Aspects of Energy Use and Conservation, and Energy Policy.* Unpublished Ph.D. Thesis, School of Australian Environmental Studies, Griffith University, Griffith, Queensland.

Crossley D J (1980b) Energy Saving Without Tears Depends on Changing Habits. *Royal Australian Planning Institute Journal* **18**: 130-3.

Crossley D J (1981) *Non-Technical Barriers to Energy Conservation by Individual Householders.* Environmental Paper No. 3, Graduate School of Environmental Science, Monash University, Clayton, Victoria.

Crossley D J (1982) Energy and Social Science Research in Australia: Separate Realities? *In* Black J (ed.) *Liquid Fuels In Australia: A Social Science Research Perspective.* Pergamon, Sydney, New South Wales. Chapt. 11: 159-167.

Crossley D J (1983) Identifying Barriers to the Success of Consumer Energy Conservation Policies. *Energy,* **8**, 7: 533-46.

Crossley D J, McKenzie B, Parin J & Taylor N (1986) *Predicting Householders' Response to Energy Conservation Policies.* Graduate School of Environmental Science Environmental Paper No. 5, Graduate School of Environmental Science, Monash University, Clayton, Victoria.

Crothers N (1991) Household Electrical Appliances - Energy Performance. *In* Australian Institute of Energy (1991) *The Marketing Challenge for the 1990's - Energy Efficiency for the Residential Sector, 1 July 1991, Adelaide Convention Centre, North Terrace, Adelaide.* Australian Institute of Energy and the School of Marketing, University of South Australia, Adelaide, South Australia.

Crowley C M (1994) *Power and Environmental Policy: Tasmanian Ecopolitics from Pedder to Wesley Vale.* Unpublished PhD Thesis, University of Tasmania, Hobart, Tasmania.

Cummine P E (1980) *Energy Conservation - A Closer Look: A Study of the Political and Social Significance of Energy Conservation.* Unpublished Master of Environmental Science thesis, Monash University, Clayton, Victoria.

Cunningham N & Lopreato S (1977) *Energy Use and Conservation Incentives.* Praeger, New York, New York.

Dahl R E & Lindblom C E (1953) *Politics, Economics and Welfare: Planning and Politico-Economic Systems Resolved into Basic Social Processes.* Harper & Brothers, New York, New York.

Dahlberg K A, Soroos M S, Feraru A T, Harf J E & Trout B T (1985) *Environment and the Global Arena: Actors, Values, Policies and Futures.* Duke University Press, Durham, North Carolina.

Daly H E (1973) Electric Power, Employment and Economic Growth: A Case Study in Growthmania. *In* Daly H E (ed.) *Toward a Steady-State Economy.* W. H. Freeman, San Francisco, California: 252-80.

Daly H E (1978) On Thinking about Energy in the Future. *Natural Resources Forum,* **3**:19-26.

Damman E (1984) *Revolution in the Affluent Society*. Heretic Books, London.

Darwin C G (1952) *The Next Million Years.* R Hart-Davis, London.

Davis B (1992) Power without Glory: Energy Strategy and the Accord. *In* Haward M & Larmour P (eds) *The Tasmanian Parliamentary Accord & Public Policy 1989-92: Accommodating the New Politics?* Federation Research Centre, Australian National University, Canberra, Australian Capital Territory: 119-26.

Davis B (1995) Adapation and Degregulation in Government Business Enterprise: The Hydro-Electric Commission of Tasmania 1945-1994. *Australian Journal of Public Administration* **54**, 2: 251-61.

Davis G R (1989) Responding to the Challenge of Global Warming: The Role of Energy Efficient Technologies. *In* IEA (1989)) *Energy Technologies for Reducing Emissions of Greenhouse Gases: Proceedings of an Experts' Seminar, Paris, 12-14 April. Vol. 2.* Organisation for Economic Cooperation and Development, Paris: 71-85.

Davis G, Wanna J, Warhurst J & Weller P (1988) *Public Policy in Australia,* 2nd edn. Allen & Unwin, Sydney, New South Wales.

Davis P (1994) *Demand Management & Energy Efficiency.* Paper presented at the Energy Council Public Symposium 'Options for the Future: Electricity in Tasmania, 7-8 May, Launceston, Tasmania.

de Camio (1993) Barriers within Firms to Energy-Efficient Investments. *Energy Policy* **21**, 9: 906-914.

de Freitas C R (1991) The Greenhouse Crisis: Myths and Misconceptions. *Area* **23**, 1: 11-18.

Demand Management Marketing Unit (1994) *Demand Management Action Plan. Final Report: Program Summaries. Book 1.* Demand Management Marketing Services, Electricity Services Victoria, Melbourne, Victoria.

Department of Industrial Development Tasmania (1982) *Submission to the Senate Select Committee of Inquiry on South West Tasmania.* Department of Industrial Development Tasmania, Hobart, Tasmania.

Department of Industry and Commerce (1978) *Whitegoods Industry Report: A Report to the Minister for Industry and Commerce by the Electrical Industry Advisory Council.* Department of Industry and Commerce, Australian Government Publishing Service, Canberra, ACT.

Department of Industry, Technology and Resources (1986) *Regulatory Impact Statement for Energy Efficiency Labelling Regulations.* Unpublished report, Department of Industry, Technology and Resources, Melbourne.

Dholakia R R, Dholakia N & Firat A F (1983) From Social Psychology to Political Economy: A Model of Energy Using Behaviour. *Journal of Economic Psychology* **3**: 231-47.

Dickson D (1974) *The Politics of Alternative Technology.* Universe Books, New York, New York.

Diesendorf M (1990) *Australian Energy Options for Slowing the Greenhouse Effect.* Australian Conservation Foundation, Fitzroy, Victoria.

Diesendorf M (1994a) Power Politics. *Habitat Australia* **22**, 1: 12-17.

Diesendorf M (1994b) Wind, Biomass and other Renewables. *In* Dovers S (ed) *Sustainable Energy Systems: Pathways for Australian Energy Reform.* Cambridge University Press, Cambridge, England; Chapt. 7: 150-169.

Diesendorf M (1996) How Can a "Competitive" Market for Electricity be made Compatible with the Reduction of Greenhouse Gas Emissions? *Ecological Economics* **17**: 33-48.

Dietz F J & Vollebergh H R (1988) Wishful Thinking About the Effects of Market Incentives in Environmental Policy. *In* Dietz F J & Heijman W J M (eds) *Environmental Policy in a Market Economy: Selected Papers from the Congress 'Environmental Policy in a Market Economy', Wageningen, Netherlands, 8-11 September 1987.* Pudoc Wageningen, Netherlands: 40-60.

Dore R (1983) Energy Conservation in Japanese Industry. *In* Belgrave R (ed.) *Energy: Two Decades of Crisis.* Gower, Aldershot, England.

Dosi G (1984) *Technical Change and Industrial Transformation.* Macmillan, London.

Douglas M & Wildavsky A (1983) *Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers.* University of California Press, Berkeley, California.

Dovers S (1994a) Preface. *In* Dovers S (ed.) *Sustainable Energy Systems: Pathways for Energy Reform.* Cambridge University Press, Melbourne, Victoria: xi-xii.

Dovers S (1994b) Introduction: The Issue of Energy. *In* Dovers S (ed.) *Sustainable Energy Systems: Pathways for Energy Reform.* Cambridge University Press, Melbourne, Victoria; Chapt 1: 2-12.

Dovers S (1994c) Historical and Current Patterns of Energy Use. *In* Dovers S (ed.) *Sustainable Energy Systems: Pathways for Energy Reform.* Cambridge University Press, Melbourne, Victoria; Chapt. 2: 13-47.

Downes A (1972) Up and Down with Ecology: The 'Issue-Attention Cycle'. *The Public Interest* **28**: 38-50.

Downey T J (1987) Understanding Public Policy Making: A Necessary First Step for Environmentalists. *Alternatives* **14** (2): 30-34.

Doyle T & Kellow A (1995) *Environmental Politics and Policy Making in Australia.* Macmillan, South Melbourne.

Drake P J & Nieuwenhuysen (1988) *Economic Growth for Australia: An Agenda for Action.* Oxford University Press, Melbourne.

Dror Y (1968) *Public Policy Making Re-Examined.* Chandler, San Francisco, California.

Dryzek J S (1987) *Rational Ecology: Environment and Political Economy.* Basil Blackwell, Oxford, England.

Dryzek J S (1995) Democracy and Environmental Policy Instruments. *In* Eckersley R (ed.) *Markets, the State and the Environment: Towards Integration.* Macmillan, South Melbourne, Victoria.

Dubnick M J & Bardes B A (1983) *Thinking about Public Policy: a Problem-Solving Approach.* Wiley, New York, New York.

Ducsik D W (ed.) (1986) *Public Involvement in Energy Facility Planning: the Electric Utility Experience.* Westview Press, Colorado.

Duffy M (1994: Apocalypse Later. *The Independent* July 1994: 46-7.

Dunphy M (1972) Emergence of the Australian Environmental Conscience - Tasmania and Lake Pedder in Perspective. *In* Jones R (ed.) *Damania: The Hydro-Electric Commission, the Environment and Government in Tasmania.* Fullers Bookshop, Hobart, Tasmania: 5-22.

Easterbrook G (1995) *A Moment on the Earth: the Coming Age of Environmental Optimism.* Viking Press, New York, New York.

Easthope G & Holloway G (1989) Wilderness as the Sacred: The Franklin River Campaign. *In* Hay P, Eckersley R & Holloway G (eds) *Environmental Politics in Australia and New Zealand.* Occasional Paper 23, Centre for Environmental Studies, University of Tasmania, Sandy Bay, Tasmania: 189-201.

Economic and Budget Review Committee (1990) *Electricity, Water and Gas: Limits of Debt. Twenty-seventh Report to the Parliament.* Parliament of Victoria, Melbourne, Victoria.

Eden S E (1993) Individual Environmental Responsibility and its Role in Public Environmentalism. *Environment & Planning A* **25**, 12: 1743-1758.

Edwards G W & Thorpe M W (1978) Energy Policy in Australia. *The Australian Economic Quarterly* **50**, 2: 22-38.

Ehrlich P R & Ehrlich A H (1970) *Population Resources Environment: Issues in Human Ecology.* W.H. Freeman, San Francisco, California.

Ehrlich P R & Ehrlich A H (1974) *The End of Affluence: A Blueprint for Your Future.* Ballantine Books, New York, New York.

Ehrlich P R & Holdren J P (1971) The Impact of Population Growth. *Science* **171**: 1212-17.

Ehrlich P R, Sagan P, Kennedy D & Roberts W O (1984) *The Cold and the Dead: The World after Nuclear War. The Conference on the Long-Term Worldwide Biological Consequences of Nuclear War.* Sidgwick & Jackson, London.

Electricity Council [UK] (1988) *International Electricity Prices Quarterly.* Issue 88/1. The Council, London.

Electricity Supply Association of Australia [ESAA] (1989) *Electricity Supply Australia 1988.* Electricity Supply Association of Australia, Canberra, Australian Capital Territory.

Elkington J & Hailes J (1989) *The Green Consumer Guide.* Penguin, Ringwood, Victoria.

Ellul J (1964) *The Technological Society.* Vintage Books, New York, New York [Translated by J Wilkonson].

Energy Council of Tasmania (1994) *Options for the Future: A Discussion Paper on Electricity in Tasmania.* Office of Energy Planning and Conservation, Hobart, Tasmania.

Energy Council (UK) *International Electricity Prices Quarterly,* Issue 88/1, October 1988.

Enzensberger H M (1974) A Critique of Political Ecology. *New Left Review* **84**, 3: 3-31.

Ester P (1985) *Consumer Behaviour and Energy Conservation.* Martinus Nijhoff Publishers, Dordrecht, Netherlands.

Etzioni A (1967) Mixed Scanning. *Public Administration Review* **27**, 385-92.

European Community (1987) Nuclear Power in the European Community one year after Chernobyl. *Energy In Europe*, No. 7 (July): 6-9.

Evatt Research Foundation (1989) *State of Siege: Renewal or Privatisation for Australian State Public Services.* Pluto Press, Leichardt, New South Wales.

Executive Office of the President and the Office of Emergency Preparedness (1973) *The potential for Energy Conservation: Substitution for Scarce Fuels: A Staff Study.* Executive Office of the President and the Office of Energy Preparedness, Washington, D.C.

Falk R A (1971) *This Endangered Planet: Prospects and Proposals for Human Survival.* Vintage Books, New York, New York.

Fells I & Horlock J (1995) UK Energy Strategy. *In* Rooke D, Fells I & Horlock J (eds) *Energy for the Future.* E & F N Spon for the Royal Society, London; Chapt. 11: 205-14.

Felmingham B (1982) *The Role of the Public Sector in the Tasmanian Economy.* Tasmanian Public Service Association, Hobart, Tasmania.

Felmingham B (1990) *Energy Efficiency and Tasmania.* Paper presented at the Hydro-Electricity Commission Seminar 'Energy Efficiency in Tasmania', 2 October, Launceston, Tasmania.

Felmingham B (1995) Green Dreams. *The Sunday Tasmanian.* 29 Oct., 1995: 17.

Felmingham B, Greenwood P, Kilpatrick S & Mansfield P (1995) *Major Industry's Role in Tasmania's Future: Report Prepared for a Group of Tasmanian Major Employers.* Australian Corporate Resources, North Hobart & UNITAS Consulting, Hobart, Tasmania.

Felmingham B & Rutherford R (1989) Tasmania. *In* Evatt Research Foundation (1989) *State of Siege: Renewal or Privatisation for Australian State Public Services.* Pluto Press, Leichardt, New South Wales. Chapt. 15: 413-65.

Festinger L (1957) *A Theory of Cognitive Dissonance.* Stanford University Press, Stanford, California.

Flacks R (1988) *Making History: the Radical Tradition in American Life.* Columbia University Press, New York, New York.

Flanagan R (1990) Return the People's Pedder! *In* Pybus C & Flanagan R (eds) *The Rest of the World is Watching: Tasmania and the Greens.* Pan Macmillan, Sydney, New South Wales: 194 - 210.

Flavin C & Durning A B (1988) *Making History: the Radical Transition in American Life.* Columbia University Press, New York, New York.

Flavin C & Lenssen N (1994) Reshaping the Electricity Power Industry. *Energy Policy* **22**, 12: 1029-44.

Fleming K B (1979) *The Demand for Household Electricity in Tasmania.* Unpublished B. Econ. Hons. Thesis, University of Tasmania, Sandy Bay, Tasmania.

Foley G (1976) *The Energy Question.* Penguin, Harmondsworth, England.

Ford K, Rochlin G, Rosenfeld A, Socolow R (1975) Part 1 - A Physics Perspective. *In* Wolfe H C (ed) *Efficient Use of Energy: The APS Studies on Technical Aspects of the More Efficienct Use of Energy.* American Institute of Physics, New York, New York. pp. 1-151.

Forrester J W (9171) *World Dynamics.* Wright-Allen Press, Cambridge, Massachusetts.

Foster J S & Holmes J H (1991) *Acceptance of Solar Efficient Housing: A Queensland Survey Using Diffusion Theory. Final Report to the Energy Research and Development Corporation.* Department of Geographical Sciences and Planning, University of Queensland, St Lucia, Queensland.

Foster J S & Holmes J H (1994) Public Acceptance of Roof Insulation for New Homes: A Queensland Survey. *Australian Geographical Studies* **32**, 1: 123-130.

Fowler J M (1972) Energy and the Environment. *The Science Teacher* **39**, 9: 10-22. Reprinted in Ruedisili L C & Firebaugh M W (eds) *Perspectives on Energy: Issues, Ideas, and Environmental Dilemmas,* Oxford University Press, New York, New York: 66-83.

Frank L (1987) The Development Game. *Granta* **22**: 231-243.

Freeman S D, Baldwin P, Canfield M, Carhart S, Davidson J, Dunkerley J, Eddy C, Gillman K, Makhijani A, Saulter K, Sheridan D & Williams R (1974) *A Time to Choose: America's Energy Future. Final Report by the Energy Policy Project of the Ford Foundation.* Ballinger, Cambridge, Massachusetts.

Fremlin J H (1972) *Be Fruitful and Multiply: Life at the Limits of Population.* Hart-Davis, London.

Frieden B J & Baker K (1983a) The Record of Home Energy Conservation: Saving Bucks, Not Btu's. *Technology Review* **85**, 11: 23-31.

Frieden B J & Baker K (1983b) The Market Needs Help: the Disappointing Record of Home Energy Conservation. *Journal of Policy Analysis and Management* **3**: 432-48.

Frost R L (1991) *Alternating Currents: Nationalised Power in France 1946-1970.* Cornell University Press, Ithaca, New York.

Fuchs W M (1946) *When the Oil Wells Run Dry.* Industrial Research Service, Dover, North Hampshire.

Furth H P (1995) Fusion. *Scientific American* **273**, 3: 140-42.

Gadgil A J & Sastry M A (1994) Stalled on the Way to the Market: Lessons from a Project Promoting Lighting Efficiency in India. *Energy Efficiency* **22**, 2: 151-162.

Galbraith J K (1958a) How Much Should a Country Consume? *In* Jarrett H (ed.) *Perspectives on Conservation* , [4th reprinting 1968]. Johns Hopkins Press, Baltimore, Maryland: 88-99.

Galbraith J K (1958b) *The Affluent Society.* Houghton Mifflin, Boston, Massachusetts.

Galbraith J K (1972) *The New Industrial State.* Pelican, Harmondsworth, England. [First published in 1967 by Hamish Hamilton].

Gas and Fuel Corporation of Victoria, Economic Policy & Research Department, (1990b) *Gas Demand Management: High Efficiency Gas Appliance Penetration and Gas Savings in Victoria.* GFCV Discussion Paper No. 5, Gas and Fuel Corporation of Victoria, Melbourne, Victoria.

Geller H S (1989) Implementing Electricity Conservation Programs: Progress Towards Least Cost Energy Services Among U.S. Utilities. *In* Johansson T B, Bodlund B & Williams R H (eds) *Electricity: Efficient End-Use and New Generation Technologies, and Their Planning Implications.* Lund University Press, Lund, Sweden: 741-786.

Geller H S (1991) *Efficient Electricity Use: A Development Strategy for Brazil.* American Council for an Energy-Efficient Economy, Washington, D.C.

Gellings C W (1996) Then and Now: the Perspective of the Man Who Coined the Term 'DSM'. *Energy Policy* **24**, 4: 285-8.

Gellings C, Rabl V & Chamberlin J (1992) *Keynote Address: Demand Side Management: Is the Dream Still Alive?* Proceedings of the Electricity Supply Association of Australia Conference 'Focus for the Future', 26-28 May, Melbourne; Vol. 1: 1-14.

George Wilkenfield & Associates (1993) *Benefits and Costs of Implementing Minimum Energy Efficiency Performance Standards For Household Electrical Appliances in Australia.* SECV Demand Management Unit, Melbourne, Victoria.

Georgescu-Roegen N (1971) *The Entropy Law and the Economic Process:* Harvard University Press, Cambridge, Massachusetts.

Georgescu-Roegen N (1976) *Energy and Economic Myths: Institutional and Analytical Economic Essays.* Pergamon Press, New York, New York.

Gever J (1987) *Beyond Oil: the Threat to Food and Fuel in the Coming Decades.* Ballinger, Cambridge, Massachusetts.

Gibbons J H (1985) Reflections on Fifteen Years of Energy Policy. *In* Hafemeister D, Kelly H & Levi B (eds) *Energy Sources: Conservation and Renewables: American Institute of Physics Conference Proceedings No. 135.* American Institute of Physics, New York, New York; Chapt. 1: 1-14.

Gibbons J H& Chandler W U (1981) *Energy : The Conservation Revolution.* Plenum Press, New York, New York.

Gibbs H (1991) *Inquiry into Community Needs and High Voltage Transmission Line Development.* New South Wales Government, Sydney, New South Wales.

Gibbs J W (1948) The Collected Works of J Willard Gibbs. Yale University Press, New Haven, Connecticut.

Gilchrist G (1994) *The Big Switch: Clean Energy for the Twenty-First Century.* Allen & Unwin, St Leonards, New South Wales.

Gilchrist G (1995) Secret Strategy Undermines Greenhouse Fight. *Sydney Morning Herald.* 7 August: 1, 4.

Glance N S & Huberman B A (1994) The Dynamics of Social Dilemmas. *Scientific American* **270**, 3: 58-63.

Glasser R (1977) *The Net and the Quest: Patterns of Community and How They can Survive Progress.* Pica Press, New York, New York.

Goldemberg J, Johansson T B, Reddy A K & Williams R H (1987) *Energy for a Sustainable World.* World Resources Institute, Washington, D.C.

Goldsmith A (1995) Across the Green Divide - North vs Porritt. *Tomorrow: Global Environmental Business* **V**, 3: 42-43.

Goldsmith E & Hildyard N (1988) *Battle for the Earth: Today's Key Environmental Issues.* Child & Associates, Brooksvale, New South Wales.

Goldsmith E (1988) *The Great U Turn: De-Industrialising Society.* Green Books, Bidford, England.

Goodin R E (1976) *The Politics of Rational Man.* Wiley, London.

Goodin R E (1980) Making Moral Incentives Pay. *Policy Sciences* **12**: 131-45.

Goodin R E (1992) *Green Political Theory.* Polity Press, Cambridge, England.

Goodland R (1992) The Case that the World has Reached its Limits. *In* Goodland R, Daly H E, Serafy S E (eds) *Population, Technology, and Lifestyle: The Transition to Sustainability.* Island Press, Washington, D.C. Chapt. 1: 1-3-22.

Gore A (1993) *Earth in the Balance: Ecology and the Human Spirit.* Plume, New York, New York.

Gottlieb D & Matre M (1976) *Sociological Dimensions of the Energy Crisis: A Follow-up Study.* The Energy Institute, University of Houston, Houston, Texas.

Government of Tasmania (1982a) *Energy Policy Statement.* Energy Policy Unit, Premier's Department, Hobart, Tasmania.

Government of Tasmania (1982b) Energy Policy Statement. *In* Eyllyet C (ed.) *Energy Policy and Research in Australia and New Zealand.: Vol. 2.* Institute of Industrial Economics, University of New Castle, New Castle, New South Wales.: 61-91.

Government Prices Oversight Commission (1996) *Hydro-Electric Commission Retail Prices Investigation: Background Paper.* Government Prices Oversight Commission, Hobart.

Grant M S (1978) The South-West Committee. *In* Gee H & Fenton J (eds) *The South-West Book.* Australian Conservation Foundation, Melbourne, Victoria: 251-2.

Gray J (1993) *Beyond the New Right: Markets, Governments and the Common Environment.* Routledge, London.

Greene D (1990) *A Greenhouse Strategy: Sustainable Energy Development for Australia.* Department of Arts, Sport, the Environment, Tourism and Territories, Canberra, Australian Capital Territory.

Green R (1984) *The Battle for the Franklin.* Australian Conservation Foundation, Fontana, Melbourne, Victoria.

Greenberger M & Hogan W W (1987) Energy-Policy Modelling in the US: Competing Social Alternatives. *In* Baumgartner T & Midttun A (eds) *The Politics of Energy Forecasting: A Comparative Study of Energy Forecasting in Western Europe and North America.* Clarendon Press, Oxford, England; Chapt. 11: 241-63.

Griffin K (1986) State Government Conservation Programs. *In* Sawhill J C & Cotton R (eds) *Energy Conservation: Successes and Failure.* The Brookings Institute, Washington, D.C.: 205-235.

Griffith E S (1968) Main Lines of Thought and Action. *In* Jarrett H (ed.) *Perspectives on Conservation: Essays on America's Natural Resources.* Johns Hopkins Press, Baltimore, Maryland: 3-23.

Griffiths A (1990) Foreword. *In* Department of Primary Industries and Energy [DPIE] (1990) *National Energy Management*. Australian Government Publishing Service, Canberra, Australian Capital Territory: iii-iv.

Grossman R & Daneker G (1979) *Energy, Jobs and the Economy*. Alyson Publications, Boston, Massachusetts.

Grosvenor S, Wilde P D & Wood L J (1993) *Recent Changes in the Tasmanian Space Economy*. Department of Geography and Environmental Studies, University of Tasmania, Hobart, Tasmania.

Grove R H (1995) *Green Imperialism: Colonial Expansion, Tropical Island Edens, and the Origins of Environmentalism*, 1600-1860. Cambridge University Press, Cambridge, England.

Grubb M (1992) Wind Energy. *In* Grubb M, Walker J, Buxton R, Geln T, Herring H, Hill B, Holman C, Patterson W C, Proctor J & Rouse K (1992) *Emerging Energy Technologies: Impacts and Policy Implications*. Dartmouth Publishing Co., Aldershot, England, for The Royal Institute of International Affairs, London. Chapt. 10: 163-91.

Grubb M J (1992) Energy Efficiency and Economic Fallacies. *Energy Policy* **18**, 8: 783-785.

Grubb M, Walker J, Buxton R, Gelny T, Herring H, Hill B, Holman C, Patterson W C, Proctor J & Rouse K (1992) *Emerging Energy Technologies: Impacts and Policy Implications*. Dartmouth Publishing Co., Aldershot, England, for The Royal Institute of International Affairs, London.

Grundmann R (1991) *Marxism and Ecology*. Clarendon Press, Oxford, England.

Guldbrandsen T & Nørgård J S (1986) *Achieving Substantially Reduced Energy Consumption in European Type Refrigerators*. Energy Group, Physics Laboratory III, Technical University of Denmark, Lyngby, Denmark.

Haavelmo T & Hansen S (1992) On the Strategy of Trying to Reduce Economic Inequality by Expanding the Scale of Human Activity. *In* Goodland R, Daly HE & Serafy S E (eds) *Population, Technology, and Lifestyle: the Transition to Sustainability*. Island Press, Washington, D.C.; Chapt. 3: 38-51.

Habermas J (1971) *Towards a Rational Society*. Heineman, London.

Habermas J (1979) *Communication and the Evolution of Society*. Beacon Press, Boston, Massachusetts. [Translated by T. McCarthy].

Haigh N (1994) The Introduction of the Precautionary Principle to the UK. *In* O'Riordan T & Cameron J (eds) *Interpreting the Prercautionary Principle*. Earthscan, London; Chapt. 13: 229-51.

Halacy D S (1959) *Fun with the Sun*. Scholastic Books, New York [Reprinted as *Solar Science Projects for a Cleaner Environment* in 1974].

Halacy D S (1973) *The Coming Age of Solar Energy*, 2nd edn. Harper & Row, New York.

Hall R H (1990) *Health and the Global Environment*. Polity Press, New York, New York.

Hallsworth A G (1992) *The New Geography of Consumer Spending: A Political Economy Approach*. Belhaven Press, London.

Hamblin D M & Vineyard, T A, (1985) Engineering/Economic End-Use Energy Models. *In* Hafemeister D, Kelly H & Levi B (eds) *Energy Sources: Conservation and Renewables: American Institute of Physics Conference Proceedings No. 135.* American Institute of Physics, New York, New York; Chapt. 4: 52 - 80.

Hamilton C (1994) *Comparison of Emission Sources and Emission Trends among OECD Member Countries.* Australi Institute, Canberra, Australian Capital Territory.

Hammond A L, Metz W D & Maugh T H (1973) *Energy and the Future.* American Association for the Advancement of Science, Washington, D.C.

Hanson S (1993) 'Never Question the Assumptions' and Other Scenes from the Revolution. *Urban Geography* **14**, 6: 252-256.

Hardin G (1968) The Tragedy of the Commons. *Science* **162**, 3859: 1243 - 8.

Hardin G (1991) Paramount Positions in Ecological Economics. *In* Costanza (ed.) *Ecological Economics: The Science and Management of Sustainability.* Columbia University Press, New York, New York; Chapt. 4: 47-57.

Harries R I (1965) The Major White Appliances Industry: A Study in Market Structure and Conduct. *Australian Economic Papers* 14, 2: 111-38.

Harris S F (1982) Social Aspects of Energy in Australia: A Social Science Literature and Research Review. *In* Black J (ed.) *Liquid Fuels in Australia: A Social Science Research Perspective.* Pergamon, Sydney, New South Wales; Chapt. 1: 7-81.

Harrison P (1992) *The Third Revolution: Environment, Population and a Sustainable World.* Tauris, London.

Harwood C E & Hartley M J (1980) *An Energy Efficient Future For Tasmania.* Tasmanian Conservation Trust, Hobart, Tasmania.

Hawke R J (1989) *Our Country, Our Future: Statement on the Environment.* Australian Government Publishing Service, Canberra, Australian Capital Territory.

Hawken P (1994) *The Ecology of Commerce: A Declaration of Sustainability.* Weidenfield & Nicholoson, London, England.

Hawley R (1995) Nuclear Power - Energy for the 21st Century. *In* Rooke D, Fells I & Horlock J (eds) *Energy for the Future.* E & F N Spon for the Royal Society, London; Chapt. 6: 85-108.

