Prepared for

BrightEconomy Advisory Board

Rotorua

Rotorua Area Energy Assessment

Status and Opportunities

By

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and

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Final

Preface

The Rotorua Area Energy Assessment has been commissioned by the BrightEconomy Advisory Board to proactively identify the range and scope of potential energy initiatives in the Rotorua District that can improve the Rotorua community's economic and social wellbeing.

This study is based on the known and potential energy resources of the area, the assessed market demand for energy, and response to both traditional and new emerging energy technologies for as a source use and means of improving efficient use of energy. The report also focuses on key constraint issues, including the supply of electricity to and within the area and the use of energy across the Area. It is important to note that this report provides a snapshot of current energy market trends and sector responses, which are subject to constant change.

This document is a baseline from which a District Energy Strategy could be developed. The creation of a service delivery mechanism or agency, for example a Rotorua Energy Initiatives Trust could partner such a Strategy as the largest constraint relates to the need for leadership and facilitation of possible initiatives. The possible initiatives need to be also included the development of a District Energy Plan of Action.

The Rotorua Area Energy Assessment identifies a number of potential opportunities for action. This report is the outcome of a collaborate exercise. The authors acknowledge the positive contribution made by Unison, Rotorua District Council, Te Arawa, Ngati Whakaue and many individuals interviewed.

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Rotorua Area Energy Assessment

Executive Summary

The Current Energy Scene

The Rotorua area has a combination of local energy resources (geothermal, hydro and bioenergy) that are already partially utilised for electricity and heat. The area also has connections to the natural gas transmission system and the national electricity grid that, in association with local energy sources, provide a good measure of security of supply.

The Drivers for Change

National drivers for improvement in energy supply to the area include:

- Increasing costs of energy as natural gas supply becomes limited.
- Increasing constraints in availability of gas except for high value uses.
- Increasing costs of electricity as new higher cost power generating stations have to be built.
- The removal of the requirement on network companies to supply electricity after 2013.
- Implementation of Government policy as outlined in the Government Policy Statement (GPS) and Government objectives "*that electricity is delivered in an efficient, fair, reliable and environmentally sustainable manner to all consumers*".

District drivers include:

- Having sustainable, reliable, and affordable energy supply.
- A desire to attract new industry to the area.
- To increase the extent of primary product processing in the area.
- The desire for warm and healthy communities.
- Reducing transport costs.
- Reducing the cost of energy to business
- Energy contributing to wealth creation

Energy Riches

The area is rich in untapped energy that can be used to increase economic growth and community well-being. District energy resources in the area are typically of a size that they can be developed and used locally. Much of the resource can be developed at a community level with larger opportunities being regionally based. There are only a few energy investment opportunities that are of a size such that have potential to export from the district into the national grid.

Economic Activity

Forestry, wood processing, tourism and agriculture are significant activities that dominate the economic landscape of the Rotorua area. Although energy developments need to be sensitive to the potential effects on that economic landscape, as well as the potential effects on the cultural and ecosystem environments, this should not be seen as preventing appropriate energy developments. Energy developments can also enhance the forestry, wood processing, tourism and agricultural activities of the area if sustainable energy use is taken as one of the themes of the area.

The Way Forward

Meeting the energy needs of the Rotorua Area can be best achieved through the pursuit of a portfolio of supply and demand reduction initiatives. Ideally, parties in the area (including industrial/commercial and residential users and electricity/energy operators) would participate according to their own specific needs and ability to contribute. Unlike other areas in New Zealand where there are economies of scale for large energy company solutions, in the Rotorua Area, the low level of energy demand, large number of small potential opportunities, and spread out communities of interest, indicate that the Rotorua community (business and residential) can implement many of its own solutions, and is well placed to so.

Rotorua is fortunate in that throughout the area there is potential for a balance between energy supply and demand reduction by energy substitution. In theory, the energy sources within the area itself are adequate alone to meet local demand. However, in reality, the economics of many opportunities are such that this balance will not be able to be achieved in the short term, and medium and longer term plans or

transition paths will need to be developed. Such plans should be a prime focus of a District Energy Strategy.

The way forward for the area on energy issues will require strong leadership, identification of opportunities for community involvement and skill development, co-ordination and facilitation of the various interested parties and the fostering of a climate of innovation and fit for purpose solutions. An inclusive approach is essential. If these attributes are not assured then opportunities will not be fully exploited. Achievement of these attributes will have to come from a number of avenues, and will require the input of resources and expertise both internal and external to the area.

Energy Demand

Electricity demand in the Rotorua area is expected to increase at about 2% per year over the next 10 years[1,2]

Bottled gas and solar water heating is expected to increase throughout the area as energy users diversify energy supply options.

Transport Energy

Transport energy is expected to remain at current levels.

Electricity Supply

The Rotorua area has adequate electricity supply capacity into the area but has some local distribution constraints that will need to be addressed to allow for future growth and greater security of supply.

Sustainability

The Rotorua area has a wealth of potential energy resources. While there is potential for a number of these resources to be developed over time they will never and should not be viewed as an alternative to national grid electricity supply and the supply of natural gas. Their incremental development will complement national supplies and in some cases will allow industries to control their energy costs better. The area has an opportunity to develop 'fit-for-purpose' resources, for example, expanding the use of bioenergy, geothermal and gas for heat while local electricity resources, for example geothermal and hydro are developed to complement existing heat supplies and national electricity supplies to the area where it is economic to do so.

Full sustainable energy supply to the area is likely to be expensive because of the need to provide backup and other system benefits that connection to the national electricity grid and natural gas transmission system will always provide.

Solar

While not as effective as in other parts of the Bay of Plenty, the area has relatively ample solar radiation for solar water heating or electricity production from photovoltaic cells. Both these technologies are expected to have high growth rates and the installation industry will have to increase capabilities to meet demand in the area.

Installation of solar water heating systems can reduce household electricity costs by 30%. The production of electricity from photovoltaic systems is currently only economic in off-grid applications but in the long term, has the potential to allow off-grid existence and self-sufficiency for individuals and community groups.

The capital cost of both systems will remain a major barrier and initiatives such as lease-to-buy will need to be investigated to assist uptake. Other initiatives will be required to develop the skills necessary to meet the demand for installations.

Hydro

There are opportunities in the Rotorua area for medium, small and micro-hydro electricity developments.

One potential development that is being considered is Bay of Plenty Electricity's proposed 13.5 MW hydro power station development on the Kaituna River. If this power station is built the combination of the Kaituna and the existing Wheao/Flaxy schemes will supply over 40% of Rotorua's present electricity demand.

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[1] Unison Asset Management Plan August 2006

[2] This and other information is updated on a regular basis. Appendix 6 has a table listing these information sources.

There are a number of other possible sites for small hydro developments in and around the Rotorua area. These sites have been identified in studies and assessments carried out over 25 years ago. A 1982 study of hydro-electricity potential in the Bay of Plenty area indicated there could be of the order of 110 MW of feasible generation from the Kaituna and Tarawera river systems. Because developments are likely to make more cost-effective utilisation of the water resource (flow and head) such as the Bay of Plenty Electricity proposed 13.5 MW Kaituna scheme that uses only part of the reach of the river that a 1982 option rated at 37.5 MW used, this figure of 110 MW should be considered "high" in the present day context. The critical aspects for any development will be overall economics and acceptability of environmental effects and mitigation measures.

The area is also suitable for micro hydro for individual rural electricity users where the cost of upgrading or extending the existing network may make micro hydro a cost-effective option.

A barrier to any sized hydro facility is the cost of constructing electricity transmission lines to get the electricity to where it is needed.

Hydro has high upfront costs for investigation and consenting. Investors are unlikely to spend the large sums necessary for investigating a hydro project if there is a low probability that the scheme would obtain resource consents. This barrier disproportionately affects smaller sized schemes.

If the community wishes to have hydro as a source of secure electricity supply then the community needs to signal through the Regional and District Plan policies to investors that hydro projects are welcome provided specified environmental conditions are met. Landowners' involvement in projects is essential if projects are to proceed.

Wind

The wind energy potential in the area is low with little or no opportunities for cost-effective development. However in areas where the rural grid may not be adequate in the future small windmills for direct pumping of rural water are expected to make a come-back as alternatives to rural grid supplied electricity use are sought.

Geothermal

There is potential for greater use for electricity generation, heat extraction, ecotourism, and greenhouse heating while maintaining the environmental characteristics and allowing for other existing and potential users.

Research should be undertaken into using deep drilling and hot rock energy extraction technologies to obtain heat for electricity generation. While not likely to be economic in the short to medium term, it is expected that such technologies will become economic in the next decade. While this can focus on the obvious development resources e.g. Ohaaki or Horohoro, there is potential generally through the area.

Gas

Adequate reticulated natural gas and bottled gas is available in the district.

Coal

Coal could continue to be used for heat production but it is expected that other technologies using geothermal or forest residue as an energy source will become more economic as an energy source. Wood pellets in particular have the handling characteristics that allow them to substitute coal easily.

Bioenergy

The opportunities for bioenergy facilities throughout the area are significant. Current economics for bioenergy plant are such that heat production from on-site processing residues is economic but sites are often constrained by limited residue quantities.

Currently within some localities in the area it is (or soon will be) economic to produce electricity from forest residues, initially in cogeneration applications and then for stand-alone electricity generation. It would be expected that all new wood processing sites would install a cogeneration plant when they are installing new heat plant.

Domestic heating from burning firewood is possibly still the most economic form of space heating in existing buildings throughout the area. Community programmes to improve the efficiency of installed wood burners should be a high priority. The addition of a wet-back burner can provide water heating in addition to space heating. This however needs to be undertaken in conjunction with initiatives associated with air emissions reduction.

Warm Home Programme

The highest priority energy investment opportunity in the area should be that associated with having warm and healthy homes. However, the capital cost barrier is very significant for many who would gain most from this kind of investment. The Government has recognized this and has established a number of national housing improvement programmes that aim to both increase domestic energy efficiency (solar water heating and insulation retrofit programmes) and improve community well being.

The delivery of these programmes in the Rotorua Area appears to be somewhat limited due to the need to find co-funding and to have facilitation to assist the establishment of programme delivery capabilities. In addition to the difficulties in sourcing matching funding for government programmes, the lack of continuity in terms of funding duration for existing programmes means that there is an inability to keep trained implementers available and involved. Programmes with a delivery horizon of up to three years could go some way to addressing the issue of continuity. .This is an area of activity where local leadership would be advantageous.

Energy Efficiency

Government also has a number of energy efficiency programmes that would produce economic benefits to domestic and commercial energy users. Energy efficiency is about using less energy to achieve the same or similar energy outcomes – with a cost saving to energy users.

The establishment of effective delivery programmes requires assistance and facilitation from trained and experienced practitioners. Specific efforts should be focused on securing assistance from nationally funded programmes and on the delivery of local solutions by local people solving local problems. Unless a deliberate effort is made to train such people from within the area the implementation and delivery of national programmes will be compromised and will require additional external assistance.

Impediments

There is no “single solution” that will reduce energy costs or provide opportunities for additional energy at less than current costs and uncertainties. There is however a portfolio of opportunities.

To assist the area meet its energy needs in the most cost effective manner will require addressing the significant impediments that exist. The most significant barriers to most economic opportunities are:

- the lack of awareness and understanding (among residential and commercial energy users),
- the lack of information, case studies, and reference sites,
- limited or no access to sound technical advice,
- high capital costs (from large scale supply and demand projects to small scale demand projects),
- inability to access co-funding partners,
- high cost of feasibility studies,
- apparent low accessibility of Government funded programmes,
- the need for facilitation and coordination of local efforts.
- uncertainty of outcome from regulatory approval processes

Many other opportunities will not be economic in the short and medium term.

Commercial Energy Users

Commercial energy users whether big or small are all in a good position to contribute to reducing their own energy costs, and to assist meet energy demand through local initiatives. Again, national programmes directed at aiding understanding and identifying energy efficiency opportunities could achieve savings if they were targeted effectively at the District level.

The Capacity to Deliver

Many of the energy opportunities will require the establishment of service delivery organisations who can manage and deliver Government programmes, be able to provide the community with guidance on opportunities and options, facilitate implementation, and look after local interests. It is inefficient for each small local community group (residential and commercial) to try and do this themselves.

There is a danger that if there are too many energy project initiators and if every local community tried to be a knowledgeable energy facilitator that scarce resources would be spread too thinly and the quality of advice and implementation would suffer. There is a need to co-ordinate efforts and programme delivery throughout the area so that economies of scale can be achieved and a strong delivery team can be developed.

Local solutions require local leadership and the involvement of the all the key groups in the local community. The development of local skills and the use of local knowledge are of paramount importance. District facilitation should be supportive of local initiatives rather than be dominant.

Councils have a key role to play in providing leadership on energy matters, from setting good example to developing appropriate policies.

Regional and District Planning

Rotorua District Council (RDC) and Environment Bay of Plenty (EBoP) have key roles to play through the Regional and District planning processes. The plans can assist or hinder the implementation of energy opportunities. RDC and EBoP are encouraged to review their plans to identify how they can be improved from an energy perspective. The Regional Policy Statement and District Plan both provide some coverage of energy matters but there are also gaps that lead to non-optimal energy solutions.

Energy Market Regulation

Analysis of the energy market rules and regulation raises a number of issues which the District should take up with Central Government and the Electricity Commission in particular. These include:

- the ability of Network Companies to retail electricity,
- inclusion of distributed generation facilities in the Commerce Commission Optimised Deprival Valuation [3] (ODV) Handbook,
- local community combined ownership of generation and distribution lines,
- relaxation of Network Company generation constraints,
- ownership and utilization of electricity meters and ripple control,
- net metering.

Investors

Many of the energy investment options available (both supply and demand side) are such that the investment is often able to be made by the beneficiary of the investment itself, i.e., the home owner or business energy user.

The capital cost of many opportunities is often a major barrier and seed funding or other financial support will usually be necessary. Sources over and above the traditional funding providers may need to be considered.

Future investment in generation developments will require an initial process of awareness raising. This will assist the community to support prospective investments by making their support for generation projects known during consent application processes. It will also add balance to the consent process so that public apathy does not allow it to be captured/dominated by minority groups.

Investors need to engage in the Regional and District planning processes so that opportunities are facilitated, not hindered, by resulting policies.

Research Initiatives

The area has been, and continues to be, the focus of a number of wide ranging energy research projects over the last 10-15 years. Projects range from small-scale solar water heating programmes to health and bioenergy and geothermal studies. Typically, the projects have been research focussed (limited demonstration or delivery focus) and many have retained intellectual property rights to the findings of the work. As a result, there have been limited wider benefits to the area. Other projects that have been more operational in nature have failed to deliver on monitoring and reporting aspects which again limits the potential for the area to learn and benefit. Future initiatives need to clearly demonstrate the actual benefits delivered to the area. A condition of District Council involvement should be the public availability of research results so that the wider community can utilise the information.

Opportunities exist for the District to create a Centre of Excellence for Bioenergy Research based on Scion and the Taupo Clean Energy Centre. Coordinated research will help to attract research funding.

District Energy Champion

In order that the area can coordinate and establish a capacity to deliver good energy outcomes there is a need for the establishment of an Energy Champion to work with the various existing and potential parties involved in energy projects. This would allow the build up of a competence in working with all the players in the energy market and sourcing funds from central government.

[3] This is a methodology used to value the assets of monopoly infrastructure companies

The Energy Champion structure could be modelled on several Energy Trust entities that have been established in other areas. The Energy Champion would focus on activities that are currently not being adequately addressed by existing entities such as Scion. It may be a virtual organisation or it could have a delivery presence such as is provided by Energy Options in Whakatane. It is however important that the area build up its own skill base for delivery of energy outcomes.

It is recommended that a District Energy Strategy based on the following principles be established:

- Improving community wellbeing through warm home programmes.
- Reducing costs of energy through implementing energy efficiency, solar water heating and efficient fireplaces.
- Development of programmes that actively encourage industry and commercial enterprises to have energy management plans and investment in energy efficiency initiatives.
- Establishment of an energy services delivery organisation to meet the needs of local residential and business energy/electricity users.
- Assistance for greater investment in solar electric, hydro and geothermal exploration.
- A programme of engagement with Central Government Agencies responsible for the delivery of national programmes on security of energy supply, energy efficiency (industrial and commercial), residential retrofitting programmes etc in order to secure supportive funding for programmes, to maximize the opportunities for the area and ensure economic growth and community well-being.
- Policies that assist the Rotorua District Council being energy developer friendly.

The District Energy Strategy should be a fundamental component of the Long Term Council Community Plans for Rotorua District and so ensure community buy-in and that it is established as a key component of the area's future planning focus.

Rotorua Area Energy Assessment

1 Introduction

The BrightEconomy Advisory Board (BEAB) has commissioned this study which is an assessment of the:

- Security of current energy supply.
- Limitations of the current electricity networks and how deficiencies are being addressed.
- Potential sources of untapped energy and opportunities for generation; advantages and disadvantages of utilisation of these sources and barriers to their use.

The assessment provides information on current and predicted future energy demands, and provides an overview of energy development opportunities in the area.

The focus of the assessment project brief is aimed at identifying:

- Existing information and data.
- Rotorua's current energy resource use and infrastructure.
- Constraints or barriers (if any) for District economic development caused by a lack of 'distributed power,' infrastructure limitations, grid management, energy security and any other factors.
- The range of options and the possible viability of renewable energy types.
- Any District advantage with respect to renewable energy resources.
- Current and future energy demand and overall projected energy needs.
- Energy efficiency opportunities (for industry and residential users).
- Enabling technologies and energy management systems.
- Community energy issues and home heating.
- District energy tariffs and pricing.

The impact on the Rotorua area of the Resource Management Act, the Local Government Act, and the Long Term Community Council Plans, and possible mitigation strategies

The assessment is based around a review of publicly available information and recently updated data prepared by East Harbour Management Services (East Harbour) for, and published by, the Ministry of Economic Development and the Energy Efficiency and Conservation Authority (EECA). In addition East Harbour has drawn on data from its broad experience of the energy sector and on relationships with key players in the area. Where necessary, data from earlier reports has been moderated by the experience of the authors.

The assessment has also drawn on the substantial amount of work undertaken by Environment Bay of Plenty associated with the geothermal resource and its use, as well as air quality, on a study for the Tairawhiti Development Taskforce carried out by East Harbour, and a similar study carried out on behalf of Venture Southland.

The information collated has been expanded where appropriate by interview with relevant local parties on specific topics.

The assessment identifies the estimated energy scale, and cost resulting from the deployment of a range of technologies, along with the potential community and economic development benefits, and opportunities associated with:

- Renewable energy.
- Energy efficiency.
- Infrastructure development.
- Community (residential) energy use.
- Commercial energy use.

- Industry opportunities.
- Reducing transport costs.
- Public energy efficiency promotion.

The assessment covers the whole of the Rotorua District and beyond where appropriate. It covers all energy forms but priority is given to those energy drivers that are within the district's ability to influence, or to respond to.

The report provides a list of opportunities to ensure adequate availability of reliable energy at affordable prices for the area in the near term and into the future. It then ranks them in terms of likely importance and recommends actions that may address barriers and facilitate opportunities for future energy supply and demand in the area.

2 Background

2.1 District Details

Over 600 years ago, the Te Arawa people moved inland from the Bay of Plenty coast and settled in the Rotorua area. Today, the Rotorua district has a multi-cultural population of 65,900[4] including rural and lakeside communities and the city of Rotorua. It is estimated that 80% of the population is in the urban area. Rotorua District covers 2708 square kilometres. Figure 2.1 shows the Rotorua District Area[5] and Figure 2.2 indicates Rotorua's proximity to major centres.

Two Regional Councils, Environment Bay of Plenty and Environment Waikato have responsibilities for resource management in parts of the Rotorua District Council's territorial area.

[4] 2006 Census
[5] Rotorua District Council, Rotorua Growth Model November 2005

Figure 2.1 Rotorua District

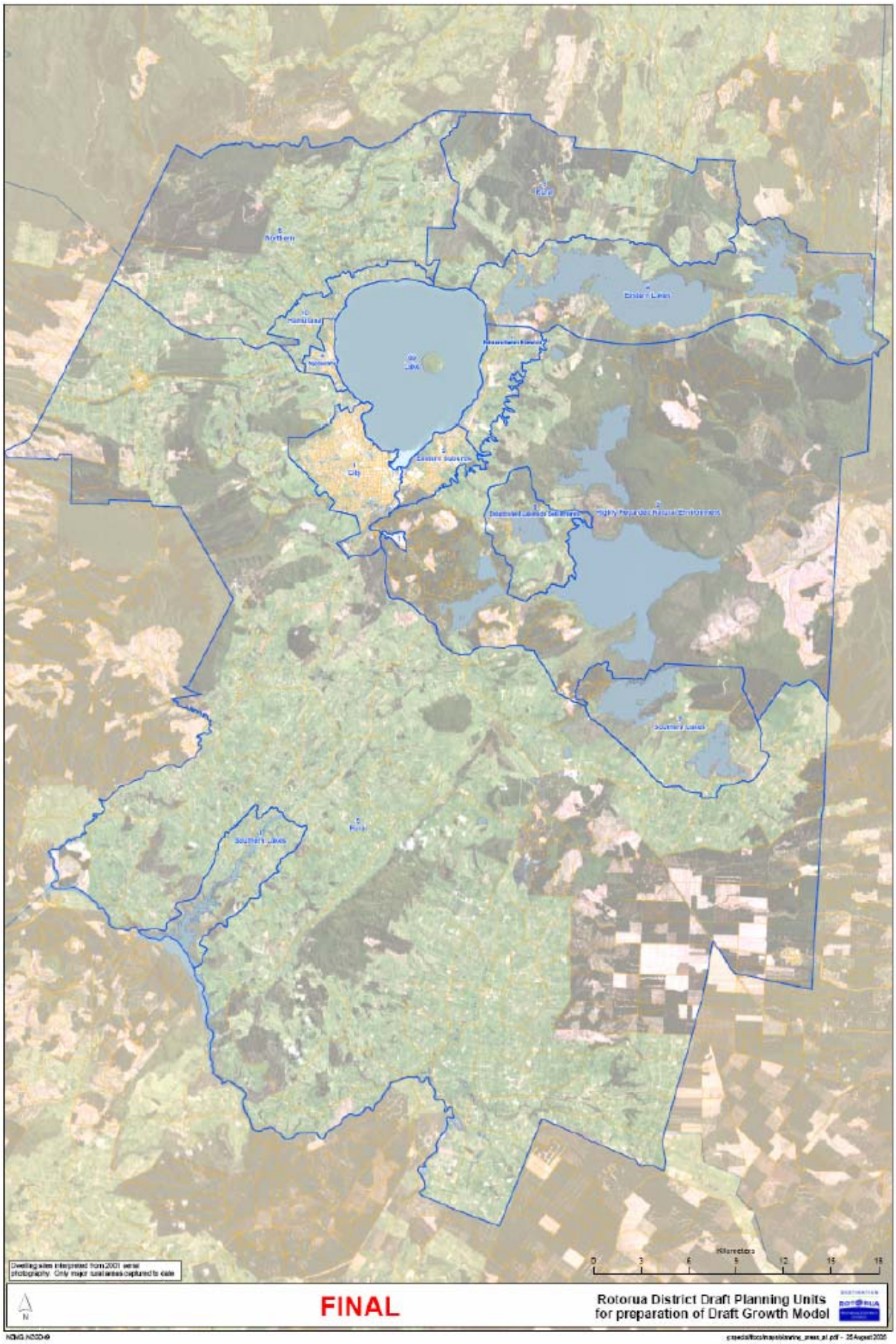


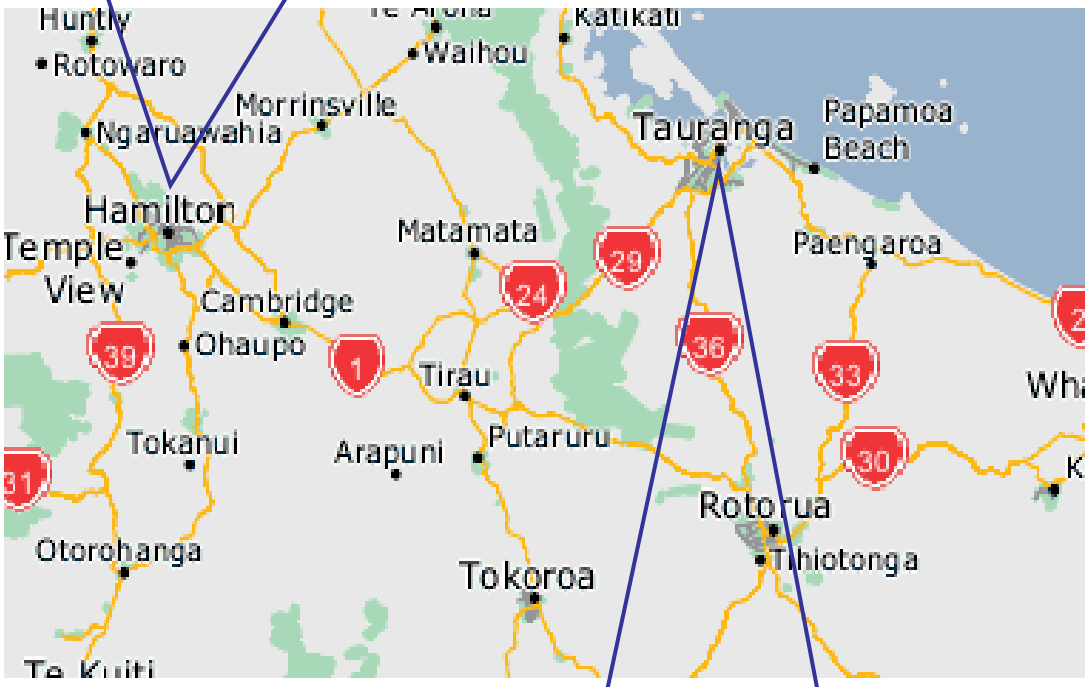
Figure 2.2 Rotorua's Proximity to Major Centres

Population: Urban Area 179,000

Distance from Rotorua: 111 km

Major industries: Dairy; Hi-tech innovative manufacturing/ engineering industries; Science research and numerous major research facilities; More than 40,000 tertiary students at University of Waikato, Waikato Institute of Technology (Wintec) and Te Wananga o Aotearoa

Major infrastructure: City's proximity to two main sea ports (Auckland and Tauranga); 2 international airports (Auckland and Hamilton); railway; South Auckland industrial base and state highways provide significant opportunities for export and import



Population: 110,000

Distance from Rotorua: 86 km

Major industries: Shipping port; Container terminal; Tourism?; approx 17% of people employed in the manufacturing industry (FTE), approximately 30% in manufacturing, is in the fabricated metal products, machinery and equipment sector a further 10% in construction another 24% are in the food, beverages and tobacco industry.

Major infrastructure: Port of Tauranga; Airport (national); Tauranga harbour is a valued recreational haven; 44% of New Zealand's population lives within 200 kilometres of Tauranga.

2.2 District Statistics [6]

2.2.1 People

The population of Rotorua is stable, but the District's make-up is steadily changing. Key trends include:

- A relatively high level of inward and outward migration.
- An increasing number of Mäori residents.
- A young but ageing population.
- A falling average household size.
- An increasing number of people living alone.
- An increasing rate of paid employment.

2.2.2 Education

Almost half of Rotorua students attend schools with a decile rating of 3 or lower.

A decreasing number of Rotorua children are enrolling with early childhood service providers.

The number of students stood down from school has fallen in recent years but the upward trend in early leaving exemptions has continued.

An increasing proportion of people have some form of academic qualification, although Rotorua still has an above average number of students leaving school with no qualification.

The population of the Rotorua District is forecast to grow at around 0.4% per annum over the coming 20 year period, reaching 72,300 in 2021.

2.2.3 Standard of Living

Real household incomes grew slightly higher than the national average over the period 1991 to 2001.

The number of people receiving the Unemployment Benefit in Rotorua fell by more than 25% in the twelve months to June 2005.

The percentage of Rotorua 0-4 year-olds living in sole-parent families has increased slightly over the past decade.

Almost half of the District's population lives in areas that are considered the 30% most deprived in the country.

2.3 BrightEconomy

The BrightEconomy Strategy, the Rotorua regional economic development strategy was launched in May 2005.[7] The BrightEconomy Advisory Board, (BEAB) established to drive the implementation of the strategy is made up of 11 leading Rotorua business people, working with Destination Rotorua Economic Development.

The Strategy has five themes:

- Adding Value to the Economy: - Broadening and deepening the economy to extend opportunities, particularly in the tourism, forestry / wood processing and agricultural sectors
- Dynamic Place: -Creating a dynamic environment to attract and retain residents, visitors, investors and business
- Business Environment:-Establishing an environment in which sustainable economic development can occur.
- Education & Skills:-Encouraging skilled workers to remain in the area and adopting methods to “up skill” and educate the local community.
- Building Networks & Growing Capacity:-Developing the structures, partnerships and networks that will produce results across the entire strategy.

