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**LEAST-COST DOMESTIC HEAT ENERGY INVESTMENTS
FOR GREAT BARRIER ISLAND UNDER RESTRICTIONS ON
THE HARVESTING OF NATIVE FUELWOOD SPECIES.**

A thesis to the value of 75 points presented in partial fulfilment of the requirements
of the degree of Master of Agricultural Economics in Natural Resource and
Environmental Economics at Massey University.

TONY L. WHARTON

1995



MASSEY
UNIVERSITY

Great Barrier Island

Ratepayer Energy Survey



**THIS SURVEY SHOULD BE COMPLETED BY THE HEAD OF THE
HOUSEHOLD.**

Through this survey an understanding is sought about the different uses of land, and the energy sources and appliances used by houses on Great Barrier Island.

Please follow the instructions below, and answer the questions which follow by ticking the boxes or filling in the spaces where appropriate. Where a question does not apply to you, please tick the box marked Not Applicable or N/a.

All of your answers to this survey are strictly confidential and will not be seen by any person other than myself.

SECTION 1: HOUSEHOLD DETAILS.

- 1) Do you currently own, rent, lease or use any property or land on Great Barrier Island?

☐

YES

☐

NO

*If you answered "NO" to the above question, please go straight to page 8.
Otherwise, please continue with question 2.*

- 2) What is the TOTAL COMBINED LAND AREA (in EITHER hectares OR acres) of ALL of the property which your household uses, rents or owns on Great Barrier Island?

EITHER: _____ Hectares OR _____ Acres

- 3) Please tick the box below which best applies to the property which you own, rent or use on Great Barrier.

☐

All of the land is contained within one property lot.

☐

The total land area is made up of more than one property lot

- How many lots in total would you own or use? _____

☐

The land is less than or part of one whole property lot.

- What percentage of the lot would your household have direct control over? _____ %

☐

Uncertain / not applicable.

4) Is there a house, bach, hut, caravan or any other dwelling situated on any of the property?

☐ YES

☐ NO

*If you answered "NO" to the above question, please go straight to page 8.
Otherwise, please continue with question 5*

5) Is this dwelling used by you, or by any other person as a MAIN residence?

☐ YES

☐ NO

*If you answered "YES", please go straight to question 6.
Otherwise, please answer part a) below.*

a) For how many weeks of each year would somebody usually stay or live in this dwelling ?

Either: _____ weeks; OR: ☐ Dwelling not usually stayed in.

*If this dwelling is not usually lived or stayed in, please go straight to page 8.
Otherwise, please continue with question 6).*

6) Is any part of your land or property used to earn any type of income? (eg farming, renting it out, or growing vegetables or firewood for sale).

☐ YES

☐ NO

*If you answered "NO" to question 6 above, please go on to question 7.
Otherwise, please continue with parts a) and b) below.*

a) Please describe the MAIN income-earning activity for the land is used.

Main Activity: _____;

b) In an average year, approximately how much money would be earned in total from this land (before tax) ?

Income from land: \$ _____ per year OR: ☐ Don't know / no answer.

7) Is any part of the total land area used to grow or produce food, firewood or any other products for use by yourself, or for use by the occupier of the dwelling, ie: not for selling?

☐ YES

☐ NO

If you answered "NO" to question 7 above, please go on to question 8. Otherwise, please continue with part a) below.

a) How much do you think these products would cost EACH YEAR if they had to be bought, rather than produced on the property?

Approximate yearly value: \$ _____

8) Please estimate the total percentage of your land area that would be used to produce food, firewood or other products, both for sale AND for use by yourself (or the occupier)

Total Percentage of Land Used: _____ %

SECTION 2: HOUSEHOLD ENERGY USES.

9) For both the cooking table below, and the home heating table on the next page, please tick the box which best describes the fuel and the appliance or method that would MOST OFTEN be used in your house on Great Barrier Island

COOKING:

FUEL	APPLIANCE
<input type="checkbox"/> Wood	<input type="checkbox"/> Stove, oven or range
<input type="checkbox"/> Gas/LPG	<input type="checkbox"/> Burner or hotplate only
<input type="checkbox"/> Electricity	<input type="checkbox"/> Open fire
<input type="checkbox"/> Coal	<input type="checkbox"/> Microwave oven
<input type="checkbox"/> None used	<input type="checkbox"/> None used
<input type="checkbox"/> Other, please describe: _____	<input type="checkbox"/> Other, please describe: _____

lease tick the box which bests describes the fuel and appliance or method that you would MOST OFTEN use for home heating on Great Barrier Island.

