Sustainable
Domestic Energy Use in North Queensland

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[1] Map of average January maximum temperatures. Comm. Aust. 1983

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Statement of Sources

Declaration

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....

Douglas Donald Goudie 23. 5.1995

“***Our future is technically feasible, and we hope that our authorities can be persuaded to begin moving now in the right direction so that the pain of inevitable change is minimised*.”**

Johnston AK 1994. *Energy- a longer view.* Aust. Inst. Energy News 12:3 **p31).**

“***It is human behaviour itself that must be controlled to ameliorate or redirect global change*”**

Stern P, 1992 *Psychological Dimensions of Global Environmental Change*. Annu. Rev. Psychol. 43:269-302. p271

“***People may lack sufficient information about how to act in ways that are environmentally responsible*.”**

Scott D and Willits F 1994. *Environmental Attitudes and Behaviour; a Pennsylvania Survey.* Environment and Behaviour 26:2 p239-260.

Abstract

Five hundred householders were interviewed to gain an understanding of domestic electricity use in Mt Isa and Townsville. Collaborating with the North Queensland Electricity Board, reported behaviour and indications of attitude toward energy were related to metered electricity use. This was done to find causes of electricity wastage by North Queensland householders; develop recommendations to reduce that wastage, and develop strategies to reduce the evening peak electricity demand. Analysis showed little connection between stated attitudes to energy conservation and electricity used by householders. An extensive literature review confirms my findings that many people lack knowledge clarifying energy supply and use issues, and lack meaningful price signals to take energy conservation and renewable energy seriously. Increased electricity price was reported as the most likely cause for serious personal electricity conservation. I conclude that extensive public education about energy supply and use should be coupled with responsible pricing of electricity, to encourage urban dwellers to develop more sustainable energy supply and use patterns. About half of domestic energy in the tropics is used for cooling food, drink and interior space during the hotter months. Rationalising use of air conditioners, refrigerators and freezers, and encouraging passive building design should be strenuously promoted by environmentally responsible government.

Domestic Energy Use in North Queensland

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Thesis Summary.

Geography and global resource depletion

Fuzzy boundaries, curiosity, adaptability and involvement in evolving reality ensure Geography's heuristic contribution to science and sustainable development. Geographers are interested in the perspective from 4,000 million years ago to human impact on our planet; the way we change the biosphere in time and space, and the way we change our survival-oriented behaviour. Human geographers are free to undertake holistic study of society in ways denied more constrained disciplines.

I wish to contribute to the knowledge and understanding of the options we face to develop sustainable social structures and behaviours. As a geographer, I am studying sustainable energy practices because of the Dominant Social Paradigm (Fien 1993). This paradigm results in Australia exporting six million ton of (mainly) old growth woodchips, and forces an extra six million hectare of human-induced desert per year (Beder 1993). The Dominant Social Paradigm renders efforts to stop ecologically disastrous population growth (Population Reference Bureau 1990) ineffective. It encourages unrestrained use of fossil fuel, against many credible commentators who warn us how finite fossil fuels are, at current and projected consumption rates (World Resources Institute 1992, Johnstone 1994). The consequences of 30 billion tonnes of air pollution per year caused by burning fossil fuel (Serpone 1992) are uncertain, based on a ‘Linear industrial model’ of acquisition, consumption and discard (Schmidheiny 1992).

Energy

This work focuses on changing patterns of supply and use of domestic energy in the tropics, as a ‘leading edge’ example of the problems and solutions facing our species. It is based on a literature review and extensive domestic survey. This thesis considers private supply and use of energy among North Queenslanders, the choices made, and how to influence those choices. This work focuses on ways to reverse the trend of increasing dependence on a depleting resource. Energy supply and use provide clear tests of our ability to use developed technologies in order to operate within natural parameters (Lovins 1990).

Aim

The aim of my research was to quantify and analyse some energy consumption and attitude patterns, and to find ways to reduce energy wastage and the evening peak. I also undertook to provide recommendations to the North Queensland Electricity Board (NORQEB) resulting from our collaborative work. It is hoped that this work will help speed the development of sustainable energy systems in North Queensland.

Objectives

1. Develop and test domestic energy research methods based only on stratified electricity consumption.
2. Formulate recommendations to reduce electricity wastage and peak demand, synthesising relevant literature with the research results.

Hypotheses

1. Reported changes in energy-using behaviour will be significantly related to energy used.
2. Appliances used unnecessarily during the evening peak (5 -9 pm) can be identified.
3. Use of electricity by households is positively related to household income level.
4. Use of electricity per household is positively related to the number of people per household.
5. Self-perception of energy-saving behaviour will be reflected in relative electricity consumption.
6. Attitudes toward energy saving behaviour will be negatively related to actual energy used.
7. Knowledge about energy supply and use will be negatively related to actual energy used.
8. Housing judged to have a higher level of passive design will have significantly lower levels of energy use for cooling than those with poor passive design.

Rationale

Biological scientists establish base lines before recommending ways to keep a sustainable population of a species in a region. This approach can be applied before recommending ways to keep a sustainable population of humans in a region. The issues are complex, but the predictive pursuit is equally valid: current status of habitats, impacts (current and/or predicted), food needs, energy balances, limitations, all are requirements for sustainability.

In this study, the domestic sector was studied because virtually everyone lives in a residence. If attitudes, behaviour and electrical appliance use change in the domestic sector, the effects may transfer into the political, management, electricity utility, construction, urban design, industrial, commercial and service sectors. Much of transport energy cost is connected with getting food and products to homes, and getting people to and from their homes. Further, the domestic sector was studied because household use causes the evening electricity peak, which in turn dictates the electricity generation capacity needed by a utility.

Method

Detailed 20 minute interviews were conducted in 300 Mt Isa households in 1992, and 200 Townsville[2] households in 1993. To refine the research methodology, the Townsville households were selected from five widely separated groups, based solely on consumption figures supplied by the utility. Each group was separated by one standard deviation from the mean daily consumption. Thus, traits of different consumption groups could be compared easily. A weighted average group was drawn from the 200 household sample to allow generalisations about the whole Townsville population. More emphasis was placed on opinions, feelings, knowledge and stated attitudes in the Townsville survey, attempting to explain wide variation of electricity use between similar households observed in the Mt Isa study.

Results

Cooling and water heating

Ninety-nine percent of households owned air conditioners or coolers in Mt Isa, and 53% in Townsville. In Townsville, 22% of the total domestic energy was used for space cooling in March. About 33% of households in both centres had two refrigerators, and 60% had freezers. In Townsville 64% of respondents preferred solar water heating if the initial cost was the same as electric or gas. Mt Isa had 24% solar systems, Townsville had 7%.

Other electricity use

[2] "Townsville" = the combined population centre of Townsville and Thuringowa

Lighting used about 3% total domestic electricity in Mt Isa and about 7% in Townsville. Over 90% of respondents in both centres reported turning off unwanted lights. Seventeen percent of households in Mt Isa and 12% in Townsville have pool pumps, averaging about 600 Watts each for about three hours per day. The pumps were generally turned on during the evening peak time. About two out of three people in Mt Isa, and three out of four in Townsville see themselves as saving energy. The reported energy-saving behaviour had very little to do with the range of actual *per capita* energy consumption.

Energy knowledge

About 70% of respondents could name one fossil fuel, 60% named one renewable energy source, 50% named a greenhouse gas, and 40% could roughly estimate the percentage of electricity used by their (main) refrigerator. About 30% of householders could explain that the expression: "sustainable energy practices" meant supply and use patterns which we could continue into the long term future. Only 20% of the survey sample could name the three appliances which used the most electricity (variations of water heater, refrigerator(s) freezers, and possibly include pumps, stove, television or lights). Fear of a major price rise, concern for the future, money savings, and personal contribution to greenhouse gases were reported as the main potential reasons for effective energy conservation programs.

Discussion

This study attempted to identify demand side management targets, and to develop approaches deemed likely to foster more sustainable energy decisions than are currently made. Such strategies could be implemented to delay the costly development of new power stations (and enact ESD goals). Sustainable energy-harnessing systems are becoming more economic (Green 1994), even compared with underpriced fossil fuel. They will need efficient storage systems powering appliances which operate with minimal energy wastage (Fickett 1990). The high proportion of respondents in favour of environmental and energy conservation implies that the public would be very receptive to practical information and help to initiate energy conservation measures.

The spread of reported change of attitude toward energy consumption was generally even across five discrete and widely spread electricity consumption groups at about one person in three. The exception to this was members of the highest consumption group, about half reporting recent changes in their attitude toward energy use. More than any other group, the group in the top 0.05% of domestic consumers reports becoming more conscious of energy consumption, trying to save money and electricity through reduced electricity use. A reported shift in attitude, has not translated into great reductions (behaviour changes) compared with the population average. This contrasts with the lowest use group which reported the least efforts to save money through reductions in electricity use.

Partial correlation tests, stepwise linear regression and other multi-variate analyses failed to find any strong and significant relationships between demographic data, energy use or ‘attitudes’ information. There are weak and significant relationships between energy use and employment type. Unexpectedly, good passive house design was positively correlated with energy used for cooling. The better the housing design, the more energy, on average, was used for cooling.

There remains no clear indicator of links between stated attitudes and actual energy consuming behaviour, no general feel among householders of their comparative energy consumption (average figures should be published with each bill mail-out), nor any universal understanding of fossil fuels, renewable energy or greenhouse gases. The importance of these issues to respondents was indeterminate in North Queensland in 1992/93. Poor levels of knowledge may help explain the general lack of linkage between feeling energy conservation is important, and personal energy consumption. The North Queensland Electricity Board has many freely available brochures on energy conservation. The further issue is whether many people really care. Electricity costs are about 3% of overall household income (transport fuel is about 4%). People use electricity as they see fit, some more thoughtful than others of the desirability of conserver usage, some apparently unable to curb their consumption to what they consider reasonable.

Survey results indicate the need to provide more meaningful public information on personal energy-related issues and preferred behaviours. This may help bridge the gap between feeling that conserving energy is very important, understanding why it is important, and actually knowing the best ways to reduce energy wastage. This will occur more rapidly once fossil fuel energy prices reflect their long term worth (Levine 1992, Nash 1989, Schmidheiny 1992, Serpone et al 1992, Stern 1992, Weinberg 1992, Johnstone 1994). Concern over costs and the future provides a focal theme for public education most likely to trigger responses. How successful public energy conservation programs may be implemented is already well documented and understood (Stern 1992, Dwyer et al. 1993).

Recommendations

The choice of times when private swimming-pool filter pumps are used forms one main target of demand side management (reducing wastage and the evening peak, see Section 1. 22). The other main target is second refrigerators, which are largely under-used (thus wasteful), and contribute to the evening peak. If a successful program was undertaken based on the findings in this research and about one-third of householders with pool pumps or second fridges (the target population) responded to the program, there would be an overall reduction in electricity use, and a predicted reduction in the evening peak of about three percent. The process of increasing knowledge of the issues and providing clear targets may encourage people to consider and undertake further actions to reduce electricity wastage and reduce the evening peak.

Some novel promotional ploys, such as ‘Light globe equivalents’, are recommended to show that each second refrigerator in operation is like leaving on two 60 Watt light globes for 24 hours per day. An average electric water heater uses about the same amount of electricity as four light bulbs burning continuously. Originally from coal-powered generators, this releases about two tonnes of CO_2 per year. Knowing this may help people see the environmental consequences of their energy choices. This kind of information is likely to draw a response from some of the 90% of people in both centres who reported consciously turning off unneeded lights, and the 98% of people in Townsville who stated that looking after the environment is important.

The option of facilitating an 'off-peak power point' for supplying electricity to freezers, pool or bore pumps should considered by NORQEB if it is felt that personal savings would encourage a greater response than co-operative behaviour. Along with the above recommendations, understanding the daily peak, clear goals, commitment, clear role modelling, participation, feedback, and rewards are needed to reduce wastage until the full costs and worth of fossil fuel use is passed on to the consumers (Stern 1992). The low knowledge inherent in core domestic energy supply and use issues implies a pressing need for wide-spread energy education on energy use (and perhaps the amount of coal and greenhouse gases involved) for all major and frequently used appliances.

Conclusion

Energy provision and use affect all of us. Sale of fossil fuels (or the energy derived from them) should reflect their true costs and worth (Fells 1993). This is probably the most effective way to promote efficiencies in energy use, and speed mass uptake of renewable energy sources. As researchers in temperate climates from Geller (1982) onward have found, the energy consumption of demographically similar households varies widely . We know that nearly everyone cares about energy use (Chapter 5.5), but the implication from this research is that there is little linkage between that attitude and meaningful, energy-saving behaviour. While energy is cheap, for most people only the easiest changes in behaviour are likely. Simple changes in major appliance purchase decisions, high efficiency uses and demand side management can forestall the need for more generating capacity until renewable energy sources are in widespread competition with fully-costed coal.

As the reasons, concepts and implications of ecologically sustainable development become more widely known, the motivation to plan and direct ourselves toward sustainable energy systems and life-styles will increase. This requires all sectors of the community to do what is reasonable and possible to reduce our impact on the environment. Sustainable development requires less reliance on fossil fuels and greatest use of solar input to meet our energy requirements. This in turn dictates the need to review our current patterns of energy use, and investigate how householders may be influenced and helped to reduce their electricity wastage.

This research may help individuals, communities and institutions to take sustainable energy directions once environmental impact or resource wastage are clear. Many energy commentators believe there is a need for major behavioural change to meet greenhouse gas reductions (ESD Chairs 1992; Beder 1993). I conclude that until there is full pricing of fossil fuels, there is no likelihood of major behavioural change to reduce fossil fuel use. As the Townsville research indicates, major price rises may be the single event most likely to cause real behaviour change.

Melding the results of a 500 household energy survey in North Queensland with those from other relevant literature indicates our total dependence on depleting fossil fuels. Carbon dioxide levels and world climate change (Serpone, Stern 1992) need to be included while considering long-term dependence on fossil fuels. Making fossil fuels last as long as possible, while developing more viable energy systems is a global task, where knowledge and world views are central to social development at the regional and local level.

A large portion of the 'energy' literature argue that forward looking, ecology-based world views are central to ordered social development (eg Stern 1992, ESD Report 1991, Tansley 1994, Throsby 1992 and Weinberg 1992). We need to greatly reduce fossil fuel consumption while developing sustainable settlements. This is the only logical goal for those who comprehend that sustainable energy systems are a cornerstone of a viable future. Developing low impact energy systems is a task of global proportions to which every region must now strive. Language moulds concepts and attitudes. Perhaps "fossil fuel" should be called "depleting fuel", and "renewable energy" should be called "sustainable energy". The underlying problems and solutions are implicit in the language.

A wide cross-section of the community favours energy conservation. In 1993 most people preferred solar water heating, rated conservation highly and were concerned about dollar savings, and the future. If government is prepared to act responsibly on these findings they can nurture wide community support. Environmental educators have a responsibility to explain both the problems, and the viable elements of a more balanced human interaction with the rest of nature.

This thesis indicates that cheap electricity may make it difficult to convert attitudes on energy conservation into energy-saving behaviour. Schmidheiny (1992) reports that energy efficiency has been the stated goal of most governments for about two decades, but policies have not supported the goal. There are no government indicators, no meaningful price signals of a serious problem and no known social norms to enable people to understand that we all directly contribute to the problems surrounding energy provision and use.

The results of the 'energy knowledge' quiz that was applied in Townsville shows the fundamental need to educate decision-makers, from householders to politicians on the underlying issues that dictate committed energy conservation as necessary for sustainability (ESD Chairs 1992). Knowing that the rarely-used (rarely opened) second refrigerator is using two to five times as much electricity as the total household lighting, and is contributing about one tonne of carbon dioxide into the atmosphere *per* year may help people act to reduce wastage without sacrificing life-style. “People may lack sufficient information about how to act in ways that are environmentally responsible.” (Dwyer 1993 p240). Simply encouraging people to turn off rarely opened second refrigerators will help reduce electricity consumption.

A typical household in the above-average electricity consumption group in Townsville lives in a highset home, both adults work, there are one or two children, a second fridge and a freezer, an air conditioner is used freely during the hotter months, and the members have active life-styles. This group has a high representation of tradespeople and people who work in offices. Such 'typical' households should be used as a model in public education about demand side management, once the political will develops to achieve effective reductions in electricity wastage.

The survey results in this thesis should be viewed within mixed social messages: prior and current cheap energy prices, and a dominant world view (Fien 1993) that generates an assumption that cheap energy is permanently guaranteed. These price messages conflict with the precautionary messages of conservationists and ESD.

The electricity supply industry in Australia is currently undergoing major restructuring. The outcome is predicted to be cheaper electricity (Tansley 1994). This implies greater wastage, coal depletion and worsening of greenhouse gas emissions. Electricity prices, set by Government, emerge as the core issue in electricity conservation. Government appears halting in response to environmental or resource depletion, currently unable to expand beyond the community perception that our depleting energy sources are abundant and cheap.

I recommend that government accepts its assumed social, environmental and resource management responsibilities. This can be done by signalling the intention to raise the price of electricity after 12 months of effective public education on underlying energy issues. The tariff should be increased by (nominally, to include exteralities) five cents per kWh over ten months. This would mean that the ordinary rate would climb from ten cents to fifteen cents over five billing periods. The twelve month lead-up to this initiative should be coupled with extensive public education on many of the issues examined in this thesis. The locally-focussed demand side management strategies could be based on those developed in the following pages, and could draw on the many references included in this work. Money raised from price increases should be managed independently to provide direct rebates to purchasers of high efficiency major appliances and solar systems, creating meaningful industrial and technological advances.

Thesis structure

Much of the technology and behaviour required to move toward sustainable energy patterns is known. A central problem explored in this work is how people may be motivated to modify their energy supply and use patterns in the future. Chapter One sets the context for this work on tropical domestic energy use and attitudes and includes a comprehensive literature review. Chapter One also explains the importance of human energy use, from the global to the national and regional scale - issues of institutional barriers to change and the influences on energy use. Descriptions of the data collection process and analysis methodology are given in Chapter Two, while Chapter Three looks at demography and relevant features of house design. Chapter Four gives details of electricity appliance ownership and use in Mt Isa (1992) and Townsville (1993). Opinions, perceptions and attitudes stated by people toward domestic energy are documented and discussed in Chapter Five. The findings, conclusions and recommendations are given in Chapter Six. Target groups for energy conservation programs have been recognised during this work, and suggestions to influence them are based on the results of the surveys. The findings in this thesis can help develop more sustainable supply and use of energy in the Australian tropics.

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CHAPTER 1
Overview of Energy Supply and Use-
Problems and Solutions

Increased dependence on a finite and depleting resource which provides the driving energy for most functions of 'developed' societies is not sustainable. This chapter provides projections on rates of fossil fuel depletion, constructs a framework to clarify aspects of energy provision and use, then looks at emerging concepts which may rationalise and restrain our use of fossil fuels. Within the global context, the focus shifts to Australia and north Queensland energy issues, and incorporates principles of Ecologically Sustainable Development. A behavioural science framework is constructed to understand many of the social and economic dynamics which will help usher in sustainable energy practices in the tropics. The chapter ends with the perspective that some global economic institutions are beginning to practice environmental stewardship.

1.1 Global Context

Fossil Fuel Depletion

Fossil fuel consumption in Australia must be seen within the global context of fossil fuel depletion. The following overview briefly summarises some facts and perspectives which some energy commentators believe need to be included in social planning. From little use of fossil fuels 100 years ago, global energy production has increased 50% in the past two decades (World Resources Institute 1992). An extreme view of the urgency to change from a 'business as usual scenario' is that most fluid fossil fuels will be burned within 20 years, while the wholesale conversion of coal to fluid fuel will see most coal used within 80 years (Serpone 1992, Grob 1992).

This century we have already burned about 20% of the Earth's recoverable oil and gas. If current trends continue, only about 20% of recoverable fossil fuels will be left within 40 years (Holdren 1990). This analysis is supported by Kuwano (1992), who estimated a similar fossil fuel depletion after 30 years. He included coal.

The total consumption of commercial energy in the developing countries tripled during the past 20 years (World Resources Institute 1992, p147), with reserves projected to last for at least another 100 years (World Resources Institute 1992). There is wide disagreement about the length of time fossil fuel extraction can continue. Two points need stressing: no qualified commentator believes that current patterns of use of fossil fuel will be possible next century, and the precautionary principle of ESD requires us to deal cautiously with uncertainty. Unless we change our energy behaviours, we will probably create great hardship for future generations, because all ‘developed’ societies are now totally dependent on fossil fuels (Kreith 1980). Humans have become increasingly dependent on a depleting resource- clearly an untenable situation. Consequently, we need to plan to minimise our dependence on fossil fuels and eventually render that use redundant.

Concepts of energy conservation, fossil fuel depletion and atmospheric build-up of carbon dioxide on a national and international level developed after the 'oil crisis' of the early seventies. Our massive use of fossil fuels shows little regard for the rest of the biosphere (Nash 1989), with the current global output of gaseous pollution at 30 billion tonnes per year (Serpone 1992). Concern over global depletion of fuel reserves is coupled with the effects of greenhouse gases we discharge into the atmosphere.

Greenhouse Gases

If predicted global warming and major climate change caused by greenhouse gas emissions are to be avoided, the Intergovernmental Panel on Climate Change concluded that 'Carbon dioxide, nitrous oxide and CFCs would require immediate reductions of over 60% to stabilise their concentrations at today's levels.' (Ecologically Sustainable Development Energy Production 1991, p30, NGAC).

The fossil fuel industry is becoming more efficient, so that the amount of useable energy recovered is maximised for each unit of fossil fuel consumed. Governments are attempting to reduce carbon dioxide emissions (see section 1.3), but in 1990, 44% of the 276 million tonnes of the carbon dioxide emitted in Australia came from the production of electricity (Greene 1990). Of the greenhouse gases produced in Australia, 44% is carbon dioxide, with CFC's, methane and nitrous oxide each contributing about 20% (Walker 1990).

Increases in atmospheric carbon dioxide concentrations are confirmed by analysis of polar ice core samples. It was found that the atmospheric concentration of carbon dioxide since the beginning of the industrial revolution has increased from 280 to more than 360 parts per million at present. These increases are exponential (Staffelbarch 1991, Rose 1993). The use of fossil fuels and the release of greenhouse gases is magnified because our per capita consumption of fossil fuels is increasing. At the moment, the global population is increasing by 93 million per year and may double in the next thirty years (Vant-Hull 1992).

Within this context of dependence on a depleting resource, uncertain effects of gaseous pollutants, and a rapidly increasing global population which is likely to further increase demand for the provision of external energy sources, Section 1.2 offers one clear and coherent framework of energy provision and use. It clarifies the reasons for wasteful and inefficient use of electricity, how it relates to North Queensland, and the need for widespread behavioural change in the use of electricity.

1.2 An Energy Framework

Little in the literature considers all aspects of energy issues[1] in one coherent account from supply through to energy-related behaviour. The following conceptual framework attempts to redress that. It includes the main divisions of technologies (hardware), concepts found in the literature and concludes with attitudes and behaviours associated with energy supply and use. The framework provides a basis for the remainder of this chapter, and clarifies the context of my research.

1) Technologies:
- a Supply and transmission from refined use of fossil fuel
- b Supply from renewable technologies
- c End-use improvements

2) Concepts and context:
- a Dominant social and new environmental paradigms
- b Externalities.
- c Least cost planning
- d Life cycle analysis
- e Demand side management
- f Sustainable practices

3) Attitudes and behaviours:
- a Political, institutional and personal attitudes
- b Refinement of old behaviours
- c Development of new behaviours
- d Connecting behaviour with attitudes

The intention of this section is to show that improved technologies and behaviours are well understood and available, and reducing fossil fuel use is largely a matter of political will. This is the context for energy conservation strategies anywhere, including the study area of North Queensland.

[1] 'energy issues' refers to energy supply and use through this text.

1.2.1 Technologies

a. More efficient use of fossil fuel

Refining power supply technologies includes more efficient use of fossil fuel. Improved efficiency in the use of fossil fuel is occurring in electricity generation plants by using pulverised fuel. The long life of coal generating plant means that as current stations run through their 20 year life-cycle, more efficient upgrades can be made (Schmidheiny 1993, Gardner and Shaw 1993). As an example of efficiency improvements, the New South Wales electricity utility, Pacific Power, has spent $68m since 1987 on improvements to the performance of their power stations (Dallow 1993). Gas fired generating plant will become more efficient, using a 'combined cycle' system where waste heat is reused through a boiler (Gardner and Shaw 1993). Road transport has also shown increases in fuel efficiency and use of renewables in recent years, with more improvements expected with ethanol (Energy Focus 1993a) and the use of solar electric vehicles (Milne 1993).

1.2.1 Technologies

b. Improving Renewable Energy Sources

Renewable energy sources are now being harnessed with greater sophistication (Schuck 1991, Stover 1993, DPIE 1993, Energy Focus 1993b, Singh 1994). The outlook for cheaper solar electric panels is promising (Green 1994). As the implications of scarce fossil fuels translate into their full long term value at the institutional and political level, the financial rewards for successful renewable energy researchers and product developers will be high in a world of increasing energy use.

Renewable systems increasingly meet energy needs in remote areas. As the global demand for energy increases, the total cost of fossil fuel will inevitably rise as the availability falls. There have been major gains from harnessing wind energy (Funston 1992, Davidson 1993), solar-electric energy (Corkish 1993), and solar thermal energy (Mills 1992, Luzzi 1993) and deploying mini hydro systems (Stephens 1993). Solar-electric systems are now used to pump water supplies to 22 Torres Straits Island communities, saving on fuel engine maintenance and running costs (Solar Progress 1993). Warren Tyson of Wagga Wagga has invented a fixed floating turbine to harness the stream flow in rivers without the need for dams. Large submerged fan-like blades float on two pontoons, driving a generator. This is a new and elegant way to harness the energy in flowing rivers (Murray 1992, Energy Focus 1993a).

Most proponents of renewable energy do not see one source providing all our energy needs; rather, a sophisticated 'cocktail' of sources and storage systems is considered to be the most likely solution for most regions. This potential mix of small sources of future electricity supply differs from the dominant electricity supply paradigm (Fien 1993) which has assumed that generators must generate hundreds of megawatts to be worth constructing. Australia pioneers much solar energy research (eg. Green 1994), but countries like Indonesia actually use the technologies. For example, Indonesia will install 50 megawatts of stand-alone solar electric generating plant over the next five years (Dallow 1993). Identifying viable renewable (sustainable) energy sources for the North Queensland region is discussed in detail in Attachment 6. It is clear that we can reduce our reliance on fossil fuel to supply energy. Lessons learned elsewhere could be applied to reduce electricity wastage. The following section shows how we can reduce requirements through use of more efficient appliances.

1.2.1 Technologies

c. Improving End-Use Appliances and Energy Efficient Products

In many 'developed' countries in recent years, the energy intensity (per capita energy use) has dropped, especially in Denmark, mainly due to increased energy efficiency of appliances and plant, and more careful use of energy for heating. In combination, conservation efforts have lowered primary energy demand by 20% from 1972 to 1988 (Schipper 1993). The State Electricity Commission of Victoria estimates large energy savings of 264 GWh simply by widespread use of appliance energy star rating labels (SECV 1993). Ways to achieve this are discussed in the following sections.

With the increased efficiency in fossil fuel use, the rapid technological advances and uptake of renewable energy sources, and the greater appliance efficiency, there is great scope to reduce fossil fuel use. Public information about these developments, and clear price signals will help reduce demand for electricity derived from depleting fossil fuels.

1.2.2 Emerging Concepts of Energy Supply and Use

1.2.2a The Dominant Social Paradigm

This section explains why there are no intensive energy conservation programs, education or incentives in the study area, and the paradigm shift needed to guarantee this. A paradigm is defined as a normative world view, .. "a constellation of concepts, values, perceptions, and practices shared by a community, which forms a particular vision of reality and a collective mood that is the basis of the way the community organises itself" (Capra in Fien 1993 p23).

The Dominant Social Paradigm incorporates beliefs which include the inalienable right to dominate, acquire, use and discard, described as 'the linear industrial model' by Schmidheiny (1992), and that there are no limits to growth. Further beliefs are: that population growth is good because it increases demand for goods; putting people and nature at risk is acceptable to maximise wealth; care and compassion are low; sense of superiority is high, and that the present decision-making structures and institutions are satisfactory (developed from Fien 1993).

This world view contrasts with the New Environmental Paradigm, which includes: the beliefs that human populations need to be stabilised; respect for other people and for all of nature should be innate; ecology constrains economic growth; and that humans can only survive within ecological parameters. The New Environmental world view accepts that we depend on other life-forms for our survival, the biophysical environment often reacts to our activities, and that using technology, humans should move toward regional integration with nature in permanent settlements (developed from Fien 1993).

1.2.2b   Externalities

Schmidheiny (1992) defines human interaction with the environment in recent centuries within the context that exploitation of nature has not created signals of scarcity because the 'ownership' and responsibility of nature by society has been assumed by Government. Government is nature’s custodian, but Government has essentially given away natural resources and services. The recent idea of externalities is an attempt to redress this, by including all the hidden costs in fossil fuel use.

Schmidheiny argues that although the environmental externalities of energy provision and use are uncertain, the direction of change is important enough to impose a small initial carbon tax. He argues that the first priority of energy use is to abolish fossil fuel subsidies, so that prices reflect the full economic costs of energy. Schmidheiny says, that although energy efficiency has been the stated goal of most governments for about two decades, policies have not supported the goal. Many writers agree there is a strong need to reform energy pricing to include externalities by abolishing coal subsidies. For fossil fuels, the quantifiable external costs include environmental, pollution, health, hidden subsidies, resource depletion and capital costs.

1.2.2c Least Cost Planning

Electricity supply industries are developing the conceptual framework to minimise fossil fuel use through least cost planning (AIE Brisbane 1993), also known as integrated resource planning (Greene 1992). This approach considers the costs of every possible way of meeting a desired energy end use (Weinberg 1992) over the full life of the appliances being considered, and their energy use over that extended period of time. The total cost of all aspects of the 'service delivery' is then considered (World Resources Institute 1992 p151), including externalities. Integrated least cost energy planning (Diesendorf 1992) determines the least cost option over the full life of the particular service appliance (eg. domestic water heating). Least cost planning is part of the language of a viable energy future.

The Greenhouse Gas Chairs report states that fossil-fuel use should be greatly reduced, and that renewable energy technologies should be introduced (Greenhouse Gas Chairs 1992). With full economic assessment of service provision (including externalities), we end up with cheaper effective energy, and less environmental damage. Least cost planning is a useful economic tool to help make the changes where the utility, consumer and environment all win.

1.2.2d Life Cycle Analysis/Assessment

Life Cycle Analysis (LCA) looks at a product from the 'cradle to the grave', and considers all costs from the raw materials to the eventual disposal of any waste. These ideas are reflected in Life Cycle Assessment (White 1993, Greene 1992). LCA is an analytical approach which gained widespread recognition in the late 1980’s. LCA shows that long lasting, inefficient appliances stand in the way of upgrading to much more efficient current models (Greene 1992). LCA is different from least cost planning. With LCA, the creation and disposal costs of the components of a particular product are assessed, aiming to minimise wastage of materials as well as the energy used to manufacture, use and dispose of the appliance.

Schmidheiny (1992) explains that the design of the 'industrial ecosystem' is flawed. Natural ecosystems are made up of cycles (ie nutrient and energy cycles), whereas in human systems the flow of goods and services is basically linear. 'Products are purchased, used and dumped, with little regard for environmental impact’ (Schmidheiny p109). Issues of inter- and intragenerational equity are central to concepts of ESD, which requires reduction in fossil fuel use. Life Cycle Analysis should help reduce use of electricity, and reduce electricity wastage.

When applied to equipment for supplying and using energy, life cycle analysis is clearly a way to put a total comparative cost on material provision, through manufacture to use, consumption and disposal/recycling. In Western Scania, Sweden, these LCA principles are being applied to energy end use. Scenarios formulated by the Department of Environmental and Energy Systems Studies at the University of Lund predict a reduction of 75% carbon dioxide output by the year 2010 (Gustavsson 1992). Whilst Sweden reduces fossil fuel use, Australia uses and exports about 260 million tonnes of coal per year. The following section introduces concerns over Australian’s use of fossil fuels, and considers the increasing appreciation of ‘best practices’ in energy supply and use.

1.2.2e Demand Side Management (DSM)

The peak demand determines the needed size of electricity generating capacity. DSM looks at ways to reduce the evening peak demand, delaying the need for new generators. The evening peak is largely driven by the domestic sector, a major reason why this work is focused on domestic consumption. Examples of DSM are off-peak charges for electric water heating, and inducements for people to reduce their overall electricity demand. DSM is "the process of influencing consumers' use of electrical energy in order to maximise either the commercial benefits to the electrical supply industry or the economic benefits to society." (Newcastle Group AIE 1992).

Reducing overall demand by behavioural change or improved end use efficiency is also part of the make-up of DSM, although it is often used only in reference to ‘peak load’ spreading (see Figure 1.1). Controlling demand, especially peak demand, delays the costly construction of new power stations, and reduces the total costs of electricity provision. Utilities see a kWh saved on the same footing, but cheaper than a kWh generated from new plant with a large capital cost. There are costs for informing people of efficiency measures, and often some costs for the technology, such as in the Lord Howe Island example cited below in section 1.3. DSM is attractive to the electricity supply utility because the cost of efficiencies is generally about one-third the cost of new generators. Thus increasing numbers of electricity supply utilities around the world are turning to DSM.

Figure 1. Daily electricity demand curve

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Above graph from a QEC publication: "Using Electricity Wisely" cira 1992.

The Australian electricity supply industry is now grappling with concepts of DSM, with the primary objective of forestalling the need for new generating capacity (Henderson 1993). The United States has well developed programs, with Southern California Edison spending $US90m per year to reduce demand (Newcastle Group AEI 1992). Many United States electricity utilities give customers financial incentives to reduce their demand. The New England Electric System spends $US85m per year on its conservation and load management program, reducing demand by 117 megawatts , saving $US161m. That utility hopes to reduce its air emissions by 45% from 1990 to 2000 (Schmidheiny 1992). Other companies in North America pay rebates to people who buy compact fluorescent tubes (Zorpette 1991).

1.2.2f Concepts of Ecologically Sustainable Energy Development

Increasingly, public utilities are required to be accountable, and to include the full costs of production into electricity and gas prices (DPIE 1992a). There is the need to consider environmental impacts of energy production, and to reduce emission of greenhouse gases. Data on supply and use need improving, along with the provision of better information and effective standards for energy labelling (DPIE 1992b). These should embrace buildings and major energy end-use products. Further, DPIE (1992b) recommends support for energy audits, special support for retrofits (making existing buildings more energy efficient) and increasing public spending on conservation and efficiency research and development. The ESD Energy Production Working Group also recommends 'increased government support for energy research, development and demonstration, especially renewables, and that research and development should include 'energy management technologies' (DPIE 1992a, p3).
This section has shown that technologies, world views and values are important elements in reducing our dependence on fossil fuel. Resource depletion and environmental consequences explain why we should want to reduce of fossil fuel use, but the desire to change is a matter of attitude.

1.2.3 Attitudes and Behaviours

Studies of domestic energy use in Mt Isa (Goudie 1992) indicated the importance of attitudes in energy use behaviour. Electricity use varied widely between households with similar demography and housing. The meaning of 'attitude' was the subject of over 20,000 articles and books during the 1970's (Dawes and Smith 1985). The word has fuzzy boundaries. In 1960 Katz wrote: *"Attitude* is the predisposition of the individual to evaluate some symbol or object or aspect of his world in a favourable or unfavourable manner....Attitudes include the affective or feeling core of liking or disliking, and the cognitive, or belief, elements which describe the effect of the attitude, its characteristics and the relationship to other objects" (Katz 1960, p168).

A 1972 study found 500 different operational definitions for “attitude” (McGuire, 1985). According to McGuire, attitudes can be considered as responses that locate "objects of thought on dimensions of judgement"; objects of thought being “foci of interest such as self, mother, equality’, while dimensions of judgement include “expectancy, evaluation, complexity” (McGuire 1985, p 239). Defining 'attitudes' presents difficulties for many behavioural scientists. Measuring attitudes has further problems. The term *non-representational measurement* is used for tests which predict attitudes around a certain issue, accepting that the results of such tests or survey questions cannot be used to make a prediction about some other response, unless they correlate more than about 0.7 (McGuire 1985 p275). An example of nonrepresentational measurement is pollsters’ rating scales about election outcomes (Dawes 1985).

The attitude survey techniques used in human geography are largely derived from the social sciences. In 1932 Likert devised a system of scales to attitude responses eliminating the need for a panel of judges to decide how results should be interpreted. The scale is usually five-point, (eg. strongly approve, approve, undecided, disapprove or strongly disapprove) (Kiesler 1969). It is quite acceptable to have a seven-point scale (Ajzen and Fishbein, 1980). The Townsville survey used a five-point scale. Likert rankings of a declarative statement (for examples, see Questions 13 through 15 in the Townsville survey- see Attachment 2), can be added and averaged, or otherwise computed, and "..they may also be used for making statistical inferences." (Dawes 1985 p536).

Ajzen and Fishbein (1980),regarded as leaders in attitude research, argue that behaviour is determined by intention- a function of attitude and subjective norm (the subjective norm is an individual's perception of the social pressures to act or not act in a certain way; it is to do with perceived prescriptions). It is generally accepted that the distinction between beliefs and attitudes is not clear (Babbie 1973). Most writers after 1960 include three components of attitude: cognitive (knowing), affective (feeling) and behavioural. Dawes cites writers like Fishbein (1967) emphasising the affective component of attitude. The view that 'attitudes' are basically composed of affect (feeling, Cacioppo 1989), behaviour and cognition (knowing, Cacioppo 1989) is accepted by many authors (eg in Pratkanis et al. 1989 p278). People reporting changes in attitude toward energy use contain some real information. The research into attitudes in this work accepts the approach of Airey (1984), whose "..surveys are restricted to measuring *expressed* attitudes." (Airey 1984, p7).

Writers like Fien (1993) seem capable of transcending much of the attitude debate, by considering the more unifying phenomenon of ideology: "World view or system of concepts, beliefs and values ... enabling people to explain, evaluate and justify their actions in relation to their understanding of the patterns of ideas and values in their social environment." (Fien 1993). With no real agreement on what constitutes attitudes, how to measure them, and little correlation between measured attitudes and actual behaviour in many reported studies, a completely different approach to what actually motivates people may be needed. Despite the 'attitude' difficulties, efforts have been made in this study to understand links between attitudes and behaviour, and to explain those links.

It is not clearly established how much environmental concerns actually translate into environmentally relevant behaviour. However, Stern and other workers have come to the conclusion that 'behaviour tended to correlate with attitudes' (Stern p282). Lutzenhiser (1992), while reviewing 68 recent energy/psychology papers, establishes a sophisticated argument to show that engineers' modelling of domestic energy consumption gives fairly poor predictive results, because the behavioural range of individuals was not properly considered. Nor does psychological research take in many larger issues, but has mainly focused on energy conserving behaviour, ignoring contextual factors like energy pricing.

“The most sophisticated application is probably that of Ester, who, in a major study of residential energy consumers, found that his carefully specified and measured model of conservation attitudes and behaviour did not predict intentions to conserve (let alone conservation behaviour) very well. He discovered that energy attitudes explained only about 30% of the variance in the intention to conserve, leading him to conclude that the energy-conservation intentions are complexly determined and difficult to predict." (Lutzenhiser, 1992 p52). The message from the research of others is that links between stated attitudes and actual behaviour relating to energy use are difficult to measure, and that no reliable methodology has yet been formulated to predict consumption from measures of attitude. Lutzenhiser argues that "...the dynamic behaviour of human groups themselves (the entities which are the sources of attitudes, evaluative strategies, meanings, preferences, and symbols deployed by individuals) are left unaccounted for in (rational and attitudinal) models." (Lutzenhiser, 1992 p53).

Section 1.2.2 has shown the tenuous links found by prior researchers between attitudes toward energy use, and actual energy use. It is clear that context (especially price signals and perceived normative behaviour) plays an active role in personal electricity consumption. The next section explores how and why the context of energy provision does not encourage conserving behaviour.

1.2.3a Institutional Barriers to Reducing Fossil Fuel Use

Many papers deal with sustainable energy technologies and behaviour changes (see Jaske 1988, or Throsby 1992). Cunha (1992) treats low energy engines, Morales (1992) bioconversion, and Tsilingiris (1992) documents solar methods of cooling. Based on the analysis in the first section of this chapter, the widespread use of such devices and practices are needed if future generations are to have the same levels of comfort as us. However, Wall (1989) reflects authors cited in the introduction to this chapter: 'The world demand for energy is expected to double in the next century. If we look ahead to the next twenty or thirty years, no drastic changes in use patterns can be seen.' (Wall 1989 p18).

There is extensive documentation on problems restricting the 'diffusion' of solar energy technology. In a 1989 review of 32 papers dealing specifically with barriers to diffusion of solar energy use, the main barriers identified were institutional underpricing of coal used in power generation and the electricity rates structure, where the low peak price is further reduced for off-peak rates (Jarach 1989). The present research asked what was likely to seriously affect energy use. One of the options offered was increased electricity prices.

Members of the Australian Institute of Energy point out that in May 1993, the Queensland Electricity Commission (QEC) Bulk Supply Energy Rate in the peak period is 5.70 cents/kWh, but private generators are only paid 3.8 cents/ kWh, (Brisbane Group AIE 1993). This shows the very real effect of monopoly control of the electricity supply and distribution network, which can exclude independent suppliers of electricity such as sugar mills. Off-peak electric tariff rates are seen as a major deterrent to the uptake of solar hot water systems. Once externalities are incorporated into the cost of all fossil fuelled electricity, that will immediately change. The electricity supply industry in Australia is seriously considering 'externalities' (ESA 1993).

There are clear institutional attitude problems where greenhouse gases are not considered in major decisions, such as expanded use and sale of coal, or construction of more freeways. There is a tendency to ignore the problems of escaping methane (a potent greenhouse gas) while encouraging its extraction from the vast methane coal beds of Queensland and New South Wales. Wind power is treated with some aloofness because each unit is likely to have a maximum output of only 500kW (Gardner and Shaw, 1993).

Like many active commentators, Diesendorf (1992) points out that our dependence on fossil fuels is very damaging to the environment and ecosystems, and is thus not ecologically sustainable. He sees the need to change to renewable energy sources within the next fifty years, relying on natural gas during the transition. Having participated in the ESD working groups on Energy, Diesendorf felt the representatives on the Energy Production Working Group identified with the coal, oil and minerals industries, there being no business representative from the energy efficiency, renewable energy or gas industries.