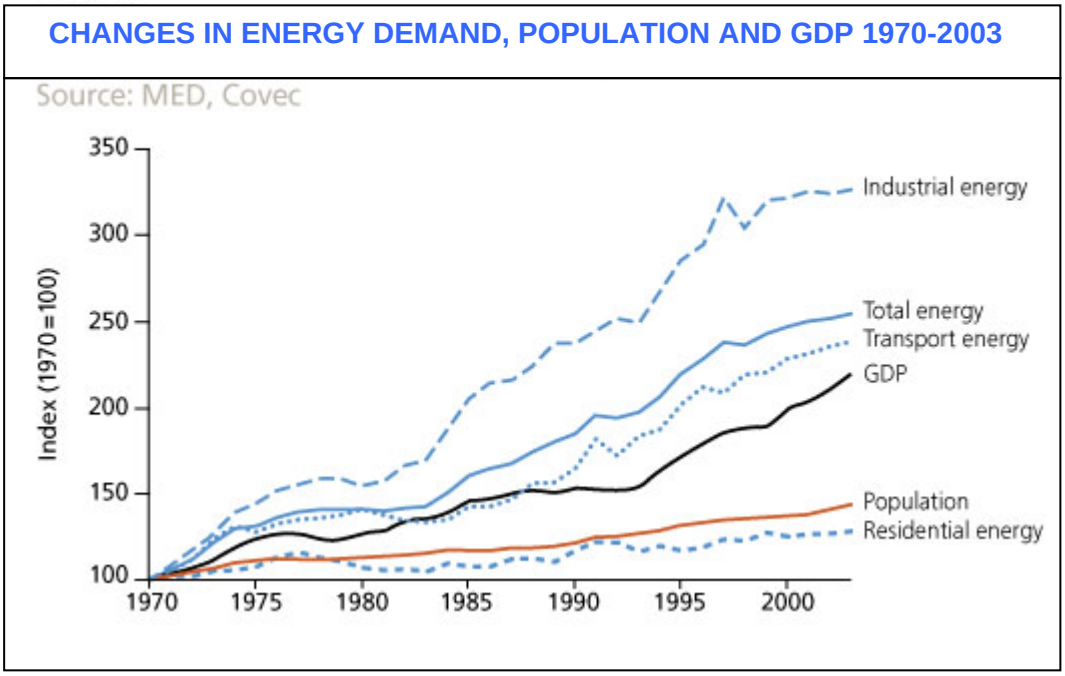
Energy has been identified as one of the key areas of focus by the BEAB in their 2006/2007 economic framework.

[6] http://www.rdc.govt.nz/About+Rotorua/Statistics+and+Demographics/Rotoruas+Quality+of+Life.htm
[7] http://www.rotorua-business.com/brighteconomy.asp

2.4 Economic Growth

Gross Domestic Product (GDP) and energy use in the district are related to the national growth. This is shown in Figure 3.1[8] which shows the changes in New Zealand energy use and GDP from 1970 to 2003.

Figure 2.3 New Zealand Energy Use, Population and GDP

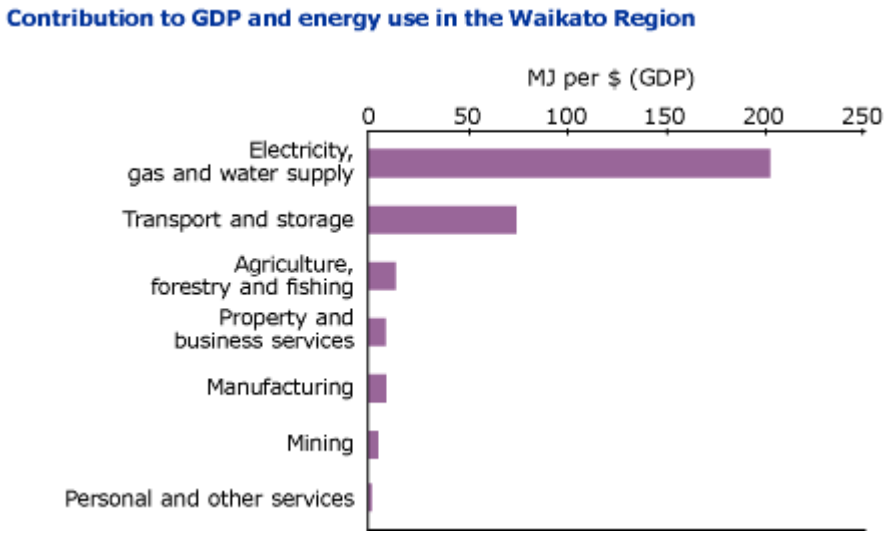


Environment Waikato measures energy use relative to economic growth in the Waikato Region[9]. A lower ratio of energy consumption to GDP suggests more energy efficiency and conservation. It can be seen in Figure 2.4 there is a strong relationship between electricity, gas and water supply and GDP in the Waikato region.

Figure 2.4 shows that in 2003 the greatest energy use relative to economic growth in the Waikato region was within the electricity, gas and water sector. This sector used 203 MJ for each dollar it contributed to the region's GDP. However, much of the energy was used to generate further power. Agriculture, forestry and fishing was the non-electricity generating sector with the most energy consumption (14 MJ per dollar contributed).

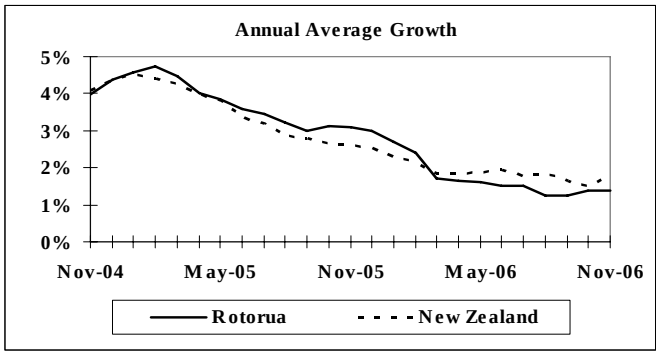
[8] http://www.nzbcsd.org.nz/energy2050/content.asp?id=391
[9] http://www.ew.govt.nz/enviroinfo/indicators/community/sustainability/energy2/keypoints.htm

Figure 2.4 GDP and Energy use in the Waikato Region



It is expected that Rotorua would have similar ratios but it does not appear to have been measured for Rotorua. This would appear to be a potential tool for the RDC to use.

Figure 2.5 Rotorua Economic Growth[10]



According to the APR index of economic growth (Figure 4.2) the annual average growth rate in Rotorua's index was 1.5% for the year ended November 2006. Since March 2006 economic growth in Rotorua has slipped behind that of New Zealand at 1.6% but the gap appears to be narrowing.

Rotorua's firms may face challenges during 2007 because of a potential deficit of skilled labour (due to a strong labour market) and the effects of a tightening of monetary policy by the Reserve Bank.

Energy policy is driven by several key pieces of Government Policy including the replacement National Energy Efficiency and Conservation Strategy (NEECS), (This is a subset of the New Zealand Energy Strategy), Sustainable Development Programme of Action, Sustainable Energy Framework, Electricity Governance (and the formation of the Electricity Commission), and Gas Governance.

Of particular note is the Government's policy for electricity is outlined in the Government Policy Statement on Electricity Governance. The policy recognises that the electricity sector has a critical role to play in underpinning the Government's growth and sustainability objectives. Sustainable economic growth will best be supported by an electricity system that:

- Is reliable and resilient.
- Is environmentally responsible.
- Delivers energy prices that are efficient, fair, and as competitive as possible consistent with these requirements.

The Electricity Commission has a key role in contributing to these objectives. The Government has amended the Electricity Act 1992 to set the following principal objectives for the Electricity Commission:

- Ensure that electricity is produced and delivered to all classes of consumers in an efficient, fair, reliable, and environmentally sustainable manner, and
- Promote and facilitate the efficient use of electricity.

[10] : APR Consultants

In December 2006, the government released its draft energy strategy[11] as the basis for stakeholder and public engagement on the medium and long-term decisions that will shape New Zealand's energy future. The draft replacement National Energy Efficiency and Conservation Strategy will form a subset of the New Zealand Energy Strategy.

The energy strategy aims to ensure New Zealand develops a sustainable and affordable energy system which minimises greenhouse gas emissions, and which will give New Zealand an enduring competitive advantage over other countries. "New electricity generation should be renewable, except to the extent necessary to maintain security of supply."

Other key elements of the strategy include:

- Introducing renewable fuels as substitutes for petrol and diesel.
- Improving efficiency of the vehicle fleet, through age/technology standards.
- Improving consumer choice through vehicle efficiency information standards.
- Biofuels increasing over time and the introduction of plug-in electric vehicles.
- Increasing support for public transport and non-motorised forms of transport.
- Developing a New Zealand shipping strategy and other different ways to move freight.
- More solar water heating.
- More energy efficient homes and buildings.
- Funding for the early deployment of marine-based electricity generation such as wave or tidal, worth $8 million over four years.
- Increasing competition in the electricity market by reducing restrictions on generation and retailing by lines companies.
- Creating a pathway for internalisation of fossil fuel emissions in the electricity sector so costs are met by those who create them.
- Consideration of RMA consent applications for wind and geothermal electricity generation projects in groups, to better compare national benefits and environmental impacts.

The Rotorua District Council growth model[12] concluded that for the Rotorua District:

- Population Growth is forecast to grow by 0.38% per annum between 2001 and 2021, and a further 0.15% per annum to 2051.
- Household occupancy will trend down from 3 people per occupied dwelling in 2001 to 2.67 in 2021 and 2.6 in 2051.
- The number of households will increase from 22,257 in 2001 to 26,917 in 2021, and continue to grow to 28,996 in 2051.
- An additional 1,221,494 visitor nights will be generated by 2021.
- Total visitor nights will be 4,214,299 by 2021.
- An additional 44.26 hectares of Industrial/Employment Land will be needed by 2021 and a further 28.64 hectares by 2051.
- An additional 8.27ha of Retail/Commercial Land will be needed by 2021 and a further 5.35ha by 2051.
- The high growth areas have been identified as the: City, Eastern Suburbs, Rotokawa and Northern planning units, while the Rural, Established Lakeside settlements, Eastern Lake and Hamurana planning units will experience moderate growth, and the Highly Regarded Natural Environment, Southern Lakes and Ngongotaha planning units will experience stable growth.
- Growth and a strong economy will help ensure the current trend of negative net migration slows or stops as the natural increase slows in line with the ageing New Zealand population.

[11] New Zealand Energy Strategy to 2050 "Powering Our Future – Towards a Sustainable Low Emissions Energy System"

[12] Rotorua District Council Rotorua Growth Model November 2005 Reference 1520-120563-01

Consequently Rotorua will maintain an increasing population growth rather than a declining population as forecast by Statistics New Zealand.

2.4.1 Key Stakeholders

The list below illustrates the key central government agencies focussing on energy.

Ministry of Economic Development

- Energy Policy (lead organisation).
- Sustainable Energy Framework.
- Small and medium business.

Electricity Commission

- Electricity sector governance.
- Security of supply.
- Rules and regulations.
- Demand response.
- Electricity efficiency.
- Transmission investment and upgrading.

EECA

- Energy efficiency.
- Promotion of renewable energy.
- Community energy projects.
- Business focussed energy efficiency projects.

Ministry for the Environment and the Climate Change Office

- Resource Management Act 1991.
- Climate Change Policy.

Ministry of Transport

- Transport energy policy.
- Transport biofuels.

Foundation for Research, Science and Technology

- Funding energy research.

Department of Conservation

- Access to land.
- Management of rivers and geothermal resources.

2.5 Key Local Stakeholders

The Federation of Maori Authorities, local iwi authorities which, alongside the council and the partners in the Rotorua Partners Programme, have a strong community presence and an involvement in energy matters.

Of specific importance is the role of the Rotorua Energy Charitable Trust which funds some energy initiatives particularly those related to healthy homes[13].

The Rotorua Energy Charitable Trust was formed so that some of the funds created by the corporatisation of the Rotorua Electricity Area Authority could be retained and used for the benefit of the community in Rotorua and the surrounding areas.

[13] http://www.rotoruatrust.org.nz/media_release/latest.htm

2.6 Industry

Rotorua District has an estimated economic output of two billion dollars per year, based on 2002 data[14]. The largest contributors are:

- tourism (around 11 percent).
- forestry (10.3 percent) and associated wood and paper processing (6 percent).
- agriculture (7.8 percent) and associated food processing (2 percent).

Manufacturing is also a significant contributor in supporting these activities.

2.6.1 Forestry/Wood Processing

A significant level of Rotorua's economy is due to forestry, wood processing and the infrastructure needed to support it. A list of local companies is given in Appendix 2. This list is not exhaustive and will need to be kept up to date.

2.6.2 Agriculture

Around 45% of the Rotorua District is in pasture. The main agricultural activities in the district are dairy, beef, sheep and deer farming. Dairying accounts for almost three quarters of Rotorua's agricultural economic output[15]. Dairy Farm energy use is estimated at 0.08 PJ.

Fonterra Reporoa Fonterra Reporoa is one of the three Fonterra factories producing ethanol from whey. Other products are casein, caseinate and total milk protein (TMP).

2.6.3 Manufacturing

Hayes International Hayes International is an established world leader in the design and manufacture of machinery for the production of roofing and wall cladding profiles, structural components such as Cee and Zed purlins and metal framing components. Also manufactured by the company are long length power folding machines and a wide variety of associated metalworking equipment. Hayes International is part of the Bradbury Group,

Patchell Industries Patchell Industries produces most types of heavy road transport equipment including a range of log transport and container handling trailers, swinglift container side lifters, stainless steel tankers and other specialised builds. The company also has abrasive blasting and painting facilities and is able to control every aspect of the equipment build from initial plate cutting to final electrical installation.

2.6.4 Tourism

Rotorua is one of New Zealand's main tourism centres, with many natural attractions including geothermal activity, forests, parks, and 14 freshwater lakes. Tourist activities include Maori cultural experiences, eco-tourism, trout fishing, and outdoor adventures.

Almost a third of all international visitors to New Zealand spend at least one night in Rotorua. In 2003, Rotorua had 1.7 million day visitors and 1.5 million overnight visitors (totalling 4 million visitor nights[11)]. Tourists spent $567 million in the district[16].

Growth in tourist numbers is seen as coming from overseas visitors. Visitors from UK/Nordic countries have the longest stays while those from north Asia the shortest[17].

Tourism (along with forestry, agriculture and manufacturing) are the largest contributors to Rotorua's economy. 20% of jobs are in the tourism industry and a further 5% are dependent on tourism.

Generally, tourism has little negative effect on the geothermal resource (has served to protect them). In addition to providing local employment, and tourist dollars, geothermal tourism also promotes public awareness and support for preserving natural areas.

2.6.5 Transport

The Rotorua District and surrounding area is very dependent on transport. Energy is just one component of the transport costs but investment in improved infrastructure transport services will lead to significant reductions in energy consumption.

In their 2006/07 highway plan and forecast[18] for the Bay of Plenty, Transit proposes to undertake strategic studies on the remaining strategic corridors, which includes three Rotorua Corridors (Southern,

[14] http://www.pce.govt.nz/reports/allreports/1_877274_43_7.pdf
[15] ibid
[16] http://www.pce.govt.nz/reports/allreports/1_877274_43_7.pdf
[17] http://www.rotoruanz.co.nz/information/about_rotorua/rotorua_economy.htm
[18] http://www.transit.govt.nz/content_files/planning/forecast-06-07/summaries/BOP.pdf

Eastern Lakes and Rotorua Central). Bay of Plenty Joint Officials Group (JOG)[19] should keep their interest in roading funding and liaison with local authorities to ensure major corridors are built in the Rotorua district, with consequential reductions in transport energy requirements.

The 1993 Rotorua Urban Transportation Study[20] identified a number of major roading projects necessary to ensure network efficiency over the next 20 years. These appeared to be mostly major road widening projects.

Wood logs are generally transported throughout the region by road. Export logs are shipped out through the port of Tauranga.

There are three domestic airports at Rotorua, Tauranga and Whakatane, with well developed plans for Trans-Tasman flights into Rotorua.

2.7 Energy Growth

Future energy growth is particularly sensitive to the pattern of development of the area's forestry resources, tourism and farming. An example of this is the increase in energy demand that is a feature of dairy conversion above that used by forestry.

Energy demand on a business as usual basis is expected to continue to increase (at around 1-2% per year for electricity) in Rotorua. For electricity in Rotorua this would be around 8GWh per year. This business as usual growth will be driven by normal industry growth and changes in the way energy is used. While there will be energy efficiency changes that may decrease energy use, the increase in energy efficiency will also drive an increase in energy consumption.

As industry moves from a commodity base to more added value there is a resulting change in demand for energy quantity, reliability, form of fuel source, and secure quality. Industry needs to demonstrate the importance of these energy supply characteristics through the way they respond in times of electricity shortage.

Within a business as usual scenario, the increase in wood product processing is expected to lead to an increase in the need for heat for wood drying. It can be expected that kiln drying could increase by about 20% above that currently used.

In addition to these business as usual scenarios, it is likely that a large wood processor (or a number of processors) will establish in the area. The entry of such a large energy user could bring about a large step change in energy demand that is more difficult to deal with. (It could be of the order of around 5-15MW electricity and 25+MW thermal). On the other hand, a large wood processor would also produce large quantities of wood processing residues which would be used as fuel for heat and electricity production. It can be expected that any new large wood processor would install a cogeneration unit and generate a proportion of their own electricity requirement thus minimising the impact on the District energy supply.

Regardless of location of any new large wood processor it is expected that forest residue will soon become economic for use as a fuel for electricity generation thus also encouraging a new large wood processing energy user to be self sufficient in energy supply. Forest residue could also be used as a feedstock for conversion to transport fuels. Research is currently underway by Scion into the economics of using forest residue for energy production.

3 Current Energy Supply to the Rotorua Area

3.1 Rotorua Electricity Supply

This section provides information on the configuration of the energy supplies in the Rotorua area and includes comments on the risks inherent in the supply systems and the management of those risks. The greater part of the information is sourced from Transpower and Unison Networks Limited publications.

The Rotorua area has a distinct electricity supply network which is owned and operated by Unison Networks Ltd (Unison).

Unison is 100% owned by the Hawkes Bay Power Consumers' Trust which was set up in 1993. It is made up of five Trustees who hold all the shares in Unison Networks Limited, on behalf of the consumers who

[19] http://www.rotchamber.co.nz/tabloid/tabloid-september2005.asp
[20] http://www.rdc.govt.nz/Our+Services/Engineering+Services/Rotorua+Urban+Transportation+Study.htm

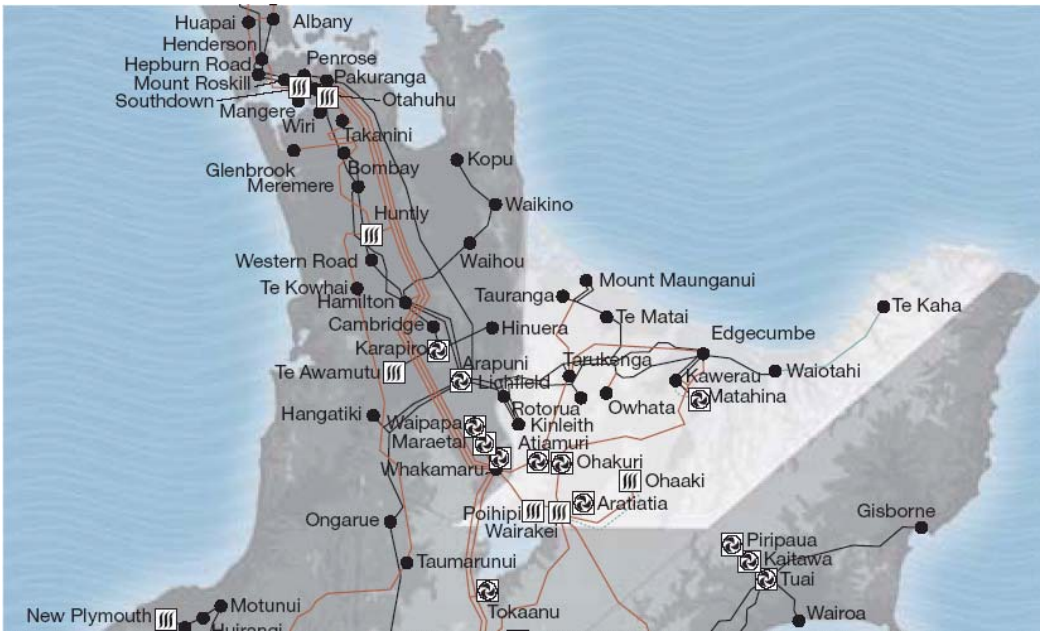
are connected to Unison's electricity network in Hawke's Bay. In simple terms, this is generally the areas of the Hastings District Council and the Napier City Council.

The distribution network connects to Transpower's national transmission system at the Rotorua (Malfroy Road), Owhata, and Tarukenga substations and Ohaaki power station. The Transpower transmission lines operate at 220 and 110 kilovolts (kV), while the sub-transmission and distribution system operates at 33 kV, 11kV down to 400V (volts) and 230V.

3.2 Transmission[21]

Electricity supply to the area comes from the national grid Bay of Plenty section that is connected to Transpower's core grid at Atiamuri and Ohakuri (220 kV) as shown in Figure 3.1. The current system also has a 110 kV line from Lichfield to the Tarukenga substation

Figure 3.1 Schematic of the Transmission Grid for the Bay of Plenty Region[22]



Rotorua is supplied principally by a 220 kV Bay of Plenty "loop" (a 220 kV ring that is connected to the core grid at Atiamuri and Ohakuri).

3.2.1 Grid Security Issues

The main Transpower grid backbone[23] issue in the next 10 years affecting Rotorua is the transmission capacity of the Wairakei ring 220 kV circuits, details of which are outlined in Table 3.1

Table 3.1 Transpower North Island Grid Backbone Issues Affecting Rotorua

Section	Issue Name	Issue	Category	Possible Transmission Solution (Year)
5.2.1.3	Transmission Capacity of the Wairakei Ring 220 kV Circuits	Loss of one of the **Wairakei Ring 220 kV circuits** may constrain power transfer north between Wairakei and Whakamaru as early as 2011 depending on generation development north of Whakamaru.	Reliability	A new 220 kV transmission line between Whakamaru, Atiamuri and Wairakei (2011 -2021)
		Loss of one of the **220 kV Atiamuri – Whakamaru or**		**Or**
		Ohakuri-Wairakei circuits presently constrains transfer into the Bay of Plenty region		Replacing the conductor on the existing Wairakei ring 220 kV circuits (2011-2021)

[21] Annual Planning Report (incorporating the Grid Reliability Report) Transpower, 31 March 2006
[22] ibid
[23] Transpower Annual Planning Report 2006 (Incorporating the Grid Reliability Report), 31 March 2006

3.2.2 Bay of Plenty Generation

The installed generation capacity in the Bay of Plenty region (as defined by Transpower) is 928 MW. This generation contributes a significant portion of the total North Island generation and exceeds local demand. However much of the generation is not close to the demand centres. The surplus generation is exported over the National Grid to other demand centres in the North Island.

Table 3.2 Forecast Annual Generation Capacity (MW) at Bay of Plenty Grid Injection Points to 2016
(Including Existing and Committed Generation)

	Years/MW										
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Generator											
Aniwhenua	25	25	25	25	25	25	25	25	25	25	25
Aratiatia	78	78	78	78	78	78	78	78	78	78	78
Atiamuri	74	74	74	74	74	74	74	74	74	74	74
Edgecumbe (Bay Milk)	10	10	10	10	10	10	10	10	10	10	10
Hinemaiaia	7	7	7	7	7	7	7	7	7	7	7
Kawerau – BOP	6	6	6	6	6	6	6	6	6	6	6
Kawerau - TPP	39	39	39	39	39	39	39	39	39	39	39
Lloyd Mandeno (Kaimai)	16	16	16	16	16	16	16	16	16	16	16
Lower Mangapapa (Kaimai)	6	6	6	6	6	6	6	6	6	6	6
Matahina	72	72	72	72	72	72	72	72	72	72	72
Ohakuri	106	106	106	106	106	106	106	106	106	106	106
Ohaaki	104/34*	104/34*	104/34*	104/34*	104/34*	104/34*	104/34*	104/34*	104/34*	104/34*	104/34*
Poihipi	55/37*	55/37*	55/37*	55/37*	55/37*	55/37*	55/37*	55/37*	55/37*	55/37*	55/37*
Ruahihi Kaimai)	20	20	20	20	20	20	20	20	20	20	20
Rotokawa	32	32	32	32	32	32	32	32	32	32	32
Wheao / Flaxy	26	26	26	26	26	26	26	26	26	26	26
Wairakei	181	181	181	181	181	181	181	181	181	181	181
Mt Maunganui Fertiliser	7	7	7	7	7	7	7	7	7	7	7
Omanawa (Kaimai)	1	1	1	1	1	1	1	1	1	1	1
Prolog - Timber Processing	5	5	5	5	5	5	5	5	5	5	5
Waitoa	4	4	4	4	4	4	4	4	4	4	4
Kinleith	40	40	40	40	40	40	40	40	40	40	40
* Restricted output due to steam availability											

The 26MW Wheao and Flaxy scheme produces around 125 GWh of electricity annually meeting about 27% of the Rotorua demand. It is connected to the Rotorua substation by a 110kV line.

Table 3.2 lists forecasts of supply at each grid injection point (GIP) on the Transpower network in the Bay of Plenty region over the next 10 years[24]. This includes all known generation including stations that are embedded within the local lines company network.

Mighty River Power has recently announced that it will build a 90MW geothermal power station at Kawerau (not included in Table 3.2). This power station will increase further the amount of regional generation for Bay of Plenty and hence contribute to the security of supply for Rotorua. The station is expected to be completed by the end of 2008.

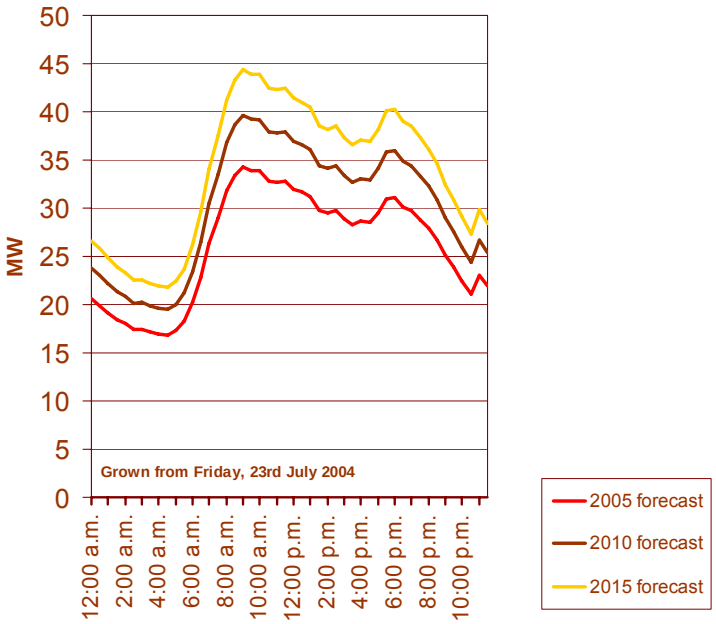
3.2.3 Rotorua Demand

Table 3.3 lists the forecasts of peak demand (load) at each grid exit point (GXP) in the Rotorua area over the next 10 years[25].

Table 3.3 Forecast Annual Peak Demand - 2006 to 2016

	Peak Demand MW										
GXP	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Owhata	14.6	15.0	15.5	15.9	16.3	16.8	17.1	17.5	17.9	18.3	18.7
Rotorua 11kV	32.7	33.7	34.7	35.7	36.7	37.6	38.5	39.4	40.2	41.1	42.0
Rotorua 33kV	40.8	42.1	43.4	44.6	45.8	47.0	48.1	49.2	50.3	51.3	52.4
Tarukenga 11kV	7.3	7.5	7.7	8.0	8.2	8.4	8.6	8.8	9.0	9.2	9.4

Figure 3.2 Rotorua 33 kV Forecast Typical Winter Load Profile[26]



[24] ibid
[25] ibid
[26] The National Grid: Bay of Plenty Region – Rotorua, Alison Little and Paul Fuge Transpower New Zealand Ltd , 8 August 2005

3.2.4 Rotorua District Transmission Capability[27]

Issues that could affect the electricity supply to Rotorua are:

(a) Overloading of a Tarukenga 220/110 kV Interconnecting Transformer

There are two 220/110 kV interconnecting transformers at Tarukenga. An outage of one interconnecting transformer may cause the remaining transformer to exceed its n-1 rating from 2006 onwards. However, as there is an on-site spare, and a relatively low risk of an interconnecting transformer failure, investment may be deferred to about 2012.

The preferred option for increasing interconnecting transformer capacity at Tarukenga is to reduce their loading by installing two 220/110 kV transformers at Tauranga (Hairini). The existing transmission line from Tarukenga to Hairini is constructed at 220 kV, but is presently operated at 110 kV.

Transpower has calculated costs for the physical works but costs have not been included in the document at this stage because the costs of property and easements associated with the project are highly variable and can have a significant impact on the overall cost of the project. The project's indicative commissioning date is 2011.

Transpower has identified this as a provisional reliability project.