HOME HEATING:

FUEL		APPLIANCE	
<input type="checkbox"/>	Wood	<input type="checkbox"/>	Single-fuel stove (eg wood fire)
<input type="checkbox"/>	Gas/LPG	<input type="checkbox"/>	Pot-Belly type stove
<input type="checkbox"/>	Electricity	<input type="checkbox"/>	Open fire
<input type="checkbox"/>	Coal	<input type="checkbox"/>	Cooking range or oven
<input type="checkbox"/>	Kerosene	<input type="checkbox"/>	Heater (Gas/electric/kerosene)
<input type="checkbox"/>	None used	<input type="checkbox"/>	None used
<input type="checkbox"/>	Other, please describe:	<input type="checkbox"/>	Other, please describe:
_____		_____	

The table below shows a number of alternative fuels and methods which can be used to heat hot water. For both the Fuel and Method tables, please tick in the columns labeled "MAIN" the fuel and the method that would most often be used as the MAIN method of water heating in your house on Great Barrier.

If, in addition to the main method of water heating you also regularly use another fuel or method as a backup, please indicate the BACKUP fuel and method used by ticking the appropriate boxes in the backup fuel and method columns labeled "B/U".

HOT WATER HEATING - MAIN AND BACKUP METHODS

FUEL		METHOD / APPLIANCE		
MAIN	B/U	MAIN	B/U	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Wetback/water jacket to stove or range
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Wetback or water jacket to open fire
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Water heated over open fire
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Water boiled on top of stove or range
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Solar-heated hot water cylinder
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	LPG/Gas fuelled instant water heater
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Electric hot water cylinder system.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	None used
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Other, please describe:
_____		_____		

SECTION 3: HOUSEHOLD FUEL USE:

11) Is any type of generated electricity used in your house on Great Barrier?

☐ YES

☐ NO

If you answered "NO" to the above question, please go straight to question 12. Otherwise, please continue with a) and b) below.

a) Which of the following devices would be regularly used for generating electricity?
Please tick all that are applicable.

☐ Solar-electric panels

☐ Wind turbine

☐ Other, please describe: _____

☐ Diesel or petrol powered generator.

☐ Micro-hydro generator

b) Of these, which ONE would you consider to be the main source of the house's electricity?
If you consider that two or more of these devices are of equal importance, please tick both boxes.

☐ Solar-electric panels

☐ Wind turbine

☐ Other, please describe: _____

☐ Diesel or petrol powered generator.

☐ Micro-hydro generator

12) If you use WOOD as a fuel in your household, for either cooking, heating or water-heating, please answer parts a) and b). Otherwise, please go straight to question 13.

a) Of the following types of wood, which one would you MOST OFTEN burn? Please tick:

☐ Pine

☐ Manuka/Kanuka

☐ Don't use wood.

☐ Eucalyptus

☐ Macrocarpa

☐ Other, please describe: _____

b) Which of the following best describes you MAIN source of firewood at the present?

☐ Grown on own section

☐ Collected from elsewhere

eg: Beach, forest scrap, friends.

☐ Purchased.

☐ Other, please describe: _____

SECTION FOUR.

The Auckland City Council has recently introduced restrictions on the amount of native scrub and timber which can be cleared from any property lot on Great Barrier Island. Could you please answer the questions which follow relating to your responses toward the restrictions.

Please be as frank as possible, remembering that your individual answers are totally confidential, and will never be seen by any person other than myself.

- 3) Are there any substantial areas of native scrub or teatree growing on your land?

☐

YES

☐

NO

If you answered "NO" to question 13 above, go straight to question 14. Otherwise, please answer question a):

- a) As best as you are able to, can you please estimate the OVERALL PERCENTAGE % of your total land area which is covered ONLY by teatree, that is, don't include any areas of your land where teatree grows mixed with other tree types.

Percentage covered: _____ %

- 14) Have the restrictions on firewood harvesting in any way caused you to modify or change the fuels which you use for cooking, water-heating OR home-heating?