Despite potential savings through efficiencies and renewables to the year 2005 totaling about $3.3b for Australia, Diesendorf (1992) says that the drafting of the final ESD ‘National Strategy and Greenhouse’ was done by state and federal bureaucrats, who sabotaged the progress that had been made, making the National Strategy "so vague that it is almost meaningless." (Diesendorf 1992 p22). There were few concrete outcomes or frameworks provided to produce effective carbon dioxide emission reductions. Paul Keating maintains: "The Commonwealth Government remains committed to ... stabilising and reducing greenhouse gas emissions ... at 1989 levels by 2000 and reducing these emissions by 20% by 2005..,(and will) fund studies of electricity subsidies, least cost planning in the energy sector, and 'externalities' in energy costing. The Government will reduce energy use in Commonwealth-occupied buildings by 15% within five years and by 25% within 10 years." The Government is also likely to help fund ethanol (see AEI 1994 p30) research and a United Nations Solar Energy Centre in Perth (Keating 1992).

There is conflict between the above two perspectives. Work carried out in Mt Isa in 1992 showed that there is a great need to inform and motivate people to consider energy efficient options (Goudie 1993a). The Business Council of Australia has said "There is much that Governments can usefully do, for example in sponsoring research or removing barriers to more efficient energy use." (Business Council 1991).

The attitudes and problems that Diesendorf documents give insight into the ways sustainable formulation processes can become ineffective. This indicates that educating 'vested individuals' is a priority. Major decision-makers need to move from a post-WWII position where resources seemed infinite to the late 20th Century understanding that resources are finite. From a long term ESD perspective, political and economic power are best exercised by individuals and groups who most carefully husband the limited resources humans seek most consistently. A habitable and biologically diverse environment in the future, and respect for other groups and species conceptually underscores Ecologically Sustainable Development.

The coal industry, as represented by the President of the United Mineworkers' Federation of Australia, is necessarily uneasy: "The options considered (for the future of coal mining) are grave, in that they canvas the virtual annihilation of the coal industry for both domestic use and exports." (Colley 1991). The struggle between ecological integration and economic pressures will mount or reconcile, as the 'dominant social paradigm' meets a continually clarifying 'new environmental paradigm' (Fien 1993). Resolving the long term 'conflict of paradigms' in Australia mining 51 million tonne of coal per year for power generation is a national challenge. Mining asbestos has ceased because the side effects were eventually perceived as unacceptably dangerous. The effects of massive and rapid use of fossil fuels call up issues of ESD and the precautionary principle. Whether 'hyperreality', with its absolute disconnection from natural processes (Luke 1991) carries major decision-makers into irreversible degraded outcomes; or whether environmental responsibility gains ascendancy is presently unclear. Denial of the inadvisability of gross fossil fuel consumption is apparent.

Possible Causes of Institutional Barriers

Attitudes are likely to affect behaviour when other factors do not override them. Environmental attitudes may guide consumer and political behaviour, but they have less influence on organisational behaviour 'because role demands typically dominate the expression of individual attitudes'(Stern 1992 p279). Occupants of a responsible decision-making positions within organisations are likely to make conservative decisions, to minimise the risk of error. Perhaps novel perspectives generally jeopardise promotion in Government organisations, making innovation prohibitive to many, even though energy conservation is clear Government policy. This point could be at the root of barriers to institutional change. If attitudes and behaviour can be changed in the home, such institutional barriers may be perceived as antisocial, and be removed.

Private enterprise seems more willing to embrace energy conservation than public utilities in Australia. Innovation in private enterprise may offer some long term solutions: capitalist decision-makers seeing that they need to adapt to environmental realities if they want their enterprises to survive and prosper. Examples are given in Section 1.6 on 'Capital Forces'

Stern (1992) feels there should be a comprehensive study of individual effects on collective action (including organisations resource consumption), and that there should be policies which set the context for resource use. Although outside the scope of this thesis, it would be interesting to quantify the effects on energy innovations flowing directly from the actions of 'concerned activists' within organisations and the wider community.

1.2.3b Refinement of Old Behaviour

This section considers energy from the perspective of political, institutional and personal attitudes, to refine old behaviours, development of new behaviours and connecting behaviour with attitudes. It is presented within the context of human impact on the planet since the industrial revolution. Energy supply and use in North Queensland do not seem to have any real importance. It is only within the context of grossly expanding population in the tropics, the projected per capita energy requirements of that population, the finite nature of fossil fuels and the uncertain effects of massive and rapid release of carbon dioxide into the atmosphere, that the value of this work emerges.

Issues around energy provision and use have received serious attention from environmental psychologists, who agree that the structural context in which people make decisions is important. These contexts include government regulations, electricity tariffs and the purchase price of major energy using items; cars and large household appliances (Stern 1992). Within these contextual restraints, purchase and behaviour decisions are attitude related- the cheaper, easier behaviours are more likely to be followed. Information and the credibility of information sources, public figures 'role modelling' energy-saving behaviours and perceived rewards have their greatest effect on energy behaviour when used together (Stern 1992, Geller 1982).

Conserving behaviour depends to some extent on individual self-image. If people have a self-perception of being environmentally caring, they are more likely to be energy conserving than if they have no particular self image in relation to the environment. There may be new behaviours available to individuals in Government, energy utilities, business or from people acting on their own behalf. But first the individual must *want* to change, or feel forced to change. In this way attitudes and behaviour are linked. Usually the attitude (or compulsion) precedes the behaviour.

Stern (1992) sets a clear context for attitudes and energy use in a pivotal literature review drawn from 150 recent psychology-based studies. Stern points out that human action is causing species extinctions at a rate 10,000 times faster than the period before the emergence of humans, arguing that even though global environmental change may threaten everyone, it may not be seen this way. Analysing environmentally significant behaviour is complex and multi-disciplinary.

The long time lag inherent in many processes of environmental change such as that mediated by chlorofluorocarbons is a major problem. By the time a catastrophe is foreseen, it may be too late to change it. This is the cognitive context for energy issues. An Australian example of this time lag between cause and effect is the biota collapse in Hervey Bay. After two floods in 1991, 1000 Km^2 of seagrass was lost with resulting serious impacts on dugongs and sea turtle populations (pers. com. H. Marsh 1993).

Many large scale environmental changes now result from human action. Stern asserts that 'It is human behaviour itself that must be controlled to ameliorate or redirect global change' (Stern 1992 p271), defining global change as any human-induced change where impacts cannot be localised. Global change may be indicated by such factors as the frequency of droughts and the survival of endangered species, or disappearing species eg. North Queensland upland frogs (Davis 1993, Tyler 1993).

Within considerations of greenhouse gases, the most important radiatively active gases (greenhouse gases) are carbon dioxide (55%), CFC's (25%), methane (11%) and nitrous oxide (6%). The consumption of fossil fuel releases about 50% of all greenhouse gases. The 'driving forces' of fossil fuel depletion include population and economic growth, technological change, political-economic institutions, values and attitudes. As this thesis reinforces, economic conditions, government policies, and technological limitations may make it difficult to convert attitudes into action.

1.2.3c Development of New Behaviour

Global environmental change matters to people because it may harm what they value. Values have a psychological component, because anticipatory responses depend on perceptions of the environment, and because behavioural change is necessary to prevent or slow global change and limit the damage it may cause. Social and behavioural science can improve our understanding of how human systems cause global change and how people respond to the anticipation of global environmental change.

Issues of sustainable development include finding ways to encourage people to take effective action to slow, then stop activities which harm environmental systems such as the climate. If our species chooses to explore this, we need to know what actions would be effective in changing behaviour. These issues, clarified by Stern form the basis of many of the attitude questions in this research.

1.2.3d   Connecting Behaviour with Attitudes

Causes of human-induced global change are based on fairly independent decisions by different individuals and groups within levels of governments, international organisations, companies (including builders) and communities, as well as householders. Levels of fossil fuel use depend on investment decisions, management, and daily operation of the vehicles, buildings and equipment that consume fossil fuels. Research (Stern 1992) shows that pursuing energy conservation depends on the amount of time and money involved, how easy it is to know the effects of your behaviour, and how big are the resultant energy savings. Purchase decisions with the greatest long-term impact are purchase decisions, because they set base levels of consumption for the whole life of the equipment (Stern 1992). Decisions by governments, corporations and householders when buying major appliances, plant and vehicles have a large impact on the environment.

Driving Forces

Driving forces create the context for individual behaviour. An example: if external costs of fossil fuel use were factored in to the production cost, the price of coal generated electricity would rise from about 3.5 to 5 cents per kWh, making some wind and bagasse electricity generation immediately viable (see Attachment 6 on bagasse, and Stephens 1993). Some of these 'contextual influences' (surrounding factors) can have more effects than any choice at the individual level.

Context is important. At the domestic level this may include the price of energy, people per household, age and number of major appliances, and occupation. In some contexts, attitudes, beliefs and knowledge may exercise great control over behaviour, while in others, context may effectively remove choice, so that psychological factors do not really matter.

Attitudes and personal norms have more effect on relatively inexpensive, easy-to-perform energy-saving actions than on major household investments in energy efficiency. Availability of financial resources and knowledge (income and education) mostly affects expensive or difficult behaviours (Stern 1992). More information is needed to properly assess items with a higher initial cost, and lower operating costs (Greene 1992).

Time Scales

Stern (1992) argues that global environmental change operates on time scales of decades to centuries. Behavioural variables that operate on that scale are: the socialisation of attitudes, fertility decisions, and the purchase of buildings, automobiles, and major household appliances. This reinforces the importance of the purchase of major items, and indicates that there is unlikely to be any sudden and massive upswing in energy conserving behaviour based solely on arguments of global climate change, or resource depletion, as these changes are slow. The long time scales involved in the larger issues again indicate that significant price rises in energy are more likely to produce rapid waste reduction than intellectual appeals based on events in the distant future.

1.3 Cultural Perspective

Lutzenhiser (1992) identifies energy use as a social problem, citing consistent research results showing that there are identifiable groups of people according to their energy-consumption levels, their likelihood of pursuing conservation, and their understandings of energy and technology. Lutzenhiser argues that these groups can be identified by: “Their social class, ethnicity, life cycle stage, gender, education, occupation, geographic location and local culture." (p53).

A clear example of consumption groups occurred in some research undertaken by David King and the author in Camooweal, a small settlement of about 240 people, 150km north of Mt Isa. We were asked to try and explain high electricity consumption from the small Utility-operated diesel generator set. It was found that the high calcium content in the water had blocked solar water heaters. One group of residents chose to leave the booster on all the time, although this is a very inefficient way to heat water. The other group of affected residents regularly cleaned their solar system (or removed it). The cultural perspective helps clarify further research. A major goal of the Townsville research was to find common traits among discrete electricity consumption groups.

Lutzenhiser says that variations can be traced back to different patterns of social activity and their housing and technology. In some cases people "... are not consuming energy, per se, but rather are pursuing cultural forms of life." (Lutzenhiser, p55). This reinforces the belief that energy consumption is partly a matter of self-image. Defining cultural groups according to their levels of household electricity consumption was a primary motivation behind the design of the Townsville field work. The results are given in Chapters 3, 5 and 6.

Normative Values

Normative values are usually broken down into descriptive (what is) and injunctive (what ought to be). The latter refers to beliefs or rules which makes for morally approved or disapproved behaviour. Studies on littering show that people are more likely to litter in a place already littered, than in an unlittered place. Even when accompanied by a litterer, subjects were found to litter more after the companion littered in a littered environment, but less when the companion littered in a basically clean environment (Cialdini 1990).

Normative values are important in the uptake of sustainable energy strategies. In December 1992, the Federal Minister for Resources stated: "We need to ensure that the installation and servicing of equipment harnessing such an abundant resource is of the highest possible standard. Only then will Australians develop confidence in renewable energy systems." (Cooper 1993). This work clearly shows that there already is a high acceptance of solar water heating. Electricity is too cheap to give solar water heaters a clear economic advantage.

Exploration of changing normative values is a main theme of this thesis: how to change attitudes and behaviour around energy supply and use. Normative values and changes to them are covered from many directions through this work, and the conclusions and recommendations contain insights into changing normative values on energy issues in Queensland.

It is clear from Cialdini's (1990) work that people tend to conform to the perceived behaviours of the larger social group. Stern's literature review (1992) indicates that information, incentives, role modelling by well-known public personalities and financial incentives combine to help energy-related behaviour shift in a sustainable direction. Olson (1993) highlights that understanding of attitudes remains contentious among experts. Theories of reasoned action ("attitudes and subjective norms combine to determine behavioural intentions, which in turn cause volitional behaviours" Olson 1993, p131) by Fishbein and Ajzen have been criticised by many researchers (Olson 1993). Issues of the effects of subjective norms, external variables, behavioural expectations or behavioural intentions all remain cloudy.

Individuals

This thesis focuses on the domestic sector, arguing that there should be a 'spill-over' effect, so that individuals take their changed values, attitudes and behaviour into the workplace, and render more sustainable energy practices in the industrial, commercial, political and service sectors. Although the usual quoted figure for domestic energy consumption in Australia is 12% (DPIE 1991), in the USA, when personal transport is included, the figure is more like 30% (Lutzenhiser 1992).

In Mt Isa and Townsville the average amount spent per household on petrol or diesel was considerably more than for electricity (see Chapter 3). Householders were the target of this research because they " ... consume the bulk of all goods and services produced in the society, making them the final beneficiaries of most ... energy use ... Despite the sophistication of ... energy supply, the demand side remains a poorly-understood sink into which utilities and governments are required to deliver ever-increasing amounts of energy." (Lutzenhiser, 1992 p47).

Individuals determine what firms, communities, and governments do to the global environment because the behaviour of firms is influenced by the demands of individual customers. The decisions of a firm may also be influenced by the choices of managers, and by employees who persistently raise environmental concerns. Communities and governments are affected by individual action through leadership and by pressures that individuals put on leaders through public opinion and lobbying.

Political action to reduce energy wastage seems similar to consumer behaviours: complex or difficult behaviours are strongly dependent on resources or abilities, while easier behaviours such as daily consumption changes are more attitude-determined (Stern 1992). Purchase decisions around cars and major domestic appliances are important, while important daily behavioural choices include running an infrequently used second fridge, when the swimming pool pump is activated, the amount of recreational travel made, and the level of interior cooling. Stern (1992) suggests that environmentally relevant behaviour is limited by the monetary costs of different behaviours, perceived difficulty of relevant behaviour, and a person's perception of how much knowledge or skill is needed to perform the behaviour. Individual knowledge about actions which have the greatest effect also seems to affect action. For energy-using behaviour, this type of knowledge was found to be faulty among many individuals.

In Mt Isa, where about half of the main-use lights are long fluorescent tubes, it is a commonly held belief that it costs about five cents every time a light is turned on, but very little to run. Once the tubes were turned on in the evening, they generally stayed on until bedtime, although, according to NORQEB staff (Essy 1992 pers. comm.), they only use a small fraction of one cent worth of electricity to turn on.

It is worth noting that personality variables rarely show systematic relationships to environmentally relevant behaviour (Cialdini 1990). This provides one rationale for the Townsville survey. Trying to classify people into personality groups and then predict their energy consumption, is circumvented by selecting groups solely on their energy consumption. One of the few consistent indicators that people will adopt costly energy conservation and renewable energy technologies is personal contact with individuals who have already adopted the technology. This was confirmed in extensive Queensland studies carried out by Foster (1991). That study found most people who chose solar hot water systems or ceiling insulation for their planned homes had a builder who advocated that practice, had friends who recommended using insulation or solar water heating, or was based on their own positive experience (Foster 1991). It is clear that some people will act on their environmental concern. However, the literature shows there are various types of concern about the environment. Each may require a different strategy if public eduction is to appeal to people with differing inner reasons for that concern.

Types of Environmental Concern

Stern (1992) documents and summarises four general types of environmental concern: ecological, altruistic, egoistic, and religious/ideological. Ecological concerns are best summarised in the New Environmental Paradigm (see 1.2.2b), based on ecological awareness, reflecting a concern for maintaining the balance of nature as an end in itself. The second type of environmental concern is called Anthropocentric Altruism, where people care about environmental quality because they believe its loss threatens to harm the health or well-being of large numbers of people. The third type of environmental concern is Egoism, when people care about environmental quality only to the extent they believe it may affect their own well-being or that of their close kin. Egoistic concerns may include expected personal costs and benefits of resource conservation, relating it to the perceived difficulty of pro-environmental activity. This set of attitudes helps to explain differences between environmental attitudes and behaviour. The NIMBY (not in my back yard) syndrome falls into this category. Finally, people may feel environmental concern because of underlying religious beliefs. In these cases, environmental concern is seen to be the product of some deeper cause.

Stern points out that these groups overlap, but research, especially in relation to political behaviour, may show that the basis of the ecological concern makes a considerable difference to the way people are likely to behave. Stern also believes it is important to learn how these orientations toward the environment are acquired and transmitted, because over the time scale of generations, change in these orientations may be a critical factor determining the pace of global change.

1.4 The Future

Forecasting human society decades ahead is not possible. However, the effects of global change are on that time scale. Future stresses depend on our anticipatory responses, so consideration of possible responses to minimise our environmental impact is the first priority. Humans have the clear ability of forethought and forward planning. We have never been faced with a global problem before, and it may prove to be a sore test of our adaptive intelligence. Social breakdown and wars are at one end of future scenarios, while population ceilings and integration with natural systems lies as a preferred direction. Using the labels of 'Dominant Social Paradigm' (depletive) and 'New Environmental Paradigm' (sustainable) helps to clarify the two clear world views, bringing issues of energy supply and use into clear focus.

Mitigation is a major response, "To prevent, limit, delay, or slow the rate of undesired impacts by ... intervening directly in the proximate causes ... or by investing in research on renewable energy technologies to replace fossil fuel" (Stern p288). Providing incentives for more self-sustaining human settlements will mitigate problems of fossil fuel depletion and possible ill effects of greenhouse gases. Stern (1992) emphasises the need for studies to take into account the long time scales involved in global change. The main concerns are the processes used to identify and anticipate global change, changing environmentally destructive behaviours, and the political dynamics and conflicts of environmental protection.

Behaviour change

Research has shown that non-experts' understanding and opinions do often change given clear, persuasive, credibly sourced 'how-to' information. Information alone, via pamphlets, slogans or instructions have proven to be generally ineffective. Assertive techniques using clear language, personalised presentation, alternative options and direct recommendations generated changes in behaviour. Daily energy-using behaviours have been changed using regular feedback on energy used, and exposure to models who demonstrate effective conservation behaviours on videotaped presentations. These techniques obviously require adequate funding, which eventually comes back to the twin issues of public pressure and political will of relevant decision-makers. At least effective techniques are documented and ready for use when the social desirability of serious energy conservation is agreed to.

These findings are reinforced by others. The World Energy Coalition believe that there is a need "... to seek necessary behavioural changes. A comprehensive approach should be adopted. This means that all available techniques are used simultaneously." (Bradbrook 1992).

It has been found that people are more likely to change their attitudes if the person giving the information (source) is considered attractive, but people may be better influenced if the source is unattractive, especially if the attitude change is more difficult. In placing these arguments, (McGuire 1985 p265) cites the cases where the individual may identify with the aggressor, such as with German prisoners in the early 1930s. "Typically, attraction and persuasive impact increase with source-receiver similarity." (McGuire 1985 p266).

Outside the scope of this work, there are many more ways to change people's attitude, from content learning theories to cognitive growth theories. All these theories have their relevance in changing attitudes and behaviour around energy supply and use. More simply, there is general agreement from behavioural science about rewards and punishments (positive and negative reinforcement). Learning occurs at a higher rate if a reward is attached to the preferred response (Franken 1988). Stern believes that investments in energy efficiency goods can be effectively encouraged by framing energy conservation in terms of avoiding future costs, and that people trained in communications techniques should be used in public education directed at purchase decisions.

Rewards and Costs

Evaluation studies of government and utility incentives for greater use of insulation, energy-efficient appliances, and renewable energy systems has shown the importance of non-financial factors. One example is the fact that although they have the same financial benefit, low-interest loans are generally less effective than grants (Stern 1992). The credibility and motivation of the sponsoring organisation is also found to have a bearing on response. Because of the variability of outcomes for any given incentive, Stern concludes that with incentives, psychological variables may have more effect than informational variables. This seems to mean that how the message is delivered on the availability of incentives is more important that the actual details of what the incentives are!

Government influence and power, combined techniques and special issues for group users are considered in the following section. Governments can impose desired behaviour on citizens and can control energy-efficient standards on appliance manufacturers and builders. Appliance efficiency standards were introduced in California in 1976, and yet they are only legally required in three states in Australia (Bradbrook 1990). Governments can invest in developing new technologies, and use their considerable purchasing power to foster preferred energy directions. Because the Electricity Supply Industry is made up of Government utilities, State Governments are in a position to force the ESI to start including externalities (see section 1.2.2b) in their pricing of power.

Energy conservation programs have been most effective when they address as many barriers as possible at the one time, by marketing intelligently and aggressively. It may be necessary to involve organisations that have good communication and trust with the program's intended audience, such as community organisations, local governments, or professional communities of builders or lenders. In group settings such as apartment buildings or university departments where energy costs are not billed directly to individual users, effective behavioural change occurs through individual metering, cash rewards or prizes for reaching conservation targets, and having energy monitors (Stern 1992). Stern points out that environmental organisations can elicit support and reshape policy debates by arousing sentiments to draw in individuals and organisations that would not otherwise become involved. Stern argues that there is nothing wrong in using emotional arguments.

Summary of Influences on Energy Use

Institutional inertia

Despite the knowledge expressed in the prior section, mainstream society clings to increasing use of a depleting resource. Humans have a complex relationship between self and social structures (Crook 1980) which helps to explain Stern's statement that individual attitudes are not likely to influence organisational behaviour, 'because role demands typically dominate the expression of individual attitudes.' (Stern 1992, p279). The deeper issue then is to change the demands of particular roles, especially within the energy industry. That is gradually happening, where supply utilities are actively promoting DSM, and conservation. Australian utilities are grappling with the implications of least cost planning, but unlike US utilities, they are slow to take up the new paradigm by reduced coal use (Weinberger 1992).

NORQEB organised a renewable energy Conference in Townsville in 1993. It was organised by and for the Electricity Supply Industry (ESAA 1993). Many speakers see renewables as a marginal issue. Solar hot water was not particularly addressed, nor were concepts of the incorporation of externalities, which would immediately make renewables more attractive financially.

Expressions of the New Environmental Paradigm

Diesendorf (1992) believes that various ESD task forces should be set up. Groups like The Australian Conservation Foundation are pursuing ESD goals, including the 'Green Fridge' competition (Sonneborn 1993, ACF 1993). The successful energy conservation programs in place overseas indicates that Australia and Queensland will probably embrace energy conservation, once the financial, political and environmental benefits are clear.

1.5 Australian and Queensland Energy Supply and Use

Demand Side Management and least cost planning are becoming part of the ecologically sustainable development process in Australia. Because of the benefits, Demand Side Management is quickly gaining interest from the electricity supply industry in Australia, as it already has in many States of the U.S. (Hubbard, 1991). Davis (1990) points out that public policy needs to anticipate future public needs.

1.5.1 Federal Initiatives

In the early 1980's the Federal Government produced booklets on energy efficiency, as part of the National Energy Conservation Program. These included a series of 16 booklets for the commercial sector, with titles such as: 'Developing an Energy Management Program'. The Federal Government has made a large effort to provide information on the need to curb fossil fuel use. In such booklets as *"Sustainable Energy in a Greenhouse Age*. A Greenhouse Energy Strategy: Sustainable Energy Development for Australia" (1990), and other publications (eg Nix 1991), the Government has carefully spelt out the context of the Toronto goal, and the ways that Australians can move to reduce excessive energy use. The purchase decisions of Government and government utilities are also important, both in leading by example, and the sheer volume of equipment for their new works and refurbishment.

From Federal Government initiatives in 1990, Australia has engaged in a public participation process of developing concepts and implications of ecologically sustainable development, and how to implement them. Eight working groups were set up, two of which considered energy production and use (Ecologically Sustainable Development Working Groups 1991. This was discussed in detail in Section 1.2.2f.

There is a shift occurring from Federal Government efforts in energy conservation to State utilities and their changing structures to become more accountable and efficient, while the private sector begins to make energy saving a lucrative business. Using mainly German technology, a Darwin-based company, Powercorp, was formed to provide 'intelligent power systems' for remote hybrid systems. Computer controls monitor and match loads with different sized generators, using batteries, solar and possibly wind to automatically provide the least fossil fuel option to met load demand for stand-alone grids (Powercorp 1993). In April 1993, a private group organised a two day conference and workshop on cogeneration (using waste energy potential in industry), with a fee of $1,895 per person attending. The conference was directed toward the senior executive strata. Topics included 'Opportunities for Alternative Energy' and 'Improving competitiveness and government incentives in Australia's energy intensive industries' (AIC 1993).

The Utilities are grappling with sustainable issues, holding the 1st National Demand Management Conference with its theme of ‘Focus for the Future' in Melbourne in 1992. There were many papers on DSM (eg Greene 1992). Somewhat behind many other countries, some Australian states are now actively pursue Demand Side Management. Measures of electricity producers’ successes are shifting from increased sales to deferred power stations.

1.5.2 Energy Initiatives in Australian States

Victoria is currently leading the Australian states in energy conservation measures (State Electricity Commission of Victoria 1991). In 1992/93, the SECV spent $34m on energy conservation programs (SECV 1993). Western Australia and New South Wales are introducing some Demand Side Management measures with the NSW Office of Energy supplying a useful journal which documents many successful DSM projects, with their clear cost benefits (eg Energy Focus 1994). Most states now have an energy advisory service which includes information on renewable energy and appropriate building design.

A clear Australian example of Demand Side Management comes from the Electricity Commission (now Pacific Power) of New South Wales. With the evening peak demand approaching the capacity of the existing generator set, Pacific Power gave householders on Lord Howe Island a total of 1000 compact fluorescent tubes to defer the cost of $264,000 for a new 200kW generator set. The exercise was successful, with the peak load dropping to a level well within the capacity of the existing generating plant, deferring the need to buy a larger, expensive replacement (Yeung 1990).

Queensland

Harvey (1982) observed that in Queensland there was an 'apparent desire of electricity authorities to grow at the fastest possible rate.' (Harvey 1982 p1). Since this observation, the rapid rate of growth in generating capacity has slowed a little, with the Queensland electricity supply industry and Queensland Government becoming more environmentally aware - the pace and scope of involvement with efficient use of energy has grown. Queensland now has an Energy Advisory Service in Brisbane. The North Queensland Electricity Board is actively promoting domestic conservation, use of off-peak electricity where possible, and supportive promotion of commercial energy audits. The

Queensland Government has recently established an Alternate Energy Advisory Board with a three-year budget of $5m, displaying a real concern for the future direction of electricity supply and use.

However, there may be institutional barriers to change in Queensland- the changing structure of the Queensland Electricity Supply Industry (QESI) means generation will be separated from distribution (NORQEB 1993). It is thus less likely that NORQEB (or the other six Queensland electricity boards) will be motivated to seriously reduce their customers' electricity demand, except for off-grid supply, nor will they be motivated to encourage local small scale supply into the grid. At the same time, the QESI is unlikely to have the regional personnel or motivation to foster more than large scale generating capacity. Separation of supply from distribution was initiated by the Queensland Government. This sets the context (as explained in Section 1.1.3) for many of the energy-related decisions that the electricity utilities, businesses and individuals make. Because of this context-setting role of utility structure and price fixing, Government energy policy grossly affects the total amount of fossil fuel used in power generation.

Information availability

Availability of information and technology is improving in Queensland. Gauging the effectiveness of the information in the domestic sector forms one of the considerations of the Townsville survey reported in this work. Foster (1991) found that word-of-mouth information is the main influence for Queenslanders building a house to install solar hot water or ceiling insulation. His study showed that information on its own does not play any substantial part in affecting peoples' behaviour. This finding agrees with Stern's (1992) work.

1.5.3 Australian Precedents to Changing Attitudes and Behaviour

The kinds of behavioural changes needed for a viable energy future have precedents with anti-littering campaigns, Life Be In It, and dietary and lifestyle awareness programs related to health. There are ongoing drink driving campaigns, wearing seat belts, and most recently in Queensland, the wearing of pushbike helmets. Another example of the ability of society to change is the changing perception of cigarette smoking. Change is equally possible for energy use. The issue of cost to the consumer not reflecting the full value of fossil fuel must be resolved before there is any clear reason to participate in anything but easy DSM strategies.

There was resistance to acknowledging the harmful effects of asbestos, but it was eventually phased out. This is true of DDT, and proving true of CFCs. We will not change our energy consumption patterns until we acknowledge that there is a problem. Grob (1992) labels the top of the fossil fuel consumption curve the: *"Inevitable climax of non-renewable energy." (p2).* The issue is not that carbon dioxide may profoundly change world climate, the issue is that Westernised societies are almost totally dependent on a depleting resource. Making that resource last as long as possible, while developing more viable energy systems is a task of global proportions, where knowledge and world views are central to ordered social development. Energy conservation is a first easy step on the sustainable energy path. Laquatra (1989) found that energy conservation is a cumulative process for households: energy-conscious behaviour is self-reinforcing. In North American states where efficiencies in energy have been actively pursued, the consumer, supplier and the environment have benefited.

The need to reduce fossil fuel use and greenhouse gas emissions seem indisputable. Having explored the role of context, paradigms and attitudes in energy-related behaviour, this chapter concludes on the optimistic note that the driving forces of capitalism may help create much of the attitude shift needed to steer society onto a path of sustainable behaviour.

1.6 Hope from Capital forces

This section rounds off the global perspective on energy issues, looking at the way large corporations are reorganising their business practices to incorporate ideas of sustainability. Most of the material is drawn from Schmidheiny (1992), resulting from his involvement on behalf of the UN in the 1992 Conference on the Environment and Development (the Earth Summit in Rio). The author formed a Business Council for Sustainable Development with fifty global business leaders, such as the chairmen of ALCOA and MIM.

In part, the commitment of the Business Council is toward greater efficiency, and a recognition of the need 'to increase awareness and encourage changes in lifestyles toward more sustainable forms of consumption.' (Schmidheiny 1992 p xiii), That such leaders wish to be seen espousing such sentiments is encouraging, but the following examples show more than just token words.

As explained in the section 1.2.2b on externalities, Schmidheiny first sets a valuable context for human interaction with the environment in recent centuries. He argues that the use and exploitation of nature has not created signals of scarcity because the 'ownership' of nature by society, as represented by Government, has essentially given away natural resources and services. The recent idea of externalities is an attempt to redress this. Schmidheiny argues that although the environmental externalities of energy provision and use are uncertain, the direction of change is important enough to impose a small initial carbon tax. He argues that the first priority of energy use is to abolish fossil fuel subsidies, making prices reflect the full economic costs of energy. Although energy efficiency has been the stated goal of most governments for about two decades, policies have not supported the goal. Because business is motivated by profit, a central problem is that no one owns natural resources such as the atmosphere or oceans. Schmidheiny argues that internalising the cost of degrading natural systems will help correct the dilemma.

Schmidheiny, like increasing numbers of authors on energy issues, sees the need to evaluate cradle-to-grave energy aspects of materials and products. Domestic recycling programs are a tangible aspect of this. In the same way that domestic energy conservation programs may heighten awareness of the issues in the marketplace, domestic recycling may help usher in more industrial recycling practices. Schmidheiny argues from an economic and industrial point of view, stating that a better mix of energy prices, stricter standards and better information would provide substantial economic benefits. He feels that international technology cooperation is a key ingredient in a global energy strategy. Schmidheiny says that although energy efficiency has been the stated goal of most governments for about two decades, policies have not supported the goal.

One way to further highlight the environmental performance of corporations would be analogous to a Moody's rating. Giving a scaled "triple EEE" rating (Environment, Efficiency and Enterprise) to help investors judge the environmental sensitivity of particular companies. Schmidheiny reports that the US will soon have such a rating system. Schmidheiny's book contains many large-scale examples of industrial recycling by such corporations as Du Pont and Volkswagen. In these examples, less overall resources and energy are used, and the companies increase their profits. He feels that eventually all products will have to fit into overall environmental management systems.

It is worth reiterating that although the energy consumption for the domestic sector is usually quoted at about 12% of total for Australia (DPIE 1991), the fact is that a lot of commercial and industrial energy is used to produce or provide domestic products (ie hardware, infrastructure), services (ie electricity, repairs) and appliances. Also, much of the transport energy costs are connected with getting food and products from their source to individual points of consumption or use. Thus the end point of consumption for much of the total energy used in Australia is the domestic sector.

According to Schmidheiny, Life Cycle Analysis has the three phases of 'an energy inventory, resource use and emissions during each step of the product's life; an assessment of the impact of these components; and an action plan for improving the product's environmental performance.' (p111). Life cycle analysis provides a viable approach for planners to incorporate the resource ramifications of their decisions.

The survey work carried out in Mt Isa and Townsville found that refrigerators used about 25% of domestic electricity. Schmidheiny tells us that refrigerators account for 30% of electricity consumption in Sweden. The Swedish government set out to promote greater refrigeration efficiency. In 1988 they set up a major competition to create a super-efficient fridge/freezer. In December 1990, Electrolux was declared the winner, with a unit using .8 kWh/litre/year. With a 400 litre unit, that constitutes an energy rating of 320 kWh per year. In Australia in 1993, a five star 400 litre fridge uses 7-800 kWh per year (Comm. Govt 1992). Australia has a long way to go. The winning Electrolux model used one-tenth of the previous amount of CFCs in the production of the insulation and refrigerant used. The extra 15% cost has a pay back time of about four years. The competition created a market for super efficient appliances, which Electrolux is going to exploit.

A healthy scepticism of large corporations 'going green' may exist, but there are more examples of a shift in the attitude of international capitalists, both from Schmidheiny, and from the World Bank. The World Bank covers environmental consciousness, perhaps with the attitude that it is hard to have an economy without a viable ecology. With this perspective on the future viability of the operation of large organisations, there is the likelihood large corporations will act in a conserving rather than exploitative manner.

As described earlier, such companies as New England Electric, with an annual budget of $US2b. now believe that conserving electricity makes good economic and environmental sense. By the late 1980's, spending $40 million on conservation, it was decided the company could make a profit for its DSM. The Chief Executive Officer said "The rat has to smell the cheese." (Schmidheiny 1992, p187). This is the positive reinforcement of psychologists, the way that larger capital forces may well become responsible environmental stewards- there are profits to be made from mature environmental responsibility. The outcome was a conservation budget of $100m per year, with a projected 45% reduction in air emissions by the year 2000. The biggest global sales of coal go to the developing world, but Britain, with its coal based industries, still uses inefficient and dirty boilers (Fells 1993). Problems with inefficient fossil fuel are planet-wide.

World Bank Perspective

The World Bank supports Ecologically Sustainable Development (Steer 1992) in the hard world of finance. As their report states, there is a "Growing consensus that policies for economic efficiency and for environmental management are complementary." (Steer p178). The World Bank Report gives clear messages that underpricing electricity has detrimental effects on the economy and the environment, reporting that: "There is now a growing awareness that renewable energy is an abundant resource that can be harnessed." (p122).

Summary of Sustainable Energy Practices from a Financial Perspective

Energy pricing needs to be reformed to include externalities, coal subsidies abolished, and a value-added tax should be placed on electricity and gas. Lifecycle analysis and energy efficiency standards and labelling should be used, and fossil carbon use reduced through clear market signals. Waste needs to be confronted and minimised, and alternative energy sources integrated into present infrastructure (such as mini-hydros for the high rainfall escarpment of Northern Queensland). Schmidheiny argues that there should be new urban and regional infrastructures, more information on the energy intensity of products and more education and public awareness programs. It is difficult to fault any of his arguments.

Future Directions in Energy Supply and Use

This chapter has presented the real issues of fossil fuel depletion and viable alternatives. Broad technical, political and social attitudes and behaviours will hopefully change before the impending era where fossil fuels are no longer abundant and cheap. Fortunately, this chapter shows that such a major set of changes are haltingly under way, including a great upswing in solar research world wide (Newman 1993). As new appliances and vehicles become more energy efficiency, urban structures may greatly change to incorporate higher local provision of food, employment, recreation and leisure activities. In North Queensland we will probably see more urban shading, urban agriculture, energy gathering and storage devices, and changed mobility patterns.

CHAPTER 2
Aims and Methodology of Research into Mt Isa and Townsville Domestic Energy Use and Attitudes.

The motivating hypothesis of this research is that electricity use is a behavioural process that may be manipulated to improve efficiency and reduce the evening peak electricity demand. The main objective of this research was to clarify features of domestic energy supply, use and stated attitudes and opinions in the two major population centres of North Queensland in the early 1990s. The second objective was to identify potential targets and use the research findings to formulate recommendations to achieve waste reduction and reduced demand during the evening peak. The third objective was to test whether the amount of energy used for cooling was related to passive building design features. The fourth objective was to establish baseline data on domestic energy use and stated attitudes for Mt Isa and Townsville, and determine the 1993 knowledge levels of some energy issues in Townsville.

Rationale

This research accepts the general tenet of behavioural psychology that there is the need to "define specifically and objectively the target behaviour which need to be changed." (Geller 1982 p17). Hence the major part of the work gathered details of appliance ownership and patterns of use, to define realistic targets in North Queensland for domestic energy waste reduction and demand side management (DSM). In both centres, detailed information was collected on energy sources used, appliance ownership and time and duration of use, along with money spent on transport fuel, and general demographic data for comparisons. There is much literature on domestic energy supply and use for temperate zones; most energy researchers live and work in the temperate zones. The tropical problem of cooling is only one of the issues with which temperate-climate researchers have to contend

(CSIRO 1990). A major domestic electricity demand in the tropics is for cooling in summer. Space heating needs are minimal. Because building design features profoundly affect summer comfort (CSIRO 1991a), building features were recorded in depth at Mt Isa.

An objective of the research was to test if energy used for cooling was related to passive building design features. If the suitability of the house design to the climate did not correlate with energy used for cooling, it was inferred that the attitude of the occupants largely determined energy use rather than actual features of the dwelling (see chapter 1.3.2, or Geller 1982, p5).

The Townsville research only targeted domestic energy use and attitudes (within the wider context of ecologically sustainable development). Hence the target population was based solely on energy consumption, stratified in five energy consumption groups: a 200 household sample of 40 households in each group. These samples were based on figures supplied by NORQEB for the whole of the Townsville population for the March period, 1992.

Overview of Attitude Assessment

Attitudes are explored in Chapter 1.2.3 and Chapter 5.1 and 5.8. The research design enables comparisons of stated energy saving behaviour with reported changes in attitude toward energy use and actual electricity used. The methodology used in Townsville was developed from the experiences in the Mt Isa research. The only questions on energy attitude asked in Mt Isa were:

"Do you presently do anything to save energy?", then prompted through a list of seven energy saving devices owned, or behaviour undertaken, and:

"Would you consider installing a solar hot water system?".

Townsville Attitudes

The instrument used in Townsville had a greater focus on ‘attitude’ indicators. Along with the above questions, the 200 respondents in Townsville were asked a further eight questions relating to their perceptions, and stated attitudes toward energy supply and use. These questions included one set of six questions to ascertain residents’ current level of knowledge of maters related to domestic energy, and three questions to test relationships between attitudes toward energy use and larger conservation issues.

The Townsville survey included direct questions such as: *'Do you think conserving energy is .. important.. ..through to unimportant*?’ Questions were asked to gain an indication of attitudes toward water heating, major appliance purchase determinants, and current thoughts on energy supply and use. Using a five point Likert scale (see section 1.2.3), energy conservation, environmental care, respondent’s effect on the environment and perceived personal match between environmental concern and actual behaviour, relative importance of energy conservation, and events likely to make a change in energy-related behaviour were recorded. The full questionnaire, the cards provided for respondent’s use, the expanded questionnaire, and the questionnaire explanation sheet are provided as Attachments 2- 5.

2.1 The 300 Household Mt Isa Survey

The Mt Isa research quantified the way domestic gas, solar energy and electricity are used in Mt Isa, seeking areas of wastage that could be targeted for reduction, especially during the evening peak electricity consumption period. Greater detail of Mt Isa results is presented in Goudie (1992).

Mt Isa's climate is described as subtropical continental, and semi-arid, with a harsh and often extremely hot climate. Summer rain prevails, with an annual rainfall of about 350 mm. The resultant vegetation is scrub and low tree savanna. Streams are intermittent (Commonwealth Govt. 1961). The summer daily maximum temperature can exceed 40^{0}C for weeks on end. Mt Isa has an urban layout that leads to high dependence on private transport, often with a distance of several kilometres between suburban shops. The business centre is placed near the major employer - Mount Isa Mines.

This research was carried out with the North Queensland Electricity Board, (NORQEB) seeking recommendations for demand side management in Mt Isa (see Attachment 12 for final DSM submission). Mt Isa relies on a stand-alone coal powered generator plant, owned and operated by Mt Isa Mines. NORQEB was interested in developing expertise in domestic energy survey techniques in North Queensland.

2.2 The 200 Household Townsville Survey

The survey aimed to clarify ways to influence residents to reduce their energy wastage, reduce the evening peak in North Queensland, establish base data for Townsville domestic energy use and some attitude indicators, and determine knowledge levels of some energy issues. The intention is that findings and recommendations will be used to help reduce our dependence on fossil fuels. Townsville[1], with a 1991 population of 125,000 (ABS, 1992), is situated in Queensland on the east coast at 19^0S in dry savanna. The main employers are the Government, the Defence Force and the University.

2.3 Research Methods in Mt Isa

Sampling

A statistically representative sample of 300 households was selected from the approximately 6,000 Mt Isa households (City Council estimate of August 1992), representing 5% of the total.

For ease of fieldwork, 60 points, each representing five households were randomly generated onto a map of Mt Isa, using a five mm grid overlay (approximately 100 metres), and a random numbers table. Each point represented five households on the same side of the street nearest to that point. With 60 points, there was an equal chance that the houses were oriented toward the each of the cardinal points of the compass. If the random point was not within 50 metres of a street (eg. in a football field or wide river bed) the point was rejected, to avoid over-representation of streets adjacent to large open areas. The survey was conducted over three weeks in March 1992, gathering detailed information on the dwelling characteristics, vegetation, shade, demography, energy use patterns, and some indication of attitudes toward respondents' energy saving behaviour.

Mt Isa Data Collection

A few days prior to commencement of the survey, North Queensland Electricity Board (NORQEB) staff delivered letters to the 300 households selected, informing them that they were chosen to participate in the survey. A press release also preceded the survey, and the survey activity was

[1]"Townsville" in this work refers to the larger population centre which is technically Townsville plus Thuringowa.

repeatedly mentioned on local ABC radio. This helped the two surveyors from James Cook University and the North Queensland Electricity Board. The results were recorded on a comprehensive questionnaire (see sample completed form: Attachment 1), with the interviews proceeded in the sequence of the questionnaire, taking about 20 minutes each, with sketch plans and notes of each residence taken.