Hay P (1987) Will the 'Tasmanian Disease' Spread to the Mainland? *Current Affairs Bulletin* **64**, 3: 4-12.

Hay P R (1988) The Contemporary Environment Movement as Neo-Romanticism: A Re-Appraisal from Tasmania. *Environmental Review* **12**, 4: 39-57.

Hay P R & Eckersley R (1993) Green Politics: Lessons from Tasmania's Labor-Green Accord, 1989-1991. *Current Affairs Bulletin* **69**, 11: 10-15.

Hay P R & Haward M G (1988) Comparative Green Politics: Beyond the European Context? *Political Studies* **26**: 433-48.

Hayes D (1977) *Rays of Hope: The Transition to a Post-Petroleum World.*

Hays S P (1959) *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890-1920.* Harvard University Press, Boston, Massachusetts.

Hean B (1972) Some Statistics Relating to the Notion of "Cheap Power" in Tasmania. *In* Jones R (ed.) *Damania: The Hydro-Electric Commission, The Environment & Government in Tasmania.* Fullers Bookshop, Hobart, Tasmania: 102-8.

Heebøll J, Mehlsen K & Nørgård J (1985) *Development of Energy Efficient Household Appliances. Part 1: Refrigerators.* Energy Group, Physics Laboratory III, Technical University of Denmark, Lyngby, Denmark.

Hellmann-Tuitert G & Kanis H (1983) *Product Testing as a Basis for Product Information. SWOKA Research Report No. 18.* Stichting Wetenschappelijk Onderzoek Konsumentenaangelegenheden [SWOKA], The Hague, Netherlands.

Hemphill R F & Meyers E A (1986) Electric Utility Conservation Programs: Successes and Failures. *In* Sawhill J C & Cotton R (eds) *Energy Conservation: Successes and Failure.* The Brookings Institute, Washington, D.C.: 137-162.

Henderson R C (1986) The Evolution of Public Involvement in Project Planning at Ontario Hydro. *In* Ducsik D (ed.) *Public Involvement in Energy Facility Planning: The Electric Utility Experience.* Westview Press, Boulder, Colorado; Chapt. 6: 141-75.

Herber L (1965) *Crisis in Our Cities.* Prentice-Hall, Englewood Cliffs, New Jersey.

Herendeen R & Jacobs C (1982) Predicting Residential Energy Consumption. *Illinois Business Review* **39**, 6: 4-8.

Herr R A & Davis B W (1982) *The Tasmanian Parliament, Accountability and the Hydro-Electric Commission.* Revised version of paper presented at the Annual Conference of the Australian Institute of Public Administration, Canberra, Australian Capital Territory, 18-20 Nov., 1981.

Herring H (1992) Is Britain a Third World Country? The Case of German Refrigerators. *Energy Policy* **22**, 2: 779-87.

Hill D G (1980) *Future Energy Supply.* Proceedings of ANZAAS Symposium 'Energy in Tasmania', 23 February, University of Tasmania, Sandy Bay: 85-92.

Hinchey M, Naughten B R, Donaldson P K, Belcher s & Ferguson E (1991) *The Case of Domestic Energy Market Failure.* Australian Government Publishing Service, Canberra, Australian Capital Territory.

Hinchliffe S (1995) Missing Culture: Energy Efficiency and Lost Causes. *Energy Policy* **23**, 1: 93-5.

Hirschman A O (1982) *Shifting Involvements: Private Interests and Public Policy.* Princeton University Press, Princeton, New Jersey.

Hirst E (1986) Comment. *In* Sawhill J C & Cotton R (eds) *Energy Conservation: Successes and Failure.* The Brookings Institute, Washington, D.C.: 235-6.

Hobbs B F (1990) The Most Value Test: Economic Evaluation of Electricity Demand-Side Management Considering Customer Value. *The Energy Journal* **12**, 2: 67-91.

Hodgson G M (1993) *Economics and Evolution: Bringing Life Back into Economics.* Polity Press, Cambridge, England.

Hogwood B W & Gunn L A (1984) *Policy Analysis for a Real World.* Oxford University Press, Oxford, England.

Hohmeyer O (1990) The Social Costs of Electricity Generation: Wind and Photovoltaic versus Fossil and Nuclear. *Contemporary Policy Issues* **8**, 3: 255-82.

Hohmeyer O (1992) Renewables and the Full Costs of Energy. *Energy Policy* **20**, 4: 365-75.

Holdren J P (1992a) The Transition to Costlier Energy. *In* Schipper L & Meyers S (eds) *Energy Efficiency and Human Activity: Past Trends, Future Prospects.* Cambridge University Press, Cambridge, New York: 1-51.

Holdren J P (1992b) The Energy predicament in Perspective. *In* Mintzer J P (ed.) *Confronting Climate Change: Risks, Implications and Responses.* Cambridge University Press, Cambridge, New York; Chapt. 12: 163-169.

Holdren J P & Ehrlich P R (eds) (1971) *Global Ecology: Readings Towards a Rational Strategy for Man.* Harcourt Brace Jonanovich, New York, New York.

Holdren J P & Herrera E P (1971) *Energy: A Crisis in Power. The Sierra Club Battlebook No. 4.* Sierra Club, San Francisco, California.

Holliman J (1974) *Consumers' Guide to the Protection of the Environment,* 2nd edn. Pan/Ballantine, London.

Holman J P (1988) *Thermodynamics,* 4th edn. McGraw-Hill, New York, New York.

Hoover H (1921) Foreword. *In* Committee on Elimination of Waste in Industry of the Federated American Engineering Societies (ed.) *Waste in Industry. 3rd impression.* McGraw-Hill, New York.

Horawitz M J & Haeri H 1990) Economic Efficiency vs Energy Efficiency: Do Model Conservation Standards Make Good Sense? *Energy Economics* **12**, 2: 122-131.

Horton S (1995) Rethinking Recycling: The Politics of the Waste Crisis. *Capitalism Nature Socialism* **6**, 1: 1-20.

Hoskins R A & Hirst E (1977) *Residential Refrigerators: Energy Conservation and Economics.* Proceedings of an International Conference on Energy Use held in Tuscan: 499-504.

House of Representatives Standing Committee on Environment, Recreation and the Arts (1995) *Inquiry into the Proposal to Drain and Restore Lake Pedder.* Australian Government Publishing Service, Canberra, Australian Capital Territory.

Hoyle F (1971) *The New Face of Science.* New American Library Press, New York, New York.

Hubbard H M (1991) The Real Costs of Energy. *Scientific American* **264**, 4: 18-23.

Hubbert M K (1949) Energy from Fossil Fuels. *Science* **109** (4 February): 103-9.

Hubbert M K (1967) *Degree of Advancement of Petroleum Exploration in the United States. American Association of Petroleum Goelogists Bulletin* **51**, 1: 2207-27.

Huëting R (1980) *New Scarcity and Economic Growth: More Welfare Through Less Production?* North Holland, Amsterdam, Netherlands.

Hughes A (1990) Dealing with Strangers: Small States and Foreign Investors. *In* Ghai Y (ed.) *Public Administration and Management in Small States: Pacific Experiences.* Commonwealth Secretariat, London, England, and University of the South Pacific, Suva, Fiji: 167-208.

Hughes B B, Rycroft R W, Sylvan D A, Front B T & Harf J E (1985) *Energy in the Global Arena: Actors, Values, Policies and Futures.* Duke University Press, Charlotte, North Carolina.

Hughes T P (1983) *Networks of Power: Electrification in Western Society, 1880-1930.* Johns Hopkins Press, Baltimore, Maryland.

Hughes T P (1987) The Evolution of Large Technological Systems. *In* Bijker W E, Hughes T P & Pinch T J (eds) *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology.* The MIT Press, Cambridge, Massachusetts: 51-82.

Humphrey C R & Buttel F H (1982) *Environment, Energy, and Society.* Krieger, Malabar, Florida.

Huntington H, Schipper L & Sanstad A (1994) Editors' Introduction. *Energy Policy* **22**, 10: 795-797.

Hydro-Electric Commission (1971) *Report on the Proposed Pieman River Power Development.* Hydro-Electric Commission, Hobart, Tasmania.

Hydro-Electric Commission (1972) *Report for the Year 1971-72.* Hydro-Electric Commission, Hobart, Tasmania.

Hydro-Electric Commission (1979) *Report on the Gordon River Power Development. Stage Two. Appendix III: Alternatives to Hydro-Electric Energy.* Hydro-Electric Commission, Hobart, Tasmania.

Hydro-Electric Commission (1984) *Hydro-Electric Commission Annual Report 1983-84.* Hydro-Electric Commission, Hobart, Tasmania.

Hydro-Electric Commission (1986) *Energy Planning in Tasmania: First Progress Report.* Planning and Public Affairs Group, Hobart, Tasmania.

Hydro-Electric Commission (1987) *HEC Annual Report 1986-87.* Hydro-Electric Commission, Hobart, Tasmania.

Hydro-Electric Commission (1990a) *Annual Report 1990.* Hydro-Electric Commission, Hobart, Tasmania.

Hydro-Electric Commission (1991a) *Hydro-Electric Commission Annual Report 1991.* HECT, Hobart, Tasmania.

Hydro-Electric Commission (1991b) *Blueprint for the Future.* Hydro-Electric Commission, Hobart.

Hydro-Electric Commission, Planning & Public Affairs Group (1986) *Energy Planning in Tasmania.* Hydro-Electric Commission, Hobart.

Illich I (1973) Tools for Conviviality. Calder & Boyers, London.

Independent Commission of Inquiry into National Competition Strategy (1993) *National Competition Policy.* Australian Government Publishing Service, Canberra.

Independent Commission of Review of Tasmania's Public Sector Finances (1992) *Tasmania in the Nineties: Government Finances, Economic Performance, Challenges and Opportunities.* Independent Commission of Review of Tasmania's Public Sector Finances, Hobart, Tasmania.

Industry Assistance Commission (1989) *Government (Non-Tax) Charges. IAC Report No. 422. Volume 4: The Electricity Supply Industry in Australia.* .Australian Government Publishing Service, Canberra, Australian Capital Territory.

Industry Commission (1991a) *Energy Generation and Distribution. Vol. I: Recommendations. Industry Commission Report No. 11.* Australian Government Publishing Service, Canberra, Australian Capital Territory.

Industry Commission (1991b) *Energy Generation and Distribution. Vol. II: Report. Industry Commission Report No. 11.* Australian Government Publishing Service, Canberra, Australian Capital Territory.

Industry Commission (1991c) *Energy Generation and Distribution. Vol. III: Supporting Appendices. Industry Commission Report No. 11.* Australian Government Publishing Service, Canberra, Australian Capital Territory.

Inglehart R (1977) *The Silent Revolution.* Princeton University Press, Princeton, New Jersey.

Inglehart R (1990) *Culture Shift in Advanced Industrial Society.* Princeton University Press, Princeton, New Jersey.

Ingram J H (1979) Energy - A Resource to Stimulate Economic Growth. *In* Taylor G (ed.) *Energy and People. The Fourth New Zealand Energy Conference: Vol. 1.* New Zealand Energy Council, Wellington: 44-52.

Institute of Engineers, Australia (1977) *Towards an Energy Policy for Australia: Report of the Task Force on Energy Use.* National Conference Paper No. 77/6, The Institute of Engineers, Australia, Barton, Australian Capital Territory.

InterDepartmental Committee (1991) *Towards and Energy Strategy.* Department of Resources and Energy, Hobart, Tasmania.

International Energy Agency (1987) *Energy Conservation in IEA Countries.* Organisation for Economic Cooperation and Development, Paris.

International Energy Agency (1991a) *Utility Pricing and Access: Competition for Monopolies.* Organisation for Economic Cooperation and Development, Paris.

International Energy Agency (1991b) *Energy Efficiency and the Environment.* Organisation for Economic Cooperation and Development, Paris.

International Union for Conservation of Nature and Natural Resources [IUCN] (1980) *The World Conservation Strategy.* International Union for Conservation of Nature and Natural Resources, United Nations Environment Programme, IUCN, Geneva.

Irvine S & Ponton A (1988) *A Green Manifesto: Politics for a Green Future.* Macdonald Optima, London.

Islam S M (1985) *The Determinants of the Demand for Wood Energy and the Pattern of Interfuel Substitution in the Domestic Sector in the Tasmanian Economy: Some Policy Considerations.* Unpublished report submitted to the Centre for Environmental Studies, University of Tasmania, Sandy Bay, Tasmania.

Jackson T (1991) Renewable Energy: Great Hope or False Promise? *Energy Policy* **19**, 1: 2-7.

Jackson T (1996: 125) Book Review. *Energy Policy* **24**, 1: 125.

Jacobs M (1991) *The Green Economy: Environment, Sustainable Development and the Future.* Pluto Press, London.

Jaffe A B & Stavins R N (1994) The Energy-Efficiency Gap: What Does it Mean? *Energy Policy* **22**, 10: 804-810.

Jänike M (1990) *State Failure: The Impotence of Politics in Industrial Society.* Polity Press, Cambridge, England. [First published in 1986 as *Staatsversagen: Die Ohnmacht der Politic in der Industriegesellshaft* by R. Piper GmbH & Co., Munich. Translated by A. Braley].

Jevons W S (1865) *The Coal Question - Can Britain Survive?* [1965 by A. M. Kelly, New York, New York].

Jochem E & Gruber E (1990) Obstacles to Rational Electricity Use and Measures to Alleviate them. *Energy Policy* **18**, 4: 340-9.

Jochem E & Hohmeyer O (1992) The Economics of Near-Term Reductions in Greenhouse Gases. *In* Mintzer I M (ed) *Confronting Climate Change: Risks, Impacts and Response;* Chapt. 15: 215-236.

Joerges J (1979) Die Armen Zahalen Mehr -Auch Für Energie. *Journal of Consumer Policy* **6**, 2: 155-165.

Joerges J (1983) Consumer Energy Conservation Policies: A Multinational Study. Fifth Interim Report. Berlin Science Centre, Berlin.

Johnson M & Rix S (1991) *Powering the Future: The Electricity Industry and Australia's Future.* Public Service Research Council (University of New South Wales), Kensington, and Pluto Press, Leichardt, New South Wales.

Jonas H (1984) *The Imperatives of Responsibility: In Search of an Ethic for the Technological Age.* University of Chicago Press, Chicago, Illinois.

Jones B, Bush S, Kanakaratnam A, Leonard M & Gillan P (1991) *Projections of Energy Demand and Supply Australia 1990-91 to 2004-05.* Australian Government Publishing Service, Canberra, Australian Capital Territory.

Jones C O (1975) *Clean Air: The Politics of Pollution Control.* University of Pittsburgh Press, Pittsburgh, Pennsylvania.

Jones C O (1984) *An Introduction to the Study of Public Policy,* 3rd edn. Brooks/Cole, Monterey, California.

Jones R (1980) *Energy Policy and Tasmania's Energy Needs.* Proceedings of ANZAAS Symposium 'Energy in Tasmania', 23 February, University of Tasmania, Sandy Bay: 93-108.

Joskow P L & Marron D B (1992) What Does a Negawatt Really Cost? *Energy Journal* **13**, 4: 41-74.

Kahane A (1991) New Perspectives for Energy Efficiency and System Optimization. *Energy Policy* **19**, 3: 199-201.

Kahn H & Wiener A J (1967) *The Year 2000: A Framework for Speculation on the Next 33 Years.* Croom Helm, London.

Kahn H (1979) World Economic Development: 1979 and Beyond. William Morrow, New York, New York.

Kahn H , Brown W & Martel L (1976) *The Next 200 Years: A Scenario for America and the World.* William Morrow, New York, New York.

Kanis H, Tweehuysen R, Stork B, Verwoerd M & Terpstra M J (1982) *Energy Saving for Household Appliances: a Compilation of Possible/ Impossible future Technical Developments for Refrigerators, Freezers, Washing Machines. Tumble Dryers and*

Dishwashers. SWOKA Research Report No. 12. SWOKA (Institute for Consumer Research), The Hague, Netherlands.

Kassiola J J (1990) *The Death of Industrial Civilisation: The Limits to Economic Growth and the Repoliticization of Advanced Industrial Society.* State University of New York Press, Abla, New York.

Kats G H (1989) Global Greenhouse Warming: Energy and Development. *In* IEA (1989) *Energy Technologies for Reducing Emissions of Greenhouse Gases: Proceedings of an Experts' Seminar,* Paris 12-14 April. OECD, Paris: 515-42.

Katz M (1971) Decision-Making in the Production of Energy. *In* Scientific American Inc. (1971) *Energy & Power.* W.H. Freeman & Co., San Francisco, California: 131-8.

Katzev R D & Johnson T R (1983) A Social-Psychological Analysis of Residential Electricity Consumption: the Impact of Minimal Justification Techniques. *Journal of Economic Psychology* **3**: 267-84.

Kazis R & Grossman R L (1982) *Fear at Work: Job Blackmail, Labor and the Environment.* Pilgrim Press, New York.

Keating K M (1996) What Roles for Utility Sponsored DSM in a Competitive Environment? *Energy Policy* **24**, 4: 317-21.

Keepin B & Kats G (1988) Greenhouse Warming: Comparative Analysis of Nuclear and Efficiency Abatement Strategies. *Energy Policy* **16**, 12: 538-560.

Kellow A & Moon J (1993) Governing the Environment: Problems and Possibilities. *In* Marsh I (ed.) *Governing in the 1990s: An Agenda for the Decade.* Longman Chesire, Melbourne, Victoria: 226-255.

Kellow A (1990) Spoiling for a Fight or Fighting for the Spoils? Resource and Environmental Politics and Policies in Australia towards 2000, in Hocking B (ed.) *Australia towards 2000.* Macmillan Press, Basingstoke, England.

Kellow A J (1982) *An Economic Evaluation of Hydro-Electric and Coal-Fired Thermal Power Development Programmes for Tasmania.* Environmental Studies Working Paper 14, Centre for Environmental Studies, University of Tasmania, Hobart, Tasmania.

Kellow A J (1986) Electricity Planning in Tasmania and New Zealand: Political Processes and Technological Imperative. *Australian Journal of Public Administration* **45**, 1: 2-17.

Kellow A J (1996) *Transforming Power The Politics of Electricity Planning.* Cambridge University Press, Cambridge, England.

Kelly P (1989) *The Hawke Ascendancy.* Angus & Robertson, North Ryde, New South Wales.

Kendall H W & Nadis S J (eds) (1980) *Energy Strategies: Towards a Solar Future. A Report to the Union of Concern Scientists.* Ballinger Press, Cambridge, Massachusetts.

Kennedy P (1993) *Preparing for the Twenty-First Century.* HarperCollins, London.

Kerby J & Phillips P (1983) *The Effect of Rising Energy Prices on Households in Three Areas of Adelaide.* National Energy Research Development and Demonstration Program *End of Grant Report EG/83/197.* National Energy Research Development and Demonstration Program, Department of Resources and Energy, Canberra, Australian Capital Territory.

Kestigan M (1994) Fuel Cells: The 21st Century's Electricity Generator. *Search* **25**, 3: 94-6.

Kestin J (ed.) *The Second Law of Thermodynamics*. Halsted Press, New York, New York.

Khazzoom J D (1987) The Savings Resulting form Adoption of More Efficient Appliances. *Energy Journal* **8**, 4: 85-9.

Khazzoom J D (1989) Energy Savings from Energy Efficient Appliances: A Rejoinder. *Energy Journal* **10**, 1: 157-66.

Kincade D & Coles P (1985) *Fuels and Energy*. Macdonald & Co., London.

King A (1990) The Human Lemmings. *In* Groen J, Smit E & Eijsvoogel J (eds) *The Discipline of Curiosity: Science in the World*. Elsevier Science, Amsterdam: 39-46.

Kinrade P (1992) Energy: Looking for Win-Win Solutions. *Habitat Australia*, **20**, 1: 16-17.

Kinrade (1995a) Towards Ecologically Sustainable Development: the Role and Shortcomings of Markets. *In* Eckersley R (ed.) *Markets, The State, and The Environment: Towards Integration*. Macmillan, South Melbourne, Victoria; Chapt. 4: 86-109.

Kinrade P (1995b) Turning down the Heat: Australia's Greenhouse Obligations and Options. *Habitat* **23**, 1: 27-34.

Knapp K W (1950) *The Social Costs of Private Enterprises*. Cambridge, Massachusetts.

Knapp K W (1963) *Social Costs of Business Enterprise*. Cambridge, Massachusetts.

Knibbs J (1987) Bill Gaskell on the Future of the HECT. *Electrical Engineering*, **64** (2): 41-44, 46.

Knoppes C R (1987) Efficiency/Equity/Esthetics: Towards a Reinterpretation of American Conservation. *Environmental Review* **11**, 2: 127-46.

Kohl B (1993) *Issues and Opportunities for the Generation and Supply of Electrical Energy in Tasmania*. SEECA Discussion Paper, Social, Economic, Ecological and Cultural Alliance, Rosny Point, Tasmania.

Kraus M (1987) Energy Forecasting: The Epistemological Context. *The Futurist* **19**, 6: 254-75.

Kreider P E (1978) Solar Energy and the Second Law of Thermodynamics. Paper presented at the Institute of Solar Energy Congress '*SUN: Mankind's Future Source of Energy*', New Delhi, January: Proceedings.Pergamon Press, New York, New York.

Krupnick A J, Markandya A & Nickell E (1993) *The External Costs of Nuclear Power*. Resources for the Future Discussion Paper QE93-28. Resources for the Future, Washington, D.C.

Kuhn T (1970) *The Structure of Scientific Revolutions*, 2nd printing. University of Chicago Press, Chicago, Illinois.

Kumar S (1995) Mining Digs Deep into Wildlife Sanctuary. *New Scientist* **147**, 1992: 10.

Larmour P (ed.) (1990) *The Greening of Government: The Impact of the Labor/Green Accord on Government in Tasmania*. Royal Australian Institute of Public Administration (Tasmanian Division), Hobart, Tasmania.

Landsberg H H & Dukert J M (1981) *High Energy Costs: Uneven, Unfair, Unavoidable?* Johns Hopkins University Press, Washington, D.C.: 34-35.

LaPierre R T (1934) Attitudes versus Action. *Social Forces* **13**: 230-237.

Larson R A (1968) *Geographic Patterns of Energy Consumption in Tasmania.* Unpublished PhD Thesis, University of Illinois.

Layton C (1972) *Ten Innovations: An Indepth Study of Technological Development and the Use of Qualified Scientists and Engineers in Ten Industries.* George Allen & Unwin, London.

Leach G, Lewis C, van Buren A, Romig F & Foley G (1979) *A Low Energy Strategy for United Kingdom.* Science Reviews Ltd., London.

Lee K N (1991) Unconventional Power: Energy Efficiency and Environmental Rehabilitation under the Northwest Power Australian Capital Territory. *Annual Review of Energy and Environment,* **16**: 337-364.

Lees E W (1995) Energy Efficiency and Approaches to it. *In* Rooke D, Fells I & Horlock J (eds) *Energy for the Future.* E & F N Spon for the Royal Society, London; Chapt. 10: 193-203.

Lewin K (1936) Principles of Topological Psychology. McGraw-Hill, New York, New York.

Lewis R S (1973) The *Environmental Revolution.* Educational Foundation for Nuclear Science, Chicago, Illinois.

Lewis M W (1992) *Green Delusions: an Environmentalist Critique of Radical Environmentalism.* Duke University Press, Durham.

Lewis J M, Nicholas L & Smith B (1987) *Study of Home Energy Conservation. Vol. II: Detailed Report.* Department of Industry, Technology and Resources, Melbourne, Victoria.

Liek R K & Kolman A S (1978) Isn't It Rational to be Wasteful? *In* Warkov S (ed.) *Energy Policy in the United States: Social and Behavioural Dimensions.* Praeger, New York, New York; Chapt. 11: 148-63.

Lindblom C E & Cohen D K (1979) *Usable Knowledge.* Yale University Press, New Haven, Connecticut.

Lindblom C E (1959) The Science of Muddling Through. *Public Administration Review* **19**: 79-88.

Lindblom C E (1977) *Policies and Markets: the World's Economic Systems.* Basic Books, New York, New York.

Lindblom C E (1979) Still Muddling, Not Yet Through. *Public Administration Review* **39**, 6: 517-26.

Lindblom C E (1982) The Market as a Prison. *The Journal of Politics* **44**: 324-336.

Linge G J (1979) Australian Manufacturing and the Role and Responsibility of Manufacturers. *Australian Geographical Studies* **17**, 2: 193-203.

Lippman W (1954) *The Public Philosophy.* Mentor Books, New York, New York.

Lönnroth M (1989) The Coming Reformation of the Electric Utility Industry. *In* Johansson T B, Bodlund B & Williams R H (eds) *Electricity: Efficient End-Use and*

New Generation Technologies, and Their Planning Implications. Lund University Press, Lund, Sweden: 765-786.

Lovelock J (1988) *The Ages of Gaia: a Biograph of our Living Earth.* Oxford University Press, Oxford, England.

Lovins A B (1976) Energy Strategy: The Road Not Taken? *Foreign Affairs,* **55**, 1: 63-96.

Lovins A B (1977) Soft Energy Paths. Ballinger Press, Cambridge, Massachusetts.

Lovins A B (1978) A Neo-Capitalist Manifesto: Free Enterprise can Finance our Energy Future. *Politicks and other Human Interests,* No. 12.

Lovins A (1980) Soft Energy Paths. *In* Kumar S (ed.) The Schumacher Lectures. Blond & Briggs, London; Chapt. 2: 28-79.

Lovins A B (1981) *Least Cost Energy: Solving the CO_2 Problem.* Brick House, Andover, Massachusetts.

Lovins A (1985) Saving Gigabucks with Negawatts. *Public Utilities Fortnightly,* 21 March: 19 - 26.

Lovins A B (1987) Abating Acid Precipitation at Negative Cost: Concept and Status. Rocky Mountain Institute, Old Snowmass, Colorado.

Lovins (1989a) *End-Use/Least Cost Investment Strategies.* Paper presented at the 14th Congress of the World Energy Congress *'Energy for Tomorrow',* 17-22 September, Montreal.

Lovins A B (1989b) Energy, People, and Industrialization. *In* International Energy Agency (1989) *Energy Technologies for Reducing Emissions of Greenhouse Gases: Proceedings of an Experts' Seminar, Paris, April 12-14 April. Vol. 2.* Organisation for Economic Cooperation and Development, Paris: 301-326.

Lovins A (1990) The Role of Energy Efficiency. *In* Leggett J (ed.) *Global Warming: The Greenpeace Report.* Oxford University Press, Oxford, England: 193-223.

Lovins A B & Lovins H L (1981) If I Had a Hammer. *In* Bohn R A, Clinard L A & English M R (eds) *World Energy Production and Productivity: Proceedings of the International Energy Symposium.* Ballinger Press, Cambridge, Massachusetts.

Lovins A & Hirst E (1989) Open Letter. *The Electricity Journal* **2**, 2: 34-37.

Lovins A B, Lovins H L, Krause F & Bach W (1989) *Least-Cost Energy: Solving the CO_2 Problem.* Rocky Mountain Institute, Snowmass, Colorado. [Originally printed in 1981 under the same title by Brick House].

Lowe D (1984) *The Price of Power.* Macmillan, South Melbourne, Victoria.

Lowe I (1989) *Living in the Greenhouse.* Scribe Press, Newham, Victoria.

Lowe I (1990a) *An Alternative Economic Strategy for Tasmania: A Report of Principles. Draft.* Parliamentary Office of the Green Independents, Parliament House, Hobart, Tasmania.

Lowe I (1990b) Global Crisis: Danger and Opportunity. *In* Pybus C & Flanagan R (eds) *The Rest of the World is Watching.* Pan Macmillan, Sydney, New South Wales: 215-231.

Lowe I (1994a) Antipodes: 'Victoria Stays out in the Cold'. *New Scientist* **143**, 1942: 43.

Lowe I (1994b) Towards Sustainable Energy Systems. *In* Dovers S (ed.) *Sustainable Energy Systems: Pathways for Energy Reform.* Cambridge University Press, Melbourne, Victoria; Chapt. 9: 194-216.

Lowe I (1994c) The Greenhouse Effect and the Politics of Long-Term Issues. *In* Bell S & Head B (eds) *State, Economy and Public Policy in Australia.* Oxford University Press, Melbourne, Victoria: 315-33.

Lucas N (1985) *Western Energy Policies: A Comparative Study of the Influence of Institutional Structure on Technical Change.* Clarendon Press, Oxford, England.

Lucas N & Papaconstantinou D (1982) Planning Under Uncertainty: Risks, Margins and Planner Uncertainty. *Energy Policy* **10**, 2: 143-52.

Luke T (1993) Reviews: A Critique of Eco-Opportunism. *Telos* **97**:141-154.

Machiavelli N (1640) *The Prince.* [Reprinted by Dent, London in 1920. Translated by W.K. Marriott].