☐

YES

☐

NO

If you answered "NO" to question 14 above, please go straight to question 15

Otherwise, please answer parts a) to d).

- a) What was the MAIN fuel which you used for COOKING before the firewood harvesting restrictions? If you have not changed the fuel you use for cooking, tick "No Change".

Cooking fuel: _____

☐

No change

b) Which fuel did you most often use for your MAIN source of HOME HEATING before the restrictions? If you have not changed the fuel you use, please tick "No change".

Home Heating fuel: _____ ☐ No change

c) Which fuel did you most often use for your MAIN source of WATER HEATING before the restrictions? If you have not changed the fuel you use, please tick "No Change".

Water Heating fuel: _____ ☐ No change

d) Which fuel did you most often use for your BACKUP source of WATER HEATING before the restrictions? If you have not changed the fuel you use, or you don't use a backup method, please tick "Not applicable".

Backup Water Heating fuel: _____ ☐ Not Applicable

15) Have the firewood restrictions caused you to change or modify your firewood sources or collecting methods?

☐ YES ☐ NO ☐ Not applicable

If you answered "NO" or "Not applicable" to the above question, please go straight to page 8. Otherwise, could you briefly describe how you have changed your firewood sources or methods in response to the restrictions?

Thank you for taking the time to complete this survey form. Your results will be collated along with those of the other respondents, and will be used as the basis for constructing fuel and energy models for Great Barrier Island.

Please place the completed survey form into the free-post envelope provided, and return it as soon as possible.

If you have lost the envelope provided, please post the results to:

Tony Wharton
Department of Agricultural Economics
Massey University
Palmerston North
New Zealand

It is anticipated that the results of this project will be published in "The Barrier Bulletin" early next year. However, if you would like a copy of the results, or of the project findings, please write to me at the above address.

Please feel free to use the remainder of this page if you have any further comments about the Council's restrictions on firewood harvesting.

Any comments you may have on this survey would be very helpful and greatly appreciated.

Once again, thank you for your help with my project.

Tony Wharton.

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ACKNOWLEDGEMENTS.

I would like to express my gratitude to the following people and organisations for their assistance in the production of this thesis:

Professor Anton Meister and Dr Robert Alexander of the Department of Agricultural Economics and Business, Massey University, for their supervision and guidance;

Associate Professor Ralph Sims of the Department of Agricultural Engineering, Massey University, for his help and support;

The Auckland City Council, for their financial support and assistance;

Earth Energy Systems, Great Barrier Island, for their support and assistance;

Coombes memorial scholarship, for their financial support of the project;

The Barrier Bulletin, Waiheke Island, for it's assistance;

and to Fiona Taylor, Paul Seiler, and Sue Wharton for their encouragement and support throughout this project.

ABSTRACT.

The Auckland City Council's 1992 district plan for Great Barrier Island introduced areal restrictions upon the clearance of manuka and kanuka (teatree), which is one of the main sources of energy for domestic heatloads on the island. The restrictions will force many households to change the way in which they allocate their resources to heat energy production, and many households will incur additional compliance costs as a result.

This study addresses the alternative energy investments available to households on the island (including teatree and eucalyptus biomass energy crops; petrol, diesel, solar, and wind generated electricity; LPG; and solar waterheating) and identifies the least-cost energy investments under the restrictions for a number typical island households. Biomass growth rates are derived for a teatree fuelwood crop, and the cost of domestic heat production is modelled for each household through the use of energy expenditure models. The optimal energy investment for each model household, both under restrictions and in the absence of restrictions, is determined, and the total financial cost of compliance for each model household is calculated. The effectiveness of the council's current restrictions and policies is assessed, and alternative energy and environmental conservation policies are evaluated.

The study found that the current policies were not effective, and that 63% of model households would incur additional energy costs from complying with the restrictions. Of all the energy sources compared, teatree fuelwood was found to produce heat at the lowest cost per kW. However the high capital cost of wood-fuelled appliances made LPG the least-cost fuel type where no appliances were owned, and appliance capital costs were found to be the main factor determining the overall economics of a particular energy system. The study also found that rather than promoting the development of eucalyptus fuelwood crops on Great Barrier Island, the promotion of sustainable methods of teatree fuelwood crop management, such as the Swiss method, would both lead to environmental conservation and would satisfy the heat energy needs of island households.