(b) Overloading of an Owhata 110/11 kV Supply Transformer

Replacing the existing Owhata 110/11 kV supply transformers with two new 30 MVA units around 2014 will manage the risk to the electricity supply for part of Rotorua from overloading of the existing transformers (forecast to exceed the supply transformers' winter n-1 capacity[28] for about 2% of the time in 2006, with an expected increase to 18% of the time by 2016). This would provide security well beyond the scope of the planning period at an estimated cost of $3.0 million.

Transpower has identified this as a provisional Unison specific project

(c) Rotorua 110/11kV Transformer Capacity

Similarly, the peak Rotorua load is forecast to exceed the existing Rotorua 110/11 kV supply transformers' winter n-1 capacity for about 4% of the time in 2006, with an expected increase to 21% of the time by 2016. Unison has identified[29] that this supply point is heavily overloaded and requires reinforcement in the short term.

Transpower has identified this as a provisional Unison specific project

(d) Rotorua Transmission Supply Security

The 110 kV Rotorua-Tarukenga line consists of two circuits each rated at 63/77 MVA[30] summer/winter. The configuration at Rotorua is such that an outage or loss of the 110 kV Rotorua-Tarukenga 2 circuit:

- results in loss of the Wheao generation; and
- may overload the remaining 110 kV Rotorua-Tarukenga 1 circuit as it now has to supply all the load to Rotorua.

Transpower and the local lines company (Unison) will discuss future supply options and capacity requirements such as:

- the local lines company can shift some load within their network to Tarukenga to reduce the Rotorua load to within the capacity of the 110 kV Rotorua-Tarukenga circuits; or
- Transpower can thermally upgrade the existing 110 kV Rotorua-Tarukenga circuits to 90/100 MVA (summer/winter).

Transpower have noted that this is an issue for information only and that future Transpower investment will be customer driven.

(e) Supply Security at Tarukenga

The load at Tarukenga is supplied by a single 20 MVA supply transformer and therefore there is no n-1 security. This load is forecast to grow to 10 MVA by 2016. Operationally, the load at Rotorua can be shifted to the Tarukenga 11 kV bus.

---

[27] ibid
[28] Usually the Maximum Continuous Rating (MCR)
[29] Unison Asset Management Plan August 2006
[30] Mega Volt Ampere, a power rating of electrical equipment, greater than (the MW rating)

Eventually a second transformer will be needed, as it is anticipated that some Rotorua 11 kV load will be permanently shifted to Tarukenga.

Transpower have noted that this is an issue for information only and that future Transpower investment will be customer driven.

3.3 Distribution

Unison owns, manages and operates distribution networks in the Hawke's Bay, Taupo and Rotorua. In Rotorua 468 GWh of electricity is distributed each year to 31,200 customers along 2660 km of line. Peak demand is 88 MVA.

In Rotorua Unison had around 3450 small commercial customers, 120 large commercial customers and 1 industrial customer[31].

In the recent Commerce Commission investigation into Unisons' pricing, evidence was given that the distribution networks in Rotorua (and Taupo) had been built down to a low price. "The poles are light, conductor appears to be light, and there is little redundancy for security of supply at the sub-transmission and feeder level. There are more vegetation issues in the Rotorua area, and some lines are very difficult to gain effective access for either vegetation management or repair after storms." [32]

As a result the current owners of the network, Unison, has a number of challenging issues in Rotorua. These issues are currently being addressed as detailed in their latest Asset Management Plan.[33]

As there is a worldwide shortage of skilled personnel Unison may have some difficulties in having some of the plan put into action.

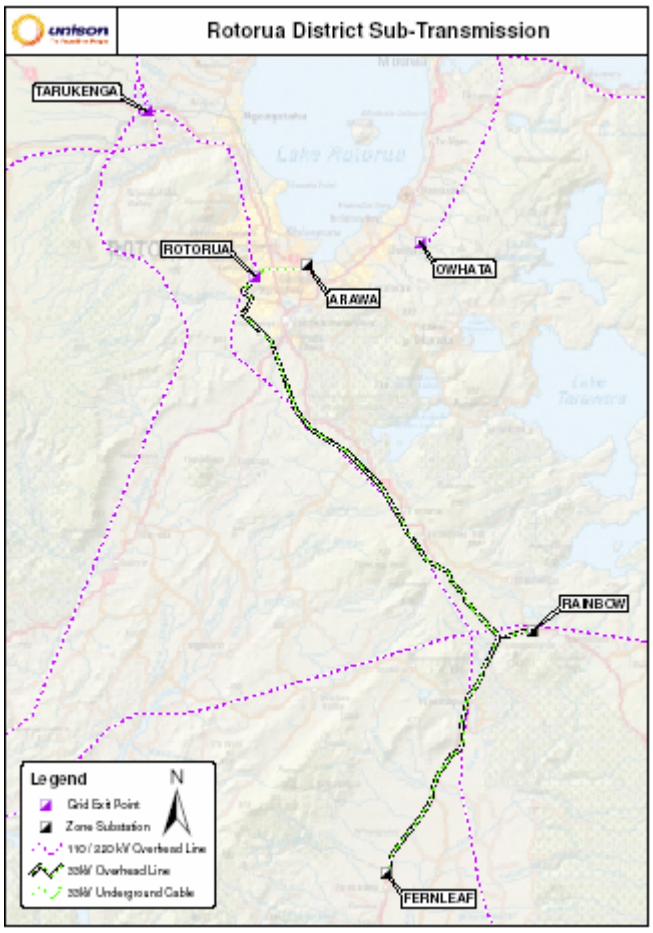
Sections 3.3.1 and 3.3.2 are extracts from the Unison 2006 Asset Management Plan.

3.3.1 Supply Parameters and Risks[34] [35]

Grid supply to Rotorua City and surrounding area originates from Tarukenga Substation, which is interconnected to the 220 kV grid. The Tarukenga regional 110 kV transmission supplies the Unison network from grid exit points at Rotorua (Malfroy Road) and Owhata. The grid supply arrangement to Rotorua GXP is via two 110kV circuits from Tarukenga with a split 110 kV busbar at Rotorua. This is shown in Figure 3.3 and Table 3.4.. Separate supply points at the Atiamuri and Ohaaki power stations supply electricity to other parts of the District. Rotorua Zone substations are listed in Table 3.5.

[31] Unison 2006 Threshold Compliance Statement
[32] http://www.comcom.govt.nz//IndustryRegulation/Electricity/ElectricityLinesBusinesses/TargetedControl/ContentFiles/Documents/Unison%20Cross-Submission%20Appendix%20IV%20-%20Dellwind.PDF
[33] Unison Asset Management Plan August 2006
[34] Appendix 7 lists Risks and Solutions
[35] Unison Asset Management Plan August 2006

Figure 3.3 Rotorua District Sub-transmission



Source Unison

Table 3.4 Rotorua District Supply

Supply	Type	2005/6 Peak Demand (MVA)	Firm Capacity (MVA)(1)
Atiamuri 11kV	Point of Supply	1.7	2.0
Ohaaki 11kV	GXP	4.0	0(2)
Owhata 11kV	GXP	14.5	12
Rotorua 33kV	GXP	36.3	66
Rotorua 11kV	GXP	23.8	27
Tarukenga 11kV	GXP	10.7	0(3)

(1) Winter post contingency (n-1) [36] rating.

(2) Single transformer bank supply point, although 11kV back-feed capability exists

(3) Single transformer bank supply point.

The loss or failure of an item such as a line or a transformer may introduce a reduction in supply capacity to a level that is less than the demand at the time. If the supply capacity is less than demand this will normally result in a loss of supply that in some circumstances can be managed by switching the supply to other circuits.

[36] An operating principle that states that the power system (including generators, lines and transformers) should be configured to ensure that the power system can survive a contingency where one item of plant fails (generating unit, line or transformer) and continue to meet demand.

Table 3.5 Rotorua District Zone Substations

Zone Substation	Supply Voltage	Sub-transmission Security	Installed Capacity (MVA)
Arawa	33kV	n-1	40
Atiamuri	11kV	N/A(1)	4(2)
Fernleaf	33kV	n	7.5
Rainbow	33kV	n	5

(1) No sub-transmission system, fed directly from Mighty River Power (MRP) generating station.

(2) Assets are owned by MRP

3.3.2 Identified Network Risks [37] and Constraints [38]

Grid Exit Points (GXP)

Atiamuri

Little growth in load is expected in this area and its capacity is expected to be adequate during the planning period.

Ohaaki

Considerable load growth is expected as a result of dairy conversion within the supply area, however firm capacity is expected to be sufficient within the planning period.

Owhata

Little growth is expected during the planning period, but this is still expected to exceed firm capacity of the supply point within the planning period. Sufficient transfer capacity exists on the 11kV distribution network in the short term.

Rotorua 33kV

Current firm capacity is adequate for the planning period, although some constraints exist upstream on the 110kV transmission which will require resolution within the planning period

Rotorua 11kV

This supply point is heavily overloaded and requires reinforcement in the short term.

Tarukenga

Low growth in load is expected in this area and its capacity is expected to be adequate during the planning period.

Sub-transmission

Fernleaf / Rainbow Substations

These two substations are currently supplied from a long radial line from Rotorua 33kV GXP with no backup supply. In addition to the security risks, projected load growth within the planning period (i.e. to 2016) will exceed the capacity of the existing circuit.

Rotorua Region Zone Substations

Arawa

The Arawa substation supplies the Rotorua township and portions of the north-western rural areas. A number of 11kV feeders at Arawa are highly loaded and moreover in some areas high ground temperatures due to geothermal activity obscure true cable ratings and result in the potential for inadvertent overload of underground cables and early failures. Arawa exceeds 120% of n-1 transformer

[37] See Appendix 7
[38] Unison Asset Management Plan August 2006

and switchboard capacity limits, with the 33kV supplies from the Rotorua GXP also exceeding 150% of n-1 capacity. A new substation in Rotorua will be required within the planning period.

Rainbow

Is situated in rural Rotorua and is supplied via a single overhead sub-transmission line. It mainly supplies remote rural mass market and small commercial load. The substation is equipped with a 5 MVA transformer that is made up of three single phase banks and one spare. In case of failure of any bank, replacement can be done within a few hours. Little growth is expected during the planning period. Increase in the load transfer capacity and remote automation are planned in the first five year period.

Fernleaf

Is situated to the south of Rotorua and supplies a mix of mass market, small commercial and industrial loads. It is supplied via a single 33kV overhead line from Rainbow zone substation. Its capacity is adequate for existing load, but a potential major development in the area cannot be supported without upgrade. Options to improve security and capacity are being investigated.

3.3.3 Network Development Plans

In their 2006 Asset Plan Unison have a number of plans and strategies to deal with these issues. Details are set out in the Asset plan. These can be briefly summarised as:

Major (>$100k) capital projects currently planned for the 2006/7 financial year:

- Augmentation Remote Automation – Tarukenga Increase in the security of the single transformer GXP at Tarukenga
- Reliability Reporoa Feeder – Install Reclosers
- Renewals Poles Ngakuru Feeder and Tarawera Feeder
- Replace Conductor Rawhiti/Goudes Rd, Pole & Conductor Upgrade Mamaku Feeder, Conductor Upgrade Waikite Valley Road Rd
- SCADA Remote terminal Unit (RTU) Replacements and Communications Upgrade

The following projects have been identified as likely to require investment in the following 2-5year period:

- New substation required on Western side of city.
- Upgrade approx 3km of 11kV overhead feeders from Rotorua substation is required to support an increase in industrial load.
- Rotorua Arawa Overload Protection.

Accelerated corrosion occurs on overhead lines due to the geothermal; atmosphere. Cross-arm failures are occurring more frequently and there are insulator failures due to the corrosion of the steel head pins. These failures are difficult to locate and can cause outages.

Because of the corrosive effects of geothermal gasses Unison intends to systematically replace copper conductors with aluminium conductors. Unison undertakes identification and blanket replacement of steel head pin insulators where these have been installed and where problems are known to exist due to the geothermal atmosphere.

There is some potential risk of damage from localised thermal activity in the vicinity of the Arawa Zone Substation.

Vegetation is another problem in Rotorua and Unison's focus is to regain control and bring the area to the same standard as other parts of its network.

Unison is currently replacing obsolete RTUs and upgrading the communications infrastructure across the Taupo and Rotorua areas in conjunction with Broadcast Communications Limited (BCL).

Earthquakes are a high or moderate risk in the Rotorua part of the Unison network, therefore mitigation work has focused on the seismic risk.

3.3.4 Network Company Regulation

Unison Ownership of Generation

Under the Electricity Industry Reform Act 1998 (EIRA) Unison as an electricity lines business is constrained with the level of investment in generation that it can be involved in. This is a barrier to the Rotorua area taking full responsibility for optimal generation / transmission solutions to energy supply issues.

While the government has loosened the ability of network companies to invest in renewable energy projects, Unison would have to apply to the Commerce Commission for exemption to increase its level of generation above 50MW and 20% of the maximum demand for investment in hydro and geothermal projects.

Investment in geothermal or hydro facility and other new renewable energy projects is an activity that is exempt from the ownership separation rule under section 46A of EIRA, provided that the Company complies with the requirements set out in sections 24 (Corporate Separation) and section 25 (Arms Length Rules). In other words Unison as a lines company must operate separately from the generating company in order to engage in the unlimited generation of electricity using geothermal or hydro. The arm's length rule require an electricity line business and an electricity supply business subject to common ownership to have completely separate managements and must act as if they had been dealing with another independent company. They cannot be seen to give either themselves or the other company an unfair advantage by virtue of the fact they share common ownership. Unison therefore cannot use staff involved with management of the network, in management of the generating plant, which is one of the advantages the involvement of the lines business brings to management of the facility.

In order to protect customers against fluctuations often occurring in the electricity generated from a renewable energy generating facility (i.e. the supply from some hydro facilities is not constant), the company may wish to purchase hedges to provide its customer(s) with certainty in relation to the price they pay for their electricity, when forced to purchase from the national grid to cover these fluctuations. However, the buying and selling of electricity hedges required to support renewable energy generated electricity sales is not an exempt activity under this provision. Similarly section 5(2)(f) does not provide the necessary exemption from the ownership rule, as this provision only exempts those Company's "selling" hedges as being outside the definition of an electricity supply business. Section 5(2)(f) does not refer to the activities of "buying and selling hedges" as exempt, by implication the ownership separation rule applies to the Company when engaged is this activity i.e. Unison could not be involved in two businesses operating separately – even if one of them was involved in generation from a renewable energy source – if that business was also engaged in the buying and selling of hedges to protect its customers against fluctuations in electricity supply.

A further constraint arises from section 46B of the Act which states that when generating electricity under section 5(2)(e) of the Act (i.e. generating and selling less than 5 MW per annum), or under section 46A, the public must be notified of the proposal to generate in each of the major daily newspapers in Auckland, Hamilton, Christchurch and Dunedin at least 30 days prior to entering into a contract to acquire or increase the ability to generate. A copy of the public notification must be provided to the Commerce Commission as soon as practicable after publication.

These provisions under the EIRA can be avoided if the Commerce Commission is prepared to grant an exemption to the application of any part of the Act. Unison have applied and received an exemption from the Commerce Commission for their Titiokura wind farm. On the other hand Eastland Networks were declined exemption for a proposed wind farm.

Additionally there is no certainty to the longevity of an exemption as the Commerce Commission is also empowered at any time to withdrawn or vary such exemption and under the current terms of the legislation there are no restrictions or procedural limitations upon the Commission as to how they may exercise this power.

Network Company Limits on Sale of Electricity

One of the major barriers limiting the development of smaller local generation opportunities is the inability of lines companies to retail the energy produced by these initiatives. This situation requires serious review as the inability to minimise risk by managing retail opportunities is limiting opportunity in this area.

3.3.5 Demand Growth

Although the focus is on the current electricity supply infrastructure and demand, the timing given for some of the proposed actions to manage issues that affect the security of supply is based on forecast demand growth.

Some initiatives and developments in the Rotorua area (e.g. greater dairy conversion than anticipated) may lead to demand growth that is faster than forecast. While this may be perceived as increasing the potential risk to security of supply it also provides an opportunity for planning network development work with more certainty.

3.4 Local Generation

The Wheao and Flaxy scheme in the Kaingaroa forest is 82km from Rotorua, 25km from Murupara and 74km from Taupo. It was commissioned in 1984.

The 26MW scheme produces around 125 GWh of electricity annually using water from the Wheao and Rangitaiki Rivers as well as from Flaxy Creek if required. This generation meets about 27% of the Rotorua demand.

3.4.1 Distributed Generation

Unison Networks Limited has based its distributed generation (DG) policy on the following key principles:

- Distributed generation will be able to connect to Unison's electricity distribution network on fair and equitable terms which do not discriminate between different DG schemes.
- Unison will make the terms under which DG can connect and operate to its electricity distribution network as clear and straight forward as possible and Unison will progress all applications to connect DG to its electricity distribution network as quickly as possible.
- Technical and safety standards for the connection and operation of DG on Unison's electricity distribution network will be based on best practice and will aim to meet the needs and protect the interests of DG schemes, other consumers and Unison.
- Unison will comply with all legislation and regulatory requirements regarding the connection and operation of DG on its electricity distribution network.

Unison has trialed its draft DG policy documents with consumers during 2005/6.

Policy document covering installations <10kW has been issued but documents covering larger installations are still in draft and will be released in the near future.

Electricity from landfill gas will add to the area's energy resources when the proposed Green Energy 1.8 MW plant is built at the landfill site in Atiamuri Road.

3.5 Gas Reticulation Network and General Usage

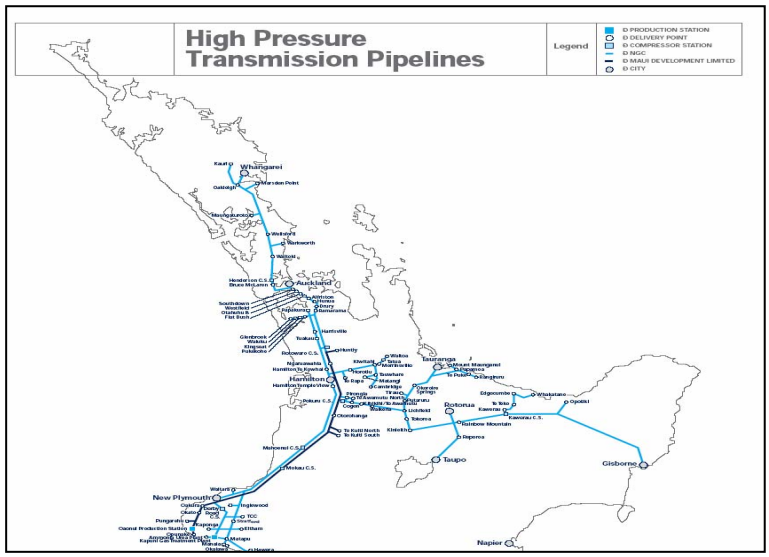
Rotorua is supplied with gas by the high pressure 18 km, 80mm lateral off the Bay of Plenty gas transmission line, owned by Vector who is also the local distribution company. Bay of Plenty Electricity, Genesis Energy and Mercury Energy are gas retailers in the area.

In their modelling of gas delivery during the peak week in the year Vector[39] consider that because both compressors at Pokuru (near Te Awamutu) need to run (but not at full load) there is no spare compressor in case of breakdown and therefore the BOP pipeline could be considered to be running at full capacity. Under these (peak week) conditions a compressor failure could put the security of gas deliverability at risk[40] This modelling assumes a Maui gas pipeline pressure of 36 barg[41] which is lower than pressures normally received but higher than the contractual pressure of 30 barg.

Upgrading the compressors at Pokuru would remove this constraint.

[39] Vector Gas Limited Pipeline Capacity Disclosure June 2006
[40] Included in Appendix 7
[41] barg is the gauge pressure measured in bars. A bar = 100 kPa. 1 bar is approximately equal to 1 atmosphere of pressure

Figure 3.4 High Pressure Transmission Pipelines[42]



3.5.1 Rotorua District Natural Gas Use

Annual natural gas consumption for 2005 in the Rotorua District is estimated at 0.64 PJ. Local area consumption is shown in Table 3.6.

Table 3.6 Estimated Annual Natural Gas Consumption

Location	Estimated Gas Use
	TJ
Rotorua	370
Rainbow Mountain (Rotomahana)	110
Reporoa	170
	640

For Rotorua the estimated gas use by each sector is shown in Table 3.7.

Table 3.7 Rotorua Sector Annual Gas Consumption

Sector	Estimated Gas Use
	TJ
Domestic	40
Commercial	210
Industrial	120
	370

Bottled LPG is supplied by On-Gas, a subsidiary of Vector, and Nova LPG a subsidiary of Todd Energy. It is used extensively in the region. The population density is such that it can be expected that this will continue under current arrangements.

Longer term there may be some change if ethanol or biodiesel were manufactured from district and regional resources, or electric or petrol /electric hybrid vehicles became more popular.

3.6 Coal

Coal could continue to be imported into the area for school and other heating uses but it is expected that geothermal or forest residue as an energy source will become more economic. Initiatives where this has already been very successful is in the conversion of coal boilers in the high schools to be fuelled on wood

[42] Source: NGC at http://www.ngc.co.nz

pellets. This is an example that could have significant wider opportunity throughout the district and where the district can become a leader.

Domestic coal use is estimated to be 300 tonnes per year[43].

3.7 Geothermal Energy

Direct Geothermal Heating

The major direct use of geothermal heat (85%) is concentrated at a few major geothermal developments near Wairakei and Kawerau. The assessed primary energy supply and assessed direct heat use (consumer energy) for the Bay of Plenty region are set out in Table 3.8.

Table 3.8 Assessed Geothermal Heat [44]

	Space Heating	Industrial Process Heat	Bathing and Swimming	Total
Assessed primary energy supply TJ	38	10,585	2,171	12,794
Assessed direct heat use TJ	19	5,315	786	6,120

Geothermal resources in the Rotorua and surrounding area and their use are listed in Table 3.9[45]

Table 3.9 Geothermal Resources and Their Use

Area or Spring	Known Usage	Temperature	Heat Assessment
Atiamuri Geothermal Field	Springs supplied hot water to a swimming pool which has subsequently been demolished. EW notes that several bores supply domestic water for dairy shed washdown and swimming pools	59-63 oC springs 165 oC in well	None known
Broadlands (Ohaaki) Geothermal Field	Numerous wells for power generation. Previously had heated greenhouses and timber/lucerne drying. At one stage the power station supplied CO2 to the greenhouse. Now has timber drying (Vanner Mills takes 931,500tonnes/year at 920kJ/kg) and marae heating supplied by heat from reinjection system with disposal of fluid onto land.	Wells at 270 oC	Take (from Ohaakiwaste): 931,500tonnes at 920kJ/kg = 857TJ, Use: 390TJ
Golden Springs	Bathing in springs	50 oC	None
Horohoro (includes Haparangi) Geothermal Field	Private well drilled tapping 87 oC water but no known use. Esendam family takes 72t/d of fluid at 95 oC for their glasshouses with shallow reinjection	95 oC	Take: 26,280 m3 at 92 oC (385kJ/kg) = 10TJ, Use: Assuming 50% load factor, with 8 oC temperature drop = 0.4TJ
Moku-Tuhana	Hotpool and swimming bath near Ohakuri	Unknown	Unknown
Ngakuru Geothermal Prospect	None - inferred to exist from resistivity measurements	Unknown	Unknown
Orakeikorako Geothermal Field	Tourism is predominant use. Geothermally heated spa pools and showers are available to guests at Orakei Korako Cave and Thermal Park extracting heat for pools and water heating through heat exchangers in a spring. Springs for bathing on shore of Lake Ohakuri	<265 oC in reservoir, springs up to 100 oC	<265 oC in reservoir, springs up to 100 oC
Reporoa Geothermal Field (includes Opaheke Hot Pools)	Butcher's Pool is maintained by Rotorua District Council and includes sealed walkways, changing sheds and toilets, but springs are not modified	<240 oC in reservoir, springs up to 97 oC	<240 oC in reservoir, springs up to 97 oC
Te Kopia Geothermal Area	Tourism but no direct use (previously mushroom growing)	<241 oC in wells	<241 oC in wells

[43] Environment Bay of Plenty Rotorua Domestic Heating Survey report September 2006
[44] An Assessment of Geothermal Direct Heat Use in New Zealand, by Brian White 2006
[45] ibid

Area or Spring	Known Usage	Temperature	Heat Assessment
Waikite Geothermal Area Waikato	Water from flowing springs used in a swimming pool complex. Extensive efforts to lose heat through sprinklers and cascade systems	<99 oC in springs	Take: 1,104,125t of water at 98oC (411kJ/kg) = 454TJ/year, Use: reject at 38oC (159kJ/kg) = 278TJ/year
Waimangu-Rotomahana Geothermal Area Waikato/Bay of Plenty	Tourism facilities	<81 oC	None
Waiotapu Geothermal Field Waikato	Tourism facilities. Consented users include a Hotel and the Arataki Honey Ltd. Arataki Honey uses the heat for space heating, water heating, honey heating, rearing bees, and domestic use	<295 oC	Take: about 46,000t of fluid at 145 oC (611kJ/kg) = 28TJ, Use: reject at 60 oC (251kJ/kg) = 16TJ
Whangairorohea Hot Springs Waikato	None known	<56 oC	None known
Humphreys Bay Hot Spring Bay of Plenty	1 well is known but there is no known use - located on the shore of Lake Tarawera	Unknown	None known
Lake Okataina Springs	None - seeps in lake shore beach sands	30-36 oC	None
Lake Rotoiti Geothermal Area (includes Manupirua, Maraeroa, Otutarara)	1 well drilled at Moose Lodge to 218m tapping 55 oC water for heating a pool. Possibly other private wells in the area	<130 oC in sediments	Take: about 850,000 m3/year at 55 oC (230kJ/kg) = 193TJ, Use: reject at 32 oC = 80TJ
Lake Rotokawa Geothermal Area (Rotorua)	8 shallow wells (most < 45m) tap fluids >99 oC. All wells have artesian discharge. These heat a glasshouse, school and swimming pools	>99 oC	Allocatedtake:127,000t/year but other details are unknown
Mangakotukutuku Springs	None	24 oC	None
Mokoia Island (includes Hinemoa's Pool)	There are several baths on SE of island	54 oC	None
Rotoma Geothermal Area (includes Tikorangi, Puhi Puhi and Otei)	Rotoma Holiday Park has 3 small hot pools fed from a 38 oC pumped well. Waitangi (soda spring) has been modified for bathing using weir, Otei spring has disappeared. One deep well drilled (data unavailable)	springs < 50 oC, fumeroles < 90oC	Take: about 94,600t at 38oC (159kJ/kg) = 15TJ, Use: reject at 35 oC (147kJ/kg)
Rotorua Geothermal Field	Numerous wells (140 production bore sites, 86 reinjection bore sites, 42 downhole heat exchangers) drilled for direct use (mostly 90-120 m deep) tapping water at around 150 oC. Various tourist attractions, Domestic and commercial heating and hot water supplies, swimming pools and mineral baths, hospital and large hotel air conditioning. Increasing use of reinjection and downhole heat exchangers but a general reduction in use overall. About 69% of the water take is for commercial uses, 26% for domestic uses and 5% for municipal use	<194 oC in wells, springs to 100 oC	Take: Approximately 3,540,000tonnes/year at about 540kJ/kg = 1,900TJ plus a further 20TJ from downhole heat exchange, Other surface water: 260,000t = 90TJ, Reinject: 3,180,000t/ year at around 85 oC (356kJ/kg) = 1,130TJ, Use = 1,900 + 20 - 1,130 -90 = 700TJ
Taheke Geothermal Area	Springs are used for bathing	<97 oC	None
Tarawera Geothermal Area (includes Te Rata and Humphrey's Bay Springs)	Springs are used for bathing	<90 oC	None
Tikitere (Ruahine Springs) Geothermal Area	Tourism at Hells Gate. About 11 wells supply heating for mushroom growing (?), holiday camp, private baths. About 35% of heat goes to private uses and 65% to commercial uses	<190 oC, assume 130 oC for wells	Allocated take: 154,000t/year at 130 oC (546kJ/kg) = 84TJ, Use: reject at 100 oC (419kJ/kg) = 20TJ
Waiaute Springs	None	23 oC	None

4 Current Energy Prices

This section of the report deals with current energy prices for electricity, reticulated gas (where available) and LPG, and firewood in the area.

4.1 Electricity

TrustPower is the incumbent electricity retailer in the Rotorua area. Other retailers are Bay of Plenty Electricity, Contact Energy, Empower, Energy Online, Genesis Energy, and Meridian Energy.

4.1.1 Time of use pricing

Large electricity users usually purchase their electricity on a half hour basis from an electricity retailer. The contract price may include a component that is "fixed" ahead of time for each half hour of the year, and a component that is based on the spot price that occurs for that half hour.