2.3.2 Energy Attitude Questions

Respondents (in Mt Isa and Townsville) were asked if they did anything to save energy, and if so, what. After the above question was rephrased until it was clearly understood, time was given for the respondent to list all their energy-saving behaviour, then prompts were given (see Attachment 1). The goal was to measure levels of awareness of energy use, self perception, and actual practices, and how well these three features correlated with actual electricity consumption data provided by NORQEB. Results are given in sec. 5.1.

Data Analysis

The information was formalised into 100 variables, with up to thirteen values per variable for each of the 300 households. After descriptive analysis, simple Spearman's non-parametric correlations were performed, and ANOVA carried out to find the variables linked with electricity consumption. Stepwise regression was used to clarify the relationship between significant dependent variables and electricity use. The large amount of information collected remains as base data for future reference.

2.4 Townsville Research Method

2.4.1 Townsville Sampling Method

This research focused on domestic energy use and attitude indicators, so the sampling was based only on energy consumption, in five narrow energy consumption groups, each separated by one standard deviation from the mean (see figure 2.1). Forty households were selected to represent each group, using exact electricity consumption figures from NORQEB for the whole of the Townsville population for the March period, 1992 (see Table 2.1).

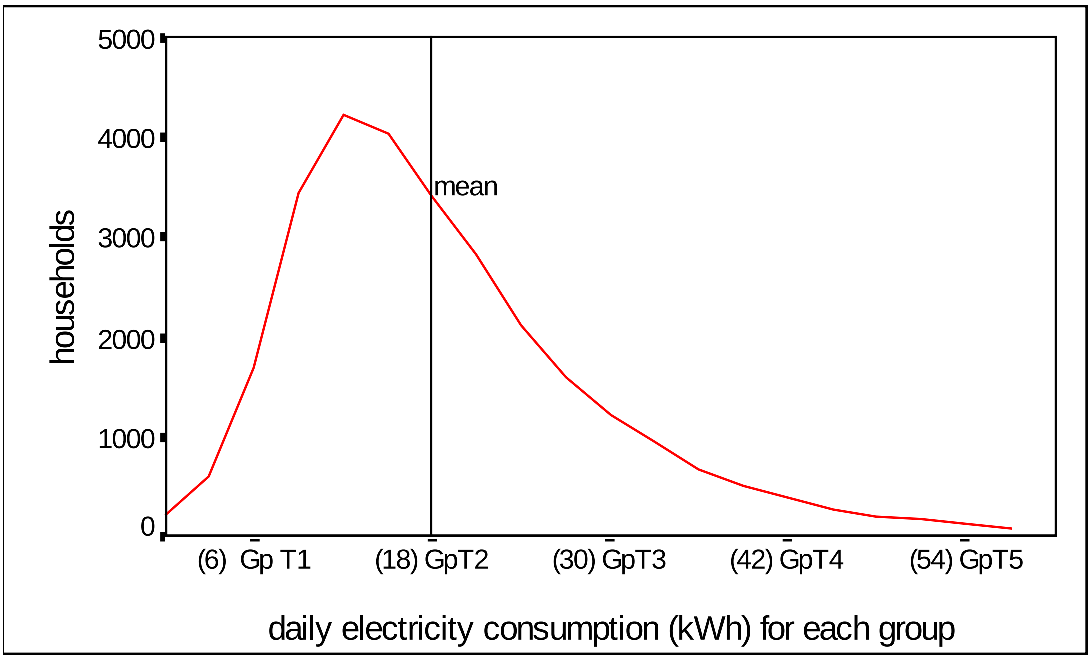
The research design, using five quite distinct electricity consumption groups, allows meaningful comparisons between groups of dissimilar users. The sample was stratified into five electricity consumption groups to clarify traits and comparisons across a broad spectrum of consumers. This provides meaningful information for use in demand side management.

Following the skewed electricity consumption curve for the all domestic electricity users in Townsville (provided by NORQEB, see Figure 2.1) with a mean daily consumption of 18 kWh, and a standard deviation of 12 kWh, a +/- 0.1 kWh range of household consumption was taken around each of the five points: 6, 18, 30, 42 and 54 kWh per day, generating an initial sample pool of 1758 households, representing five groups: below average (low), average, above average, high and very high. The narrow range of +/- 0.1 kWh was chosen to ensure an adequate number of households in the smallest group (T5) for a random selection of 40 households for survey. A wider range (greater than +/- 0.1 kWh) would have generated an unwieldy number of addresses to select from in the highly represented groups. The groups have been labelled as follows: low, average, above average, high and very high.

Table 2.1 Electricity Consumption Groups Surveyed in Townsville in 1993

Electricity Consumption Group	Daily electricity consumption during the 2 month billing period spanning March 1993. kWh per day (+/- 0.1kWh)	Number of households in sample
T1 Low	6	40
T2 Average	18	40
T3 Above Average	30	40
T4 High	42	40
T5 Very high	54	40
TT Weighted mean from the 200 household sample (see below)	20 @6, 40 @ 18, 14 @30, 5 @42 and 2 @ 54 (no. of households @ kWh daily consumption).	81

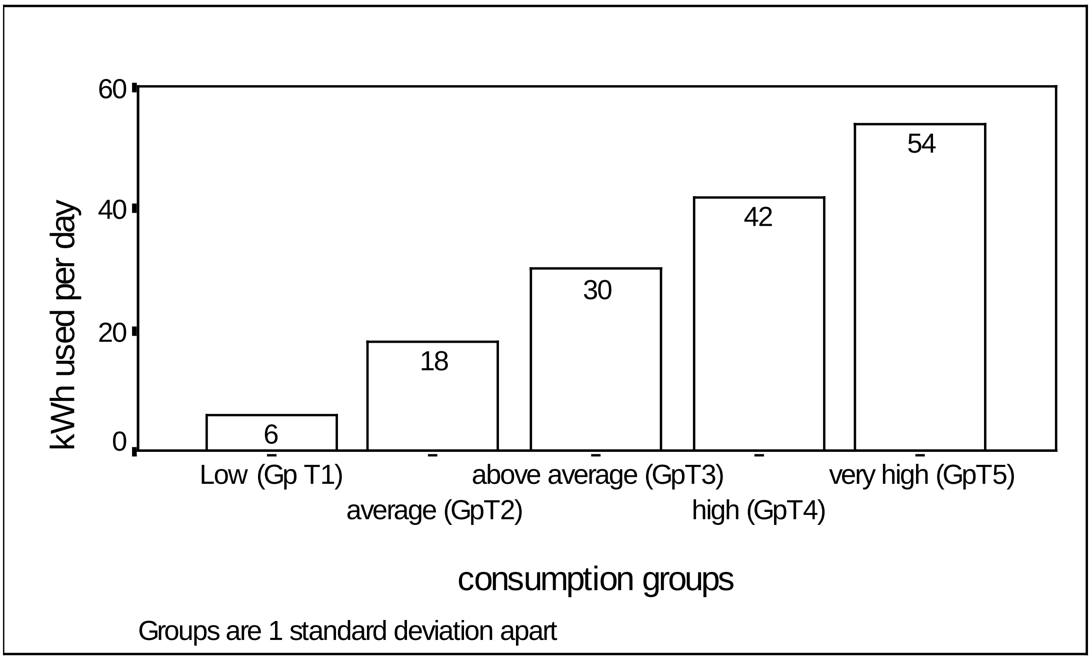
Figure 2.1 March Electricity Consumption Curve for Total Townsville Population (from NORQEB data)



From random addresses provided in each target energy use survey stratum, each group was reduced to 50 households. Forty households from each group were targeted for interview, allowing for 10 reserve households. Every fifth household was designated as a reserve. If an interview was not conducted at a designated address after three visits, the reserve household in the same consumption group geographically closest to the allotted address was approached. Before the survey commenced, a letter was sent to each household intended for interview.

2.4.2 Analysis

Figure 2.2 The five Stratified Groups Surveyed



While processing the data after the completion of the survey, files were created for each of the five consumption groups. A weighted mean group (TT) for the whole of the Townsville population was also generated, matching the proportion of each stratified group to the consumption curve for the whole population.

2.4.3 Weighted Mean Group (TT)

The TT group was created to enable generalisations for the whole of Townsville, reflecting traits of the entire community. The weighted mean group is larger and more representative of the population than the narrow band of consumers at the mean consumption - it reflects the spread of electricity users in Townsville. Traits of the TT group also allow some comparisons with Mt Isa which were not otherwise possible.

The proportion of each group (T1 through to T5) used in the representative group (TT) was calculated as follows: Number of households in each of the five consumption groups (in 3 kWh/day around the mean of each group selected) for the whole of tariff "A" consumers in Townsville was respectively 1,688; 3,415; 1231; 381 and 149 (from NORQEB). All 40 households randomly selected from the population mean electricity consumption group (T2, the largest group), are included in the weighted mean of the 5 stratified groups ie for T2 3415/40 =85, representing a proportion of one household in every 85 equivalent households in the total population- setting the weighted mean as a ratio of 1:85 to the population, so the relative proportion of low user households (T1) was 1688/85= 20, the higher use group (T3) being 1231/85= 14, (T4) 381/85=5 and (T5) 140/85=2 (rounded to the nearest whole numbers).

Thus, 20 household data sets were randomly chosen from Group T1, all 40 from T2 were used, 14 randomly selected from Group T3, five from group T4 and two from Group T5, giving a total of 81 households statistically more representative of the whole of the Townsville population than just the 40 households from the mean consumption group.

Testing Validity of the Weighted Mean Group

As the sample has been selected to have the same standard deviation as the population, showing that the group TT is representative of the population can be done by comparing the mean and standard deviation:

$$p.\sigma = s.\sigma = 18\text{kWh / day.....eq1.}$$

Where sigma is the standard deviation of the population p and the sample s. The mean of the population is given as 18kWh per day, the mean of the representative sample is:

(20X6 + 40X18 + 14X30 + 5X42 + 2X54)/81= 19.5 kWh/day,

which includes some rounding-up of the higher use groups to the nearest whole number. Using the equation

$$z = s / \sqrt{n} = 12 / \sqrt{81} = 12 / 9 = 1.33\text{...eq.2}$$

this may be written as

$$\bar{x}_{pop} = \frac{\bar{x}_i}{\sqrt{n}} \qquad \text{where} \qquad z = \frac{x_i - \bar{x}}{s^2}$$

It can be seen that z, *the standard error of the mean* (Freund 1973) is 1.33. Allowing for the rounding up, a null hypothesis is that the difference of mean for the sample is not significant at the 0.05 level,

using the equation

$$z = \frac{\bar{x} - m_o}{s / \sqrt{n}} \qquad \text{... eq.3}$$

In this case, z = (19.5-18)/12/9 =1.13, with the level of significance set at 0.05, the dividing lines are -1.64 or 1.64. As z lies within acceptable limits, the null hypothesis is accepted: the mean electricity consumption of the sample TT is not significantly different from the population.

It is possible to test the goodness of fit between variables other than electricity consumption from the combined sample of 81 households in the composite group TT, and the population statistics from the 1991 Census figures for Townsville (Australian Bureau of Statistics 1991). The following compares independent variables from the population with their equivalent from the sample weighted mean group TT.

Using the central limit theorem (from Clarke 1993, p233) where X is the random variable with a mean μ and a variance σ^2, with a mean of the random sample of size n chosen from the distribution of X, the distribution of $\frac{X_n\text{-m}}{s/\sqrt{n}}$ tends to the standard normal distribution as n approaches infinity.

Applying this theorem to compare the sample with the total population, where the number of households in the sample is 81, and the number of households in the population is 37,944, the ratio of observed to expected is 469:1. In the case of home ownership, the average for the sample was 0.64 (64%), with a standard deviation of 0.400, while the average for the population was 0.743. Applying the above formula (eq.3) produces a result of z = 1.31. As we have already seen, this is within the significance level of 0.05, where the cut-off point for rejecting the null hypothesis is when z>1.64. Thus the TT sample is statistically representative of the total population of Townsville for home ownership. Using equation 3 to test the hypothesis that the average households which are houses (rather than flats or units) statistically reflects the average for the population:

$$z= (0.802 - 0.814)/1.33 = 0.009.$$

Here the z score is well within the cut-off of 1.64 for 0.05 level of significance. Dwelling types in the sample closely match to the population.

It is possible to use the Chi square test for comparing number of cars between the weighted mean sample and the Bureau of Statistics figures for the entire population, because both data sets are available as follows:

Table 2.2 Car Ownership - χ^2 Comparison of Sample (TT) to Total Population.

Car Number	Sample (Observed)	Total Population	Adjusted Pop. (Expected)	$(O - E)^2$	$(O - E)^2/E$
0	12	4614	10	4	0.4
1	40	17129	37	9	0.2
2	22	13113	28	36	1.3
3+	7	4589	10	9	0.9
				$\Sigma(O - E)^2/E$	2.8

The adjusted population car ownership was calculated by dividing the total households in each car ownership group by the proportion of occupied households: 37944/81= 468.44. ie the total population households with no car ownership was 4614. Dividing that by 468.44 gives the expected number (10) of households in the stratified random sample of 81 which would not have a car. Using the formula

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Chi^2 = 2.8 with three degrees of freedom, giving a p value 0.4235. With a significance level of 0.05 the sample is not significantly different from the population. The above comparisons are convincing evidence that the sample group TT does adequately represent the Townsville population for the purposes of generalisation. Analysis in the following chapters explores differing traits between the five groups, with some indications from the combined group (TT) of the population in general.

CHAPTER 3

People and Housing in Mt Isa and Townsville

Introduction

In this chapter, residents' information precedes details of housing. Most of the values are in percentages, to allow easy comparisons. For the Townsville data, it becomes clear that in many respects the lowest and highest consumption groups are atypical of most of the community members surveyed. Because they represent the extremes in electricity usage, they do not constitute the highest priority for Demand Side Management. Although the highest use group leads energy intensive lifestyles, it only represents a small fraction of total consumers. For these reasons, the reader should focus attention on the bulk of the population, groups T2-4, and in particular T3, representing a significant portion of the population with above average use, perhaps with the largest gross population potential for reductions in electricity wastage (see Figure 2.1 and section 2.4 for proportions of the population in each of the sampled groups represented). Chapters 4 and 5 provide detailed information on energy use and attitudes. Relationships which emerge from this chapter are more fully explored in Chapter 6.

3.1 Household members and income

3.1.1 Mt Isa Resident Characteristics

Table 3.1 Mt Isa Residents Information

	Mean	Standard Deviation
Years lived in present dwelling	8.7	10.1
People per dwelling	3.3	1.2
Number of males per dwelling	2	3.1
Age of oldest person per dwelling	42	13.6
Number of teenagers per dwelling	.6	2.4
Gross total Household income	$41,500	$21,340

Figure 3.1 Period of Time in Current Dwelling in Mt Isa

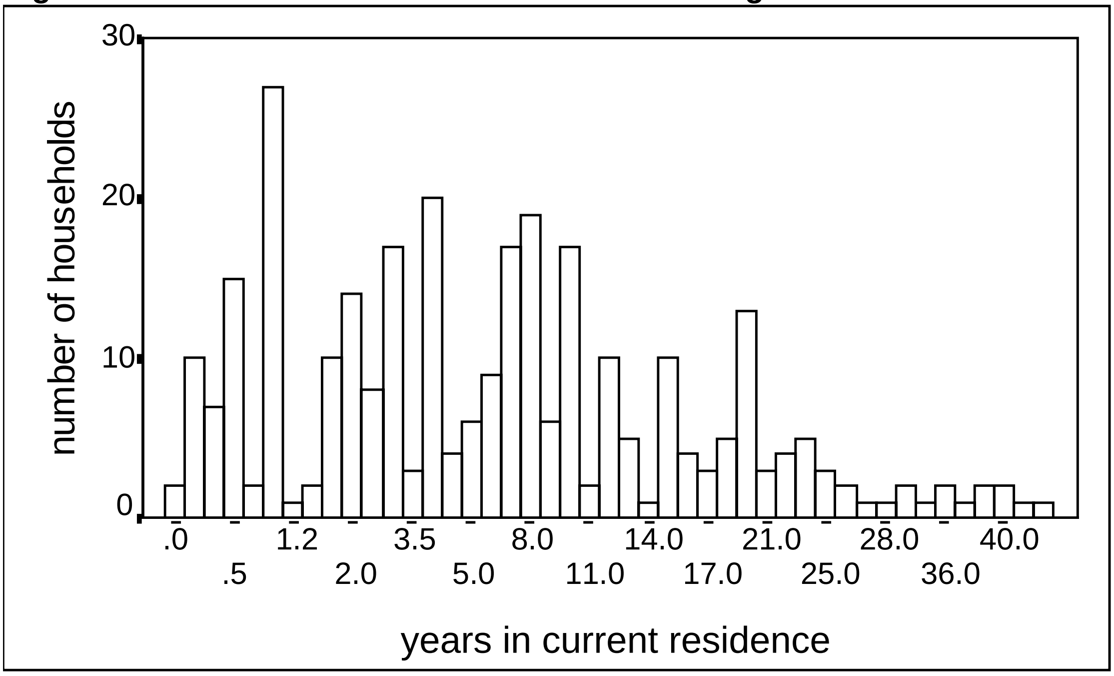


Table 3.1 (prior page) shows a wide range in the standard deviations for most demographic data collected. Although average length of residency is quite high, Figure 3.1 shows a skewed length of residency. A high proportion of the population had lived in Mt Isa for two or three years, with a mode of one year. Length of residency generally clustered around less than one year, three years, eight years, and a 'permanent' group living in Mt Isa for more than 15 years. Combining that with high income, predominance of males, miners and trade workers, some men apparently move to Mt Isa to live and work for a couple of years, then move on, giving a ratio of about three males to every two females.

The average cost of household electricity consumption in Mt Isa in March 1992 was $17 per week, and the average household income of $41,500 for that year is higher than either the national or State average of about $36,500 (ABS Cat. no.6531.0 88/89 Inc. plus annual inflation rates).

3.1.2 Townsville Resident Characteristics

This section includes demographic data of the number, age, gender distribution, income, and income/resident among surveyed households. It is clear that the low consumption group in Townsville consists of fewer people, with a mode of only one person (see Table 3.2). At the other end of the consumption scale, with twice as many occupants for the 40 household samples, the very high consumption group has a mode of four.

Table 3.2 People Per Household in Townsville

Group	T1	T2	T3	T4	T5	TT
Households in sample	40	40	40	40	40	81
Average	1.9	2.9	3.1	2.9	3.5	2.6
Mode	1	2	2	2	4	2
Standard deviation	1.0	1.1	1.5	1.2	1.2	1.3
Total	75	115	122	117	141	212

T1 - T5 represent discrete and widely spaced groups of 40 households in Townsville, defined only by electricity consumption from low to high use. Group TT represents the weighted mean for Townsville to allow generalisations about the population (see 2.4.1 for details).

The T1 group (low electricity use) consisted of 18 people who lived on their own, and 12 households with two people. This contrasts greatly with the other four consumption groups, with a maximum of five one-person households. Two person households were fairly evenly distributed across all five stratified consumption groups at the total (TT) sample average of 36%.

Table 3.3 Average Income and Electricity Consumption Per Group in Townsville

group	T1	T2	T3	T4	T5	TT
Average daily consumption (kWh)- as selected	6	18	30	42	54	19.5
Average number of residents	1.9	2.9	3.1	2.9	3.5	2.6
Average household income ($,000)	26.5	25.7	41.5	41.9	41.5	35.7
Standard deviation ($,000)	27	26	21	17	25	23.4
Per capita income ($,000)	13.9	8.9	13.4	14.4	11.9	13.7
Per capita electricity consumption (kWh per day)	3.2	6.2	9.6	14.5	15.4	7.5

There is a step relationship between electricity consumption and household income, but when the number of residents is taken into account, the per capita income per household bears no relationship to electricity use. The highest consumption group (T5) uses 5 times as much electricity per person as the lowest consumption group.

Residents were asked how long they had lived in the Townsville region, and how long they had lived in their current dwelling to see if there was any relationship with energy use, or energy used specifically for cooling.

Table 3.4 Average Length of Residency in the Townsville District, and in the Current Dwelling

Group	T1	T2	T3	T4	T5	TT
Years lived in region	22	19	21	23	21	21
Years lived in current dwelling	9	7	11	9	10	8.5

Length of residency in the region (or in a particular dwelling) does not appear to be a determinant of energy consumption, and air conditioning and fan use do not significantly correlate with the number of years respondents have lived in the Townsville region (Spearman's rank correlation test). This means the desire for higher cooling inputs is generally independent of personal climatic experienced prior to moving to the Townsville region.

The average number of people per household is about 2.6 in Townsville, and 3.3 for Mt Isa. Mt Isa has fewer one or two-person households, and in both population centres people had lived at their current addresses for an average of about nine years.

3.2 Occupations

3.2.1 Mt Isa

Table 3.5 Mt Isa Occupations (%)

Occupation	Designated primary bread winner	Other Adult	employment details per household
Below ground MIM*	28	4.6	16.3
Above ground MIM	14	5.3	9.7
Home duties	2.5	37	19.8
Trade work	16	5.7	10.7
Office work	7.7	11	9.4
Shop work	4.5	14	9.3
Retired	7.7	4.3	7.8
Medical	2	4.3	3.7

* MIM = Mount Isa Mines. Low category groups have been dropped. See Goudie 1992

Table 3.5 shows that 42% of the primary breadwinners per household work as miners, or 26% of the two adults per household. The reported unemployment rate of surveyed householders was a low 2%, with about 8% of main breadwinners being pensioners. The high percentage of trade workers (11%) reflects the mining orientation of Mt Isa, with the large equipment service and maintenance industries for the mining industry. Also, Mt Isa is the main service centre for a vast area of relatively harsh farming country. Table 3.5 reflects the dominance of the mine. Nearly 150 Mt Isa Mine workers living in the 300 households sampled implies that there is an average of one miner per two houses in Mt Isa.

3.2.2 Occupations in Townsville

Occupations were given for the totals of 63, 72, 88, 79 and 83 adults respectively in each of the groups T1-5. Excluding home duties, retired and unemployed, the final row in Table 3.6 gives the number of people in paid employment, showing that on average, two people per household work in about half of the higher use groups. The retired dominate the lowest electricity use group. Tradespeople, people who work in offices, and people engaged in home duties dominate the primary DSM target electricity use groups T2-4.

Table 3.6 Adult Occupations in Townsville (%)

Occupation	T1	T2	T3	T4	T5	TT
Tradesperson	11	13	13	27	11	15
Retired/pensioner	32	14	7	4	16	16
Administration/clerk	3	18	17	16	5	13
Home duties	5	14	10	13	15	11
Sales	11	6	9	8	2	9
Armed forces	8	7	7	4	2	6
Labourer/unskilled	9	4	6	8	8	6
Professional	0	4	6	7	18	4
Transport industry	2	4	1	1	4	5
Number of employed per group	40	50	68	65	56	-

Low category groups have been dropped

The main features defining the low electricity use group start to emerge: low numbers of residents per household, and about one-third of the low consumption householders are pensioners. Armed forces personnel tend to be in the lower consumption groups (generally they have fewer appliances, and airconditioning is not supplied with Defence Force housing. Many more professional people (architects, managers, accountants etc.) in the highest consumption group, indicating that self-image and lifestyle decisions play some role in the energy consumption decisions of many of the families where the main bread-winner is tertiary trained and working in a professional occupation.

3.3 Demographic Summary

The average household income for Townsville ($35,500) is slightly below the State average ($37,000 ABS 1991), while it is about $41,000 in Mt Isa. These differences can be explained by the high percentage of retired people in Townsville, contrasting with the high number of well paid mine workers in Mt Isa.

A comparison of occupation groups shows that Mt Isa is dominated by the Mount Isa Mine, while Townsville is dominated by tradespeople (16%, with 11% in Mt Isa), office workers (13%, and about 8% in Mt Isa) and the retired (16% in Townsville, 8% in Mt Isa). The gender ratio is fairly evenly balanced in Townsville, contrasting sharply with the ratio of three males to two females in Mt Isa. The average household size is slightly higher in Mt Isa.

3.4 Dwelling Data

3.4.1 Mt Isa

Table 3.7 Mt Isa Residential Building Statistics

Features	Average	% of total	standard deviation
Age of Building	25.5 yrs		10.3
Built on slab		50	
Above ground height of remainder	800mm	45	550
Height > 1m		5	
Width of eaves	760mm		505
Insulation[1] -none	-	59	
Insulation- wall and ceiling	-	15	
Insulation -ceiling only	-	20	

[1] Many people were not sure if their dwelling was insulated.

About half the houses in Mt Isa are built on concrete slabs, and only 5% are built more than a metre off the ground. Slab building has useful thermal properties when coupled with appropriate shading, while the traditional Queenslander on stilts generally has the advantage of catching breezes. In Mt Isa the breezes are often over 40^0C.

3.4.2 Townsville Housing Features

To test for correlation between dwelling design and energy used (especially for cooling), the following characteristics were recorded and collated: whether the dwelling was a house, unit or flat; the amount of structural and natural shade; whether or not the building reflected much radiant heat; the height of the floor above ground level; the width of the eaves (roof overhang); the wall, roof and floor construction material; wall and ceiling insulation, and the age of the building.

Table 3.8 Age of Townsville Dwellings

Group	T1	T2	T3	T4	T5	TT
Average (yrs)	31	20	25	23	22	23.3
Standard deviation	26	17	18	19	17	20.2

Table 3.9 Ownership of Townsville Dwellings (%)

Group	T1	T2	T3	T4	T5	TT
Own[1]	40	65	73	75	80	64
Rent	60	35	28	25	20	36

[1] own=own outright, or paying off a mortgage.

A high proportion of all people interviewed own their housing, with the exception of the low consumption group, who generally live in older, rented dwellings. Most households in that group have lower than average income, with one or two older people, possibly on a pension, generally renting a flat. For the other four groups, no such clear patterns emerge, except when clustered in contrast to Group T1.

Table 3.10 Townsville Dwelling Height above Ground (%)

Height above ground /Group	T1	T2	T3	T4	T5	TT
Slab on ground	35	43	20	23	35	44
200 -2000mm	20	13	13	33	25	10
High-set	33	43	55	30	18	38
Two story	13	3	13	15	23	7

The weighted mean group (TT) of 81 households has 44% slab on ground floors, 38% highset houses, 10% clearly off the ground (but lower than high-set), and only 7% two storey houses. Townsville has a bi-modal housing stock, dominated by slab-on-ground or high set.

Like Mt Isa, about half the dwellings have concrete slab floors in Townsville, and 50% wooden (see Table Attachment A13.1), although the raised dwellings in Townsville are most likely to be high set, an uncommon feature in Mt Isa. The type of flooring does not significantly correlate with the age of the building in either centre.

Table 3.11 Townsville Dwelling Type (%)

Group	T1	T2	T3	T4	T5	TT
House	48	90	95	95	90	80
Unit	25	8	5	5	5	11
Flat	28	3	0	0	5	9

Although 80% of the population sample live in separate houses, more than half the low consumption group lived in a unit or flat.

3.3.3 Wall material

About 40% of houses in Mt Isa are concrete block, compared with about 30% in Townsville (see Tables A13.2 + 3). While Mt Isa has about 15% of coloured metal cladding, it is rare in Townsville, but both centres have about 15% timber housing. Brick houses are rare in Mt Isa, but constitute about 12% of the housing in Townsville.

In Mt Isa, with a high diurnal temperature range (average 26-36^{0}C in March 1992) there may be some design advantages in using well shaded block construction, if cross-ventilation is allowed to occur freely at night. Much the same applies in Townsville, with an average temperature range of 23-32^{0}C (temperature data provided by Bureau of Meteorology in the two centres). Where there is an appreciable diurnal temperature swing, concrete block construction in the tropics may have good passive design qualities, especially if combined with deep shading (see tables 3.7 and 3.12). Occupants should close the home during the day, and allow free cross-ventilation at night. Used in this way, the high thermal mass of concrete blocks delays the penetration of day time heat into the dwelling until the external air temperature has dropped to the ‘comfort zone’.

Table 3.12 Width of Eaves on Townsville Dwellings

/Group	T1	T2	T3	T4	T5	TT%
Average	650	870	710	820	810	750
Standard deviation	450	470	340	670	520	440

Table 3.13 Townsville Ceiling Insulation (%)

/Group	T1	T2	T3	T4	T5	TT
None	73	65	55	55	75	61
Do not know	13	15	10	10	3	15
Fibreglass batts	15	10	20	10	0	14
Cellulose fibre	0	3	8	10	10	3
Foil and batts	0	3	3	0	3	1
Foil	0	0	3	13	8	4

Styrene foam	0	0	0	3	0	0

Uninsulated ceilings are fairly evenly distributed across the five electricity consumption groups. Bivariate analysis showed little correlation between building age and installation of ceiling insulation. Both centres had about 60% of occupants who knew their dwelling had no ceiling insulation, with about 25% sure that there was ceiling insulation.

3.3.4 Shade

Table 3.14 Mt Isa Shade Features (%)`

	Natural	Structural	Both Natural and Structural
Households with no shade	28	17	10
Households with excellent shade	5	3	6

NB. Some data not gathered.

Contrary to expectations, there was no significant relationship between shading and lower air conditioning use. Shading is seen as important to building design (CSIRO 1991), and needs to be included in overall passive cooling design considerations. Chapter 5 considers why there is no clear connection between passive design features and lower use of air conditioners.

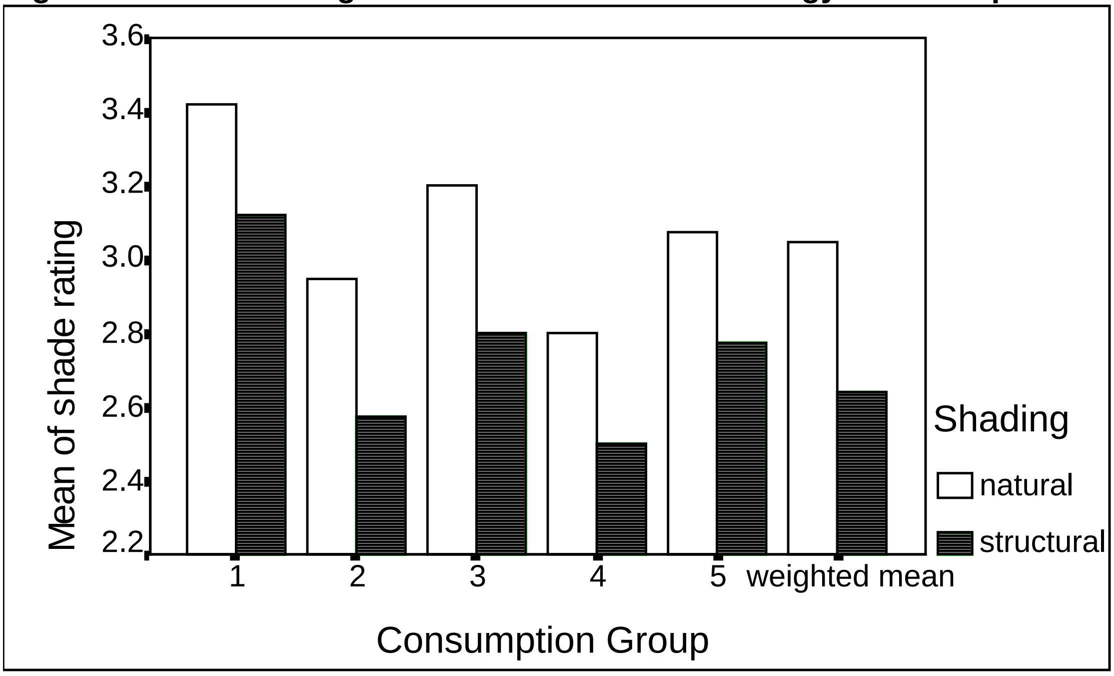
Table 3.15 Townsville Shade and Reflectivity Rating

/Group	T1	T2	T3	T4	T5	TT
Natural shade	3.4	3	3.2	2.8	3.1	3.0
Structural shade	3.1	2.6	2.8	2.5	2.8	2.3
External reflectivity	2.6	2.2	2.1	2.5	2.1	2.6

NB a lower value represents better shade/reflectivity.

The values given in Table 3.15 are a subjective assessment of natural and structural shade, and reflectivity, ranging from one to five. Values of one represent deep structural and vegetative shade, and a highly reflective white, smooth building surface (Ballinger 1992, Mastel 1995). In contrast, values of five would indicate no shading from plants; no eaves, verandahs or carports or lean-to's providing structural shade, and the building surface being matt-black (see Goudie 1992).

Figure 3.2 Shading for Different Townsville Energy Use Groups



a lower value represents better shade. One = excellent, 5 = nonexistent.

No clear patterns emerge for aspects of ‘passive design’ across the different electricity consumption groups in Townsville, except that the lowest consumption group again seems slightly disadvantaged by less summer shading. The second highest electricity consumption group (T4) has slightly better shading (see figure 3.2). At this level of simple analysis, there appear to be no major differences.

Comparing shading with air conditioning and fan use, it was found that structural shading correlates in a weak but positive way with airconditioning use (coefficient = 0.17, level of significance = 0.05), and that natural and structural shade correlate 0.3, p = 0.0, but a linear regression test produced an insignificant R^2 value. This reinforces the Mt Isa finding that passive cooling features of a dwelling have little overall bearing on the energy used for cooling, indicating that occupants’ attitude toward thermal comfort and energy use are more important than actual air temperature.

3.3.5 Comparison of Dwellings in Mt Isa and Townsville

With a shared average age of about 24 years for housing, about half the floors in both centres were concrete slabs. Homes with timber floors in Mt Isa were slightly raised (about 800 mm) while Townsville has far more highset and two story dwellings. A milder coastal climate in Townsville probably explains the height differences. The type of flooring does not significantly correlate with the age of the building in either centre.

Concrete block is the most represented wall material in both centres (40% in Mt Isa, 30% in Townsville), with fibro-cement sheet a little more prevalent in Townsville. Both centres have about one in six timber houses and the average width of eaves is about 750 mm in both cities. Finally, three out of four houses have no insulation, and there is more vegetation shading in Townsville (probably due to greater water availability).

The next chapter provides a detailed record of energy usage in the two centres.

CHAPTER 4

Domestic energy use in Mt Isa and Townsville.

This research quantified private electricity use, presented in descending order: water heating, air conditioning, refrigeration, cooking, television, lighting and general appliances. The average household electricity consumption (ordinary tariff) over the 60 day March billing periods was 1,200 kWh in Mt Isa and approximately 1,000 kWh for Townsville[1] (NORQEB). More people, freezers and slightly higher cooling loads per household account for most of the difference between the two centres. The average residential bill for Mt Isa was $145 (NORQEB), and $143 for the three hundred household sample.

4.1 Major domestic energy use

4.1.2 Water heating in Mt Isa

Twenty-four percent of domestic hot water systems in Mt is used solar heating; the State average is about 9% (Walker 1990). Almost one in three households do not use electricity as the main water heating energy source. The 28% of households on special off-peak water heating rates used a mean of 367 kWh for water heating over the billing period, indicating that water heating accounts for about 24% of total electricity per household. Of the 24% of houses with solar hot water, about half rarely or never used their booster (see Tables 4.1 and 4.2 below). In 1992, off-peak tariffs were used by about 40% of households with electric water heating systems in Mt Isa.

Table 4.1 Mt Isa water heating systems and average electricity bill March 1992.

Hot water system type	Booster use	% per category	Two monthly bill [$]
Electric only	-	67	148.10
Solar only	none	5	113.00
Gas only	-	9	111.93

1 'Townsville' in this work means the Townsville area and includes the contiguous population centre of Thuringowa.

Table 4.2 Use of off-peak tariffs for water heating in Mt Isa (%).

Electric (O/P 33)	Electric (night 31)	Electric (ord 11)
26	2	39

The initial survey work in Mt Isa showed that households with relatively unregulated solar water heating had a significantly higher electricity usage than electric-only system households. Further field work was conducted in November 1992 (Goudie 1993b) to investigate this (see Attachment 7). The Mt Isa research found that initial cost was a major prohibitive factor in the uptake of solar water heaters. This issue was further researched in Townsville (see Chapter 5). Six percent of home owners in Mt Isa did not want to install solar water heating because they had calculated they would not recoup their costs before moving from the house.

4.1.2 Domestic water heating in Townsville

Table 4.3 Main residential water heating energy source (%) in Townsville

Energy source /Group	T1	T2	T3	T4	T5	TT
Electricity:	**75**	**93**	**88**	**90**	**80**	**88**
Heat exchange type (see text)	38	33	45	33	48	49
Mains type	30	60	40	60	30	51
Tariff 11	23	5	18	5	10	14
33	50	80	73	73	65	5
31	3	8	0	8	5	69
Gas	**18**	**3**	**0**	**3**	**3**	**5**
Solar	**7**	**5**	**13**	**8**	**18**	**7**

T1 - T5 each represent discrete and widely spaced groups of 40 households in Townsville, defined only by electricity consumption from low to high use. Group TT represents the weighted mean for Townsville to allow for generalisations to be made about the population (see 2.4.1 for details). Water heating details were not recorded for some dwellings. As with most tables, some figures are rounded to the nearest whole number.

Table 4.3 shows that the lowest electricity consumption group had the highest number of gas hot water systems. The highest consumption group has the most solar systems. There is a high penetration of off-peak tariff among the 88% of households with electricity as the main water heating energy source. Twenty four percent of Mt Isa households have solar water heaters, this is so for only 7% of households in Townsville.

4.2 Transport use

Both centres are heavily reliant on private transport, with a hot climate, and long distances between shops, work, schools and home; private transport fuel costs are $26/wk in Mt Isa, and $24 in Townsville (at about 70 cents/litre). Average weekly fuel costs were $17, 25, 29, 31 and 25 respectively for the five Townsville groups. This indicates that the identified target group, T3 has a relatively mobile lifestyle. The Mt Isa research also indicated that an active life-style was a common trait in the above average consumption group (see Table 4.13). The private transport energy costs are appreciably more than the averages spent on electricity ($17/wk in Mt Isa, $14/wk in Townsville) and the energy costs were all largely seen as necessary: electricity use should not be seen in isolation from other energy-use patterns.

4.3 Cooling the dwelling

4.3.1 Mt Isa

Table 4.4 Air conditioner ownership in Mt Isa.

one unit only	two	three	more than four	none
79%	14%	4.3%	1.7%	1%

Tables 4.4 - 4.6 give data on air conditioning ownership and a calculation of energy used (for full details, see Tables A13.5 -.7). Ninety-nine percent of houses had (evaporative) air conditioning in Mt Isa, 20% with more than one unit. It is stressed that the use figures apply to March 1992, when the climate in Mt Isa had average daily maximum temperatures of 35^{o}C. The average household in Mt Isa spent approximately $36 per 60 day period to power air conditioners or coolers (Table 4.5). With an average bill of $143, this constitutes about 25% of the total domestic electricity use.

Table 4.5 Air conditioning energy use for per 100 households in Mt Isa

Air con. unit type	small	refr.	3000	4-5000	6000	8000
TOTAL (kWh)/day	51	61	30	100	330	40
				TOTAL kWh/day		610
Average amount spent per bill per household on air conditioning						$36

4.3.2 Townsville domestic cooling

Table 4.6 Townsville Airconditioning and fan use in March 1993

Cooling /Group	T1	T2	T3	T4	T5	TT
% h/h with **airconditioners**	33	50	58	58	88	**53**
Number of a/c units per group	16	31	38	40	51	60
Approx. fan energy used (kWh)/bill	48	64	89	85	87	135
Approx. kWh for AIRCONDITIONERS	43	70	117	129	140	184
Energy per h/h for cooling (kWh)/day	**2.3**	**3.4**	**5.2**	**5.4**	**5.7**	**4.0**

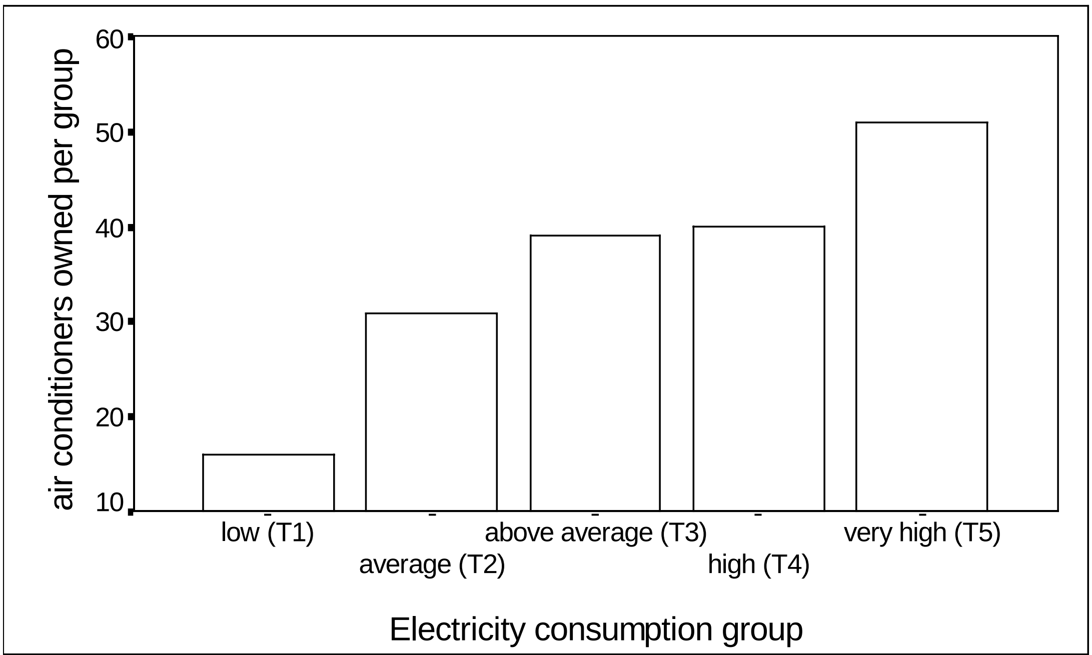
Assumptions made: that on average, airconditioners used about 500 watts per hour (on full setting, a refrigerative airconditioner uses about 1200w).
: on average, fans use about 100 Watts per hour, as they generally use about 150 Watts per hour on full setting. These assumptions perhaps underestimate airconditioning electricity consumption, and overestimate consumption caused by fans. With 4kWh per day average used for cooling, there was 4/18 about 22% total domestic energy used for cooling, representing about $24 per bill average per household. For full details, see Table A13.7.