CHAPTER 1. INTRODUCTION

1.1 RESOURCE CONFLICT ON GREAT BARRIER ISLAND.

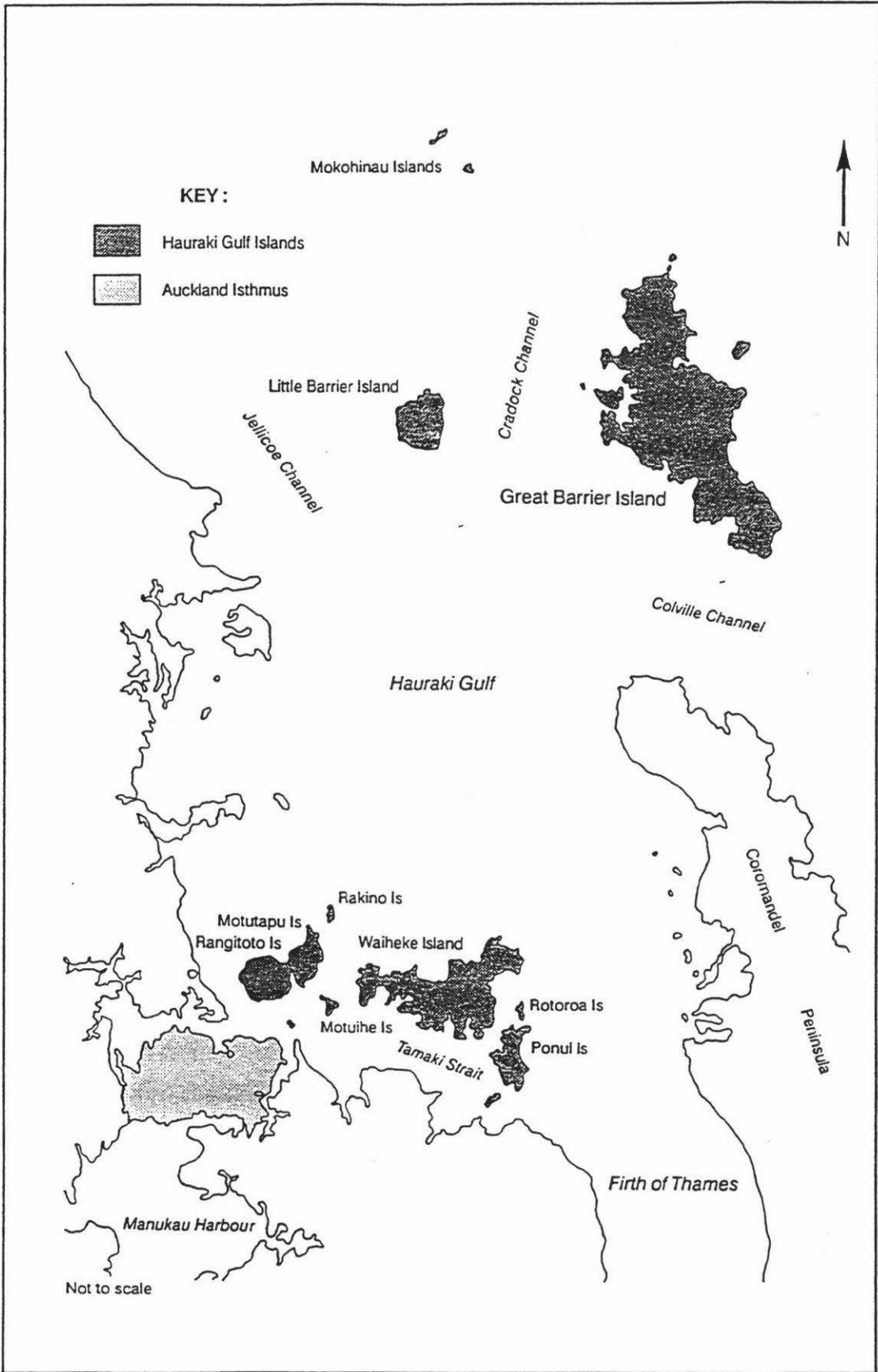
1.1.1 INTRODUCTION.