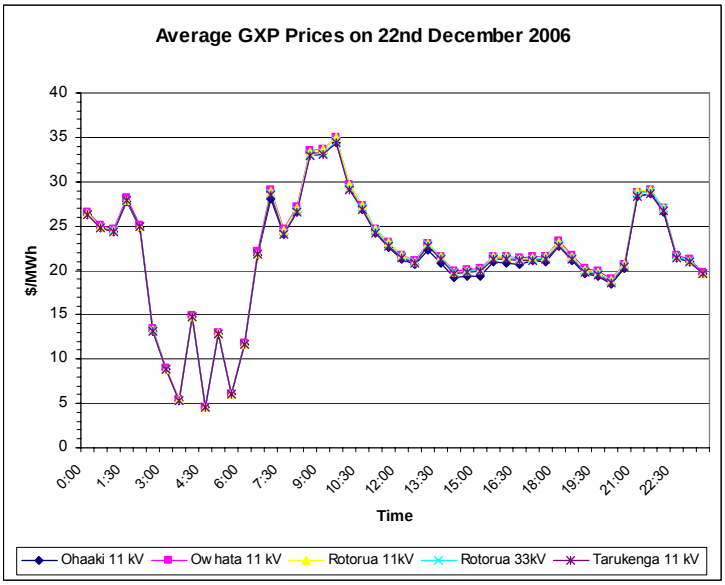
Customers with a high spot component may cover the risk of price fluctuations by taking a hedge contract with the electricity retailer. With a hedge contract the energy user pays the half hour hedge price and the retailer takes the "unders and overs" of the actual spot price.

Residential and small commercial electricity users have a fixed tariff split into a daily charge and a variable (per kWh) component. In many cases the majority of the daily charge arises from lines charges while the variable charge covers the energy component. Residential and small-use commercial customers are not charged differently according to the time of their electricity use.

4.1.2 Wholesale Electricity Prices

Wholesale electricity prices are set throughout the country by reference to nodal prices. These are the prices set at the Transpower grid exit points (there are 244 of these throughout New Zealand and 4 in the Rotorua area) and for the North Island referenced to the price at Haywards near Wellington. The difference in nodal price reflects the system losses accumulating to that grid exit supply point, and any transmission constraints that may be in effect. The local lines company (Unison) pays transmission costs to Transpower, and passes the costs on to the electricity retailers (or directly to some large users), which in turn pay for electricity received at these points. The retailers then add their margin and on-sell to their customers according to either a fixed price (monthly or half hourly), or "floating price" usually referenced to the half hourly spot price at the nearest grid exit point.

Figure 4.1 Rotorua GXP Prices –Friday 22nd December 2006

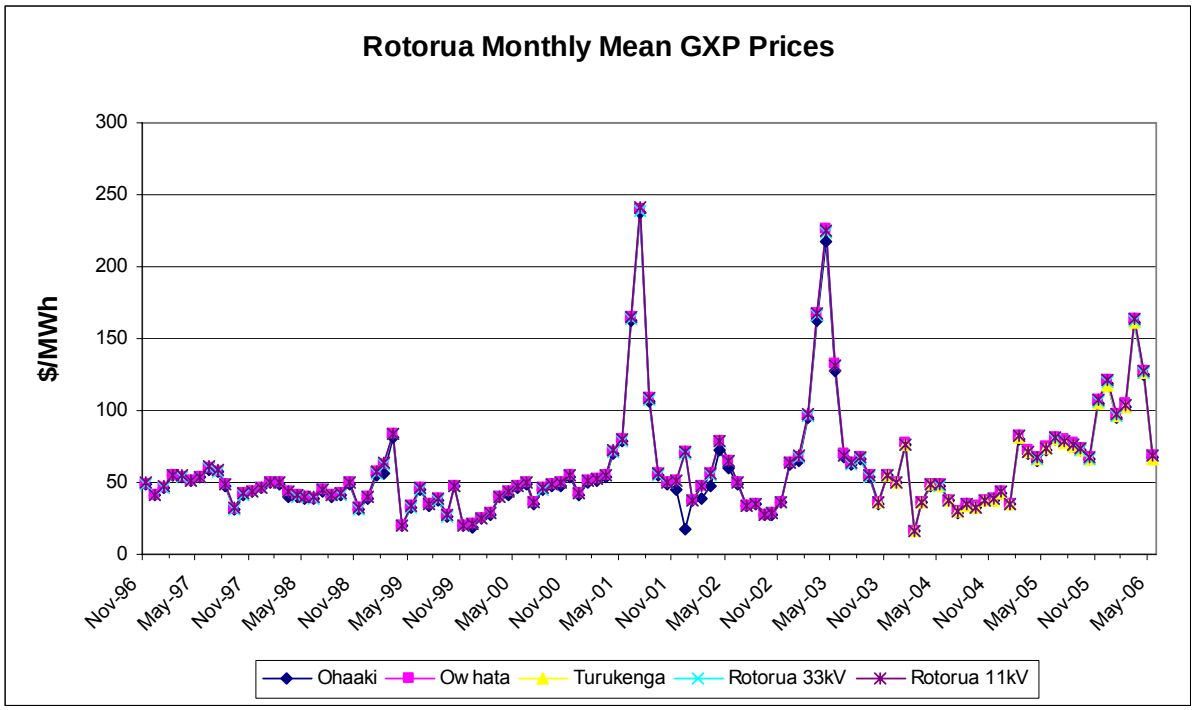


The grid exit points for the Rotorua area are located at the Ohaaki (Power Station),, Owhata Rotorua and Tarukenga substations. Spot prices at substations in the Rotorua area during December 2006 are shown in figure 4.1. Mean monthly load weighted average GXP prices for the period May 2000 to May 2006 are shown in Figure 4.2 [46]

Nodal price factors change on a half hourly basis and this affects the certainty of determining exactly what the local electricity price is.

[46] http://nwcl.co.nz/monthly_load_weighted_mean_prices.html

Figure 4.2 Rotorua Monthly Average GXP Prices

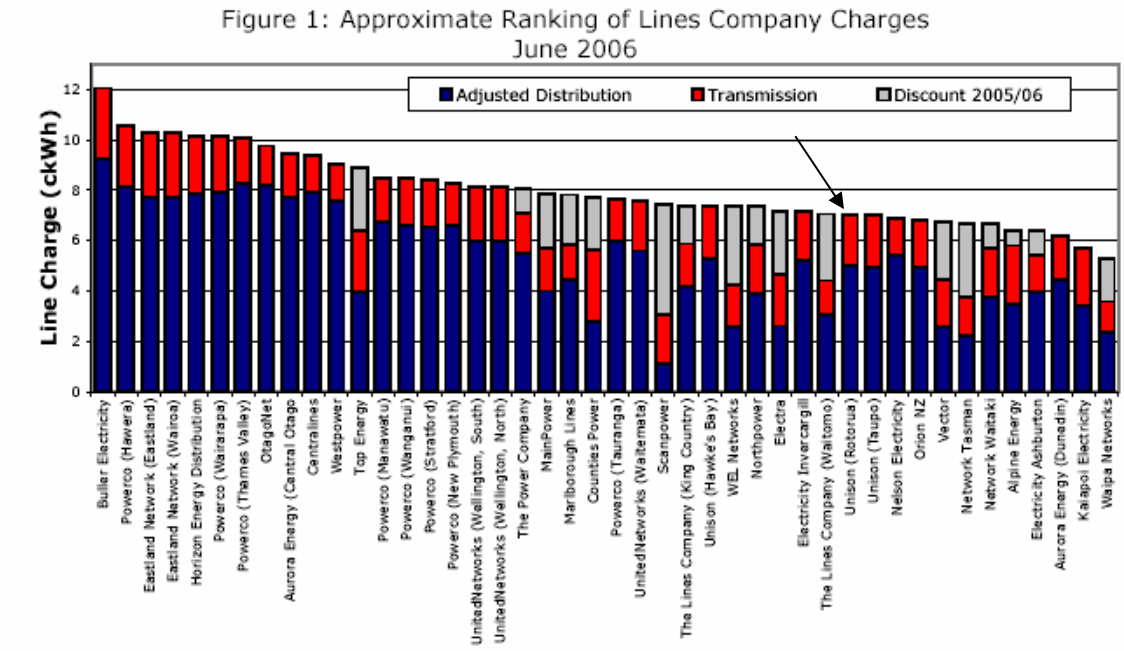


4.1.3 Lines Charges

Unison, the local electricity distribution company in the area, transfers electricity from the grid exit points to customers. The charge for distribution depends on the capacity amount of electricity able to be taken by each customer. The capacity is set by agreement between Unison and the customer.

The electricity distribution costs for delivery of electricity by Unison and other local electricity distribution companies are shown in Figure 4.3. Unison charges are at the lower end of the scale as shown.

Figure 4.3 Comparative Domestic Electricity Network Prices[47].



Line charges for the various customer groups are shown in Figures 4.4 and 4.5

[47] Source Ministry of Economic Development

Figure 4.4 Equivalent Line Charge (Unison) [48]

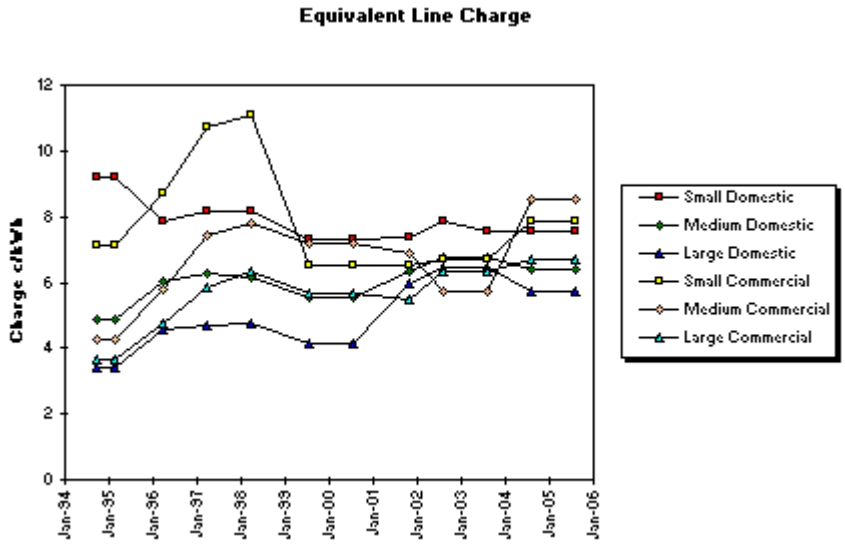
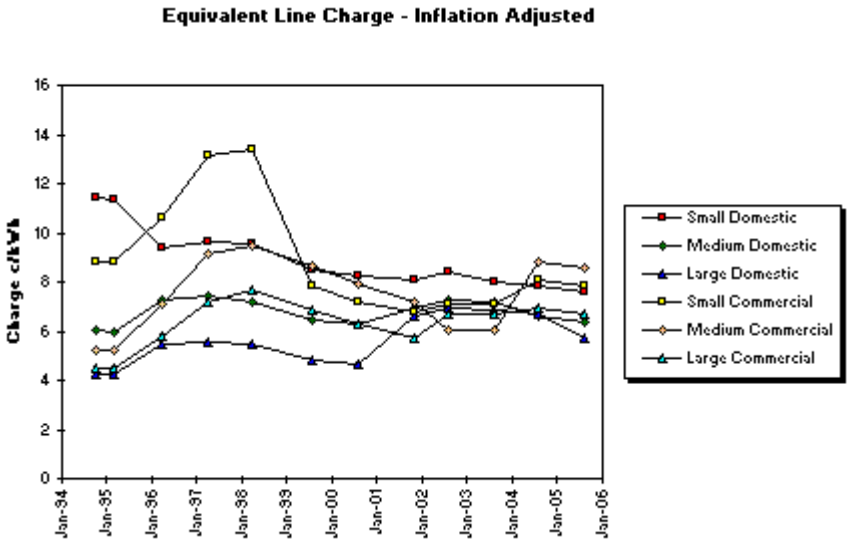


Figure 4.5 Equivalent Line Charge (Unison) (Inflation adjusted)



The figures illustrate that in real terms that line charges overall have changed little since the network company was restructured although some customer groups have changed. The percentage changes for these groups are shown in Table 4.1.

Table 4.1 Inflation Adjusted Price Changes Since Lines Companies Restructuring in 1999

Customer Group	% Price Change since 1999
Small Domestic	-11.1%
Medium Domestic	-1.2%
Large Domestic	19.3%
Small Commercial	-0.1%
Medium Commercial	-1.6%
Large Commercial	-2.5%

[48] ibid

4.1.4 Residential Retail Prices

TrustPower (the incumbent retailer) sells electricity in the Rotorua area under three alternative plan types:

- Unrestricted 24 hour supply.
- Controlled supply – suitable for fixed supply such as hot water heating and night store space heaters. A number of heating options are available from 10 hours each day to being switched off at peak times.
- Day and night. Different tariffs apply for day and night. This is suitable for appliances that can be used at the cheaper night rate.

Other retailers offer a similar suite of plans.

Table 4.2 summarises the residential electricity costs that have applied over the last few years.

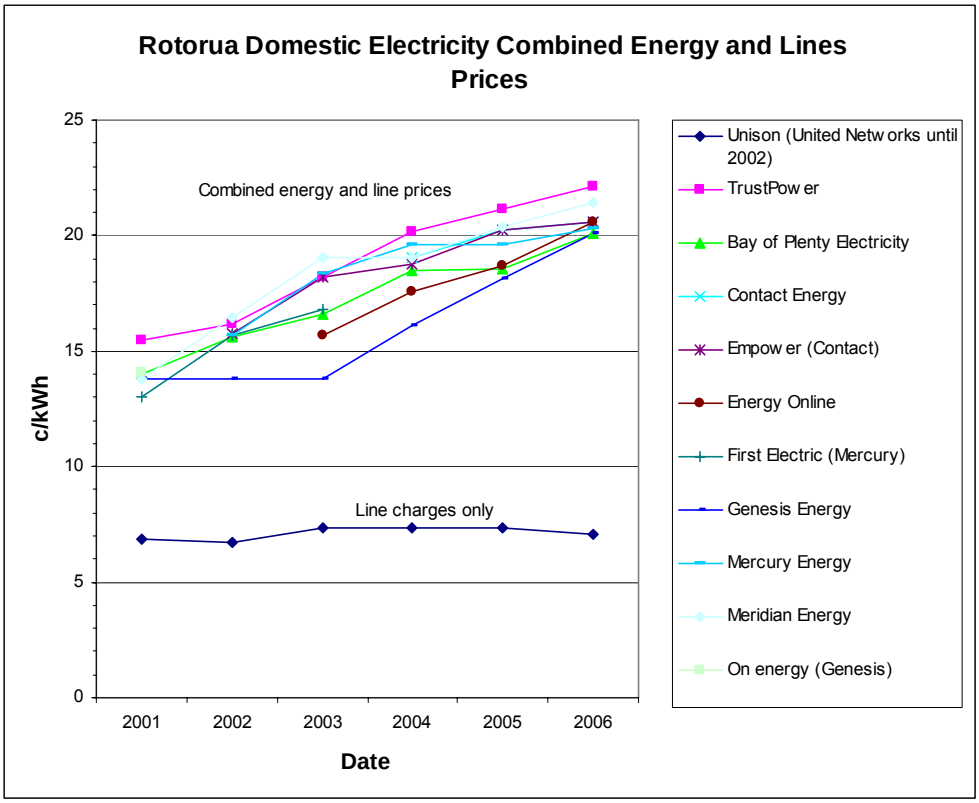
Table 4.2 Summary of Residential Electricity Costs in Rotorua 2001 – 2006[49].

Line Business (approx customer no. as at Aug 2005)/*Retailer*	**15 Nov 1999**	**15 May 2006**	**15 Aug 2006**	**Change May 2006 to Aug 2006**	**Change Nov 1999 to Aug 2006**	
	c/kWh	**c/kWh**	**c/kWh**	**%**	**%**	**$**
Unison (Rotorua) (26,000)	**6.66**	**7.04**	**7.04**	**0%**	**6%**	**$30**
TrustPower	15.08	22.23	22.23	0%	47%	$572
Bay of Plenty Electricity		19.3	19.3	0%		
Contact Energy		20.91	20.91	0%		
Empower		20.91	20.91	0%		
Energy Online		18.72	20.23	8%		
First Electric (Mercury)	13.05					
Genesis Energy		18.17	20.08	11%		
Mercury Energy		19.67	19.67	0%		
Meridian Energy	13.82	21.2	21.2	0%	53%	$590

For residential electricity customers, their delivered cost of electricity due to the cost of distribution has remained relatively constant since 2001. The split between fixed daily rate and variable use rate will depend on the tariff chosen but generally around 25% is fixed.

[49] Source: Ministry of Economic Development.

Figure 4.6 Rotorua Domestic Electricity Prices[50]



Retail electricity prices for residential customers in Rotorua supplied by the incumbent retailers are presented in Figure 4.6 which illustrates how each of the electricity retailers has moved tariffs over the period. These are in contrast to the line charges which have changed little since 2001. Currently there is a spread of about 2 c/kWh between the dearest and cheapest supplier.

4.1.5 Commercial and Industrial Prices

The electricity prices for commercial industrial users are shown in figures 4.7 and 4.8. This shows delivered commercial electricity prices in January 2006 at around 16-20c/kWh with 40% of the price being transmission and distribution charges and 25% set on a fixed daily rate.

[50] Source: MED

Figure 4.7 Incumbent Retailer TrustPower: (Line Owner: Unison)[51]

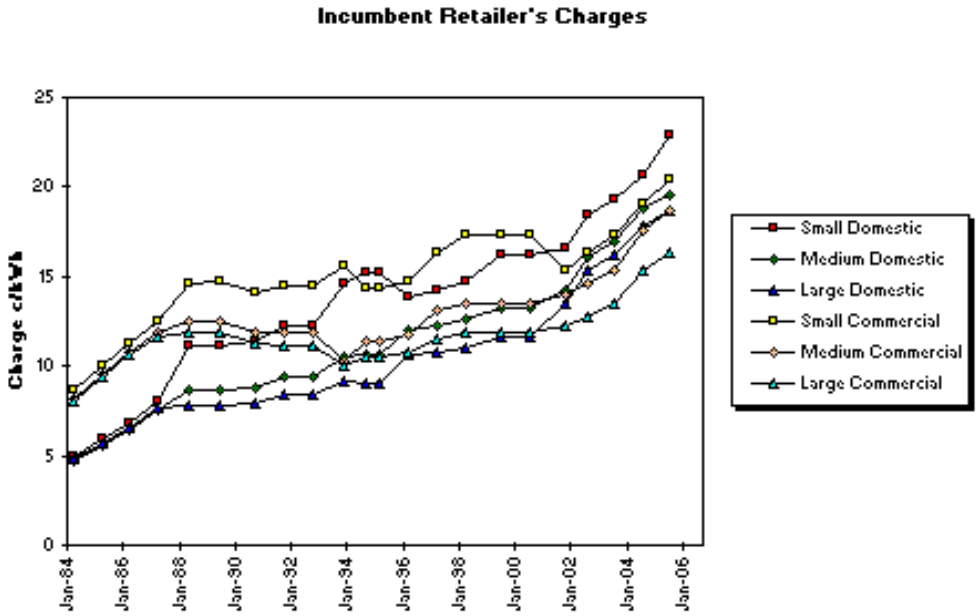
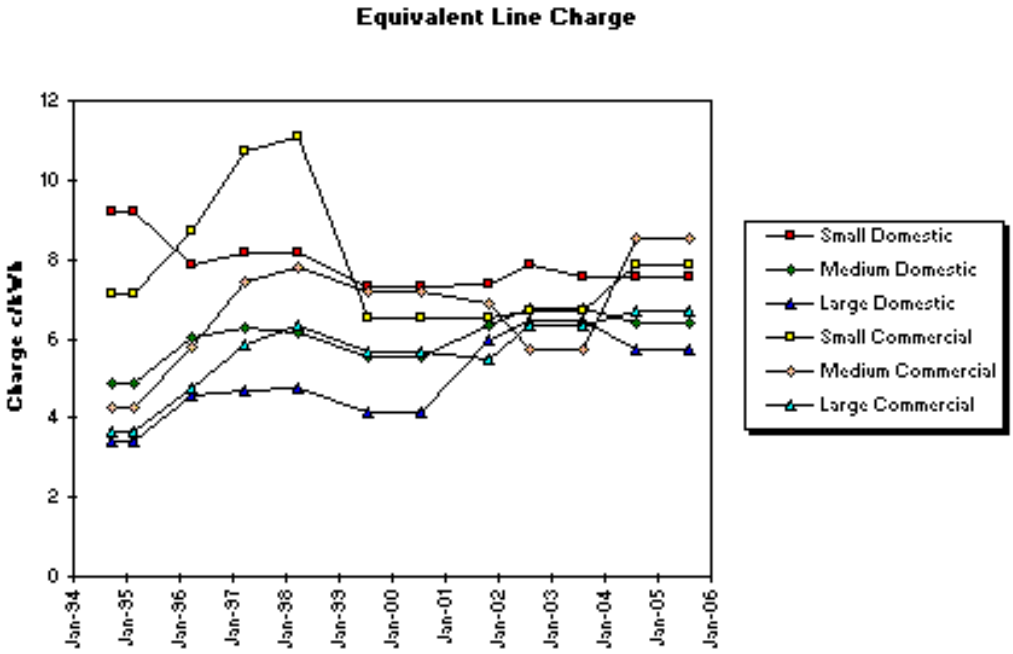


Figure 4.8 Equivalent Line Owner Charges: Unison)[52]



Variations in commercial electricity prices highlight the necessity for all commercial electricity customers to gain a good understanding of electricity contracts and how energy management can reduce costs. Experience elsewhere has shown that there is significant lack of knowledge of commercial electricity contracts and often misunderstandings of how billing is calculated. It is suggested that significant cost savings can be made for all business in the area if a series of seminars was held to assist understanding. This may need to be backed by on-going support from an independent District based energy advisor.

4.1.6 Marginal Electricity Prices

The marginal cost of electricity within the Unison Network area varies for domestic (household) connections. TrustPower is the incumbent supplier within the Rotorua area, with a marginal cost of 22

[51] Source: MED
[52] Source: MED

cents/kWh for anytime use, and 19 cents/kWh for controlled tariff (Hot water heating available 17 hours/day).

4.2 Gas

Several options exist for the supply of gas within the area. Network supplied gas is available from Bay of Plenty Electricity, Genesis and Mercury Energy (Mercury only supplies gas to their electricity customers). Domestic gas supply charges are outlined in Table 4.3.

Table 4.3 Rotorua Residential Gas Supply Costs

Supplier	Options	Cost (Excl GST)	Unit	Marginal Cost (c/kWh)
Bay of Plenty Electricity	Heating	12.5	c/kWh	
	Daily Connection Charge	90.6	c/day	
Genesis	Heating Only	10.7	c/kWh	
	Daily Connection Charge	90.6	c/day	
Mercury Energy	Daily Connection Charge	61.4	c/day	
	Variable	7.9	c/kWh	
On Gas (Bottled)	Heating Only	85 - 90	$/45kg Bottle	14.9 – 15.8
	Heating + Water Heating	79 - 84	$/45kg Bottle	13.8 – 14.7
	Annual Bottle Lease	$126	2 Bottles Per Annum	

While there is normally gas capacity in the high pressure transmission line this could be constrained at peak times because of insufficient compressor capacity at Pokuru (near Te Awamutu). Securing a long-term gas supply contract at a reasonable price is the impediment to investment.

The cost of LPG is around 14 – 16 c/kWh depending on location

The cost of reticulated gas is around 10.5 – 12.5 c/kWh. Commercial reticulated gas rates vary depending on demand, with marginal rates of between 7.5 – 8 c/kWh. Large commercial customers are understood to be able to purchase gas at 3.6 c/kWh ($10/GJ) .

4.3 Other

Radiata Pine firewood that has been cut, split and partially dried can be purchased for about $100 per Cord (approx $30 per m3). Free firewood is also available from several locations.

5 Future Energy Price Trends

5.1 National Energy

Future energy prices will be driven by the availability and cost of North Island gas supply and any introduction of a future carbon charge to act to reduce CO_2 emissions. The Maui gas supply is dropping and this has the following effects:

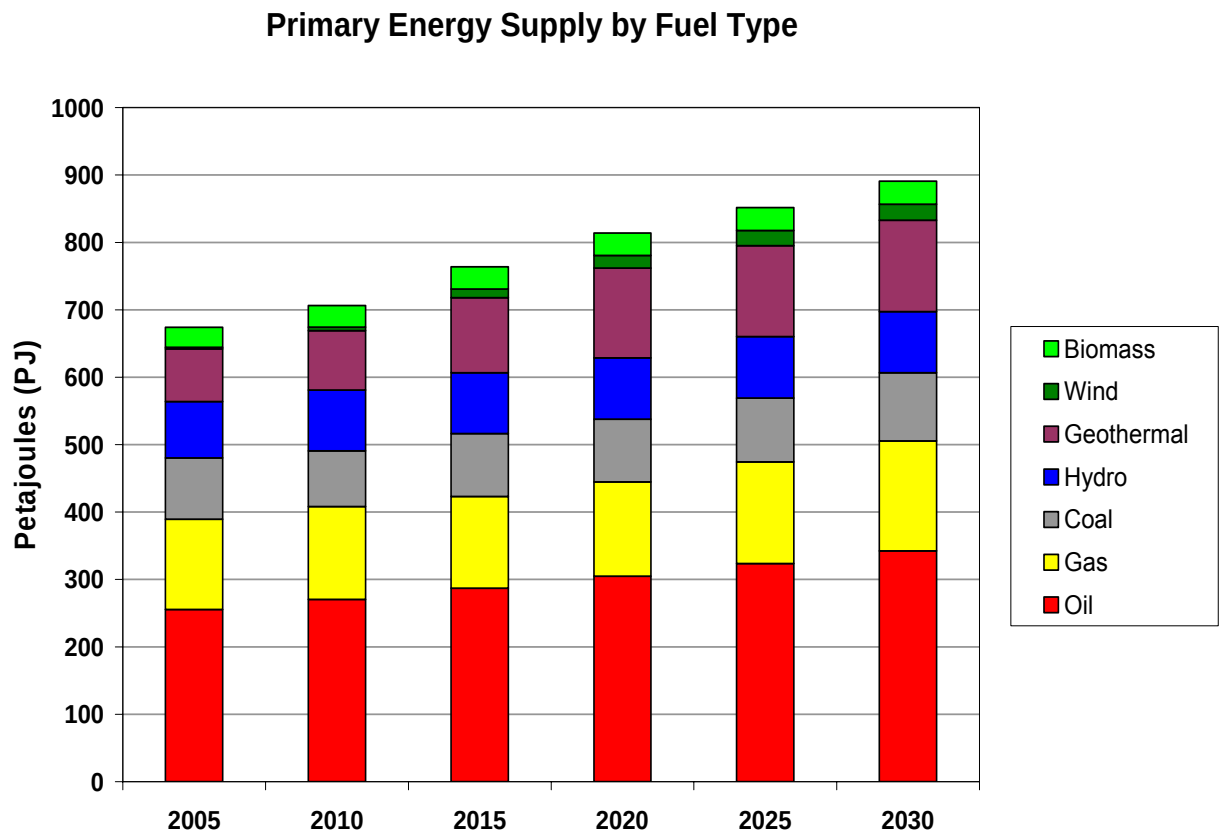
- Increased supply from other small gas fields.
- Increased supply from other energy sources.
- Potential for shortage of electricity supply in dry hydro years.

5.1.1 Changes in Energy Supply and Costs

The Government's analysis of possible future energy supply and prices are provided from the New Zealand Energy Outlook to 2030. Figures 5.1 and 5.2 show the national movement in total energy.

Results of the analysis are shown in Figure 5.3 for wholesale energy prices (in real terms[53]) and for delivered electricity prices. Fuel for electricity generation is shown in Figure 5.4.