About 50% of households in Townsville have air conditioning. About 60% of these were used in March (see Table A13.8); that is, about 30% of Townsville households reported using air conditioners in March. Table 4.6 shows that Townsville relies more on fans for cooling, whereas Mt Isa residents rely largely on evaporative coolers . In Townsville the increased energy used for cooling is a clear trend across the different electricity consumption groups surveyed: both the number of households with airconditioners (33% to 88%), and the number used in March increases markedly across the groups. Twelve air conditioners were used in the lowest electricity use group, and 39 in the highest electricity use group. The average energy used per household per day for cooling was more than twice as much for the highest group than for the lowest group (see Figure 4.1).

About 90% of dwellings in Townsville have fans. With the low use group averaging two or three fans, all the other groups averaged four to five. The higher use groups use fans considerably more than the two lower electricity use groups. Fans used about one-third of the total domestic cooling energy, servicing about 90% of all homes, while airconditioning used the other two-thirds, servicing about 30% of homes. The Townsville domestic cooling load graded fairly evenly across the groups from low to high; from 90 kWh for the low electricity use group to 227 kWh for the highest use group.

Many statistical trials were conducted using step-wise linear regression, narrowing statistical relationships of note between the variables given in the prior two chapters. ‘Group’ was the dependant variable, and the variables: 'fridge number', 'freezer number', 'air conditioning number' (number of refrigerators, freezers and air conditioners per household); 'income'‘ and 'number of residents' were placed in the model to begin with. Step-wise linear regression (modelling on SPSS) shows that air conditioning ownership is most linked with number of residents, with an R^2 of 0.26 (26% of airconditioning ownership is “explained” by numbers of people per household), while the 'air conditioning length of use' is most linked with household income (with an R-squared of 0.16). The number of airconditioners per group rose markedly from lowest to highest electricity use groups (see Figure 4.1). it is clear that as the number of residents rise, there is a tendency for airconditioning ownership to increase as well. There is a linkage between household income and amount of airconditioners use. A significance level of 0.05 was used for these regression runs.

Figure 4.1 Air conditioners per group



T1 - T5 each represent discrete and widely spaced groups of 40 households in Townsville, defined only by electricity consumption from low to high use. Group TT represents the weighted mean, to allow generalisations (see Chapter 2.4.1 for details).

On average, about 240 kWh of electricity was used over the March 1993 billing period for cooling in Townsville, about 22% of the total domestic electricity use, compared with about 24% during an equivalent period in Mt Isa. On a daily basis, this equates to an average of about 4 kWh of electricity per household for home cooling in Townsville, and about 6 kWh per day in Mt Isa. About 23% of all domestic electricity was used for home cooling in both centres during late summer.

4.4 Refrigeration and Freezing

4.4.1 Mt Isa

One-third of households run two refrigerators (Table A13.8), and about 70% of refrigerators are larger than 350 litres (Table A13.9). Seventy-two percent of the surveyed households had freezers (Table A13.10). Three or four 'star-rated energy efficient' refrigerators probably use about 200 kWh per bill in the tropics (Suehrcke pers.com. 1992). Households with one fridge (66% of the population), spend about 20% or $20 per bill on refrigeration. People with two or more fridges used an average of 20% more electricity than those with only one fridge. Analysis also showed that households with a freezer use, on average, 300 kWh/bill more than households without a freezer.

Townsville

Two households in the lowest group have second fridges, while every second household had a second refrigerator in the higher use groups (see Table 4.7). With a per capita consumption five times higher for the high group than the low group, the household size is one consumption indicator, and ownership of a second fridge increases the likelihood of being a higher than average electricity consumer (see Table 4.7). Ownership of a third fridge is a strong indicator of high electricity consumption (see Figure 4.2). Slightly more than half Townsville households (57%) have freezers (see Table 4.8), compared with 72% in Mt Isa. The age of 26 freezers was recorded in Townsville, averaging 10 years. Unlike Mt Isa, no householders reported a second freezer.

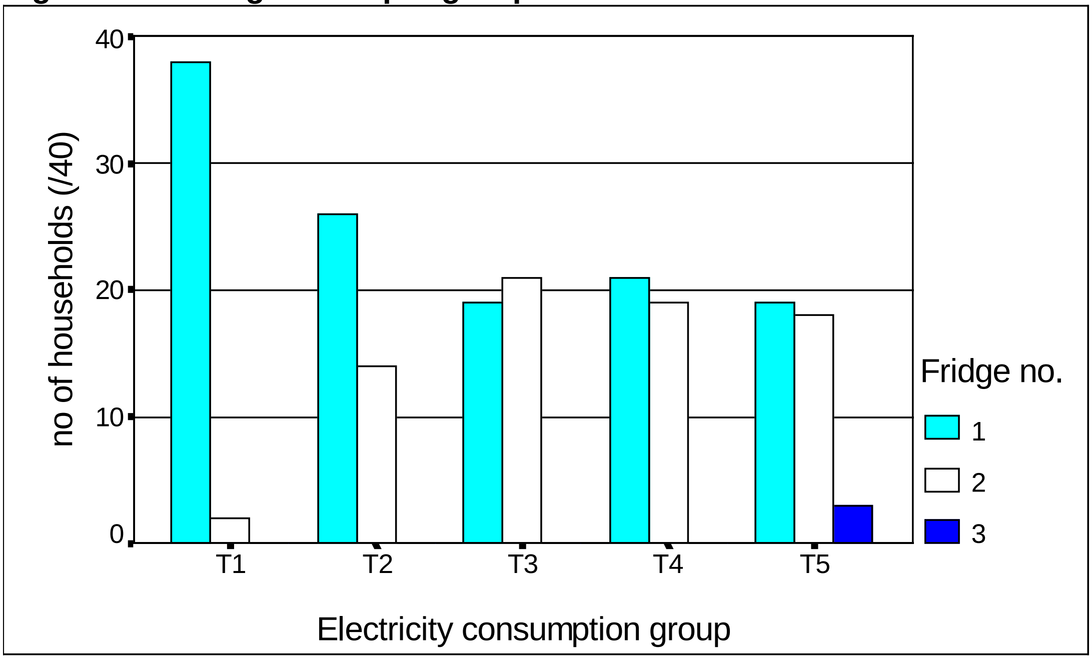
Table 4.7 Townsville Domestic Refrigeration Ownership (%)

	T1	T2	T3	T4	T5	TT
Average age (yrs) of main fridge	6.3	7.9	8	6.7	7.9	7.5
No. of second fridges (%)	5	35	48	48	55	37

Table 4.8 Townsville Freezer ownership

Freezers /Group	T1	T2	T3	T4	T5	TT
Freezers owned (%)	28	55	65	90	78	57

Figure 4.2 Refrigerators per group in Townsville



4.5 Lighting

4.5.1 Mt Isa

On average, Mt Isa households used 0.7 kWh[2], per day in March on lighting (see Table A13.13), about 3% of domestic energy consumption, and about 7% in Townsville (see Table A13.15), accounting for about 1.2 kWh/day per household. The difference in energy used for lighting was largely because most of the main use lights in Mt Isa are efficient fluorescent tubes. Residual differences could be explained by Townsville houses having more shade, requiring more lighting earlier in the evening, or that Townsville people are generally less careful. Average length of use of light bulbs in Townsville is about twice as long as in Mt Isa, with fluorescent tubes being left on 50% longer in Townsville.

4.6 Other appliance use

After air conditioning, hot water use, refrigeration and freezer (see previous Tables), Table 4.9 shows that television is the next largest electricity user. An average of about one kWh per day per household is used watching TV in Townsville and Mt Isa, about the same as for all domestic lighting.

Table 4.9 Mt Isa stove and appliance ownership, March 1992.

APPLIANCE	% of H/H which have	% often used	av. length of use (hr.min)	energy kWh/ day H/H av.
Gas stove	17	100	.50	-
Electric stove	83	80	.25	0.4
Microwave	72	95	.45	0.48
Ceiling fan	26	32	10.45	0.27
Portable fan	62	41	7.45	0.20
Washing machine	96	100	1.3	0.6
Television	112[1]	90	5.7	1.0
Pool pump	17	90	3.9	0.37
			total	3.32

H/H = household, av. = average. 1 About one in eight households had two televisions.

[2]W= Watts, Wh= Watt-hour, kWh= kilowatt-hour, the amount of energy used in one hour by a 1000 Watt appliance such as a vacuum cleaner. A 720W swimming pool filter pump used for 4 hours would use 2880Wh or 2.88kWh.

The low electricity use group has a high gas stove ratio (33%), while the Townsville sample has 19% gas stove use. This also contributes to Group T1 using less electricity than the bulk of the population. 72% of households own microwaves in Mt Isa; Townsville has 67% microwave ownership.

Table 4.10 Townsville Domestic stoves (%)

Cooking /Group	T1	T2	T3	T4	T5	TT
Gas stove	33	18	18	13	15	21
Electric stove	68	83	83	88	83	79
Microwave	38	83	55	40	43	67

Table 4.11 Other Mt Isa domestic appliance ownership (%).

household appliance ownership /use	don't own	own/ rarely used	1 X/wk	>2X/wk	1 X/day
Dish washer	78	5	2	16	10
Clothes drier	78	12	2	3	2

For further details of other appliance use, see Table A13.16

From Table 4.9 and Goudie (1992) more than half the residents of Mt Isa do not own, or rarely use a heater. About 17% of residences have swimming pools, 16% regularly use a dishwasher; 7% use a clothes drier, and 37% regularly use their barbecue. Video machines are only used frequently by 4% of the population, and about 17% of households use their stereo more than 10 hours per week.

Table 4.12 Other Townsville Domestic Appliances

/Group	T1	T2	T3	T4	T5	TT
Machine washes per week	3	4	5	4	8	4
Average tv ownership	1.1	1.4	1.8	1.8	1.7	1.5
Av. tv use (hrs/day)	5.1	5.9	6.5	6.4	7.1	5.6
Number of **computers** (%)	10	20	18	18	25	22
Average hrs use/day	1.5	1.6	1.4	2.8	8.2	1.6
Pool pump ownership (%)	5	8	18	18	18	12
Av. hours on per day	3	2	3	4.3	5	4
Dish washers owned (%)	8	25	30	35	25	25
Average hrs use/week	2.5	4.8	5.3	5.5	5.2	3.9
Bore pump - no.	-	6	8	7	8	14 (17%)
Average hrs use/week		2.5	2	2	2.5	2

Table 4.12 (and Table A13.17) shows that the high electricity use group (T5) uses its washing machines appreciably more than the others. This is another instance where more people use more energy. About 75% the population wash their clothes in the morning, indicating little scope to target clothes washing as a behaviour to lessen the evening peak demand. With a general computer ownership of about one in five households, Group T1 is appreciably under-represented. Generally computer owners report using them for about two hours (average) per day. The exception to this was the very high (T5) electricity consumption group, who owned the most computers, and used them about eight hours (average) per day. Groups T1 and T2 have lower than the weighted average number of 12% swimming pool ownership in Townsville, compared to the average of 17% in Mt Isa. Pool pumps were turned on for an average of three hours per day. There is a total of 17% bore pump ownership in Townsville, used for an average of about two hours per week in March 1993. With group T1 well down, generally one in five households have dishwashers, used about five times per week.

Some Townsville exceptions

One household in Group T2 used floodlights a lot, while one Group T3 resident used an air compressor, perhaps helping to explain their higher than average consumption. Group T4 residents include one who operated an electric potters wheel for six hours per day. One Group T5 householder used an industrial sewing machine for at least four hours per day. One also ran a graphic arts business via the domestic electricity meter, and another very high electricity use household operates a 400 watt fish tank motor 24 hours per day.

4.7 Summary of energy use in Mt Isa and Townsville.

Table 4.13 Features and means of 60 day electricity consumption in Mt Isa over March 1992

DESCRIPTION	Av. kWh	DESCRIPTION	Av. kWh
Insulation in walls and ceiling	1630	No insulation in building	1417
17[1] power points or more	1622	less than 17 power points	1387
Youngest resident less than 5 years old	1546	Youngest resident more than 5 years old	1465
Oldest resident less than 60 years	1506	Oldest more than 60 years old	1400
Income greater than $41,500[1]	1579	Income less than $41,500	1406
Occupant owns home	1561	Occupant rents home	1262
ATTITUDES - Unprompted yes to:			
Do you do anything to save energy? (62% said yes)	1542	33% said no	1415
4% who were unsure	1109	Do you walk instead of drive	1576
Wash clothes in cold water	1555	Minimise air conditioning use	1501
Switch off unused lights	1569	Perform general switch-offs	1409
APPLIANCE USE			
Average TV time greater than 5.5[1] hours	1550	Owning one fridge	1387
Not owning a freezer	1270	Owning a freezer	1566
Using a dish washer approx. once/day (10% of households)	1794	Not owning a dishwasher	1410
Using a BBQ more than once per week	1659	Not owning a BBQ	1291

[1] represents the average

The Mt Isa survey produced the following general results: people with good home insulation have higher energy use, in the same way that people with unregulated solar boosters used more electricity than those with electric-only systems; people with more power points use appreciably more electricity than those with less power points. People who own their home use more electricity than renters, while people who report doing things to save energy use more than those who did not see themselves as conscious energy savers. Quite a number of the interviewees had no idea of their relative consumption patterns, and expressed a desire to know what the average was. People who reported 'no' energy saving activity had the second lowest average consumption of all tested groups. Comparing self-reported and self-perceived electricity use to actual consumption indicates that self-competition (reducing consumption compared to prior bills) should be encouraged. Encouragement should also be given to compete with the (published) town average (taking into account the number of people in the household).

Townsville and Mt Isa comparisons

In Mt Isa, about 66% of households used electricity for heating water, compared to about 90% in Townsville. Solar water heating was used for 24% of Mt Isa households compares to about 7% in Townsville. The 99% airconditioning (mainly evaporative conditioners) ownership in Mt Isa compares to about half in Townsville. Households in Mt Isa used about six kWh a day in March for cooling, compared to about four kWh per day in Townsville. The relative amount of energy used for cooling as a percentage of total cooling was about 23% in both centres. Overall, Townsville residents used less energy per household. Although there was more airconditioning used in Mt Isa (with the more extreme climate), systems used are efficient evaporative units. These rely on low humidity, not often occurring in Townsville during the wet season. Airconditioning ownership and use rose steadily with the overall energy consumption of households in Townsville.

About one in three households in both centres have second refrigerators. Mt Isa has 72% freezer ownership, Townsville has 57%. Seventeen percent of Mt Isa households had swimming pool pumps, compared to 12% in Townsville, but Townsville also had 17% of households which ran bore pumps, usually for two hours per week. Apart from pumps, the only other significant electricity use is for television, using about the same amount as lighting. The main finding for lighting is that nearly every-one (93%) is very conscious about use of lighting (see 5.1 for details). This can form a core component of public education programs: by comparing the use of such things as second fridges to an equivalent amount of lighting use (see Section 6.10).

A summary of associated energy survey findings in Camooweal and Burketown is given in Attachment 8 for the reader interested in considering issues of energy supply and use in remote settlements. Chapter 5 considers the apparently central issues of attitude to energy supply in use, with emphasis on the detailed data collected in Townsville.

CHAPTER 5
Attitudes of North Queenslanders to Domestic Energy Supply and Use

Many energy commentators (ESD Australia 1992; Beder 1993, Dwyer 1993, Walker 1990, Johnstone 1994) believe there is a need for major behavioural change to meet greenhouse gas reductions. The data which follows were gathered to see how people might change their energy-using behaviour through public education. The survey results which follow should be viewed within the mixed social messages of prior and current cheap energy prices, and a dominant social paradigm (Fien 1993) generating an assumption that cheap energy is a permanently guaranteed way of life. These contextual price messages conflict with the precautionary messages of conservationists and ESD.

Results from the Mt Isa survey support the tenor of current literature, which indicates that domestic energy use is a social issue concerning groups of people (Lutzenhiser 1992). Electricity consumption groups were selected for a stratified survey. The methodology of the Townsville study developed from the experiences in Mt Isa, with a far greater focus on attitudes.

Self reporting

Self-reporting in survey research has limitations. White (1989) reviewed the topic, concluding that self reporting produces meaningful results when the subject has to properly consider their answer (White 1989 p37). Poor correlations between reporting and other measures of accuracy occur "... when words like choice and responsibility are not considered appropriate." (White 1989 p37). In the questions treated below, there is a high 'intent' content in many of the attitude measures used: words like 'choice' and 'responsibility' are expressed or implicit. White reports from Warshaw and Davis (1984) who assert that "Self-prediction (is) an example of verbal reports that tend to be accurate" (White 1989 p36). White concedes that the issues are exceedingly complex, (see Chapter 1.2.3d). White indicates that "the more closely ... measures correspond in their specification of action, target, context and time, the higher the correspondence between ... verbal and behavioural measures of attitude." (White 1989 p 38). He asserts that respondents try to give accurate responses, although it is well recognised that people respond to some extent to please the interviewer, or to give answers they expect conform to social norms. Interpretation of attitudes based on stated change or intent needs to be made with great caution.

Behaviour as a Measure of Attitude

Different behaviour within a similar context implies a different attitude[1]; different feelings or knowledge levels. A disparity between stated attitudes and apparent dissonant behaviour (non-matching of beliefs with behaviour- Kiesler 1969, Ajzen and Fishbien 1980) may be explained by a poor level of knowledge. Arguments showing links between attitude and behaviour, along with details of relevant authors and 'attitude' definitions are discussed in Chapter 1.2.3 and Attachment 11. Scott found insignificant relationships between attitudes and behaviours, in line with eight other reported studies (Scott 1994 p255). Attitudes are formed from what an individual knows, knowledge contributes to attitudes; and thus knowledge may influence behaviour by changed feelings and beliefs (Shafer pers com 1994).

Sequence of results

The survey results from 500 households are given as follows: self-perceptions of energy saving behaviour and attitudes toward solar water heating; and measures of the current knowledge base on general issues relating to energy supply and use. This chapter then explores attitudes directly related to energy conservation and their relationship to other environmental issues. Self assessment of respondents' environmental

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[1] More detail of some "attitude", survey results are given in Attachment 11.

impact is also explored. Residents were asked to rank ten options which may make them seriously consider their energy use, then an open-ended attitudinal question about energy supply and use. The chapter finishes with a summary of issues related to attitudes and behaviour.

Results

5.1 Self-perception as an Energy Conserver

Respondents in Mt Isa and Townsville were asked: *"Do you presently do anything to save energy?"* To clarify self-perceptions of energy saving behaviour, respondents were then asked: *"Is there anything that you (or other household members) do to save energy?"* The interviewer waited while respondents considered further, then rephrased*: 'Is there anything (else) that is done around the house, or with local travel that could be seen as saving energy, compared to what you might otherwise use?'* When the respondent indicated they could think of nothing more they considered energy saving, prompts (see Table 5.3) were read out to all participants and the responses recorded (see Attachments 2-4 for the full survey form). Tables 5.1-.6 summarise individuals' responses. They show the cognitive (knowledge) level, showing what is perceived as energy-saving. The tables also indicate how respondents feel, think about and judge their behaviour.

Table 5.1 Mt Isa Energy Saving Behaviour (%)

Yes	No	unsure/ sometimes
63	33	4

Table 5.2 Townsville Energy Saving Behaviour (%)

/Group	T1	T2	T3	T4	T5	TT
Yes	73	73	83	58	65	74
No	23	20	10	15	18	15
Undecided	5	8	8	28	18	11

T1 - T5 each represent discrete and widely spaced groups of 40 households in Townsville, defined only by electricity consumption from low to high use. Group TT represents the weighted mean for Townsville to allow generalisations about the population (see Chapter 2.4.1 for details).

About two out of three people in Mt Isa, and three out of four in Townsville see themselves as saving energy (Tables 5.1 and 5.2). The responses from both centres had very little to do with actual per capita energy consumption. The hypothesis that self perception of energy-saving behaviour will reflect in relatively low electricity consumption must therefore be rejected.

Table 5.3 Self assessment of energy saving traits in Mt Isa (%)

FEATURE	unprompted yes	prompted yes
Switch off unused lights	59	34
Minimise air con. use	38	34
Cold clothes washing	9	67
Local walking instead of driving	6	35
Have solar hot water	15	9
Installed compact tubes	4	10

Allowing respondents to volunteer energy-saving behaviours before prompting them through a list was done to understand what people perceived as energy saving. The results in Tables 5.3 and 5.4 show that while 14% of people in Mt Isa had compact fluorescent tubes, only one out of three perceived that as energy saving without prompting. Variations of this can be seen for the other forms of behaviour, showing that appliances or behaviours which are clearly energy-saving are not necessarily appreciated as such.

Table 5.4 Reported Energy Saving Traits in Townsville (%).

Trait	T1	T2	T3	T4	T5	TT%
Switch off lights	90	93	95	93	93	94
Wash clothes in cold water	88	88	78	83	85	88
Main cook micro- or gas	43	58	58	63	63	56
Minimum air con. use	25	45	53	48	63	46
Plant shade trees	23	60	55	73	70	54
Walk instead of drive	60	55	53	45	48	54

Table 5.4 is a condensed view of self-perceptions of energy saving behaviour in Townsville. Greater detail of prompted and unprompted responses is given in Table A11.11. Forty percent of people in both centres with solar water heaters did not consciously report their use as an energy-saving strategy until prompted. This is discussed in Section 5.8. Table 5.3 (and Table A11.11) clearly show disparity between perceptions and actualities, a gap between unprompted, or conscious (White 1988) energy strategies and actual (unprompted plus prompted) behaviours or technology used. Further, the results from Townsville (Table 5.6) show that people who use the most electricity think of the most ways they save energy.

Over 90% of people in both centres say they consciously turn off unused lights (Table 5.3 and 5.4). This indicates that nearly all adults in the two centres believe turning off lights is important. Other things which people volunteered as helping save energy in Townsville are listed in Table A11.1.

Table 5.5
Total Energy Saving Reports from the Prompt List (%)

Energy saving trait	Mt Isa	Townsville
Switch off unused lights	93	94
Wash clothes in cold water	76	88
Minimise air conditioning use	72	46
Local walking instead of driving	41	54
Have solar hot water	24	8
Have installed compact tubes	14	8

Table 5.6 Total Energy Saving Behaviours in Townsville

/Group	T1/40[1]	T2	T3	T4	T5	TT/81
Unprompted yes totals	75	101	85	110	100	232
Prompted yes totals	94	119	122	117	126	106
Totals of reported energy-saving behaviours	169	220	207	227	226	338

1. The figures given are the totals for each of the 5 groups of 40 households. The figures for TT are the total for the 81 households in the weighted mean sample.

The group using the least energy (T1), consistently reported doing the least to save energy or reduce their energy wastage. Explanations for this are developed in the discussion. From Tables 5.3 and 5.4, switching off unused lights, minimising air conditioning use, minimising fan use or riding a push-bike (see Attachment 11) were seen as the main energy saving behaviours without prompting. With prompting, switching off lights, minimising air conditioning use, washing clothes in cold water, local walking instead of driving, mainly cooking in microwave or with gas or planting shade trees were reported by between 30 - 70% of people as energy saving behaviour.

5.1.1 Recent attitude change

People interviewed in Townsville were asked: *"In the past 12 months, have your attitudes toward energy use around your home changed at all?"*

Table 5.7 Changed attitude toward energy use over previous year (%)

/Group	T1	T2	T3	T4	T5	TT
Attitude has changed	35	38	33	30	50	46

Change in attitude toward energy use is generally reported by about one person in three. Of the five groups surveyed, the exception is the very highest consumption group, where half the respondents reported attitude change.

Respondents were then asked:
[If 'Yes'] How and why? [If 'no', any comments were recorded in Table 5.9]

Table 5.8 Grouped reasons for changes in energy attitude (%)

/Group	T1	T2	T3	T4	T5
Become more conscious/aware	13	5	13	5	15
Try to save money	8	13	10	10	15
Try to save electricity	3	8	3	3	10
Have become more careful	5	3	5	3	3

T1 - T5 each represent discrete and widely spaced groups of 40 households in Townsville, defined only by electricity consumption from low to high use. Group TT represents the weighted mean for Townsville to allow generalisations.

Group T5, using 54 kWh per household per day (in the top 0.05% of domestic consumers in the population), reported becoming more conscious of energy consumption than lower use groups. More than lower electricity use groups, members of Group T5 changed their attitude toward energy use because they had become more aware, and were trying to save money or electricity (the 'reward' component of their changed attitude). This contrasts with the lowest use group, T1, where each household uses six kWh per day. They reported the least efforts to save money through electricity use reductions. High users reported most concern about their consumption levels. Half of the highest use group appear conscious of the 'excessive' use of household electricity. Being very high consumers shows that their willingness to use large amounts of electricity is stronger than their environmental or financial concerns. It is a little like dieting- highest consumers saying they are trying the hardest to stop consuming the most. There was a weak positive correlation between stated energy conservation behaviour and actual energy consumption. This was also found in Mt Isa.

Table 5.9 Self reported reasons for No change in energy attitude (%)

/Group	T1	T2	T3	T4	T5
Always been conscious/aware/careful	13	23	20	18	0
Have been very careful for years	8	8	8	0	10
Set in ways	3	3	3	3	0
I use so little	5	0	3	0	0

People who have not changed their attitude toward energy use do not see the need to. It is of interest that four people (10%) in the highest use group report that they have been very careful for years. They have no benchmark for their own consumption. This finding indicates the need to publish average per household consumption figures. In this way, people can make informed comparisons between their own consumption and the average.

5.2 Attitudes toward Solar Water Heating

Table 5.10 Intention to install energy saving technology in Mt Isa (%)

Would you install?	compact fluorescent tubes	solar hot water
Yes I would	3	1
No I would not	2	2
Reason not to install		
Too expensive	33	26
Have already installed	8	24
Haven't heard about them	28	1
Am only renting (20%)	4	21
Will when existing system fails	0	1.7
Present system adequate	8	18
Heard bad reports	1	1.7
Will install soon	4	0.3
Do not have enough information	8	0.3
Will leave premises before I recoup $	1	5

Some % total>100% because of rounding values.

Respondents in Mt Isa were asked if they would consider installing compact fluorescent tubes, or a solar hot water system. Table 5.10 shows initial cost is reported as a major prohibitive factor in the uptake of solar hot water and compact fluorescent tubes. About 25% of the householders had not heard of compact fluorescent tubes. The same question of intent to install compact fluorescent tubes was not asked in Townsville.

5.2.1 Water heating in Mt Isa

Each of the 15 households without a booster (21% of solar water heater owners) were perfectly happy with the level of hot water supplied. These people believe occasional cool water is no great hardship. Of the 24% of houses with solar hot water, about half rarely or never used their booster. People with electric only water heating averaged $148 per bill, while the 14% of households which had gas or solar only water heating averaged $112 per bill, an implied saving with solar of about $200 per year.

5.2.2 Water heating in Townsville

Sixty-four percent of respondents in Townsville showed a preference for installing a solar water heater if the initial cost was equalised with electric or gas systems:
Q *“If a solar, electric or gas hot water system all cost the same amount to buy, which one would you chose?”*

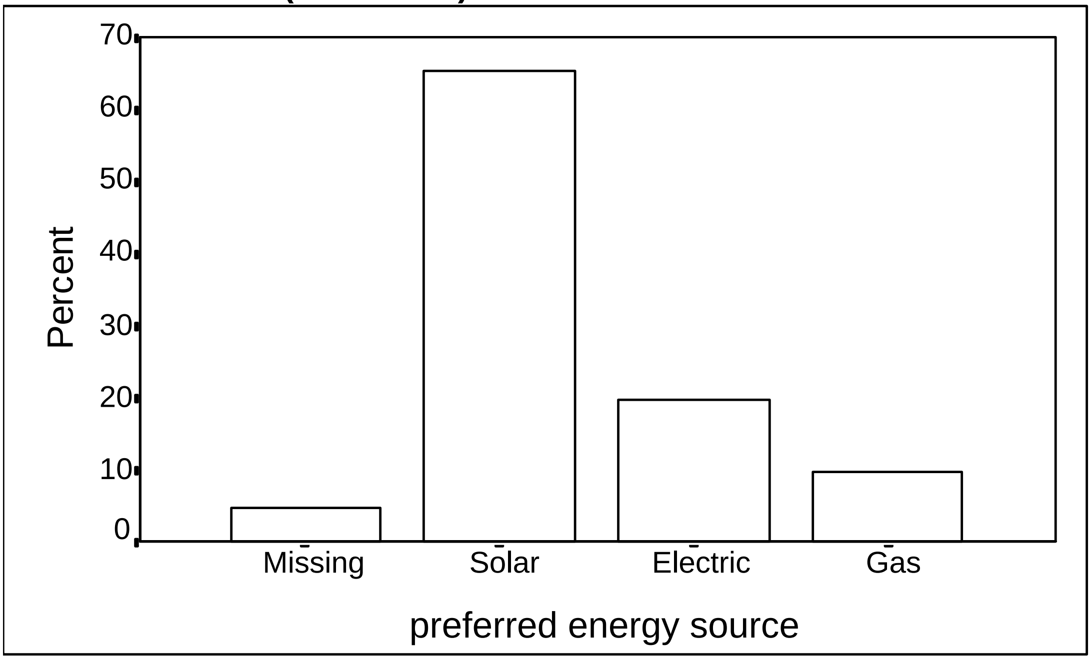
As shown in the previous table, some of the people interviewed were in rental properties. They were asked: *“If you DID have to replace your heating system , and solar, electric and gas systems all cost the same to begin with, which type would you most prefer?”*

Table 5.11 Preference for water heating energy source if all cost the same (%)

/Group	T1	T2	T3	T4	T5	TT
Solar	68	75	75	60	75	64
Electric	20	15	20	23	18	21
Gas	8	8	3	10	5	9

Data are missing from 4 households for this question

Figure 5.1 Preferred energy source for water heating if initial cost the same (Townsville).



Note: "missing" indicates that water heating energy source preferences were not recorded for 4% of households in the survey.

If the initial cost was equalised, the results shown in Tables 5.10, 5.11 and Figure 5.1 express a clear preference for solar water heating across a broad range of domestic consumers. The most common reasons given were that solar was cleaner, or better (environmentally). Many people pointed out that it was stupid not to use solar heaters in “The Sunshine State”. The strong preference for solar heating shown in Figure 5.1 is linked to Table 5.12, also showing a preference among Townsville residents for solar water heating. Figure 5.1 clearly shows that initial higher price of solar is the main reason for it limited uptake.

5.2.3 Main considerations if purchasing a new hot water system

The survey set out to discover the main criteria for selecting various major domestic appliances. For water heaters, the choices offered were: initial cost, how long the unit will last, how many showers you could have one after the other, the energy efficiency of the unit (running costs), whether it is solar, gas or electric, or any other. The energy efficiency (running costs) of the unit was the major reported consideration if buying a new hot water system. Durability is also important. For their purchase criteria for a new water heater, they were asked:

"Looking at Q7 on the card: if you were buying a new hot water system, which feature would you consider most important, next important,....

Table 5.12 Main considerations if buying a new hot water system in Townsville. Ranking per 40 households.

Choice /Group	Ranking[2]	T1	T2	T3	T4	T5	TT%[3]
Energy efficiency of the unit	1 2	14 13	11 12	19 6	14 14	17 11	63
Durability	1 2	5 13	9 10	8 7	7 7	6 7	47
Energy source	1 2	12 4	9 7	3 13	11 5	10 10	39
Initial cost	1 2	7 5	11 5	8 9	4 10	6 7	39

[3] The figures in this column were derived by adding together the percentage of people who nominated first or second preference in each of the five categories. Full details are given in Table A11.4 of Attachment 11.

5.3 Energy knowledge base in Townsville - the mini quiz.

This section reports knowledge levels of energy related issues in Townsville during July-September 1993. For future longitudinal studies in Townsville, or comparative studies with other populations, the following results provide base-line data.

To put respondents at ease, the questions were asked in a sequence intended to grade from easiest to hardest. The questions were (verbatim):

[2] In this and the following ranked tables, the numerals 1 and 2 denote first and second preference.

What follows is a 'Mini quiz' setting a 1993 knowledge base:

Q1. What is the name of one fossil fuel?
Q2. What is one renewable energy source?
Q3. What is a greenhouse gas?
Q4 Starting with the highest user, what three things do you think use the most energy around your house?
Q5. What % of your total electricity do you think your (main) refrigerator uses?
Q6. What do you understand by the expression: "Sustainable Energy Practices"?

For question Q4, there was a fair amount of leeway for an answer to be deemed correct. If the list included three of the following items it was recorded as accurate: hot water, refrigerator, air conditioner, freezer, stove, pump. If the answer included lights or television, plus two items from the first group, it would be scored as partially right, or fully accurate, depending on ownership of items in the first group. An answer with less than two of the first group, was scored as 'inaccurate'. Question Q5 and Q6 were as leniently assessed. Anything from 10-35% was considered an acceptable estimate of electricity used by the main refrigerator (depending on size and efficiency of the fridge in relation to the total electricity consumption for the household). Any explanation of "Sustainable Energy Practices" which mentioned solar, wind, renewables, or generally being able to keep supplying energy in the long term future was recorded as acceptable. A typically accepted answer was: "Energy which can be used indefinitely" (Household 90).

Results of 'Mini-Quiz' on Energy Knowledge

The question order in the survey is indicated by the Question number. The results, however, are grouped by knowledge of supply or use.

5.3.1 Energy supply knowledge

Q1. What is the name of one fossil fuel?

Table 5.13 Naming one fossil fuel (%)

response	T1	T2	T3	T4	T5	TT
Accurate	60	73	87	75	65	71
Inaccurate	5	5	3	3	10	5
Dont know	35	23	10	23	25	24

T1 - T5 each represent discrete and widely spaced groups of 40 households in Townsville, defined only by electricity consumption from low to high use. Group TT represents the weighted mean for Townsville to allow generalisations about the whole population.

The responses in Table 5.13 and the following tables are grouped in the widely dispersed electricity consumption groups in order to detect any uneven spread of results across different consumption groups. Overall, about three out of four people could name a fossil fuel. The low (T1) or very high (T5) electricity consumption groups were least able to do this. With the exception of T1, the following responses show little clear relationship between knowledge of energy issues and amount of electricity consumed.

Q2. What is one renewable energy source?

Table 5.14 Naming one renewable energy source (%)

response	T1	T2	T3	T4	T5	TT
Accurate	33	63	73	45	70	57
Partly correct	3	3	-	-	-	1
Inaccurate	10	13	8	13	5	10
Dont know	55	23	20	43	25	37

T1 - T5 each represent discrete and widely spaced groups of 40 households in Townsville, defined only by electricity consumption from low to high use. Group TT represents the weighted mean for Townsville to allow generalisations about the population.

Renewable energy researchers should note that in Townsville, September 1993, only about three out of five adults could name or describe a renewable energy source is. Only about one in three people in the lowest electricity consumption group (T1) were successful in this.

Q3. What is a greenhouse gas?

Table 5.15 Naming or describing a greenhouse gas (%)

response	T1	T2	T3	T4	T5	TT
Accurate	30	50	68	50	60	47
Partly correct	5	5	5	3	3	2
Inaccurate	18	13	8	15	13	14
Dont know	48	33	20	33	25	37

These values are a direct % of the raw data, ie for T3, 27 people gave an accurate answer. There were 40 respondents in each of the five stratified electricity consumption groups in Townsville, 27/40x100%=68%

Although frequently mentioned in the media, the concept of a greenhouse gas eludes half the population, with the low electricity consumption group again faring worst. An ANOVA (see Figure 5.3) shows that knowledge of energy issues tends to be clustered. if individuals know about fossil fuels, they are more likely to be able to answer the other questions than those who did not.

Q6. What do you understand by the expression: "Sustainable Energy Practices"?

Table 5.16 Understanding the meaning of "Sustainable Energy Practices" (%)

response/	T1	T2	T3	T4	T5	TT
Accurate	25	30	28	33	30	28
Partly correct	13	23	20	20	18	20
Inaccurate	0	13	10	15	13	11
Dont know	63	35	43	33	40	41

T1 - T5 each represent discrete and widely spaced groups of 40 households in Townsville, defined only by electricity consumption from low to high use. Group TT represents the weighted mean for Townsville to allow generalisations about total population traits (see Chapter 2.4.3 for substantiation) .

Sustainable energy practices are those which will remain viable in the long term. Only about one in three people have clear ideas about what sustainable energy practices may be. The criteria for judging sustainability were lax, and any answer which included mention of greater efficiency, less wastage or more care was judged partly correct. Answers which mentioned renewables as our future energy source, or talked about the long term future were deemed correct. "Use only solar energy", or "not using coal" would be considered correct.

5.3.2 Energy use knowledge

Q4 Starting with the highest user, what three things do you think use the most energy around your house?

Table 5.17 Perceptions of appliance electricity consumption (%)

response	T1	T2	T3	T4	T5	TT
Accurate	13	23	33	38	40	22
Partly correct	20	38	35	25	28	35
Inaccurate	55	56	33	33	33	41
Dont know	13	3	0	5	0	2

The data show that people have a poor understanding of relative electricity consumption of household appliances. Many people suggested that kettles, toasters, irons or vacuum cleaners used the most energy around their home. In Section 5.5 the high support for energy conservation is shown. Results in Table 5.17 show that without information about major consumption appliances, people cannot make informed choices about how to significantly improve their own conserver behaviour, even if they wanted to.

There is poor knowledge of appliance electricity consumption in many households. NORQEB has many freely available brochures on the topic. The further issue is whether many people care enough to find out. The reported 95% importance of energy conservation (Table 5.20) is counterbalanced by low electricity costs, a very small overall cost per household (3% of the average household income), compared with rent/house repayments, food and transport. People use electricity as they see fit, some more thoughtful about the use of inappropriate appliances or over-use of appliances. Of those who attempted an answer, there were two wrong answers to every right answer.

Q5. What % of your total electricity do you think your (main) refrigerator uses?

Table 5.18 Estimated proportion of household electricity used to operate (main) refrigerator (%)

response/	T1	T2	T3	T4	T5	TT
Correct	45	53	53	50	55	43
Partly correct	5	18	5	3	5	11
Inaccurate	18	15	18	20	18	16
Dont know	33	15	25	25	23	28

The level of awareness about the contribution the refrigerator makes to the total electricity bill was fairly evenly divided. About half the interviewed people had a reasonable feel for the relative electricity consumption of their refrigerator. Anything between 10 and 35% was considered correct, depending on the overall consumption patterns of the household and the age and size of the fridge.

5.3.1 Summary of Quiz Results

Group T1, the lowest electricity use group, knows the least about each of the areas of energy-related knowledge assessed in the above quiz, adding a general lack of awareness of larger energy issues to their generally lower socio-economic status. This is explored in the following discussion section. The knowledge levels vary from question to question among the higher use groups T2 - 5. About half the people interviewed had a rough idea of the relative electricity use of their fridge, about one in three had a clear idea of the concept of sustainable energy practices. In the questions about naming a fossil fuel, a renewable energy source and a greenhouse gas, the above average electricity consumption group showed a higher knowledge level than any other group. The questionnaire did not ask education levels, which may have correlated. The summary chapter which follows constructs descriptive traits of the five groups, with a special focus on features of group T3. Group T3 emerges as the most relevant target for DSM, representing the bulk of the population who could achieve ‘no regrets’ reductions in electricity use. For the representative population sample, the following generalised results emerged:

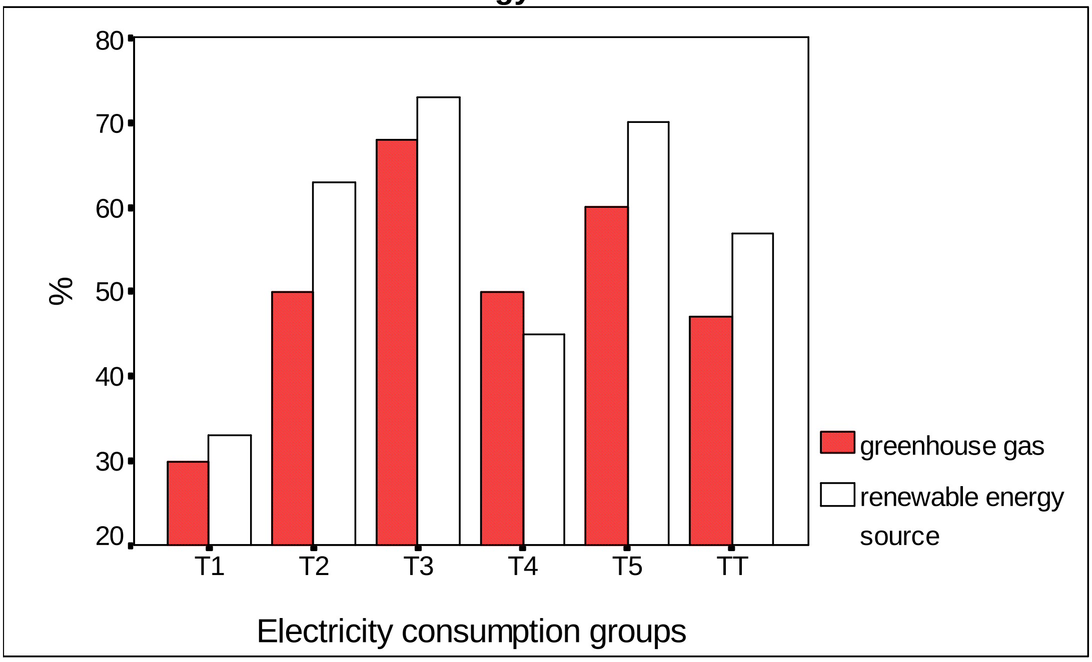
Table 5.19 Generalised results from mini-quiz

Question	correct responses (%)
1. Naming one fossil fuel	71
2. Naming one renewable energy source	57
3. Naming a greenhouse gas	47
4. Naming main electricity use appliances etc. within the home.	22
5. Estimating % of electricity used by own (main) refrigerator	43
6. Understanding of expression: “sustainable energy practices”	28

renewable energy= based on a non-depletive energy source, greenhouse gas=any radiatively active gas, The main electricity appliances are almost always water heaters, airconditioners, refrigerators, freezers, swimming pool pumps, and to a lesser extent, lights and televisions.

Figure 5.2 shows the spread of responses from two energy knowledge questions. The results in Table 5.19 and Figure 5.2 clearly indicate the fundamental need for public education on the issues of human energy use, so that people can make informed behavioural choices. This is discussed in detail in Chapter Six.

Figure 5.2 Knowledge levels about Greenhouse gases and renewable energy sources



5.4 Purchase criteria for new major appliances

Writers such as Stern (1992) argue that major appliance purchase decisions have a profound influence on actual energy used. After asking details on appliance ownership and use (see Chapter 4), respondents were asked to identify the most important criteria they would apply when buying a new appliance (see Table 20). The responses indicate the relevance of energy efficiency in purchase decisions.

"Looking at the card [Initial cost, gas or electricity (for stove), how long it will last, energy efficiency], what would be the most important consideration if you were buying a new one."