MacKenzie D & Wajcman J (1985) Introductory Essay: The Social Shaping of Technology. *In* MacKenzie D & Wajcman J (eds) *The Social Shaping of Technology: How the Refrigerator got its Hum.* Open University Press, Milton Keynes, England.

MacLean C (1972) *Island on the Edge of the World: the Story of St. Kilda.* Canongate, Edinburgh, Scotland.

Maddox J (1972) *The Doomsday Syndrome.* Macmillan, London.

Maddox J (1975) *Beyond the Energy Crisis.* Hutchinson & Co., London.

Malpas R (1990) Moving Toward Greater Energy Efficiency. *Scientific American* **263**, 3: 132.

Malthus T R (1798) *An Essay on the Principles of Population and A Summary View of the Principle of Population* [Reprinted in Flew A (ed.) (1970) by Penguin, Harmondsworth, England].

Manners G (1964) *The Geography of Energy.* Hutchinson University Library Press, London.

Marcus M G (1986) Environmental Policies in the United States. *In* Park C C (ed.) *Environmental Policies: an International Review.* Croom Held, London; Chapt. 2: 45-75.

Marcuse H (1972) *Counterrevolution and Revolt.* Allen Lane, London.

Martin B (1978) Soft Energy - Hard Politics. *Undercurrents* **27**: 10-13.

Martin B (1987) *Neglected Environmental Issues.* Paper presented at Ecopolitics II Conference, 22-25 May, University of Tasmania, Hobart.

Martinez-Alier J (1987) *Ecological Economics: Energy, Environment and Society.* Basil Blackwell, Oxford, England.

Martinez-Alier J (1991) Ecological Perception, Environmental Policy and Distributional Conflicts: Some Lessons from History. *In* Costanza R (ed.) *Ecological Economics: The Science and Management of Sustainability.* Columbia University Press, New York; Chapt. 9: 118-136.

Maslow A H (1966) *The Psychology of Science: A Reconnaissance.* Gateway Press, South Bend, Indiana.

Maugh T (1979) Cancer and the Environment. *Science* **205**, 28: 1363-1364.

Maurice C & Smithson C W (1984) *The Doomsday Myth: 10,000 Years of Economic Crises*. Hoover Institution Press, Stanford, California.

McColl G D (1976) *The Economics of Electricity Supply in Australia*. Melbourne University Press, Carlton, Victoria.

McConnon D (1986) Public Participation in Routing Transmission Lines: A Program Born of Adversity. *In* Ducsik D W (ed.) *Public Involvement in Energy Facility Planning: The Electric Utility Experience*. Westview Press, Boulder, Colorado; Chapt. 9: 217-39.

McKibben B (1989) *The End of Nature*. Random House, New York.

McMahon J E (1991) National Appliance Energy Efficiency Regulations and their Impacts. *In* Tester J W, Wood D O & Ferrari N (eds) *Energy and the Environment in the 21st Century: Proceedings of the Conference held at the Massachusetts Institute of Technology, Cambridge, Massachusetts, March 26-29 1990*. Massachusetts Institute of Technology Press, Cambridge, Massachusetts: 529-533.

McQueen H (1982) *Gone Tomorrow: Australia in the 80s*. Angus and Robertson, London.

Meadows D H, Meadows D L, Randers J & Behrens W W (1972) *The Limits to Growth. A Report for the Club of Rome's Project on the Predicament of Mankind*. Earth Island, London.

Meadows D H, Meadows D L, Randers J & Behrens W W (1992) *Beyond the Limits: Confronting Global Collapse, Envisaging a Sustainable Future*. Chelsea Greens P. Co., Post Mills, Vermont.

Merchant C (1989) *The Death of Nature: Women, Ecology and the Scientific Revolution*. Harper & Row, New York, New York.

Mesarovic M D & Pestel E (1974) *Mankind at the Turning Point: The Second Report of the Club of Rome*. Dutton & Co., New York, New York.

Mesdag L M (1983) The Appliance Boom Begins. *Fortune International* **108**, July 25: 52-7.

Mestel R (1995) 'Doomsters' take on Global Bet. *New Scientist* **146**, 1980: 5.

Mestrovic S G (1991) *The Coming Fin de Siecle: An Application of Durkheim's Sociology to Modernity and Postmodernity*. Routledge, London.

Meyers N (1994) An Age of Environmental Opportunity. *The Environmentalist* **14**, 2: 85-86.

Midttun A (1996) Electricity Liberalisation in Norway and Sweden: Political Trade-Offs under Cognitive Limitations. *Energy Policy* **24**, 1: 53-65.

Mikes G (1968) *Boomerang - Australia Rediscovered*. Penguin, Harmondsworth, England.

Miller D L (1989) *Market, State, and Community: Theoretical Foundations of Market Socialism*. Clarendon Press, Oxford, England.

Miller P (1991) A Comeback for Nuclear Power? *National Geographic* **180**, 2: 60-89.

Mills D (1991a) *The Comparative Efficiency of Renewable Forms of Energy for Tasmania*. Paper presented to the SECV/HECT Conference Energy for Tasmania for the

1990's (sic) and Beyond: Towards a National Energy Network, 11-12 October 1991, Launceston.

Mills D (1991b) *Clean Solar Heat for Home, Factories and Electric Power Utilities.* Paper presented to the World Clean Energy Conference, Geneva, Nov. 4 - 7, 1991.

Milstein J (1976) *Attitudes, Knowledge and Behaviour of American Consumers Regarding Energy Conservation with some Implications for Government Action.* Office of Energy Conservation and Environment, U.S. Federal Energy Administration, Washington, D.C.

Mirowski P (1989) *More Heat than Light: Economics as Social Physics.* Cambridge University Press, Cambridge, Massachusetts.

Mishan E J (1969) *The Costs of Economic Growth.* Penguin, Harmonsworth, England.

Mishan E J (1970) *Technology and Growth: The Price We Pay.* Praeger, New York, New York.

Mittra B, Lucas N & Fells I (1995) Is There a Policy in the House? *New Scientist* **147**, 1994: 45-6.

Monnier E (1983) Energy Inputs and Household Behaviour in France. *Journal of Economic Psychology* **4**: 197-207.

Moran A, Chisholm A, Hartley P & Porter M (1991) A Framework for Policy. *In* Moran A, Chisholm A & Porter M (eds) *Markets, Resources and the Environment.* Allen & Unwin, North Sydney, New South Wales; Chapt. 2: 16-45.

Morrison D E (1980) The Soft, Cutting Edge of Environmentalism: Why and How the Appropriate Technology Notion is Changing the Movement. *Natural Resources Journal* **20**, 2: 275-98.

Moskovitz D H (1992) Profits and Progress through Least-Cost Planning. *Annual Review of Energy,* **15**: 399-421.

Moskovitz D & Austin T (1993) Australia's Energy Future: Options to Reconcile Market Competition and Least Cost Services. *In* ANZMEC (1993) *Least Cost Services for Australia: Vol. 2.* ANZMEC Report No. 9503.

Motluk A (1995) Deadlier than a Harpoon? *New Scientist* **198**, 1984: 12-3.

Mula J M, Ward R A, Thornton B S & Malanos C (1977) *Solar Energy: Australia at the Crossroads.* Foundation for Australian Resources, Sydney.

Mullins J (1995) The Mine on the Moon. *New Scientist* **148**, 2004: 32-5.

Mumford L (1934) *Techniques and Civilisation.* Harcourt, Brace & World, New York, New York.

Munasinghe M & Schamm G (1983) *Energy Economics, Demand Management and Conservation Policy.* Van Nostrand Reinholdt, London.

Nader L & Milleron N (1979) Dimensions of the 'People Problem' in Energy Research and 'The' Factual Basis of Dispersed Energy Futures. *Energy* **4**: 953-67.

Nash R (1979) Trouble in Paradise. *Environment* 2,6 and 7:25-27, 39-40.

National Audubon Society (1984) *The Audubon Energy Plan.* National Audubon Society, New York, New York.

National Grid Management Council (1993a) *Statement of Opportunities, 1993-2005, May 1993*. National Grid Management Council.

National Grid Management Council (1995) *Demand Management Opportunities in A Competitive Electricity Market: Report tot he Council of Australian Governments.* National Grid Management Council.

National Institute of Economic and Industry Research (1990) *Efficient Renewable Energy Scenario Study for Victoria: Executive Summary*. Renewable Energy Authority Victoria, Melbourne, Victoria.

Natural Resources and Environment Committee (1988) *Electricity Supply and Demand Beyond the Mid-1990s*. Parliament of Victoria, Melbourne, Victoria.

Nelkin D (1977) Technology and Public Policy. *In* Spiegel-Rösing I & de Solla Price D (eds) *Science, Technology and Society: A Cross-Disciplinary Perspective*. Sage, London; Chapt. 11: 393-447.

Newman P (1994) Energy Conservation in Transport and Urban Settlements. *In* Dovers S (ed.) *Sustainable Energy Systems: Pathways to Australian Energy Reform.* Cambridge University Press, Melbourne, Victoria; Chapt. 4: 76-110.

Newman T A (1977) *The Tasmanian Legislative Council: its Committee System, 1926-1976*. Unpublished thesis, University of Tasmania, Sandy Bay, Tasmania.

Newman T (1992) *Hare-Clark in Tasmania: Representation of All Options.* Joint Library Committee of the Parliament of Tasmania, Hobart, Tasmania.

Newstead G H (1980) Future Energy Supply: The Hydro-Electric Commission's Assessment. Proceedings of ANZAAS Symposium 'Energy in Tasmania', 23 February, University of Tasmania, Sandy Bay: 22-40.

Nicholson M (1970) *The Environmental Revolution: A Guide to the New Masters of the World.* Hodder, London.

Nisbet R (1982) *Prejudices: A Philosophical Dictionary.* Harvard University Press, Cambridge, Massachusetts.

Nivola PS (1986) *The Politics of Energy Conservation*. The Brookings Institution, Washington D. C.

Nolan T B (1958) The Inexhaustible Resource of Technology. *In* Jarrett H (ed.) *Perspectives on Conservation* Johns Hopkins Press, Baltimore: 49-66.

Nordhaus W D (1979) *The Efficient Use of Energy Resources.* Yale University Press, London.

Nordlund W J & Robson R T (1980) *Energy and Employment*. Praeger Press, New York, New York.

Nørgård J S & Christensen B L (1987) *Social and Psychological Barriers to Electricity Savings.* Energy Group, Physics Laboratory III, Technical University of Denmark, Lyngby, Denmark.

Nørgård J S (1989) Low Electricity Appliances - Options for the Future. *In* Johansson T B, Bodlund B & Williams R H (eds) *Electricity: Efficient End-Use and New Generation Technologies, and Their Planning Implications.* Energy Group, Physics Laboratory III, Technical University of Denmark, Lyngby, Denmark.

Norimarna M K (1992) *Viability of Renewable Systems for Island Communities in Developing Countries.* Unpublished Ph.D. thesis, Centre for Environmental Studies, Department of Geography & Environmental Studies, University of Tasmania, Hobart, Tasmania.

North R D (1995) *Life on a Modern Planet: A Manifesto for Progress.* Manchester University Press, Manchester, England.

Nuclear Energy Agency (1991) *Small and Medium Reactors: 1. Status and Prospects. Report by an Expert group.* OECD, Paris.

Nye D E (1990) *Electrifying America. Social Meanings of a New Technology, 1880-1940.* The MIT Press, Cambridge, Massachusetts.

O'Conner J (1973) *The Fiscal Crisis of the State.* St. Martin's Press, New York, New York.

O'Riordan T & Cameron J (1994) Seeping through the Pores. *In* O'Riordan T & Cameron J (eds) *Interpreting the Prercautionary Principle.* Earthscan, London; Chapt. 16: 292-6.

O'Riordan T (1981) *Environmentalism,* 2nd edn. Pion, London.

O'Riordan T (1989) Contemporary Environmentalism: The Tasmanian Wilderness and the Franklin Dam. *In* Gregory D A & Walford R (eds) *Horizons in Human Geography.* Barnes & Noble, Totowa, New Jersey; Chapt 6.2: 395-411.

Odell P R (1963) *An Economic Geography of Oil.* G. Bell, London.

Odell P R (1973) The Future of Oil: A Rejoinder. *The Geographical Journal* **139**, 3: 436-54.

Odell P R (1992) Global and Regional Energy Supplies: Recent Fictions and Fallacies Revisited. *Energy Policy* **20**, 4: 284-96.

Odum E P (1969) The Attitude Lag. *Bioscience* **19**: 403.

Organisation for Economic Cooperation and Development (1976) *The Energy Label as a Means of Energy Conservation: Report by the Committee on Consumer Policy.* Organisation for Economic Cooperation and Development, Paris.

Offe C (1975) *Stress and Contradiction in Modern Capitalism.* Heat & Co., New York, New York.

Ogburn W F (1922) *Social Change.* Huebsch, New York, New York.

Oliver D, Maill H, Nectoux F & Opperman M (1983) *Energy Efficient Futures: Opening the Solar Option.* Earth Resources Research Ltd, London.

Olsen M E & Goodnight J A (1977) *Social Aspects of Energy Conservation.* Northwest Policy Project, Pacific NorthWest Regional Commission, Portland, Oregon.

Olsen M E (1978) Public Acceptance of Energy Conservation. *In* Warkov S (ed.) *Energy Policy in the United States: Social and Behavioural Dimensions.* Praeger, New York, New York; Chapt. 8: 91-109.

Olson M (1965) *The Logic of Collective Action: Public Goods and the Theory of Group.* Harvard University Press, Boston , Massachusetts.

Olstead J (1993) Global Warming in the Dock. *Geographical* **LXV**, 9: 12-13, 15-16.

Orchison K (1994) Tasmania Tackles its Future Options. *Electricity Supply Magazine* No. 15 (July): 4-6.

Orchison K (1996) Last Word: A New Industry Paradigm. *Electricity Supply Magazine* No. 29 (Oct.): 37-8.

Ordway S H (1953) *Resources and the American Dream.* Ronald Press, New York, New York.

Osborn F (1948) *Our Plundered Planet.* Little & Brown, Boston, Massachusetts.

Osborn F (1953) *The Limits of the Earth.* Faber & Faber, London.

Ottinger R L, Shepard C & Buchanan M (1987) *The Environmental Costs of Electricity. Oceanea Publications,* New York, New York.

Owens S (1995) Comment: Sustainability and Environmental Policy: Five Fundamental Questions. *In* Miliband D (ed.) *Reinventing the Left,* 2nd printing. Polity Press, Cambridge, England: 207-15.

Paehlke R (1985) Environmentalism: Motherhood, Revolution or Just Plain Politics? *Alternatives* 12,1: 29-33.

Paehlke R C (1989) *Environmentalism and the Future of Progressive Politics.* Yale University Press, New Haven, Connecticut.

Paehlke R (1990) Democracy and Environment: Opening the Door to the Administrative State. *In* Paehlke R & Torgeson D (eds) *Managing Leviathan: Environmental Politics and the Administrative State.* Belhaven, London: 35-55.

Paine J& McLean H (1991) *Economics for Australians: Book Two,* 2nd edn. Macmillan, South Melbourne, Victoria.

Papadakis E (1994) Environmental Policy. *In* Parkin A, Summers J & Woodward D (eds) *Government, Politics, Power and Policy in Australia,* 5th edn. Longman Chesire, Melbourne, Victoria; Chapt. 21: 385-397.

Papadakis E & Moore A (1994) Environment, Economy and State. *In* Bell S & Head B (eds) *State, Economy and Public Policy in Australia.* Oxford University Press, Oxford, England; Chapt. 14: 334-53.

Pardy R, Parsons M, Siemon D & Wigglesworth A (1979) *Purari: Overpowering PNG.* International Development Action Group, Fitzroy, Victoria.

Park C F (1968) *Affluence in Jeopardy: Minerals and Political Economy.* Freeman, San Francisco, California.

Parliament of Tasmania (1914) Hydro-Electric Power and Metallurgical Co. Ltd., Great Lake, Tasmania. *Papers and Proceedings of the Parliament of Tasmania* **LXX1**, No. 9.

Parliament of Tasmania, Standing Committee of Public Accounts (1994) *Report into the Hydro-Electric Commission.* Parliament of Tasmania, Hobart, Tasmania.

Passell P & Ross L (1974) *The Retreat from Riches: Affluence and its Enemies.* Viking Press, New York, New York.

Passmore J A (1974) *Man's Responsibility to Nature: Ecological Problems and Western Tradition.* Scribner, New York, New York.

Patterson W C (1991) *The Energy Alternative: Changing the Way the World Works,* 2nd edn. Macdonald & Co., London.

Patterson W C (1992) The Commercialization of New Technologies. *Energy Policy* **20**, 3: 186-89.

Pearce D W, Markandya A & Barbier E B (1989) *Blueprint for a Green Economy.* Earthscan, London.

Pearce D (1995) Costing the Environmental Damage from Energy Production. *In* Rooke D, Fells I & Horlock J (eds) *Energy for the Future.* E & F N Spon for the Royal Society, London; Chapt. 2: 21-34.

Pearce F (1995) Global Row over Value of Human Life. *New Scientist* **147**, 1991: 19.

Pears A K (1990) Are Greenhouse-Friendly Energy Strategies Lifestyle-Friendly? *In* Swaine D J (ed.) *Greenhouse and Energy.* CSIRO, East Caulfield, Victoria: 444-453.

Pears A & Brotherton P (1990) *Sustainable Power Options for Western Australia for the 1990s and Beyond: A Summary.* Unpublished paper submitted by the Australian Conservation Foundation to the Western Australian Government committee of inquiry ('Harman Committee') into the options for new base load power in Western Australia.

Pears A & Versluis P (1993) *Scenarios for Alternative Energy in Western Australia.* Renewable Energy Advisory Council Government of Western Australia.

Peck A E & Doering O C (1976) Voluntarism and Price Response: Consumer Reaction to the Energy Shortage. *Bell Journal of Economics* **7**: 287-292.

Pederson P B (1987) *Electricity Savings in Refrigeration Processes.* Energy Group. Physics Laboratory III, Technical University of Denmark, Lyngby, Denmark.

Pedersen P H & Lawætz H (1989) *LER-Koleskabet: Udvikling, produktion og test af lavenergikoleskabet LER200: Projektet er et Resultat af et Samarbejde Mellem.* Fysisk Laboratorium III, Danmarks Tekniske Højskole, Lyngby, Denmark.

Penner S S (1979) Challenges in the Implementation of Energy Conservation. *Energy* **4**: 911-18.

Pepper D (1984) *The Roots of Modern Environmentalism.* Croom Helm, London.

Perlman R & Warren R L (1977) *Families in the Energy Crisis: Impacts and Implications for Theory and Policy.* Ballinger, Cambridge, Massachusetts.

Petroll M (1990) Statistics, Nuclear Power and Public Opinion. *Sciences Review* **57**, 1: 36-8.

Pfaltzgraff R L (1980) *Energy Issues and Alliance Relationships: The United States, Western Europe and Japan.* Institute for Foreign Policy Analysis Inc., Cambridge Massachusetts and Washington, D.C.

Pfeffer J (1981) *Power in Organisations.* Pitman, Boston, Massachusetts.

Pillai K K (1989) Pressurised Fluidised Bed Combustion. *In* Johansson T B, Bodlund B & Williams R H (eds) *Electricity: Efficient End-Use and New Generation Technologies, and Their Planning Implications.* Lund University Press, Lund, Sweden: 555-93.

Pittas A C (1979) *Energy Utilization and Resources in Australia: Past, Present and Future.* University of Tasmania Occasional Paper 18, University of Tasmania, Sandy Bay, Tasmania.

Platt J (1988) What Can Case Studies Do? *Studies in Qualitative Methodology* **1**: 1-23.

Platt S (1973) Social Traps. *American Psychologist* **28**: 641-51.

Ponte L (1976) *The Cooling*. Prentice-Hall, Englewood Cliffs, New Jersey.

Poole R (1991) *Morality and Modernity.* Routledge, London.

Porritt J (1984) *Seeing Green: The Politics of Ecology Explained,* Basil Blackwell, Oxford, England.

Porsch N & Sharples C (1993) *Tasmania's Past, Present and Future Electricity Supply and Demand: A Critical Examination with Reference to the Problems of Forecasting.* Unpublished Environmental Technology Report, Centre for Environmental Studies, University of Tasmania, Hobart, Tasmania.

Porter M G (1982) Social Aspects of Energy in Australia: A Social Science Literature and Research Review - A Comment. *In* Black J (ed.) *Liquid Fuels In Australia: A Social Science Research Perspective.* Pergamon, Sydney, New South Wales. Chapt. 4: 87-100.

Poulsen M F & Forrest (1988) Correlates of Energy Use: Domestic Electricity Consumption in Sydney. *Environment and Planning A,* **20**, 3: 327-338.

Pounds N J (1955) *An Introduction to Economic Geography,* 2nd edn. John Murray, London.

President's Materials Policy Commission (1952) *Resources for Freedom, Foundation for Growth and Security.* The Commission, Washington, D.C.

Presthus R (1962) *The Organisational Society: An Analysis and a Theory.* Vintage, New York, New York.

Prindle W R (1991) Viewpoint: Demand-Side Management in the 1990s. *Energy Policy* **19**, 3: 205-216.

Prins G & Stamp R (1991) *Top Guns & Toxic Whales: The Environment & Global Security.* Earthscan Publications, London.

Prior M (1994) What it Really Takes to Make Us Greener. *The Australian* 22 June 1994: 26.

Prosser B (1984) *A Survey of Energy Use in Four Melbourne Suburbs, National Energy Research, Development and Demonstration Program . End of Grant Report EG/85/420.* National Energy Research, Development and Research Program, Department of Resources and Energy, Canberra, Australian Capital Territory.

Pugsley S & Olejniczak J (1994) *Issues Involved in Calculating Australian Household Implicit Discount Rates for Energy Efficiency.* Paper presented at the Australian Institute of Energy International Conference 'Energy, Economic, Environment', Sydney, New South Wales, 14-16 March 1994.

Puiseux L (1987) The Ups and Downs of Electricity Forecasting in France: Technocratic Elitism. *In* Baumgartner T & Midttun A (eds) *The Politics of Energy Forecasting: A Comparative Study of Energy Forecasting in Western Europe and North America.* Clarendon press, Oxford, England; Chapt. 9: 180-207.

Pusey M (1991) *Economic Rationalism in Canberra: A Nation Building State Changes its Mind.* Cambridge University Press, Cambridge, England.

Putman P C (1954) *Energy in the Future.* Macmillan, London.

Quade, E S (1982) *Analysis for Public Decisions*, 2nd ed. North Holland. New York, New York.

Ray D L (1973) *The Nations' Energy Future: A Report to Richard M Nixon, President of the United States*. Atomic Energy Commission, Washington, D.C.

Redclift M (1992) Sustainable Development and Global Environmental Change: Implications for a Changing Agenda. *Global Environmental Change*, **2**, 1: 33-42.

Reddy A K (1991) Barriers to Improvements in Energy Efficiency. *Energy Policy* **19**, 10: 953-61.

Reich C (1970) *The Greening of America*. Random House, New York, New York.

Reisman D (1950) The Lonely Crowd: a Study of the Changing American Character. Yale University Press, New Haven, Connecticut.

Repetto R (1986) *World Enough and Time: Successful Strategies for Resource Management*. Yale University Press, New Haven, Connecticut.

Resnick S A & Wolff R D (1987) *Knowledge and Class: A Marxian Critique of Political Economy*. University of Chicago Press, Chicago, Illinois.

Resources for the Future (1954) *The Nation Looks at its Resources*. Resources for the Future, Washington, D.C.

Ruedisili L C & Firebaugh M W (1975) Preface. *In* Ruedisili L C & Firebaugh M W (eds) *Perspectives on Energy: Issues, Ideas, and Environmental Dilemmas*. Oxford University Press, Oxford, New York: i-ii.

Ritzer G (1993) *The McDonaldization of Society: An Investigation into the Changing Character of Social Life*. Pine Forge Press, Thousand Oaks, California.

Roan S (1989) *Ozone Depletion: The 15-Year Evolution of a Sudden Global Emergency*. Wiley, New York, New York.

Roberts J , Elliott D & Houghton T (1991) *Privatising Electricity: The Politics of Power*. Belhaven Press, London.

Roberts P C (1987) Malthus and After: A Retrospective Look at Projection Models and Resource Concerns. *In* McClaren & Skinner B J (eds) *Resources and World Development*. John Wiley & Sons, Chichester, England: 101-11.

Robinson F A (1976) Preface. *In* The Chemical Society (1976) *Conservation of Resources: A Symposium held at the University of Glasgow, 5-9 April*. Chemical Society Special Publication No. 27. The Chemical Society, London: vii-ix.

Robinson J B (1982a) Bottom-Up Methods and Low-Down Results: Changes in the Estimation of Future Energy Demands. *Energy* **7**, 7: 627-35.

Robinson J B (1982b) Energy Backcasting: A Proposed Method of Policy Analysis. *Energy Policy* **10**, 4: 337-44.

Robinson J B (1982c) Backing into the Future: On the Methodolgical and Institutional Biases Embedded in Energy Supply and Demand Forecasting. *Technological Forecasting and Social Change***21**: 229-40.

Robinson J B (1988) Loaded Questions: New Approaches to Utility Forecasting. *Energy Policy* **16**, 2: 58-68.

Robinson J B (1990) Futures under Glass: A Recipe for People Who Hate to Predict. *Futures* **22**, 11: 820-42.

Rogner H H (1989) Natural Gas as the fuel of the Future. *Annual Review of Energy* **14**: 47 - 73.

Roland A, Wilson R & Rahill M (eds) (1965) *Adlai Stevenson, 1900-1965, of the United Nations.* Free Asia Press, Manila.

Rooke D (1995) Preface. *In* Rooke D, Fells I & Horlock J (eds) *Energy for the Future.* E & F N Spon for the Royal Society, London: xi-xii.

Rose H M (1965) Conservation in the United States. *In* Smith G (ed.) *Conservation of Natural Resources*, 3rd edn. John Wiley & Sons, New York, New York; Chapt. 1: 3-24.

Rosenfeld A H (1991) Energy-Efficient Buildings in a Warming World. *In* Tester J W, Wood D O & Ferrari N (eds) *Energy and the Environment in the 21st Century: Proceedings of the Conference held at the Massachusetts Institute of Technology, Cambridge, Massachusetts, March 26-29 1990.* Massachusetts Institute of Technology Press, Cambridge, Massachusetts: 459-473.

Rosenthal S & Russ P (1988) *The Politics of Power: Inside Australia's Electric Utilities.* Melbourne University Press, Melbourne, Victoria.

Ross M H & Williams R H (1976) Energy Efficiency: Our Most Underrated Energy Resources. *Bulletin of Atomic Scientists* **32**, 9: 30-38.

Ross M H & Williams R H (1980) Drilling for Oil and Gas in our Houses. *Technology Review* **82**, 5: 24-36.

Ross M H & Williams R H (1981) *Our Energy: Regaining Control.* McGraw-Hill, New York, New York.

Ross M W & Williams R H (1982) The Potential for Fuel Conservation. *In* Ruedisili L C & Firebaugh M W (eds) *Perspectives on Energy: Issues, Ideas, and Environmental Dilemmas.* 3rd edn. Oxford University Press, Oxford, New York: 528-541.

Rossin D (1980) The Soft Energy Path: Where Does it Really Lead? *The Futurist* **14**, 3: 57-63.

Rossin A D (1990) Experience of the US Nuclear Industry and Requirements for a Viable Industry Future. *Annual Review of Energy* **15**: 153-72.

Roszak T (1969) *The Making of a Counter Culture: Reflections on the Technocratic Society and Its Youthful Opposition.* Doubleday, Garden City, New York.

Royal Commission into the Attempt to Bribe a Member of the House of Assembly (1991) *Report of the Royal Commission into the Attempt to Bribe a Member of the House of Assembly and Other Matters.* Royal Commission into the Attempt to Bribe a Member of the House of Assembly, Hobart, Tasmania.

Rudig W (1992) *Anti-nuclear Movements: a World Survey of Opposition to Nuclear Energy.* Longman, Harlow, England.

Russell B (1935) *In Praise of Idleness and Other Essays*, 2nd edn, 6th impression. Union Books, London.

Saddler H (1981) *Energy in Australia: Politics and Economics.* George Allen and Unwin Australia, Sydney, New South Wales.

Saddler H (1982) *A Review of the Hydro-Electric Commission's Most Recent Financial Analysis of the Gordon below Franklin Scheme.* Energy Policy and Analysis Pty Ltd, Sydney, New South Wales.

Saddler H (1990) *Toward Toronto: Australian Technological Innovations for Efficient Energy Futures.* Australian Government Publishing Service, Canberra, Australian Capital Territory, for the Commission for the Future.

Saddler H (1994) Using Energy Efficiently in Buildings and Industry. *In* Dovers S (ed.) *Sustainable Energy Systems: Pathways to Australian Energy Reform.* Cambridge University Press, Melbourne; Chapt 3: 50-75.