Humanity's use of energy is one of the characteristics along with culture, literature, religion, and art, which separates us as a species from animals. It was estimated in 1975 that humanity's consumption of energy from woody biomass was greater than the combined total of all of the energy which was consumed from hydroelectricity, nuclear power and geothermal energy (Earl, 1975). Although this situation has no doubt altered over the past 20 years, fuelwood is still a major source of domestic energy for a large proportion of the world's population, not only in less developed countries but also in the remote areas of developed countries (Ibid).

Great Barrier Island is one of such places in New Zealand. Great Barrier Island lies in the Hauraki Gulf 90 kilometres north-east of Auckland City (Figure 1.1) and is the largest island off the coast of the North Island, and the fifth largest island of the New Zealand group after the South, North, Stewart and Chathams Islands. The Island is approximately 285 square kilometres in area and derives its name from the protection or 'barrier' it affords the Hauraki Gulf as its north-eastern boundary (Great Barrier Committee of Enquiry, 1975).

One of the significant attractions of Great Barrier Island is its expansive native forests and scenic natural environment, which were considered by Clunie (1993) to be unique and outstanding. Because of its extent and pervasive qualities, the native vegetation and communities of the native scrub species manuka and kanuka in particular, are considered to be a key element contributing to the distinctiveness, visual quality and character of Great Barrier Island (Auckland City, 1992; Clunie, 1993).

FIGURE 1.1 GREAT BARRIER ISLAND LOCALITY MAP.



The permanent population of the island is approximately 1,200 people, many of whom are attracted to living on the island by the remoteness and the 'back-to-nature' lifestyle which it offers (Great Barrier Committee of Enquiry, 1975). Indeed, one of the island's unique features which is considered to enhance its appeal to many visitors and residents is the lack of any public reticulated mains electricity supply, forcing households to adopt alternative sources of energy in order to meet their domestic heat energy needs (Ibid, 1975).

1.1.2 THE ROLES OF MANUKA AND KANUKA.

Leyland *et al* (1986) reported that in the New Zealand the main requirements for domestic energy in order of annual quantity consumed are water heating, space heating, cooking, and lighting/other household appliances. The majority of energy demanded by households is in the form of heat, with up to 78% of a household's total annual energy demand being a demand for heat (Ibid).

One of the principal heat energy sources of Great Barrier Island households is fuelwood from the native scrub species manuka (*Leptospermum scoparium*) and kanuka (*Kunzea ericoides*), each or collectively known as teatree (Auckland City, 1992; Clunie, 1993). Manuka and kanuka are prominent trees or tall shrubs which are found either growing together or growing separately throughout New Zealand, and are often considered to be a plant pest by many farmers and landowners (Allen *et al*, 1992; Grant, 1967). Vegetatively the species are similar, but the main difference between the two is in their flowers and fruit (Burrell, 1965). Both species can vary in habit from a small tree 10 metres high to a compact bush usually less than 4 metres in height. Estler *et al* (1974) reports that most teatree scrubland has developed from bare ground or from short open vegetation, and its presence on land often indicates the destruction of previous native vegetation by fire.

Teatree stands cover well over half of the land area in the central and southern parts of Great Barrier Island, particularly on private land. The two species dominate the vegetation canopy in a substantial portion of the native vegetation on the island, much of which is regenerating from the past excesses of forestry exploitation and land clearance (Clunie, Ibid). Teatree's predominance in a naturally occurring state throughout the island combined with its high biomass density and heat content has contributed to its widespread popularity and usage as a fuel in many households throughout the island.

In addition to being one of the major sources of domestic heat energy on the island, manuka and kanuka are also considered to play a number of important roles in the environment and landscape of Great Barrier Island. In addition to their aesthetic role as the predominant land-cover on the island, both manuka and kanuka also play a significant ecological role as a seral community or 'nurse crop' and are considered to play a key role in the re-establishment of native forests on sites from which they have been displaced through felling and land clearance (Estler *et al*, 1974; Grant, 1967; Clunie, 1993). Almost all teatree communities are transitional, and Clunie (Ibid) considered that the teatree communities on Great Barrier Island were the most important and by far the most extensive of the seral communities regenerating to species rich native forests.