Table 5.20

Main Purchase criteria for new major appliances already owned

Appliance	Criteria for purchase	T1	T2	T3	T4	T5	TT%
Air conditioner	energy efficiency	3	7	12	12	18	48
Washing machine	durability	12	15	22	15	13	44
Stove	electric	15	13	9	11	14	34
Fridge	energy efficiency	17	18	18	16	24	44
Freezer	-energy efficiency -Initial cost	4 1	8 4	11 9	15 8	15 5	43 40

Full results are given in Table A11.4 in Attachment 11. T1 - T5 figures are given per 40 households.

Energy efficiency is the most important reported consideration for fridges, freezers and air conditioners. These results indicate that 40 - 50% of people consider energy efficiency important if they buy a major appliance. As seen in Table 5.12, this also applies for water heating. Although outside the scope of the present work, the above results could be checked by surveying electrical appliance retailers, to test for correlations between stated criteria and actual purchase decisions. Durability was reported as most important if the respondent was going to buy a new washing machine.

5.5 Perceived importance of Energy Conservation

The following section is based on ranked responses to questions about energy and environmental conservation. *"Using this scale, do you think conserving energy is Very important, Important, Neither important nor unimportant, Unimportant, Very Unimportant?"*

Table 5.21 Attitude toward energy conservation (%)

/Group	T1	T2	T3	T4	T5	TT
Very important	68	68	73	68	75	68
Important	30	28	28	28	25	27
Neither important nor unimportant	3	5	0	5	0	5

Data in Table 5.21 expresses a clear belief from 95% of the population that energy conservation is 'important' or 'very important'. Nearly everyone agrees conserving energy is important, but this is not particularly linked to the amount of electricity consumed by most respondents (see Table 3.3).

Question 2 asked: "*Again from the scale: do you think looking after the environment is .. Very important, Important, Neither important nor unimportant, Unimportant, Very Unimportant?""*

Table 5.22 Importance of looking after the environment (%)

/Group	T1	T2	T3	T4	T5	TT
Very important	73	85	85	70	80	82
Important	23	13	15	28	20	16
Neither important nor unimportant	5	3	0	3	0	3

T1 - T5 each represent discrete and widely spaced groups of 40 households in Townsville, defined only by electricity consumption from low to high use. Group TT represents the weighted mean for Townsville to allow generalisations.

Q3 asked: "Using scale 3 on the card: are you concerned about the effect <u>your</u> behaviour has on the environment ...(always - never)

Table 5.23 Concern for own effect on the environment (%)

/Group	T1	T2	T3	T4	T5	TT
Always	33	38	33	28	25	36
Usually	33	35	38	38	48	33
Sometimes	25	23	23	30	25	26
Not often	10	4	8	3	3	7

Tables 5.22 to 5.24 show that 98% of people surveyed believe that looking after the environment is important or very important. Two out of three people report being usually or always concerned about the effect their behaviour has on the environment (not one person said they were never

concerned about their own effect on the environment). Sixty percent of people report their behaviour toward the environment generally matches their high environmental concern, with little correspondence to the amount of carbon dioxide they cause through their coal-based electricity consumption.

Q4 "How often does your behaviour match your environmental concern?

Table 5.24 Match between environmental concern and behaviour (%)

/Group	T1	T2	T3	T4	T5	TT
Always	20	25	13	15	15	24
Usually	45	38	55	43	55	36
Sometimes	23	25	20	30	25	26
Not often	10	8	8	8	5	10
Never	0	3	0	0	0	0

Seventy percent of people report their behaviour toward the environment generally matches their high environmental concern. This question indicates how comfortable people are with their own behaviour in relation to how much they care about the environment. Many people reporting "not often" have internal conflict (dissonance) between their environmental concern and their own behaviour. Those in the higher use groups reporting "always" display a lack of understanding about the impact their own behaviour has on the environment. This is a very important issue. It emerged from this study that many people see no connection between their attitude toward environmental care and their own behaviour. It is as if their own behaviour did not count.

5.5.1 Relative importance of energy conservation to other conservation issues

People interviewed were asked to look at a card displaying the following alternatives listed in Table 5.25, then rank them in order of importance. Many people said they were all interrelated, or that they were all important. They were encouraged to try and rank them anyway.

QB1 asked people: *"Using the card for Q16, which do you think is the most important regional environmental issue (=1), next important...:* The following table presents the results in descending order of overall perceived importance.

Table 5.25 Ranking of Regional Environmental Issues (rank 1= most important)

Issue /Group	rank	T1	T2	T3	T4	T5	TT%	TT% r 1+2
Water conservation	1 2	17 12	9 11	17 10	13 14	17 9	35 30	75
Land management	1 2	9 8	3 13	11 10	14 13	15 10	22 27	49
Energy conservation	1 2	10 7	8 9	8 12	6 8	8 12	21 21	42
Protecting the reef	1 2	9 5	12 3	3 6	5 7	3 5	19 14	33
Urban sprawl	1 2	3 5	3 3	1 2	1 2	2 2	6 7	13

Full results are given in Table A11.7 Occasionally there was a language barrier, and a couple of people just glossed over the question - their prerogative, or remained with the stance that the issues were all important. Most people did rank the five issues.

The final column in Table 5.25 shows that 42% of respondents ranked energy conservation first or second among the five regional conservation issues offered for comparison. The overall perspective given by many householders in response to this question was quite sophisticated: if we looked after our water resource properly, we be practising good land management, and properly consider urban sprawl. This line of argument links good water conservation/management to less nutrient run-off onto the Great Barrier Reef. People felt the Great Barrier Reef was extremely important, with structures already in place to protect it.

5.6 Events which may change energy use

People were encouraged to rank at least five of the 10 choices supplied on events likely to impact on their energy use (Table 5.26). Some people only gave one or two, other people ranked the entire array. Table 5.27 only gives the group responses to the first two identified events most likely to make them seriously consider their energy use. The householders were asked (while being shown a card identical to that in Table 5.26):

“Using the box on the card, which event is most likely to make you seriously consider your energy use, in your general behaviour, or if you were buying a new major appliance or car? ....next most important..”

Table 5.26 Events which may cause personal reduction in energy use

* Concern about your contribution to Greenhouse gases. * Your friends were reducing their energy use. * The price of electricity and petrol rose by 25%, * Low interest loans were given to buy major energy items. * Government paid 25% of new high efficiency appliances. * You realise that energy efficiency can save you money. * Concern over how much fossil fuels you use. * Nothing. * People you respected were reducing their energy use. * Concern about the future. * Other.

White (1988) states that self-reporting “knowledge of intentions ... [is] introspectively accessible” (p15). People are in touch with their intentions, and possible changes likely to effect their behaviour. From Table 5.27 it can be seen that fear of electricity price rises, concern for the future, ability to save money and own contribution to greenhouse gases were reported as likely to produce conserver behaviour, and thus should form the focus for future energy conservation programs. They provide the central 'why' of energy conservation most likely to trigger a response in people. The ‘how’ is already well documented and understood (Stern 1992, Dwyer et al. 1993). The impact of substantial energy cost rises would probably render the greatest reduction in electricity consumption. Public education linking future choices and quality of life to current behaviour is also likely to elicit a response from many people. Providing the context and information based on personal savings and concern for the future is likely to reduce electricity wastage.

Many of the categories in Table 5.27 were selected to compare findings of prior researchers and what householders themselves perceive as the most likely to be effective. From Table 5.21 it is clear that the vast majority of people interviewed see energy conservation as important. This is in accord with current researchers elsewhere (eg Dwyer et al. 1993).

Table 5.27 Most likely events to cause energy use reductions (%)

/Group Event	rank	T1	T2	T3	T4	T5	TT	rank 1+2

Electricity and fuel price rise of 25%	1 2	23 15	30 10	20 15	25 10	33 15	27 15	42
Concern about the future	1 2	18 13	18 25	30 13	25 18	28 13	20 16	36
Concern over your own greenhouse gas contribution	1 2	8 8	23 13	18 23	28 20	13 40	15 11	26
Realisation that energy efficiency can save you money	1 2	23 10	10 13	23 5	8 10	15 10	17 7	24
Govt. paid 25% of new high efficiency appliances	1 2	3 8	8 13	10 18	5 10	5 15	7 11	18
Low interest loans for efficient appliances	1 2	3 8	0 8	0 10	5 13	0 3	1 11	12

T1 - T5 each represent discrete and widely spaced groups of 40 households in Townsville, defined only by electricity consumption from low to high use. Group TT represents the weighted mean for Townsville to allow generalisations about the total population.
The first five ranks are given in Table A11.8.

In the study by Foster et al.(1991), the overwhelming finding was that word-of-mouth (the influence of friends and builders) was the strongest influence on actual home builders choosing to have insulation or solar hot water in Queensland. The perception of most Townsville respondents was (see Table A11.9) that the influence of friends would be minimal. Behavioural scientists (eg Stern 1992) believe that clear role modelling by a well-respected person is a strong reinforcer of energy saving behaviour. Few of the people interviewed in Townsville consciously agreed with that. There is clearly a gap between the theory and the actual perceptions of people interviewed about what may or may not influence their energy consumption behaviour. The data in Table A11.9 show that respondents generally do not think they would be particularly influenced by friends or role modelling by a public figure. This may only mean that the other options are seen to be more compelling. Perhaps when we are directly asked, we do not like to admit that other people greatly influence us. ”There is a self-serving bias here- people do not like to admit that *their* view is substantially influenced by the views of others (Reser pers.com.1995).

People are strongly in favour of energy conservation as an abstract ideology (for environmental reasons), but only core issues like money or concern for the future are considered likely to profoundly effect personal energy consumption. Influence of the mass media, role models or friends as part of a societal shift in normative values (Ajzen 1980) may be outside many respondents' way of thinking, going against the 'individualism' seen as characteristically Australian. Why so few people should acknowledge the influence of friends in reducing energy use is an issue which is too complex to cover in this work, but may help public education theory through further research. The dissonance between mateship and individualism in the Australian make up may be linked with our notions of convict/outlaw antisocial/authoritarian myths. Such possibilities are left for others to pursue.

5.7 Respondents' thoughts on energy supply and use.

The final survey question was open-ended:

"What are your current thoughts on energy supply and use?"

The answers are given in order of frequency. They are listed in detail, to keep the information as 'fine grained' as practicable.

Table 5.28 shows that using renewable energy is seen by the greatest number of people (about 10%) as the most important thing when asked about the current supply and use of energy in Townsville. There is a stated dislike of wastage. There is a clear desire for Government to provide more investment in renewable energy research. There were many more perspectives, given in Attachment A11 following Table A11.9.

Table 5.28 Current thoughts on energy supply and use in Townsville

comment/group	T1	T2	T3	T4	T5	total
Use renewable/solar sources	1	3	6	2	7	19
Too much car use	3	1	4	4	3	15
Shouldn't waste	5	1	1	1	5	13
Govt. should invest in renewables and research	2	3	5	-	3	13
Don't like water wastage	1	4	2	3	2	12

Greater detail is given in table A11.12.

5.8 Summary, discussion, conclusions and recommendations derived from 'Attitudes' questions.

Overall Analysis

Much of the analysis given in the earlier part of this work is based on relevant literature and descriptive statistics of the survey work conducted in the two major population centres of North Queensland. The following section focuses

on more complex relationships of the data collected in Townsville, attempting to find relationships among the measured variables, using partial correlations, analysis of variance, one way analysis of variance and linear (and stepwise) regression and multiple regression . Exhaustive statistical testing and discussion of analysis with such statisticians as Dr B. McArdle (Uni. of Auckland, Sept 1994) convinced me that the very design of the Townsville research made the relationships between electricity consumption and other variables self-evident. People who used more electricity tended to have more people in the household, have more gross-using appliances and use them more often. Attitude measures were generally unrelated to consumption, with the exceptions noted in the prior section. Tests using one way analysis of variance
with the energy consumption controlled, then the number of residents being controlled (to see what relationships were a direct result of the number of residents) were run, only confirming the above generalisations.

Correlations

Partial correlation tests were performed for both electricity consumption and resident numbers, testing variables singularly, with others held constant. Using multiple correlations (comparing correlations with the electricity consumption, then the number of residents held fixed, Spiegel 1972 p269), the following correlations were found, where ‘r’ is the coefficient of multiple determination, or linear multiple correlation. Weak ($.2<r<.3$) relationships were found between freezer ownership and the number of residents. Older respondents (over 60) tended to have less concern about the future and more refrigerators. It was found that household income (but not per capita income) weakly correlated with electricity consumption. Owning a freezer indicated a reasonable likelihood of owning a clothes drier, and the analysis showed that the number of cars in a household was weakly correlated with the amount of electricity used.

Figure 5.3 Statistical links between variables

Weak correlations

Number of residents — freezer ownership

Older residents (>60 yo) — less concern for the future; more refrigerators

Household income — electricity consumption

Electricity used — number of cars owned

Medium correlation

Knowledge of fossil fuel — knowledge of sustainable energy

Knowledge of renewable energy — knowledge of sustainable energy

Number of residents — number of cars

Clearly correlated

There was clustered knowledge of:

Fossil fuel — green house gases

Greenhouse gas — renewable energy

Fossil fuel — % electricity consumption of refrigerators

Other relationships with medium ($.3<r<.5$) correlation, were almost all clustered knowledge about energy issues: knowledge of fossil fuel and sustainable energy were linked. Knowing about renewable energy correlated moderately with an understanding of sustainable energy. The amount of airconditioning used was related to the number of airconditioners, and the number of residents gave an indication of the number of cars per household.

A third group of relationships was found, (see figure 5.3) related to knowledge clusters which were reasonably strong positive correlations ($.5<r<.7$). Knowledge (or lack of) about fossil fuels and greenhouse gases, renewable energy and greenhouse gases, fossil fuels and the proportion of electricity used for refrigeration were clearly interconnected for many respondents. Many tests were run across the full range of data collected, including forward and backward step-wise linear regression. Apart from the obvious links between consumption, appliance ownership and use documented in Chapter four, there were few significant relationships. The only correlations found are recorded in this section. Knowledge of energy supply and use is clustered: a respondent who knows about renewable energy is likely to know most of the other energy-related issues.

A working hypothesis of this research was that a poor understanding of energy supply and use facts may explain why many people think energy conservation is important, but use as much electricity as suits them. Superficially, the research has not substantiated that hypothesis. Table 5.21 shows that the perceived importance of energy conservation is quite uniformly spread across the five consumption groups, but a five-fold increase in per capita electricity consumption occurs across the five groups. Tables 5.13 - 18 show no meaningful connection between electricity use and knowledge level. On a superficial level there is no connection between knowledge of energy matters and the amount of electricity used. Strategies to increase knowledge which is personally relevant are outlined in the recommendations. The main issues are being aware of what are the major consumption appliances, and how much carbon dioxide their use causes. Twenty percent of Townsville people said that renewable energy should be used more, 64% said they would prefer solar water heating with equalised initial costs. There is a clear awareness among many people of the preferable options, but little sense that ‘context’ (electricity pricing) is producing meaningful change.

This chapter indicates some 1992/93 base levels of North Queenslanders’ attitudes about energy sources and use. Two people of the 500 interviewed suggested that electricity costs too much. Many writers on contextual parameters of energy use (eg Greene 1992) agree that the underpricing of fossil fuels may be more important than attitudes toward energy. There is institutional underpricing of coal used in power generation and the electricity rates structure. The price is further reduced for off peak rates (Jarach 1989, Brisbane Group AIE 1993, ESA 1993).

This research indicates that cheap electricity helps explain the gap between stated attitudes toward energy conservation behaviour and actual electricity used by the majority of the householders surveyed. While 95% of Townsville residents reported that they believe conserving energy is important, and report that increased cost is the most likely thing to make them reduce their energy use, there is no great incentive to be overly concerned with energy-saving behaviour.

The Townsville survey shows that people who use the most electricity think most about waste reduction. Four people (10%) in the highest use group report that they have been very careful for years. Perhaps because they have little with which to compare their own consumption. The group using the least energy (T1), consistently reported doing the least to save energy or reduce their energy wastage. This group has the lowest residents per household, and the lowest number of major appliances. The first and last tables in this chapter clearly show what respondents think does and does not constitute energy saving. The most reported behaviours or features are switching off unnecessary lights, cold water clothes washing, minimising air conditioning use and walking to nearby destinations rather than driving. People would like greater use of renewable energy sources, and expressed the belief that energy should not be wasted.

5.8.1 Stated attitudes toward solar water heating

This research into attitudes accepts the approach of Airey (1984). "Surveys are restricted to measuring *expressed* attitudes." (Airey 1984, p7). In the Townsville survey, 64% of respondents reported a preference for solar water heating, but consider that the initial price (compared to electric or gas systems) was too high. Energy efficiency is the major reported consideration if or when buying a new hot water system.

5.8.2 Summary of quiz results

About 75% of respondents named a fossil fuel, 60% named a renewable energy source, 50% could name a greenhouse gas, or had a reasonable idea of the percentage of electricity their refrigerator used. Only about 33% of respondents could identify their main electricity use appliances, or were able to indicate what the expression 'sustainable energy practices' might mean. In the questions on naming a fossil fuel, a renewable energy source and a greenhouse gas, the above average electricity consumption group showed a higher knowledge level than any other group.

The results of the quiz highlight the fundamental need to educate decision-makers, from householders to politicians. There is the need to comprehend the underlying issues which dictate committed energy conservation strategies are necessary for sustainability (ESD Chairs 1992). Knowing that the rarely used second refrigerator is using two to five times as much electricity as the total household lighting may help people know what to do to reduce wastage without sacrificing life-style. "People may lack sufficient information about how to act in ways that are environmentally responsible." (Dwyer 1994 p240).

5.8.3 Perceived importance of energy conservation

Energy efficiency is the most important reported consideration if purchasing a fridge, freezer or air conditioner. White argues that self prediction in self reporting “tends to be accurate.” (White 1988 p 34). The research indicates that people consider energy efficiency important; the primary consideration if purchasing a major electrify-consuming item.

More than 90% of the population believe energy conservation and looking after the environment important. People may be expressing what they consider expected or normative values (Cialdini 1990). Even so, there is a clear message that people feel conservation is important, or think that it is ‘correct’ to say that. Nearly everyone wishes to be recorded in that way, making “culturally sensible and collectively sanctioned choices.” (Lutzenhiser 1992 p 54). If more than 90% say conservation is important, this implies that conservation is collectively sanctioned. Many authors argue that energy conservation programs need to be “compatible with the prevailing culture.” (Geller 1982 p205).

Two out of three people report being concerned about the effect their behaviour has on the environment. For about 60% of the population, the impact they believe they have on the environment matches their high environmental concern. With 88% of Townsville households having electric hot water systems, each responsible for the emission of about two tonnes of carbon dioxide each year, this self-perception of low personal environmental impact prove there is a fundamental lack of knowledge about the issues of energy supply and use. Authors like Geller (1982) argue that an average North American householder could cut their energy use in half without a drop in life style. Being motivated, knowing how and having the right technology are seen by him as essential.

My research also shows that people do not know how their electricity use compares to other households, and thus cannot form normative values. Most people reported they did not know whether they used a lot or a little electricity. The exceptions to this were in the lowest and highest use groups. Lack of a benchmark is displayed by four highest-use households who reported they had not changed their attitude to energy use in the prior twelve months because they “have been careful for years.”

Respondents identified events most likely to change energy use. In descending frequency, they are: fear of electricity price rises, concern for the future, ability to save money, and their own contribution to greenhouse gases. These main potential motivators of conservation behaviour, with further testing, should form the focus of future energy conservation programs. Substantial cost increases would probably produce the greatest changes in electricity consumption, followed by concern about the future.

The reported impact of increased price rises converges with the literature about the underpricing of electricity (eg Wall 1989 p18, Diesendorf 1992, Jarach 1989, Business Council 1991, Greene 1992). Electricity is too cheap. It does not include the ‘externalities’ of pollution, health impacts, hidden subsidies or the long term worth of coal. Coupled with a more efficient solar water-heating industry (Saddler 1994), a substantial electricity price rise will make solar water heating cost-effective. The final open-ended question of the survey on supply and use of energy produced the following responses (in descending frequency): use renewable/solar sources (about 10%), shouldn't waste, too much car use, and that the Government should invest in renewables and research.

5.8.4 Discussion of attitudes, context and Government role in DSM

"Surveys are the major means by which social psychologists and others attempt to assess the attitudes, beliefs and values of the general public ... we shall refer to all of them under the rubric of 'attitudes'" (Schuman 1985).

Different electricity usage within a similar context (similar household type and demography) implies a different attitude to energy use: different feelings or different knowledge levels. Within a given context, energy using behaviour is a part of, and reflects attitudes about energy use. Writers like Bell et al. (1990) argue that underlying beliefs are more important than stated attitudes. In America, many people "believe that conserving energy by lowering the heat in their house could adversely affect their health and comfort. Environmental education could be aimed at attacking such beliefs." (Bell et al. 1990 p 477).

Five percent of the Mt Isa population with solar-only water heating (about 300 households) are not bothered by an occasional cool shower. There may be a whole theory of social divisions based on self-pampering; the right to have what is perceived as perfect comfort at all times, which may be a trait of the high consumers. This is in clear contrast to a group which is a little more stoic, a little more rough and ready. Such speculations are outside the scope of this analysis, but data in studies such as this could probably be used to support social partitioning into broad groups of the grossly self-indulgent compared to the reasonably rough and ready.

Knowledge, attitudes and behaviour

The results of the research undertaken in Mt Isa and Townsville substantiate the overall lack of connection between energy use and stated attitudes toward energy conservation, confirming the work of many researchers. "Indeed, previous studies show that, although people express a relatively high level of concern about the environment, they engage in few environmentally oriented behaviours" Scott et al. (1994 p241). Based on the findings reported in this chapter, and an understanding of attitudes outlined in Section 1.5, this research indicates that the lack of connection between stated attitudes and behaviour may stem partly from a lack of knowledge about relative energy use, greenhouse gases or fossil fuel depletion. Electricity is very cheap (only two people in 500 commented that electricity costs too much), it is probably not widely known that Australians are among the highest per capita energy users on the planet.

Most householders were unaware of their relative electricity consumption and had little conception of the electricity used by various appliances. Their stated support for energy conservation has little monetary motivation (electricity is priced to squander), or solid information about simple changes which will directly contribute to greater energy efficiency (see recommendations in chapter 6). As Scott (1994) reports, Dunlap (1991) "has identified a number of reasons why attitudes and behaviours are at variance ... the public tends to see institutions, not individuals as the primary culprits [and] people may lack sufficient information about how to act in ways that are environmentally responsible." (Scott 1994, p241). Scott also found insignificant relationships between attitudes and behaviours, in line with the other eight reported studies (Scott 1994 p255).

The relatively low levels of knowledge people have about their own energy use implies a pressing need for blanket information on the relative daily energy use (and perhaps the amount of coal and greenhouse gases involved) for all the major and frequently used appliances. Many people suggested that kettles, toasters, irons or vacuum cleaners used a lot of the electricity in their home. There is a clear lack of understanding about the electricity consumption of appliances in many households.

NORQEB has many freely available brochures on the topic. The further issue is whether many people really care. Electricity costs are a very small overall cost per household (about four percent of average of gross household income). The 'affect' or feeling part of attitudes (Oskamp 1984, Pratkanis 1989) toward conservation is very high, but the cognition or knowledge part is quite hazy. For example, knowledge about the pollution and resource depletion involved with electricity supply; and how to effectively reduce wastage, seemed low. With electricity being cheap (eg Greene 1992), there is no great incentive to do much more than say that conservation is important. This issue of pricing context and its effect on behaviour (Stern 1992) should not be underplayed. However, this study highlights the need to add information into the cognitive position in the triangular ‘attitudes’ construct. This should be done with the full range of public education techniques summarised in the following chapter to help bridge the gap between feeling that conserving energy is very important, understanding why it is important, and actually knowing what are the best ways to reduce energy wastage.

Government pricing of electricity

Responses to an open-ended question on energy supply and use indicated a clear desire from about 15% of respondents for increased focus on renewable energy sources. This research provides the government with clear messages about the perceived desirability of energy conservation and preferred future energy sources. Whether government (State or Federal) chooses to take any notice of this kind of sentiment remains to be seen.

The price context is covered in a 1994 submission by the author to the public consultation on the future of electricity supply in Queensland, and is included in this work as Attachment 10. With the electricity supply industry in

Australia currently undergoing major restructuring, the outcome is predicted to be cheaper electricity (Tansley 1994). This implies greater wastage, coal depletion and worsening of greenhouse gas emissions. Government context-setting of electricity pricing emerges as the core issue in electricity conservation. The dominant world view (Fien 1993) appears halting in responses to environmental or resource depletion issues. The dominant world view appears reluctant to look beyond the era of abundantly cheap fossil fuels, apparently believing economic imperatives will somehow keep cheap energy supplied to ordinary people to use in ‘ordinary’ ways. Belief structures and faith are beyond the scope of this work. I hope to explore them in further study.

Demand Side Management

Within the context of cheap fossil fuels, there is an apparent need to use as many intervention techniques as possible at the one time (Dwyer 1993 p310). The effect of each antecedent or consequent intervention is not easy to analyse from a reductionist point of view, but holds the likelihood of greater and more permanent overall behavioural change (the aim of intervention) than single focus interventions, which have largely been found ineffective after three months (Dwyer 1993). A public education program in north Queensland could use the fact that energy efficiency is reported as the most important purchasing criterion for fridges, freezers and air conditioners. This is a positive indication to energy researchers, because
“.. energy demand depends more on one time investment [major energy use items] than on everyday behaviours” (Stern 1992 p295). The link between the respondent’s stated behavioural intent (as a portion of attitudes) in major appliance purchase decisions could be tested by surveying electrical goods retailers about customer purchase criteria.

In combination with the many behavioural change techniques discussed in Chapter 1.6, knowing impacts of personal energy use and ways to reduce their use will provide people with informed choice. The literature contains much information on energy conserving behaviour and public education. The information has been available for at least 10 years (Oskamp 1984). There are many psychology books and papers on motivating people to change (eg Franken 1988, Szymanski 1993). Until Government is prepared to act in the long-term best interest of the residents and the environment, this knowledge will remain largely unused in encouraging energy conservation in Australia.

The research indicates that people have little idea of their relative electricity consumption. This was particularly apparent while conducting the surveys in Mt Isa. Further surveys may benefit from a question about what respondents think the average consumption is, and compare that to their own. People use electricity as they see fit, some more thoughtful than others about the desirability to minimise unnecessary usage through inappropriate appliances or over-use. Electricity use does not appear to be particularly constrained by the current cost per kilowatt hour.

5.8.5 Recommendations

Increase price

The most obvious recommendation is to increase the cost of electricity, at least to the point where it is not the recipient of hidden subsidies. Increased cost should be preceded by massive public education programs based on findings of research such as this. The results in Table 5.19 and Figure 5.2 indicate the need for public education on the serious need for energy conservation, providing the public with an understanding of how much electricity is used by major appliances.

Clear price signals and a good understanding of the details of energy supply and use will give people the motivation and knowledge to make sound energy conserving decisions. Thus the key short term recommendation is to improve knowledge of energy issues, especially of ways that individuals can reduce their personal energy use. Increasing knowledge about comparative use is also recommended; publishing average household electricity consumption at each billing round. There is an apparent lack of connection in the ‘attitudes triangle’ between feelings, behaviour and knowledge (Pratkanis 1989). In combination with the many behavioural change techniques discussed in Chapter 1.4, knowing impacts of personal energy use and ways to reduce their use will provide people with informed choices. Notices in newspapers could encourage people to compete with their own prior bill, compete with the adjusted (number of people per household) average consumption, and act as a member of the community as a whole to reduce the evening peak and reduce overall consumption. Government has assumed responsibility for electricity provision in larger settlements. While the average per capita electricity consumption is about 7 kWh per day, the higher use groups averaged about 15 kWh per person per day. Charging more for electricity during the evening peak, like many US utilities (Weinberg 1992), and charging more for electricity use which exceeds the per capita average is the easiest likely way to reduce the need for more coal-based power stations, and greatly reduce excessive use.

Change pool pump timers and discourage use of second refrigerators

The following five demand targets meet the criteria of authors like Geller (1987) and Stern (1992). Peak demand can be reduced by encouraging swimming pool pump owners to reset pump timers outside the evening peak period. Turning off low-use second refrigerators will further reducing peak load. Successful demand side management will encourage use of low interest loans for solar water heating and the use of compact fluorescent bulbs. Group T3 should be targeted. They represent the majority of above average electricity consumers. Households with one or two people working, especially with children, should be encouraged to undertake reductions.

'Light bulb equivalents'

Public education strategies should test the effects of using 'light bulb equivalents'. 94% of householders in Townsville reported consciously switching off lights when not in use (it was 93% in Mt Isa). This indicates the possibility of using the equivalent amount of electricity used by a light bulb when encouraging other electricity conservation behaviours- running a second fridge is like leaving two lights on 24 hours per day all year.

Light-bulb equivalent ratings should be given: if you use 360 kWh of electricity per bill on electric water heating (Mt Isa electric only average), it is the same as leaving four 60 watt light globes continuously, releasing about two tonne of carbon dioxide into the atmosphere (Walker 1990) per year.
All techniques (Stern 1992) should be used in conjunction.

CHAPTER 6
Summary Results, Discussion and Recommendations

6.1 Emerging perceptions

Historically governments in Australia have assumed responsibility for environmental stewardship. This carries the responsibility to engender conserver behaviour in energy sources and use (Keating 1992). Conserver behaviour is perhaps most easily achieved by signalling incremental rises in the retail price of electricity to encourage further uptake and development of renewable energy sources, and greater energy efficiency and parsimony (Troy 1992). Such a paradigm shift will involve public education, hastened by using language of “depleting” or “sustainable” energy sources. Our survival urge and forethought include the needs of future generations. Reducing reliance on depleting energy sources needs to be coupled with selective and efficient use of energy.

Government has historically assumed custodial responsibility for the environment, then underplayed that responsibility. Government also provides cheap electricity. Coal subsidies and other ‘hidden’ costs (including infrastructure, resource depletion and pollution) provide underpriced electricity. This is especially true of off-peak rates (Jarach 1989). The two dissonant roles of assuming environmental care, and providing electricity at a price which does not foster electricity conservation have been conducted within a paradigm of growth and human dominance (Nash 1989, Fien 1993). Domestic energy conservation within the nullifying context of cheap electricity becomes an issue of self-awareness.

Responses at the household level to ‘energy saving’ questions indicate that people try to minimise waste (especially turning off unneeded lights). This research showed that nearly everyone (98%) thinks looking after the environment is important, but not many people seem to see that their behaviour contributes to environmental problems. On average, heating water with electricity releases about two tonnes of carbon dioxide per household every year (from average H2 tariff kWh figures in Mt Isa, and carbon dioxide from coal-electricity from Walker 1990). The core of public education should be the direct results of personal energy choices: the amount of carbon dioxide emissions caused by using major appliances. Confronting the problem of depleting fossil fuels requires a general shift in values. A shared belief that underpriced electricity is a right can be replaced by a value system which considers the provision of electricity expensive. Electricity use should become specialised for 'fine' applications, like lighting and operating electronic equipment such as televisions or high efficiency motors (Holdren 1990).

Beliefs or 'world views' can be conceptualised as relationships between the dominant social paradigm (DSP, see Chapter 1.3), the public sector, the new environmental paradigm (NEP), and the private sector. An expression of the dominant social paradigm is that supply should continue to grow. An expression of the NEP is that all resources should be used sparingly. Electricity supply demonstrates the conflict between centralist power and greater self-reliance at a local and personal level. Electricity supply is an issue of government and community dependency. Data from five hundred households indicate that electricity is perceived as inexpensive; to be used in whatever way suits.

6.1.1 Time horizons and change.

Stern (1992) argues that global environmental change is a process operating over decades or centuries. Relevant behavioural variables that operate on that scale are: the socialisation of attitudes; fertility decisions; and the purchase of buildings, automobiles, and major household appliances. This reinforces the importance of major item purchases. Minimising future problems depends on forethought, forward planning, behavioural and technological changes. Understanding problems of current and extrapolated energy use patterns sets the scene for considered anticipatory responses to depleting energy sources. Reduced reliance on depleting energy sources is considered necessary to minimise further human impact on the planet and to avert future hardship (eg Stern 1992, Kempton 1987, Lovins 1990 and McGowan 1993).

6.2 General Knowledge of issues

6.2.1 Supply

No qualified commentator believes that current patterns of fossil fuel use will be tenable within a century (World Resources Institute 1992). An estimated three billion people are directly reliant on petrol and diesel for our supply of food (ploughing, seeding, weeding, harvesting, transport). Forethought suggests the need to develop alternative ways to provide food before there is real global scarcity of depleting liquid energy (Serpone 1992 p222, Grob 1992). Unless we change our energy behaviour, we will probably create great hardship for future generations, because all 'developed' societies are now totally dependent on fossil fuels (Kreith 1980). Our massive use of fossil fuels shows little regard for the rest of the biosphere (Nash 1989), with the current global output of gaseous pollution at 30 billion tonnes per year (Serpone 1992). The intergovernmental panel on climate change believe we need to reduce this output to 60% of 1988 emission levels (ESD *Working Group* 1991). Concern over global depletion of fuel reserves is coupled with the greenhouse gases we discharge into the atmosphere.

A conceptual base for enabling the development and mass use of efficient technologies includes an understanding of the dominant social paradigm (Fien 1992), which has successfully brought wealth and technological miracles to increasing numbers of our species for hundreds of years. Unfortunately, it is based on the premise of growth and exploitation. An alternative world view exists: the new environmental paradigm. The NEP includes long-term ecological and resource considerations, and accepts the urgent need to reduce human impact on surrounding resources and ecosystems. Both these world views are coherent. The dominant one is currently more powerful, but survival drive and forethought can easily direct human choice and behaviour in favour of sustainability, as many multinational companies now acknowledge (Schmidheiny 1992). These issues are a matter of political and public education.

I argue that it is the responsibility of environmental educators and environmentalists to effectively inform decision-makers at all levels of society. Our clarified perspectives (as tertiary educators) have been largely gained though public funding; we have been given the time to understand environmental processes and like government, we have an onus of responsibility. Our responsibility is to provide information about the relative future merits and problems as these two coherent world views become more widely understood as a core issue.

6.2.2 Context

The 'driving forces' causing fossil fuel depletion are based on values and attitudes, which manifest as population and economic growth, technological change; guided by politico-economic institutions. Undervaluing nature has a very clear expression in the undervaluing of our petrol and coal reserves. The external costs of subsidies, resource depletion and pollution need to be included in the price structure (Schmidheiny 1992, Greene 1992, Stern 1992). As this thesis reinforces, economic conditions, government policies and technological and knowledge limitations may make it difficult to convert attitudes toward a more environmentally sustainable future into ‘conserver’ action.

Driving forces create the context for individual behaviour. If external costs of fossil fuel use were factored in to production costs, the price of coal-generated electricity would rise from about 3.5 to 5 cents per kWh, making some wind and bagasse electricity generation sites immediately viable (see Attachment 6 on bagasse, and Stephens, 1993). Some 'contextual influences' (surrounding factors) have more effect than any attitudinal choice. If the full cost of electricity was charged, solar water heating would immediately and obviously be cost effective. With 64% of people expressing a preference for solar, honest price signals will make a great difference to greenhouse gas emissions (Elkstrom 1993 pers.com., Saddler 1994).

There are other ways to look at energy supply than just meeting an ever-increasing demand. Least cost planning (Greene 1992) calculates all the costs for different ways of providing an energy service, then chooses the cheapest. Life cycle analysis, also known as cradle-to-grave analysis, (Greene Consultants 1992) is similar, looking at all the costs for service provision, from the raw materials and manufacturing, to all the hidden disposal costs at the end of the useful life of an appliance. Demand side management aims to reduce overall demand, and the evening peak, to reduce emissions, and delay the need for new generation plant (Weinberg 1992). Demand side management is cheaper than building new generators.

6.3 Householders

The domestic sector is studied because much of the costs of transport energy is connected with getting food and products from sources to homes, and to transport people to and from their homes and because everyone lives in a residence. The evening electricity peak is created by the domestic sector, which in turn dictates the generation capacity needed. If values, knowledge levels, behaviour and appliance use change in the domestic sector, the effects may spill over into the political, electricity utility, construction, urban design, industrial, commercial and service sectors.

Transport fuel

Average weekly transport fuel costs per household across the five electricity consumption groups in Townsville were $17, 25, 29, 31 and 25 respectively. These costs are appreciably more than the averages spent on electricity ($17/wk in Mt Isa, $14/wk in Townsville). If the trend of increasing dependence on a depleting resource is to be reversed, electricity use should not be seen in isolation. Commentators like Grobb and Holdren (1992) believe there will be wholesale conversion of coal to petroleum within forty years.

Energy commentators (eg Lovins 1990) argue that there should be new urban and regional infrastructures, more information on the energy intensity of products and more education and public awareness programs. An integrated approach to urban design, social change, energy supply sources, storage and use patterns need to be melded with a developed knowledge of local sustainable directions among people at the community level.

6.4 General summary of findings

Table 6.1 Hypotheses and findings

Hypothesis	Finding
1. Reported changes in energy-using behaviour will be significantly related to energy used.	No such relationship was found.
2. Appliances used unnecessarily during the evening peak (5 -9 pm) can be identified.	Swimming pool pumps, aircondtioners and unneeded second refrigerators offer the easiest peak load-shedding targets.
3. Use of electricity by households will be positively related to household income level.	There is a step relationship between household income and electricity use[1].
4. Use of electricity per household is positively related to the number of people per household.	A weak correlation was found between electricity used and the number of people per household.
5. Self perception of energy-saving behaviour will reflect in relative electricity consumption.	No such relationship was found.
6. Attitudes toward energy saving behaviour will be negatively related to actual energy used.	No such relationship was found.
7. Knowledge about energy supply and use will be negatively related to actual energy used.	No such relationship was found.
8. Housing judged to have a higher level of passive design will have significantly lower levels of energy use for cooling than those with poor passive design.	No such relationship was found. A weak negative correlation was found.

1. The Townsville research found that the two lowest electricity use groups had similar average household incomes, and the three higher use groups had near-identical household incomes. Further, it was found that on a *per-capita* income analysis, there was no relationship between income and electricity use. Investigations of disposable household income (eg if the home is owned outright) may produce a significant relationship.

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6.4.1 Mt Isa

The group which reported, without prompting, that they generally switched off lights and appliances had an average electricity bill lower than the whole sample group. An unexpected outcome of the analysis is that people who frequently have barbecues use a lot more electricity than the group who never have barbecues (1660 kWh/bill, compared to 1290 kWh/bill). Perhaps the higher use group are generally more active, which included greater appliance use.

More expected results were that households with one or more young children use more electricity on average than houses with older residents. Households with the oldest person over 60 years of age used less than the sample average. People who earn more spend more on electricity, but with only a weak correlation. This represents one of various groups where there was a significant but statistically weak relationship between a variable and energy use (Goudie 1992a, p44). The outline of hypotheses and findings given in Table 6.1 briefly summarises hypotheses tested in this thesis. Details and analysis are given in the remainder of this chapter.
Some indicators of high electricity use could not have been foreseen. Indicators found in Mt Isa included greater than average (17) power points, more than one fridge or a freezer, running a pool pump or frequent dishwasher use. These groups all used about 20% more than their counterparts. The profile of the composite high consumer: a home with many power points, owns two fridges and a freezer, uses a dish washer more than three times a week, and self-reports as saving energy.

All the above variables were analysed *via* stepwise regression, showing only weak correlation. People who own their home use more electricity than people who rent, while people who report doing things to save energy use more than those who did not see themselves as conscious energy-savers. Self-reporting and self-perception measures compared to actual average consumption indicate that self-competition (encouragement and incentives to reduce household electricity consumption compared to prior billing periods) should be encouraged, along with competition to reduce the householders consumption below the town average. Many people had no idea of their relative consumption, and wanted to know the average. Table 6.2 summarises traits grading from highest to lowest electricity users.

Table 6.2

Components of average electricity consumption for a three hundred household survey in Mt Isa. 1992

2000 kWh
5 people in household
high dishwasher use
work in shop or office
more than one fridge
more frequently used solar booster
BBQ used more than once per week
income greater than $50,000
insulation in walls and ceiling
more than 17 power points
youngest resident <5 yo
minimised air conditioning use
AVERAGE 1483 kWh/billing period
perform general switch-offs
own only one fridge
less than 17 power points
not own a BBQ
not own a freezer
occupant rents home
one person only in household
pensioner/retired.
gas hot water
solar-only hot water
1000 kWh

The base measure is kWh used during 2 month period spanning March.

6.4.2 Townsville and Mt Isa comparisons

In Mt Isa, about two-thirds of households used electricity for heating water, in Townsville, about nine out of ten households heat water electrically. Solar water heating by 24% of the population in Mt Isa compares with about 7% in Townsville. The introduction of off-peak rates in Mt Isa only seven years ago may explain the higher use of solar systems.

The 99% airconditioning ownership (nearly all evaporative) in Mt Isa compares to about half that level in Townsville. In March, Mt Isa households used about six kWh per day for airconditioning, compared to four kWh in Townsville. The relative amount of energy used for cooling (including fans) as a percentage of total electricity was about 23% in both centres- Townsville used less energy per household overall. In the more extreme climate of Mt Isa, the efficient evaporative systems work effectively, but are unpopular in Townsville because of the high summer humidity. As expected, airconditioning ownership and use rose steadily with the overall energy consumption of households in Townsville. There was a weak negative correlation between building design and use of air conditioning. High airconditioning use in well designed homes (see Attachment 9) seemed in conflict with householders' stated attitude about the importance of energy conservation.

About one in three households in both centres have second refrigerators, but Mt Isa has 72% freezer ownership, compared to 57% in Townsville. People in Mt Isa used about 3% of their total electricity for lighting, compared to about 7% in Townsville. In very general terms television uses about the same amount of electricity as lighting. The main finding for lighting energy is not the amount used. Nearly everyone is conscious about not wasting lighting energy (see Chapter 5.1 for details). This can form the core of education programs to help motivate people to reduce their energy use for such things as second fridges, by focusing their understanding of use to an equivalent amount of lighting use.

6.5 Townsville Group Traits

Demography

Two person households were fairly evenly distributed across all five stratified consumption groups at the total (TT) sample average of 36%. Houses with teenagers tended to use more electricity, indicating the potential for the school system to play a more active role in education about energy issues. The highest consumption group (T5) uses five times as much electricity per person as the lowest consumption group. Households with two or more people are defined targets for concerted conservation and demand side management strategies. Public education should focus on the above-average use groups, with freezers or second fridges and high air conditioner use.

Housing

Contrary to expectations, there was no significant relationship between shading and lower air conditioning use. There was a weak positive correlation between good passive design features and energy used for cooling (see Chapter Two). The inference is that something other than measurable 'comfort zone' criteria is causing higher airconditioning use in well-designed homes. Physiological differences may account for people wanting to be cold in the tropics. It is more likely that 'climatic overcompensation' reflects a reactive attitude towards the climate.