Saddler H, Bennett J, Reynolds I & Smith B (1980) *Public Choice in Tasmania: Aspects of the Lower Gordon River Hydro-Electric Development Proposal.* Centre for Resource and Environmental Studies, Australian National University, Canberra, Australian Capital Territory.

Sadler B (1994) Environmental Assessment and Development Policymaking. *In* Goodland R & Edmunson V (eds) *Environmental Assessment and Development.* The World Bank, Washington, D.C.; Chapt. 1: 3-19.

Sagoff M (1988) *The Economy of the Earth.* Cambridge University Press, Cambridge, England.

Sandbach F (1980) *Environment, Ideology and Policy.* Blackwell, London.

Sanders N (1980) *A Time to Care.* Chris Bell, Blackman's Bay, Tasmania.

Sant R, Bakke D W, Naill R F & Bishop J (1979) *The Least-Cost Energy Strategy: Minimising Consumer Costs through Competition.* Energy Productivity Centre & Mellon Institute, Arlington, Virginia.

Sarre P (1991) Introduction. *In* Blunder J & Reddish A (eds) *Energy, Resources and Environment.* Hodder & Stoughton, London: 3-42.

Sathaye J & Gadgil A (1992) Aggressive Cost-Effective Electricity Conservation. *Energy Policy,* **20**, 2: 163-172.

Savitz M L (1984) Ten Years Out - A Problem Not Crisis. *In* Morrison B M & Kempton W (eds.) *Families and Energy: Coping with Uncertainty: Conference Proceedings.* Institute of Family and Child Studies, College of Human Ecology, Michigan State University, Ann Arbor, Michigan: 7-9.

Savitz M & Hirst E (1986) Technological Options for Improving Energy Efficiency in Residential and Commercial Buildings. *In* Sawhill J C & Cotton R (eds) *Energy Conservation: Successes and Failure.* The Brookings Institute, Washington, D.C.: 97-121.

Sawhill J C & Cotton R (1986) *Energy Conservation: Successes and Failures.* The Brookings Institute, Washington, D.C.

Sayer A (1992) *Method in Social Science: A Realist Approach,* 2nd edn. Routledge, London.

Schattschneider E E (1960) *The Semisovereign People.* Holt, Rienhart & Winston, New York, New York.

Scheraga J D (1994) Energy and the Environment: Something New under the Sun? *Energy Policy* **22**, 10: 798-803.

Schipper L & Darmstadter J (1978) The Logic of Energy Conservation. *Technology Review* **80**, 1: 41-50.

Schipper L & Ketoff A (1990) Energy Efficiency - the Perils of a Plateau. *Energy Policy* **17**, 6: 538-543.

Schipper L & Meyers M (1992) *Energy Efficiency Trends and Human Activity: Past Trends, Future Prospects.* Cambridge University Press, Cambridge, England.

Schipper L (1995) Book Review. *Tomorrow: Global Environment Business* **5**, 3: 52-3.

Schrecker T (1980) Canada's Nuclear Commitment: A Challenge in Technological Assessment. *In* Dwivedi O P (ed.) *Resources and the Environment: Policy Perspectives for Canada.* McClelland & Stewart, Toronto, Ontario: Chapt. 12: 288-305.

Schrecker T (1990) Resisting Environmental Regulation: The Cryptic Pattern of Business-Government Relations. *In* Paehlke R & Torgeson D (eds) *Managing Leviathan: Environmental Politics and the Administrative State.* Belhaven, London: 165-199.

Schumacher E F (1973) *Small is Beautiful: Economics as if People Mattered.* Blond & Briggs, London.

Schurr S H (1963) Energy. *Scientific American* **CCIX**, 9: 111-26.

Schurr S H, Darmstadter J, Perry H, Ramsay W, Russell M (1979) Energy in America's Future: The Choice Before Us. Johns Hopkins Press, Baltimore, Maryland.

Secretariat for the Future (1977) *Energy in Transition - A Report on Energy Policy and Future Options.* The Swedish Institute, Stockholm, Sweden.

Self P (1993) *Government by the Market: The Politics of Public Choice?* Macmillan, Basingstoke, England.

Seligman C (1985) Information and Energy Conservation. *In* Byrne J, Schultz D A & Sussman M B (eds) *Families in the Energy Transition.* The Haworth Press, New York, New York; 135-149.

Selwell W R (1987) The Politics of Hydro-Megaprojects: Damming with Faint Praise in Australia, New Zealand, and British Columbia. *Natural Resources Journal,* **7**, 3: 497-532.

Senate Standing Committee of Inquiry on South West Tasmania (1982a) *Transcripts of evidence.* Senate Standing Committee of Inquiry on South West Tasmania, Parliament of Australia, Canberra, Australian Capital Territory.

Senate Standing Committee of Inquiry on South West Tasmania (1982b) *Future Demand and Supply of Electricity for Tasmania and Other Matters.* Australian Government Publishing Service, Canberra, Australian Capital Territory.

Senate Standing Committee on Industry, Science and Technology (1991) *Rescue the Future: Reducing the Impact of the Greenhouse Effect.* Australian Government Publishing Service, Canberra, Australian Capital Territory.

Shaw B (1912) *John Bull's Other Island.* Constable & Co., London.

Shcherbak Y M (1996) Ten Years of the Chornobyl Era. *Scientific American* **274**, 4: 32-7.

Sheraga J D (1994) Energy and the Environment: Something New Under the Sun? *Energy Policy* **22**, 10: 798-803.

Siddayao C M (1986) *Energy Demand and Economic Growth: Measurement and Conceptual Issues in Policy Analysis.* Westview Press, Boulder, Colorado.

Siebert H (1992) *Economics and the Environment: Theory and Practice.* Springer-Verlag, Berlin.

Silvennoinen P (1991) The Case for More Nuclear Power in Finland. *Energy Policy* **19**, 5: 503-8.

Simeon R (1976) Studying Public Policy. *Canadian Journal of Political Science* **9**, 4: 548-80.

Simon H A (1957) *Models of Man.* John Wiley, New York, New York.

Simon J L & Kahn H (1984) *The Resourceful Earth: A Response to Global 2000.* Basil Blackwell, Oxford, England.

Simon J L (1981) *The Ultimate Resource.* Princeton University Press, Princeton, New Jersey.

Simonson J (1993) *Thermodynamics.* Macmillan, Basingstoke, England.

Sinclair J (1991) Global Warming: A Vicious Circle. *Our Planet* **3**, 1: 4-7.

Sinclair T C (1974) Environmentalism: A la Researche du Temps Perdu - Bien Perdu? *In* Cole H S, Freeman C, Jahoda M & Pavitt K L (eds) *Thinking about the Future: a Critique of the Limits to Growth.* Chatto & Windus for Sussex University Press, London: 175-91.

Sioshansi F P (1990) *An Energy Efficiency Blueprint for Tasmania.* Dept. of Resources and Energy, Hobart, Tasmania.

Sioshansi F P (1991) The Myths and Facts of Energy Efficiency. *Energy Policy,* **19**, 3: 231-243.

Sioshansi F P (1996) Editor's Introduction: DSM in Transition: From Mandates to Markets. *Energy Policy* **24**, 4: 283-4.

Smil V (1987) *Energy, Food Environment: Realities, Myths, Options.* Clarendon Press, Oxford, New York.

Smith B, Lewis J M & Nicholas L (1987) *Household Energy Conservation: Literature Sources.* Department of Industry, Technology and Resources, Melbourne, Victoria.

Smith C (1994) *Economic Development, Growth and Welfare.* Macmillan, Basingstoke, England.

Smith D I & Handmer J (1991) Water Conflict and Resolution: A Case Study of Dams in Southwest Tasmania. *In* Handmer J W Dorcey A H & Smith D I (eds) *Negotiating Water: Conflict Resolution in Australian Water Management.* Centre for Resource and Environmental Studies, Australian National University, Canberra, Australian Capital Territory.

Socolow R H (1977) The Coming Age of Energy Conservation. *Annual Review of Energy,* **2**: 239-289.

Socolow R H (1981) Failure of Discourse: Obstacles to the Integration of Environmental Values into Natural Resource Policy. *In* Scherer D & Attiz T (eds) *Ethics and the Environment.* Prentice-Hall, Englewood Cliffs, New Jersey: 152-169.

Socolow R H (1985) The Physicist's Role in Using Energy Efficiently: Reflections on the 1974 American Physical Society Summer Study on the Way Ahead. *In* Hafemeister D, Kelly H & Levi B (eds) *Energy Sources: Conservation and Renewables: American Institute of Physics Conference Proceedings No. 135.* American Institute of Physics, New York, New York; Chapt. 2: 15 - 32.

Socolow R H (1991) Themes of the Building Sessions. *In* Tester J W, Wood D O & Ferrari N (eds) *Energy and the Environment in the 21st Century: Proceedings of the Conference held at the Massachusetts Institute of Technology, Cambridge, Massachusetts, March 26-29 1990.* Massachusetts Institute of Technology Press, Cambridge, Massachusetts: 571-575.

Soddy F (1928) *Wealth, Virtual Wealth and Debt.* Allen & Unwin, London.

Solar Energy Research Institute [SERI] (1981) *A New Prosperity: Building a Sustainable Energy Future.* Brick House, Andover, Massachusetts.

Sonneborn C (1994) Of Green Fridges and Grass Roots. *Habitat Australia* **22**, 1: 6-7.

Sorenson B (1980) *An American Energy Future.* Neils Bohr Institute, University of Copenhagen, Copenhagen. [Reprinted in *Energy*, 7 (1982)]

Sornarajah M (ed.) (1984) *The South West Dam Dispute: The Legal and Political Issues.* University of Tasmania, Hobart, Tasmania.

Spann R N (1979) *Government administration in Australia.* George Allen & Unwin, London.

Spencer H (1879) *The Data of Ethics.* Hurst & Company, New York, New York.

Spinrad B I (1973) The Case For Nuclear Power. *Ambient-Environment* **1**, 2. Reprinted in Ruedisili L C & Firebaugh M W (eds) *Perspectives on Energy: Issues, Ideas, and Environmental Dilemmas.* Oxford University Press, New York, New York: 183-195.

SRC International Pty Ltd & Artcraft Research (1994) *The Effectiveness of Australian Energy Information Programmes for the Domestic Sector: Vol. 1. A Report Submitted to the Energy Management Task Force of the Australian and New Zealand Minerals and Energy Council.* SRC International Pty Ltd , Melbourne, Victoria, and Artcraft Research, Chatswood, New South Wales.

Srinivasan C (1994) Viewpoint. The Role of Energy Policy: Markets of Marketing? *On Demand*, June 1994: 5-6.

Standards Association of Australia (1986) Australian Standard 1430-1986 Household Refrigerators and Freezers. Standards Association of Australia, North Sydney, New South Wales.

Standards Australia & Standards Association of New Zealand (1989) *Energy Labelling of Appliances Part 1: Refrigerators, Refrigerator/Freezers and Freezers - Specification for Appliance Energy Rating Label.* Standards Australia, North Sydney, New South Wales, and Standards Association of New Zealand, Wellington.

Starr C (1973) Science and Public Affairs. *Bulletin of the Atomic Scientists* **XXIX**, 7: 15-20.

State Electricity Commission of Victoria & Department of Industry, Technology & Resources (1989a) *Demand Management Development Project: Status Report. Information Paper No. 1.* State Electricity Commission of Victoria & Department of Industry, Technology & Resources, Melbourne, Victoria.

State Electricity Commission of Victoria & Department of Industry, Technology & Resources (1989b) Demand Management Development Project: *Short Term Demand Management Objectives. Information Paper No. 2.* State Electricity Commission of Victoria & Department of Industry, Technology & Resources, Melbourne, Victoria.

State Electricity Commission of Victoria & Department of Industry, Technology & Resources (1989c) Demand Management Development Project: *3 Year Demand Management Action Plan, Information Paper No. 5* . State Electricity Commission of Victoria & Department of Industry, Technology & Resources, Melbourne, Victoria.

State Electricity Commission of Victoria & Department of Industry, Technology & Resources (1989d) Demand Management Development Project: *Public Communication & Consultation. Information Paper No. 6.* State Electricity Commission of Victoria & Department of Industry, Technology & Resources, Melbourne, Victoria.

State Electricity Commission of Victoria & Hydro-Electric Commission Tasmania (1991a) *Energy for Tasmania in the 1990's and Beyond: Toward a National Energy Network.* Proceedings of Conference, 11-12 October, Launceston, Tasmania.

State Electricity Commission of Victoria & Hydro-Electric Commission Tasmania (1991b) *Basslink Feasibility Study Report: Interconnection between Tasmanian and Mainland Electricity Systems.* SECV, Melbourne & HECT, Hobart, Tasmania.

State Electricity Commission of Victoria & Hydro-Electric Commission Tasmania (1992) *Basslink Feasibility Study Report: Environmental and Social Issues.* SECV, Melbourne & HECT, Hobart, Tasmania.

State Electricity Commission of Victoria, Demand Management Unit (1991) *Annual Report 1991.* SECV, Box Hill, Victoria.

Steering Committee of the Climate Change Study (1995) *Climate Change Science: Current Understanding and Uncertainties.* Academy of Technological Sciences and Engineering, Academy of Social Sciences in Australia & Academy of Science, Canberra, Australian Capital Territory.

Stern P C, Aronson E, Darley J M, Kempton W, Hill D H, Hirst E & Wilbanks T J (1987) Answering Behavioural Questions About Energy Efficiency in Buildings. *Energy,* **12,** 5: 339-353.

Stewart W E (1985) *Determination of Validity of Refrigerator/Freezer Testing, Phase 1.: Report prepared for the American Society of Heating, Refrigerating and Air Conditioning Engineers.* Energy Research Laboratory, University of Missouri-Columbia, Kansas City,

Stockwell D (1987) *Energy Use Testing of Domestic Refrigeration Appliances: Part 2 of a Project to Design and Demonstrate an Energy Efficient Kitchen.* New Zealand Energy Research and Development Committee, Auckland.

Strange S (1986) *Casino Capitalism.* Blackwell, Oxford, England.

Stretton H (1976) *Capitalism, Socialism and the Environment.* Cambridge University Press, Cambridge, England.

Strümpel B (1979) *Energie Alternativ: Testfall Berlin.* Oldenbourg Verlag, Berlin.

Strümpel B (1983) Energy Policy Research in the Consumer Interest. *Journal of Economic Psychology,* **3**: 193-201.

Study of Critical Environmental Problems [SCEP] (1970) Man's Impacts on the Global Environment. The MIT Press, Boston, Massachusetts.

Sutherland R J (1991) Market Barriers to Energy Efficiency Investments. *Energy Journal* **12, 3: 15-34.**

Sutherland R J (1994) Energy Efficiency or the Efficient Use of Resources. *Energy Supply* **16**, 2: 257-268.

Sutherland R J (1996) The Economics of Energy Conservation Policy. *Energy Policy* **24**, 4: 361-70.

Swatek P (1970) *The User's Guide to the Protection of the Environment.* Friends of the Earth/Ballantine, New York, New York.

Switzer J V (1994) *Environmental Politics: Domestic and Global Dimensions.* St Martin's Press, New York, New York.

Szokolay S (1984) The Solar System- A Soft Option for Everyone. *Simply Living,* **4**, 2: 22-23.

Tapp B A & Watkins J R (1990) *Energy and Mineral Resource Systems: An Introduction.* Cambridge University Press, Cambridge, England.

Tashchian R O & Slama M E (1985) Survey Data on Attitudes and Behaviour Relevant to Energy. *In* Byrne J, Schulz D A & Sussman M B (eds) *Families and the Energy Transition.* Haworth Press, New York, New York.

Taylor N F (1982) Petroleum and Liquid Fuel Alternatives in Australia: Potential and Problems - An Industry Viewpoint. *In* Black J (ed.) *Liquid Fuels in Australia: A Social Science Research Perspective.* Pergamon, Sydney, New South Wales. Chapt. 6: 115-20.

Tester F (1994) Book Reviews. *Environment and Planning A,* **26** (8): 1320-1321.

Tasmanian Wilderness Society (1984) *Overpowering Tasmania: A Briefing Paper on Power Demand and Supply.* The Wilderness Society, Hobart.

Thomas I, Todd J, Blakemore K & Harries D (1993) *Residential Energy Conservation in Brunswick: Monitoring the Effectiveness of a Residential Energy Campaign.* Faculty of Environmental Design and Construction, Royal Melbourne Institute of Technology, Melbourne, Victoria.

Thomas K (1983) *Man and the Natural World: Changing Attitudes in England. 1500-1800.* Allen Lane, London.

Thomas S & Berkhout F (1992) The First 50 Years of Nuclear Power: Legacy and Lessons. *Energy Policy* **20**, 7: 594-5.

Thompson P (1981) *Power In Tasmania.* Australian Conservation Foundation, Melbourne, Victoria.

Tighe P J (1992) Hydroindustrialisation and Conservation Policy in Tasmania. In: Walker K J (ed.) *Australian Environmental Policy: Ten Case Studies.* New South Wales University Press, Kensington, New South Wales; Chapt. 7: 124-155.

Tindale S (1995) Sustaining Social Democracy: The Politics of the Environment. *In* Miliband D (ed.) *Reinventing the Left,* Second printing. Polity Press, Cambridge England; Chapt 9: 192-206.

Tisdell C A (1990) *Natural Resources, Growth, and Development: Economics, Ecology, and Resource Scarcity.* Praeger, New York, New York.

Todd J (1991) *A Sustainable and Ecologically Sound Energy System for Tasmania.* Paper presented at the Department of Geography & Environmental Studies Symposium An Ecologically Sustainable Society for Tasmania', 16-17 March 1991, University of Tasmania, Sandy Bay, Tasmania.

Tonn B E & Berry L (1985) An Illustration of Household Energy-Conservation Modelling Using the Search-List Decision-Heuristic. *Environmental Planning A* **17**, 9: 1243-61.

Toone R C (1991) *From Greedy Fridge to Greenie Fridge.* Paper presented at the Australian Institute of Energy National Conference 'Energy for the 21st Century: Are We Prepared?', 1 July 1991, Adelaide Convention Centre, North Terrace, Adelaide.

Toyne P (1991) Australia in 2010: A Letter to the Prime Minister on the Progress of Sustainable Development Initiatives. *In* IPA (1994) *IPA Current Issues: The Environment in Perspective.* IPA, Canberra, Australian Capital Territory: 40-42.

Trainer T (1991) Thinking About the Nature of the Required Conserver Society. *In* Cock P (ed.) *Social Structures for Sustainability.* Centre for Resource and Environmental Studies, Australian National University, Canberra, Australian Capital Territory.

Treadwell R (1993) Will 'No Regrets' Policy Options Reduce Greenhouse Gas Emissions? *Agriculture and Resources Quarterly* **5**, 1: 85-93.

Turiel I & Levine M D (1989) Energy-Efficient Refrigeration and the Reduction of Chloroflourocarbon Use. *Annual Review of Energy* **14**: 173-204.

Turnbull S (1981) *Tasmanian Power Options for Industrial Development: A Review of Hydro, Thermal and Decentralised Alternatives.* The Business Association for Economical Power, Hobart, Tasmania.

United States Federal Power Commission (1971) The 1970 National Power Survey. Part 1. U.S. Printing Office, Washington, D.C.

van der Tak H G (1966) *The Economic Choice between Hydro-Electric and Thermal Power Development.* World Bank Occasional Papers No. 1, The Johns Hopkins Press, Baltimore, Maryland.

van Lersner H (1995) Commentary: Outline for an Ecological Economy. *Scientific American* **273**, 3: 153.

van Raaj W F & Verhallen T M (1983) A Behavioural Model of Residential Energy Use. *Journal of Economic Psychology* **3**, 1: 39-63.

Veblen T B (1899) *The Theory of the Leisure Class: An Economic Study of Institutions.* Macmillan, New York, New York.

Vitousek P M, Ehrlich P R, Ehrlich A H & Matson P A (1986) Human Appropriation of the Products of Photosynthesis. *Bioscience* **36**, 6: 368-373.

Volpato R (1995) *Major Employer Group Social Survey.* Unpublished report for Major Employer Group, UNITAS Research, University of Tasmania, Sandy Bay, Tasmania.

Walker K J (1991) *"Statist Development" - An Environmental Perspective.* Paper presented at the 33rd Annual Conference of the Australasian Political Studies Association, Griffith University, Nathan, Queensland, 17th-19th July.

Walker K J (1994) *The Political Economy of Environmental Policy: An Australian Introduction.* University of New South Wales Press, Kensington, New South Wales.

Walker R A & Large D B (1975) The Economics of Energy Extravagance. *Ecology Law Quarterly* **4**, 4: 963-85.

Walsh P J & Kerby J S (1990) Energy Management Programs in Australia - Past Experience and Future Prospects. *In* Swaine D J (ed.) *Greenhouse and Energy.* CSIRO, East Melbourne, Victoria: 391-400.

Walsh P J (1992) *Minimum Appliance Energy Performance Standards.* Paper presented at the 1st National Demand Management Conference '*Focus for the Future*', 26-28 May 1992, Melbourne: 616-24.

Walter E (1981) *The Immorality of Limiting Growth.* State University of New York Press, Albany, New York.

Ward Research (1991) *A Qualitative Study to Understand Attitudes Towards Energy Conservation Measures: Current Barriers, Key Communications Themes, and Recommended Actions.* Unpublished Report prepared for the Energy Division of the Department of Business and Economic Development and Tourism by Ward Research, Honolulu.

Wark K (1989) *Thermodynamics.* Macmillan, Basingstoke, England.

Warman H R (1971) Future Problems in Petroleum Exploration. *Petroleum Review* **25**, 3: 96-101.

Weale A (1992) *The New Politics of Pollution.* Manchester University Press, Manchester, England.

Webb J (1995) Rebel With a Cause. *New Scientist* **145**, 1965: 32-35.

Weber M (1952) Bureaucracy. *In* Gerth H H & Mills C W (eds) *From Max Weber: Essays in Sociology.* Routledge & Kegan Paul, London. [Translated by Gerth H H & Mills C W] [Originally published in 1946].

Weizeorick J (1991) A 'Place on Which to Stand' for the Appliance Industry. A Commentary on Appliance Engineering: Energy, Environment and Ethics. *In* Tester J W, Wood D O & Ferrari N (eds) *Energy and the Environment in the 21st Century: Proceedings of the Conference held at the Massachusetts Institute of Technology, Cambridge, Massachusetts, March 26-29 1990.* Massachusetts Institute of Technology Press, Cambridge, Massachusetts: 525-528.

Weldon M (1991) *Tasmania's Options for Meeting Future Energy Needs.* Paper presented to the SECV & HEC Conference 'Towards a National Energy Network', 11-12 October, Launceston, Tasmania.

Wensley P (1994) Global Trends: The Emergence of International Environmental Law. *In* Boer B, Fowler R & Gunninham N (eds) Environmental Outlook: Law and Policy. Federation Press, Annandale, New South Wales; Chapt. 1: 7-16.

White D, Sutton P, Pears A, Mardon C, Dick J & Crow M (1978) *Seeds for Change: Creatively Confronting the Energy Crisis.* Patchwork Press, North Melbourne, Victoria.

White K (1981) The Economics of Conservation. *IEEE Transactions: Power Apparatus & Systems.* **P99S 100**, 11: 4546-52.

Wigley T M , Richels R & Edmonds J A (1996) Economic Choices in the Stabilization of Atmospheric CO_2 Concentrations. *Nature* **379**, 6562: 240-3.

Wilcox M (1983) The 'Dam Case': Implications for the Future. *Habitat Australia* **11,** 5: 32-34.

Wildavsky A (1979) *Speaking Truth to Power: The Art and Craft of Policy Analysis,* 2nd edn, 3rd printing 1992. Transaction Publications, New Brunswick, New Jersey.

Wildavsky A (1992) Global Warming as a Means of Achieving an Egalitarian Society: An Introduction. *In* Balling R C (1992) *The Heated Debate: Greenhouse Predictions versus Climate Reality.* Pacific Research Institute for Public Policy, San Francisco: xv-xxxvi.

Wilde P D (1975) Problem's of Planning Tasmania's Electricity Supply. *Geography* **60,** 11: 303-7.

Wilde P D (1978) The Environment, Growth Projections and Hydro-Electricity in Tasmania's South West. *In* Gee H & Fenton J (eds) *The South West Book: A Tasmanian Wilderness.* Australian Conservation Foundation, Melbourne, Victoria: 205-25.

Wilkenfield G L (1990) Energy, Environment and Economics: Greenhouse Policy in the Balance. *In* Swaine D J (ed.) *Greenhouse and Energy.* CSIRO, East Melbourne, Victoria: 401-409.

Williams R H (1989) Innovative Approaches to Marketing Electric Efficiency. *In* Johansson T B, Bodlund B & Williams R H (eds) *Electricity: Efficient End-Use and New Generation Technologies, and Their Planning Implications.* Energy Group, Physics Laboratory III, Technical University of Denmark, Lyngby, Denmark: 831-862.

Wilson B, Trieu L H & Bowen B (1993) *Energy Efficiency Trends in Australia.* Australian Bureau of Agricultural and Resource Economics, Canberra, Australian Capital Territory.

Weinstein N (1982) *Tasmanian Electricity Policy: Public Potlatch.* Institute for Energy Studies, Flinders University of South Australia, Bedford Park, South Australia.

Wittgenstein L (1949) *On Certainty.* [Reprinted *In* Anscombe G E & von Wright G H (1969) *Wittgenstein. Book V: On Certainty.* Blackwell, Oxford, England. Translated by D Paul D & G E Anscombe].

Winner, L (1977) *Autonomous Technology: Technics-Out-of-Control as a Theme in Political Thought.* MIT Press, Cambridge Massachusetts.

Woods W A (1981) *Consumer Behaviour: Adapting and Experiencing.* Elsevier North Holland, New York, New York.

Woodson T T (1976) Residences. *In* Smith C B (ed.) *Efficient Electricity Use: A Reference Book on Energy Management for Engineers, Architects, Planners, and Managers.* Pergamon Press, New York, New York: 107-143.

Woodward D (1993) 2020 Vision: A Look at the Oil Industry - the 21st Century Middle East Well. *Evaluation Review* No 14: 13-23.

Working Party on Thermal Insulation of New Dwellings (1981) *Report to the Energy Advisory Council.* Working Party on Thermal Insulation of New Dwellings, Hobart, Tasmania.

World Commission on Environment and Development (1987) *Our Common Future.* Oxford University Press, Oxford, England.

Waddington C (1957) *The Strategy of Genes.* George Allen & Unwin, London.

Wright J & Baines J (1986) *Supply Curves of Conserved Energy: The Potential for Conservation in New Zealand's Houses.* New Zealand Ministry of Energy, Wellington.

Wright J, Meier A, Maulhardt M & Rosenfeld A H (1981) *Supplying Energy Through Greater Efficiency: The Potential for Conservation in California's Residential Sector.* Lawrence Berkeley Laboratory, University of California, Berkeley, California.

Wrigley T M, Richels R & Edmonds J A (1996) Economic and Environmental Choices in the Stabilization of Anthropogenic CO_2 Emissions. *Nature* **379**, 6562: 240-3.

Yates S M & Aronson E (1983) A Social Psychological Perspective on Energy Conservation in Residential Buildings. *American Psychologist*, **38**, 4: 435-444.

Yergin D (1979) Getting More Mileage out of Incentives. *Psychology Today* **12**, 11: 18, 28, 30.

Yergin D (1991) *The Prize: The Epic Quest for Oil, Money and Power.* Simon & Schuster, New York, New York.

Zernike J (1973) *Entropy: the Devil on the Pillion - A Popular Exposition.* Kluwer, Deventer, The Netherlands.

APPENDIX I

The Early History of Electricity Planning in Tasmania

1. The Beginnings

Tasmania, or Van Diemen's Land as it was called, was settled as a British penal colony in 1803 and the transportation of convicts continued until 1856 when the colony attained self-government. With the end of transportation, gold was discovered in Victoria and many Tasmanians migrated. Outmigration became a persistent problem for the State and was stemmed only briefly in the late nineteenth century with the discovery of gold and tin in the north west (Blainey 1954, du Cross 1994). Development of the State's resources thereafter was recognised as the one of the few means at the colony's disposal to achieve economic prosperity (Kellow 1996: 45). During the twentieth century, development of the State's hydro-electric resources became an integral part of that strategy.