Figure 5.1 Total Primary Energy Supply 2005-2030 (Base Case)



[53] prices have been deflated

Figure 5.2 Total Consumer Energy by Fuel Type (Base Case)

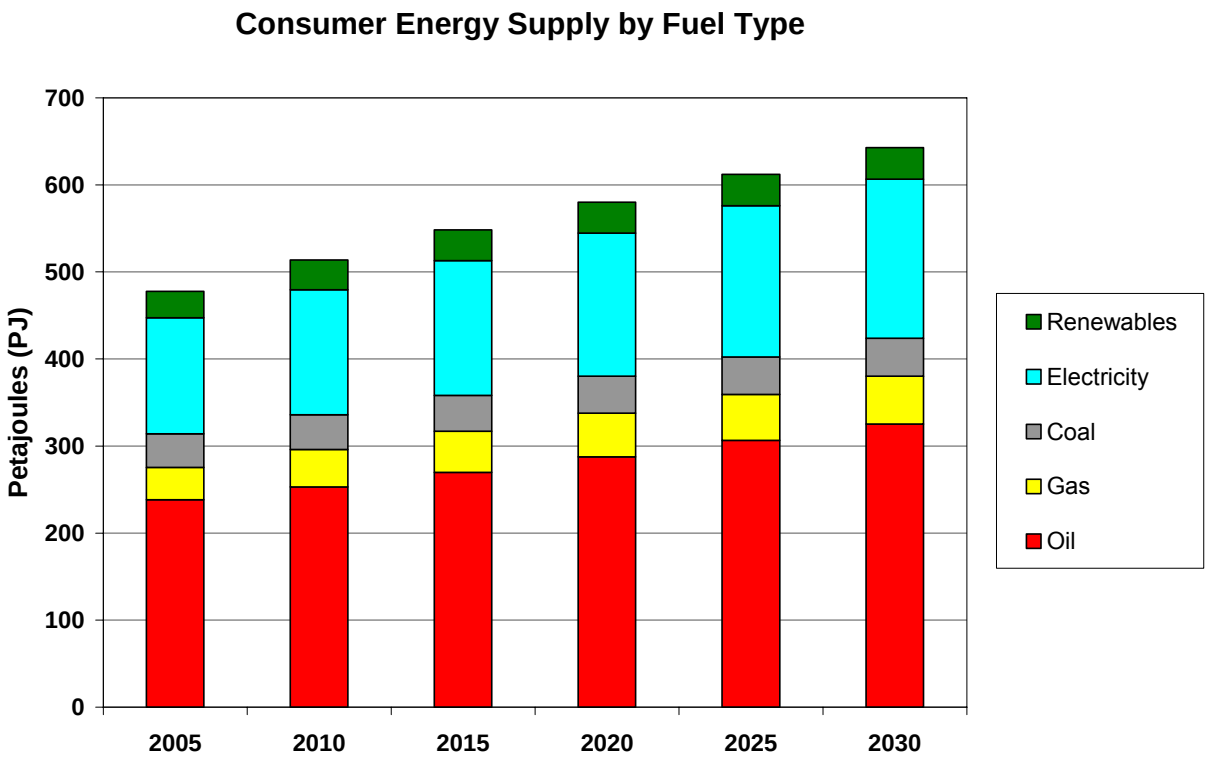
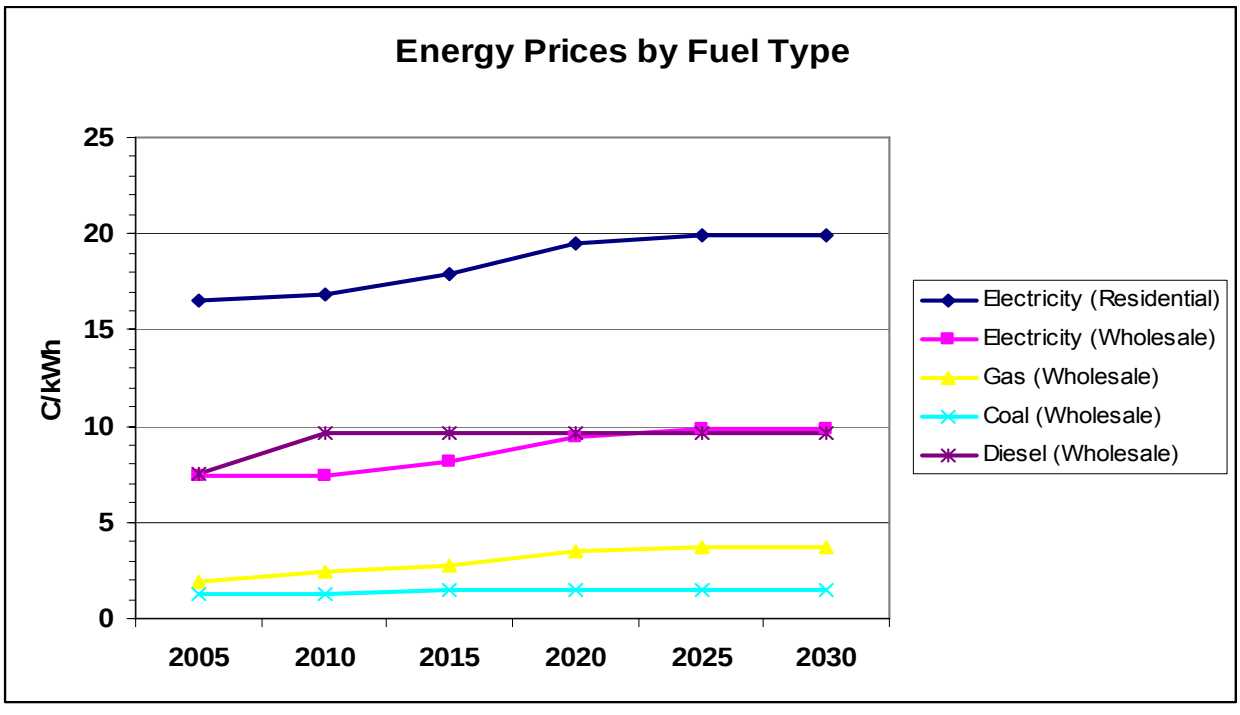


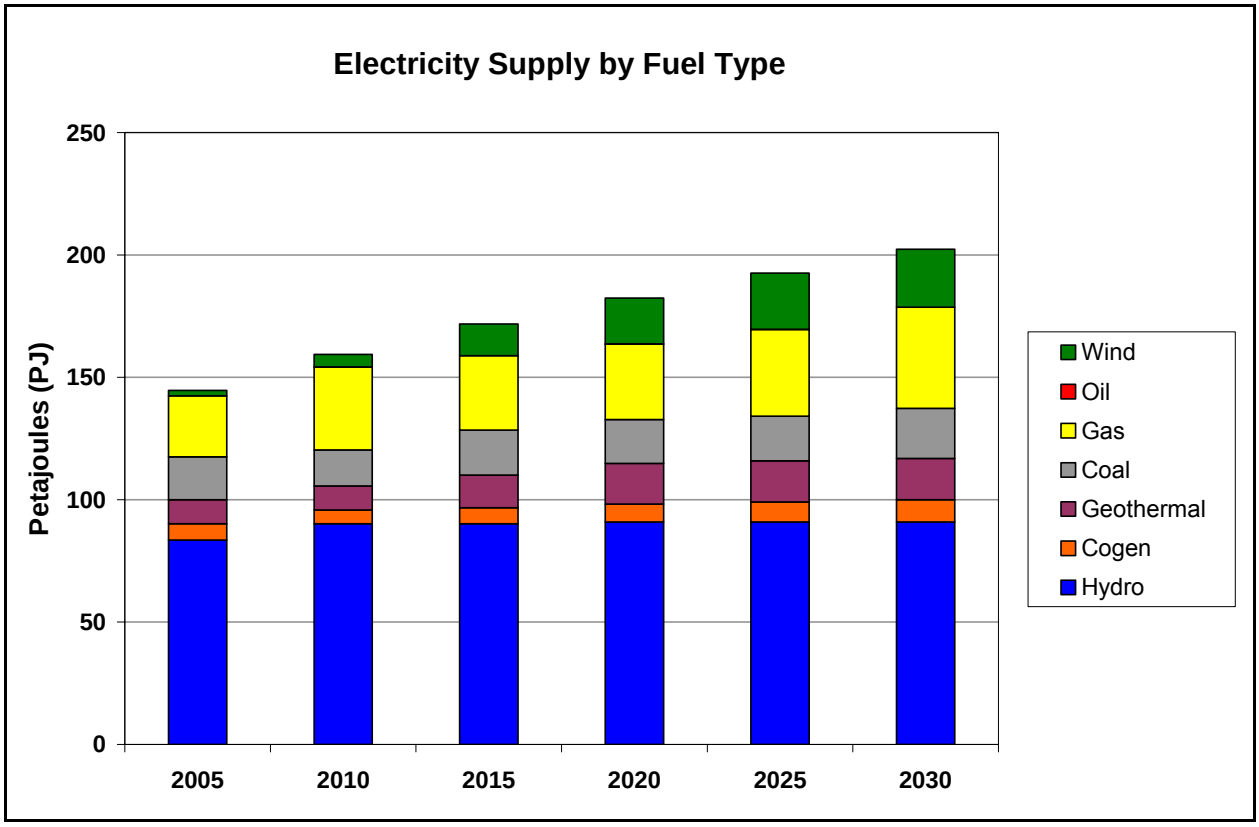
Figure 5.3 Energy Prices by Fuel type 2005-2030 (Base Case)[54]



In the base case or business as usual, coal prices rise slightly (14%) over the 25 years while gas nearly doubles in that time. Diesel rises rapidly by 28% in 2010 and remains constant thereafter while electricity prices rise by 33% for wholesale and 21% for retail.

[54] $25/GJ is equivalent to 9c/kWh

Figure 5.4 Electricity Supply by Fuel Type (Base Case)



5.2 Local Energy

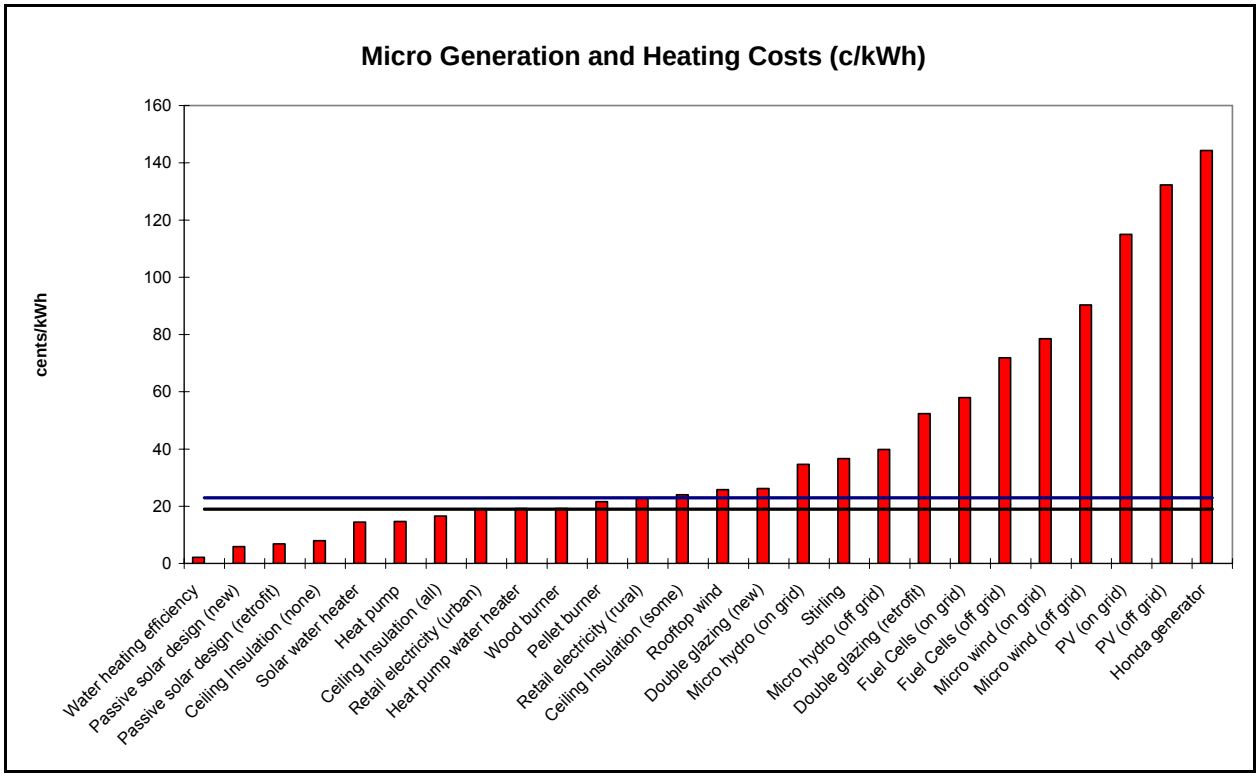
The District is and will continue to be a price follower with regard to future energy costs. National transport energy costs are set by the international cost of oil and other energy prices are set by the cost and availability of natural gas. The District follows national energy price trends.

5.2.1 Micro generation and heating

Home owners are able to influence their electricity use and costs by using a variety of options. Many of these options will not be economic. However in time as electricity prices increase and the technologies improve the economics of these options will improve also. The approximate costs of these options are shown in Figure 5.5[55]. The higher horizontal line represents the average rural electricity price and the lower one the average urban electricity price.

[55]"Get Smart, think small Local energy systems for New Zealand" Parliamentary Commission for the Environment, 2006

Figure 5.5 Micro generation and Heating Costs



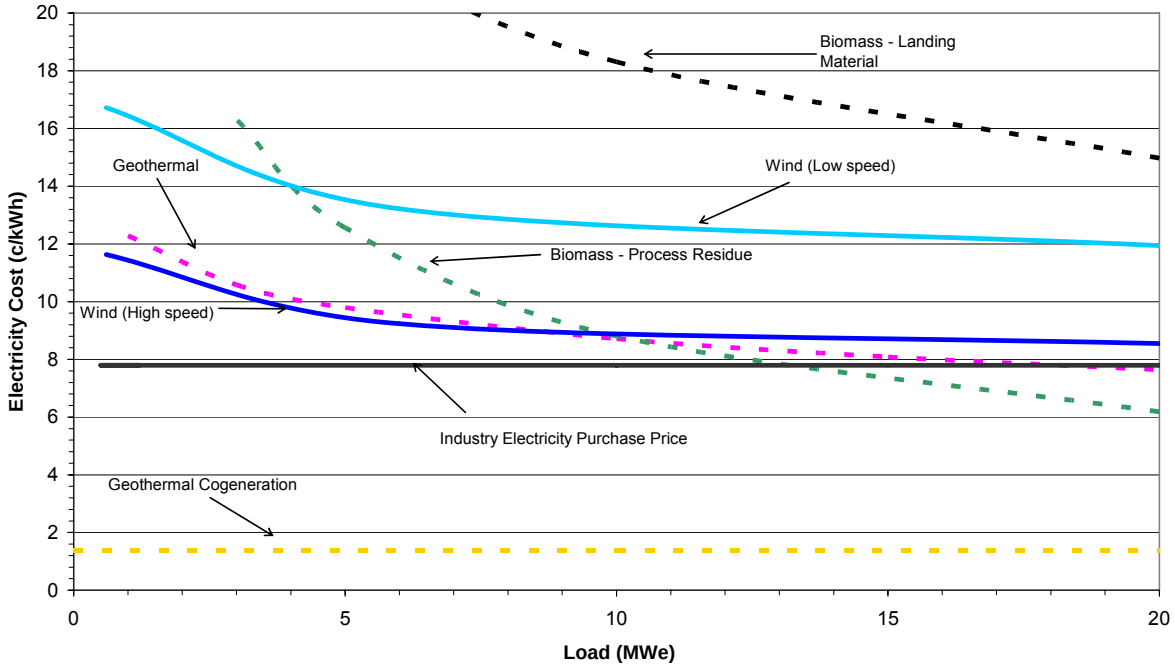
5.3 Projected New Electricity Generation Costs

The introduction of a carbon charge would mean that the relativities between fossil fuels and renewable energy would change. In addition fossil fuel prices are expected to increase further in future. The use of bioenergy can become cost effective relative to coal. Figure 5.6 shows some expected relativities between fuels. New technologies may however change these.

Generally electricity generated using biomass landing material as a fuel cannot compete with current electricity prices. This is because of the cost of transport of the fuel from forest to the plant. Geothermal cogeneration where the electricity is treated as a by-product is competitive with grid supplied electricity. Electricity generated using wind, geothermal and process residues are competitive particularly at the larger sizes[56].

[56] MWe = MW electrical

Figure 5.6 Comparison of Unit Electricity Costs for various fuels [57]



In their report for the Electricity Commission, SSG[58] listed electricity generation alternatives for the North Island. Some of the geothermal projects listed are shown in Table 5.1.

Table 5.1 Geothermal Electricity Generation

Year	Location	MW
2021	Atiamuri	50
2021	Horohoro	40
2026	Ngatamariki	30
2029	Rotoma	40

6 Barriers to Improving Energy Supply

6.1 Local Barriers

6.1.1 Need for District Coordination and Collective Action

There are a large number of initiatives that could be undertaken by energy investors and users to ensure reliable energy supply and to reduce costs. The access to information and the transaction costs for each individual generally mean that the initiatives are not economic on an individual basis. Coordination of activities and collective action can however produce economies of scale that will improve individual economics.

6.1.2 Need for Skills and Experience for Selection and Installation

There is a general limited need to increase the level of technical skills necessary for implementing many of the energy investment opportunities available in the area. Currently implementation is generally undertaken by enthusiastic trades people who "learn by doing". Opportunities are spread over quite an area. This has meant that no obvious focal point for activities around installation and maintenance, and information and advice, has emerged. Specific efforts directed at creating such a focal point particularly at

[57] Source: East Harbour Management Services
[58] Adapted from "Transmission Augmentations into Auckland :Technical Analysis of Transpower's Proposal and Short Short-listed Alternatives, Part II" for the Electricity Commission - Transmission Advisory Group, by System Studies Group NZ Limited

trades level will be necessary. The provision of sound advice and high quality services to the people of the District is of paramount importance. Otherwise, there is a real possibility that 'failures', in terms of systems being installed by inexperienced and improperly trained tradespeople or inappropriate advice given out will send the wrong message to the community and inhibit future uptake. There is a need to establish reliable delivery mechanisms that will provide economies of scale through regular involvement with a range of appropriate technologies.

6.1.3 Access to Government Funding

Several government agencies have funding that targets small-scale electricity generation opportunities, energy efficiency for the residential and business community and general awareness raising. Despite accessing some of these national funds, the District could do more to access them by improving coordination, awareness, familiarity with processes and in general facilitating collective action. Individuals and small community groups often do not have the experience to access government funding or to implement energy solutions that are durable and will provide optimal benefits. There is a need for communication between different groups to provide a sense of shared objectives, and coordination. The potential for local gain and improved community wellbeing from this is significant. A strong community spirit exists amongst many groups in the district and needs to be tapped into with respect to energy.

Most government agency funding requires cost sharing. Where the benefits accrue to the area there is a need for the community to collectively provide some District contribution.

6.1.4 Local Authority Attitude to/View on Energy Projects

The Rotorua District Plan recognises the importance of energy for the health, safety and convenience of the people in the District in its Utilities section. It notes that the sustainable management of utility services through the District Plan involves the development of enabling and co-ordinating measures to facilitate the operations of a range of public and private utility operators, while controlling the adverse effects of these activities on amenity values and the wider environment.

The Plan provides information on the status of energy activities (e.g. transmission lines, power stations) as permitted, controlled or discretionary.

The Bay of Plenty Regional Policy Statement (RPS) contains an Energy section. Although it is silent on the importance of energy to the economic, environmental and social well being of the Bay of Plenty Region the RPS recognises the important role of energy management to the economic, environmental and social well being of the Bay of Plenty District.

The Regional Council also recognises its role in promoting the sustainable management of energy and its responsibility to promote energy efficiency and the use of renewable energy resources in the region.

The background to the Energy section notes that the importance of the area's hydrological and geothermal resources has long been recognised at the national scale and by local electric power suppliers and comments that these seemingly sustainable and renewable resources may be at risk of over exploitation.

In its Energy section the RPS identifies the energy issues as:

- Society's reliance on fossil fuels and the associated effects of greenhouse gas production.
- The lack of progress towards the development and adoption of renewable energy sources may lead to energy shortages in the future.
- Energy conservation and efficiency is not widely practised.
- Power generation and transmission developments can have significant adverse effects on the environment.

The RPS objectives focus on:

- The efficient use of energy.
- Reduced reliance on fossil fuels and increasing use of renewable energy resources.
- Avoiding, remedying or mitigating the adverse effects on the environment associated with the development of energy resources and the production, distribution and use of energy.

with the anticipated environmental results being:

- The efficient and sustainable use of energy resources.
- A decreased dependence on energy from non-renewable sources.

- Stabilised or reduced emissions of greenhouse gases.
- The appropriate use of hydroelectric and geothermal resources.
- Less pressure on the environment from the development of new energy projects.
- Environmentally sensitive energy development.

A brief list of Environment Bay of Plenty energy initiatives in the Rotorua District area is:

Education and advocacy:

- Assisting public enquires about biomass energy generation initiatives.
- Directing enquires to related websites (often to EECA website).
- Sponsoring the Sustainable Backyard public education programme in the Bay of Plenty region. This programme includes a topic on Energy.
- The Rotorua office (like other Environment Bay of Plenty's offices in Whakatane and Tauranga) is fitted with energy efficient fittings for lighting and heating.

Improving Energy Mix:

- Providing support to Housing New Zealand Corporate to establish a pilot project on retrofitting efficient heating methods in existing homes.

Transport system:

- Improved the public transport service in July 2004 by increasing bus routes from 5 to 10, and the frequency from 60 minutes to 30 minutes.

Management structure and programme:

- Operative Rotorua Geothermal Regional Plan.

noting that the RPS adopts advocacy policies for energy efficiency and utilisation of renewable energy resources.

In general, there are a number of positive steps that the Councils can take to address energy issues in the district and region through both raising the issues they want to address and following through in terms of providing additional information about how they will deliver and monitor on their own performance. This approach can go along way to setting a positive baseline for community attitudes on energy use, while ensuring good environmental outcomes.

The Long Term Community Council Plan (LTCCP) is about empowering communities, planning for the future and ensuring the well being of individuals. As a reflection of what the community wants and needs, the importance of these plans for the future of the district cannot be underestimated.

The Ten Year (LTCCP) Plan for the Rotorua District makes reference to energy in a number of places including recognising that the geothermal energy source is a valuable resource for the economy and studying new technologies for Waste-to-Energy solutions. One matter of note is a rating issue where utilities may be required to contribute to general rates. However there seems to be nothing about opportunities for businesses to save energy or use it more efficiently, and the benefits of warm and healthy homes in the area. The development of initiatives aimed at growing community understanding and awareness on both these issues is essential. It will help elevate them to an issue of relevance for the local community.

The Rotorua District Council has a key role to play through the Regional and District planning processes. Preparation of a second-generation Bay of Plenty Regional Policy Statement and a further Proposed Rotorua District Plan are both opportunities for the Council to ensure that the relevant plans can assist rather than hinder the implementation of energy opportunities.

6.1.5 Conservation Management

Conservation Management strategies are prepared and used for management of the Crown's Conservation Estate (primarily Reserves). These plans provide information on the importance placed on features of the Conservation Estate and the priority for activities related to management of the estate. Energy infrastructure has the potential to impinge on the conservation estate (the proposed Kaituna hydro power station is an example of this) and a sound understanding of the conservation values that may be affected can assist in developing a possible way forward.

Of interest to the energy supply sector is that "Volcanic lakes, geothermal systems and associated forests" is one of the five special places in the Department of Conservation Bay of Plenty Conservancy's 10 year strategic plan. It should be noted that, in addition to managing the conservation estate, the Department of Conservation carry out an advocacy role. An example of this occurred recently when there was a whole-of-Government submission in support of the Project Hayes Wind Farm in Central Otago while the Department of Conservation made a submission that raised concerns about the effect of the wind farm on the environment.

6.1.6 Wrong Messages lead to Inappropriate Investment

A major issue arising from the lack of information on opportunities is that the community will be led by effective salesmen rather than good informed decision making. Energy is fashionable but because it is generally capital intensive the public can be led into inappropriate investment decisions unless sound information is available to them. Identifying what is sound information is of course difficult but by a district based energy facilitator working with all parts of the energy sector a level of experience can be established that should weed out the good from the bad which is generally beyond an ability for lay people to do for their one-off decisions.

6.1.7 Awareness Raising and Access to Resources

It is also inefficient for each individual to have to undertake their own research on possible energy initiatives. A district collective sourcing and dissemination of energy information can reduce the transaction costs for each potential individual investor.

6.1.8 Access to Information

Potential investors and in particular, small/medium enterprises such as farmers are often hindered from investment in energy opportunities because of the lack of information about the opportunities. This may be in the form of resource data or role models (in the form of case studies). There is often also a lack of information on the technologies available, those that are appropriate and their availability, and where to find experienced installers.

Not only is the information difficult to obtain but there is no appropriate vehicle for storing the information and assisting its dissemination to potential users. A focal point for information and advice in the district is essential.

The preparation of case studies, reference sites and handbooks would show the opportunities available and indicate the financial benefits achievable. This is applicable to opportunities around both energy efficiency and the development of local energy generation resources.

The education and transfer of knowledge needs both coordination and a facilitator whose task it would be to ensure the delivery of District projects. As a facilitator, the individual would also be a good conduit to Central Government for accessing specific programme funds that are available for energy generation, use and efficiency activities.

There has been extensive research into energy opportunities in the district. In many cases, the information and data has been held only by those directly involved and little useable data or other information has been passed on to others who may benefit from it. It is essential that the research results be shared and built on so that there is a transfer of knowledge and build up of expertise. It will be hard for the district to benefit otherwise.

6.1.9 Resource Consents

As the process of issuing resource consents is ‘effects’ based, potential investors in energy projects have to provide information on the potential effects of their proposed developments. This can involve extensive research and investigation and can be very costly which often limits the accessibility of such developments to larger developers or consortia of smaller developers. In order to reduce costs and encourage good outcomes from the process it would be advantageous to all parties involved if information that is common to a number of potential opportunities are prepared as standard references. Further, it would also be advantageous to potential investors if the councils clearly spelt out their requirements/expectations (in terms of information) on a range of types of developments.

Over the next two decades, geothermal and possibly some small hydro are likely to be distributed in a number of locations in the area. In order to facilitate these applications, the process for obtaining resource consents must be as efficient as possible, and at minimal cost so as to ensure that investment in renewable energy is an attractive opportunity for all potential developers (irrespective of size). It is important to appreciate that excessive costs will effectively prohibit local farmers and land owners from accessing this resource.

6.1.10 Accessing Guaranteed Energy Supply

For resource based energy projects the term of any resource consents can significantly influence the risk profile on a project for investors. (This is also the situation if an investor can not guarantee access to the resource.) This is specifically a problem for both geothermal and hydro opportunities. Regional policies can increase or decrease the risk profile for projects and should be addressed in development of an energy strategy.

6.1.11 The Cost of New Supply Options

An energy user seeking supply of electricity has to pay the full costs of any necessary electricity lines, transformers, or other equipment. This makes it important that as many alternative options as possible to network connection are considered. Alternatives may include installation of their own energy system - it may be that they can meet their energy requirements by other energy forms such as solar (PV or solar water heating), bioenergy, small or micro-hydro systems, wood-burning wet-backs offering space heating and water heating, and LPG gas for heating or cooking.

Most people do not have good information on the options available to them. Some may not even consider that there are alternatives while for others, it may simply be too expensive for them to consider and then fully investigate. The value of case studies and role models that may assist individuals in the evaluation of the options should not be underestimated. Homeowners or business owners will be able to see (and relate to) what is possible and see what specialist assistance they may need and where to get it.

6.1.12 Local Air Management Area (LAMA)

The Government issued a National Environmental Standard in relation to air quality that took effect from October 2004. This required regional councils to enforce minimum ambient air quality standards. One of these requirements is related to airborne particulates.

This (PM_{10}) standard has been exceeded in the Rotorua urban area and as a result Environment Bay of Plenty was required to put in place a Local Air Management Area (LAMA) in terms of particulate matter. This LAMA is shown in Appendix 4.

PM_{10} concentrations already exceed the standard at times and are to be reduced by 1 September 2013 to meet the concentration level set in terms of the standard. Environment Bay of Plenty have advised that, unless an action plan is developed in conjunction with the Rotorua District Council, industry, and the community, this risk (of not meeting the standard) will continue and that scientific investigative work must be undertaken to support the Action Plan. Ensuring that an appropriate plan is developed will be critical to investment in further bioenergy facilities.

There needs to be positive engagement by all parties to ensure that the 2013 requirement is met in a way that minimises the risks and costs to the Rotorua and wider community. While some may consider the need to reduce the discharge of particulates into the atmosphere as a restriction on the construction and operation of some types of energy plant, it is evident that this also creates opportunities for innovative solutions.

6.2 National Barriers

6.2.1 Fragmented Energy Market

The New Zealand energy market is very fragmented with a number of players focussing specifically on generation and retail activities – the 'gentailers', and lines companies, or electricity network companies whose main focus is transporting electricity on a local level. Lines companies also now have the potential to generate small amounts of non-renewable electricity (up to 50MW) (with no limit to renewable generation). Despite this, the isolation of some geothermal and hydro sites from electricity distribution lines make this difficult.

With the market as it is currently set up, electricity suppliers are the point of customer contact yet the local network company could through greater interaction with energy users implement energy management techniques that could reduce energy costs throughout the area. Without contractual connection to energy users, such actions are difficult.

On a national level, this fragmentation means that there are significant inflexibilities in the market and its few players mean that there is little competition. Lack of competition in the electricity retail markets keeps prices up and reduces innovation in energy products and this is typical of most NZ areas so is unlikely to be changed without government intervention.

6.2.2 Lack of Incentives for Investment in Energy Efficiency

Investment in energy efficiency is best undertaken by those able to directly gain the benefits of the investment. Those benefits may come in the form of reduced energy costs or increased productivity. The barrier to such investment is often the capital cost, particularly for residential homeowners who may have

higher priorities such as food and education, or business that do not have the profitability to increase capital expenditure.

There is also little incentive for energy sellers to advise customers of actions that they could take which could improve energy use effectiveness or reduce cost. It is in their interest to retain a low level of understanding or awareness of opportunities amongst their customers as proves a significant barrier to reducing sales. For example, from 18 October 2004, all retailers were obliged to offer their customers a low fixed charge (generally resulting in lower annual cost for users using less than 8000KWh annually). As a rule, customers must request their retailer to move them on to this low rate tariff, as they are not typically advised about it.