Although 80% of the population sample live in separate houses, more than half the low consumption group live in a unit or flat. A high proportion (65%) of all people interviewed owned (or were paying off) their housing, with the exception of the low consumption group (40%). This indicates that the low consumption group, rather than using less because of 'conserver' attitudes, is somewhat disadvantaged in terms of property ownership. Coupled with their lower access to all major electricity appliances, they may use less simply because they have fewer major appliances. With the least people per household, the main lesson from this group is to make do with less.

Transport

Average weekly fuel costs were appreciably more than the averages spent on electricity. If increasing dependence on a depleting resource is to be reversed, electricity use should not be seen in isolation- an integrated approach to urban design, social change, energy supply sources, storage and use patterns needs to be developed at the community level.

Electricity use

Two of the forty households in the lowest electricity group (T1) have second refrigerators, while half the households in the higher use groups had a second refrigerator. Group T1 was under-represented, but generally one in five households have dishwashers, used about five times per week. About one in five houses has a computer, with Group T1 under-represented.

Water heating

There is a high penetration of off-peak tariff among the 88% of households with electricity as the main water heating energy source (75% of the 88% have off-peak rates) in Townsville. While Mt Isa has a 24% domestic solar water heating base, Townsville only has 7%. Energy efficiency is the major consideration for consumers buying a new hot water system.

Cooling

An average of four kWh per day was used for cooling in Townsville. About 22% of total domestic energy was used for cooling in March 1993, representing an average of about $24 per bill per household. In March, fans used about one third of the total energy used in domestic space cooling, servicing about 90% of all homes, while air conditioning used the other two-thirds, but only serviced about 30% of homes (not all the 50% of homes with airconditioners used them in March). With the low use group having 2-3 fans, all the other groups had 4-5. The higher use groups use fans much more than the two lower energy use groups. Slightly more than half Townsville households have freezers, mainly in the higher use groups.

Pumps

Townsville has swimming pool and bore pumps, while Mt Isa only has swimming pool pumps. In Townsville, groups T1 and T2 have lower than the weighted average of 12% swimming pool ownership, compared to the average of 17% in Mt Isa. Pool pumps were switched on for an average of three hours per day, usually during the evening peak, each drawing an average of 1.8 kWh. This produces the same extra peak load demand as those households turning on an extra ten 60W globes for the three hours of the evening peak.

Knowledge

Among the higher use groups T2 - 5, there is little relationship between the level of household electricity consumption and average knowledge level. About half the people interviewed had a rough idea of the relative electricity consumption of their fridges, about one in three had a fair idea of the concept of sustainable energy practices.

Attitudes

Ninety-five percent of the sample believe energy conservation is important or very important, while 98% believe that looking after the environment is important or very important. Most people preferred solar water heating, rated energy conservation highly, and were concerned about dollar savings, and the future. If government is prepared to act on these findings it will find community support.

The quiz revealed that many people are unaware of the relative consumption of electricity used by various appliances in the home. They were also unaware of their own electricity use compared to other households. Ten percent of the very highest (0.05%) use group report that they are always careful with their electricity use, while members of the lowest use group reported doing the least to save energy. Lack of a benchmark could be easily rectified.

Current thoughts on energy supply and use in Townsville

Ten percent said that renewable/solar sources should be used, 7% said there was too much car use, 7% said we shouldn't waste energy, and 7% said the government should invest in renewables and research. Four percent announced they were glad people use solar; that there should be more. Finally, 4% of respondents reckoned people leave too many lights on all night, or that government buildings shouldn't be lit at night.

About one in four people reported that a 25% rise in electricity prices was most likely to make them reduce wasteful electricity usage. Significant numbers of people also feel there is too much car use, and that government sets a poor (and very visible) example of electricity wastage by having state-owned buildings brightly lit at night. For government to encourage adoption of its own energy conservation policies, it was seen as setting a poor example.

6.5.1 Low electricity use Group T1

Demography

Most households in this group have lower than average income. Sixty percent of householders rent and the household often consists of one or two older people. About half the sample live in flats. Thirty-two percent of Group

T1 are pensioners, while the other groups average 10%. For the other four groups, no such clear patterns emerged, except clustered in contrast to Group T1. The households tended to have lower car ownership and use much less petrol. Eighteen people lived on their own, in contrast with a maximum of five lone-person households in the other four consumption groups. Forty of the 75 adults in this group work, mainly in trades, sales, armed forces or as labourers (See Tables 3.2 and 3.6).

Housing

Half the people in the lowest electricity use group live in flats. The average dwelling age was 26 years, while dwellings of the other four groups averaged 18 years. The dwellings tended to have less vegetation shading than those of the other groups.

Electricity use

The low use electricity group has high gas cooker ownership (33%), compared with the Townsville frequency of 19%. The group had the most gas hot water systems (18%) compared to about 2% for the other four groups. This preference for gas was linked mainly with rented flats, indicating low cost installation rather than the finer points of carbon dioxide emissions as the likely explanation. About one third of households had air conditioners, while the other groups averaged 63%, and fan ownership was about half that of the other groups. Only 5% of households have second refrigerators. About three-quarters of the refrigerators were medium sized. The other groups had about 50% second fridge ownership, and a medium sized main fridge in only about 40% of cases.

Knowledge

Group T1, the lowest electricity use group, knew the least about energy. Because its members use the least electricity *per capita*, they are not a logical target for DSM strategies. It was hoped that, as a group, features would emerge from the lowest use group that could be used to encourage higher electricity users to emulate low consumption behaviours. This now appears doubtful. Group T1 lagged uniformly last in the accuracy of its members responses to each of the questions, adding a lack of overall awareness of the larger energy supply and use context in which they operate to their generally lower socio-economic status.

Self perception

T1, the group using the least energy, consistently reported doing the least to save energy or reduce their energy wastage as explained in Section 6.7.2. As a group, these people may use less electricity because they own less electrically-intense appliances: less refrigerators, freezers and airconditioners. As a group, they do not see themselves doing much to save energy. This is legitimate, because they generally do not have much scope to use or conserve a great amount. Because many of the summary feature of other groups have been mentioned in Group T1, and because there are some unremarkable features of some of the other groups, there will not be a detailed coverage of all the topics used to summarise this group.

6.5.2 Average electricity use Group T2

Group T2 users represents the arithmetic average. Many of the generalised traits apply, however, they can be distinguished in their own right as follows.

Demography

The highest single occupation group is administration/clerk. Like T1, T2 has a household income of about $26,000 *pa*, but the lowest per capita income of $8,900 *pa*. This compares with an average of $14,400 for the other four groups. Comparing *per capita* incomes of the five groups shows that the average and highest electricity use groups have the lowest *per capita* incomes. Without further research which measures disposable income, the impression of the surveyors is that the highest use group has the highest disposable income. This is born out by the high percentage of home owners. Further research should ask if the home is owned outright, or how many years are left to pay on the mortgage, as an indicator of the size out the monthly repayments.

Housing

This group had the highest proportion of slab-on-ground housing, (43%) compared with an average of 25%. Like the following three groups, 90% of the average electricity consumers (Group T2) live in houses rather than flats. T2 houses have the marginally highest proportion (33%) of concrete block walls.

6.5.3 Above average electricity use Group T3

Demography

Seventy-seven percent of adults in this group are working, with 17% adults working in administration or as clerks. Some clear demand side management (DSM) occupation targets emerge in Groups 2-4. Tradespeople, people who work in offices, and people engaged in home duties dominate the primary DSM target electricity use groups. Two person households are most frequently represented: well defined targets for concerted conservation and demand side management strategies in the average to high use groups. Members of these groups tend to have a freezer and a second fridge, and high air conditioner use.

Housing

There are only 20% slab-on-ground compared to the generalised 44% for the population. Over half the group (55%) live in highset houses, compared to the population average of 38%. 63% are timber homes against a population average of 47%

Knowledge

This group fared best at naming a fossil fuel, a renewable energy source and a greenhouse gas. Naming a fossil fuel was much easier for the above average and high electricity consumers than for the low or very high electricity consumption groups. Because T3 represents the above average electricity use group, they emerge as the group most relevant as a target for DSM. They represent the 30% of 'typical householders': role models for behaviour change programs, showing no great loss in lifestyle, but reduced costs and carbon dioxide emissions.

A typical household in Townsville to use as a focus for DSM lives in a highset home, both parents work, maybe there are one or two kids, they have a second fridge and a freezer, use their air conditioner freely during the hotter months, and have active life-styles. More specific traits of this group are described above.

6.5.4 High electricity use Group T4

Demography and Housing

This group is dominated by 27% tradespeople against the sample average of 15%. This group has the highest percentage of teachers, and the highest gross *per capita* income. Group T4 has the greatest proportion of low-set housing (33%) compared to the population mean of 10%, and the second highest proportion of fibro walls (30%) compared to the weighted mean of 19%. Thirteen percent of their dwellings have foil ceiling insulation (c.f. 4% average).

6.5.5 Very high electricity use Group T5

Demography

The highest electricity consumption group has the greatest number of people per household, with a mode of 4, the average was 3.5 (Table 3.2). This group had the lowest *per capita* income (See Table 3.4) and a high proportion of adults working in professions (18%, see Table 3.6). This group has a *per capita* electricity use twice as high as the average, and five times greater than that of the lowest use group (see Table 3.4), suggesting that electricity use is a lifestyle choice.

This group has a household income almost identical with the other two higher use groups, yet the per capita income is second lowest at $11,900 compared to the weighted mean of $13,700. Income is not a significant factor in electricity consumption. Electricity consumption is quite unrelated to per capita income per group, and related to household income in a step-wise fashion: the two lowest groups had almost identical household incomes, and the three higher use groups had very similar household incomes. This fine-tuned result shows the benefit of the research design, stratified on electricity consumption alone into five groups, removing the uncertainty of prior researchers about the nature of the weak correlation between income and electricity consumption (eg Kempton 1987, Lutzenhiser 1992).

Members of Group T5 are most articulate about reasons why they have become more aware of their energy use, whilst remaining in the top consumption group. Although they lead energy intensive lifestyles, they only represent a small fraction (.05%) of total consumers, and only constitute a focus for DSM in that they tend to hold more professional jobs and they may be influential in the work-place. Eighteen percent of this group reported as professionals, the other groups only average 4%. Group T5 also reported the highest percentage of people conducting home duties (15%), the other groups averaged 11%. Fifty percent reported a change of attitude toward electricity use within the last year.

Housing and electricity use

Twenty-three percent of this group lives in two storey dwellings compared to the average of 11% for the other four groups. There is 80% home ownership; the above average and high consumption groups have 73 and 75% home ownership respectively. The high electricity use group (T5) use its washing machines appreciably more than the other groups, and, along with the second highest use group - T4, is the most likely group to have a large washing machine. This is an instance of more people using more energy.

Generally computer owners report using them for about two hours (average) per day. The exception to this was the very high (T5) electricity consumption group, which owned the most computers, and used them about eight hours (average) per day. Because this group represents such a minority, its consumption is not a logical focus for demand side management public education: Group T3 represents a large sector of the population which consumes above average amounts of electricity. Some Group T5 traits may provide insights into how to effect people in the professions.

Self perception

Half of the highest consumption group reported energy attitude change, against the general background of about one in three. It may be that attitudinal changes precede behavioural changes (possibly resulting in reduced electricity consumption in the future). Ten percent of this group reported that they were always careful with their use, while members of the lowest use group reported doing the least to save energy. A lack of benchmark could be easily rectified.

The household income of the above average, high and very high use groups is statistically identical at $41,700 per year. The electricity used in each group of 40 households was 30, 42 and 54kWh respectively: 80% higher for very high use group. Thus, on the data collected, income can be categorically ruled out as a determinant of electricity use. Further research linking disposable income (ex house payments/rent) may show significant relationship with electricity use.

6.6 Knowledge of electricity use

6.6.1 Results from mini-quiz

About 75% of respondents could name one fossil fuel, 60% named one renewable energy source, 50% named a greenhouse gas, and about 50% had a reasonable idea of the percentage of electricity their refrigerator used. Only about 33% of people interviewed could identify main electricity use appliances, or understand the expression: "sustainable energy practices". Many people suggested that such things as kettles, toasters, irons or vacuum cleaners used the most energy around their home. Many people lack knowledge of financially neutral or beneficial energy-related decisions. Two out of three people interviewed feel that their behaviour usually or always matches their environmental concern. There is no benchmark, no standard, with which to compare personal behaviour, except comparisons with friends (peers), advertising, the media, and written material.

Respondents feeling that their behaviour matched their environmental concern is to be expected, to avoid internal tension. Almost everyone attempted to identify their major electricity-use appliances: 76% were inaccurate. Changing behaviour may be accomplished through widespread improvement in knowledge. Improved knowledge and provision of incentives can bridge the gap between feeling that conserving energy is very important, and actually knowing how to most effectively reduce energy wastage.

Research shows that pursuing energy conservation depends on the amount of time and money involved, how easy it is to know the effects of your behaviour, and how big the resultant energy savings are. Purchase decisions have the greatest long-term impact, because they set base levels of consumption for the whole life of the equipment (Stern 1992). Decisions by governments, corporations and householders when buying major appliances, equipment and vehicles have a large impact on the environment.

Attitudes and personal norms have more effect on relatively inexpensive, easy-to-perform energy-saving actions than on major household investments in energy efficiency (Stern 1992). Availability of finance and knowledge is seen by Stern as most effective for expensive or difficult behaviours - more information is needed to properly assess items with a higher initial cost, but much lower operating costs (Greene 1992). Purchase decisions around cars and major domestic appliances are important, while important daily behavioural choices include use of a second refrigerator or freezer, setting of the pool pump timer, amount of recreational travel made, and level of interior cooling. Stern (1992) suggests that environmentally relevant behaviour is limited by the monetary costs of different behaviours, perceived difficulty of relevant behaviours, and a person's perception of how much knowledge or skill is needed to perform the behaviours. Knowledge seems to have a great effect on action. My research shows knowledge of energy-using behaviours is faulty among many individuals.

Two out of three people report being usually, or always concerned about the effect their behaviour has on the environment. It is worth noting that quite a few older people (over 55) maintained that they did not have any effect on the environment, even though we had just documented all the electricity they used. Education programs concerning environmental impacts should emphasise that individual behaviour DOES make a difference. These programs should promote the connection between our consumption patterns and the impacts which they cause.

In the Townsville study, the group using the least energy consistently reported doing the least to save energy or reduce their energy wastage. In Townsville, householders reported an average of five behaviours they considered energy saving. The assertion that there are no electricity consumption norms is supported by the fact that half of the highest consumption group reported energy attitude change, against the general background of about one in three.

Knowledge of personal contribution to greenhouse gases must be coupled with clear financial messages about the long term value of fossil fuel reserves before any major behavioural shifts can be expected. Underpricing emerges as the most acceptable reason for the low-level efforts made toward energy conservation. There appears to be a low sense of responsibility for personal contribution to greenhouse gases. What follows should be viewed within the mixed social messages of previous and current cheap energy prices, coupled with fairly lame encouragement to be energy-conserving.

6.7 Current behaviour, preferred behaviour

The key recommendations from this study are to increase the cost of coal-derived electricity to reflect its full cost and long-term value; improve knowledge of individuals’ contribution to greenhouse gases, and what actions individuals can adopt to reduce unnecessary electricity use. These recommendations are based on the apparent lack of connection in the ‘attitudes triangle’ between feelings, behaviour and knowledge. Knowledge is the missing link.

It is clear from Cialdini's (1990) work that people tend to conform to the perceived behaviour of the larger social group. While conducting the surveys it was found that there is no information on the electricity usage of the general population. Stern (1992) indicates that information, incentives, role modelling by well-known public personalities and financial incentives combine to help energy-related behaviour shift in a sustainable direction. Few people interviewed felt a need to reduce their own energy use except in the very high use group.

Research (Stern 1992) has shown that the non-experts’ understanding and opinions do often change given clear, persuasive, credibly sourced 'how-to' information. Information, *via* pamphlets, slogans or instructions has proved to be generally ineffective. Assertive techniques using clear language, personalised presentation, alternative options and direct recommendations generated changes in behaviour in energy-related behaviour for 'weatherising' houses in the US. These techniques summarised in Stern (1992) have produced lasting results.

Public education obviously requires adequate funding, which eventually comes back to the twin issues of public pressure and the political will of relevant decision-makers. Effective techniques are documented and ready for use when the social desirability of serious energy conservation is agreed. These findings are reinforced by others. The World Energy Coalition believes that there is a 'need to train the public as to methods ... to seek necessary behavioural changes. A comprehensive approach should be adopted. This means that all available techniques are used simultaneously.' (Bradbrook 1992). Investments in energy efficient goods can be effectively encouraged by framing energy conservation as avoiding the prospect of future costs. That carbon dioxide levels may profoundly change world climate is overshadowed by Westernised societies' total dependence on a depleting resource. Making that resource last as long as possible, while developing more viable energy systems is a task of global proportions, where knowledge and world views are central to ordered social development. Electricity costs are a very small overall cost per household (~4%), compared with rent/ repayments, food and transport. People use electricity as they see fit, some more thoughtfully than others.

6.8 Government and utilities

"Households also consume the bulk of all goods and services produced in the society, making them the final beneficiaries of most energy use... Despite the sophistication of energy supply, the demand side remains a poorly-understood sink into which utilities and governments are required to deliver ever-increasing amounts of energy." (Lutzenhiser, 1992 p47).

If Geography has fuzzy boundaries, politics has spongy boundaries. Current politicians have inherited governments which have already assumed the onus of responsibility for environmental stewardship. Unfortunately, government has undervalued desirable resources, from the perspective of future generations. The government has also undervalued the environment by allowing pollutants into it with little real regard for the rest of nature (Schmidheiny 1992, Beder 1993, Stern 1992, Dwyer 1993, Nash 1989).

Schmidheiny (1992) sets a lucid context for human interaction with the environment in recent centuries: the use and exploitation of nature have not created signals of scarcity because the 'ownership' of nature by society, as represented by government, has essentially given away natural resources and services. The recent idea of externalities is an attempt to redress this. Schmidheiny (1992) explains that the design of the 'industrial ecosystem' is flawed. Natural ecosystems are made up of cycles (ie nutrient and energy cycles), whereas the flow of goods and services in human systems is basically linear. 'Products are purchased, used and dumped, with little regard for environmental impact' (Schmidheiny p109). Issues of inter- and intragenerational equity are central to concepts of ESD, and are directly relevant to most forms of consumption, including fossil fuel.

Governments can impose desired behaviour on citizens and can control energy-efficient standards on appliance manufacturers and builders. Appliance efficiency standards were introduced in California in 1976, but are only legally required in three states in Australia (Bradbrook 1990). Governments can invest in developing new technologies, and use their considerable purchasing power to foster preferred energy directions. Because the electricity supply industry is comprised of government utilities, state governments can instruct the Industry to include externalities in electricity pricing.

This sets the context (as explained in Section 1.1.3) for many of the energy-related decisions of electricity utilities, businesses and individuals. Because of this context-setting role of utility structure and price fixing, government energy policy grossly affects the total amount of fossil fuel used in power generation. Costs to the consumer do not reflect the full value of fossil fuel. The 'externalities' of resource depletion, infrastructure costs, hidden coal subsidies and intrinsic worth of the coal are not included in the price of electricity to the consumer. This must be resolved before there is any clear reason to participate in anything but easy DSM strategies. Utilities are grappling with the implications of least cost planning, but the uptake of the new paradigm of the role of utilities as environmentally responsible (Weinberger 1992) is very slow.

Effective energy conservation will occur more rapidly once fossil fuel energy prices reflects long-term worth (Levine 1992, Nash 1989, Schmidheiny 1992, Serpone et al 1992, Stern 1992, Weinberg 1992, Johnstone 1994). Concerns over costs and the future provide a focal theme for public education in energy conservation most likely to trigger a response in people.

Schmidheiny says that although energy efficiency has been the stated goal of most governments for about two decades, policies have not supported the goal. Because business is motivated by profit, a central problem is that no one owns natural resources such as the atmosphere or the oceans. Schmidheiny argues that internalising the cost of degrading natural systems will help correct the dilemma. Schmidheiny, like increasing numbers of authors on energy issues, sees the need to evaluate cradle-to-grave energy aspects of materials and products.

It would appear that there is an internal conflict (dissonance) within government, conflict between environmental responsibility and supplying electricity cheaply. There is a need to redefine what is a fair and equitable price for electricity, considering the intrinsic value of coal, and the environment.

Individuals determine what firms, communities, and governments do to the global environment because the behaviour of firms is influenced by the demands of individual customers. The decisions of a firm may also be influenced by the choices of managers, and by employees who persistently raise environmental concerns. Communities and governments are affected by individual action through leadership and by pressures that individuals put on leaders through public opinion and lobbying (Stern 1992). Therefore individual activities to achieve greater energy efficiencies should be encouraged.

6.9 Discussion

The high concern expressed in favour of environmental and energy conservation clearly show the public is receptive to information and help, to initiate energy conservation measures. More than any other group, the group in the top 0.05% of domestic consumers reports becoming more conscious of energy consumption, trying to save money and electricity through reduced electricity use. This contrasts with the lowest use group which reported the least efforts to save money through reductions in electricity use. It is a little like dieting- highest consumers trying the hardest to stop consuming the most.

6.9.1 Overall Analysis

Statistical analysis showed that there were three main levels of correlation between demography, knowledge levels and energy use. There were weak correlations: older respondents tended to have less concern about the future, and more refrigerators. Owning a freezer indicated a reasonable likelihood of owning a clothes drier. Analysis showed that the number of cars in a household was weakly linked with the amount of electricity used. There were other relationships with medium positive correlation ($.3<r<.5$), almost all to do with clustering of knowledge about energy issues. Knowledge of fossil fuel and sustainable energy were linked. Knowing about renewable energy correlated moderately with an understanding of sustainable energy. The number of residents gave an indication of the number of cars per household. A third group of relationships was found, related to knowledge clusters which were significant and reasonably strong positive correlations ($.5<r<.7$). Knowledge of fossil fuels and greenhouse gases, renewable energy and greenhouse gases, fossil fuels and the proportion of electricity used for refrigeration were clearly interconnected for many respondents. A respondent who knows about fossil fuel is likely to know most of the other energy-related issues.

A working hypothesis of this research was that a poor knowledge in matters of energy supply and use may be central to the apparent lack of linkage between thinking energy conservation is important, and actual energy used. Superficially, this research did not substantiate this. Knowledge which is personally relevant is indicated in the recommendations, within the context of underpriced electricity. Twenty percent of Townsville people said renewable energy should be used more, 64% said they would prefer solar water heating with equalised initial unit costs. There is a clear awareness among many people of preferable options.

6.10 Recommendations

Survey methods

The stratified survey design based on utility consumption figures appears useful in clarifying types of consumers most logically targeted for DSM campaigns. Future DSM surveys need only involve people in the consumption range one standard deviation above mean. That will reduce survey requirements, producing a clear picture of group characteristics to target for community energy waste reduction. Group T3 represents the bulk of the population (~60%) with above average electricity consumption. Their changed behaviour will most affect the overall consumption of electricity.

To clarify underlying energy problems and solutions in the language used, the term “fossil fuel” could be replaced by “depleting’, and “renewable” by “sustainable”. Government should accept its onus of care as premier environmental custodian, by decisively implementing the consequences of ESD principles. Recommendation EU15 of the ESD Working Group Chairs on Greenhouse (1992) states that energy conservation information, education and support programs should be extended to local government and community organisations. More research and testing ways to modify energy use should be undertaken.

Widespread public education should promote awareness of the long-term problems associated with increasing global reliance on a depleting resource, personal amounts used and the emissions caused by individuals. People can then realistically grapple with what a future with no fossil fuels may mean, and how we should seriously begin to prepare for it. This work provides some base data and perspectives for use. In 1993 most people preferred solar water heating, rated energy conservation highly, were concerned about dollar savings, and the future.

6.10.1 Efficiency promotion

Energy utilities should lead by example. Within the context of environmentally responsible energy pricing, all members of energy utilities should become involved in instigating energy efficiency. This will be achieved through extensive training courses for management and staff, to develop reduction strategies. Such programs stress the need for the commitment of senior management (DPIE 1991). Utilities like NORQEB should increase their promotion of energy efficient building features, including emphasis on the use of structural and natural shade, use of natural cross-ventilation and ceiling insulation in the tropics. They could adopt the idea of light-bulb-equivalents in their promotion of energy efficient appliance sales.

Energy conservation programs have been most effective when they address as many barriers as possible at the one time, by marketing intelligently and aggressively. It may be necessary to involve trusted organisations that have good communication with the program's intended audience, such as community organisations, local governments, or professional communities of builders or lenders (Stern 1992).

6.10.2 Demand Side Management

The finding that householders with teenagers are in the upper range of electricity users indicates scope for schools to become more involved in energy education, imparting the idea that individual actions do make a difference. Households with two refrigerators should know it costs about $25 per bill to run a refrigerator. If the second fridge is not absolutely necessary, it should be turned off except for specific short term uses. Householders with pumps should be encouraged to use them outside peak hours.

To help people become aware of their relative energy consumption, utilities should publish the average domestic electricity usage at the time electricity bills are posted. Encouragement should be given to reduce that average, especially to reduce evening peak demand.

Specific Recommendations

Public education examples

'Think in light globe equivalents'

- 94% of householders consciously switch off lights when not in use.
  Leaving a rarely-used second fridge on is like leaving 2 X 60 W lights on 24 hours per day all year.
- ***1 fridge = 2 lights, = 1 tonne CO_2 per year***
- ***1 electric hot water system = 4 lights, = 2 tonnes CO_2 per year***

Because of the known perception surrounding switching off unwanted lights, using 'light-globe equivalents' for electricity consumption of appliances may prove effective. It could become public knowledge that a fan on normal setting is equivalent to one (75W) light bulb, whereas a normal air conditioner in Mt Isa uses the equivalent of 5 light globes (350w); or that a TV uses 'two light globes' worth of electricity. The low use householders seem to have a greater preoccupation with general switch-offs, and minimising hot water use (among the highest single domestic electricity use in the tropics). Perhaps this indicates the potential for an education program for the higher consumers in these results.

Public Education in electricity

The daily demand load:

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Above graph from a QEC publication: "Using Electricity Wisely" cira 1992.

The evening peak from 5 -10 pm dictates the size of the electricity generators we need.

Reducing evening demand saves the huge cost of more generators. Reduced electricity use saves money, and reduces pollution.

6.10.3 Water heaters

People who are replacing their electric hot water systems should consider getting a 300 litre or greater storage, so that solar panels could be fitted at a later date, using the same storage tank. Solar boosters should be wired to an off peak tariff, with a manual 'one-shot' switch installed, using the booster only during high demand or cloudy weather. Encouraging off-peak for solar water-heaters would reduce the morning and evening peak demands, and on T31 they would reduce their CO_2 output because the morning hot water used would usually be reheated by the sun during the day. In promoting sustainable energy practices, incentives should be offered to overcome the higher initial price of solar water heaters.

6.10.4 Air cooling

About 23% of all domestic electricity was used for home cooling in both centres during March. Solar airconditioners which meet 80% of the load are marketed in Japan by Sanyo. Such devices could be developed in north Queensland for the local and export market. Anything which assists passive cooling should also be encouraged.

Some people accept the discomfort of tropical summers, some do not. People in the second group could perhaps be encouraged to lower their urge to be cold in the midst of the prevailing climate. Time switches for air conditioners should be promoted - many people left their air conditioners on all day, to return to a cool home. A timer could start their unit an hour before their return. Timers would also reduce the number of people with refrigerative air conditioners who arrive home from work and turn them on full during the peak, to get an 'instantly' cooled house. Shading of air conditioners should be encouraged. A unit against an exposed block western wall has to work harder than one under a dense shade tree. People should be encouraged to use fans where possible, rather than airconditioners. A typical airconditioning unit uses about

400 watts per hour (5 light bulb electricity equivalent), a fan uses about 75 watts (one light bulb equivalent).

Shading can contribute to reduced need for air conditioning as attitudes mature about fossil fuel consumption. Shading devices, trees and vines should be actively encouraged in the tropics. Because air cooling, hot water services or fridges need replacing from time to time, there is a strong case for replacing them with the most efficient units available, then use them sparingly.

6.10.5 Fridges/freezers

There is a clear market for refrigeration that freezes bulk water at night, then requires no external energy source during the peaks. The same principle applied in a sustainable way would produce a solar-powered fridge with bulk ice storage - the hotter the day, the harder the fridge works. If the second fridge is not absolutely necessary, it should be turned off except for specific short term uses.

6.10.6 Pumps

There is 12% swimming pool ownership in Townsville, compared with 17% in Mt Isa. Pool pumps were on for an average of three hours per day. There is a total of 17% bore pump ownership in Townsville, used for an average of about two hours per week in March 1993. The use of bore pumps is likely to be higher in the drier months from April to December. Most of the pumps were used during the evening peak. This forms a ready target for DSM.

The results of the quiz highlight the fundamental need to educate decision-makers from householders to politicians on the underlying issues which dictate committed energy conservation strategies as necessary for sustainability (ESD 1992). As outlined to NORQEB, the following is a specific DSM strategy to be tested in Mt Isa. The details to the proposal are given as Attachment 12. Knowing the rarely-used second refrigerator is using two to five times as much electricity as the total household lighting may guide people to reduce that waste without sacrificing life-style. “People may lack sufficient information about how to act in ways that are environmentally responsible.” (Dwyer 1994 p240).

Recommendation Summary

Demand Targets

- reduce peak demand by encouraging swimming pool pump owners (17% of all households in Mt Isa) to reset pump timers outside the evening peak period.
- turn off low-use second refrigerators further reducing peak load.
- promote uptake of low interest loans for solar water heating.
- promote use of compact fluorescent tubes

- The majority of consumers who use above average amount of electricity (Group T3) should be especially targeted for more general reductions- one or two people working in the household, often with children.

- Testing public education strategies using ‘light globe equivalents’. There is a reported 94% of householders who consciously switch off lights when not in use (it was 93% in Mt Isa). This indicates the possibility of using the equivalent amount of electricity used by a light bulb when encouraging other electricity conservation behaviours- leaving a rarely-used second fridge on is like leaving 2 lights on 24 hours a day all year.

Light-globe equivalent ratings should be given to bring home the message that if you use 360 kWh of electricity per bill on electric water heating (Mt Isa electric only average), it is the same as leaving four 60 watt light globes on for 24 hours per day, releasing about two tonne of carbon dioxide per year. This perspective should be stressed in advertising, and other public education techniques as outlined by Stern (1992) developed.

- Techniques used in the DSM program-

clear goals, commitment, understanding the daily peak demand, increased knowledge of energy issues, clear role modelling, participation, feedback, and rewards.

6.11 Conclusion

Humans have the clear ability of forethought and forward planning. We have never faced a global problem before. Reducing greenhouse gas emissions in the ways described in this thesis may prove a sore test of our adaptive intelligence. In the inevitable tension between the dominant social paradigm and the new environmental paradigm, major bouts of global wars, starvation, disease, ecological and social breakdown are at one end of future scenarios, if we continue ‘business as usual’. Decision-makers embracing the New Environmental Paradigm, guiding themselves and the rest of us into integration with natural systems, is a preferred direction.

Energy provision and use effects us all. Sale of fossil fuels (or the energy derived from them) should reflect their true costs and their true worth. This is probably the most effective way to promote efficiencies in energy use, and speed mass uptake of renewable energy sources. While energy is so cheap, most people are only likely to undertake the very easiest changes in behaviour. Simple changes in major appliance purchase decisions and DSM can forestall the need for more generating capacity until renewable energy sources are in widespread competition with fully costed coal.

If knowledge of personal contribution to greenhouse gases and resource depletion is not understood, it must be difficult to see why conservation is important. If there is little with which to compare personal electricity use, it is difficult to consider relative use. If there are no effective instructions or incentives, there is little likelihood of waste reduction.

A wide cross-section of the community favours energy conservation. In 1993 most people preferred solar water heating, rated conservation highly, and were concerned about dollar savings, and the future. If government is prepared to act on these findings it will find community support. There are opportunities clarified from the present work to target two to four person households for energy waste reduction, to publish average electricity consumption figures conspicuously following each billing batch, and to challenge people to reduce their contribution compared to the average. The issues of self-reporting and self-perception compared to actual average consumption indicate that self-competition should be encouraged. Quite a number of the interviewees had no idea of their relative consumption patterns, and expressed a desire to know the average.

Within the principles of ESD, government is obliged to provide clear price signals to consumers about the real worth of coal-derived energy, incentives and easy ways to reduce personal use. At ten cents per kWh, only two of five hundred people said electricity was expensive. If a gradual price rise to 15 cents per unit was foreshadowed a year in advance, in parallel with well-funded application of the above public education techniques, significant reduction in generating costs, resource depletion and pollution would follow. Money gained in this way could be used to fund rebates for energy efficient purchases. Solar water heating would become financially attractive, and other ‘sustainable’ energy sources would move closer to being economically competitive.

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Attachments

The Attachments are given in the following order

ATTACHMENTS.

Attachment 1 Mt Isa Survey Form

Attachment 2

- * JCU/NORQEB * -

- * 1993 TOWNSVILLE HOUSEHOLD ENERGY USE SURVEY * -

confidential + voluntary Is this your main place of residence? [No = close interview and record as weekender.]

Have you lived here for more than 6 months? [No = close interview and go to next reserve address of the same group]

Address___________ Sub.___ Date _______Meter__________ H /U /F

A. DWELLING SHADE: Strl (1-5, 1=>) ____ Nat. ____

ht ab gnd___ Width of eaves ___ Exterior reflectivity ___

Materials: Walls Roof Floor

B. BEHAVIOUR AND ATTITUDES

1. Do you presently do anything to save energy? **y n**
2. (if yes) What?

solar hot water	up	p	install c/f	up	p
cold clothes washing			main cook micro/gas		
walk instead of drive			minimise a/c use		
switch off lights			pl shade trees/other		
other					

4. "In the past 12 months, have your attitudes toward energy use around your home changed at all?" **Y N**

[If Y] How and why? [If no, record any comments]

____

____

What follows is a 'Mini quiz' setting a 1993 knowledge base:

5a. What is the name of one fossil fuel?____________________

5b. What is one renewable energy source? ___________

5c. What is a greenhouse gas? ____________________

5d Starting with the highest user, what three things do you think use the most energy around your house? _______________________________________.

5e. What % of your total electricity do you think your (main) refrigerator uses?_______

5f. What do you understand by the expression: "Sustainable Energy Practices"?

____

____

____

C. ELECTRICAL USAGE

6. Do you have an electric hot water system? **N Y** If so.. is it a **H**eat exchange or **M**ains storage type [refer to ID]?

Using Scale 1, how satisfied are you with its performance: **V**ery satisfied **S**atisfied, **N**either satisfied or dissatisfied, **D**issatisfied **VE**ry dissatisfied

7. Looking at Q7 on the card: if you were buying a new hot water system, which would be most important? next important?..

	cost	durabil-ity	(many showers)	energy effic.	energysou rce	other
[rank]						

8. If a **S**olar, **E**lectric or **G**as hot water system all cost the same amount to buy, which one would you chose? _______

9. APPLIANCE	/	**TIME ON**	**TIME OFF**	**HRS/ DAY**	**HRS/ WK**	**<u>TAR IFF</u>**	**BUY**
A/C TYPE	**no.**	in	March				
A/C. setting							
WASH. MACH	type size		Times/wk.				
STOVE type			-		-	-	
FRIDGE size	age	energy rating:			-	-	
2nd FRIDGE		-	-	-	-	-	
FREEZER type		-	-	-	-		
CLOTHES DRIER type			-				
WTER BED HTR			time of yr				
FAN type	no.	in	March			-	-
TV	no.					-	-
COMP/VIDEO	no.					-	-
MICROWAVE						-	-
WATER HTR	cap.					*	-
HEATER type			-		/yr	-	-
DISH WASHER	-		-	-			
POOL PUMP	Watts						
BBQ type		times per month					-
OTHER:weld..							

9. Looking at Q9 on the card, what would be the <u>most important</u> consideration if you were buying a new one. [list through the major appliances owned, and repeat the question].
[for 'BUY', code in as I=initial cost, L=how long it will last, EE=energy efficiency, and G or E for gas or electric]
>>>**9b**. Are any of your appliances on special tariffs [mark in the table above]
10a. Are you aware that NORQEB are promoting energy efficiency? **Y N**

10b. Using scale 1 on the card: how satisfied are you with NORQEB's promotion of the efficient use of energy?

Very satisfied **S**atisfied, **N**either satisfied or dissatisfied, **D**issatisfied **VE**ry dissatisfied
[record any unsolicited comments]

____

____

____

11. **Lights**: used for more than an hour per day

TYPE	no.	lou (hrs)	**TYPE**	no.	lou (hrs)
long fluoro			comp.fl.		
short fluoro			ord.bulb		

D. TRANSPORT
12. What follows are a number of questions around your transport use.

In total, how many **public transport** trips do members of your household make per week? ________. **Taxi trips** _______.

How many **pushbikes** are regularly used? ___________.

How many **motor bikes**? _________. Size? (cap)________.

How many **cars**, utes, vans or four-wheel drives are used for private travel?____.
Types: __________,__________
engine capacity/ no of cylinders_________,_______.

E. ATTITUDES
13. Using scale 2, do you think conserving energy is... **V**ery important, **I**mportant, **N**either important or unimportant
Unimportant **VE**ry Unimportant?

14. Again from scale 2 on the card: do you think looking after the environment is
Very important, **I**mportant, **N**either important or unimportant **U**nimportant **VE**ry **UN**important?

15a. Using scale 3 on the card: are you concerned about the effect your behaviour has on the environment ...
Always, **U**sually, **S**ometimes, **NO**t often, **N**ever.

15b. How often does your behaviour match your environmental concern? **A**lways, **U**sually, **S**ometimes, **NO**t often, **N**ever.
[if NO or N for 15a, skip 15b.]

16. [Rank] Using the card for Q16, which do you think is the most important Regional environmental issue (=1), next important...:
Water cons.___; **L**and Management___; **U**rban sprawl___; **E**nergy cons___; and **P**rotecting the reef___.

17. [Rank] Using the Q17 box on the card, which event is most likely to make you seriously consider your energy use, in your general behaviour, or if you were buying a new major appliance or car? ....next most important.. :

greenhouse concern____, friends____, price rise____, loans____, 25%paid____, energy efficiency____,
fossil fuel concern____, nothing____, respected person_____,
the future____, other: ________________________________

18. What are you current thoughts on energy supply and use? ____

____

Finally, there are a few questions about your house and household members, so that we can do statistical analysis to compare different households.

Are your walls insulated? **Y N** type __________
Is your ceiling insulated **Y N** type _________

Approximately how old is the building?_____.

Do you own or rent the residence? _____.

How long have you lived in the Townsville region?____
How long have you lived in this particular house/flat? _____.
All together, about how much per week would the household spend on petrol or diesel? _____.

Very approximately, what is your total (gross) household annual income (or income group)? ______.

F. RESIDENTS

no. of residents	1	2	3	4	5
sex					
age					
occupation					

Thank you for your time and help. There may be a short follow-up survey some time in the future. I would like to get your meter number on the way out.

____

JCU/NORQEB 1993 Domestic Energy Use Survey (DG22793)

Attachment 3 - very detailed questionnaire

- * JCU/NORQEB * -
- * 1993 TOWNSVILLE HOUSEHOLD ENERGY USE SURVEY * -
confidential + voluntary *Is this your main place of residence? [No = close interview and record as weekender.]

*Have you lived here for more than 6 months? [No = close interview and go to next reserve address of the same group]
Address___________ Sub.______ Date _______Meter__________
House /**U**nit /**F**lat __________

A. DWELLING * SHADE: Strl (1-5, 1=>) ____ Nat. ____
Exterior reflectivity ___

[With structural shade, 1 is very well shaded in all aspects, through to 5 is no structural shade at all. The same applies for natural shade. External reflectivity is a ranking of:1=bright white, through to dull grey/dark=5.

* height above ground_______ [note whether 2 story (2S), High Set (HS), Slab (S) or estimated height in millimetres

*Width of eaves ______

*Materials: Walls _______ Roof______ Floor________

B. BEHAVIOUR AND ATTITUDES

1. Do you presently do anything to save energy? **y n**

2. (if yes) What?

[Allow plenty of time for people to tell you all the things they do to save energy.] Ask:

"Is there anything else you do around the home, or in your local travel so that you use less energy than you otherwise might?"

Record any of the volunteered behaviours, either as ticks in the 'up' (unprompted) column, or in the space for 'other'.

Give the respondent plenty of time. Once you are satisfied they have no further ideas on the subject, say:

"We have thought of a few things too."

For any of the listed behaviours which they did not give an unprompted response to, ask (as appropriate):

3."Do you have a solar hot water system?...
Do you generally wash your clothes in cold water?...
Do you generally walk instead of drive the car if you are just travelling locally, say to the shop?..
Do you generally switch off lights when they are not in use?...
Do you have any compact fluorescent tubes for your lighting? Do you mainly cook on gas, or in the microwave, rather than with an electric stove?...
If you have any airconditioners, do you try to minimise their use during the hotter months?...
Have you planted any shade trees or vines? [tick any 'yes' responses in the 'prompted'(p) column.

solar hot water	up	p	install c/f	up	p
cold clothes washing			main cook micro/gas		
walk instead of drive			minimise a/c use		
switch off lights			pl shade trees/other		
other					

4. "In the past 12 months, have your attitudes toward energy use around your home changed at all?" **Y N**
[If Y] How and why? [If no, record any comments]

____

____

5. What follows is a 'Mini quiz' setting a 1993 knowledge base:
5a. What is the name of one fossil fuel?____________________

5b. What is one renewable energy source? ___________

5c. What is a greenhouse gas? ____________________

5d Starting with the highest user, what three things do you think use the most energy around your house? ______________________________________.

5e. What % of your total electricity do you think your (main) refrigerator uses?_______

5f. What do you understand by the expression: "Sustainable Energy Practices"?

____

____

____

C. <u>ELECTRICAL USAGE</u>

6. Do you have an electric hot water system? **Y N** If so.. is it a **H**eat exchange or **M**ains storage type [refer to ID]?
Using Scale 1 [hand over the guide card], how satisfied are you with its performance: **V**ery satisfied **S**atisfied, **N**either satisfied or dissatisfied, **D**issatisfied **VE**ry dissatisfied

7. "Looking at Q7 on the card: if you needed to buy a new hot water system, how would you rank those considerations ... what would be most important for you?... next important?.." [put numbers in the box 1= most important through to 5= least important. Just write in any 'other', but get ranking 1-5 in the relevant boxes].

	cost	durabil-ity	(many showers)	energy effic.	energyso urce	other
[rank]						

8. If a **S**olar, **E**lectric or **G**as hot water system all cost the same amount to buy, which one would you chose? ________

9.1 [from Q3 you know whether or not they have airconditioning. If they have, ask]: " How many air conditioners do you have?______
Thinking back to March, when it was late summer and still fairly hot, when would the airconditioner(s) normally go on and off?
What setting were/was they/it on?