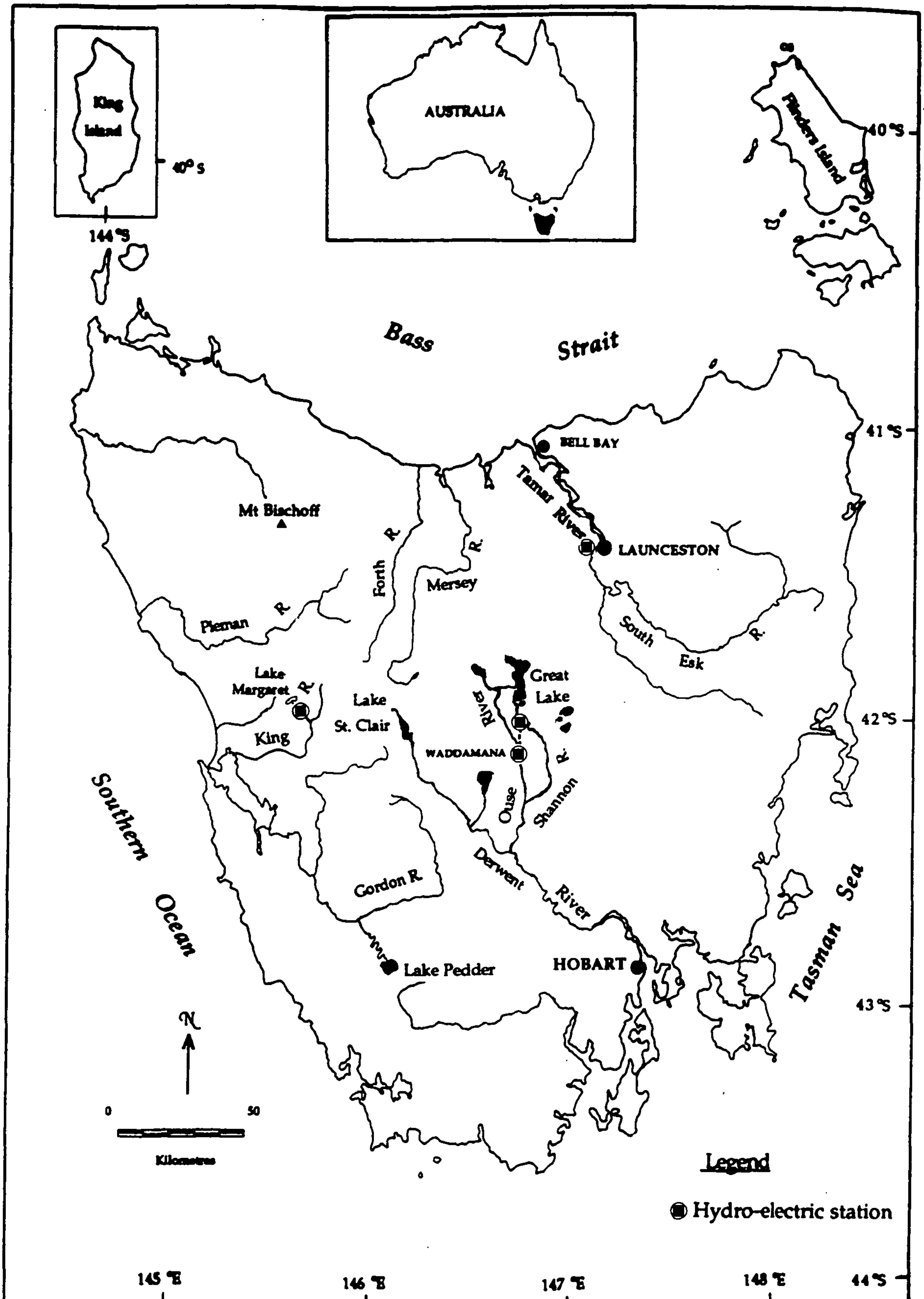
A self-governing British colony with a population of less than 150,000 at the turn of the century, Tasmania was an agrarian backwater. The colony was quick to adopt the steam-driven alternator technology only because promotion of the technology in the small island was seen by overseas electrical equipment manufacturing firms as a means of creating markets for their products in the larger Australian colonies. The German manufacturing firm, Siemens, established a London-based subsidiary, the Hobart Tramway Company, which included three prominent members of the Tasmanian parliament on its Board of Directors. In 1893, Hobart became the first town in the southern hemisphere to be serviced with an electric tramway, despite considerable local opposition. The 500 volt (DC) system was installed completely by the Siemens company (Allbut 1958: 72). The firm also installed its own electric arc lighting and this generated immediate interest in the use of electricity by local businesses, prompting the Hobart Gas Company to obtain a franchise to supply electricity and install three 69.7h.p. (52 kW) Siemens generators driven by 200 h.p. (149.1 kW) steam engines (Read 1986: 13). In 1902 the Hobart Tramway Company followed by also acquired the rights to sell electricity (Allbut 1958: 72).

It was the production of electricity from hydraulic source, however, that created most interest. In the latter half of the nineteenth century, Germany and the USA rapidly electrified and became world industrial leaders. Most other countries attempted to follow. When hydro-electric technology was developed as a cheap source of energy in the early 1870s, it provided a number of peripheral economies previously unable to compete with the western European or North American market with a new means of attracting capital and industrialising. Countries with large hydro-electric resources such as Norway (Øystein 1986) and Finland (Myllyntaus 1991, Huëding 1992) quickly seized on this new technology.

Tasmania at the time was a small, remote British outpost of capitalism. Word of hydro-electricity quickly reached Tasmania's shores and generated immediate interest among entrepreneurial circles. First to adopt the technology were the isolated mining ventures in the remote western region of the island (Dallas 1960: 87). A tin mining company at Mt Bischoff constructed its own scheme in 1881 (Kayser 1892: 349) and a syndicate of directors of the large mining and mineral processing firm, Broken Hill Proprietary (BHP) Ltd, floated a company with a view to harnessing the waters of the Pieman River and selling the electricity to mining operations on the west coast).

2. Municipal Investment in Electricity Supply

Industry in urban centres followed the lead of the remote the mining ventures and in 1888 a woollen mill in Launceston became the first manufacturing plant in the Southern Hemisphere to be provided with electric lighting (Green 1959: 3). Entrepreneurs were quick to recognise the potential for profitable investment in hydro-electric development and a consortium of Launceston businessmen floated a proposal to construct a hydro-electric scheme on the South Esk River with the intention of selling the electricity to the local council. The fact that the gas used for public street lighting in Hobart was run by a business for private profit was greatly resented (Read 1986: 21) and the proposal for to develop hydro-electric resources as a private venture in Launceston met with considerable public opposition (Dallas 1960: 84). To fend off the private proposal, the local municipality lobbied parliament to hand over the water rights to the municipality. Once these rights were acquired, the Launceston Council tendered out the construction a 579 h.p. scheme at Duck Reach on the South Esk River, 2 km from its junction with the Tamar River. Much of the materials required were supplied by Knight's engineering foundry, a newly established firm in the State. On the 10th of December 1895, Launceston became the first town in the world to be provided with electric public street lighting (Dallas 1960: 86). The output of the scheme was subsequently increased and Launceston became the first city in Australia to provide households with electricity from a publicly owned hydro-electric system (Allbut 1958: 73). The station continued to operate until 1955 when it was replaced by the Larger Trevallyn scheme (Knight *et al.* 1962: 5). The public development of the hydro-electric resources in Launceston re-ignited tension over the private ownership of the electricity supply in Hobart and in 1913, the Hobart City Council purchased the Hobart Tramway Company and its electricity generation and distribution operations (Allbut 1958: 72).



Map 1 Tasmania showing location of places mentioned in text and hydro-electric schemes completed before 1935.

3. State Entry into the Electricity Supply Industry

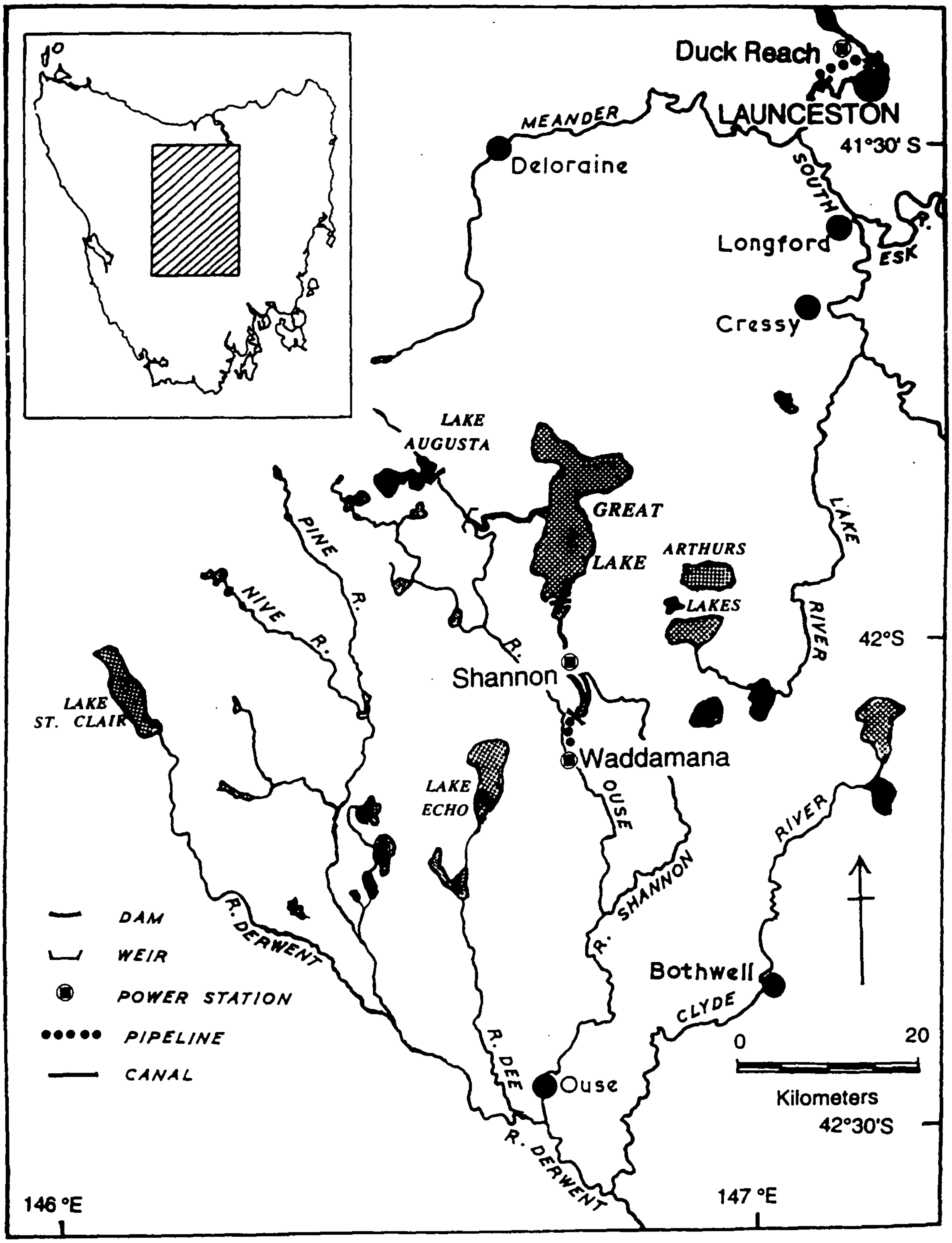
The success of the Launceston venture germinated the seeds of a grander vision within sections of the Tasmanian community. One of the countries was rapidly harnessing its hydro-electric resources at the time in order to industrialise was Switzerland, a small mountainous country in Europe, and many believed that by utilising the water resources of the Central Plateau, Tasmania could become the 'Switzerland of the South' (Green 1959: 4). Soon after federation in 1901, the outline of a hydro-electric scheme on the Shannon River draining the Great Lake on the Central Plateau was mooted and the Government came under increasing pressure to develop this option. Deterred by the high risks of large public investment in development of hydro-electric resources in the absence of a proven market, the government demurred and was criticised by proponents of the scheme for lacking both courage and conviction (Jetson 1989: 67). A market for electricity materialised in the form of James Gillies.

Gillies, a metallurgist from New South Wales, had managed to develop a means of refining complex Broken Hill zinc-lead sulphate ores using an electrolytic process. Due to the high costs of electricity on the mainland - £55 per h.p. per year in Victoria and £75 per h.p. per year in Broken Hill (Campbell 1916) - his new refining process was prohibitively expensive without access to a large source of cheap electricity. Gillies therefore travelled to Tasmania to investigate the island's hydro-electric resources, and having inspected these, put two alternative proposals to the government. His company's preferred option was that the government develop the Great Lake scheme and sell electricity to his Complex Ores Company. The second option was to grant his company concessionary rights to develop the hydro-electric resources of the Central Plateau and the rights to sell electricity surplus to its own requirements on the market.

Gillies' proposals generated both excitement and dispute. Parochial infighting broke out over whether the electricity from the scheme should be taken north to Launceston or South to the island's capital, Hobart (Jetson 1989: 66). Although the scheme was closer to Launceston, Hobart was chosen as the site for the zinc refinery due to its better port facilities (Allbut 1958: 74). Gillies' proposal also met with considerable mistrust over the true intentions of the company and divisive argument over whether development of the State's water resources should be a public or private venture (Jetson 1989: 67). The government preferred to retain control of electricity generation in public hands but was opposed by a business community that was ideologically opposed to government investment in areas that could be undertaken by private business, and by a conservative Legislative Council concerned over the high risks of the venture. The latter view prevailed and in 1909 Gillies' company was granted concessionary rights to use the waters of the Central Plateau to generate electricity. Work began in the following year on a dam to raise the level of the Great Lake and divert water from the Shannon River to the Ouse River and on the Waddamana A power station, consisting of two 4900 h.p (3.65 MW) turbines (see Map 2). The plan was to eventually increase the number of generators to nine with a total output of 65,800 h.p. (49.1 MW).

Gillies floated a private London-based company, the Hydro-Electric and Metallurgical (HEPM) Co., to raise the necessary capital for construction of the scheme. The firm entered into an agreement to supply the privately owned Hobart Gas Company and the Hobart City Council-owned Hobart Tramway Co. with electricity at $3 per kW per annum plus 0.5 pence per unit of electricity consumed. The HEPM Co. also began to construct its own distribution system that outstripped that of the Hobart Tramway Co. (Read 1986: 23). To prevent the firm from using its concession as a means of profiting purely by selling electricity, however, the firm was required to consume a certain amount of the generated electricity in its own manufacturing process or forfeit its rights. The Bill also included a provision for public acquisition of the hydro-electric scheme at cost after 20 years (Kellow 1996: 46).

Construction of the Waddamana A scheme began in 1910 but work under difficult conditions was slow. The weather was harsh and lack of access forced the company to construct a wooden tramway to haul equipment with horses. Chaff for horses became an unanticipated large expenditure that amounted to a considerable portion of total capital costs of the scheme (Australian Bureau of Statistics 1967: 319). The difficulty of raising the finance on the London market to build the scheme, moreover, was compounded by the manoeuvring of a group of Hobart-based businessmen and politicians keen to take over the company (Gillies 1984: 24). These difficulties and the slow pace of construction contrasted with a simultaneous, but successful, story of hydro-electric construction being played out by a mining company in the western region of the State. The west coast region was one of the most expensive places in the world from which to export bulk, unrefined ores due to the lack of infrastructure such as roads, railways or ports. The alternative, refining the ores on site, was also prohibitively as the same lack of infrastructure substantially increased the costs of importing coal or coke. The Mt Lyell Mining Co. had therefore resorted to the use of local timber as the energy source for its smelters. In 1911, the company decided to follow the lead of a small number of mining companies, such as the Mt Bischoff Tin Mining Company', and began work on the 12,000 h.p. Lake Margaret scheme on the Yolande River (Allbut 1958: 74). The construction workforce consisted of Maltese immigrants and when the scheme was commissioned in 1913, both the Maltese construction workforce and the large number timber cutters employed by the mining company were retrenched. Their plight was overshadowed by the fact that Tasmania could now boast the largest hydro-electric scheme in Australia, a fact that inspired the Minister for Mines to suggest that the State, with its greater resources, ought to be able to construct even



Map 2 The Great Lake hydro-electric scheme in Tasmania

larger schemes. One historian has suggested that the avid support for large hydro-electric projects by West Coast politicians over the following half century was attributable in part to this early success of the Lake Margaret scheme (Blainey 1954: 233).

With the outbreak of hostilities in Europe in 1914, material shortages and the reduced ability to raise capital on the London market forced the Hydro-Electric and Metallurgical Company to approach the State government with a request that the government take over construction. The government saw it as a means of rescuing not only a hydro-electric project but also as a chance to develop a zinc processing industry (Tighe 1992: 128). The assets of the company were acquired by the state for £624,000. The Government also acquired the electricity distribution rights of the Hobart Gas Co. and the Hobart Tramway Company, investing the functions of both of these firms in its new Hydro-Electric Department (HED). This direct recruitment of the management of the newly created electricity department from the nationalised companies, according to historian Peter Read (1986: 24), gave the HED the outlook and ethos of a business enterprise from its very start.

The HED entered into a take-or-pay twenty-one year contract to supply the Complex Ores Co. with 3,500 h.p. (2.61 MW) per annum at a price of £3/10/- per h.p. per annum, with further rights up to a total of 10,000 h.p. (7.46 MW) per annum at a price of £2/10/- per horse power per annum (Parliament of Tasmania 1914: 6).. Bulk electricity contract prices from hydro-electric schemes in the USA at the time were between \$8 and \$10 per h.p. per annum (Dallas 1960: 92). The reason for the cheap contract price offered by the HED was three-fold. One was the view that large-scale contracts would result in high load factors and reduce the unit cost of electricity. The second was that decision to operate the HED on a non-profit basis, while the third was the belief that encouraging energy intensive industries would generate secondary growth in the economy and provide spin-off community benefits such as electrified rail system (Tasmanian Parliament 1914: 6). The HED defended the cheap bulk tariffs on the basis that only those industries for which electricity presented a substantial portion of total costs could be attracted to the State, since the transport and market obstacles meant that small industries would not be attracted even if electricity were made available for free (HED 1916: 7-8).

With the outbreak of war, Broken Hill Pty Ltd had lost its major market for zinc ore, Germany. A new company, the Amalgamated Zinc Co. (subsequently the Electrolytic Zinc Co.) to refine the zinc ore. In 1917 the HEC entered into a contract with Amalgamated Zinc to supply 2.98 MW at the same contract price but with further rights up to 38.78 MW at £2 per h.p. per annum. The HED also indicated to the company that a site at Risdon on the Derwent River, 6 km upstream from Hobart would be made available. The generous electricity price and the siting of the plant created an uproar when the contract was tabled in Parliament. The State Health Officer refused to approve the site on the grounds that it was too close to urban areas but was overridden by the Government which approved the HED's contract (Gillies 1984: 145). The HED's contractual commitment to supply Amalgamated Zinc with much of the electricity from the planned schemes, at low prices, gave the company a virtual monopoly on future zinc production in the State as it ensured that little electricity would be available to prospective competitors. The decision to support Amalgamated Zinc in this effective monopoly was justified on the basis of the strategic need for zinc as a part of the war effort. No zinc was produced before the end of the war. Gillies' plans to use his new electrolytic method to produce zinc were therefore thwarted in this manner. His Complex Ores Company was persuaded, however, to establish a carbide manufacturing plant at Northwest Bay, 20 km south of Hobart, as a means of providing employment for returning soldiers.

The Government immediately instructed its Agent General in London to advertise the State on the basis of its cheap bulk electricity rates (Tighe 1992: 128-9) and directed the HED to investigate the island's total hydro-electric resource (Dallas 1960: 92). Almost $210,000 was spent on a 34.5 MW King River scheme before it was abandoned when the Mt. Lyell Co. objected that it would inundate part of its railway line which could not be rerouted (Blainey 1954: 253). In the same year, 1917, the Scenery Preservation Board was established, becoming the first bureaucracy in Australia vested with the responsibility for natural heritage protection (Lowe 1984: 12).

This early history of hydro-industrialisation in Tasmania illustrates two points. First, that the adoption of this new technology did not occur automatically. In Read's historic interpretation (1986: 7), the development of an electricity generation and supply organisation in Tasmania required both a need and the preconditions. The necessary preconditions were finance, technical expertise, resources (physical and labour) and vision. Read's account, however, lacked the detail of the more personal account written by James Gillies' son and published by his granddaughter (Gillies 1984). This latter account described the events that led to the formation of the electric supply bureaucracy in the State as a long, difficult and unrewarding struggle that was dogged by political feuds and treachery. It could perhaps best serve as a warning for contemporary proponents of technological innovation that the adoption of any energy technology, be it gas fired thermal generation, wind generators or energy efficiency, is not necessarily straight forward, no matter how simple the technology or how great the need. Change occurs neither effortlessly, nor overnight. The second point which this early history makes clear is the close association that developed between industry and the energy bureaucracy in Tasmania from the very beginnings, and the rapidity with which the Government saw in hydro-electric development a potential means of solving what were perceived to be the island's particularly acute economic problems.

4. Water Conservation and the Rationalisation of Electricity Supply

The early involvement of the State government in electricity supply and the creation of an hydro-electric engineering bureaucracy in Tasmania coincided with the rise of the Progressive Conservation Movement in the USA under the leadership of the forester Guilford Pinchot. The dominant idea embodied in the movement was that through the rational management of resources by experts using scientific principles, a shared vision of an affluent and humane society could be achieved by using resources efficiently. The engineer, more than any other expert group, symbolised this rational manager (Nye 1990: 167). In Tasmania, the new corps of hydro-engineers set about 'conserving' the State's water resources (HED 1925: 7) by diverting the Upper Ouse River into the Great Lake with the construction of the 8 km long Liawenee Canal to maximise the use of the waters from the Great Lake before being used in the Waddamana scheme.

The relatively slow pace of this construction programme was a consequence of the fact that it used manual labour and because construction was matched to the slow growth in the demand for electricity. The HED described this as a 'just-in-time' policy which entailed keeping in hand a surplus sufficient only to meet growth in demand during construction of the next project (HED 1925: 64). Although the HED had indicated to Parliament that many energy-intensive industries had expressed an interest in locating in Tasmania (HED 1915: 2), by the end of the 1920s no new firms had arrived. The only substantial increase in projected load occurred in 1923 when the Electrolytic Zinc Co. exercised its rights to take up its full 38.78 MW quota.

The development of the electricity supply industry throughout the Australian states during this early phase was rapid and chaotic, with many small independent producers and distribution systems using different voltages. Eventual state control of the production and supply was seen as inevitable in order to rationalise the large numbers of producers and establish an efficient system. In other states, this was made easier by the war and depression which forced production and supply into the hands of municipal, county and state public bodies. This process was most advanced in Victoria where the State Electricity Commission was formed in 1921 and given responsibility for the production, transmission and distribution of electricity throughout that state (Murray 1974: 31). In Tasmania's case, the failure of the private sector led to even earlier public involvement in the production of electricity. The Chief Engineer of the HED, moreover, argued from the very start that hydro-electric development and electrification of the island would be best served if his Department was given freedom to get on with the business of hydro-electric development by removing it from the day-to-day dealings with the government. To this end, he recommended that his Department be abolished and a semi-autonomous Commission created in its place. In 1925, a Bill establishing a

Hydro-Electric Commission passed both houses of Parliament, but was jettisoned amidst constitutional conflict between the two Houses without being presented for Royal approval (Read 1986: 57). The HED recommended the change again in 1929 on the basis of the growing need to organise and regulate the haphazard growth of the State's various municipal electricity generation and supply systems. If the State was to have an efficient electrical system, it was argued, it needed to be coordinated and managed in an integrated manner. The Hydro-Electric Commission (HEC) Act was passed in that year and in 1930 the new Commission with monopoly powers over the planning, generation, distribution and sale of electricity throughout the State was established. The Bill, however, referred awkwardly to a 'commission-headed department' (McKenry 1972: 9). The Commission's first project was the 14,500 h.p (10.5 MW) Shannon power station, completed in 1935 (Knight *et al.* 1962).

Over the following years the HEC gradually took control of the various municipal and private generators and distributors, one of the last to concede to the HEC being the Municipality of Launceston in 1944. The Commission's distribution system was also greatly expanded under the Government's policies of rural electrification and uniform tariffs. This programme emulated Roosvelt's grand social experiment in the USA, in which the Rural Electricification Authority was created to spearhead the country's development programme (Nye 1990: 175), the purpose of that rural electrification in the USA being described as making the home 'a more spiritual environment for all members of the family' (Sporn 1950: ii) and a means of advancing democracy (Lilienthal 1944: 5). In Tasmania, urban electricity rate payers subsidised their rural counterparts in one of most generous schemes in the world (Townsley 1994: 51). Under the scheme, the Government paid up to 75% of the costs of connection and by 1964/65, 98% of Tasmanian households were connected to the grid. A cheap continuous hot water tariff was also introduced as a social policy to make hot water universally available (Read 1986: 65). It was a policy initially opposed by the HEC as it strained its resources and increased the overall household tariffs and tariffs in other sectors.

5. Hydro-Electric Construction as a Job Creation Scheme, 1934-1944.

Planned expansion by the Electrolytic Zinc Co. and a proposal to build a pulp and paper manufacturing plant in the north of the State by Australian Pulp and Paper Manufacturers (APPM) led to the decision in the early 1930s to proceed with a new hydro-electric project, the Tarraleah scheme, which harnessed the headwaters of the Derwent River (Allbut 1958: 76)[1]. There was, however, an added motive behind the

[1] Allbut (1958: 74) acknowledged that his notes on hydro-electric development in Tasmania by the HEC after 1930 were written by the HEC's Chief Commissioner, Allan Knight.

decision. In 1934, hydro-electric development took on a new function. In that year Albert Ogilvie was elected as Premier, beginning thirty five years of uninterrupted Labor government in the State. Ogilvie was elected largely on a policy of accelerating hydro-electric construction to create jobs, thereby pulling Tasmania out of the doldrums of the Depression. Elsewhere, governments of diverse political persuasions had undertaken massive public capital works projects for the same purpose. By 1933, Germany's fascist government had achieved full employment (Stewart 1991: 23), while the Roosvelt Republican administration in the USA had launched a massive public spending programme under the New Deal (Marcus 1986: 49).

Under Ogilvie's leadership, work on the Waddamana B station commenced, the 9 km Liawenee Canal was constructed to divert the upper Ouse River to the Great Lake, and a new dam on the Great Lake was built to further raise the level and increase the storage capacity of the lake. The Upper Derwent scheme was also started as the last of the 'pick and shovel' schemes, recruiting the workforce from the army of unemployed. While the scheme was began in the faith that demand for the electricty would materialize, it was pushed ahead as an employment relief programme with for long-term economic benefit (Rackham 1981: 5). Funding for the scheme was facilitated by new financing arrangement between the federal and the states. Ogilvie's Labor predecessor, Premier Joseph Lyons, had attempted to set Tasmania on a course that would enable it to control its own destiny throughout the 1920s. A popular view of the day was that Tasmania's economic problems were a consequence of its joining the federation. The State's poor economic position had seen it become, in the eyes of its leaders, a 'vassal state' used to supply cheap labour and resources to foreign companies. This low status, together with an economy dependent upon the Commonwealth, was deeply felt by Tasmania's political leaders and Lyons desperately wanted to find a means of regaining dignity and economic independence (Townsley 1994: 4). He was assisted in this task by his economic advisor, Lyndhurst Faulkner Giblin, an eccentric but brilliant Professor of Economics at the University of Tasmania with no formal training in economics (Hytten 1960: 153). Giblin espoused the highly unpopular view that Tasmania's economic problems were not a consequence of federation but that Tasmania was a naturally poor state that counted for little within the Commonwealth. The State's Achilles' heel, according to Giblin, was its dependence on shipping, and because it was a poor state, the Tasmanian government could afford to borrow for only income-producing public projects such as railway infrastructure and hydro-electric construction.

In 1927 Lyons and Giblin persuaded the Commonwealth to set up a Loans Council, an intergovernment body through which the states could coordinate the raising of low interest loans by using the Commonwealth's borrowing power. Giblin and Lyons were also instrumental in the establishment of the Commonwealth Grants Commission with the function determining the distribution of Commonwealth funding to the various states (Brown 1960, Hytten 1960: 158-9). The formula for funding used by the Grants Commission was designed specifically to assist development in the smaller states (Townsley 1994: 6). In the 1930s, hydro-electric development became an election issue and Ogilvie turned to these instruments to finance his hydro-electric construction programme in order to create further jobs (Rackham 1981: 51). He was greatly assisted by the fact the Tasmania's former Premier, Joseph Lyons, was elected Prime Minister of Australia and had retained the services of L. F. Giblin as his economic advisor.

Ogilvie's hydro-electric construction programme did not see further energy-intensive industries establishing in the State and the firms which located in the State throughout the 1930s did so primarily for reasons other than cheap electricity. Two pulp and paper manufacturing firms, Australian Pulp and Paper Manufacturers (APPM) and Australian Newsprint Mills (ANM), were attracted in the main by generous concessions to public forests. A British chocolate manufacturing firm set up in the south of the State and although local folklore would have it that the firm's decision to locate was based on Tasmania's temperate climate (Read 1986: 69), a more likely reason according to industrial geographer, Dr Peter Wilde, was the reputation of the State's workforce as nonmilitant (Dr Peter Wilde, personal communication, November 1995). A cement manufacturer, Goliath, set up at Railton in the north of the State. No energy-intensive electro-metallurgical companies arrived during the period.