Where the beneficiary of energy efficiency investment is not the home or commercial building owner, i.e., a tenant, then the investment barrier is even higher.

There is little incentive for energy retailers to promote energy efficiency as any reduction in energy use reduces revenue. The exception however is when electricity retailers are over-contracted at fixed price during times of hydro electricity shortage where spot prices are extremely high. Any action that electricity retailers may have taken at such times will however be limited because of the Government investment in reserve generation such as from Whirinaki Power Station where price is capped at 20c/kWh.

6.2.3 Lack of Incentives for Lines Companies to Invest in Energy Efficiency

There are some perverse effects resulting from regulation that make investment in energy efficiency a poor business decision for lines companies. Two key issues are:

- Revenue and consumption—90% of a lines company's costs are fixed. Most of their revenue is gained via the variable charge which is of course energy sales (kWh) driven. Less consumption for them equals less revenue. However, many line companies choose to lower fixed charges because they want to send tariff signals to users to conserve.
- Price regulation—Electricity network companies are under price regulation by the Commerce Commission. They cannot increase prices beyond that set by a formula related to movements in the Consumers Price Index (CPI). This is referred to as the CPI-X regulation. Under this regulation, prices when applied to the base year's quantities (i.e., kWh consumption per tariff type) must meet the CPI-X test. When there is energy efficiency the base years quantities (in terms of consumption) remain the same. When there is no change in quantity there is no ability for the network company to rebalance their tariffs so that they can be revenue neutral to improved energy efficiency, with the result that they are heavily penalised. In a recent case, as part of its settlement with the Commerce Commission, Unison voluntarily reduced its average prices to comply with the Commerce Commission's price path threshold[59].

On the other hand, there are good district system benefits which Unison could achieve through energy efficiency initiatives, such as reduced maintenance costs, fewer outages, reduced electricity transfer losses etc. However, these benefits (such as reduction in electricity transfer losses) may not flow to Unison but to the incumbent electricity retailer who currently pays for losses.

6.2.4 Access to Capital

While there are many energy investment opportunities available to business, their access to capital funding is a significant constraint to realising many of the benefits. Access to capital is essential to both investors who are considering the development of renewable generation projects or those users of energy (business and residential) who, with an immediate investment could realise long-term energy efficiency savings.

The long-term benefits of many renewable projects don't fit well with financiers who look for short-term returns and may be risk averse in particular with respect to investment in renewable energy, an area or technology that they are unlikely to be familiar with.

In addition to the difficulties of businesses getting access to capital for energy efficiency improvements, for many homeowners, access to the capital needed to upgrade their homes in terms of insulation or consider the purchase of solar water heating equipment is also difficult.

Access to subsidised Government programmes focussing on energy efficiency gains are offered by EECA to both the business and residential sectors. Despite this, for many, being able to locate the additional co-funding is still a major barrier. Other funding opportunities exist from Trade and Enterprise and are focussed on business development, export opportunities and the development of cluster activities. Funding from this source still requires matching co-funding.

[59] http://www.comcom.govt.nz/MediaCentre/MediaReleases/200607/unisontorebalancepowerpricesinhawk.aspx

6.2.5 Sale of Electricity

Where a cogeneration (heat and electricity produced) or other similar facility is operated and there is surplus on-site electricity, the ability to sell the electricity is a valuable revenue driver. Currently, there is a difficulty in finding anyone to purchase the electricity other than at around 85% of the spot price at the grid exit point (with an allowance for losses). Even if a purchaser can be found it is difficult to be able to get a price that makes the sale worth entering into. If the energy is controllable and able to be scheduled to high price times of the day, then it is easier to find a purchaser. The transaction costs of setting up a sale and purchase agreement; with an associated distribution agreement is generally too high and ultimately kills the project.

For photovoltaic and other small sources of generated electricity, it may be possible to have a net metering[60] arrangement. (Eg Orion[61] have a net billing approach for small generators where export quantities are offset by import quantities and Orion only charges for the net import.) This is generally not supported by the major energy players but the benefits are such that it should be worked through with relevant parties. Government officials are currently addressing this issue and that net billing[62] (as opposed to net metering) is included in draft regulations[63].

6.2.6 Fixed or Spot Price Contracts

Whether a company takes a fixed price electricity supply contract, or takes electricity based on spot prices is usually a risk management decision. Where a company has an ability to control and vary the amount of electricity used, then in this situation it can be advantageous to have the variable quantity covered by spot prices. When prices are high, the amount of electricity used can be cut back to reduce costs. If a company is highly exposed to the spot prices, they will usually take a financial hedge to cap prices paid.

For companies with manageable electricity demands, part exposure to spot prices can be financially beneficial.

A difficulty of the current electricity market has been that it has been difficult to obtain hedge contracts. It is also been difficult for some companies to secure fixed price contracts and have been 100% exposed to spot prices. Many companies have also had little experience working without fixed electricity prices.

Companies having even only a small percentage of their electricity demand exposed to spot prices have a strong incentive to have load management and planned load-shedding capability. Examples are:

- Restricting pumping of water to off peak times,
- Restricting heating of water to off peak times,
- An ability to turn off freezers/chillers for periods of up to two hours and
- Rescheduled high electricity use activities.

6.2.7 Low Value Renewable Energy and the need for Storage Initiatives

Because electricity generated from wind, run of river hydro and solar is not economically storable this generation may have low value. Support should be given to national research efforts being channelled into investigating technologies for storing renewable generated energy. The ability to store energy in batteries or other such media could enable some households in remote rural areas to become fully independent of the national grid system.

6.2.8 Resource Management Act Legislation

There are a number of specific issues that still limit the effectiveness of the Resource Management Act, for example, the definition of renewables is limited to only covering electricity generation and does not cover heat production. Further, there is no provision for the access of transmission lines to any resulting development. This is a particular issue for the development of geothermal and small-hydro developments that are typically remotely located.

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[60] One meter with the ability to record power flow in two directions (depending on whether the owner is importing from or exporting to the network).
[61] http://www.comcom.govt.nz/MediaCentre/MediaReleases/200607/unisontorebalancepowerpricesinhawk.aspx
[62] Two meters running side by side, one showing imported electricity the other showing exported electricity.
[63] Draft Electricity Governance (Connection of Distributed Generation) Regulations, 2006.Schedule 2 Clause 8

7 Available Energy Resources and Technologies for Utilisation

7.1 Geothermal

Within the Rotorua District there are geothermal resources from which the district benefits both economically and culturally.

Larger geothermal fields in the district and some of their characteristics are shown in Table 7.1 and Figure 7.1[64].

Table 7.1 Quantity of High Temperature Resources (based on Lawless and Lovelock 2004)

Field	Resource Area km^2	Depth to Reservoir m	Resource Thickness m	Mean Temperature[1] °C	Mean Potential Generating Capacity MWe[65]
Fields Available for Further Development (High/Medium Confidence Resources)					
Horohoro	5 max	500	2,000	200	5
Ohaaki	10	400	2,100	270	130
Rotorua	5	500	2,000	240	35
Subtotals					**170**
Fields Available for Limited Development (High/Medium Confidence Resources)					
Atiamuri	0	800	1,700	220	6
Tikitere-Taheke[2]	35	500	1,800	240	240
Subtotals					**246**
Fields with a Research or Protected Status (Unavailable Resources)					
Reporoa	9	700	1,500	230	42
Orakei-Korako	10	400	1,800	250	110
Rotorua[3]	4	500	1,800	240	35
Te Kopia[4]	10	500	2,000	240	96
Waimangu	12	400	2,100	260	280
Waiotapu[5]	20	500	1,800	275	340
Subtotals					**903**
Totals:					**1,319**

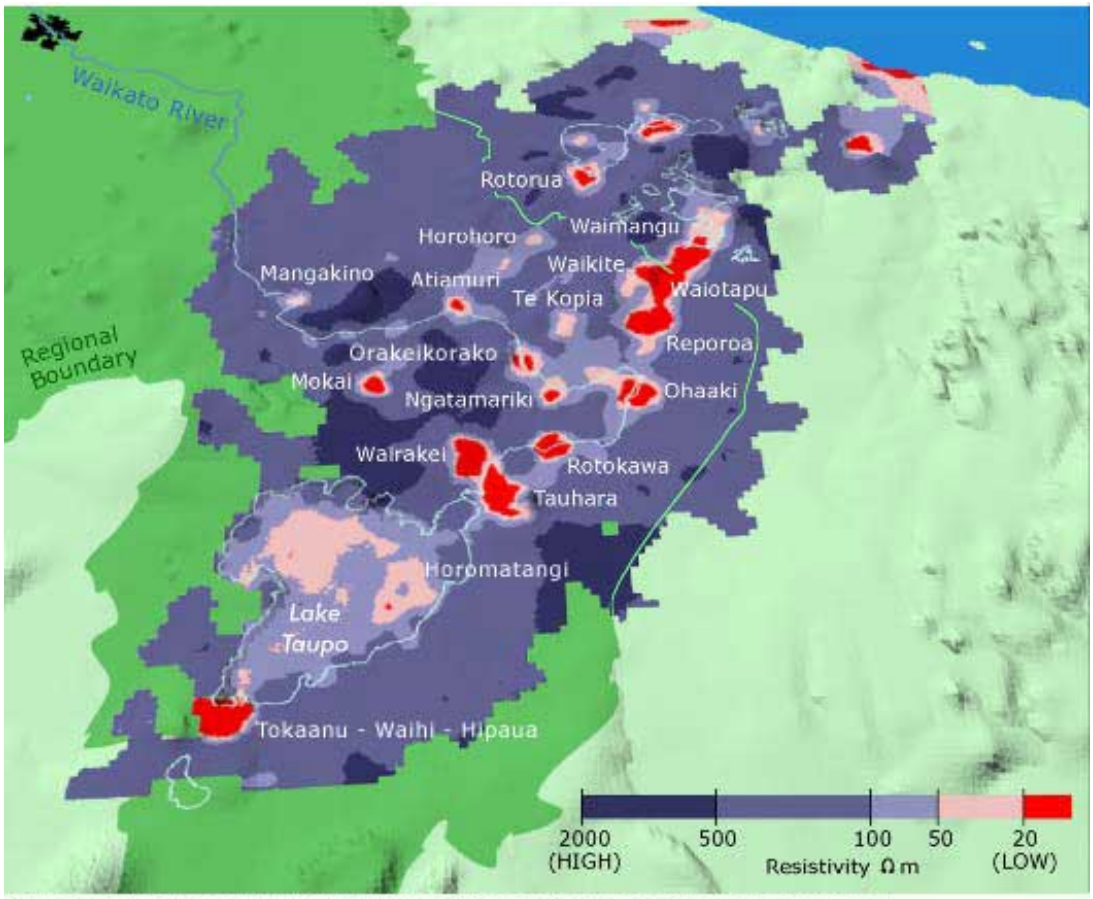
Notes:

1. Mean temperature through accessible reservoir thickness and area, not maximum, and for developed fields, before exploitation.
2. Excludes Lake Rotoiti.
3. Excludes Lake Rotorua. Limited use of the Rotorua field is permitted and occurs, but preservation of surface features is of prime importance so cannot be considered for large-scale development.
4. Te Kopia is a "Research" field but is unlikely to be developed because of proximity to fully protected fields.
5. Includes Waikite.

Source East Harbour Management Services

[64] http://www.ew.govt.nz/enviroinfo/geothermal/classification/taupovolcaniczone.htm
[65] MWe = MW electrical

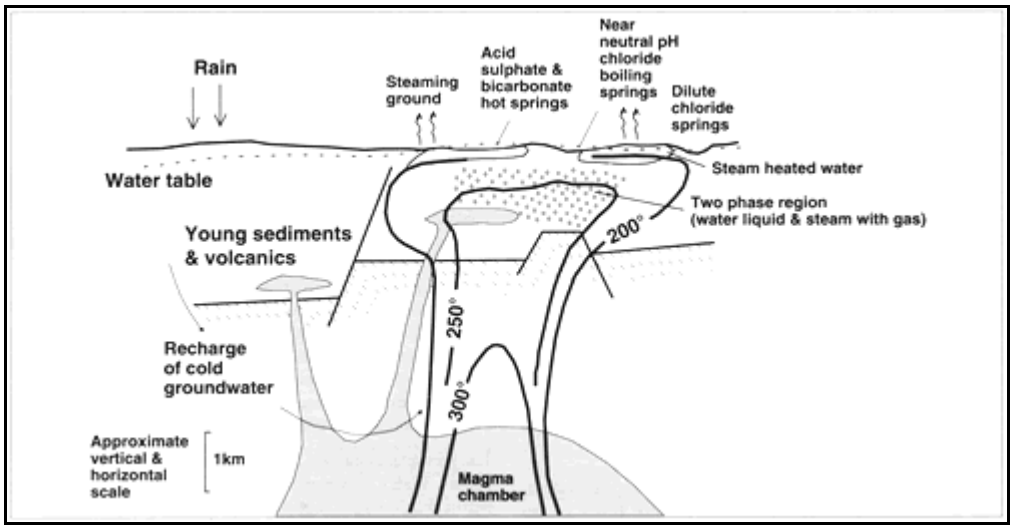
Figure 7.1 Taupo Volcanic Zone



Electrical resistivity imagery supplied by Institute of Nuclear and Geological Sciences. Copyright reserved.

Geothermal energy shows itself in a number of ways. These are illustrated in Figure 7.2[66].

Figure 7.2 Generalised Geothermal System of the Taupo Volcanic Zone



7.1.1 Rotorua District Geothermal Fields

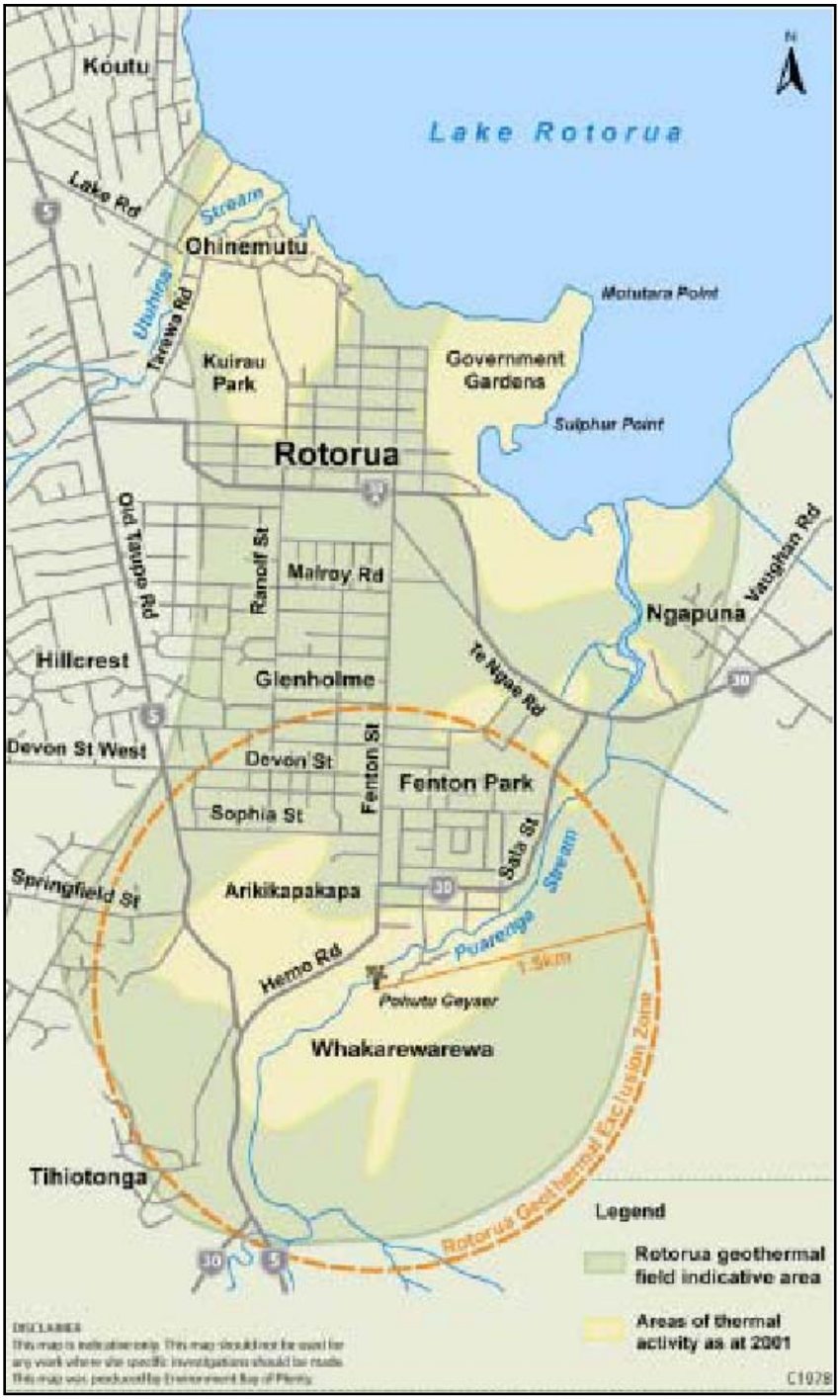
Rotorua

The Rotorua geothermal field underlies much of Rotorua City and the southern margin of Lake Rotorua. Surface geothermal activity is generally confined to three areas, Whakarewarewa/Arikikapakapa in the

[66] http://www.nzgeothermal.org.nz/geothermal_energy/geothermal_systems.asp

south, Kuirau Park/Ohinemutu (on the shore of Lake Rotorua) to the north and Government Gardens/Ngapuna/Sulphur Bay to the northeast which is also on the shore of Lake Rotorua.

Figure 7.3 Rotorua Geothermal Field [67]



The natural features associated with the field, particularly the geysers and hot springs of Whakarewarewa, are one of New Zealand's foremost tourist attractions. The field and its associated surface features have strong local social, cultural, intrinsic, and economic values.

The resource is regulated by Environment Bay of Plenty.

In the late 1970s there were significant changes to the surface features at Whakarewarewa and there were concerns that this was related to the level of draw-off from the Rotorua wells. This prompted the Government in 1985 to put in a programme of compulsory well closure within a 1.5 km radius of the Pohutu geyser and a field management regime.

Since then monitoring has shown the water level in the main production aquifer has largely recovered and some natural surface features are recovering but at a slower rate. Computer modeling has indicated that at present, the field is in a stable dynamic state.

Environment Bay of Plenty[68] expect that future changes in usage patterns of the geothermal resource will follow those already established, in that the proportion of commercial use will continue to slowly rise and domestic use will decline. Total withdrawal is likely to increase slightly and net withdrawal is (following completion of the reinjection programme) expected to fall by approximately 6 percent.

Bore numbers are not expected to change markedly. Domestic bores that fail are not likely to be replaced whereas bores supplying group heating or commercial services will be.

There are currently 42 known downhole heat exchangers in use mainly by domestic users. These are perceived as poor performers. This is often a result of inefficient and/or older technology. Until more

[67] Rotorua Geothermal Field Management Monitoring Update: 2005
[68] Ibid

efficient down hole heat exchangers are put in place in the field and shown to be more effective, large scale increase in their use is unlikely.

However Environment BOP recognise that significantly more down hole heat exchangers could exist, particularly within the 1.5 kilometre mass extraction exclusion zone. Computer modeling showed that increasing the use of downhole heat exchangers by up to 200% within the 1.5 km exclusion zone would have a negligible impact on surface activity. Downhole heat exchangers extract heat without measurably affecting geothermal fluid flows.

It is recommended that the district institute a programme of replacement and expansion of downhole heat exchangers so that this immensely valuable resource is utilized for the wider wellbeing of the community.

Larger Field Developments

The following geothermal resources have development potential which should be pursued for extraction of heat. Resources that have protected status such as Orakei-Korako, Te Kopia, Waimangu and Waiotapu have not been included.

Tikitere [69]

The Tikitere geothermal field is located about 18 km northeast of Rotorua City on the southeast shore of Lake Rotoiti and comprises the Tikitere geothermal area and the Ruahine Springs several kilometres to the northeast. Thermal features included steaming ground, boiling springs and vigorous steam and gas discharges. The Hell's Gate thermal area is a popular tourist attraction

The Tikitere Trust which operates the Hell's Gate facility is investigating a limited development for electricity generation (10MW). Energy potential of the field has been estimated at greater than 160 MWe[70], but significant energy production could affect the natural features of the field. The field is regulated by Environment Bay of Plenty.

Rotoma

This field is located between Lakes Rotorua and Rotoehu and the Tarawera River to the south. Dominant features are the Tikorangi volcanic dome and the Waitangi Soda Springs which rise in the Waitangi no. 3 Springs Reserve.

Local Maori Trustees have an interest in the development of Rotoma for electricity generation. A limited development may be possible, say 10 MW initially but ultimately 35-50 MW.

Atiamuri [71]

The Atiamuri geothermal field is located north of the Waikato River between Atiamuri and Ohakuri and about 40 km north of Taupo. It contains three springs (Whangapoa Springs) in an area of farmland and pine forest. Various other geothermal features are scattered throughout the farmland.

Atiamuri is classified as a Limited Development Geothermal System by Environment Waikato. Land around the system was converted from pine forest to dairy pasture in 2003.

Ohaaki – Broadlands [72]

The Ohaaki-Broadlands geothermal field is located 20 km northeast of Taupo immediately south of State Highway 5. Power development is the main feature of the area. The Ohaaki Ngawha (boiling pool) is the dominant remaining natural feature of the field.

Wood drying kilns use waste geothermal energy directly as a heat source for the drying process

Ohaaki is classified as a Development Geothermal System by Environment Waikato.

Reporoa [73]

The field has two springs that are still depositing sinter, hot pools, steaming ground, mud pools and seepages. There are large numbers of a rare fern at Golden Springs.

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[69] http://www.nzgeothermal.org.nz/geothermal_energy/nz_geothermal_fields.asp

[70] MWe=MW electrical

[71] http://www.ew.govt.nz/enviroinfo/geothermal/fieldsmap/atiamuri.htm

[72] http://www.ew.govt.nz/enviroinfo/geothermal/fieldsmap/ohaaki.htm

[73] http://www.ew.govt.nz/enviroinfo/geothermal/fieldsmap/reporoa.htm

Reporoa is classified as a Research Geothermal System by Environment Waikato.

Land drainage for pasture is ongoing.

Horohoro

The Horohoro geothermal field is located about 15 km southwest of Rotorua City. It has presently two hot springs depositing small sinters.

A commercial glasshouse operation takes heat from the system to grow flowers.

The field is classified as open to development by Environment Waikato.

Whangairorohea [74]

Whangairorohea Geothermal System contains several hot springs in a pine forest and is classified as a small geothermal system by Environment Waikato.

Deep Geothermal

The region between the Bay of Plenty and Mt Ruapehu is exceptional by world standards for the concentration of hydrothermal features. In turn these are associated with a mantel plume relatively close to the surface. As a result there are exceptional thermal gradients throughout the region, though particularly focussed near where surface expressions of geothermal activity are found.

Research should be undertaken into using deep drilling and hot rock energy extraction technologies to obtain heat for electricity generation. While not likely to be economic in the short to medium term, it is expected that such technologies will become economic in the next decade. While this can focus on the obvious development resources e.g. Ohaaki or Horohoro, there is potential generally through the area.

Additional Information

Additional information relating to geothermal energy can be obtained from GNS Science at Wairakei. Topics covered are listed in Appendix 1.

7.2 Woody Biomass

7.2.1 Introduction

Bioenergy is the conversion of plant-based materials to energy, and includes a broad range of possible fuels, conversion systems, and energy products (Figure 7.1). Bioenergy already contributes a significant amount of energy in New Zealand, about 5% of total energy supply (35 Petajoules[75]). Much of this bioenergy is produced and used by the forestry industry, in particular, large-scale pulp and paper operations, through the burning of lignin produced during pulping processes. In addition, recent information has also indicated that home heating using solid-wood fires may contribute an additional 5-8 PJ[76]. Although, bioenergy is an important energy supply, there is potential to significantly increase the total contribution through increasing the use of forest industry residues (wood left in the forest post-harvesting, wood-processing residues such as sawdust, bark and shavings), other crop sources, and organic waste from a range of industries and sectors. The New Zealand government has set a target of 30 Petajoules of new renewable energy by 2012 (from 2001) and it is generally expected that bioenergy will provide at least half of this. There is also a target for the use of biofuels in New Zealand of at least 2 Petajoules a year by 2012 (about 65 million litres of biodiesel or bioethanol). In addition, the "Biofuels sales obligation" would require oil companies to sell a minimum percentage of biofuels in transport fuels, beginning with 0.25% of sales in 2008, and rising to 2.25% by 2012. These targets are currently under review and are expected to increase.

Rotorua is located near large pine plantation forests and close to a number of wood processing operations. In "Rotorua's Strategic Advantages for Bioenergy" (see Section 7.3) this is discussed in more detail, including an assessment of the forest and wood-processing residues in and around the Rotorua area. Furthermore, there is sufficient land that can be used for a range of crops to either supplement forest-derived materials or alternatively be used as a sole source of energy. With a decisive community led programme of action within the Rotorua area, Rotorua could become a national leader in deploying bioenergy, and a centre for bioenergy technologies and systems internationally. The area already has the genesis of such a programme with the location of Scion (New Zealand's primary bioenergy research agency) already based in Rotorua.

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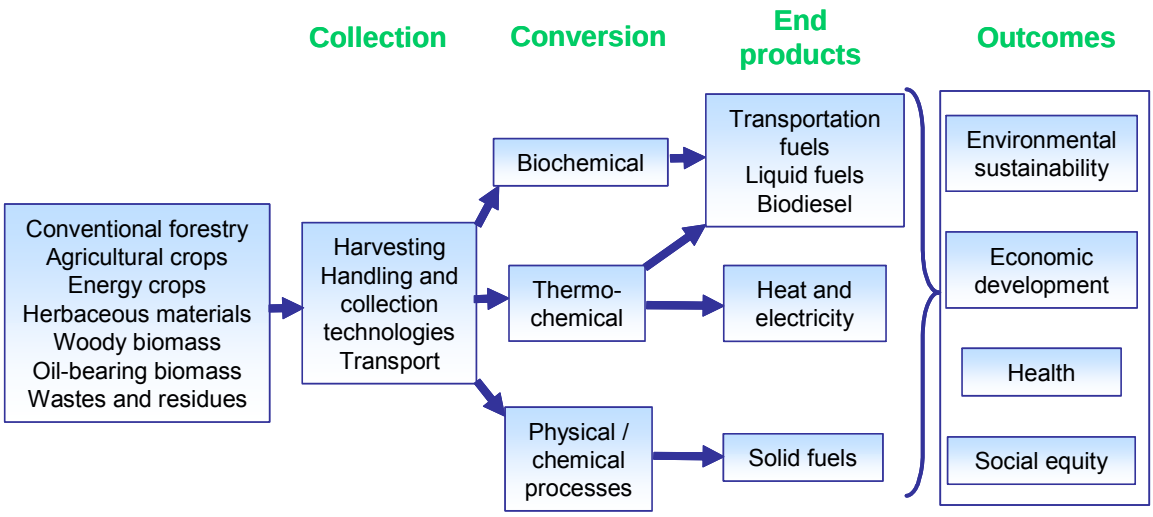
[74] http://www.ew.govt.nz/enviroinfo/geothermal/fieldsmap/whangairorohea.htm

[75] Energy Data File

[76] BRANZ House Energy End Use Project, 2006

Figure 7.4 Bioenergy systems



Bioenergy has a number of key advantages compared to other energy forms[77], namely:

Biomass is a sustainable or renewable resource, as the fuels can be replenished through the growth of new plant material. The use of wood from plantation forests is regarded as renewable energy provided the forest is replanted and managed sustainably.

- Biomass can produce heat, power, and liquid biofuels with proven and second-generation technologies for converting biomass into useful forms of energy.
- Unlike other variable renewable energy resources like wind and solar, biomass can be easily stored and deployed where and when required.

Biomass can be easily deployed using existing infrastructure (i.e., distribution systems, electricity networks, or as blended with petroleum-based liquid fuels).

- Biomass systems can often provide a range of co-products (e.g., carbon sinks or nutrient removal).

Current constraints for the rapid uptake of bioenergy include:

- The competitive cost of electricity, biofuel production, and heat production against other energy sources such as natural gas, coal, geothermal and hydro.
- The availability of knowledge on the use of bioenergy as an alternative energy source that markedly reduces risks associated with its use over the medium-to-long term.
- The development of mature biomass trading markets in New Zealand which ensure a decoupling of fuel supply from forest growers or other biomass producers. Furthermore, such markets would assist in systems being fuelled by a range of biomass supplies and reduce dependence on only one fuel source.
- Lack of certainty regarding the long-term energy options for New Zealand and the impact of climate change on energy production.
- Consumer and industry perceptions that bioenergy is non-traditional and has higher risks compared to other energy forms.

For Rotorua to become a major player in either bioenergy production or the development of biomass technologies, these barriers need to be addressed through an integrated energy plan for the area.

