

# **Sustainable Domestic Energy Use in North Queensland**

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Thesis submitted for the research degree of Master of Science,  
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<sup>1</sup> Map of average January maximum temperatures. Comm. Aust. 1983

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## Statement of Sources

### Declaration

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

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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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# **Sustainable Domestic Energy Use in North Queensland.**

## **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<sup>2</sup> 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**

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<sup>2</sup> "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 conserving 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<sub>2</sub> 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 be 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 externalities) 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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