6. The Myth of Hydro-Industrialisation, 1944-1954

Hydro-industrialisation was increasingly employed as an engine of economic growth in the island under the premiership of Ogilvie's successor, Robert Cosgrove. Cessation of war-time production had led to a downturn in economic activity and governments everywhere feared a relapse into Depression. A number of governments nationalised their electricity and other industries. Saddler (1981: 51) has interpreted this nationalisation as a means of assisting capital by passing onto the state the high risk, low return task of electricity supply expansion and thereby leaving private enterprise free to invest in more lucrative ventures. The lack of opposition from business community, Saddler suggests, provides the evidence to support his argument. This explanation is incomplete, however, as it overlooks the fact that government stepped in and took over many task associated with economic development when the efforts of private business appeared ineffective or faltered. Harris (1993), for example, has described the way in which the Tasmanian government was persuaded in 1914 to take on the task of promoting tourism in the State. Saddler's interpretation also ignores the pervading attitudes of the day. The nationalisation of the electricity supply industry by many governments after the second world war has to be understood in terms of the perception that capitalism had failed to avoid the Depression. As a consequence, governments of all ideological persuasions in the post-war period put aside their doctrines, embraced Keynesian economics, and adopted pragmatic policies to create employment and generate growth (Field & Higley 1980: 7-10). Governments did what they did primarily to improve the lot of the common person rather than from adherence to ideology. Both private enterprise and conservative governments supported this policy, and due to its popular appeal, any business leaders opposed to it would have remained silent. In Tasmania, increased public expenditure on hydro-electric construction was neither a purely socialist nor capitalist policy but amounted to state-led development to attract capital. The Labor Party in Tasmania may have been nominally socialist, but none of its parliamentary members knew anything about socialism (Townsley 1994: 52).

Cosgrove inherited an HEC torn by internal division, personality clashes and accussations of administrative irregularities, engineering incompetence and conflicts of interest (Read 1986: 71). The HEC was also beset by other problems and construction of work on the Upper Derwent Scheme had slowed due to army recruitment for the war, strikes over conditions (Rackham 1982: 12). A Board of Inquiry into the HEC in 1940 recommended sweeping reforms. The HEC Act was amended in 1944 to improve the efficiency of hydro-electric construction programme by further removing the Commission from the day-to-day workings of Government. The ambiguity over whether it was a department or commission was removed (McKenry 1972: 9). Under this new act the HEC was master of its own affairs with the ability to raise semi-government loans independently from the Loans Council. Furthermore, while the Minister administering the Act was answerable to Parliament for the activities of the Commission, the Commission was answerable only to Parliament and was neither answerable to nor directed by the Minister (ABS 1967: 373). The legislation gave the Commission powers unequalled by those of its mainland counterparts. In the Launceston vs HEC case, however, theHigh Court ruled in 1959 that under the HEC Act of 1944, the HEC was not concerned soley with the provision of hydro-electricity, was accountable for its actions just as any other person or corporation, and had none of the immunities of the Crown (McKenry 1972: 9). Two years after the HEC Act was introduced, Cosgrove moved his Head of Public Works, Allan Knight, to the position of Chief Commissioner of the HEC. Knight served as Chief Commissioner for thirty-one years, out surviving the reigns of five Premiers. He was noted for his technical achievements and was, in the words of political theorist, Bruce Davis (1995: 3) 'elusive, cool and almost diffident in manner', and a person with persuasive powers 'well beyond those of other civil service heads'. In Read's view (1986: 71), with Knight's appointment it was as if Cosgrove was working to a plan.

At the time, growth in industrial demand for electricity was still gradual, and by 1949 the total generating capacity of the system was only 107.9 MW. An opportunity to rapidly expand the demand for electricity in the State arose as a consequence of a Commonwealth initiative. During the second world war, aluminium was seen as a strategic material and the Federal government announced its intention to undertake a public aluminium smelting venture (Fagan 1971: 191). Cosgrove persuaded the Prime Minister that Tasmania was the most suitable site for the smelter. The Australian Aluminium Production Commission (AAPC) was established under the Aluminium Industry Act 1944 as a joint venture project, the Commonwealth and Tasmanian governments agreeing to contribute $3 million each. Selection of the eventual site for the alumina refinery and aluminium smelter at Bell Bay on the mouth of the Tamar River north of Launceston took three years. By time construction of the smelter began, the initial strategic purpose of the operation was irrelevant (Fagan 1971: 191). Under the Aluminium Industry Act of 1944, the Tasmanian government was required to 'make provision as it thinks necessary to enable the Hydro-Electric Commission to provide electricity at a price satisfactory to the AAPC. The State agreed to construct both the Trevallyn hydro-electric station in the Tamar Valley and houses for the smelter's workers. Discussions over the price the AAPC would pay for the electricity were protracted, the AAPC demanding rates as low as possible so that it could compete with the large North American producers. In 1948 the AAPC, under protest, entered into a 25-year contract for 26 MW at a price calculated according to the estimated non-amortised construction costs of the dam and associated transmission lines (Male 1993).

Cosgrove's vision of rapid expansion of hydro-electric construction lacked but one ingredient, a large construction workforce. In 1946 Cosgrove approached the Prime Minister and requested 1,000 migrants under assisted passage to be bonded to the HEC. The conditions under which these migrant workers laboured have been described as harsh and not much better than those which existed during the first half of the nineteenth century when the State served as penal colony (O'Brien 1994). It was the beginnings of a wave of such assisted migration, and between 1947 and 1954 a third of the increase in the State's population was the direct result of the immigration programme. Hydro-electric development therefore became the lynch-pin for expansion of the manufacturing sector and the Government's attempts to increase the island's population.

Between 1950 and the mid 1960s, hydro-industrialisation in Tasmania reached its zenith. In the late 1940s, industry's planned expansions accelerated and industry leaders became critical of the HEC's inability to keep pace. The introduction of a 40 hour week in 1948 added further to construction costs (Rackham 1982: 12). Growing concern over whether the HEC could meet the contractual obligations it had entered into with a number of large industries led to the establishment of a Select Committee of the House Assembly in 1951 (Lowe 1984: 9). Taking evidence *in camera* from representatives of industry and the Commission only, the Committee recommended that the HEC form a closer working relationship with its industrial clients and that its construction programme be accelerated (Tighe 1992: 133). In the same year, the HEC began to capitalise interests during construction so that interest on loans were added to construction costs until commissioning, thereby keeping electricity prices low by reducing the need to rely on internal funding for construction (Kellow 1996: 49).

7. Hydro-Industrialisation as Political Dogma, 1954-1964

In the mid 1950s, the benefits of the policy of hydro-industrialisation were perceived to be increasingly questionable and the policy came under increasing public and political criticism. The HEC's construction programme was based on the forecasting assumption of a doubling in demand every eight years (Allbut 1958: 81). The costs of the schemes was beginning to increase, however, as the supply of cheap migrant labour force began to dry up. The State was also beset by drought which lead in 1954 to the introduction of the Water Act that handed over to the HEC total control of all State water resources, thus alienating those landowners whose irrigation rights were retracted. The Lower Derwent scheme, then under construction ,was also the first scheme to inundate significant tracts of farming land, further raising the ire of affected landowners. To this was added general public disaffection over a 25% increase in electricity tariffs and the combination created a wave of questioning of the hydro-industrialisation policy (Townsley 1994: 51). In Parliament, the HEC was described by the Liberal Opposition as a 'state within a state' and Parliament was accused of abrogating too much responsibility to the Commission (The Mercury 1 April 1954: 5). Premier Cosgrove did not so much defend the decision to increase the HEC's power as suggest that the decision was irreversible. To reduce the Commission's power, the Premier warned, was risky for the State since it would be interpreted by the financial world as a loss of Government confidence in the HEC, which would in turn undermine the Commission's ability to borrow on the international market (*The Mercury* 31 March 1954: 18). The proportion of Treasury loans devoted to hydro-electric construction and the lack of Government control over the electricity planning were also raised as issues (Lowe 1984: 16). Brendon Lyons, son of the former Premier and Prime Minister, Joseph Lyons, and the only Parliamentary member of the Centre Party, described Parliament as a mere rubber stamp for HEC proposals and the HEC as a potential 'Frankenstein' (Lowe 1984: 17). Even government members, and Dr Turnbull in particular, publicly questioned the portion of public loans spent on hydro-electric construction (Lowe 1984: 18).

Dissent from within the Government's ranks was quashed, however, when the last of the avidly pro-hydro Labor Premiers, 'Electric Eric' Reece, gained office in 1959. Dr Turnbull, an adversary of Reece, was sacked for disloyalty and sat in Parliament as an independent before moving into Federal politics. Reece, a West Coast politician recruited from the trade union movement, was doggedly pro-development, and a clever political tactician. He demanded absolute loyalty from his Labor colleagues on the floor of the House and confined any debate over policy to the Party room. The policy of hydro-industrialisation became an unchallenged dogma steered by a powerful cabal: Premier, Eric Reece, his deputy, Roy Fagan, the Under Treasurer, Kenneth Binns, and the HEC Chief Commissioner, Allan Knight. The four formed a powerful pro-hydro bloc, represented on almost every Board and Committee of any import in the State (Lowe 1984: 27). The HEC Chief Commissioner, for example, served amongst his many other capacities as a member of the Scenery Preservation Board (McKenry 1972: 10, Castles 1986: 88). The HEC itself had become the *prima donna* and envy of State government bureaucracies, with the Commissioner earning a higher salary than the Premier. To fulfil its obligations to the public, the Commission began to produce booklets describing its past engineering feats (Garvie 1962). The Commission maintained a policy of minimising idle capacity by keeping just ahead of demand, stating that:

> Prudent economic policy dictates that an authority should try to keep just ahead of demand, and not have unremunerative investment in a large block of idle generating capacity; the margin in hand at any one time is therefore comparatively small. (ABS 1967: 330)

The Commission added, however, that although its policy was to continue a rolling construction programme to keep just ahead of demand while avoiding restrictions in supply, its aim was to encourage expansion of continuous industrial sector load and to promote off-peak retail electricity tariffs in order to increase load factor. In the 1961/62 financial year, the HEC increased its comprehensive sales promotion and began to distribute public relations material with its quarterly accounts. Two years later, the Commission created its Consumer Advisory Service and began to make extensive use of the printed and electronic media to promote electricity (HEC 1968: 5).

Although many writers have suggested that throughout the 1950s and 1960s, the policy of hydro-industrialisation was a hegemonic vision, this appears to overstate the case. By the early 1960s the Liberal opposition is said by Townsley (1994: 176), to have become obsessed with matters relating to hydro-electric development. There is little question, however, that Reece was undeterred by this criticism and under his leadership hydro-industrialisation remained an unchallenged policy (Davis 1972: 47). Steering the State down this policy road was a small group of influential individuals. For the Government, the policy provided a means of retaining electoral popularity by promising economic prosperity and visible jobs in economically depressed regions of the State, a policy readily sold to a relatively unsophisticated electorate. For the HEC, it provided both continuity and increased load factors. The political needs of government and the vision of a rapidly expanding manufacturing sector which would then stimulate the other sectors of the State's economy both dovetailed perfectly with the needs of the

Commission. The Government's and the Commission's needs dovetailed also with the needs of industry and so created a three-way symbiotic relationship. Neither the Government nor the HEC were coy about their support for the policy of supplying large industries with subsidised electricity. In a circular to his employees in 1961, the Chief Commissioner wrote:

> If the whole of industrial power were given away free it would cost the consumer an additional £15 per annum. Would this appear an unduly high price to pay for the presence of such large and important industries to the State? (Cited in Bound 1961: 6)

The HEC defended the sale of cheap electricity to industry in the following manner:

> The householder may be tempted to ask why industry should not pay more and the residential sale price be reduced. The answer is simple: to diversify the Tasmanian economy and to give employment to an increasing work force, industry has to be attracted to the island; cheap bulk power has been, and will continue to be, a major attraction. (ABS 1967: 332)

The industry that was to benefit most from this policy was aluminium smelting venture at Bell Bay. Production of aluminium at Bell Bay began in 1955 and at the opening of the smelter the Federal Minister for Supply stated that the 'sole and only justification for establishing the smelter in Tasmania was the promise and expectation of cheap and plentiful electrical power' (The Mercury 12 March 1991: 8). The unit electricity price paid by the AAPC was around 0.14 c/kWh (Male 1993). It was soon found that its production level of 13,200 tonnes per annum was uneconomic and that tariff protection was necessary to protect the AAPC from cheaper aluminium produced in the USA and Canada (Male 1993). To increase production, the Commonwealth invested a further $8.5 million in the venture, taking its equity holding to two-thirds.

In the same year that the Bell Bay aluminium smelter began production, the British transnational, Consolidated Zinc, acquired rights to the massive bauxite deposits which had been discovered at Wiepa on Cape York Peninsula in Queensland and began to seek entry into the production of alumina and aluminium. In 1961, the smelter was privatised, the Commonwealth selling its share to the Consolidated Zinc Corporation which set up a subsidiary company, Comalco Aluminium Ltd. The Tasmanian government gradually reduced its equity to its current 17.4% preferential share holding. To make the company more economically viable, Comalco sought tariff protection which it received in the form of quantity restrictions on aluminium imports. The company also planned to increase production to 28,000 tonnes p.a. and the HEC began construction of the 250 MW Poatina scheme to supply the electricity. In 1962 the HEC's industrial clients announced plans to expand production and increase load by a total of 122 MW. The 308 MW Mersey-Forth scheme was started in the following year. Another footloose firm, Temco, constructed a ferro-manganese smelter at Bell Bay adjacent to

Comalco's aluminium smelter and began production in 1965. Kellow (1996: 49) states that there was some evidence that Temco, a subsidiary of steel making giant BHP, relocated from Newcastle in NSW due in part to Tasmania's lax environmental regulations. Industrial electrical load had doubled over the decade and the HEC anticipated that this rate of expansion would to continue. By 1967, Tasmania, with only 3% of the nation's population, accounted for 15% of the electricity used in the country.

Proponents of hydro-electric development at the time traditionally argued that the indirect benefits of hydro-electric development other than the provision of electricity needed to be included in the decision over whether to proceed with a hydro-electric development. Common among the side-benefits mentioned were flood control, navigation channels, increased income to communities, job creation and increased irrigation capacity (Lilientathal 1944: 39, Datta 1973: 8). While the HEC's projects tended to be single purpose schemes, a major spin-off of hydro-electric development in Tasmania, the HEC argued, was the opening up of remote areas with excellent roads built by the Commission (ABS 1967: 318). Over time, however, the converse argument, that the indirect *costs* of hydro-electric development also ought to be included in the decision as to whether to proceed with development proposals, began to be argued more forcefully. Accompanying this construction programme had been costs in the form of the loss of both valued natural and man-made assets. Elsewhere, the construction of dams had often led to conflict because of such costs. In New Zealand, for example, hydro-electric development had already been an episodic political issue for a considerable period (Farrell 1957: 208). As early as the mid 1940s, the Chairman of the Tennessee Valley Authority had warned that planning of hydro-electric developments needed to ensure that the total benefits outweighed the costs, including environmental costs, and had expressed the opinion that rather than a task left soley to experts, the public need to be involved in the planning of such developments (Lilienthal 1944: 6). In Tasmania, construction of a three-metre weir on Lake St Clair at the head of the Derwent River in the late 1930s had inundated the Lake's natural foreshore and beaches and was strongly opposed and resented by naturalists and bushwalkers at the time. The raising of the Great Lake to construct the Poatina scheme for aluminium production stopped water flowing down the Shannon River in 1962 and destroyed the world renowned trout fishing phenomenon, the Shannon Rise, that had been created with the Hydro-Electric Department's first hydro-electric scheme (Taylor 1993). To the Government, these represented small prices to pay for economic growth and although both losses were deeply felt by the respective interest groups, overall, the Tasmanian community was resigned to the fact that nothing stood in the way of hydro-electric development. With this rapid expansion of hydro-electric construction, all available large economic hydro-electric sites had been developed or were under construction and the HEC began to turn its attention in the late 1950s to the island's more rugged and remote south west. The Chief Commissioner, writing in 1956, tentatively outlined the future projects, including schemes using the King and Franklin Rivers, the Pieman River, and the Gordon River. The Commissioner claimed that due to the rough terrain, little investigation work had been carried out on those schemes, although preliminary cost estimates had been calculated (Allbut 1958: 82-3, 86). By the early 1960s, the HEC planning of a scheme on the Gordon River was rapidly accelerated. No one anticipated the furore that the decision would create.

8. The Lake Pedder Controversy

The Scenery Preservation Board had been informed as early as 1954 by the HEC Chief Commissioner that a dam would probably be constructed near the confluence of the Gordon and Serpentine Rivers in the rugged South West (Lowe 1984: 25). It was an area recognised for its high wilderness values by the increasing popularity of bushwalking in the post-war period and its perceived status began to shift from wasteland to valued wilderness. Among its many natural features, one in particular stood out. Lake Pedder, a 2.5 km^2 glacial lake in the Serpentine River catchment with an extensive quartzite beach, was considered the 'jewel' of the South West wilderness and in 1955 the Lake Pedder National Park was declared.

Concern over development and rumours of planned hydro-electric construction in the South West led in 1962 to the formation of the South West Committee made up of representatives from various bushwalking and other organisations (Grant 1978: 251). This Committee lobbied for a comprehensive management plan for the region and an InterDepartmental Committee was established to advise the Government on the desirable balance between development and exploitation in the area. In the following year, construction of a road from the township of Maydena to the Gordon River began using a $5 million grant from the Commonwealth (Green 1984: 23). Although the government of the day claimed that no definitive plans had been developed and that the purpose of the road was purely to facilitate HEC investigations, it was revealed years later that the road had been carefully surveyed to avoid inundation when the dams were constructed, indicating that the HEC's plans had been already well advanced at the time (Wilde 1978: 210).

In mid 1965, Reece announced that there would be some need to 'modify' the Lake Pedder National Park to accommodate the new hydro-electric scheme (Smith & Handmer 1991: 50). One year later the Commonwealth agreed to provide the State with a $47 million *ad hoc* special purpose loan towards construction of the Middle Gordon River Scheme (also referred to as the Gordon River Power Development Stage 1). The information was withheld from the public until early 1967 when the Inter-Departmental

Committee on South West Tasmania tabled its report which recommended that the Lake Pedder National Park be enlarged as a South West National Park. To fend off the demand for an increased Lake Pedder National Park, the Premier revealed that Commonwealth money had already been made available for construction of a scheme, thus sparking intense debate. The silence of the Scenery Preservation Board throughout that debate was considered by Davis (1980: 153) to be 'strange'. Also silent was the Liberal Opposition, in contrast to its earlier outbursts of criticism of the HEC and the continuation of hydro-industrialization.

Environmentalists responded by immediately forming the Save Lake Pedder National Park Committee. On the 25th May the HEC tabled its report in Parliament, which recommended construction of a dam on the 288 MW Middle Gordon and three smaller dams to flood the Serpentine catchment as supplementary storage for the Middle Gordon dam. It became clear that 'modification' of Lake Pedder meant total inundation of the Lake Pedder National Park under the largest man-made freshwater impoundment in the Southern Hemisphere, over 600 km^2 in area.

Without support in the House of Assembly, environmentalists turned to the Legislative Council which established a Select Committee of Inquiry in early June of 1967. Reece meanwhile introduced a Bill in the Lower House to approve construction of the scheme. Apart from a question from a Liberal backbencher as to why the South West Committee had not been allowed to put its case for saving Lake Pedder National Park to the Scenery Preservation Board, the Bill was passed with almost no debate (Lowe 1984: 27).

The reason for the lack of dissent from within the Government's own ranks is likely to have been Reece's demand for party unity. The Opposition's sudden relapse into uncritical acceptance of HEC proposals, however, is more difficult to explain. One explanation is the drought which had led to the use of cloud seeding, beginning in 1964. This problem was exacerbated by catastrophic bushfires which swept through the southern half of the State in February 1967. Drought worsened throughout that year and HEC storages fell to a record low of 14%. A 10 MW oil-fired electricity generating vessel, the George H. Evans, was purchased from New Zealand and anchored off Bell Bay. In terms of the HEC's attempts to persuade politicians of the need for the scheme, the drought was timely. As the fact that as a storage rather than a run-of-river scheme, the HEC was able to advance the Middle Gordon scheme as a drought-proofing measure, since the only other storage scheme in the State was the Great Lake (Poatina) scheme. The HEC simultaneously recommended to Parliament that a 120 MW oil-fired emergency power station be built adjacent Comalco's smelter at Bell Bay at a capital cost of $20.75 million. These are likely to have been highly significant factors behind the opposition's sudden reversal on the issue of continued hydro-electric construction, as an election was drawing close and the Liberal opposition could ill-afford to risk alienating the public. The fact that the opposition had never challenged a specific proposal before, however, meant that the opposition's silence may have also been a result of its inability to critically question the technical expertise of the Commission.

This inability was a major factor in determining the outcome of the Legislative Council Select Committee of Inquiry. Neither the small group of politically naïve environmentalists nor the Legislative Counsellors proved a match for the HEC. The Commission's representatives bamboozled the members of the Committee with technical details while remaining silent on critical issues (Davis 1972: 34). The Commission persuaded the Committee that the Gordon Catchment without the additional storage of the Serpentine Impoundment would not produce electricity at a sufficiently low cost and that the Serpentine impoundment represented, furthermore, an additional drought-proofing measure. Late in the day the HEC indicated that it would be feasible to avoid flooding Lake Pedder by lowering the level of the Serpentine impoundment and pumping water into the Gordon catchment, at an estimated capital cost of $15 million. The HEC, however, convinced the members of the Select Committee that the pumping option was not only expensive but would be futile as it would not preserve Lake Pedder in a natural form (Lowe 1984: 38). With no independent expert advice, the Select Committee reported on the 22nd of August that it had reluctantly accepted the HEC's view that there was no satisfactory alternative to flooding Lake Pedder. Two days later the Legislative Council passed the Bill. As a compromise, the South West National Park was enlarged, but with many areas of strategic importance to mining and timber extraction omitted.

The drought, meanwhile, had worsened, and in September the HEC (Emergency Powers) Bill was passed giving the Commission legal power to introduce rationing. Daylight saving was introduced, 33% of public street lights were turned off and electric bus services were curtailed while residential load fell 20% below demand level of the same period in the previous year. Major industries were asked to reduce output by 25%. By December of that year, industries were asked to reduce output by 35% relative to the same period in the previous year.

The Lake Pedder affair and the shortages were damaging for the Reece government and in the 1969 State election Bethune's Liberal Party skilfully exploited anti-government sentiments, blaming the Labor government for the electricity shortages and loss of employment, promising voters that under a Liberal government there would never again be an electricity shortage in the State, and that all electricity supply options, including nuclear energy, would be investigated. To appease environmentalists, Bethune promised to set up a National Parks and Wildlife Service governed by an Advisory Board, with representatives from community interest groups (Lowe 1984: 30). At the election, the

Liberal and Labor Parties both won seventeen seats each, with the crucial thirty-fifth seat being won by the Centre Party's Brendon Lyons. Bethune and Lyons formed a coalition government and for the first time in 35 years, the Labor Party moved to the Opposition benches.

The Coalition government introduced a number of major reforms. These included the establishment of a State Planning Authority, despite strong opposition from the HEC (Lowe 1984: 30). The 120 MW oil-fired emergency power station was constructed and, at the insistence of industry, construction of a second 120 MW unit began. The drought eased, and the sense of urgency dissipated. The HEC requested that emergency measures such as daylight saving be lifted. Daylight saving, however, had proved popular, and was not only retained but was extended from four to six months of every year. The electric bus service, with much of its infrastructure damaged by the 1967 bushfires, was phased out (Cooper 1979: 19).

By 1971, the HEC was predicting an 80% to 100% increase in demand for electricity over the next decade and in mid 1971 tabled its report on the 390 MW Pieman River Scheme, estimated to cost $134 million. The HEC recommended an immediate start to construction, warning that failure to do so was likely to 'lead to power restrictions of some form' (HEC 1971: 7). The now beknighted HEC Commissioner and his senior officers set about persuading politicians of the need for the scheme. Their argument was the need to maintain a rolling construction programme to hold together its 2,000 strong construction workforce. Politicians were also reminded of the political ramifications of shedding this workforce during a period of high unemployment.

The dilemma for the Government was that although the HEC proposals were becoming costly, to openly question the policy risked undermining the credibility of its own major economic strategy (Davis 1981: 180). For the HEC, the difficulty was forecasting the increase in load of a relatively small system in which the industrial load was prone to rapid fluctuations. This in turn impacted on the rate of economic growth and, therefore, the rate of growth of general load. Superimposed on this was the dependence of the system on unpredictable rainfall. The HEC and the Government had to weigh up the risks of undersupply in terms of reduced employment, industrial output and HEC revenue. The most damaging impacts of shortages were considered to be the undermining of industrial growth. Unless further schemes were constructed Tasmania's reputation as an industrial investment risk could damage the chances of growth. Some feared that existing industries would decamp. Against this had to be balanced the risks of overcapacity which would not generate income to pay off construction loans and result in unpopular tariff increases. The HEC was able to persuade the Government that the risk of electricity shortages was potentially far more damaging than the risks of overcapacity.

One of the effects of the long lead time of the Gordon Scheme was that it allowed the environmentalists' campaign to build up momentum. The degree to which this occurred was totally unpredicted by both the Liberal and Labor parties. While a few members of both the Legislative Council and the Labor Party began to have a change of heart, senior members of the Labour Party insisted that it would it be extremely difficult to abandon hydro-electric construction as this would jeopardise the Government's ability to create jobs. Even if the Government attempted to abandon the policy, it was argued, it had little ability to control the HEC since past attempts to bring the HEC under ministerial control had been thwarted by the Legislative Council (Batt 1972: 57). Criticism of the large portion of the State's capital works budget absorbed by the HEC was dismissed as a red herring, since the only projects for which the State could raise money through the Loans Council, it was maintained, were income-producing projects. As one of the few income-producing projects available to the State government, hydro-electric construction automatically received the largest share of State capital borrowings (Batt 1972: 56).

The environmentalists' attack on hydro-industrialisation over the flooding of Lake Pedder opened the door for questioning the economics of the policy. The contradiction between a dramatic rise in the manufacturing sector's electricity demand and slowing growth of manufacturing sector employment was becoming more apparent (Hean 1972: 102). Independent economists began to suggest that if the economic costs of drought and drought-protection measures were factored into electricity cost-benefit analyses, thermal power stations had already become competitive with hydro-electric construction in the State (Davidson 1972, McColl 1976). As an alternative to further hydro-electric development, many environmentalists supported the thermal option, justifying this on the grounds that a coal-fired power station would not pose a pollution problem since the emissions from coal-fired stations all occurred naturally in the atmosphere in large quantities and were therefore innocuous (Johnson 1972: 76). The HEC ridiculed the environmentalist support for a coal-fired plant by adopting the slogan "HEC: Power without Pollution". Environmentalists parried with their own "HEC: Power without Purpose".

The increasing questioning of hydro-industrialisation and growing support for saving Lake Pedder led to a call in Parliament for the fate of Lake Pedder to be decided by referendum. The call was defeated. Environmentalists, however, refused to surrender and adopted other tactics. The first of these was to form a political party. In early 1972 Bethune and Lyons fell out. Lyons resigned from Parliament and moved to the mainland, taking with him $25,000 as payment for the publication rights to his unwritten memoirs by a firm which had been involved in a scandal over its purchase of large tracts of public land (Sanders 1980: 56). The government collapsed and went to the polls. To contest the election, environmentalists, led by an ecologist from the University of Tasmania, Dr Richard Jones, formed the United Tasmania Group (UTG). It was the first formal green political party in the world, predating the New Zealand Values party by two months. The enthusiasm and grass-roots campaigning skills caught its 'Laborial' opponents by surprise. Compared to their lack lustre efforts, the UTG ran a slick and professional campaign on a shoe-string budget (Green 1984: 54). The HEC responded by entering into the election campaign, using media statements and advertisements to denigrate environmentalists as irresponsible, warning voters that if the environmentalist attempt to alter the scheme succeeded electricity tariffs would be raised. The Labor Party under Reece won a land slide victory. At the election, the UTG's candidate in the inner Hobart electorate of Denison missed out on winning a seat by a mere 150 votes. Outraged, the UTG claimed that it was a travesty of the democratic process, and called for a Royal Commission into the role played by the HEC in the election (Green 1984: 56). Its demands were ignored by the government (Sanders 1980: 57).

The second tactic employed by environmentalists was to launch a legal challenge. A new group, the Lake Pedder Action Committee (LPAC) was formed in 1971 to lobby Tasmanian politicians. In July 1972 the LPAC challenged the legality of the construction of the scheme as it contravened the 1968 proclamation of the enlarged South West National Park. The LPAC's application for a fiat from the Attorney-General to allow litigation was blocked when Reece indicated that irrespective of the litigation, retrospective legislation would be passed to validate construction. The Attorney-General resigned on principle, Reece took over his portfolio and introduced *The Removal of Doubts Bill 1972* (Lowe 1984: 42).