[77] IEA Bioenergy publication "Benefits of Bioenergy", includes case studies of Bioenergy projects from around the world: http://www.ieabioenergy.com/MediaItem.aspx?id=52

7.2.2 Biomass Fuels and Bioenergy

National Bioenergy Scene

New Zealand is fortunate to have an energy system which is relatively CO_2 neutral with only 30% of the electricity being produced from fossil fuels. Electricity is mainly processed from hydropower, fossil fuels and geothermal sources. The heat market is covered with coal, gas and biomass. Bioenergy has played a relatively constant role of covering 5% of the primary energy supply over the last decade, which means that the increase in bioenergy use has followed the increase in energy demand.

Use of biomass is predominantly in the wood processing sector, in particular, at pulp mills and sawmills, utilising the mill's own waste biomass materials. The pulp mills use the black liquor produced in the pulping process to generate heat and power. However, the woody biomass market has undergone a change over the last couple of years, with 120,000 tonnes of forest residues being extracted in 2006 and utilised on two sites.

The residential market has typically used biomass in the form of firewood for heating. With stringent air emissions regulations from the Ministry for the Environment, traditional log burners are under pressure from other technologies. Wood pellet heaters are considered an accepted alternative. The wood pellet market has expanded significantly over the last 5 years mainly in the residential area, but wood pellets have also begun to be used in school boilers.

Landfill gas is utilised for electricity generation at the biggest landfills and the biggest waste water treatment plants also have biogas production.

Some biodiesel is produced in New Zealand and ethanol is produced in the dairy industry and biofuels could also be produced from meat industry byproducts. However, the liquid biofuel market is in its infancy and a political framework not fully developed.

International Bioenergy Scene

Bioenergy resources such as forestry and agriculture crops, biomass residues and wastes already provide about 14% of the world's primary energy supplies. In many countries Bioenergy is a major source of renewable energy. For example, in Denmark, Bioenergy accounts for 20% of primary energy consumption and 10% of electricity demand; In Sweden, biomass now contributes 12% of the total energy consumption (energy production from biomass having tripled since 1980) and 5% of the total electricity consumption; in Finland the share of bioenergy has increased from about 10% of the supplied energy during the 1980s to 19% at present. Most of the electricity generation is from highly-efficient cogeneration (or combined heat and power). In "Opportunities" (Section 7.3) cogeneration in the Rotorua context is discussed further. In addition, the demand for wood pellets is rapidly increasing all over Europe and North America. The local wood-pellet industry will be discussed further in the "Opportunities" (Section 7.3). Driven by increasing oil prices (largely regarded to be a result of "peak oil") and environmental concerns (in particular the Kyoto protocol) in many countries, liquid biofuels derived from biomass are increasingly under investigation as an alternative to fossil transport fuels. Liquid biofuels will be discussed further in a local context in "Opportunities" (Section 7.3).

In addition to the provision of energy, the practical application of renewable energy technologies has been shown to lead to economic growth through exports and new jobs. As a dramatic example, in Denmark from1992 to 2005 energy equipment exports increased their share of total exports by a factor of 10.

A number of these international trends could be adopted in the Rotorua area through a decisive programme of action.

Biomass fuels

Biomass fuels can be highly variable depending on the source of the material (i.e., species, plantation forests, agricultural crops); means of material collection and pre-processing; on-site handling; processing conditions giving rise to the residues. The main characteristics important for different biomass fuel feedstocks are moisture content, particle size, ash content, mineral composition, ash characteristics, and bulk density.

Critical issues to consider with regards to fuel characteristics and quality are:

- The variability of fuel quality over a year due to seasonal changes and how the mix may vary due to varying supplies of different fuels to changing supply and demand.
- Flexibility of a biomass energy plant to cope with different fuel types (plants typically need to be able to handle more than one fuel type).

- Moisture content and the need to either pre-dry before conversion or to integrate drying into the design of the conversion system.
- Design of fuel-handling systems to ensure fuel remains clean and to minimise contamination with dirt and stones.

The suitability of certain fuel types to be used for specific purposes needs to be well understood by users of the resource (i.e., the development of specific processing conditions to use different fuel types such as Douglas fir sawdust and shavings for wood-pellet manufacturing).

As trading in biomass fuels increase, and to maximise uptake, there will be a requirement to develop appropriate fuel quality standards to ensure consistency between suppliers and to simplify the purchasing process for potential users. Currently, there are no formal fuel quality standards in New Zealand for biomass fuels, although effective fuel specifications can be prepared on a case-by-case basis. Such standards are being developed internationally (e.g., CEN/TC 335[78]) and cover all forms of solid biofuels within Europe, including wood chips, wood pellets and briquettes, logs, sawdust and straw bales. CEN/TC 335 allows all relevant properties of the fuel to be described, and includes both normative information that must be provided about the fuel, and informative information that can be included but is not required. As well as the physical and chemical characteristics of the fuel as it is, CEN/TC 335 also provides information on the source of the material (i.e., provide indicators that can be used to verify if the fuel is from a sustainable source).

Technologies for Utilising Biomass

Useful energy can be produced from biomass fuels using a wide range of technologies. In Figure 7.1 above, conversion systems were divided into three main categories: biochemical, thermochemical, and physical-chemical. Each of these conversion systems has distinct benefits, depending on the energy product that is to be produced. Biochemical processing typically refers to the use of biological organisms or systems (bacteria, algae, and enzymes) as a means of producing energy, for example the digestion of organic wastes and effluents to produce methane gas. Thermochemical conversion refers to processes such as combustion, gasification, and pyrolysis of biomass. Combustion is the complete burning of biomass to produce heat (which may also be used to generate electricity); gasification is the partial burning of biomass to produce a fuel gas stream and solid char, and pyrolysis is the partial burning of biomass to produce a condensed liquid (bio-oil) and solid char. Gas and liquid streams can be used to produce heat, electricity, liquid biofuels and secondary chemical products that can be used as substitutes for oil-derived chemicals.

Each of these technologies is well understood and substantial development internationally has been undertaken to improve their commercial application. Combustion systems are by far the most common and are used extensively for producing heat and electricity both domestically and internationally in many commercial situations. Although gasification technology has been developed markedly over the last 10 years, its application has been limited largely due to technical issues related to efficient cleaning of the gas stream to give reliable gas motor or turbine operation for electricity generation. Commercial application of pyrolysis has been constrained by small bio-oil yields and the high corrosivity of the oil products.

New and Emerging Technologies

A range of second-generation technologies are rapidly evolving to further improve the efficiency of biomass conversion to a mix of energy, fibre, and chemical products. These are considered briefly below.

- ***Small-scale combustion systems***
  Wood heating system technology has advanced significantly in the past decade. Modern wood-fuel boilers are clean, dust free, operate at over 90% efficiency, and provide consistent high-temperature heat (±1ºC). With fully automated ignition and controls, advanced automatic fuel feed and ash removal systems, the operating convenience of modern wood-fuel systems is similar to that of an oil or gas boiler.[79] In New Zealand, there are now a variety of imported wood pellet boilers available.

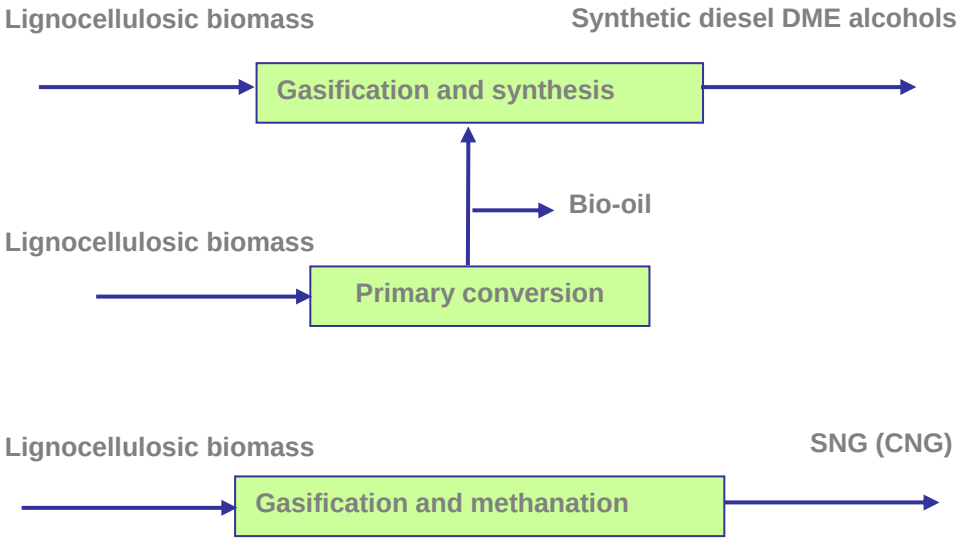
[78] CEN/TC 335 is the technical committee developing the draft standard to describe all forms of solid biofuels within Europe, including wood chips, wood pellets and briquettes, logs, sawdust and straw bales.
[79] http://www.sustainabledevelopments.ie/content/section/2/magazine?id_content=386&WOOD+FUELLED+HEATING+SYSTEMS&id_parent=384

These range in size from 25 to 300 kW and are suitable for light commercial or industrial use[80]. There are also a range of locally manufactured boilers which are compatible with wood pellets.

Standards for woodchip and wood-pellet fuel are set by the Central European Network (CEN/TC 335). Industry standards for the installation and maintenance of wood heating systems are also set in the same manner as for oil and gas. With high efficiency and standard fuels, emissions are very low, and ash is less than1% of the input fuel weight.

- ***Organic Rankine Cycle (ORC)***[81],[82]
  Organic Rankine Cycle (ORC) systems are similar to conventional steam-cycle systems for generating electricity. However, they use an organic oil instead of water as the heat transfer medium. Such systems operate at lower temperatures and pressure. These systems typically have relatively high capital costs but save on maintenance, operator costs, and have greater flexibility to operate at variable loads between 30 and 100%.
- ***Co-firing***[83]
  Co-firing refers to simultaneous use of biomass and typically some other fuel such as coal or gas. Co-firing of biomass with coal has gained significantly over the last 5 years due to the introduction of regulations to encourage the reduction in greenhouse gas emissions and greater uptake of renewable energy. Substitution of coal (or natural gas) with biomass can occur at small and large scale, though may of the applications internationally have occurred at large-scale, power generation facilities. Co-firing systems have the advantage of producing useful quantities of renewable energy for minimal capital investment and, in many situations, offers the most cost-effective way to achieve target CO2 reductions (Van Loo and Koppejan (eds), 2002).
- ***Gasification for second-generation liquid biofuels***
  A wide range of biomass feedstocks can be used to produce synthetic fuels, including dimethyl ether (DME), methanol, Fischer-Tropsch (F-T) diesel and F-T kerosene. In particular, the conversion of lignocellulosic biomass appears very attractive as a medium- to long-term prospect for producing large quantities of biofuels. Although this option is not commercially proven, there is significant ongoing R&D effort, particularly in Europe. Lignocellulosic biomass can be converted into biofuels based on gasification technologies using a range of processes (Figure 7.5).

Figure 7.5 Gasification for second-generation liquid biofuels



[80] -http://www.naturesflame.co.nz/
[81] -http://www.orc-process.com/index2.htm?doc/gmk/
[82] -http://www.turboden.it/orc.asp
[83] http://www.nrel.gov/docs/fy00osti/28009.pdf
http://www.fwc.com/publications/heat/heat_html/spr99/confiring.cfm
http://www.ieabcc.nl/meetings/task32_Rome_WS_Cofiring/0_van_Loo.pdf
http://www.ieabcc.nl/

Finland has recently announced that such second-generation technology is about to undergo commercialisation, with the development of a 500kw plant in 2007 and a 50 MW plant in 2008/09. The third phase of the programme involves the development of a full-scale plant that will produce around 3% of Finland's transport fuel demand. The total value of the project is estimated at EUR 300 million.

New Zealand has access to a methanol plant so there is an opportunity to link the supply of forest material to the production of biofuels using these facilities[84], although this would need to be developed in collaboration with other partners (Refer Appendix 2).

- ***Fast pyrolysis***[85]

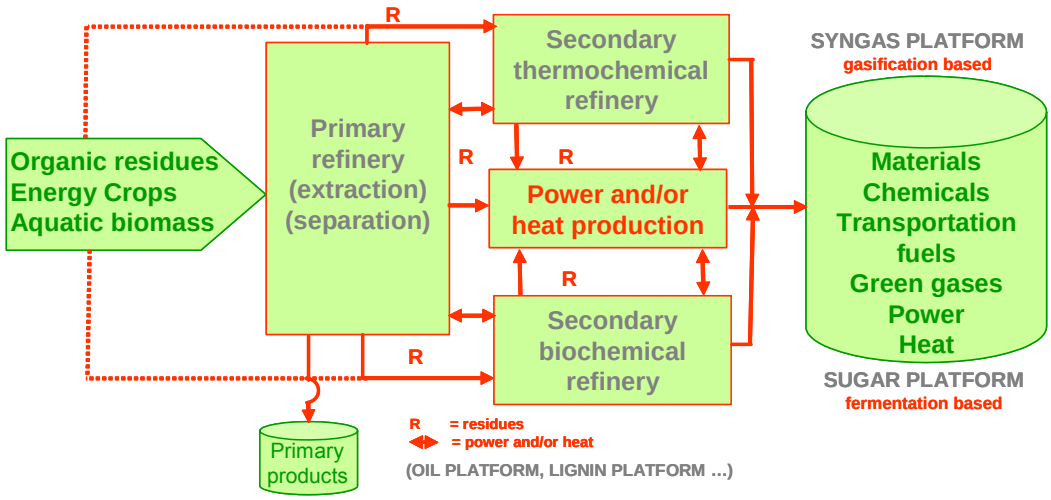
  Fast pyrolysis is a process which converts organic materials to organic vapours, and charcoal. The vapours are condensed to a bio-oil. Typically, 70-75 weight % of the feedstock is converted into oil. The liquid produced in fast pyrolysis is of a more consistent quality compared to the solid biomass and allows for ease of handling and transport. Since the 1990s several fast pyrolysis technologies have reached commercial status.

  Short-term applications of the bio-oil from fast pyrolysis are boilers and furnaces (including power stations), whereas turbines and diesel engines may become available on the somewhat longer term. Upgrading of the bio-oil to a transportation fuel is technically feasible, but needs further development. Transportation fuels such as methanol and Fischer-Tropsch fuels can be derived from the bio-oil through synthesis gas processes. Furthermore, there is a wide range of valuable chemicals that can be extracted or derived from the bio-oil.

- ***Biorefineries***

  The expected growth of biofuel production and the ongoing development of new biotechnology-based transformations opens up the possible introduction of biorefineries which would have the capacity to convert biomass into a broader range of value-added product streams (biofuels, high-value chemicals, and fibre feedstocks) (Figure 7.6).

Figure 7.6 Biorefineries



Relatively simple biorefineries already exist today (e.g., sugar/ethanol plants; oil seeds crushing/trans-esterification plants; pulp and paper mill; biodiesel units). The co-production of fuels and co-products, i.e., basic chemicals for synthesis purposes or high-value components all contribute to meeting future challenges of more efficient production, improving financial returns from the use of resources, and for improving sustainability.

[84] www.vtt.fi/uutiskirje/042006.jsp
- www.biomatnet.org/publications/1919rep.pdf

[85] www.vtt.fi/uutiskirje/042006.jsp
- www.btgworld.com/technologies/pyrolysis.html

Scion's biomaterials strategy is fundamentally based on R&D to develop new-generation processes that extract more value from biomass materials (with a strong focus on lignocellulosics such as wood). Scion has recently formed a collaborative R&D arrangement with Diversa (a US-based biotechnology company) to investigate technologies for utilising existing pulping-based systems for ethanol production.

7.3 Bioenergy Opportunities for Rotorua

Biomass Fuels and Bioenergy

Rotorua's Strategic Advantages for Bioenergy

Rotorua has a number of strategic advantages which suggest this area is an ideal locality to take on the challenges of becoming a national centre for bioenergy production and technology development. The generic attributes are considered in the following section.

The main strategic advantages are:

- Rotorua can integrate biomass energy with other energy forms such as geothermal, natural gas, and small-to-medium hydro.
- Rotorua has direct access to a broad range of bioenergy- and forestry-related experience and expertise (Refer Appendix 2).
- Due to concerns over lake water quality due to nutrient run-off a number of alternative land uses have been proposed for Rotorua, including the use of short rotation crops for nutrient stripping and subsequent utilization as fuel.
- Proximity to major commercial centres (Auckland, Hamilton and Tauranga.
- Proximity to the Port of Tauranga.
- Substantial existing infrastructure (wood-pellet manufacturing facilities, sawmilling and wood processing, forestry establishment and harvesting support businesses (Refer Appendix 2)).
- Surrounded by an off-highway roading network established by the forest industry (Refer Appendix 3).

Assessment of Forest Resources

Within a 75km radius of Rotorua there are 459,318 ha of established, sustainably managed exotic forests[86] (see Table 7.2 and Figure 7.4).

Wood resources within the Rotorua District are shown in Table 7.3

Table 7.2 Exotic forests around Rotorua

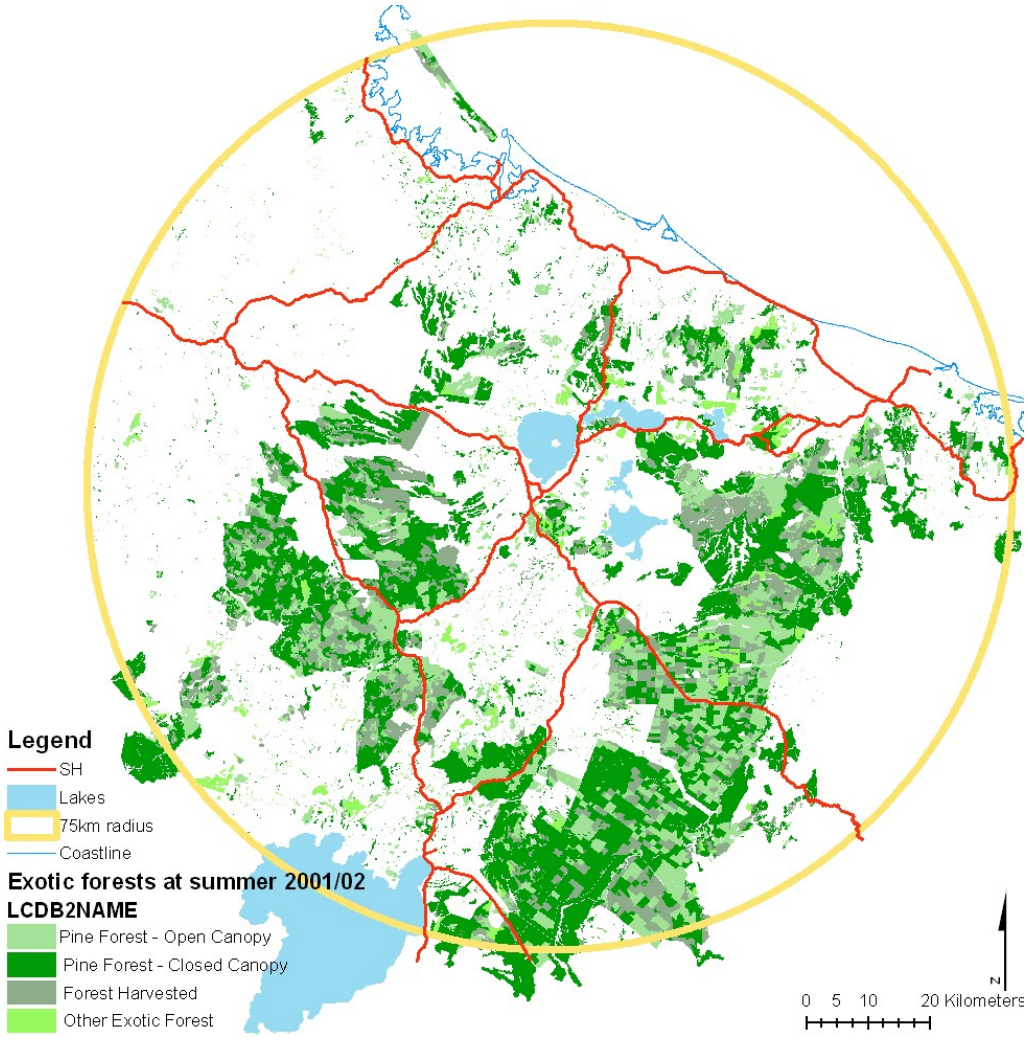
	Within 75km radius (ha)	Within 75km along roads (ha)
Pine Forest - Open Canopy	109,874	90,607
Pine Forest - Closed Canopy	232,557	181,180
Forest Harvested[87]	94,519	78,100
Other Exotic Forest	22,368	17,507
Total	459,318	367,394

[86] As of summer 2000/2001
[87] Satellite images in summer 2000/2001 showed this area had been harvested, and subsequently replanted or about to be replanted.

Table 7.3 Rotorua Wood Supply[88]

Territorial authority	Area (ha)	Standing volume (000 m3)	Area-weighted average age (years)
Central North Island wood supply region			
Rotorua District	58,051	12,369	13.02
Bay of Plenty Regional Total	**557,862**	**140,356**	**14.14**

Figure 7.7 Forests in the vicinity of Rotorua



From the planting to pre-harvesting phase of a forest there are a number of opportunities to remove forest biomass, in particular material arising from pruning and thinning activities. Pruning will typically occur around six and nine years of age and thinning at several times during the development of forest stands. Pruning material is typically left in the forest as extraction costs are high, so for the purposes of this assessment are not further considered. Thinnings are often used for pulp wood or posts and poles, therefore there is not a lot of this material currently available for potential bioenergy uses.

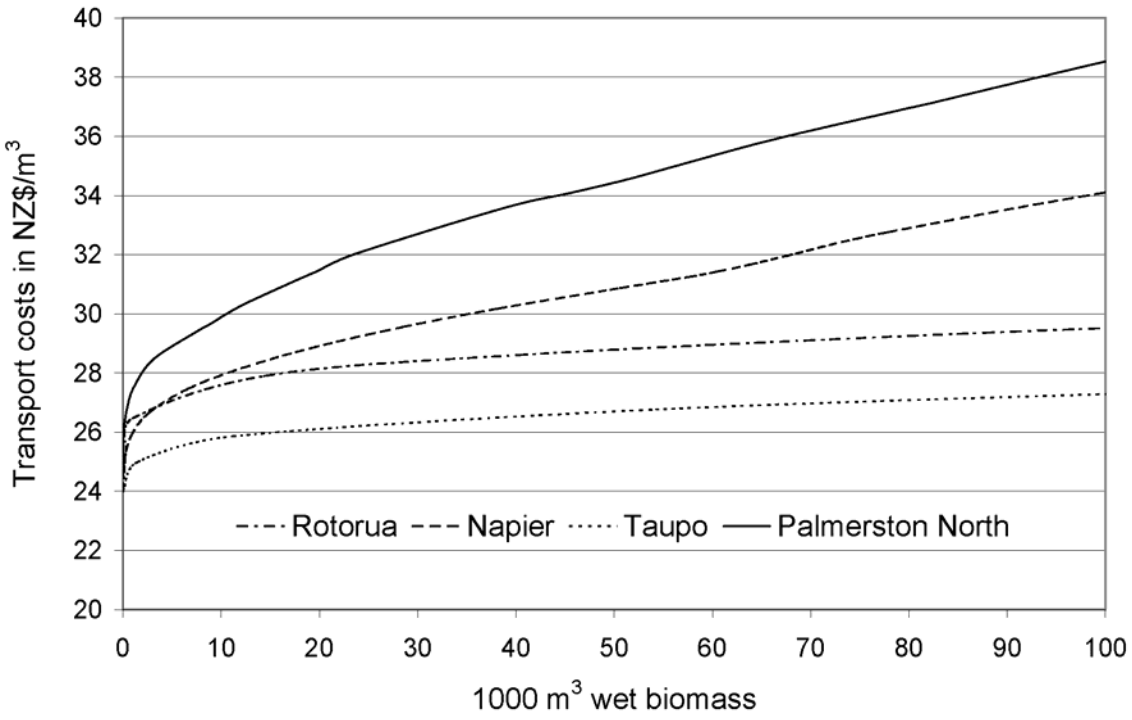
The major source of forest residues for bioenergy production arises during the harvesting phase of the forest and will comprise cutover and landing residues. Cutover residue is the material left on the

[88] Source: MAFF (NEFD 2004 Publication)

harvested area, which consists of broken stems, limbs, tops, needles, and other wood debris. The landing-residues comprise trimmings, log-ends, limbs, and wastes arising from sawing logs to appropriate commercial sizes prior to transporting them from the forest.

The most relevant economic factor is the amount of biomass that can be recovered for a particular cost. Figure 7.8 shows the volume of residue recoverable per year for a particular cost in dollars per cubic metre for the four cities of Rotorua, Napier, Taupo and Palmerston North. The relatively slow increase in cost with increasing quantity is related to the almost 360 degree distribution of forests around Rotorua and demonstrates the potential of the Rotorua area for residue recovery operations. Rotorua compares favourably with all cities except Taupo. Note that these costs should be treated as indicative only, as they are based on the National Exotic Forest Description yield tables and a number of other simplifying assumptions.

Figure 7.8 Harvesting residue recovery costs[89].



Key forest managers in and around the Rotorua area are: Hancocks, Timberlands, Blakely Pacific, Matariki, Ministry of Agriculture and Forestry (MAF)/Landcorp, NZFM, Olsens (see Appendix 2).

Wood Processing Residues

Forest-derived materials are also available from the processing of logs into lumber (boards and other timber products), panel products, and pulp and paper. Such process residues typically consist of woodchips, sawdust, shavings, bark, and timber offcuts. The quantities of these materials produced in each wood-processing operation vary depending on the technology used, production volumes, and products produced.

Wood-processing residue is the ideal fuel for a bioenergy facility as its use as an energy source usually avoids disposal costs that would otherwise be incurred. The ideal biomass fuel is when the processing residue is hogged to a homogenous chip size and its moisture content is regular. This comes at a cost but reduces storage costs and allows steady operation of the heat plant.

Most wood processors use heat on site and are able to use all of their waste for their own needs. Some are now becoming fuel constrained and have a shortfall and would complement on-site processing residues by importing from sites with an excess if the price was right.

While there are likely to be some sources of woody biomass available from small wood processors, there is no guarantee that they would continue as a source of fuel. Experience elsewhere has shown that such

[89] B. Moller, *A Spatial Model of the Biomass to Energy Cycle*, Presentation at Wasteminz conference 2003.

sources of biomass may not last long as other parties also see their value and they are used either in new on-site energy facilities or are taken to closer users.

The value of waste woody biomass is increasing and it can no longer be always assumed to be a free fuel. There is also a further security of supply problem in that what is one person's waste today is another person's raw material for processing tomorrow.

Within the Rotorua district there are thirteen major wood processing operations, seven of which are significant sawmilling sites, with the balance being timber product manufacturing facilities (Appendix 3).

Based on the production statistics for a number of mills and annual mean production volumes of different residue types the estimated total wood processing residues produced in the Rotorua area is around 750,000 m3 (Table 7.4).

Table 7.4 Estimated volumes of total wood processing residues within Rotorua (thousands m^3 /yr.).

Residue Type						
Wood Chips	Shavings	Sawdust	Bark	Off-cuts	Other by-products	Total
465.8	52.6	146.5	75.1	3.8	3.8	747.6

Currently much of the woodchips, shavings, and sawdust are either sold to other wood processors (panel mills or pulp and paper operations) as primary fibre feedstocks for processing and therefore are not currently available for new energy production. Quantities are also used to produce heat, either on site or at alternative sites, as part of the wood-processing activities (primarily as heat for timber drying or for boilers at pulp and paper mills).

Other existing uses of wood processing residues within the Rotorua area include diversion of sawdust and shavings to the Nature's Flame wood-pellet production facility, sawdust for landfill cover, bark and sawdust for gardening and farm products and wood offcuts for home heating.

Based on these current uses and a relatively small contribution from secondary timber manufacturing facilities, it is estimated that only around 5% (i.e., 38,000 m3) of the total wood processing residues produced annually within Rotorua would currently be available for additional energy production (i.e., beyond that already occurring within the area). Factors that may influence this volume in the future will include:

- Increases in the production of sawn lumber at either existing or new sawmills or other wood-processing facilities.
- Increases in the amount of lumber locally processed into value-added products (i.e., remanufacturing facilities, solid-timber housing, timber component manufacturing).
- Production changes at any of the major panel or pulp and paper mills in the region which affect the demand for fibre supplies.
- Changes in wood processing technology that markedly improve the recovery of lumber from logs during processing.
- Development of new manufacturing processes that utilise wood process residues as primary feedstocks (i.e., high-value chemical extraction from bark residues).
- Increased demand for wood-based fuels due to changes in the cost of energy supply from fossil fuels.
- Improvement in waste recovery from skid sites, either through improved management or superior waste recovery technologies.

By extending the potential supply of wood processing residues further afield to include the broader Central North Island (CNI) area, then the volume of potential residues for energy production could total more than 80,000 m3/yr. This is based on a total CNI timber production of over 1.8 million m3/yr and total log harvest of 9.2 million m3/year (based on the 2005 figures). (Note: This is the total harvest in the CNI region and includes logs harvested for unprocessed log exports, sawmilling, and other forest product manufacturing). However, transport costs are likely to significantly impact using this material in Rotorua.