Is your aircondtioning evaporative (very large unit) or refrigerative (usually set into a wall or window)?

Unit	time on	time off	setting	type
1				
2				
3				
4				

.2 Is you washing machine- **t**op or **f**ront loading?
- **s**mall, **m**edium or **l**arge?

Do you normally wash in the **m**orning, **a**fternoon or **e**vening?
About how many times per week do you wash?________

.3 Is your stove **G**as or **E**lectric?
About what time do you normally start cooking?_____
On average, about how long would the stove be on for?_____

.4 Is your fridge **s**mall, **m**edium or **l**arge?
[just a general guide, but if you want to get very particular, I am defining **s**= <250li., 251<**m**<379li., **l**>380li.]

About how old is your fridge?____ [If <5 years] Do you know the energy star rating on it?______.

Do you have a second fridge? Is it **s**mall, **m**edium or **l**arge?
About how old is it?____ [If <5 years] Do you know the energy star rating on it?______.

Do you own a freezer **N.** [If yes] Is it a **c**hest or **d**oor type?
Is it **s**mall, **m**edium or **l**arge? [For the record, here s<151li., 152<m<249li., l>250li.]

.5 Do you own a clothes drier? **N** Is it a tumble drier **Y**
How often do you use it? _____/week

.6 Do you own a water bed heater **N** How many?____. Is the heater on all year? **Y.** What setting?____. Is it just on ion the winter **Y**.

.7 How many fans do you own?________Thinking back to March, when would they normally go on and off? What setting?

Fans	number	time on	time off	usual setting
Living areas				
bed rooms				

.8 How many TV's do you own?______
When is it/[or the main use] Tv normally turned on ____and off____? What is the normal use pattern of other tv's?
on_______, off________?

.9 Do you own a video **N** .
Is it used much outside the normal TV watching hours? **Y** **N**
Do you own a computer? **N** How many hours per week is it normally used___________

.10 Do you own a microwave? **N**. Is it **s**mall, **m**edium or **l**arge
About how many minutes per day do you use it?

.11 [If the water heater is electric] Is you water heater on special tariff? **N** Which tariff.

.12 Do you own any heaters? **N** What sort, and when did you use them?____.

.13 Do you own a dish washer? **N** How many times per week do you use it?________.

.14 Do you own a pool pump? **N** What time of day is it normally turned on and off? ______________________. How many Watts is it?___________________.

.15 Do you ever have BBQ's? **N** What fuel do you use? **w**ood, **g**as, **c**harcoal, **e**lectricity. How often do you have a BBQ?____/mth.

.16 are there any other major electricity users, like welders or bore pumps which we have not covered? [list]______________

[Besides your hot water system] Are there any appliances connected to one of the cheaper tarrifs? **N** [list]_______________________.
.17 "Looking at Q9 on the card, which would be your main consideration if you were going to buy a new ...: [only ask of the major appliances which they already own] ...

appliance	initial cost	durability	energy effic.	(for stove) gas or elec.
washing machine				
stove				
fridge				
(freezer)				
(clothes drier)				
(air con.)				

10a. Are you aware that NORQEB are promoting energy efficiency? **Y** **N**

10b. Using scale 1 on the card: how satisfied are you with NORQEB's promotion of the efficient use of energy?

Very satisfied **S**atisfied, **N**either satisfied or dissatisfied, **D**issatisfied **VE**ry dissatisfied
[record any unsolicited comments]

____

____

____

11. **Lights**: How many fluorescent tubes are used for more than an hour per day _______. When are they normally turned on and off?______________ _________ [total hours = ____]

How many normal light bulbs are used for more than an hour per day _______. When are they normally turned on and off______________ _________ [total hours = ____] [Compact fluorescent tubes _____________________]

D. TRANSPORT

12. What follows are some questions on your transport use.

In total, how many **public transport** trips do members of your household make per week? ________. **Taxi trips** _______.

How many **pushbikes** are regularly used? ___________.

How many **motor bikes**? _________. Size? (cap)________.

How many **cars**, utes, vans or four-wheel drives are used for private travel?____.
no of cylinders_________,_______.

E. ATTITUDES

13. Using scale 2, do you think conserving energy is... **V**ery important, **I**mportant, **N**either important or unimportant
Unimportant **VE**ry Unimportant?

14. Again from scale 2 on the card: do you think looking after the environment is **V**ery important, **I**mportant, **N**either important or unimportant **U**nimportant **VE**ry **UN**important?

15a. Using scale 3 on the card: are you concerned about the effect <u>your</u> behaviour has on the environment ...
Always, **U**sually, **S**ometimes, **NO**t often, **N**ever.

15b. How often does your <u>behaviour</u> <u>match</u> your environmental <u>concern</u>? **A**lways, **U**sually, **S**ometimes, **NO**t often, **N**ever.
[if NO or N for 15a, skip 15b.]

16. [Rank] Using the card for Q16, Please rank the listed environmental issues, starting with the one that you think is the most important Regional environmental issue (=1), next important...:
Water cons.___; **L**and Management___; **U**rban sprawl___; **E**nergy cons___; and **P**rotecting the reef___.

17. [Rank] Using the Q17 box on the card, please rank those events, in terms of how likely they are to make you <u>seriously consider</u> your energy use, in your general behaviour, or if you were buying a new major appliance or car? ..Which one would

effect you most? ..which would next have a real effect on your behaviour around energy use .. which one would next make you sit up and take real notice of your energy use:

greenhouse concern____, friends____, price rise____, loans____, 25%paid____, energy efficiency____,
fossil fuel concern____, nothing____, respected person_____,
the future____, other: _________________________________

18. What are you current thoughts on energy supply and use? ____

____

Finally, there are a few questions about your house and household members, so that we can do statistical analysis to compare different households.

Are your walls insulated? **Y N** type __________
Is your ceiling insulated **Y N** type _________

Approximately how old is the building?_____.

Do you own or rent the residence? _____.

How long have you lived in the Townsville region?____
How long have you lived in this particular house/flat? _____.
All together, about how much per week would the household spend on petrol or diesel? _____.

Very approximately, what is your total (gross) household annual income (or income group)? ______.

F. RESIDENTS

no. of residents	1	2	3	4	5
sex					
age					
occupation					

Thank you for your time and help. There may be a short follow-up survey some time in the future. I would like to get your meter number on the way out.

____

JCU/NORQEB 1993 Domestic Energy Use Survey (DG7993)

Attachment 4

GUIDE TO 1993 TOWNSVILLE HOUSEHOLD ENERGY USE SURVEY

Code = first three letters of the street name + the street number ie 12 Mary St is Mar12
Meter - get meter number(s) at the end of the interview H /U /F = house, unit or flat

---

SHADE Strl/ Nat.: see shade rating chart: 1=> shade, 5=virtually none. ht ab gnd = height above ground
Exterior colour - dazzling white=1, very dark = 5.

---

solar hot water up = unprompted (it is important to give the respondent plenty of time .. "Is there anything else you can think of that you do which keeps your energy use down?..).

p = prompted ie read through the list and mark in further things that they do actually do that we would consider energy-reducing.

7. RATING 1 = most important.
Many showers = people using the shower three or four times in a row without the water going cold.

9b. TARIFF - here we need to ask them if any of their appliances are on any special off-peak tariffs, and if so, record which one(s) in the Tariff column.

BUY - this column only concerns major appliances. We need to ask each interviewee the same question as for question 7 (except showers).

eg: after we have asked about air conditioners, we ask: "If you were going to buy (another) airconditioner would you consider cost, durability (how long it lasts) or energy efficiency as the most important thing in making your choice?

9. It is important to get the air conditioning type (refg. or evaporative) and the normal setting for March

11. **Lights**: lou (hrs) = length of use

If there is a____ on the questionnaire, there should be an entry of some sort on it.

don't forget the meter number

"Thank you for your help. There may be a short follow-up survey some time in the future."
It's important to say this, so that some form of follow-up remains possible.

Attachment 5
Guide card - NORQEB/JCU 1993 energy use survey

SCALE 1

1. Very satisfied,
2. Satisfied,
3. Neither satisfied or dissatisfied,
4. Dissatisfied,
5. Very Dissatisfied

SCALE 2

1. Very important,
2. Important,
3. Neither important or unimportant
4. Unimportant,
5. Very Unimportant

SCALE 3

Always, **U**sually, **S**ometimes, **N**ot often, **N**ever.

FOR 7 (rank 1-5)

If you were buying a new hot water system, which feature would you consider most important.. next most important ...

* Initial cost;
* How long the unit will last;
* How many showers you can have one after the other;
* The energy efficiency of the unit (running costs);
* Whether it is solar, gas or electric.

Other.

- 2 -

FOR Q9

As we discuss each major appliance: if you were buying a new one, what would be most important to you?
How long the unit will last; **W**hether it is gas or electric. **I**nitial cost; **T**he energy efficiency of the unit (running costs); **O**ther

FOR Q16. (rank 1-5)

From the following group, tell me which you think is the most important environmental issue ...next most important .. etc
* Water conservation.
* Land management.
* Urban sprawl.
* Energy conservation.
* Protecting the reef.
(Other).

Q17 Using the box below, which event is **most likely to make you seriously consider your energy use** in your general behaviour, or if you were buying a new major appliance or car? ....Which do you think next most important....next ...
(rank 1-10)

* Concern about your contribution to Greenhouse gasses.
* Your friends were reducing their energy use.
* The price of electricity and petrol rose by 25%,
* Low interest loans were given to buy major energy items.
* Government paid 25% of new high efficiency appliances.
* You realise that energy efficiency can save you money.
* Concern over how much fossil fuels you use.
* Nothing.
* People you respected were reducing their energy use.
* Concern about the future.
* Other.

Attachment 6
Details of renewable energy options for North Queensland

1 Solar Hot Water
2 Solar Thermal
3 Mini Hydro
4 Bagasse
5 Wind Power
6 Remote Area Power Systems (RAPS)

The relevant renewable energy sources for Northern Queensland are solar water heating, mini hydro, bagasse, wind power and using Remote Area Power Systems (RAPS). These are detailed in many publications (ie Choice 1993, Rostvik 1992, Solar Progress 1992, Schuck 1993). Although there are other renewable sources, such as wave power (Whittaker 1992) or using animal waste (Andreoli 1992), I have concentrated on those which seem applicable on what should collectively become a large scale in Northern Queensland. Their widespread application is also useful in many other tropical regions.

1 Solar hot water

Of all the available renewable technologies for the domestic sector, solar hot water heating is the most commonly known. Australia exports millions of dollars of solar hot water systems annually.

The energy advantages of solar water heating are that solar heat is free and is non-polluting. A hindrance to greater uptake of solar water heating systems is the higher initial cost takes time to recoup. There are a number of different types which means a system can be tailored to suit particular requirements. The general savings in domestic water heating energy costs in Townsville are calculated to be about 80% (CSIRO 1991).

Currently, about five percent of NSW homes have solar hot water (Stephens 1993), compared to about 6% of Queensland homes. The Mt Isa study conducted in 1992 (Goudie 1993) found that Mt Isa had about 24% solar water heating, while the 1993 research carried out by the Award applicant found Townsville had about 8% ownership. In Townsville, about 88% of domestic water heating is by electricity (Crow 1993). In Mt Isa, only about 66% of home water heaters are electric only (Goudie 1993).

2 Solar thermal
Solar Thermal is a method whereby solar heat is focused via reflectors onto a tube, usually carrying water or oil (Mills 1992). This fluid becomes very hot and is used to drive a steam turbine to generate electricity. Such a generating system may be used in Tennant Creek (Finch 1992). The cost of this method of generation is expected to fall to about 9 cents/kWh by the year 2000, and about 5 cents by 2030 (Stephens 1993, p2).

3 Mini Hydro
The Townsville-based electricity utility, North Queensland Energy Board (NORQEB) hosted a two day conference "Remote area Power Supplies and Renewable Energy Applications Conference" in Townsville in late April 1993. The conference was held for members of the Electricity Supply Association of Australia.

The Queensland Minister for Mining and Energy Tony McGrady opened the conference. He said that 'small hydroelectric units, built on privately-owned dams, could provide a small, but significant, source of electrical power....."(McGrady 1993).

At the same conference, another speaker said that mini-hydros have a low impact on the environment, and could be installed on existing dams presently used for irrigation and town water supplies. Combined with solar-thermal based electricity, these systems could supply in excess of 300 MW (Stephens 1993).

Because the North Queensland Electricity Board is charged with supplying cheap, safe, reliable electricity throughout North Queensland, consideration should be given to establishing mini-hydro systems in accessible mountainous coastal rain-belt sites in North Queensland. However, with the new corporate structure of the Queensland Electricity Commission becoming solely responsible for power generation in Queensland, it is difficult to assess what could motivate that organisation to investigate use of many mini hydro sites in North Queensland.
There is a small private company, Planetary Power, which is promoting and installing some micro-hydro in Far North Queensland (Law 1993). Some mini hydro are also proving themselves in Victoria (Lemon 199291). Via the process of word of mouth, there is the chance that these highly desirable, cheap and reliable sustainable energy sources will be harnessed.

Global attention on micro-hydro (Salakalauskas 1991, Scales 1992, Kotakorpi 199294) is increasing. Kotakorpi describes a recent example of a mini-hydro installation in Finland where the generator is sited underwater, minimising environmental impact. It has a pay-back time of about 10 years, and a technical life time of 40-50 years, the output is 2000kW. Kotakorpi concludes positive public attitude toward mini-hydro use in Finland is increasing. Small hydro systems are being used or considered in Nepal and China (WP+DC 1993).

The high altitudes and rainfall in the Tully area make the widespread installation of these low-impact systems possible at suitable sites close to existing roads and mains grid.

4 Bagasse

The burning of bagasse (the fibre left in sugar mills after the extraction of sugar from the cane) in more efficient ways to generate surplus electricity for the grid is currently being researched. An independent progress report indicates that the investigations 'have potential for benefits to accrue reasonably soon' (Chudleigh 1993 p43). The efficient use of bagasse has the potential to generate about 650 MW (more than the Tully Mill-stream proposal), and the cost of co-generation (using energy byproducts of one process to meet other energy needs) is about the same as current State tariff rates. Over 7 million tonne of bagasse was burned in North Queensland in the 1988/89 season. Most of this was burned with low energy efficiency. Storage methods are being investigated- one of the main problems is the inability to offer continuous electricity supply outside the crushing season.

Using sugar cane as a renewable energy source has the advantage that it is a very high efficiency converter of solar energy into biomass (Fogg 1972) for human energy use. Efficiently using bagasse and ethanol can reduce greenhouse gases.

The larger issues of institutional barriers to change can be seen by comparing the buyback of 2c/kWh for bagasse-derived electricity, while coal generated electricity costs about 4 c/kWh (ignoring externalities using fossil fuel) to generate.

Advanced Gasification Steam Injected Gas Turbine Technology (Kaneff 1992, World Resources Institute 1992 p155) is the most efficient way of utilising stored energy in bagasse. Although entering the realm of pure engineering, it is mentioned to indicate that there is a renewable energy resource and technology waiting to make a major contribution to sustainable energy in the tropics and subtropics, but the political landscape is not yet mature enough to properly pursue it. (largely from Dr. T. Dixon, 1993- Principle Engineer, Sugar Research Institute, Mackay- pers.com.).

If there is a problem with continuous supply, there is the possibility of developing strategies to supply the evening peak, or growing other energy crops (such as cassava) on more marginal land. Bagasse should be used as an efficient and permanent supplier of electricity to the grid in those areas of the tropics where sugar is grown in quantity.

In Zimbabwe, an ethanol plant has been operating from surplus sugar production since 1980. In 1984 it was calculated that this local renewable liquid fuel source saved $125m in foreign exchange. With the core aim of maximum resource efficiency, the Triangle plant uses the 'waste' silage as a spray-on fertiliser, increasing crop yield, while the 'nuisance' bagasse is now burned in 82% efficiency boilers with inlet air heaters and water economisers. In 1989 Triangle supplied 2MW to the national grid. The whole scheme has maximised local employment and training (Schmidheiny 1992).

5 Wind Power

At suitable sites, wind generation is currently cost competitive with grid power (Stephens 1993). The technology is mature, and used extensively (globally, 20,000 machines are operating commercially) including some sites in Australia (McGowan 1993, Stephens 1993 p7). The installed capital cost of major wind turbines has now dropped to one quarter of costs in 1980. Locations as diverse as Camooweal and Cooktown could provide much of their electricity needs through wind generators. The first step is to gain accurate wind pattern records.

5 Remote Area Power Supplies (RAPS)

Many countries, including Mexico, Brazil, Indonesia and Sri Lanka are using photovoltaic solar modules (panels) and often wind generators to provide electricity in more remote areas (Vera 1992, Josephson 1993).
RAPS systems are also gaining widespread use in Australia and New Zealand (MacKay 1993). RAPS systems are important because they save the need for expensive extensions to main grids. They provide the market incentive to develop and trial small scale renewable energy supply systems, usually coupled with the motivation to use minimal electricity via efficient plant and appliances.

This argument is well recognised: "Developing equipment for the remote area power supply market is not an end in itself. It provides the renewable energy industry with an opportunity to obtain a cash flow and provides a commercial incentive to develop the more cost effective components that will be required when these technologies find wider applications." (Stephens 1993).

RAPS have a very definite place in the Northern Territory where in 1991 the operating costs for remote settlement power provision was $15.5m, while the revenue was only $2.2m (Edwards 1991).

The State and Federal Government are cautiously moving to actually help individuals set up RAPS systems, showing their understanding of the benefits, and that the 'initial price hill' of equipment cost is stopping many potential users from becoming less reliant on their petrol or diesel generators.
"The Commonwealth Government will provide funding of up to 50% of the installation cost of new raps systems, or $35,000, whichever is less." (McGrady, State Minister for Minerals and Energy, 1993)

Renewable energy technologies are available for immediate use in North Queensland, once the political will is expressed.

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Attachment 7

Solar water heating anomalies in Mt Isa

Goals and Outcomes

In Mt Isa, electricity is bought from Mt Isa Mines, with marginal profit, and a price structure based on a minimum evening peak. In Camooweal and Burketown (see Attachment 8), electricity is generated in each town by NORQEB with diesel generators, costing about twice as much per unit of electricity overall as the fixed state wide tariff. There is clear motivation for NORQEB to reduce wastage, and reduce the evening peak.

In each of the three population centres under study, people interviewed were asked: "Is there anything you can think of that you or the town could do to reduce electricity use, or spread the evening electricity peak?"

Mt Isa

Analysis of Energy use data collected in March 1992 showed anomalies with higher-than-average electricity consumption for some households with electric boosted solar water heaters. Twenty-one relevant households were revisited to discern the relative contributions of booster problems and surrounding energy intense behavior.

The results of investigation of the 21 subject households in November fell into the four categories of:

A.. Apparent booster/system faults - 7 cases

B.. Apparent overuse of boosters - 4 cases

C.. Inconclusive booster contribution - 4 cases

D.. Probable other electricity-intense behaviour (including 3 households with 'one-shot' boosters). - 6 cases

Background:

From a random sample of three hundred households surveyed in Mt Isa in March 1992, there were a total of 72 Solar systems (24%). Fifteen of these had no booster connected. Of the 24% of houses with solar hot water, about half rarely or never used their booster.

The 85 households on special off-peak water heating rates used a mean of 367KWh per household for electric water heating for the two month billing period spanning March 1992.

The 13% of householders who have a relatively unregulated solar electric system have an average electricity bill of $158 over a two month period. The above-average households within this group are the subjects of this paper. People with electric only water heating average $148, while the 14% of households which had gas or solar only water heating averaged $112 per bill (see Table A8.1 below).

Table A8.1: Hot water system type and average 2 month electricity bill and electricity consumption, Mt Isa, March 1992.

Hot water system type	Reported Booster use	number per category [%]	Two monthly bill [$]	Average kWh used
electric only	-	202 [67]	148.10	1540
solar/electric	>5X/year	40 [13]	157.65	1681
solar/electric	<6X/year	17 [6]	121.06	1292
solar only	none	15 [5]	113.00	1059
gas only	-	26 [9]	111.93	1088

In the November investigation, households using more than 1300 kWh with solar/ electric water heating systems were investigated. Only two thermostats could be looked at without a ladder. One thermostat was set at 50^{o}C, the other at 60^{o}C, which are acceptable temperature settings.

The responses to the question shown in the introduction are recorded below in the sections headed '**Suggested:**'.

Seven households with higher-than average use could quite clearly be attributed to physical faults with the water heating system.

Four households appeared to overuse hot water outside the solar input hours, and thus rely on the booster.

Four households were in a grey area where above-average use could have been explained by water heating or surrounding 'energy intensive' behaviour (that is, there was above average use, number or type of high electricity consumption appliances, such as pool pumps, dishwashers, extra televisions, refrigerators or freezers, and/or more than four people in the household).

Six households had energy intensive behaviour that probably explained their higher electricity consumption, with no disproportionate use of their electric boosters. This group includes three households with one-shot booster switches, which are therefore considered exempt from excess booster use.

The 11+ households with system or behavioural problems giving high electric booster use represents approximately 3.5% or 200 households in total for Mt Isa, each making greater than expected electricity demand.

With 57 of the 300 household sample having solar/electric water heating systems, the results of the November survey indicates that one in five of such systems have associated physical or use problems.
There seemed to be a general trend that if the booster switch was in the outside meter box, people were more inclined to leave them on.

A. Apparent booster/system faults

Case 1: Consumption 7157 kWh. Used a lot of air conditioning in March. "Had trouble with hot water in the middle of winter - hot water streaming off the roof." After the water heating system was repaired, the bill following the March period fell from $657 to $393.

Suggested energy reduction strategies from householder: reduce air conditioning use. Use insulation. Adjust thermostat from 22 to 25 degrees. Close windows. Change behaviour.

Case 2: Consumption 3572 kWh. Although a boys' hostel, with 6 -12 residents there were few appliances, one refrigerative airconditioner that was not often used, with the residents mainly relying on breezes and fans for cooling. The solar water heating system was a three piece parabolic trough tracking device, which observation showed was stuck in the due east position. The hostel caretaker was not aware of the system on the roof. The booster was turned on.

Case 3: Consumption 2966 kWh. "Real problem with booster .. old system .. bought the place because of it .. it must be gummed up, it slowly stopped."
Suggested: Turn off freezer. Mine uses lifts 24 hours per day. Do they operate during the evening peak? Suggests solar fields for solar-electric generation.

Case 4: Consumption 2647 kWh. Outside switch for booster. A single trough tracking device. "Tracking device doesn't always work properly. Needs water pressure to move tracker, and water pressure not always there. Have tried to get parts for tracker, but can't get them. .. Have noticed a drop in the electricity bill since converted to night rate."
Suggested NORQEB give every-one two compact fluorescent tubes, or buys them in bulk and sells them cheap.

Case 5: Consumption 1938 kWh. System 20 years old. Booster turned on for the last couple of months. The need to use the booster has slowly increased over the past couple of years. There will be a telephone follow-up with this householder, who is going to either have the solar plates flushed out or replaced.

Suggested: change to a smaller freezer, "should be off-peak power points for pool pumps and washing machines." Encourage early food preparation (to reduce evening peak demand).

Case 6: Consumption 1548 kWh. The owner in this case had experienced too many problems with his solar system, and has converted to a small electric water heater. His electricity bill had been much the same as with his solar/electric booster system. He did point out something that was echoed by others: if the property has a dog, the electricity consumption is estimated by the NORQEB meter reader. This means that houses with dogs are liable to have recorded consumption figures that are probably inaccurate estimates; not conducive to exact analysis.
Suggested: "The mines use too much."

Case 7: Consumption 1915 kWh. They have replaced their solar system since March, as their old one rusted out. There are 5 householders, 2 fridges, no freezer, no excessive airconditioning use.
Suggested: Make compact fluorescent tubes cheaper.

B. Apparent over-use of boosters
Case 8: Consumption 1503 kWh. "Husband turned it (booster) off for a while, but the kids turn it back on."
Suggested: "Sometimes they leave the street lights on all day. I've seen this a few times."

Case 9: Consumption 1523 kWh. Outside booster switch.".. like we should switch the booster off .. we never bloody do."
Suggested: Keep switching off lights and stuff, advertise that we should conserve electricity. Twenty-third Ave. street lights on in the morning. Sometimes see street lights on during the day.

Case 10: Consumption 1863 kWh. Outside booster switch. ".. tend to shower often and put the booster on."

Suggested: Turn off air conditioning when possible.

The Irish club seems to leave the oval lights on all day. There is a need to adjust times for security lights with the shorter nights. Minimise TV use.

Case 11: Consumption 1398 kWh. In this household there are only three people, and although reported they only used the booster when cloudy, the booster was on. This highlights the problems of self reporting.

Suggested: Turn off second fridge, use less lights. Another household who felt there were anomalies with their bill, in that they felt they used the same amount of electricity from bill to bill, but there was a $10 to $20 variation.

C: Possible booster overuse, or other high electricity use patterns:

Case 12: Consumption 1863 kWh. External switch. There are six residents, reported booster use 15 times per year, only one fridge and a 400 litre freezer. Air conditioning use was less than average. They had no pool pump or dishwasher.

Case 13: Consumption 1964 kWh. Water thermostat set at 50^0C. Five people in household, including children from 8 - 14. Air conditioning use was average, and they operate a pool pump. Booster has an outside switch, "..left on in winter, and when its cloudy .. sometimes forget to turn it off .. had worried the booster worked too well."

Suggested: Change pool pump to off peak. Use compact fluorescent tubes.

Case 14: Consumption 1598 kWh. Booster switch on their back verandah, reported used occasionally for half an hour. Three adult household members, average air conditioning use, two refrigerators and a 340 litre freezer and a dish washer, and use two TV's occasionally. The problem of estimating by NORQEB meter readers was again highlighted by this householder, who reported that they consistently had bills around $190, then their last bill was $30.

Case 15: Consumption 1930 kWh. The house has been rewired since March, as there was something wrong. Occupants have changed since March. In

March there were only two occupants, with only one fridge and a 290 litre freezer, low airconditioning use and no extra appliances. It is hard to explain this high consumption without considering problems with booster operation.
Suggested: they turn off everything after 9.30 pm.

D: Likely surrounding energy intense behaviour.
Case 16: Consumption 2476 kWh. Five householders, including three teenagers, 5 TV's, one computer, two videos, one refrigerative airconditioner (used when very hot) one evaporative air conditioner, used 12 hours per day in March, Clothes drier used 5 hours per week, a dish washer used every second day, and a pool pump used for four hours per day.
Suggested: " Cut down on it .. shop lights on during the day."

Case 17: Consumption 1573 kWh. Four householders, 2 fridges, no freezer, pool pump for four hours per day, dish washer use.
Suggested: encourage kids to turn lights off. Civic Centre lights are on all night.

Case 18: Consumption 1412 kWh. Inside booster switch. Three residents, one fridge, two freezers, moderate use of airconditioners.
Suggested: Cook outside, go to bed early, have quick showers, turn lights off, minimise use of lights, especially outside.

Cases 19 - 21. With one shot booster switches, their consumptions were 1371, 1603 and 2412 kWh, with three or four people in the residences. Each residence had a pool pump and a dish washer, the highest consumer also had a tumble drier, two fridges and a freezer.
Suggested (Household 20): "Short of external constraints .. cook dinner outside of the evening peak, use the pool pump late at night .. shops leave many lights on at night." Household 21: "Get new bulbs .. try and use less of it."

RECOMMENDATIONS

Remind people that, like most appliances, water heaters grow old and eventually need replacing. This is true for solar water heaters. NORQEB should promote solar water heaters combined with night rate boosters. There should be active promotion to get people with solar systems to be careful in their use of boosters (perhaps by installing one-shot switches), and that they should take advantage of night tariff when they do need electric heating for their hot water supply.

The argument re-emerged that much peak load shedding would occur if NORQEB made one power point in the house available to off peak tariff, for the use of pool pumps and washing machines, giving a clear reduction in the evening peak. There may be a need to consider this on a state-wide basis: increase the general tariff, then discount an off-peak 'laundry' power point, so that the financial returns are calculated to be substantially the same, but the evening peak is definitely to be avoided.

It is perhaps worth encouraging people to turn their air conditioners down or off for a while during the evening peak. The cumulative effect on the peak of many co-operative individuals may be promoted as a display of community spirit, and should not be underestimated in a City like Mt Isa.

Attachment 8
Energy survey of Camooweal and Burketown

Camooweal

Detailed inspection of main electricity users was carried out, seeking targets for demand side management. The two main areas for Demand Side Management and least cost planning focused on water pumping, and Calcium Carbonate build-up on electric water heating elements, forming an effective heat insulation, and very inefficient heat transfer.

Burketown A full consumer survey of domestic and commercial electricity users was conducted, to compare patterns of use with Camooweal, and to target possible electricity use reductions.

Both Bourketown and Camooweal people are generally very electricity conserving, with some residents very interested in the use of solar electricity for their towns.

<u>Camooweal</u>

With little more than basic appliances, the average householder in Camooweal is quite electricity conserving. The water pumping station use about 10% of the total electricity generated in the town, with the one Hotel and the two Roadhouses using the majority of the rest of the electricity generated. The water is pumped from two bores. The situation is described in an earlier report by Steve Rosetti. There are options of using 'mono' pumps; direct diesel; solar; wind or combinations that Steve will further report on. Water conservation should be promoted, and a realistic and detailed analysis of alternatives, using a 'cocktail' combination of solar and wind pumping should be exhaustively explored.

<u>Calcium build up on water heating elements</u>

Calcium build up on water heating elements leads to a thick insulating layer of material. The rate of build-up of the deposit is indicated by the Owner/manager of one of the road houses, who reports that he cleans out approximately one Kg every three months from the urn, and that when he had a solar hot water system, he used to clear out a bucket full of lime every six months, just from the area he could access around the booster element. Considering the insulating properties of calcium carbonate for every water heating device in Camooweal, the electricity wastage, often during peak use times must be quite high. All the boosters of the solar water heaters at the Aboriginal hostels were switched on, probably operating inefficiently through lime accumulation. Samples have been passed to the Department of Chemical Engineering to see if there is a way, perhaps similar to the method used at the seed research station in Charters Towers, to precipitate the calcium out of solution immediately after it leaves the bore.

There were a few obvious minor problems with the main electricity users in Camooweal - some leaking refrigerator seals, and the continuous use of an incandescent bulb in the cool room of the pub.

The people interviewed in Camooweal **suggested:** use solar preheater for hot water systems, use gas for cooking (X2), keep refrigerators full, reduce use of water for gardens (X2), there are unoccupied houses with lights on, turn off everything when you go out, especially air conditioners and lights, use windmills for water pump, the town water tanks sometimes overflow, use the pending sewerage water to water public land, use microwave for cooking, consider key switch for air conditioners, so that you would have to turn them off when you went out (for the hotel rooms), use compact fluorescent tubes, turn off
extra refrigerators, run pool pump (Roadhouse) outside the evening peak. Two households in Camooweal are experimenting with the use of plants to cool their houses, or the inlet air to their air conditioners, via the use of plants. A local vine (Mile-a-minute) is very effective for giving eastern and western wall shade for buildings.

There are arguments for connecting Rockland Downs onto the system in Burketown -IF the evening peak could be heavily reduced, both for Camooweal and Rocklands (see recommendations below). Connecting Rocklands would help maximise the use of the existing diesel set - the day we inspected the power station, at about 2 pm, the generator was running at only about half output capacity.

Burketown

The results of the 'commercial' user survey will be reported on later. There are 41 houses in Burketown, and one block of two flats. Six houses were vacant. Almost no-one saw themselves as energy conserving, although of the thirty occupied households analyses at the time of writing, 8 have no water heating, 6 have solar water heating (two with their boosters on), 11 did not own a car, and 18 did not own air conditioners. Mt Isa had 99% household air conditioning ownership. A more detailed analysis of Burketown domestic consumption may be undertaken at a later date, however, the above figures show plainly that the town has a generally low consumption lifestyle and attitude already.

The **suggested** ways of reducing wastage or the evening peak follow: ".. think about using the sun, replace main bulbs with compact fluorescent bulbs, use esky instead of fridge, a lot of people leave lights on at night, only use hot water for washing up and bathing, dont use electric stoves, lots of people leave lights on, solar panels were smashed in strong wind, install a turbine pump at the mouth of the river, with its' 3 metre tidal range. Freezers tend to burn out ... it may be the power surges, or it may be the extreme heat. Street lights could be turned off, seldom leave lights on, all power points are turned off at night, sit down in the dark in the lounge with the street lights on, evaporative air conditioner works well at night, turn lights off at night, watch less TV, some people leave lights on all night, careful already, see some lights left on a lot, get rid of electricity, hardly use lights, have timer on TV, get wind generators, use whirly bird in roof, solar panels should be flush with roof line - after the last cyclone, panels were lifted, use light dimmers, have thermostat control on air conditioner.

Residents of both Camooweal and Burketown complained of power surges and drops, which are probably unavoidable.

RECOMMENDATIONS

Camooweal

Pamphlets should be drawn up to explain the fact that, as an isolated settlement, Camooweal was reliant on limited and costly diesel electricity generation, with the best value gained by having the evening peak as flat as possible. This pamphlet should discourage all afternoon/evening garden water use. If all garden watering was actively discouraged from 4 - 8pm, the existing water pumps could be changed to off peak use, reducing the peak load.
NORQEB should encourage more people to agree to have their electric or solar/electric water heater converted to off-peak use.

For **Burketown**, the only domestic DSM recommendation is to consider use/ provision of 5 Watt compact fluorescent tubes, for toilets, as quite a few householders reported leaving that light on all night for the kids. Like Camooweal, Burketown is small and generally very co-operative, with steady wind and ample solar radiation. It would be a very good place for some experimentation in the use of solar/wind input into a remote settlement. A further option is that, because the cost of provision is greater than the price electricity is sold for, NORQEB should promote the use of solar/electric on a householder basis: provide incentives for town householders to become electrically self-sufficient.

Attachment 9

Booklet: *Energy Efficient Housing in the Tropics*

This booklet is placed in the pocket inside the back cover.
Please return it after use.

Attachment 10

Initial Submission to Future Supply Consultative Electricity Task Force.

New Paradigms for sustainability- future options for electricity supply and use in Queensland.

- Douglas D Goudie-

(please contact if you require more detail/input)

Abstract

The discussion document 'Powering our Future' is an updated variation of business as usual. Neither Ecologically Sustainable Development, least-cost planning, 'externalities' nor the New Environmental Paradigm have been included. The range of offered choices excludes social change. Including those perspectives would define an approach where supply is not so easily or geographically separated from demand, carbon dioxide emissions against the Toronto target were emphasised, and small scale local sources were explored.

Summary

The options offered in the ‘public consultation’ material are dated- like other States and countries, Queensland should spend strongly on energy conservation and small scale renewable energy systems.

There is mixed and misleading information as to the potential for conservation saving, while experience elsewhere clearly shows that conservation spending is cheaper and environmentally preferable to more coal-based generating capacity.

The old fashioned view and ‘industrial culture’ displayed in the consultation material should, as the result of many submissions, be replaced by final recommendations and strategies similar to those contained in the following submission.

Introduction

'Powering our Future' 'logically' lead the reader to believe that-

(i) Electricity demand will rise

(ii) all future conservation possibilities have already been factored in to that rise (ie page 12),

(iii) solar and co-generation supply replacement is fairly marginal and that

(iv) more hydro is a little taboo.

Thus the implied conclusions that we need to (re)commission coal powered generating stations, that the relevant State decision-makers accept the electricity demand growth projections, that social change around energy use is off limits, and that global warming and resource depletion is not part of the context of the Task Force.

The real ramifications of CO_2 emissions are covered in many publications (see Leggett 1992), and as you will no doubt have other submissions on this core intergenerational issue, I will not dwell on it. As pressure mounts to reduce CO_2 emissions, Queensland, the Sunshine State, has the potential to be a world leader, if there is the political will to spend money on implementing conservation and renewables now. New England Electricity in the USA spends $90m per year on conservation measures believing that the cost of 15 cents per kW demand reduction is cheaper than 45 cents per kW cost to install new generating capacity (Weinberg 1990).

The New Environmental Paradigm (NEP) departs from our classic anthropocentric world view, replaced by beliefs in '.. limits to growth, the necessity of balancing economic growth with environmental protection, the need to preserve the balance of nature, and the need for humans to live in harmony with nature.' (Scott 1994).

The old paradigm world view is graphically illustrated in the widely distributed flier, asking for bright ideas, but using the symbol of an old inefficient incandescent light bulb, rather than a compact fluorescent tube.

Energy Conservation

The Victorian Government has been actively spending many million dollars per year to promote conservation in that state (ie DMI 1991). If the Queensland Government is considering spending hundreds of millions of dollars on new generating plant, it is ignoring major conservation spending trends in many other countries- ie, Mexico spent $24m on domestic compact fluorescent tubes, in 1991 Brazil spent $20m and saved $1b (Roodman 1993)- surely Queensland can spend substantially on DSM and renewable sources.

Renewable Sources

Although "Powering our Future" marginalises renewable sources, there are other countries like Finland (Kotakorpi 1992) and the state of Hawaii (Phillips 1989) which believe it is possible to greatly reduce their reliance on more environmentally harmful sources of energy. Solar, mini-hydro and bagasse use (for peak demand) all have great potential in Queensland.

Behavioural Changes

There is need for major behavioural change to meet greenhouse gas reductions (Ecologically Sustainable Development Working Group Chairs final 'Greenhouse Report' 1992; Beder 1993). There are many books and papers on changing human behaviour around their energy use (ie Oskamp 1984, Dwyer 1993).

As the motivation to plan and direct ourselves toward sustainable energy systems and life-styles increases, consideration needs to be given to what affects peoples behaviour. The core question is: what influences are likely to speed Queensland individuals, communities and institutions (there are over 20 international papers on "Institutional Barriers to Change"- see Jarach 1989) to take sustainable energy paths. Our Government, through recommendations of the Task Force, is in an enviable position to explore options, employ committed experts in sustainable energy strategies and public education programs, and implement long term integrated resource planning to meet the needs that the most benign sources of energy can service.

Because every-one lives in a residence (and the domestic peak demand determines the generating capacity needed), the target group for behavioural change should be the residential sector, in the belief that if attitudes, behaviour and appliance use change in the domestic sector, the personal effects will spill out into the industrial, commercial and service sectors.

Because a lot of the technologies and behaviour to move toward sustainable energy patterns are know (ie Stern 1992), a central problem remains: how to motivate people to modify their energy use patterns in the future. Target groups for electricity conservation programs should be the group of roughly average use- two-four member households. As an MSc tropical domestic energy researcher, preliminary findings indicate that concern for the future, and feed back on their own consumption will help reduce demand. Clear behavioural messages role-modelled by respected individuals has proven effective. IF the Task Force and the Government want to help move Queensland in a more sustainable direction than more burning of fossil fuels, these options should prove much cheaper than bringing more large-scale generating plant on line.

Minihydro

The Queensland Electricity Board is charged with supplying cheap, safe, reliable electricity throughout Queensland, and should consider the possibility of micro-hydro systems in the mountainous coastal rain belt area of North Queensland. Global attention on micro-hydro (Lemon 1992 Salakalauskas 1991, Scales 1992, Kotakorpi 1992) is increasing. Kotakorpi describes a recent example of a mini-hydro installation where the generator is submerged. It has a pay-back time of about 10 years, and a technical life time of 40-50 years, the output is 2000kW. Kotakorpi concludes that public attitude in Finland toward mini-hydro use is increasing. With the high rain belt in the Tully area, The Queensland Electricity Board should consider the widespread installation of these low-impact systems.

Solar cooling

There is a clear market to develop a refrigeration/ airconditioning unit that freezes bulk water at night rate, then requires no external energy source during the peaks. The same principle applied in a sustainable way would produce a solar cooler with bulk ice storage. The hotter the day, the harder the unit works. Solar airconditioners which meet 80% of the load are marketed in Japan by Sanyo. There is obvious room for development of such devices for use in Queensland, where, in Mt Isa for example, there is 99% air conditioning ownership (Goudie 1993). Such devices developed in Australia would have a good local and export market, and could largely use local metals.

Recommendations

A concerted public campaign, working from local and international experience should be implemented to achieve 15% overall demand reduction, and further reduction of the evening peak through DSM.

All staff of the Queensland Electricity Boards should become involved in the commitment to energy efficiency. This will be achieved through extensive training courses for management and staff, learning of the shifting industry paradigm to achieve ESD goals, to develop reduction strategies, in consultation with interested organisations and community members. For example, QEC management needs to actually believe that solar water heating is preferred to off peak electric water heating.

DSM

The finding that householders with teenagers are in the upper range of electricity users (Goudie 1993) indicates that there is scope for schools to become more involved in energy issues education, imparting the idea that individual actions do make a difference.

Households with two refrigerators should be alerted to the fact that it costs in the order of $20 per bill to run a refrigerator, and that if the second fridge is not absolutely necessary, it should be turned off except for specific short term uses. Householders with pumps (pool or bore- 17% in Mt Isa and 12% in Townsville) should be encouraged to use them outside peak hours, which the Mt Isa study (Goudie 1993) has shown are mainly timed for evening operation.

Solar

People who are replacing their electric hot water systems should be encouraged (subsidised?) to install a solar system. A 200 household energy survey in Townsville in 1993 shows that if solar, electric or gas water heater all cost the same to buy, solar would be the preferred energy source for 70% of respondents.

Light-bulb equivalent ratings should be given to bring home the message that if you use 360 kWh of electricity per bill on electric water heating (Mt Isa electric only average), it is the same as leaving ten 60 watt light globes on for ten hours every night, releasing about a third of a tonne of carbon dioxide during each billing period.

Householders with solar water heaters should be encouraged to fit timers into their booster circuit, to allow electric heating only from 2-4pm, thus restricting electric heating to those days when solar input is insufficient to fully heat the stored water.

The fact that a solar system is likely to increase the resale value of the property should be promoted.

The average domestic electricity usage should be published at the time electricity bills are posted, encouraging people to all do they can to reduce that average, especially to reduce their evening peak demand.

Conclusion

Wearing seat belts, push bike helmets and reducing drink driving are all examples of successful public campaigns of change. Explaining the evening peak, and why it is advantageous to reduce it is a first step in having supply more evenly match demand.