The third tactic taken by the environmentalists proved more successful. Tasmanian members of the national conservation body, the Australian Conservation Foundation (ACF) had been unable to convince the national body to lobby the federal government to intervene and therefore orchestrated a 'palace coup' (Green 1984: 61). With more militant environmentalists at the helm, the ACF lobbied the Federal government to intervene. Gough Whitlam's Labor Party won office in December 1972 and although the new Prime Minister was personally against intervention, his Minister for the Environment, Moss Cass, visited the Lake and met with the Premier. Reece threatened to lead Tasmania out of the Commonwealth if the Federal government meddled in the State's internal affairs. The Federal government set up a House of Representatives Select Committee of Inquiry to investigate the matter. The Tasmanian Premier was furious and instructed his departments to adopt a policy of non-cooperation (Green 1984 24). In its final report, the Senate Committee was extremely critical of both the secrecy with which the destruction of Lake Pedder had been planned and of the HEC's planning methodology, and recommended the use of standard project appraisal methods in future (Lake Pedder Committee of Enquiry 1974: 250-1). The Committee considered that Lake Pedder ought to be saved, called for a moratorium on construction while an agreement was reached, and recommended that the Commonwealth meet the costs of altering the scheme to save the Lake. The HEC reassessed the costs of altering the scheme to $55 million and the Commonwealth offered the Tasmanian government up to $47 million. Reece rejected the offer out of hand (Lowe 1984: 44) and environmentalists could do nothing but watch and lament as their 'temple was ransacked' (Kiernan 1990).

References

Allbut G (1958) *A Brief History of Some of the Features of Public Electricity Supply in Australia and the Formation and Development of the Electricity Supply Association of Australia 1918-1957*. The Electricity Supply Association of Australia, Melbourne, Victoria.

Australian Bureau of Statistics (1967) *Tasmanian Year Book*, No. 1. Australian Bureau of Statistics, Tasmanian Office, Hobart.

Batt N (1972) Realms of Political Choice. *In* Jones R (ed.) *Damania: The Hydro-Electric Commission, the Environment and Government in Tasmania*. Fullers Bookshop, Hobart, Tasmania; pp. 56-71.

Blainey G (1954) *The Peaks of Lyell*. Melbourne University Press, Carlton, Victoria.

Bound M (1961) *The Consequences of Monopoly Growth in Tasmania*. Communist Party of Australia, Tasmanian Branch, Hobart, Tasmania.

Brown H P (1960) Giblin and the Grants Commission. *In* Copland D (ed.) *Giblin: The Scholar and the Man: Papers in Memory of Lyndhurst Faulkner Giblin*. F.W. Chesire, Melbourne, Victoria: 49-55.

Campbell F H (1916) Tasmanian Hydro-Electric Power and Chemical Industry. *Proceedings of the Society of Chemical Industry of Victoria* **9**: 419-429.

Castles G (1986) *Handcuffed Volunteers: A History of the Scenery Preservation Board 1915-1921*. Unpublished Honours thesis, University of Tasmania. Sandy Bay, Tasmania.

Cooper I G (1979) *Trolley Buses of Tasmania*. Australian Electric Traction Association, Melbourne, Victoria.

Dallas K M (1960) Water Power in Tasmania. *Papers and Proceedings of the Tasmanian Historical Research Association* **8**, 4: 85-93.

Davidson B (1972) Wilderness Conservation and the Generation of Electric Power in Tasmania. *In* Jones R (ed.) *Damania: The Hydro-Electric Commission, The Environment & Government*. Fullers Bookshop, Hobart, Tasmania: 72-8.

Davis B W (1972) Waterpower and Wilderness: Political and Administrative Aspects of the Lake Pedder Controversy. *Public Administration* **31**, 4: 21-42.

Davis B W (1974) Waterpower and Wilderness: Political and Administrative Aspects of the Lake Pedder Controversy. *In* Dempsey R (ed.) *The Politics of Finding Out*. Chesire, Melbourne: 42-61.

Davis B (1980) The Struggle for South-West Tasmania. *In* Scott R (ed.) *Interest Groups and Public Policy.* Allen & Unwin, Melbourne; Chapt. 7: 152-69.

Davis B (1990) Autonomous versus Controlled Public Enterprise: Training Tasmania's Hydro-Electric Juggernaut. *In* Kouzmin A & Scott N (eds) *Dynamics in Australian Public Management: Selected Essays.* Macmillan, Melbourne; Chapt. 7: 94-101.

Davis B (1995) Adapation and Degregulation in Government Business Enterprise: The Hydro-Electric Commission of Tasmania 1945-1994. *Australian Journal of Public Administration* **54**, 2: 251-61.

du Cross H (1994) History. *In* Harries D N (ed) *Forgotten Wilderness: North West Tasmania,* 2nd revised edn. Tasmanian Conservation Trust, Hobart, Tasmania; Chapt. 2: 6-24.

Fagan RH (1971) Government Policy and the Mining and Metalliferous Mining and Processing Industries. *In* Linge G J & Rimmer P J (eds) *Government Influence and the Location of Economic Activity*. Residential School of Pacific Studies, Australian National University, Canberra, Australian Capital Territory; Chapt. 10: 191-231.

Farrell H (1957) New Zealand Water Power: Present-Day Problems and Development. *The Geographical Review* **XLVII**, No 2: 194-210

Field G L & Higley J (1980) *Elitism.* Routledge & Kegan Paul, London.

Garvie R M (1962) *A Million Horses: Tasmania's Power in the Mountains*. Hydro-Electric Commission, Hobart.

Gillies A J (1984) *Tasmania's Struggle for Power.* Michael Francis & Christine Anne Lillas, Burnie, Tasmania.

Grant M S (1978) The South-West Committee. *In* Gee H & Fenton J (eds) *The South West Book: A Tasmanian Wilderness*. Australian Conservation Foundation, Melbourne: 251-2.

Green F C (1959) Hydro-Electric Development in Tasmania. *Papers and Proceedings of the Tasmanian Historical Research Association* **8**, 1: 3-11.

Green R (1984) *Battle for the Franklin River.* Fontana Books and the Australian Conservation Foundation, Melbourne, Victoria.

Harris S (1993) *Selling Tasmania: Boosterism and the Creation of the Tourist State 1912-1928.* Unpublished Ph.D., University of Tasmania, Sandy Bay, Tasmania.

Hean B (1972) Some Statistics Relating to the Notion of "Cheap Power" in Tasmania. *In* Jones R (ed.) *Damania: The Hydro-Electric Commission, the Environment and Government in Tasmania.* Fullers Bookshop, Hobart, Tasmania: 102-108.

Huëding V (1992) Hydro Power Development in Norway. *Hydro Power Development* 1, 1: 1-23.

Hydro-Electric Commission (1971) *Report of the Gordon River Power Development*. Hydro-Electric Commission, Hobart, Tasmania.

Hydro-Electric Department (1915) *Report for the Year 1914-15.* Hydro-Electric Department, Hobart, Tasmania.

Hydro-Electric Department (1916) *Report for the Year 1915-16.* Hydro-Electric Department, Hobart, Tasmania.

Hydro-Electric Department (1925) *The Hydro-Electric Power of Tasmania*. Tait Publishing, Melbourne, Victoria.

Hydro-Electric Commission (1968) *Report for the Year 1967-68.* Hydro-Electric Commission, Hobart, Tasmania.

Hytten T (1960) Giblin as an Economist. *In* Copland D (ed.) *Giblin: The Scholar and the Man: Papers in Memory of Lyndhurst Faulkner Giblin.* F.W. Chesire, Melbourne, Victoria: 153-63.

Jetson T (1989) *A History of the Central Plateau.* Pelion Press, Launceston, Tasmania.

Johnson D (1972) *Lake Pedder: Why a National Park Must be Saved.* Lake Pedder Action Committees of Victoria and Tasmania, and the Australian Union of Students.

Kayser H W (1892) *Mt Bishoff.* Australian Association for the Advancement of Science, Hobart.

Kellow A J (1996) *Transforming Power: The Politics of Electricity Planning.* Cambridge University Press, Cambridge, England

Kiernan K (1990) I Saw My Temple Ransacked. *In* Pybus C & Flanagan R (eds) *The Rest of the World is Watching: Tasmania and the Greens.* Macmillan, Chippendale, New South Wales: 20-33.

Knight A W , Benjamin A H & Colebach G T (1962) *The Development of Hydro-Electric Power in Tasmania*. Paper presented at the Sixth world Power Conference, Melbourne, Paper No. 65111.12/2: 20-27.

Lake Pedder Committee of Enquiry (1974) *The Future of Lake Pedder.* Australian Government Publishing Service, Canberra, Australian Capital Territory.

Lilienthal D E (1944) *Tennesee Valley Authority: Democracy on the March.* Harper & Brothers, New York, New York.

Lowe D (1984) *The Price of Power.* Macmillan, South Melbourne, Victoria.

Male D (1993) Power Cost: Vital Factor for Comalco and the HEC. *The Mercury* 13 April 1993: 21.

Marcus M G (1986) Environmental Policies in the United States. *In* Park C C (ed.) *Environmental Policies: an International Review.* Croom Held, London; Chapt. 2: 45-75.

McColl G D (1976) *The Economics of Electricity Supply in Australia.* Melbourne University Press, Carlton, Victoria.

McKenry K (1972) A Hstory and Critical Analysis of the Controversy Concerning the Gordon River Power Scheme. *In* Australian Conservation Foundation (1972) *Anatomy of a Decision.* ACF, Parkville, Victoria: 9-30.

Murray P (1974) *Energy Australia.* J & D Burrows, Blackburn, Victoria.

Myllyntaus T (1991) The Transfer of Electrical Technology to Finland, 1870-1930. *Technology & Culture* **32**, 2: 293-317.

Nye D E (1990) *Electrifying America: Social Meanings of New Technology, 1880-1940*. The MIT Press, Cambridge, Massachusetts.

O'Brien E (1994) Two Years Hard Labour: Post War Immigrants with the Hydro-Electric Commission. *Papers and Proceedings of the Tasmanian Historical Research Association* 41, 1: 9-27.

Øystein N (1986) Energy Policy and Prospects in Norway. *Annual Review of Energy* **11**: 293-317.

Parliament of Tasmania (1914) Hydro-Electric Power and Metallurgical Co. Ltd, Great Lake, Tasmania. *Papers and Proceedings of the Parliament of Tasmania* **LXX1**, No. 9.

Rackham S (1981) *Hydro-Construction Villages: Vol. 1: Waddamana, Shanon, Tarraleah.* Hydro-Electric Commission, Hobart, Tasmania.

Rackham S (1982) *Hydro-Construction Villages: Vol. 2: Butlers Gorge, Bronte Park, Trevallyn. Wayatinah.* Hydro-Electric Commission, Hobart, Tasmania.

Read P C (1986) *The Organization of Electricity Supply in Tasmania.* The University of Tasmania, Sandy Bay, Tasmania.

Saddler H (1981) *Energy in Australia: Politics and Economics.* George Allen and Unwin Australia, Sydney, New South Wales.

Sanders N (1980) *A Time to Care.* Chris Bell, Blackman's Bay, Tasmania.

Smith D I & Handmer J (1991) Water Conflict and Resolution: A Case Study of Dams in Southwest Tasmania. *In* Handmer J W, Dorcey A H & Smith D I (eds) *Negotiating Water: Conflict Resolution in Australian Water Management.* Centre for Resource and Environmental Studies, Australian National University, Canberra, Australian Capital Territory.

Sporn P (1950) *The Integrated Power System as the Basic Mechanism for Power Supply.* McGraw-Hill, New York, New York.

State Electricity Commission of Victoria & Hydro-Electric Commission of Tasmania (1992) *Basslink Feasibility Study: Environmental and Social Issues.* State Electricity Commission of Victoria, Melbourne, Victoria, and Hydro-Electric Commission of Tasmania, Hobart, Tasmania.

Stewart M (1991) *Keynes and After,* 3rd edn. Penguin, Harmondsworth, England.

Taylor H J (1993) *Shannon Rise Revisited: A Story of Tasmanian Angling Folklore.* Blubberhead Press, Sandy Bay, Tasmania.

Tighe P J (1992) Hydroindustrialisation and Conservation Policy in Tasmania. *In* Walker K J (ed.) *Australian Environmental Policy: Ten Case Studies.* New South Wales University Press, Kensington, New South Wales; Chapter 7: 124-155.

Townsley W A (1994) *Tasmania: Microcosm of the Federation or Vassal State, 1945-1983.* St David's Park Publishing, Hobart. Tasmania.

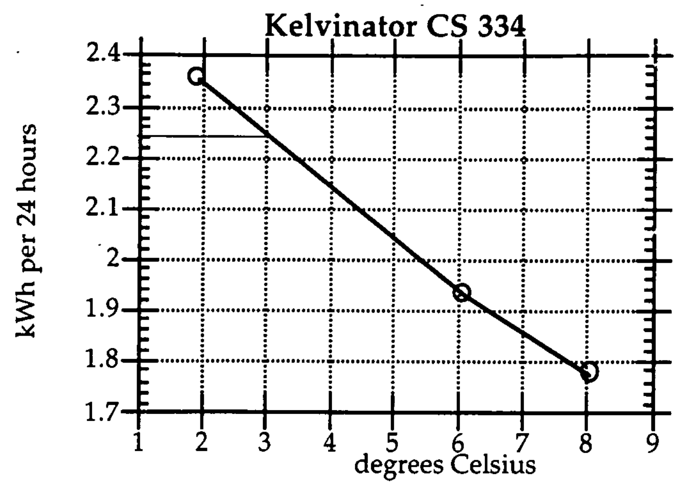
Wilde P D (1978) The Environment, Growth Projections and Hydro-Electricity in Tasmania's South-West. *In* Gee H & Fenton J (eds) *The South West Book: A Tasmanian Wilderness.* Australian Conservation Foundation, Melbourne: 205-225.

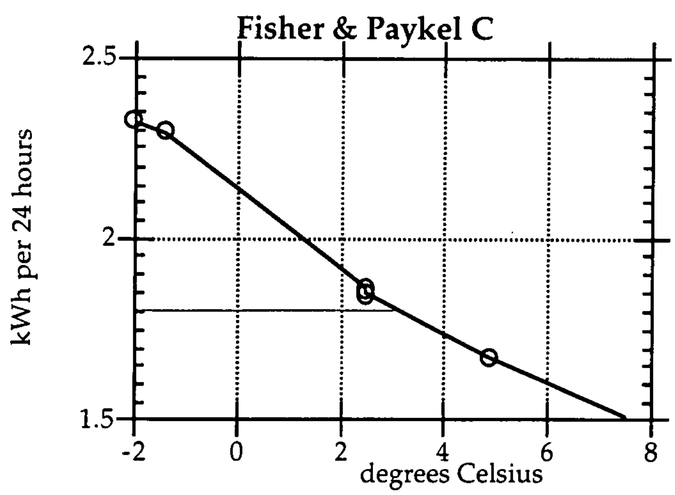
APPENDIX II

The Calculation of Refrigerator Energy Consumption at an Average Compartment Temperature of 3 ^{0}C.

Energy consumption per 24 hours for an average refrigeration compartment temperature of 3 ^{0}C was found at each ambient temperature by setting the refrigerator's thermostat at its mid-point, measuring the energy consumed and calculating the average compartment temperature. The thermostat setting was then adjusted up or down depending on whether the calculated average compartment temperature in the first test was higher or lower than 3 ^{0}C and energy consumption and average compartment temperature re-determined. This was process was continued so that energy consumption per 24 hours was found for a range of average compartment temperatures at a particular ambient temperature. The two average compartment temperatures closest to 3 ^{0}C were then used to interpolate (or extrapolate if one of the average temperature readings was sufficiently close to 3 ^{0}C) from this data to find the energy consumption at an average compartment temperature of 3 ^{0}C at the particular ambient setting. This information is presented in Figures 1 to 4 for the Kelvinator CS 334, the Fisher & Paykel C 190 and the Gram LER 200.

Figure 1 Average refrigerator compartment temparature and energy consumption at two settings of the refrigerator thermostat and an ambient test temperature of 43 ^{0}C used to calculate energy consumption at an average compartment temperature of 3 ^{0}C.





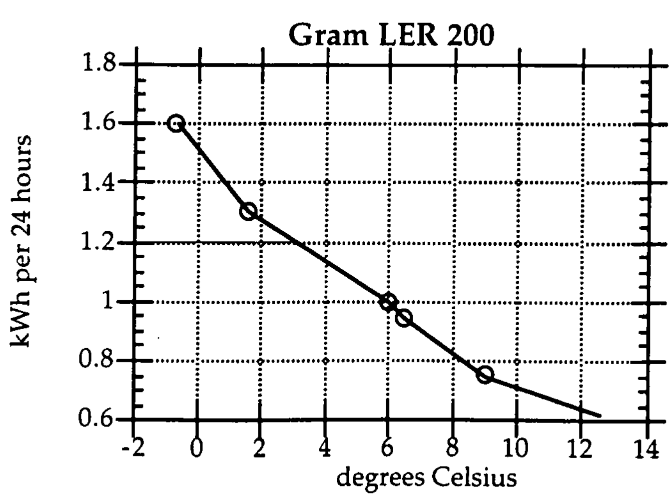
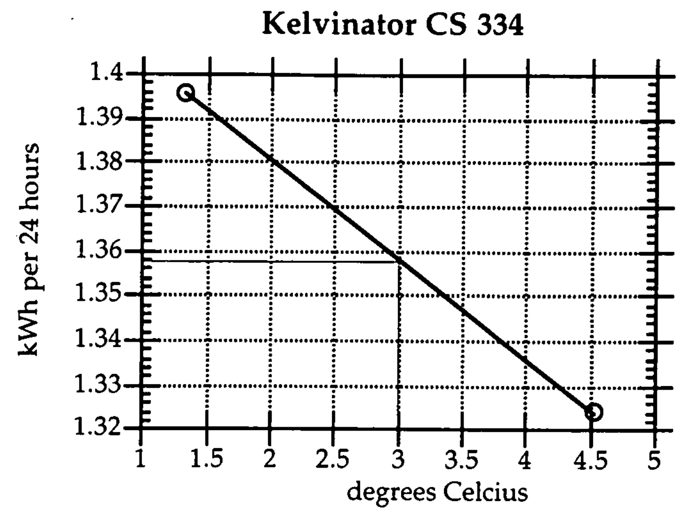
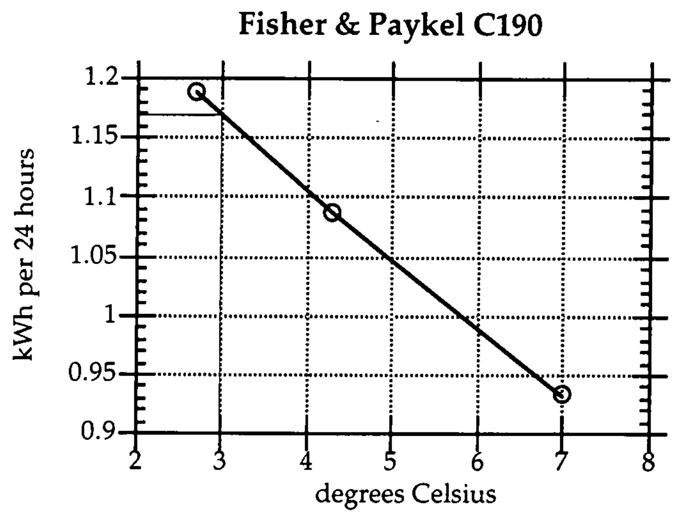


Figure 2 Average refrigerator compartment temparature and energy consumption at two settings of the refrigerator thermostat and an ambient test temperature of 32 ^{0}C used to calculate energy consumption at an average compartment temperature of 3 ^{0}C.





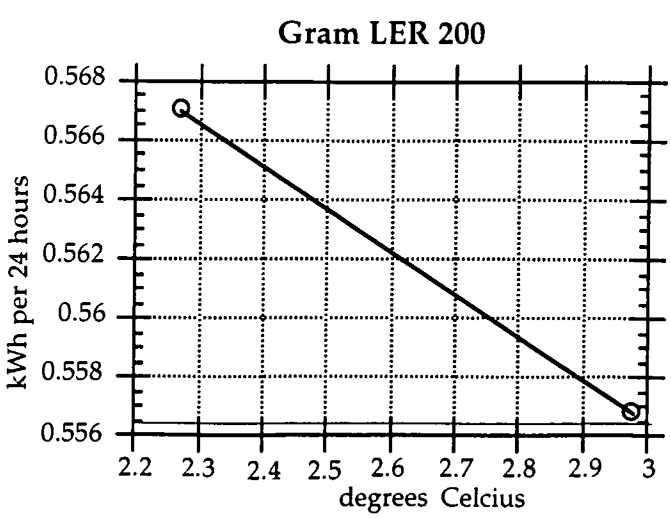
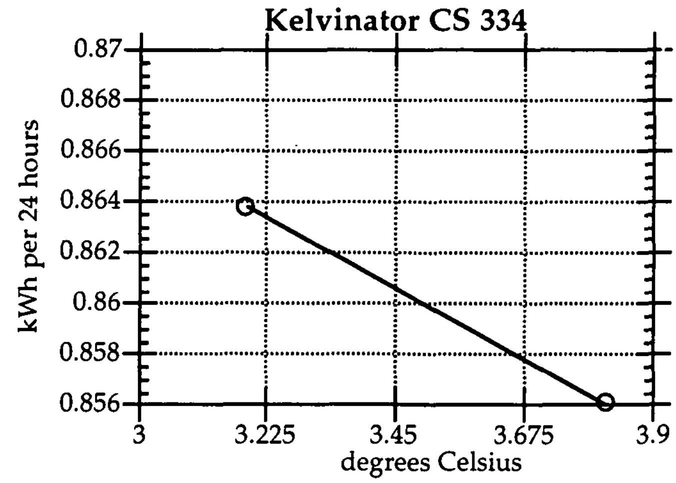
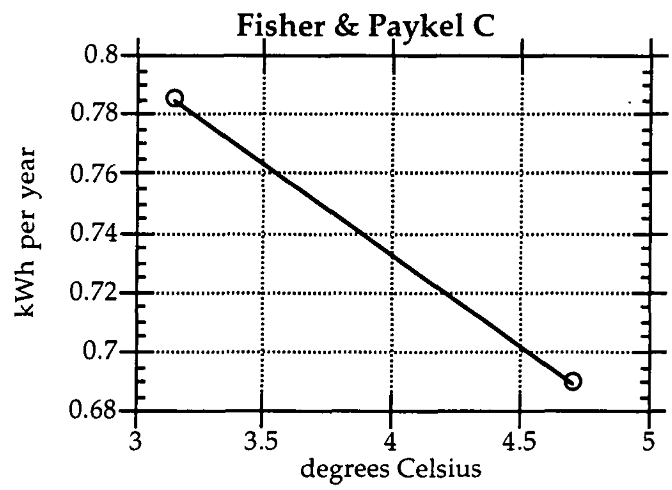


Figure 3 Average refrigerator compartment temparature and energy consumption at two settings of the refrigerator thermostat and an ambient test temperature of 21 ^{0}C used to calculate energy consumption at an average compartment temperature of 3 ^{0}C.





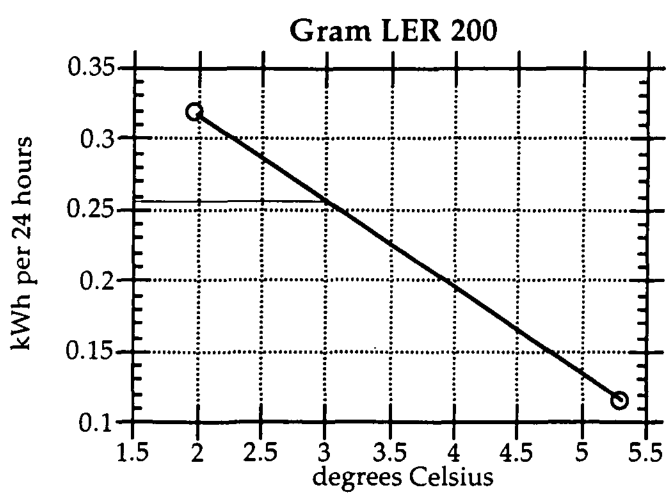
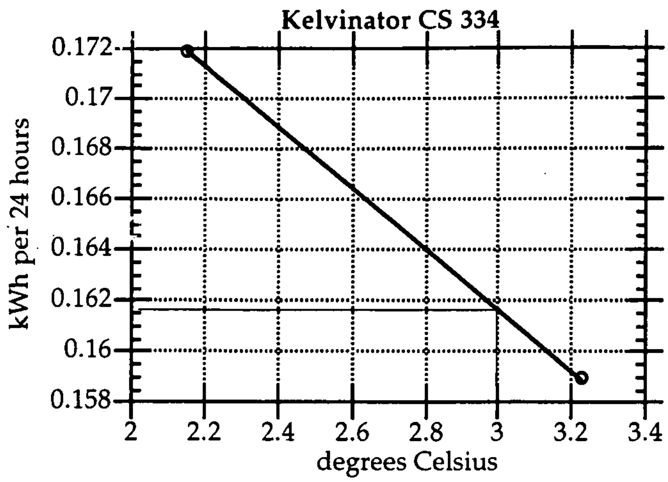
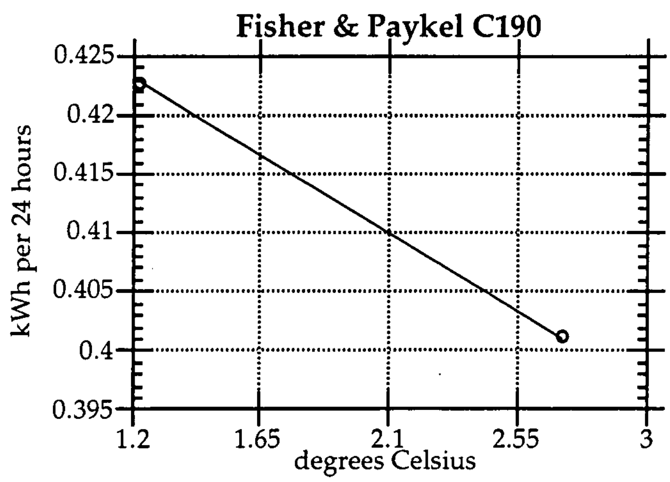
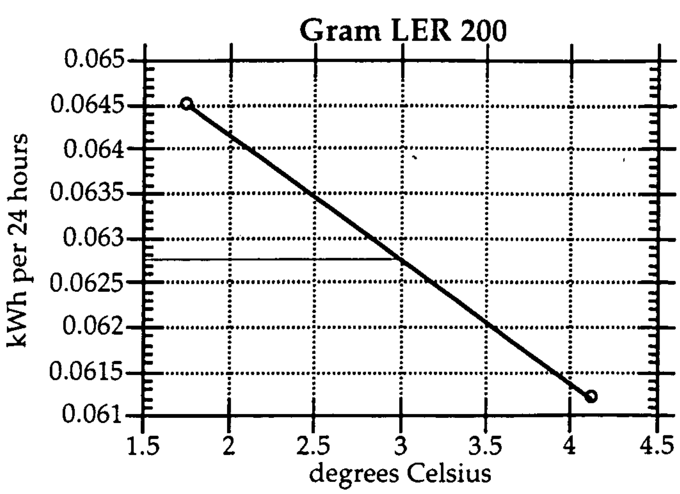


Figure 4 Average refrigerator compartment temparature and energy consumption at two settings of the refrigerator thermostat and an ambient test temperature of 10 ^{0}C used to calculate energy consumption at an average compartment temperature of 3 ^{0}C.