Manuka and kanuka communities are also considered to have other significant roles in protecting and sustaining the natural environment. Teatree stands are considered to have substantial intrinsic value as a major reservoir of natural biodiversity on the islands of the Hauraki Gulf and are home to a diverse range of native plants and animals, many of which are considered to be of international significance (Clunie, Ibid). Clunie also reports that there is a much greater diversity of teatree stands on Great Barrier Island than on the inner islands of the Hauraki Gulf, or on Waiheke Island. Teatree stands on steep slopes are considered to serve an important function in soil conservation, and well established stands of vegetation provide continuous protection of water quality in streams, by regulating runoff and dispersing and filtering erosion products (Clunie, Ibid).

1.1.3 TEATREE CLEARANCE RESTRICTIONS.

Auckland City (formerly the Auckland City Council) is the local-body authority which has territorial jurisdiction over the resources and communities of Great Barrier Island. Under the Resource Management Act 1991, Auckland City has both a mandate and a responsibility to give effect to, and promote, the sustainable management of the natural and physical resources on Great Barrier Island. (Resource Management Act, 1991; Auckland City, 1992). Sustainable management is defined in the act as: "managing the use, development, and protection of natural and physical resources in a way, or at a rate which enables communities to provide for their social, economic and cultural well being, and for their safety and well-being, while:

- a) sustaining the potential of natural and physical resources (excluding minerals) to meet the foreseeable needs of future generations; and
- b) safeguarding the life-supporting capacity of air, water, soil and ecosystems; and
- c) avoiding, remedying or mitigating any adverse effects of activities on the environment" (Resource Management Act, 1991).

The Resource Management Act also requires Auckland City to "recognise and provide for matters of natural importance" (section 6), of which "the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna" (6c) is one.

The district plan (Hauraki Gulf Islands Section) is the main policy tool by which Auckland City implements and gives effect to the sustainable resource management principles of the Resource Management Act on Great Barrier Island. The district plan presents the rationale for the council's adopted resource management strategies on the island, which are expressed in rules, regulations and restrictions governing the development and use of the island's key resources as perceived by Auckland City. In the district plan Great Barrier Island is separated

into 16 strategic management areas, and for each area the key resource issues are identified, and provisions made via policy instruments to ensure their sustainable management and protection.

As the harvesting and clearance of teatree for use as a household fuel has a large potential to detrimentally impact the "life-supporting capacity of soils and ecosystems", and the "protection of areas of significant indigenous vegetation", Auckland City's 1992 district plan for the Hauraki Gulf Islands introduced policies to promote the revegetation of Great Barrier Island through introducing restrictions on the removal of native vegetation (Auckland City, 1992). In particular the district plan introduced the following restrictions governing the clearance of teatree from private land:

- a ban on the clearance of any native vegetation above 3 metres in height, with the exception of teatree where the height restriction is 6 metres in recognition of the widespread use of teatree as a fuel;
- a restriction on the maximum area of any single lot which is able to be cleared of native vegetation (Auckland City, 1992).

The district plan divided the entire land area of Great Barrier Island into a number of land classes, each determined by the character, use and cover of the land area. The maximum area able to be cleared on any lot under the restrictions is dependent on the classification of the land on which the lot is situated. The clearance restrictions for the removal of indigenous vegetation as a permitted activity (permitted by households as of right) were set at three possible levels across all of the land classes: either not permitted, a maximum total clearance of 300 m², or a maximum total clearance of 500 m² (Auckland City, 1992). The district plan also provided for an increased level of clearance limits for the clearance of teatree as a discretionary activity where a resource consent had been granted. However, this is only permitted for the purposes of commercial firewood harvesting (section 6F1.1.3).

The maximum clearance areas also took account of the area of previously cleared land existing on a section, and were based on a "reasonable minimum area within which a standard dwelling could be located inclusive of an area for an accessway" (*Pers Comm*: Auckland City, 1994). Therefore, on many sections the area which could be cleared as of right is sufficient only to enable a house to be built. It is considered by Auckland City that the vast majority of sections on the island fell into land classes 8 (Regenerating slopes: - 30% of total land area) and 10 (Forest and bush areas: 45% of land) (Ibid). Appendix 1 presents the complete list of land classes for Great Barrier Island and their associated clearance restrictions as a permitted activity.