The Department of Minerals and Energy can either view the current supply-use review as a perfect opportunity to seriously initiate renewable sources and efficiencies in supply and use of energy, and invest in that option (as many other countries are doing), or it can authorise more fossil fuel use. It can either embrace ESD intergenerational principles, or miss this easy chance to show real initiative for a cleaner future, by spending even half the cost of new major generating plant on facilitating greater use of renewable sources, and creating the right economic climate so people will invest in more efficient plant and appliances.

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Attachment 11

Further information on attitude measures

Fossil fuel reserves and government responsibility

Despite the importance of liquid fossil fuel depletion (see Chapter 1), major local, national and international decision-makers do not appear to express urgency on the need to reduce our dependence on it. Westernised societies are absolutely dependent on a depleting resource, and to smoothly disassociate from that dependence will take many years. Commentators like Grobb (1992) and Serpone (1992) believe that there will be wholesale conversion of coal to liquid fuel, causing scarcity of coal within 80 years.

The ‘dominant social paradigm’ (Fien 1993) includes the belief that continuous growth is possible. This dominant world view means retarded responses to environmental or resource depletion issues, within the current context of abundant cheap fossil fuels. Until the price of fossil fuels increases to reflect their true long-term worth (World Resources Institute 1992, Holdren 1990, Kuwano 1992), there is little likelihood of major social changes to reduce their use. There is unrealistic optimism (McKenna 1993) about the continued status quo of energy availability. As my research found, major price rises were reported by respondents as the single most likely event to cause real behaviour change.

Expected and observed results

The results from this North Queensland research generally support Kempton’s (1987) findings that energy conservation habits were not predicted by socio-economic status, except for the very lowest electricity consumers. Such authors as DPIE (1992), Welsh et al.(1982 p5), and Kempton (1987 p283) report a general lack of correlation between actual and expected energy use. Comparing the four higher energy-use groups in Townsville shows that for an equal household income, per capita electricity more than doubled, from lower to higher electricity use groups.

“Differences [of energy used for heating] between the households principally reflect the influence of the occupants, their needs, habits and comfort criteria. The differences between substantially similar houses was quite large.” (Welch 1982 p5)

This indicates that attitude is a central issue of energy use, because if there is a wide range of behaviour (electricity use) between similar households, there must be a cause. Behaviour is often caused in part by attitudes (Pratkanis 1989), if the behaviour is widely different within a similar context, attitudes are likely contributors to the widely different behaviour (Ajzen and Fishbein 1980).

My research undertaken in Mt Isa and Townsville substantiates the overall lack of connection between energy use and stated attitudes toward energy conservation. Energy conservation was seen as important by nearly everyone. The attitude of electricity use to fulfil self-image and lifestyle ‘as of right’ would appear to clearly override this motherhood statement of the general importance of energy conservation.

Personal energy use has no norm for comparison, so that the dissonance seen by the researcher, is not seen by the respondent. The finding of low linkage between conservation attitudes and behaviour confirms the work of many researchers. “Indeed, previous studies show that, although people express a relatively high level of concern about the environment, they engage in few environmentally oriented behaviours” (Scott 1994 p241). Based on my findings, and an understanding of attitudes outlined in Section 1.5, this research indicates that the lack of connection between stated attitudes and behaviour may in part be due to a lack of knowledge about relative personal energy use, personal contribution to greenhouse gases, the global rate of fossil fuel depletion, and the fact that Australians are among the highest energy users on the planet.

Dwyer (1994) reviewed 54 recent papers on environmental interventions, reporting on a study (Syme 1987) where residents of different Australian cities were exposed to intensive television messages about petrol use. The tested viewers showed “a small but significant increase in attitudes, knowledge, intentions and reported gasoline-conservation activities..” (Dwyer 1994 p289), but probably not enough to be cost effective. Knowledge (information on aspects of fossil fuel use and simple conserver behaviour) and clear financial messages about the long term value of fossil fuels (World Resources Institute 1992, Serpone 1992 p222, Grob 1992, Holdren 1990) are needed in unison.

There is an apparent need to use as many intervention techniques as possible at once (Dwyer 1994 p310). The effect of each antecedent or consequent intervention is not easy to analyse from a reductionist point of view, but holds the likelihood of greater and more permanent overall behavioural change (the aim of intervention) than single focus interventions, which have largely been found ineffective after 3 months (Dwyer 1994).

The meaning of “attitude” used in this work has been drawn from the 500 working definitions. I have elected to use the cluster of researchers who sees attitude as an integral mix of behaviour, thoughts/knowledge and feelings. Behaviour is explained in part by habit and context (Stern 1993) and, where there is choice, by attitude.

Some of the following tables show what individuals see as energy saving behaviour, indicating an attitude as to what constitutes energy saving behaviour. These tables should be read as an adjunct to Tables 5.3 - 5.10.

Table A11.1 Further self reported energy saving behaviour in Townsville (%)

	T1	T2	T3	T4	T5
take short showers	5	8	10	8	5
use off peak electricity	5	8	-	13	8
minimise fan use	5	-	10	10	5
full washing loads	3	8	10	8	3
ride a pushbike	10	3	10	3	3
combine trips	3	5	5	10	3
mainly use long fluorescent tubes	3	8	8	-	3
turn off hot water- in summer or when on holidays	5	5	5	-	3
minimise drier use	3	-	3	5	8

There were quite a few other behaviours, appliance purchases or use, along with building features which are all worth noting, because they are energy conserving behaviours which should be encouraged. The remaining reported energy saving strategies were spread fairly evenly across the five consumption groups. The reported behaviours are given below in descending frequency, ranging from five to two cases.

List of reported energy saving behaviour (5 or less cases)

Water heating

Boil a kettle for dish-washing water, minimise hot water use, have cold showers, have water saver shower rose, reduce hot water temperature. insulated hot water pipes, don’t run tap when shaving, rarely use solar booster

Home cooling

Installed insulation, increased structural shade, installed shade louvres, installed reflective windows, use heavy curtains, house built under shade trees, have a small house, used light coloured paint, painted roof with reflective paint, installed roller shield, installed whirly birds, put in breeze way

Kitchen

planned oven use (bulk cooking), use pressure cooker,, , , minimise opening of fridge door, brought energy efficient fridge, have no stove, have low energy stove, removed dish washer, second fridge turned off, got rid of second freezer, keep freezer full.

Other

teach kids minimise TV use, have automatic security lights, , installed skylights, turn off water bed heater and dont use a heater have compost heap, avoid waste, recycle. Drive a small car. There is little doubt that if the entire list was shown to all respondents as a check list, there would have been many affirmatives. Only one in two hundred people reported using a small car as an energy saving strategy. Eighty-eight percent of households have at least one car: 42% have 6 cylinder cars, 61% have 4 cylinder cars.

It is worth noting that about 7% of people reported having appliances (mainly hot water) on off peak as energy saving. NORQEB has advertised it as such, but the same amount of energy is used to heat the water. It is purely a matter of when. Off peak electricity use has the advantage of reducing the evening peak, delaying the (energy intensive) need to build further power stations to meet that peak (see Chapter 1, Section 23). The average householder in Townsville reported doing four things to save energy or reduce energy wastage around their home, while householders in Mt Isa averaged about four energy saving behaviours.

The following, less frequent reasons for an energy attitude change are given in the consumption groups, showing the range of reasons for attitude change toward energy use is greatest in the highest use group.

Table A11.2 Other reasons for an attitude change toward energy use in prior 12 months (one respondent only).

Group T1	now ride to work, individuals effect the big picture
Group T2	faxes use more, preached at by kids, more aware of environment.
Group T3	bills going up, use breezes, fridge has padlock to stop the kids, more aware of recycling, turned off second fridge, need to teach kids, am careful with dishwasher.
Group T4	conscious of petrol use, air conditioner sent the bill up, use washing machine less, using NORQEB booklet, use less and mulch more.
Group T5	teach kids, environmental aspects, decided against air conditioner, use energy efficiency ratings, brought energy efficient fridge, reading; and programs on TV, use low flow shower, have a vegetable garden.

Some of the answers in Table A11.2 are not attitudes. They have been included in this attachment because they show some people do not greatly differentiate between attitude and behaviour. The attitude is implicit in the behaviour. Putting a padlock on the fridge to stop the kids using the fridge all the time exemplifies the strong and often intimate links with an implicit attitude (The kids are at the fridge all the time and leave the door open too much) and the resultant behaviour. Putting the padlock on to stops the kids opening the fridge all the time, letting all the cold air out.

Table A11.3 Unchanged attitude

Other comments from people with **no** attitude change toward energy use in prior 12 months (one respondent only).	
Group 1	cursing electricity bill
Group 3	had solar for years, need to help save the planet, always try to save $
Group 4	not really aware of energy, getting compact fluorescent bulbs
Group 5	disappointed with solar.

T1 - T5 each represent discrete and widely spaced groups of 40 households in Townsville, defined only by electricity consumption from low to high use. Group TT represents the weighted mean for Townsville to allow generalisations.

Table A11.4 is included because NORQEB was a research collaborator. They have clear public approval of their energy efficiency promotion.

Table A11.4 Satisfaction with NORQEB's promotion of the efficient use of electricity

/Group	T1	T2	T3	T4	T5	TT%
very satisfied	4	7	6	1	3	19
satisfied	18	18	11	21	22	54
neither satisfied nor dissatisfied	8	6	16	8	10	21
dissatisfied	1	3	0	1	3	6
very dissatisfied	0	0	0	0	0	0
less than satisfied	9	9	16	9	13	27

Three out of four people report being satisfied to very satisfied with NORQEB, the local electricity supply Board. There is a grouping of people in the higher than average electricity use group (T3) who are disproportionately neutral about NORQEB's energy efficiency promotion. .

Table A11.2 suggests that members of the highest use group are most articulate about reasons why they have become more aware of their energy use, but remain top consumers. The very high electricity consumption group has the greatest number of people per household, with a mode of 4 (see Table 3.2), the lowest per capita income (see Table 3.4) and a high proportion of adults (18%) working in professions (see Table 3.6). This group has a per capita electricity use twice as high as the average per capita use See Table 3.4. This group profile suggests electricity use is a high energy lifestyle choice for many in the very high use group.

The following tables have been included in this Attachment as more detailed versions of their counterparts in Chapter 5, from Table 5.11 to 5.27.

Table A11.5 Main considerations if buying a new hot water system in Townsville

/Group Feature	Ranking[1]	T1	T2	T3	T4	T5	TT%[3]
energy efficiency of the unit	1 2 3 4 5	14 13 5 5 1	11 12 6 7 3	19 6 7 6 1	14 14 3 6 1	17 11 7 4 1	63
energy source	1 2 3 4 5	12 4 5 7 10	9 7 3 9 12	3 13 5 7 11	11 5 6 6 11	10 10 2 7 11	39
durability	1 2 3 4 5	5 13 12 6 1	9 10 10 7 3	8 7 15 10 0	7 7 13 9 2	6 7 12 13 1	47
initial cost	1 2 3 4 5	7 5 8 9 9	11 5 12 8 3	8 9 8 7 7	4 10 11 6 7	6 7 12 5 9	39
how many showers one after the other	1 2 3 4 5	1 3 5 8 20	1 4 8 9 17	2 4 8 7 18	3 2 5 11 17	1 5 7 10 16	13

[3] The figures in this column were derived by adding together the percentage of people who nominated first or second preference in each of the five categories.

[1] In this and the following ranked tables, the numeral 1 denotes first preference, through to 5 being the last choice.

Table A11.6 Purchase criteria for new major appliances already owned

/Group Appliance	Criteria for purchase	T1	T2	T3	T4	T5	TT%
Air conditioner	-durability -energy efficiency -Initial cost	3 3 3	5 7 8	3 12 9	4 12 3	2 18 4	24 48 32
washing machine	-durability -energy efficiency -Initial cost	12 14 9	15 10 10	22 6 11	15 10 13	13 13 12	44 28 28
stove	-durability -gas -electric -energy efficiency -Initial cost	5 3 15 10 3	6 5 13 3 8	5 6 9 12 5	8 6 11 8 4	0 11 14 6 7	15 16 34 18 18
fridge	-durability -energy efficiency -Initial cost	8 17 9	7 18 12	10 18 8	10 16 9	8 24 8	22 44 33
freezer	-durability -energy efficiency -Initial cost	2 4 1	3 8 4	3 11 9	7 15 8	6 15 5	17 43 40

Table A11.7 Ranking of Regional Environmental Issues (rank 1= most important)

/Group Issue	rank	T1	T2	T3	T4	T5	TT%	TT% total rank 1+2
Water conservation	1 2 3 4 5	17 12 7 2 1	9 11 10 6 2	17 10 5 2 3	13 14 10 1 1	17 9 9 6 2	35 30 19 9 6	75
Land management	1 2 3 4 5	9 8 7 12 3	3 13 15 1 3	11 10 8 8 2	14 13 3 8 1	15 10 7 7 0	22 27 26 15 7	49
Energy conservation	1 2 3 4 5	10 7 8 8 4	8 9 7 9 5	8 12 14 4 1	6 8 15 6 4	8 12 9 8 1	21 21 25 21 7	42
Protecting the reef	1 2 3 4 5	9 5 9 7 7	12 3 4 10 9	3 6 8 12 10	5 7 6 12 9	3 5 9 14 7	19 14 14 24 26	33
Urban sprawl	1 2 3 4 5	3 5 4 5 19	3 3 3 11 18	1 2 3 11 22	1 2 3 10 23	2 2 4 6 23	6 7 12 25 45	13

The sum of many of the results is not 100% because some people did not answer, or did not fully answer this or the following question. Occasionally there was a language barrier, and a couple of people just glossed over the question - their prerogative, or remained with the stance that the issues were all important. Most people did rank the five issues.

Table A11.8 Most likely events to cause energy use reductions (%)

/Group Event	ranking	T1	T2	T3	T4	T5	TT	rank 1+2
electricity and fuel price rise of 25%	1	23	30	20	25	33	27	42
	2	15	10	15	10	15	15	
	3	5	8	8	13	5	6	
	4	8	13	8	13	5	9	
	5	3	15	8	5	13	9	
concern about the future	1	18	18	30	25	28	20	36
	2	13	25	13	18	13	16	
	3	8	8	10	8	5	7	
	4	15	13	3	8	10	10	
	5	3	5	13	5	10	6	
concern over your own greenhouse gas contribution	1	8	23	18	28	13	15	26
	2	8	13	23	20	40	11	
	3	5	13	20	5	10	10	
	4	13	8	18	5	20	11	
	5	3	3	5	5	0	2	
realisation that energy efficiency can save you money	1	23	10	23	8	15	17	24
	2	10	13	5	10	10	7	
	3	15	23	20	13	40	21	
	4	3	10	13	5	15	10	
	5	5	5	5	8	3	4	
Govt. paid 25% of new high efficiency appliances	1	3	8	10	5	5	7	18
	2	8	13	18	10	15	11	
	3	13	5	5	8	10	7	
	4	0	3	3	10	3	2	
	5	5	3	18	5	0	2	
low interest loans for efficient appliances	1	3	0	0	5	0	1	12
	2	8	8	10	13	3	11	
	3	5	8	3	5	8	6	
	4	3	13	3	8	5	9	
	5	3	5	0	8	13	5	

T1 - T5 each represent discrete and widely spaced groups of 40 households in Townsville, defined only by electricity consumption from low to high use. Group TT represents the weighted mean for Townsville to allow generalisations about the total population.

Table A11.9 Events less likely to cause changes in energy attitudes (%)

/Group	ranking	T1	T2	T3	T4	T5	TT	rank 1+2
concern over you fossil fuel consumption	1 2 3 4 5	8 8 8 5 13	3 8 20 8 8	0 8 15 13 3	0 13 18 10 8	5 8 23 13 5	1 6 15 9 6	7
a respected person 'modelled' energy conserving behaviour	1 2 3 4 5	0 3 3 3 3	5 3 3 0 3	0 5 0 8 5	0 0 3 0 3	0 0 0 0 5	2 5 2 1 6	7
friends were reducing their energy use	1 2 3 4 5	0 0 5 0 3	0 0 3 5 0	0 0 0 3 5	0 0 8 3 0	0 5 0 3 3	0 1 4 2 2	1
nothing	1 2 3 4 5	0 3 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0

Comments on current energy supply and use (from four or less people)

Money and conservation

Too expensive, price does matter, LPG gas should be a lot cheaper in Townsville.

Transport

More public transport, help better traffic flow, use more push bikes.

Homes

Need good passive home design, consider use of natural light, worried that people use air conditioners, plant more trees, NORQEB prunes too severely.

Waste

Why light up Castle Hill, get rid of lit advertising.

Planning

Important to conserve, need better planning- do it right the first time, worry about centralised grid, perhaps build Tully, don't need Tully [Millstream Hydro Dam], grid too large, get energy from plants for fuel, need north power station, use hydrogen.

Finally, individuals from the various groups had the following comments:

Table A11.10 Single comments on energy supply and use

Group 1	we want to use solar water heating, want to build an energy efficient home, have excessive gas bill, key to growth, should have an electric car, solar car, I use as little as possible.
Group 2	find alternative ways to do things, all available surfaces as solar collectors, more unleaded petrol, stop using coal, use small motorcycles, and street lights should be fluoro.
Group 3	use natural gas, happy with my second house with solar hot water, probably use too much, conserving saves money, price doesn't effect, use local gas, more energy efficiency needed, use Collinsville, too much air conditioning, subsidise compact fluorescent tubes, need incentives for reverse cycle air conditioners, vote out Govt. if price rose >20%, is reliable.
Group 4	cut back trees for light, protect trees, not really aware of it, ban dishwashers, business wasteful, no interest, most people don't use properly, more information on appliances, more high efficiency lights, consider wind, like to know chemistry of borax in cellulose fibre insulation, no urgency in next 20 years, science will deliver, surprised bill so high, how accurate are the bills, Kirwan Hospital is trying.
Group 5	some streets need more lights, removed water bed, use sensibly and economically, rural clearing then bore pumps a waste, greenie protest a waste of energy, try to reduce bill, should not have minimum off peak charge, don't want nuclear, see hints on TV, people wont sacrifice for the future, get rid of power poles, persuade people to save money by better energy use, off-peak boosters for solar water heaters, more advertisements to increase awareness, too convenient, electricity too cheap, use more LPG, inappropriate building designs, should use some 12V solar, lower petrol prices, plant shorter trees, mulch, gas more reliable ie cyclones, heating with electricity is a concern, radiation is a concern.

Table A11.12 Current thoughts on energy supply and use in Townsville

comment/group	T1	T2	T3	T4	T5	total
use renewable/solar sources	1	3	6	2	7	19
too much car use	3	1	4	4	3	15
shouldn't waste	5	1	1	1	5	13
Govt. should invest in renewables and research	2	3	5	-	3	13
don't like water wastage	1	4	2	3	2	12
glad people use solar/should be more	1	4	1	2	-	8
people leave too many lights on all night	2	2	1	1	1	7
don't light Govt. buildings so much at night	1	1	2	1	2	7
need education	-	2	-	2	3	7
street lights on all day	1	2	2	1	1	7
build Burdekin Dam	3	1	1	1	-	6
recycling good	3	-	1	1	1	6
supply and use are good	1	-	1	1	2	6
wean off fossil fuels	1	1	2	1	-	5
use hydro	-	2	1	2	-	5

Table A11.11 Reported Energy Saving Traits in Townsville

Trait	/Group	T1	T2	T3	T4	T5	TT
Switch off	unprompted yes	23	20	24	26	22	56
lights	prompted yes	13	17	14	11	15	38
Wash clothes	unprompted yes	9	5	3	4	7	13
in cold water	prompted yes	26	29	28	29	27	75
Main cook	unprompted yes	6	4	5	4	3	15
micro- or gas	prompted yes	11	19	18	21	22	41
Minimum air	unprompted yes	1	5	2	5	5	10
con. use	prompted yes	9	13	19	14	20	36
Plant shade	unprompted yes	2	2	3	3	2	5
trees	prompted yes	7	22	19	26	26	49
Walk instead	unprompted yes	3	1	2	1	4	3
of drive	prompted yes	21	21	19	17	14	51
Own solar hot	unprompted yes	2	2	3	2	6	5
water system	prompted yes	3	0	2	1	1	3
install compact	unprompted yes	1	3	2	3	3	4
tubes	prompted yes	1	2	2	1	1	4
other		37	61	44	61	48	106

The columns for groups T1-5 are the totals for the 40 households interviewed in each group.

Attachment 12

29.7.94 Working paper Re proposed

Demand Side Management Strategies for Mt Isa- 1994

What follows are considered suggestions to incorporate into NORQEB's intended DSM program in Mt Isa.

Aim: Have a maximum number of people in Mt Isa reset their pool pump timers to any time after midnight, and/or turn off their unneeded second refrigerators from (say) Friday 7th of October.

This working summary contains points and inexpensive strategies I consider centrally relevant to successful and easily documented DSM in Mt Isa, developing and applying the collaborative research of JCU with NORQEB.

Need for commitment, demonstration and goal setting.
I refer you to a paper by Dwyer et el 1993: *Critical Review of Behavioural Interventions to Preserve the Environment,* Environment and Behaviour 25:3 275 - 321 (copy previously provided). Their review of fifty-four studies includes 15 on energy conservation. The authors conclude that there is a need for commitment, demonstration and clear goal setting.

All staff of North Queensland Electricity Board in Mt Isa should become involved in and committed to energy efficiency. Studies in the 80's by the Commonwealth Government stressed that a first necessary criteria to the success of any energy conservation program is adoption and advocacy from the top down. This will be achieved through training courses for management and staff, learning of the shifting industry paradigm to postpone the need for further generating plant, achieve ESD goals, and develop waste reduction strategies, in partnership with interested organisations and community members.

Goal 1 Set pool pump timers to any time after midnight

The 1992 research (Goudie 1992) found that 17% of householders have swimming pool pumps, most pumps were 720 W, set on automatic timers to operate between 4-8pm, running for an average of 4 hours through the evening peak. This represents an unnecessary burden of about 700kW on to the evening peak demand. Thus a major DSM goal is to encourage people with pool pumps to reset their timers to any time after midnight.

In general, for the purposes of ease of results measurement, and a clear goal, I suggest that we try as many strategies as possible simultaneously, with the aim of having as many people as possible in Mt Isa set their pool pumps timers to any time after midnight and/or turn off their unneeded second refrigerators from (say) Friday 7th. October. Having a time-based focus for the desired behaviour will help mobilise people, and will allow very easy measurement of effect of the campaign.

When pool-pump owners interviewed in Mt Isa had the situation with peak demand explained, all expressed a great willingness to adjust their pool timer- there is a real sense of community co-operation that perhaps no longer exists in such a strong form in larger population centers. Thus, to have a clear and measurable drop achieved simply by disconnecting unnecessary fridges, and adjusting pool pump timers would give private pool and second refrigerator users a focus and a motivation to make the suggested adjustments by aiming to reduce peak consumption on a particular day. The reward can come by making the consumption curve for the evening peak of Saturday 8 October as public as possible- radio and local TV, with a relay of the demand and recorder placed in a well-frequented public place.

Goal 2 - turn off the second fridge- save $10 per month

Households with two refrigerators (30%) should be alerted to the fact that it costs in the order of $20 per bill to run a refrigerator, and that if the second fridge is not absolutely necessary, it should be turned off except for specific short term uses.

Goal 3- Increase knowledge of issues- Get Schools, community groups and individuals involved

The finding that householders with teenagers are in the upper range of electricity users indicates that there is scope for schools to become involved in the aims of this DSM strategy, building on the idea that individual actions do make a difference.

Framework for behaviour change (from behavioural science):

>**Antecedent** (happens before the time of initiation of the target behaviour)

>Increased knowledge about the context and desired behaviour- CO_2 emissions and the nature of the evening peak (there should be graphs of the daily consumption curves made widely available, and the evening peak and its problems explained ad nauseam).

>Light-bulb equivalent ratings should be given to bring home the message that if you use 360 kWh of electricity per bill on electric water heating (Mt Isa electric only average), it is the same as leaving ten 60 watt light globes on for ten hours every night, releasing about a third of a tonne of carbon dioxide during each billing period. For these reasons, people who are replacing their electric hot water systems should be encouraged to install a solar system.

>Well defined target behaviour- collectively reduce consumption and the evening peak on and after the 8 of October, then build on those changes, sharing knowledge of ways to further reduce the peak.

>Clear role modelling (demonstration) of desired behaviour by a well know and liked person. (Stern 1992)- ie use someone like the Mt Isa Mayor on television to actually change his pool timer and move the beer out of his second refrigerator and turn it off until preparation for his next BBQ. Involve Minister for Primary Industries and Energy.

> Public (written) commitment. Making a public commitment proves an effective and long-lasting change- 'public commitment participants were significantly lower in energy consumption that the private commitment participants..' and 24% lower than control groups, and remained significantly lower in a follow-up conducted a year later (Oskamp 1984 p220).

>Consequent (happens after the start of the target behaviour)

>awards and prizes

>feedback- (I) during the final stages of the public education, pledging and encouragement, have the relay of record and current use set up in a public space, with local celebrities explaining the goals. This would be focused on during the Saturday afternoon start of the evening peak, with the hope that it is 10% lower than the prior running average.

(ii) publish averages with each round of bills, with prompting to try and reduce your households consumption (making allowances for the number of people in your household).

Notes.

1. Because there is already a high proportion of Mt Isa households with fluorescent lighting in the main use areas, the **lightsaver campaign** should specifically target people who have ordinary bayonet bulbs in their main use areas.

2. Because there is a lot of evidence that **personal contact** is a very effective way of influencing people (ie Dwyer 1993, Foster 1990), it is worth considering advertising that NORQEB is seeking people interested in energy conservation from the various suburbs of Mt Isa to offer their services to explain the context and proposals to people in their neighbourhood, that these people could volunteer to provide information and encouragement to further reduce electricity wastage and reduce the evening peak after (lets say,) the 7th of October.

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Yours

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Attachment 13
Subsidiary tables about dwellings, electricity use and attitudes

Table A13.1 Townsville Dwelling Floor Material (%)

Material/Group	T1	T2	T3	T4	T5	TT
Slab[1]	50	48	30	53	45	49
timber	50	50	63	40	48	47
combination	0	3	8	5	8	4

[1] About half of the slab floors were on the first or second floor of blocks of flats.

Table A13.2 Mt Isa Wall Material Type

Material	%
concrete block	41
fibro cement	15
zincanneal (colour bond sheet metal)	14
timber	15
no-fines concrete[1]	2
brick veneer	1
cladding	5
mixed (block, fibro, timber, zinc combined)	6

[1]No-fines concrete is a type of construction used in Mt Isa where the walls are cast in concrete directly into position, but the concrete mix does not have fine sand in it, producing a cool porous wall.

Table A13.3 Townsville Wall Material (%)

/Group	T1	T2	T3	T4	T5	TT
concrete block	30	33	23	23	28	31
fibro	20	15	28	30	23	19
timber	23	20	13	10	15	16
brick	18	10	8	20	15	12
block and fibro	3	10	13	8	13	9
hardi-plank and fibro	4	0	4	4	0	4
block and timber	0	5	3	5	5	4
fibro and timber	0	0	5	3	3	1
metal (iron)	3	3	0	0	0	3
cement (cast)	0	5	0	0	0	3

Table a 13.4 Mt Isa Wall Material Type

Material	%
concrete block	41
fibro cement	15
zincanneal (colour bond sheet metal)	14
timber	15
no-fines concrete[1]	2
brick veneer	1
cladding	5
mixed (block, fibro, timber, zinc combined)	6

[1]No-fines concrete is a type of construction used in Mt Isa where the walls are cast in concrete directly into position, but the concrete mix does not have fine sand in it, producing a cool porous wall.

Table A13.5 Townsville Wall Material (%)

/Group	T1	T2	T3	T4	T5	TT
concrete block	30	33	23	23	28	31
fibro	20	15	28	30	23	19
timber	23	20	13	10	15	16
brick	18	10	8	20	15	12
block and fibro	3	10	13	8	13	9
hardi-plank and fibro	4	0	4	4	0	4
block and timber	0	5	3	5	5	4
fibro and timber	0	0	5	3	3	1
metal (iron)	3	3	0	0	0	3
cement (cast)	0	5	0	0	0	3

Table A13.6 Mt Isa Primary air conditioner type and use.

Type of unit	small (wall/ portable)	refiger - ative	3000 cfm[1]	4-5000 cfm	6000 cfm	8000 cfm
wattage	240/ 320	1000/ 1200	160/ 360	250/ 600	350/ 750	350/ 750
(%) of units	11.3	2	9.3	17.3	52.3	6.7
av. time turned on (hrs.min)	12.10	14.00	13.10	14.10	13.15	14.40
average length of use (hrs)	12.3	6.3	16.2	16.7	15.9	12.6
Average control setting[2]	1.6 (265w)	1.0 (1000)	1.4 (200)	1.6 (350)	1.3 (400)	1.6 (470)
kWh/day/HH	3.3	6.3	3.2	5.8	6.3	5.9
Approx $/bill	20	38	19	35	38	35.4

[1]cfm=cubic feet per minute. This is the way bulk evaporative air conditioners are rated. The wattage rating was derived from the few compliance plates found on units.

Table A13.7 Mt Isa Secondary air conditioning units.

	small	refrig- erative	3000 cfm	4-5000 cfm	6000 cfm	8000 cfm
No. of secondary units	22	23	4	2	2	1
av. time turned on (pm)	2.9	2.1	4.5	i[1]	i	i
av. length of use	7.9	5.6	i	i	i	i
av.control setting	1 (240w)	1.4 (1080w)	i	i	i	i
kWh/day/household	1.9	6.0				
approx. cost per 60 day billing period ($)	11	36				

i[1] = insufficient data to give meaningful information.

Townsville domestic cooling

Table A13.8 Townsville Airconditioning and fan use in March 1993

Cooling /Group	T1	T2	T3	T4	T5	TT
% h/h with **airconditioners**	33	50	58	58	88	**53**
number of a/c units per group	16	31	38	40	51	60
no. of aircons used in March	12	17	21	20	26	39
aircon unit 1: hours used per day	6.2	7.0	7.7	8.9	8.7	7.0
approx. energy used kWh/day	37	60	81	89	113	136
other a/c units- hours of use	4@13	5@4	8@9	9@9	6@9	16@6
approximate energy used kWh	6	10	36	40	27	48
% **fans** usage in March	85	100	93	93	95	93
av. no. of fans owned	2.8	4.5	4.6	4.6	4.6	4
hours of fan use/day	14	16	24	23	23	18
approx. fan energy used (kWh)	48	64	89	85	87	135
approx. kWh for AIRCONDITIONERS	43	70	117	129	140	184
energy per h/h for cooling (kWh)/day	**2.3**	**3.4**	**5.2**	**5.4**	**5.7**	**4.0**

Assumptions made: that on average, airconditioners used about 500 watts per hour (on full setting, a refrigerative airconditioner uses about 1200w).
: on average, fans use about 100 Watts per hour, as they generally use about 150 Watts per hour on full setting. These assumptions perhaps underestimate airconditioning electricity consumption, and overestimate consumption caused by fans. With 4kWh per day average used for cooling, there was 4/18 about 22% total domestic energy used for cooling, representing about $24 per bill average per household.

Table A13.9 Mt. Isa home refrigeration ownership

	1 fridge (fr)	2 fridges> 350 l (l=litre)	1 fr<250 l 1 fr>350 l	250 l< 2 fr< 350 l
% households	67	22	9	3

Table A13.10 Mt. Isa Refrigerator size distribution

	Bar	<250 litre	251-350 litre	351-400 litre	>400 litre
% ownership	1%	10%	21%	35%	33%

Table A.13.11 Mt Isa Freezer ownership.

	200 litre	2-299 litre	3-399 litre	>400 litre
freezer ownership	26	21	16	5

Table A13.12 Townsville Domestic Refrigeration Ownership (%)

Size of main fridge (%):	T1	T2	T3	T4	T5	TT
small (less than 250 li)	13	5	5	3	3	9
medium (250-379 li)	73	40	45	43	35	40
large(greater than 380 li)	15	55	50	55	63	51
% of fridges with energy rating	25	30	15	28	28	23
Star Rating 3	8	13	0	5	5	7
4	15	18	13	18	18	14
5	3	0	3	5	5	2
Average age (yrs) of main fridge	6.3	7.9	8	6.7	7.9	7.5
second refrigerator	i[2]	9.3	14	7	12	10.9
No. of second fridges (%)	5	35	48	48	55	37
size: small	1	3	6	11	9	13
medium	0	5	9	7	8	8
large	1	4	4	1	5	9

some refrigerator details were not recorded.

Table A13.13 Townsville Freezer ownership

Freezers /Group	T1	T2	T3	T4	T5	TT
Freezers owned (%)	28	55	65	90	78	57
Freezer type - chest	7	10	11	20	21	26
-upright	3	7	12	11	8	20
small (less than 150 Lt)	5	7	8	8	10	16
med. (150-249 Lt)	3	4	7	12	10	16
large (more than 250 Lt)	1	8	6	10	6	16

Table A13.14 Domestic lighting in 300 Mt Isa households

	average number per house hold	no. usually used	average time turned on (hrs.min)	average length of use (hrs.min)	average energy used (kWh per day)/HH
long fluor-escent	3.2	1.3	19.00	4	0.23
short fluor-escent	0.8	0.5	17.30	3.40	0.05
light bulbs	9.6	1.9	18.20	3.10	0.45
Compact fluor-escent	0.2	0.2	i[1]	2.30	i

i[1] = insufficient meaningful data

[2] i= insufficient data

Table A13.15 Domestic lighting in Townsville

Lights used > 1 hr/day	details of use	T1	T2	T3	T4	T5	TT
fluoro. tubes	houses using av. no. used av. length of use (hrs)	22 1.7 6.7	34 1.4 5.9	31 2.4 8.4	34 2.3 9.7	33 2.6 10.1	74 1.7 6.0
ordinary bulbs	houses using av. No. used av. length of use (hrs)	29 1.4 6.8	31 1.6 6.2	28 1.9 8.9	35 2.9 11.5	30 2.3 9.6	73 1.8 7.8
compact tubes	houses using	1	3	2	3	3	4

Table A13.16 Mt Isa domestic appliance ownership and electricity use.

household appliance ownership /use	don't own	own/ rarely used	600w	650w	700w+
microwave	84	11	28	97	69
heater	133	bar 91	fan 51	oil 18	kero 31
heater			>4X/ winter	>10x/ winter	>20X/ winter
heater		40	23	27	27

Appliance		100-299W	300-499W	500-719W	>720W
Pool pump	248 don't own	13	5	21	11

Appliance	don't own	own/rarely use	1 X/wk	>2X/wk	1 X/day
dish washer	233	15	5	18	29
clothes drier	234	35	6	10	5
BBQ	81	90	1/mth 67	~ 1/wk 28	>1/wk 16

Table A13.17 Other Townsville Domestic Appliances

/Group **Washing machine (%)**	T1	T2	T3	T4	T5	TT
top load	83	95	95	93	93	93
front load	0	0	3	3	0	1
twin tub	10	3	3	8	5	6
Wash.Machine:Small	23	13	10	8	15	16
Medium	48	30	25	25	15	33
Large	28	55	65	68	70	50
washes per week	3	4	5	4	8	4
time used: morning	70	75	70	73	75	69
midday	8	8	3	18	10	2
afternoon/evening	10	10	13	3	3	12
average tv ownership	1.1	1.4	1.8	1.8	1.7	1.5
av. tv use (hrs/day)	5.1	5.9	6.5	6.4	7.1	5.6
Number of **computers** (%)	10	20	18	18	25	22
average hrs use/day	1.5	1.6	1.4	2.8	8.2	1.6
Pool pump ownership (%)	5	8	18	18	18	12
av. hours on per day	3	2	3	4.3	5	4
Dish washers owned (%)	8	25	30	35	25	25
average use/week	2.5	4.8	5.3	5.5	5.2	3.9
Bore pump - no. and average hours/week.	-	6@2.5 hrs	8@2 hrs	7@2 hrs	8@2.5 hrs	14@2 hrs (17%)
Power tools	1	-	-	-	1	i
spar pool	-	1	-	1	1	i
welders	-	-	1	-	1	i

i= insufficient data

Attachment 14

Pilot efforts in public education about domestic energy issues

I initiated a public energy conservation program in 1993 on behalf of the Townsville Energy Action Group (TEAG), with $10,000 funding from the Federal Department of Primary Industries and Energy. The funds were provided under the Local Energy Efficiency Program (LEEP). All work done by TEAG members was voluntary, showing the commitment of individuals which Stern (1992) feels is likely to be important to rendering more sustainable social change.

The funds were intended to simultaneously run three separate public education programs, in accordance with Stern (1992) and Dwyer, (1993) for using as many techniques as possible at the same time. There has been no way of testing the effect of any of the projects. They were undertaken to make more people aware and motivated to undertake energy-saving behaviour. The first project was a competition to encourage people to actually make energy improvements around their homes. The prize was an energy-efficient fridge. The other projects were to encourage and participate in the design and construction of an energy efficient display home, and to compile and freely distribute about 3,500 copies of a domestic energy-efficiency booklet for the tropics.

Competition:

The Townsville Bulletin ran $1,800 worth of free advertising, and 1500 copies of the form (see Attachment 12) were distributed through the region via the local electricity authority, The Conservation Centre, and through retailers of energy efficient products. There were five excellent entries. Three finalists were selected, with the winner announced on 22 August 1993 by Federal Member Ted Lindsay at the "Festival of the Wind" in the Strand Park. The booklet was also launched then.

Booklet:

The booklet was first workshopped at an international meeting of 30 tropic building researchers at James Cook University in Sept. 1992. Modifications were incorporated into a first draft, which was sent to potentially interested architects and others likely to give feedback. The material was then refined into a semi-professional second draft, and distributed to local government planning departments, architects, builders, building suppliers and plant nurseries. Two hundred copies were distributed throughout North Queensland. This was done to pool local knowledge, and to engage those people in the ideas of energy efficient housing. That extensive feedback was incorporated, and formatted into the booklet's final form. There are 5 illustrations, 20 references and 12 A5 pages of clear instructive text on energy efficient tropical building design features (see Attachment 10). The booklet includes some information on trends of increasing energy efficiency in home appliances.

The final 3,500 run has been widely distributed to - all high schools, libraries, local government planning departments, to all conservation groups, and been further distributed through all regional newspaper offices. It continues to be distributed through the Townsville Environment Centre. The booklet is being critically used by systems Engineering students and First Year Environmental Science students. From the above, it is clear that this has been popular with the media, business and the public. Enough copies were printed to provide free booklets on Energy Efficient Housing in the Tropics to the genuinely interested for the next couple of years- they are being treated like a limited and useful resource. The need to plant more shade vegetation, provide more shade and breezes through houses at night has been brought further into the public domain via this section of the grant.

Promotion of the construction of an energy efficient display home:

A local architect accepted the co-operative brief to produce plans for an energy efficient house to serve as a prototype for the public housing sector. This was done in close collaboration with the local public housing builders - TOGAS.

As yet there is no final decision from the Dept. of Local Government and Housing in Brisbane on the acceptance of the design.

There was a display of the better Competition entries in the window of North Queensland Conservation Council shop, and the 'Energy Trailer' constructed by the Cairns LEEP group was on display at "The Festival of the Wind" (22.8.'93, with 300 people at the presentation, and about 800 people looking at features and information from the Energy Trailer).

The Fridge Competition

In order to win an energy-efficient fridge, people had to send in an entry describing two things they had actually done to reduce their energy use. Although there is a lot known on domestic energy use reductions, there is the need to shift individual decisions and behaviours toward energy use reduction. Environmental psychologists currently believe that a clear message coupled with a clear reward helps render preferred behaviour. The effect of the competition is impossible to gauge. With 2000 forms printed, there were demands for a total of 300 more, and yet there were only 23 final entries.

TEAG conducted a small competition for kids in Oct 1992, as a test run. In that case there was just one group entry, so we gave blanket coverage to the fridge competition. There may be a ripple effect - the 200 retailers who distributed the forms were already selling energy-efficient goods, the forms serving as some endorsement of their products. The main regional newspaper, the Townsville Bulletin gave us a lot of free advertising, so they obviously believed it to be a valid endeavour which would find favour in the public eye. Those advertisements may have had some stimulating effect on some readers.

Summary of entries to the Domestic Energy Efficiency Competition held in North Queensland 1993

House aspect

* chose a house with a north-south aspect, with the front to the north.
* we positioned the house to minimise afternoon sun by using shade from existing trees
* built our home with an east-west axis.
* the north wall is not insulated, to allow some winter heat through.

* we minimised the wall area exposed to the morning and especially afternoon sun
* windows should face the prevailing easterly winds
* shade east and west windows with louvre blinds
* kitchen at western end of house with exit for hot air
* tall trees planted
* plant shade trees
* planted shade and food-bearing trees, vines and creepers. "Vines and creepers grow on our lattice to insulate against loss of heat in winter and unwanted heat in summer."

Insulation, shade and breezes

* insulation in ceiling x 5 (all who added insulation later reported it having a noticeable effect on the temperature in the house).
* put awnings over the windows
* fitted pergolas to the eastern and western ends of the house
* use insulated cladding
* installed casement windows with grey tinted glass
* use windows to allow breezes
* install whirlybird
* roof vent

Efficient uses

* solar hot water x 2 (one with manual booster)
* use fluorescent lighting
* to cook, I use the microwave to save energy
* use movement sensors for security lighting.
* use compact fluoro tubes
* all our appliances have energy savings ratings

Behaviour

* modify behaviour and practice energy saving tips.
* recycle everything, and compost or mulch all food scraps
* avoid buying excessively packaged products.
* the lights are switched off when not in use.
* the fridge is kept at an operating temperature of 4-6 degrees.
* we use minimum electricity at peak times- if more people did this, the power stations could run more efficiently, and we could all benefit in the long run.
* by keeping some windows open at night and then closing them in the morning we can keep the cool fresh night inside for most of the day in summer.
* we 'switch off' before shopping
* get in some natural shade outside during the heat of the day.
* dry clothes in the sun
* educate children to save electricity
* use hints in NORQEB booklet
* I cook as many meals as possible in my oven at the same time.

There were other entries which did not actually say what they had done themselves, but some of the points are worth recording:

* use solar hot water
* grow tall trees in front of windows
* force hot air out of the living area through the ceiling with a vent fan
* use a skylight for dark areas inside during the day

The above list was on public display in the front window of the Townsville Environment Centre for a month after the competition, with the following statement at the bottom:

Fossil fuel use and greenhouse gases matter, because the long-term well-being of the planet matters.

The booklet will have a more enduring effect than the competition. There are many retail competitions, with glamorous prizes. The competition may be viewed more as an eye-catcher to draw people into the ideas of energy efficiency, rather than change much behaviour. The two clearly successful prongs of the 1992/93 Townsville LEEP have hopefully rendered a real increase in consideration and behaviour around efficient energy use, in appliance use, building design and modifications in the tropics of Queensland.