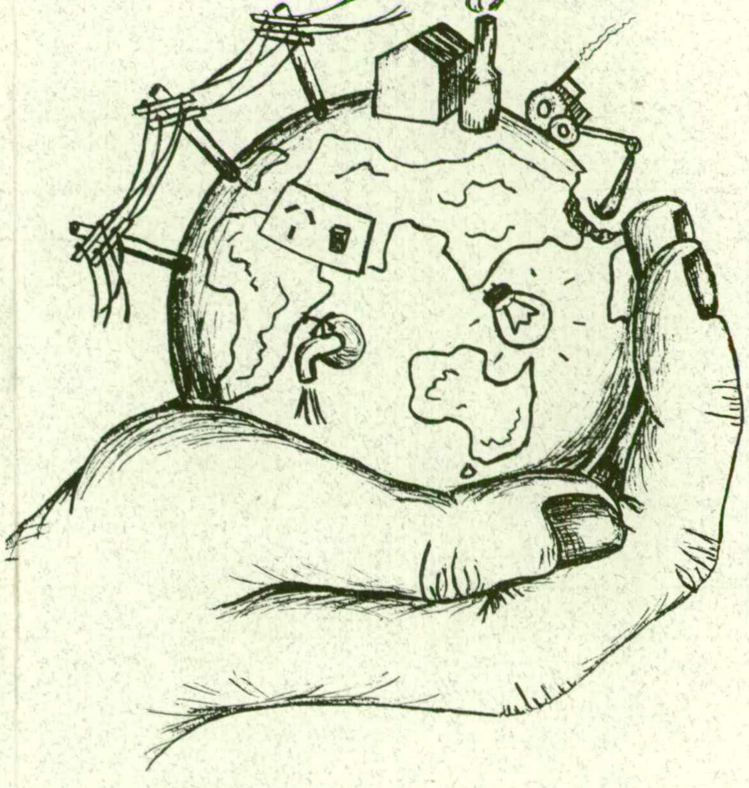






BY SAVING ENERGY IN YOUR HOME

THE UNIVERSITY OF TASMANIA LIBRARY



YOU CAN HELP TO SAVE THIS PLANET

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Further information

For further information on reducing your energy bills, contact one of the following officers:

City of Brunswick Electricity Supply Department
Main Office
209-213 Stewart Street,
East Brunswick 3057
Phone: 389 4100

Branch Office
386-370 Sydney Road,
Brunswick 3056

Energy Information Centre
139 Flinders Street,
Melbourne 3000
Phone: 650 1195

Gas and Fuel Corporation
171 Flinders Street,
MELBOURNE 3000
Phone: 652 5122

Home Energy Advisory Service
27 Ellingworth Parade,
Box Hill 3128
Phone: 890 1771
(Available to low income households on a once-only basis)

Questo volantino tratta di come risparmiare soldi riducendo il consumo dell'energia (elettricità, gas) che si adopera in casa. Meno elettricità e gas si consuma, più basse saranno le bollette da pagare e più saranno i soldi da poter spendere in altre cose. Questo non significa dover rinunciare a qualcosa. Il volantino mostra come una tipica famiglia può ridurre il consumo dell'energia (fino ad un terzo) usando elettrodomestici più efficienti, soffitti isolati, ecc. Sul rovescio vi è una lista di controllo di simili provvedimenti per il risparmio dell'energia.

Το φυλλάδιο αυτό αναφέρεται στο πώς μπορούμε να σας βοηθήσομε να προστατεύετε το περιβάλλον, χρησιμοποιώντας λιγότερη ενέργεια (ηλεκτρικό ρεύμα, αέριο) στα σπίτια σας. Αν χρησιμοποιούμε λιγότερη ενέργεια σημαίνει ότι το περιβάλλον μας λερώνεται λιγότερο. Αυτό δεν σημαίνει ότι χρειάζεται να διακόψετε ο,τιδήποτε. Το φυλλάδιο δείχνει πώς μια συνηθισμένη οικογένεια μπορεί να μειώσει την ποσότητα της ενέργειας που καταναλώνει (μέχρι κατά το ένα τρίτο) χρησιμοποιώντας πιο αποδοτικές συσκευές, απομονώνοντας σκεπές κλπ. Στο πίσω μέρος έχομε ένα πίνακα τέτοιων μέτρων που εξοικονομούν ενέργεια.

ان هذه النشرة تتعلق ببيئتنا وكيف لنا المساعدة على حمايتها عبر استهلاك الطاقة بنسبة أقل في بيوتنا. اطلب من صديق أن يشرحها لك أو الاتصال بدائرة الكهرباء في برانزويك، 209-213 Stewart St., East Brunswick.

Quyển sách nhỏ này nói về môi trường và làm cách nào chúng ta có thể giúp bảo vệ nó bằng cách sử dụng ít năng lượng trong nhà. Hãy nhờ một người bạn giải thích nó cho quý vị, hay liên lạc *Sở Điện Lực Brunswick* (Brunswick Electricity), 209–213 Stewart St., East Brunswick.

Bu broşür çevremizle ilgili olup evlerimizde daha ez enerji kullanarak onu korumakta nasıl yardımcı olabileceğimizle ilgilidir. Bunu size bir arkadaşınızın anlatmasını isteyiniz veya 209-213 Stewart St., East Brunswick adresindeki Brunswick Elektrik İdaresine başvurunuz.

Energy and the environment

There are many adverse environmental effects of using energy in our homes - both local and global! The more electricity we use to heat our houses and run our appliances, the more coal we burn in our power stations and the more 'Greenhouse' gases and other pollutants we put into our atmosphere. Burning gas, oil, or wood adds carbon dioxide and other pollutants to the atmosphere. However, we can decrease these impacts on our environment if we use energy efficiently and wisely.

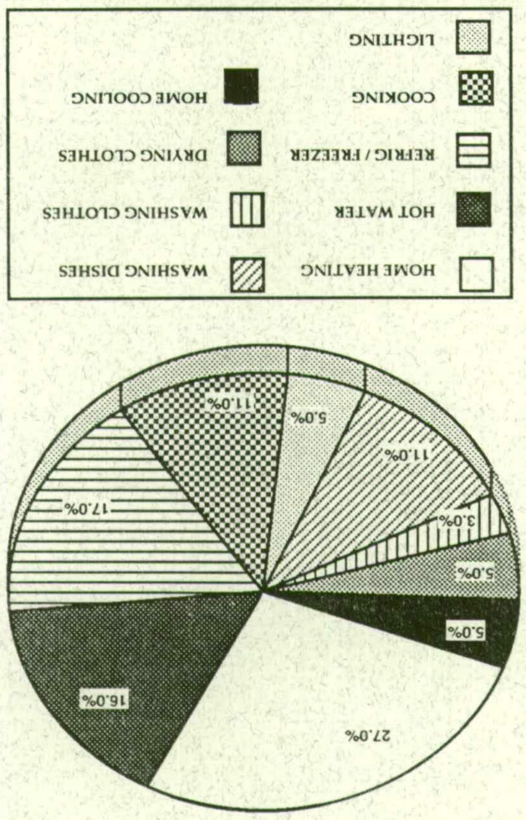
This leaflet is designed to show you how you can use less energy in your home and help protect our environment while still having a comfortable home and enjoying the same standards of living as you do now. On the inside of this leaflet is a checklist of energy saving measures. Some of these, such as turning off lights in empty rooms, take little effort but nonetheless save significant amounts of energy. Other measures, such as insulating your home, take more effort but can result in very large energy savings. Together, these measures can reduce the amount of energy you use in your home each year by up to one third. And if we all did that, we would burn a lot less coal each year in our power stations, we would put less pollutants into the atmosphere and we would all be better off.

If we save energy we put less pollutants into the atmosphere, there is less environmental damage caused by mining and petroleum extraction, and our limited resources of fossil fuels will last longer.

This leaflet has been produced as part of a research project run by RMIT, University of Tasmania, City of Brunswick, and University of Adelaide with support from the National Energy Research Development and Demonstration Programme.

How do we use energy in our homes?

The typical household in Victoria uses about 90 MJ of energy per year, the equivalent of about 3 tonnes of coal. To generate and supply this energy requires about 10 tonnes of coal for each household. The breakdown of how we use this energy is shown below:



By following the energy saving measures on the inside of this leaflet, you can save a lot of energy. This does not mean any reduction in your standard of living. And if your friends and neighbours reduce their energy use as well, we can really start to improve our environment.

Energy labels help you save energy

One way of saving a lot of energy in your home is by looking for appliances that use less energy when buying a new one.

Electric appliances ~ "energy rating label"

The more stars in the red band the more energy efficient the appliance and the less damage to the environment.

Gas appliances ~ "gas energy label"

The Gas Energy Label identifies those appliances which are 20%, 30%, or 40% more efficient than the standard required by the Australian Gas Association. Buying a highly efficient unit means that you will reduce pollution and help preserve our environment.

See the dollar saving checklist inside

THREE STAGES TO SAVING OUR ENVIRONMENT BY SAVING ENERGY

By following the steps below, the typical household can reduce its impact on our environment by minimising its energy consumption.

Typical share of energy consumption	STAGE 1 Significant energy saving measures	STAGE 2 High energy saving measures	STAGE 3 Very high energy saving measures
(A) Heating your home 27%	☐Wear warmer clothing instead of extra heating. ☐Keep doors to unused rooms closed.	☐Close off unused fireplaces. ☐Build pelmets over windows to enclose curtains. ☐Make sure curtains are close fitting. ☐Install ceiling fan(s).	☐Turn down heater thermostat (to between 18°C and 22°C). ☐Insulate your ceiling - particularly above living areas. ☐Invest in new, efficient heating system - efficient gas or wood heaters - efficient heat pumps - efficient off-peak heaters
(B) Hot water 16%	☐Insulate exposed hot water pipes. ☐If no one is going to be in the house for over three days, turn off the hot water system.	☐Take 3 minute showers instead of baths. ☐Fix dripping hot water taps. ☐Replace shower head with "flow control" head. ☐Add extra insulation around your hot water tank.	☐Turn down the thermostat on your hot water cylinder (55 to 65°C).. ☐Connect solar panel to hot water system. ☐Replace your old hot water system with a new, efficient "off-peak" or "New Dimension" system.
(C) Cooling and freezing food 17%	☐Ensure that there is at least an 8 mm gap between the condensor coils and the wall. ☐Locate the fridge/freezer in a position that is not too hot. ☐Do not overfill or underfill fridge. ☐Ensure liquids kept in fridge/freezer are covered. ☐Allow warm foods to cool before refrigerating	☐Clean the condensor coils at least once every two months. ☐For manual defrost, defrost before ice build up exceeds 6 mm.	☐Turn off the garage/bar fridge until you really need it. ☐Trade in your old fridge/freezer on a new, highly efficient model. • If buying a new fridge/freezer: - do not buy one larger than you need. - look for the energy efficient label. The more stars, the more efficient it is and the less power it uses.
(D) Cooking food 11%	☐When using the oven, cook several dishes at once. ☐Open the oven door as little as possible. ☐Thaw frozen foods completely before cooking. ☐Only preheat oven if absolutely necessary. ☐Simmer food instead of continuously boiling.	☐Use small, efficient appliances (such as electric frying pans, pressure cookers, ☐Buy twin/triple saucepan sets with tight fitting lids. ☐Use minimum water in saucepans. ☐Ensure the size of the saucepan matches the size of the hot plate.	☐Consider buying a microwave oven. They can cook a meal using much less energy. ☐If buying a new electric or gas oven, look for the energy rating label. Efficient, fan-forced ovens use up to 35% less energy. ☐Eat more salads and fruit and less cooked foods.
(E) Lighting 5%	☐Turn lights off if the room is unoccupied [for fluorescent lights it is worth turning off if no one is in the room for more than 10 mins.].	☐Replace high wattage globes with lower wattage globes unless bright lighting is needed. ☐Turn off flood lighting/security lighting unless it is needed.	☐Invest in compact fluorescent globes which fit normal bayonet light sockets. They use 20% of the power of normal incandescent globes.
(F) Dish-washing 11%	☐Use the dishwasher only when full.	☐When buying a new dishwasher, look for the energy rating label.	☐Use only cold water if possible. ☐Use "economy" cycle.
(G) Washing clothes 3%	☐Do not overload the machine. ☐Do not underload the machine - wait until you have a full load.	☐If purchasing a new washing machine, look for the most efficient model. Machines that do not heat their own water and are front loading, use less energy.	☐Use cold water washes and rinses with a detergent suited to cold water. ☐Use hot/warm washes only when absolutely necessary.
(H) Drying clothes 5%	☐If drying more than one load, use in quick succession to save heat.	☐Keep the lint filter of clothes dryer clean. ☐Pre-spin clothes in the washing machine.	☐Use the clothes line - solar energy is non-polluting. ☐ Use clothes dryers only if absolutely necessary.
(I) Cooling your home 5%	☐Use appliances such as dishwashers in the morning rather than during the day on hot days.	☐If buying an air conditioner, look for the energy rating label. Do not buy a unit larger than you need.	☐Use windows and doors to ventilate rather than the air conditioner whenever possible. ☐Raise the thermostat setting of your air-conditioner (24°C - 27°C). ☐Insulate your ceiling. ☐Shade northern windows on hot days.
Other sugg-estions	☐Heaters for fish aquariums use a lot of energy - about as much as small refrigerator. ☐Think twice before installing/using a spa bath - they can use very large amounts of energy! ☐Install solar heating if you have a swimming pool.	☐Watching 5 hours of TV/video per night uses half as much power as your refrigerator. ☐If you have an "instant on" TV set, turn it off at the wall otherwise it continues to use power warming the tube.	☐Water beds can use as much energy as your hot water system. ☐Heated towel rails use about as much energy as a refrigerator. Only use it if you have to. ☐Turn off the timer on the swimming pool filter in winter and filter only as necessary.

KEEP THIS CHECKLIST ON YOUR WALL - TICK OFF ENERGY SAVING MEASURES AS YOU COMPLETE THEM.

Ο πιο πάνω πίνακας δείχνει μερικούς απ' τους διαφορετικούς τρόπους που μπορούμε να μειώσομε την ποσότητα της ενέργειας (ηλεκτρικού ρεύματος, αερίου) που χρησιμοποιούμε στο σπίτι μας. Όσο λιγότερη ενέργεια χρησιμοποιούμε τόσο περισσότερο βοηθούμε να προστατευθεί το περιβάλλον μας. Τα μέτρα αυτά διατήρησης του περιβάλλοντος διαφέρουν αναφορικά με την ποσότητα της ενέργειας που εξοικονομούν και κατά το επίπεδο μέτρων που χρειάζεται να λάβετε. Αν έχετε κάποιο φίλο που μπορεί να σας μεταφράσει τον πίνακα, ζητείστε-του να σας τον εξηγήσει. Ή πάλι ζητείστε τα φυλλάδια για διαφύλαξη ενέργειας, γραμμένα στα Ελληνικά, απ' το τμήμα Ηλεκτρισμού, 209-213 Stewart St, East Brunswick.

La lista di controllo di cui sopra illustra alcuni dei diversi modi di ridurre il consumo dell'energia (elettricità, gas) che si adopera a casa. Meno energia noi consumiano, più contribuiamo alla protezione del nostro ambiente. Queste misure per la conservazione della energia variano a seconda della quantità di energia che esse possono risparmiare e del livello dell'impegno che esse richiedono. Se hai un amico in grado di tradurre la lista di controllo, chiedi a lui di spiegartela. Oppure procurati l'opuscolo per la conservazione della energia scritto in italiano dal Brunswick Electricity, 209-213 Stewart St., East Brunswick.

Questo volantino tratta di come possiamo aiutare a proteggere il nostro ambiente consumando meno energia (elettricità, gas) nelle nostre case. Usare meno energia significa inquinare di meno l'ambiente. E tanto non significa dover rinunciare a qualcosa! Il volantino mostra come una tipica famiglia può ridurre il consumo della energia (fino ad un terzo) usando elettrodomestici più efficienti, soffitti isolati, ecc. Sul rovescio vi è una lista di controllo di simili provvedimenti per il risparmio dell'energia.

Το φυλλάδιο αυτό αναφέρεται σε τρόπους να εξοικονομήσετε χρήματα, μειώνοντας την ποσότητα της ενέργειας (ηλεκτρισμού, αερίου) που χρησιμοποιείτε στο σπίτι σας. Όσο λιγότερο ηλεκτρικό ρεύμα και αέριο χρησιμοποιείτε τόσο πιο χαμηλοί είναι οι λογαριασμοί σας και πιο πολλά τα χρήματα που μπορείτε να ξοδέψετε σ' άλλα πράγματα. Αυτό δεν σημαίνει ότι χρειάζεται να διακόψετε ο,τιδήποτε. Το φυλλάδιο δείχνει πώς μια συνηθισμένη οικογένεια μπορεί να μειώσει την ποσότητα της ενέργειας που καταναλώνει (μέχρι κατά το ένα τρίτο), χρησιμοποιώντας πιο αποδοτικές συσκευές, απομονώνοντας σκεπές κλπ. Στο πίσω μέρος έχομε ένα πίνακα τέτοιων μέτρων που εξοικονομούν ενέργεια.

تشرح هذه النشرة أساليب توفير النقود من خلال استعمال الطاقة بنسبة أقل في بيتك. اطلب من صديق أن يشرحها لك أو الاتصال بدائرة الكهرباء في برانزويك، 209–213 Stewart St., East Brunswick.

Quyển sách nhỏ này giải thích những cách tiết kiệm tiền bạc bằng cách sử dụng ít năng lượng trong nhà của quý vị. Hãy nhờ một người bạn giải thích nó cho quý vị, hay liên lạc *Sở Điện Lực Brunswick* (Brunswick Electricity), 209–213 Stewart St., East Brunswick.

Bu broşür evinizde daha az enerji kullanarak paradan tasarruf yollarını anlatmaktadır. Bunu size bir arkadaşınızın izah etmesini isteyiniz veya 209-213 Stewart St., East Brunswick adresindeki Brunswick Elektrik İdaresine başvurunuz.

Further information

For further information on saving energy in your home contact one of the following

City of Brunswick Electricity Supply Department
Main Office
209-213 Stewart Street,
East Brunswick 3057
Phone: 389 4100

Branch Office
386-370 Sydney Road,
Brunswick 3056

Energy Information Centre
139 Flinders Street,
Melbourne 3000
Phone: 650 1195

Gas and Fuel Corporation
171 Flinders Street,
MELBOURNE 3000
Phone: 652 5122

Home Energy Advisory Service
27 Ellingworth Parade,
Box Hill 3128
Phone: 890 1771
(Available to low income households on a once-only basis)

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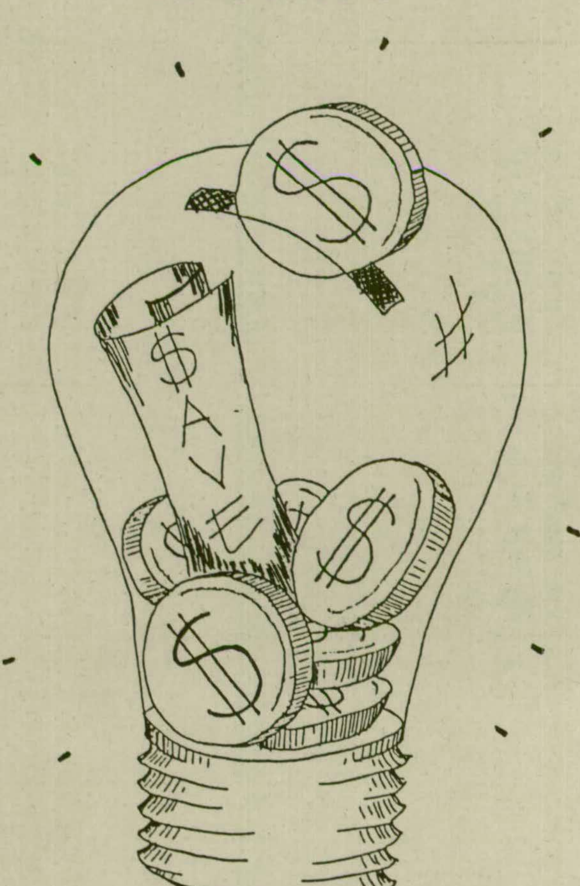
SAVE MONEY



by

SAVING ENERGY

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Saving your money by saving energy

Many of us are finding it harder and harder to make ends meet: food bills, clothing, the rent, the mortgage, the car, and so on, takes up most of our spare money. That is why it is important to save money on your energy bills - every dollar spent on energy in the home is a dollar less you can spend elsewhere.

This leaflet is designed to help you save money by reducing your energy bills while still having a comfortable home and enjoying the same standard of living. On the inside of this leaflet is a checklist of energy saving measures you can follow. Some measures, such as turning off lights, cost you nothing. Other measures, such as insulating your ceiling require you to spend money - but they can save you so much money (by reducing your energy bills) that they pay for themselves quickly - sometimes surprisingly quickly!

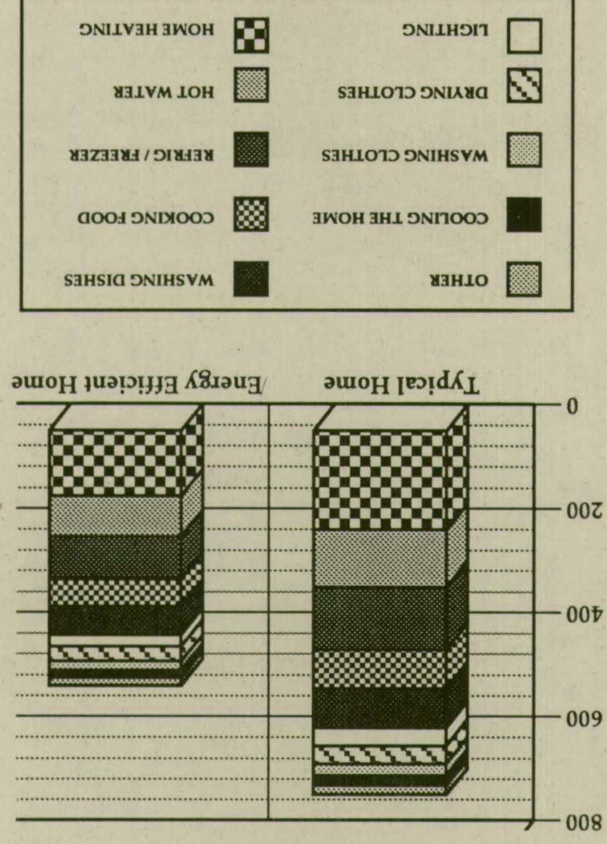
By following the energy saving measures on the checklist inside, you can save yourself a lot of money!

This leaflet has been produced as part of a research project run by RMIT, University of Tasmania, City of Brunswick, and University of Adelaide with support from the National Energy Research Development and Demonstration Programme.

Where do your energy dollars go?

The typical household has an annual energy bill of about $700. The breakdown of where this money goes is shown below:

Annual Household Energy Bill

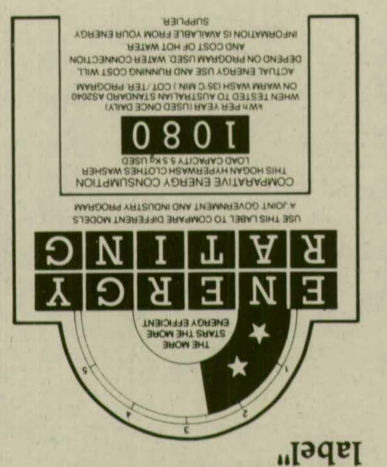


By following the dollar saving measures on the inside of this leaflet, your bill can be reduced by over 30%. That means a saving of over $210 per year - for a typical household.

Energy labels help to save your money

One way of saving yourself a lot of money on energy is by looking for appliances that are cheap to run when buying a new one. You can save yourself hundreds of dollars in running costs over the lifetime of the appliance.

Electric appliances ~ "energy rating label"



The more stars in the red band the more energy efficient the appliance and the more money you save!

Gas appliances ~ "gas energy label"

The Gas Energy Label identifies those appliances which are 20%, 30%, or 40% more efficient than the standard required by the Australian Gas Association. Buying a highly efficient unit means that you will save money on your energy bills!

See the energy saving checklist inside

$$ THREE STAGES TO SAVING DOLLARS BY SAVING ENERGY $$

By following the steps below, the typical household can reduce its annual energy bill from $700 to below $490.

Typical energy cost per year	STAGE 1 Minimal Investment - Minimal effort (investments repaid within one year)	STAGE 2 Moderate investment - moderate effort (investments repaid after more than one year)	STAGE 3 Higher Investment
(A) Heating your home $190	☐ Seal draughts around doors and windows ☐ Close off unused fireplaces ☐ Turn down heater thermostat (between 18°C and 22°C). ☐ Wear warmer clothing instead of extra heating. ☐ Keep doors to unused rooms closed.	☐ Build pelmets over windows to enclose. curtains ☐ Make sure curtains are close fitting. ☐ Install ceiling fan(s).	☐ Insulate your ceiling - particularly over living areas. ☐ Invest in a new efficient heating system - efficient gas orwood heaters - efficient heat pumps - efficient off-peak heaters
(B) Hot Water $110	☐ Turn down thermostat on hot water cylinder (55 to 65°C). ☐ Take 3 min. showers instead of baths. ☐ Fix dripping hot water taps. ☐ If no one is going to be in the house for over three days, turn off the hot water system	☐ Replace shower head with "flow control" head. ☐ Insulate exposed hot water pipes. ☐ Add extra insulation around hot water tank.	☐ Replace your hot water system with a new efficient, gas,"off-peak" or "New Dimension" electric hot water system. ☐ Connect solar panel to hot water system.
(C) Cooling and freezing food $120	☐ Ensure there is at least an 8 mm gap between rear of fridge/freezer and the wall. ☐ Locate fridge/freezer in position that is not too hot. ☐ Do not overfill or underfill fridge. ☐ Ensure liquids kept in fridge/freezer are covered. ☐ Let warm foods cool before refrigerating.	☐ Clean condensor coils (on back) at least once every two months. ☐ For manual defrost fridges, do not let ice build up to more than 6 mm before defrosting. ☐ Turn off the bar/garage fridge until you really need it.	☐ Trade in your old fridge/freezer on a new highly efficient model. *If buying a new fridge or freezer: - do not buy one bigger than you need; - look for the energy rating label. The more stars the less it will cost you to run.
(D) Cooking food $75	☐ When using the oven, cook several dishes at once. ☐ Open the oven door as little as possible. ☐ Thaw frozen foods completely before cooking.	☐ Use small, efficient appliances (such as electric frying pans, pressure cookers, toasters) instead of stoves. ☐ Buy twin or triple saucepan sets.	☐ Consider buying a microwave oven. They can be a very cheap way of cooking meals. ☐ If buying a new electric or gas oven, look for the energy rating label. Efficient, fan-forced
	☐ Only preheat oven if absolutely necessary. ☐ Simmer food instead of continuously boiling. ☐ Eat more salads and less cooked foods ☐ Use minimum water in saucepans.	☐ Use saucepans with tight fitting lids. ☐ Match the size of the saucepan to the hot plate.	ovens can cut your cooking costs by 35%.
(E) Lighting $35	☐ Turn lights off if the room is unoccupied. [For fluorescent lights it is worth turning off if no-one is in the room for more than 10 minutes.]	☐ Replace high wattage globes with lower wattage globes unless bright lighting is needed. ☐ Turn off flood lighting/security lighting unless it is needed.	☐ Invest in compact fluorescent globes which fit normal bayonet tight sockets. They cost more to buy but cost less to operate and last longer..
(F) Dish-washing $75	☐ Only use the dishwasher when it is full. ☐ Use "economy" cycle.	☐ Use only cold water if the hot water service is connected to day-rate electricity tariff.	☐ When buying a new dishwasher look for the energy rating label.
(G) Washing clothes $22	☐ Do not overload washing machine. ☐ Do not underload - wait until you have a full load.	☐ Use cold water washes and rinses with a detergent suited to cold water. ☐ Use hot water only when necessary. cheaper to operate.	☐ If purchasing a new washing machine look for the most efficient model. Machines that do <u>not</u> heat their own water and are front loading are
(H) Drying clothes $35	☐ Use the clothes line and free solar energy. ☐ Use clothes dryers only when absolutely necessary. ☐ Prespin clothes in the washing machine.	☐ Keep the clothes dryer lint filter clean. ☐ If drying more than one load, use in quick succession.	
(I) Cooling your home $20	☐ Use windows and doors to ventilate instead of using air conditioner. ☐ Raise the thermostat setting of the air-conditioner (24°C to 27°C).	☐ Shade northern windows and walls on hot days. ☐ Use appliances such as dishwashers in the morning rather than during the day.	☐ Insulate your ceiling. ☐ If buying an air conditioner - look for the energy rating label, and do not buy a larger air conditioner than you need.
(J) Other suggest-ions	☐ Water beds can cost you as much to run as your hot water system. Leaving water beds uncovered can double their running costs. ☐ Watching 5 hrs of TV/radio per day can cost you $60 per year	☐ Heated towel rails cost as much to run as a refrigerator. Do not use heated towel rails unless they are absolutely necessary. ☐ Turn off the timer on the swimming pool filter in winter and filter only as necessary.	☐ If you have an "instant-on" TV set, turn it off at the wall switch or else it continues to use power warming the tube. ☐ Aquarium heaters can cost as much to run as a small refrigerator. ☐ Think twice before installing a spa bath - they can cost you over $5 per week.

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La lista di controllo di cui sopra illustra alcuni modi diversi di ridurre il consumo dell'energia (elettricità, gas) che si adopera a casa. Meno energia si consuma, più soldi si risparmiano. Alcuni di questi provvedimenti per risparmiare energia sono semplici e non richiedono alcun investimento. Altri implicano spendere soldi, che però sono sorprendentemente recuperati con rapidità riducendo le bollette. Se hai un amico in grado di tradurre la lista di controllo, chiedi a lui di spiegartela.