1.2 THESIS OBJECTIVES AND APPROACH.

1.2.1 OBJECTIVES

The widespread use of teatree as a fuel source in households, combined with the restrictions imposed on the clearance of native vegetation and teatree has resulted in a resource-use conflict on Great Barrier Island. Under the restrictions, many households may be placed in the position of having to modify or change the energy sources and fuels which they use in order to comply with the district plan requirements, possibly at considerable additional expense to the household.

In order to provide an alternative to the harvesting of native teatree on Great Barrier, Auckland City has been considering implementing a policy of encouraging households to provide for their heat energy requirements by growing their own sustainable fuelwood plots utilising exotic hardwoods, particularly eucalypts, by distributing information on the costs and benefits of household's planting their own eucalyptus fuelwood crops (*Pers comm*: Auckland City 1994).

The objective of this thesis is to address this resource use issue by examining and quantifying the impact of the restrictions upon Great Barrier Island households, determine the optimal energy investments for households under the restrictions,

and to examine alternative policies to the current restrictions which are available to Auckland City to lowering the rate of teatree clearance toward a socially optimal level and minimise the environmental and ecological effects of teatree clearance. Specifically, the main objectives of the study are fourfold:

- i) to determine which energy project investment will be optimal for Great Barrier Island households under the teatree clearance restrictions given their current household resources, energy investments, and energy demands;
- ii) to quantify the effects that compliance with the restrictions will have on households in terms of additional energy costs incurred where the household's use of teatree for fuelwood is restricted¹;
- iii) to assess the overall effectiveness of the council's current policies, the quantitative levels of the restrictions, and the council's plan to promote eucalyptus fuelwood production regimes on the island; and
- iv) to evaluate the economic competitiveness of alternative domestic energy systems and fuels.

1.2.2 OUTLINE OF STUDY.

A number of energy investments are compared in this study to determine which would be the least-cost energy investment for households both in the absence of the teatree clearance restrictions and under compliance with the restrictions. Each energy type was selected on the basis of it's appropriateness for use as an energy investment in remote area households. The energy investments selected for comparison in the study are:

¹ It is assumed that the main value of teatree to the household is as a fuel.

- Eucalyptus biomass fuelwood crops;
- Teatree biomass fuelwood crops;
- Purchased teatree fuelwood;
- Liquid Petroleum Gas (LPG);
- Diesel generated electricity;
- Petrol generated electricity;
- Wind and solar generated electricity;
- Solar radiation (waterheating only).

A review of the theory and the literature on energy project investment, domestic heat energy economics, and biomass energy crop production economics is presented in Chapter 2, and it's relevance and contribution to the present study are highlighted.

The cost of each energy investment is modelled using a net present cost criteria applied to a series of energy expenditure models which incorporated capital, maintenance and fuel costs as well as appliance efficiencies. The development of each of the expenditure models and the assumptions made in their use and analysis are presented in chapter 3.

Biomass growth functions for eucalyptus and teatree wood are derived for use in the fuelwood energy expenditure models, and the collection and analysis of biomass growth data and the development of the growth functions for both species are presented in chapter 4.

In recognition of the fact that the least-cost investment for a household will depend upon the household's current energy investment and resources, a postal-administered questionnaire was designed and implemented to collect data on household resources and the average annual duration of residence of Great Barrier Island households. From the questionnaire results a series of model households are developed which can be considered to be typical island households in respect of

their energy appliance ownership characteristics. The development, implementation and the results of the postal questionnaire and the formulation and characteristics of each of the model households are presented in chapter 5.

The questionnaire results, biomass growth functions, and additional data collected on household heat energy requirements are then used to derive the values of the variables used in the energy expenditure models. The calculation of the expenditure model variable values, together with the results of each of the models are presented in chapter 6.

Each of the model Great Barrier Island households are then analyzed using both the results of the energy expenditure models and the data on the household's land and appliance ownership characteristics. The least-cost investment for each model household by heatload is determined both in the absence of the teatree clearance restrictions and under compliance with the restrictions. Chapter 7 presents the analysis and the least-cost investments for each of the model households.

The financial effects of the clearance restrictions upon the model households are calculated and analyzed in chapter 8, and alternative policy options available to Auckland City are explored. The results of the study are summarised in chapter 9, and conclusions are made on the effects of teatree restrictions on households, on the current clearance restriction policies and eucalyptus proposals, and on the economics of alternative domestic heat energy systems.