The cost of supplying wood processing residues to an energy plant is highly variable and will depend on the competitive cost of alternative fuels (e.g., coal or gas); transport costs (i.e., the cost of transporting residues from the site where they are produced to the energy plant); cost of disposal of residues into landfills; the nature of alternative demand for residues (e.g., use for agricultural or horticultural products); local demand for wood residues as an energy fuel; volumes available within an area; and the quality of the material (e.g., moisture content and ash content).

To assist future decision-making processes for energy options for Rotorua, Table 7.5 provides estimated costs for wood-processing residues. (Note: These values should be regarded as indicative only, as specific costs would depend on site-specific circumstances). In some cases, wood-processing residues may have a zero or negative cost, where a producer may pay a user for residues as an offset for disposal costs. In the past, typical situations would see wood-processing residue users paying only the cost of transport for residues, however this is changing due to raised expectations of producers that the residues have an increasing value.

Table 7.5 Indicative cost of wood-process residues for energy production ($/tonne)

Wood processing residue	Indicative cost (1) ($/tonne)	Comment
Wet sawdust and shavings	15 20	Includes the cost of the material and $10/tonne transport
Mixed hog fuel (bark and sawdust)	20 - 45	Includes cost of material, additional processing, transport and fuel management fee.

(1) Indicative cost is an estimate of the price paid to a supplier for a delivered fuel. These costs are indicative only and will vary on a site-specific basis.

Forest Residue

There is potentially huge quantities of residue from forest harvesting operations that could be processed into a homogenous fuel product. Current estimates are that this could cost up to 3-4 $/GJ ($40-60/tonne) delivered to a bioenergy facility. However, in the Tokoroa area, costs are reported to be down to $31/tonne delivered.

The economics of using forest residue as a fuel are fast changing as specialist mobile chipping/shredding equipment is becoming readily available. In the Rotorua/Tauranga area, there are now three units working. Mobile plant is able to be located at the harvesting skid sites where they can reduce the volume of biomass. This is then easily trucked to heat plant where it can be used as fuel.

Because of the lack of demand for heat energy and the availability of alternatives it is expected that forest residue is not likely to be suitable as a source of energy for heat production until post 2007, and electricity generation until at least the end of this decade. The cost of collecting, processing and transferring forest residue to a bioenergy facility adds an additional 5c/kWh to the cost of producing electricity.

A cogeneration arrangement would bring the timing of electricity production forward.

Wood/energy Crops

In a number of overseas areas purpose grown trees are grown solely as an energy source. With the abundance of forest residue already available it is unlikely that such plantings will occur in the region except as a strategic reserve for bioenergy plant owners and niche plantings e.g. to assist in lake cleanup.

Council Municipal Waste

Processing landfill waste is commencing at some NZ landfills but it is usually undertaken by independent parties who negotiate contracts with the Council and possible fuel purchasers. These parties utilise specialist equipment and are often able to spread costs over several activities. It can also be expected that they will only enter the market when they are able to sell the processed waste as fuel.

Agriculture and Animal Waste

With the value of energy in New Zealand it is not expected that crops will be purpose grown for energy this decade, however as energy sources change purpose grown crops are likely to be of greater interest.

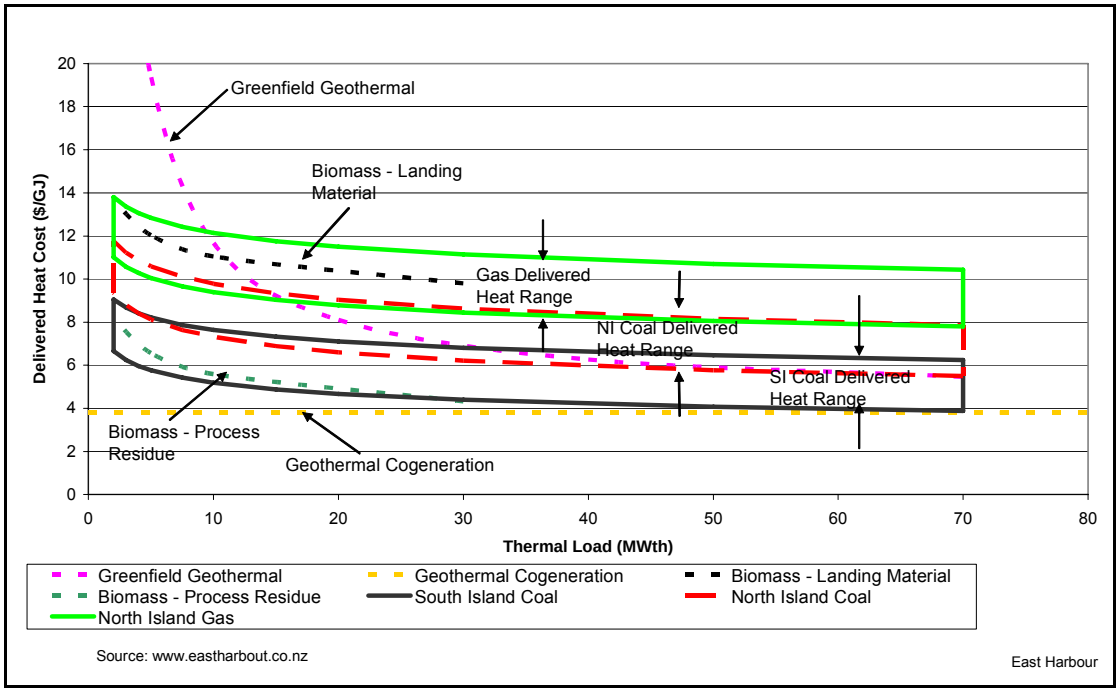
There are no large numbers of poultry, pigs, dairy or beef cattle in the district. Hence there appears to be little potential for the economic production electricity from biogas derived from the anaerobic digestion of animal manure.

7.3.1 Industrial Bioenergy

The conversion process to provide heat and electricity from woody biomass is commercially viable. There are a number of examples throughout the New Zealand wood processing industry.

Direct combustion of wood processing residues in 2-20 MW_{th} [90]boilers or furnace systems is a common form of conversion in the forest processing industry throughout New Zealand producing steam, hot water, hot gases or hot air. A typical large sawmill in the Rotorua area could have a 10-20MW_{th} heat plant producing heat for timber kiln drying. Where surplus heat is available, electricity production may be feasible for use on site or for export to the grid. Electricity production from such a facility could have an electricity generation capability of around 1.5-2.5MW_e. A smaller sawmill site is likely to have a 4 -6MW_{th} heat plant only for kiln drying.

Figure 7.9 Comparison of Unit Heating Costs for various fuels post 2007[91]



Currently wood-processing residue is considered to be competitive with coal or gas only for industrial heating. Biomass material from forest residue (Figure 7.9) or short rotation crops is generally too expensive because of waste collection and processing and transport costs. However in the Tokoroa area where there are some mobile chipper/shredders working forest residue processing and delivery costs have decreased significantly.

The economics of generation of electricity from a sole purpose bioenergy facility are such that while currently uneconomic, with increased gas and coal costs, electricity generation from bioenergy will begin to become economic. The economics will commence with investment in cogeneration facilities and then embedded electricity production leading to larger scale electricity production post 2012. Cogeneration is where there is a multi-use of heat for both process use and electricity generation. This combination often occurs on wood processing sites

Cogeneration provides a significant opportunity to hedge future industrial electricity costs but the capital expenditure is usually too great for a single site to fund by itself. Economies of scale may be realisable where several businesses can cluster to share capital costs. Recognising this, it is recommended that any new industry coming into the area should be encouraged to co-locate with other energy users.

The construction of cogeneration facilities is dependent on the host party needing heat. Generally there are two options available:

[90] MW_{th} = MWthermal,
[91] Source: East Harbour Management Services

- plant sizing is optimised and plant is designed for electricity generation as the primary output,
- the plant is sized and designed principally to meet process heat requirements with excess heat being used for generation of electricity.

This can result in plant being suboptimal within a few years when processor products change. Designing a plant configuration that minimises this risk is necessary.

For the combustion of biomass in the non-wood processing sectors such as education or health, the biomass is processed into pellets for ease of transport and on-site handling.

In the longer term independent heat and electricity generating utility companies could establish in the area to produce electricity and/or process heat for sale, based on wood-fired technology. Installations ranging from 10 MWe to 30 MWe (electric) output appear to be necessary in order to provide adequate economies of scale. The fuel source could be cutover, arisings, residues, tree crops or mixtures of all four. However such heat plant would need to be 30-90 MW thermal and would consume a large quantity of fuel each day. It would be a big investment with significant commercial risks unless designed and built around dedicated forests for fuel.

7.3.2 Bioenergy Economics

The most likely sized bioenergy facilities for Rotorua wood processing sites are likely to be plant of around 2-3 MW_e embedded into a wood processor site. With the probable shortage of on-site wood waste it is likely that for any plant size greater than this the biomass will have to be supplemented by forest residue.

For a cogeneration facility using on-site wood processing waste it appears that for a 10 MWth boiler feeding all the steam into a 2.6 MWe second hand steam turbine generator would result in electricity being produced at a cost of 9-11c/kWh. Use of a new steam turbine generator would increase the cost of electricity very significantly. Where the plant is used in a cogeneration mode of operation the electricity cost reduces substantially because of the “additional sale” of heat for process use. If forest residue was used the cost of electricity would rise to around 14-16 c/kWh because of the increased cost of the supplementary fuel particularly through the inclusion of transport costs.

7.3.3 Socio-economic Benefits of Bioenergy

In addition to providing energy, the production and/or harvesting of biomass (grown for energy) can provide a broad range of other benefits. Key examples relevant to Rotorua include the following:

- *Land application of effluent:* The establishment of short-rotation plantation crops, such as willow, eucalypts, or other suitable species, have been used locally and at other New Zealand locations as part of secondary treatment for effluents (Whaka effluent spray irrigation trial and Waihi effluent land-application system). The crop can be subsequently harvested as a feedstock for energy production, effectively removing the nutrients from the soil. Any ash or residues produced from combustion or other conversion systems can be recycled back onto the plot to increase soil fertility and promote subsequent crops.
- *Riparian nutrient stripping:* To minimise nutrient runoff from pastoral catchments, riparian strips can be developed consisting of short-rotation crop species. Provided the trees are harvested in an appropriate manner, then such riparian zones can become areas for biomass production suitable for energy. This concept is commonly referred to as ‘integrated land management and energy production’, and has been identified as having the potential to improving lake water quality.
- *Sludge strategy:* A feasibility study on various bioenergy scenarios (including biogas, heat and cogeneration plants) has been carried out by the Rotorua District Council to develop a long-term solution for wastewater sludge that meets the NZ Waste Strategy.
- *Diversion from landfill:* To minimise waste going to landfill, biomass such as domestic green waste and wood processing waste could be diverted to a bioenergy plant producing heat and/or electricity for local industry. In the Bay of Plenty it is estimated that more than 100,000 tonnes of landfilled material, including timber, paper and garden waste could potentially be diverted from landfill and used for bioenergy[92]. Based on population distribution, more than 20,000 tonnes could be diverted in Rotorua alone.
- *Air Emissions:* Rotorua has a significant air emission problem, which is related to the use of log burners and emissions from traffic and industry. Both Environment Bay of Plenty and the RDC are working on collecting data to better understand the problem. The replacement of log burners with

[92] T. Evanson and I. Nicholas, *The Potential of Woody Waste Going to Landfill as a Biomass Fuel* Scion (Forest Research) internal report.

clean-burning wood pellets is seen by Environment Bay of Plenty as one of the solutions to help clean the air in Rotorua.

7.3.4 Commercial Opportunities

Domestic Heating

The value in using firewood for domestic heating is an issue which has not generally been recognised as an alternative to electricity for heating. The replacement of open fires with high efficiency wood burners can be one of the most effective investments homeowners can make. If the wood burner is connected with a wet-back to the hot water storage cylinder electricity costs for heating water could nearly be eliminated during winter. This could be around 30% of household electricity costs. If the wetback is connected with a solar water heater then the heating of water by electricity could be eliminated year round. This would reduce household electricity cost by around a third.

Wood Pellets

The wood-pellet market is relatively new to Rotorua and New Zealand. The New Zealand market was initially developed with wood pellets being supplied from a manufacturing facility in Christchurch. More recently, Natures Flame (a subsidiary of Solid Energy) have established the largest wood-pellet plant in New Zealand in Rotorua. Key drivers for Natures Flame to establish the plant in Rotorua were the availability of feedstocks from the local wood-processing industry and the proximity to a number of major North Island markets.

The main target markets for the wood pellets are:

- Residential heating.
- Community buildings (schools, hospitals, district council facilities).
- Motels and hotels.

Strengths of Rotorua for wood pellets

A number of factors make Rotorua an ideal location for accelerating the deployment of wood-pellet energy systems. These are briefly outlined below.

- The use of solid wood or coal fireplaces and burners has an adverse impact on Rotorua's air quality during winter periods. Such impacts relate to the inefficient burning of home-heating fuels and the release of particulates and other smog-causing components. Wood-pellet burners are highly efficient due to their design and the consistent quality of fuel supplied. The use of wood-pellet heaters in more Rotorua homes would reduce emissions and markedly improve heating efficiency in older homes, or those belonging to lower socio-economic groups.
- Schools in Rotorua typically require heating for 5 months of a year. Existing heating systems in many of those schools can readily be converted to wood-pellet systems, as they typically consist of coal or gas boiler systems delivering hot water to a network of pipes and radiators. Three conversions from coal to wood pellets have been completed in Rotorua to date at Rotorua Girls' High School, Selwyn Primary, and Sunset Primary. Such conversions cost around $10k per school. These projects have been joint initiatives between Scion and Natures Flame and partially funded by the Rotorua Energy Charitable Trust. Other schools are currently being investigated for similar fuel conversions. If the 28 primary and secondary schools with a total peak heat demand at around 3 MW were converted, this would create a demand for a further 1000 tonnes of pellets.
- It is estimated that there are 3,000 hotel rooms in Rotorua and, collectively, these utilise around 78 GWh of energy/year. A large proportion of this energy demand (54 GWh/year) is for low grade heat[93]. Motels and hotels use much of their energy at peak times, i.e., mornings and afternoons, as this is when clients are using the facilities. These operations typically have hot-water boilers fuelled by gas. Such systems are amicable for conversion to wood-pellet heaters, the utilisation of heat storage, and possible cogeneration. The peak heat demand for the hotels is around 14 MW $_{thermal}$, with an average of 5 MW $_{thermal}$ over the year. If all hotels used wood pellets then 54 GWh of energy would be used, which corresponds to 10,000 tonnes of wood pellets. As many Rotorua hotels and motels are close to the Central Business District

[93] P. S. Nielsen and J. Gifford, *Transforming the forest waste streams into biofuels for energy: A case study on Rotorua*, Presentation at Wasteminz conference 2001

(CBD), this also suggests that a district heating system (designed to supply both heat and power) could be quite feasible.

Based on a preliminary analysis of the residential heating market, approximately 20,000 tonnes of wood pellets could be used each year (Table 7.6).

Table 7.6 Wood pellet utilisation scenarios for the Rotorua residential market

Scenario description	No	Firewood consumption Tonnes/year	Wood pellet consumption Tonnes/year
Present use of biomass	1	36,000	
If today's firewood stoves are changed to pellet stoves	2		23,000
Today's firewood stoves remain + all other houses install pellet stoves	3	36,000	21,500
All houses using pellets	4		44,500
All houses using firewood	5	71,000	

Pathway through barriers for wood pellets

Rotorua has a significant air emission problem, which is related to use of log burners and emissions from traffic and the industry. Environment Bay of Plenty is working on collecting data to better understand the source of the problem. The use of wood pellets is seen by Environment Bay of Plenty as one of the solutions to help clean the air in Rotorua.

Economics of wood pellets

In residential houses log burners are currently the cheapest options for heating and coal is typically the cheapest option for commercial applications. However, both of these forms of heating contribute to negative environmental impacts. In both cases it is likely that in the future their use will be regulated or new technologies, such as air-cleaning technologies, will be required for continued use. If log burners and coal boilers are required to be equipped with sufficient cleaning equipment, their use becomes more expensive and wood pellets may become competitive economically. Wood-pellet systems can supply heat at around six cents/kWh (for fuel only) for a range of applications.

From an economic perspective, what is perhaps more important is that a long transition is required to make the conversion to modern technologies less expensive. In other words, changing to a wood-pellet heater is much more cost effective when conversion is delayed until a log burner needs replacing, than by forcing early replacement.

Cogeneration

Cogeneration is the joint production of electricity and heat[94]. Cogeneration plants are typically located at sites with significant process heat requirements. On these sites fuel is burnt to produce electricity and the waste heat from this process is utilised on site. Due to the utilisation of the waste heat, cogeneration is an extremely efficient method of generating electricity and internationally is considered "best practice" energy management.

The advantage for sites is reduced energy costs. In addition, on a local level distributed electricity generation, such as this, can lead to a more robust electricity network, where the impact of the failure of a major power station or line is lessened by local generation.

Cogeneration plants are well suited to utilise local renewable energy resources, which can significantly enhance their ability to reduce greenhouse gas emissions. Even more benefits are possible if organic production waste, such as woodwaste, can be utilised as fuel in the cogeneration plant, diverting this waste from landfill.

[94] Similarly, tri-generation is the joint production of electricity, heat, and cooling and can be even more efficient than cogeneration.

Rotorua's Potential and Strengths for cogeneration

- *Local R&D at Scion:* The Energy Group at Scion has an active energy management research programme, including energy demand modelling for cogeneration plants. This modelling is crucial for designing, sizing, and determining the economic feasibility of cogeneration plants.
- *Specialist engineering expertise:* Allan Estcourt Ltd. of Rotorua (see Appendix 2) is one of a limited number of Energy Consultancies around the country specialising in the implementation of bioenergy installations such as biomass-fuelled cogeneration plants. Allan Estcourt has 20+ years of experience in the Bioenergy area.
- *Sawmills and wood-processing plants:* Red Stag's Waipa mill was one of the earliest sawmills to install a cogeneration plant. They use on-site woodwaste to generate electricity (5 MW_e) and heat (40 MW_{th}) for drying kilns, and excess electricity is sold back to the grid. Waipa stands as an excellent local example of the possibilities for cogeneration. There are 6 sawmills in Rotorua, including Tachikawa and Red Stag timber, collectively producing more than 500,000 cubic metres of sawn timber per year. In addition there are 6 major wood manufacturers. Some of the sawmills and the wood manufacturers already have heat plant fuelled on wood process residues and some could benefit from installation of cogeneration plants if they have surplus process residues after meeting their heat demand. It is estimated that the collective heat requirements of these industries could be of the order of 60 MW_{th}.
- *Community heating schemes:* There are some communities throughout Rotorua that could benefit from centralised heating systems, and the large heat demand from this type of community scheme can provide the opportunity for a cogeneration plant. For example, a feasibility study carried out by Scion on the hotels along Fenton Street in 2002[95] showed that a cogeneration plant of 2 MW_{th} could cover the base heat load of the hotels. The heat load is variable throughout the day, with the peak being 7.5 MW, so a cogeneration facility could benefit from some form of heat storage acting as a 12-hour buffer.
- *Municipal waste facility*: In a study completed for the Rotorua District Council[96] in which Scion took part, one scenario considered was for drying the municipal waste followed by combustion in a cogeneration facility. The size of the cogeneration plant considered was 12 MW thermal to cover the drying load and 1.2 MW electrical to cover the effluent pump load. The municipal waste was to be supplemented by wood waste.

Barriers and pathways to cogeneration

The main barriers to cogeneration plants are the low relative cost of alternative energy sources and the general lack of industry/community investment in energy management initiatives. One particular problem is that, while it is economically advantageous to generate electricity to replace usual consumption, it is less economic to sell back to the grid (due to large buy/sell price differentials), rendering many projects unfeasible. One solution to this may be to form "energy cooperatives", where a number of industries, or a community, operate on a mini-electricity grid with one point of contact to the main grid. In this way, electricity generated within the mini grid is effectively replacing electricity which would otherwise be purchased from outside, maximising the possible savings.

Resource consent is another barrier, with concerns about particulate emissions from biomass combustion, increased noise from generators and industrial smoke stacks spoiling natural skylines and views. Modern, highly-efficient, sound-proof equipment should be utilised to minimise these concerns about emissions and noise pollution. Educational programmes emphasising the benefits of renewable energy generation from biomass may sway public opinion.

Economic evaluation of cogeneration

Partnerships between Scion and local engineering firms in this area could produce a valuable spin-off industry of cogeneration plant design.

Assuming electricity is generated at 10% of the heat load in the above plants, collectively the above possibilities amount to approximately 8 MW of electricity generation. Assuming an avoided cost of electricity of $0.17 per kWh and 8000 hours of operation per year, this amounts to energy savings of almost $10 million per year for these industries and communities. On top of this there would be the savings due to more efficient heat production, fuel savings from using on-site waste, and reduced waste disposal costs.

[95] Scion internal report.
[96] RDC:Sludge Strategy, Dr Sean Barns, July 2005.

Liquid Fuels from Biomass

The transport fuel economy consumes 42% of the energy used in NZ, and is responsible for 46% of carbon dioxide emissions. New Zealand uses 6.3 billion litres of transport fuel (3.4 billion litres of petrol and 2.9 billion litres of diesel). New Zealand's geographic isolation and the fall-off of indigenous reserves make it especially vulnerable to fluctuations in the global oil market. It seems likely that the national economy will be severely impacted by sustained high oil prices. Fortunately, the legacy of New Zealand's previous experience with CNG and LPG, is an acceptance of alternative fuel technologies and imbues New Zealand with a significant advantage over many other developed nations in the adoption of alternative fuel technologies.

Both biodiesel and bioethanol are considered as alternative fuels to complement current transport fossil fuels. Biodiesel can be manufactured from waste oil and tallow, a waste product of the meat processing industry. It is considered that New Zealand tallow could produce 200 million litres of biodiesel, approx 5% of diesel fuel consumption.

Bioethanol, or ethanol derived from biomass, is a renewable resource that readily blends with gasoline to create a fuel for the transport industry that is easily stored and dispensed. Existing "E10" blends containing ten percent ethanol and ninety percent petrol are already in use in the US and do not require any modification to motor vehicles. Brazil makes even greater use of ethanol in "E10" to "E20" blends.

Ethanol produced from starch in corn or sugar cane has been successfully used as a transportation fuel in the US and Brazil for several decades. In the near future, ethanol's competitiveness as an energy source will improve through lower cost production. This will be achieved through the production of lower cost, dedicated energy crops containing high levels of cellulose, and lower extraction costs of separating cellulose from lignin and then converting the cellulose to sugars to be fermented into ethanol.

Potential feedstocks for bioethanol are:

- Maize.
- Grasses such as miscanthus[97].
- Lignocellulosic (woody) feedstocks such as pine (forestry residues, wood -processing waste).
- Coppicable woody crops.

Rotorua's Strengths for production of transport biofuels

- *Taupo Willow Biofuel Project*
  BioJoule Ltd, a company which has emerged from the plant programme of Genesis Research and Development Corporation Limited now held in AgriGenesis BioSciences and the Lake Taupo Development Company, has initiated a biofuel project based on willow as a feedstock. Willow has been proposed for three key reasons:
  - Ease of, and cost-efficient, establishment.
  - Vigorous early growth and ability to coppice (regrowth from the cut stump).
  - Efficient, continuous harvest systems.

  The project was originated from a search for alternative land use due to a concern over the decline in the water quality of Lake Taupo, thought to largely due to increased inputs of nitrogen from pastoral land. It is considered that the willow biofuel project has the potential to provide many positive outcomes for the Taupo area. These include:
  - Maintain agricultural infrastructure by providing another economic agricultural alternative.
  - May solve nitrogen problems in catchment areas.
  - Potential for capital investment into a biorefinery.
  - Good quality manufacturing, technology jobs.
  - Direct use of geothermal energy.

  In addition to available land, the Taupo area has another key resource for the process - geothermal heat.

[97] Miscanthus species are woody, perennial, rhizomatous grasses, originating from Asia and can be used as an energy crop. Miscanthus giganteus uses sunlight very efficiently which makes it very productive in terms of yield.

The project consists of developing processes using enzymes to break down starch and cellulose in willow to produce sugar for fermentation and lignin as a by-product. The biorefinery is being designed as a three product operation:

(i) Ethanol for fuel: Using a range of processes fibre is broken down into its sugar components and following fermentation produces ethanol.

(ii) Xylose: From hemicellulose, sugars for use in diabetic sugars.

(iii) Lignin: As a by-product of the process will be used in the production of bio-polymers, which is used as a binder or emulsifier in many industries including paint, food, building, and bioplastics etc.

A large amount of low-grade heat is also required for various parts of the production process and the local availability of geothermal heat represents a key resource.

The project also includes willow demonstration trials. In 2004 a small (2 ha) demonstration trial was established on Hauhangaroa 2C Maori Trust land to the west of Lake Taupo. This aimed to give an early indication of establishment issues and provided a demonstration site for potential stakeholders. In 2005 a much larger (4 ha) trial was established at Rotokawa, North of Taupo. Results from this trial series have provided pointers for establishment of a further 2 ha of best-practice demonstration plantings (Nicholas et al. 2006). One of the latest best practice trials has been established near Rotorua Airport.

As Rotorua has similar land-use issues to that of Taupo and similar geothermal resources, many of the drivers to deliver a similar biofuel plant are the same.

Alternatively, Rotorua is within the collection catchment of the proposed Taupo biorefinery, and could be used to provide raw material to a Taupo plant. This opportunity has been recognised by the Taupo project with one small trial established in Rotorua.

- *Bay Biodiesel*
  Bay Biodiesel is a Rotorua-based initiative that has recently started producing biodiesel from waste oil from cafes, restaurants and fish 'n' chip shops in the Rotorua area. This small, two-man operation can produce 1000 litres of biodiesel per day. Scion has been involved in testing and quality control of the biodiesel, which is of high quality, and the biodiesel is being run in test vehicles in a 50/50 blend with mineral diesel.

Research and Development of transport biofuels

Scion is the national research leader in biomass processing, tree growing, and pest management and has been involved in the willow trials. Scion is also New Zealand's leading bioenergy research organisation, having had a government-funded research programme for much of the last 20 years. It is also New Zealand's contracting agency for IEA Bioenergy, an international research and implementation collaboration involving 23 OECD nations and which gives direct access to over $1 billion of bioenergy-related R&D globally. In addition, Scion has recently formed a collaborative R&D arrangement with Diversa (a US-based biotechnology company) to investigate technologies for utilising existing pulp-based systems for ethanol production.

Barriers and Pathways for transport biofuels

An important barrier to the establishment plantations for biofuel crops is land-use competition. Emphasising the nutrient stripping benefits of biofuel crops in the proximity of the lakes will make this option more viable.

Barriers to establishment of a biorefinery are likely to be technical (due to the state-of-the-art nature of the technology), siting, and economic. Scion's involvement in international research collaborations will reduce the technical risks involved. Flexibility in resource consents will reduce the risks of finding a suitable industrial site and continually rising oil prices will reduce the financial risks.

Barriers to small biofuel producers such as Bay Biodiesel are finding early adopters (users) and the prohibitive expense of standards tests, which are designed for large producers. Rotorua District Council could act as an early adopter to provide incentive for small companies such as this to become established.

Economic evaluation of transport biofuels

A recent Royal Society study estimates that woody coppicable crop such as Salix[98] if used to produce ethanol in a biorefinery could provide a return to land owners of $350 per annum per hectare[99, 100].

[98] A species of willow

Preliminary calculations based on overseas pilot plants have confirmed these numbers, taking into account harvesting and transport to plant[101]. In the Royal Society study they identified 640,000 hectares centred about a point 30 km north of Lake Taupo that is currently yielding a net return of less than $350 per hectare per year. Even excluding land currently committed to pine forestry, this land would produce enough bioethanol to support a E23 (23% ethanol petrol blend) mandate on transport fuels.

7.3.5 The Rotorua Bioenergy Opportunity

Specialist Skills

Rotorua is in the centre of a major forest resource growing area, and is the largest centre providing a comprehensive range of goods and services to the sector. Within Rotorua there is a broad range of businesses that can readily expand and capitalise on the bioenergy opportunity through the supply of labour, specialist equipment for residue collection and management, design and construction of energy systems, research and development and training organisations which cover forestry and many other technical aspects. In addition, bioenergy could provide a number of additional socio-economic benefits, such as, waste management and nutrient stripping, which make it a very advantageous option for the Rotorua area.

Rotorua currently uses a broad range of energy forms: geothermal heat, biomass (wood pellets and firewood), hydro-electricity, coal and natural gas. Access to this mix is unique and provides an opportunity for Rotorua to investigate the means to utilise 100% renewable energy over the medium term. By transitioning from coal to biomass and then gas to geothermal or biomass, Rotorua could readily produce much of its heat energy from renewable and/or sustainable resources.

7.3.6 Implementing a Bioenergy Strategy for Rotorua

International examples have shown how bioenergy industries can grow substantially. In comparison, the New Zealand bioenergy industry is in its infancy and has the potential to grow immensely. Two possibilities for Rotorua to capitalise on the bioenergy opportunity have been identified in this study: the creation of a centre for Bioenergy Research, and the development of a Bioenergy industry through local developments in Rotorua. These possibilities are discussed further below. The pursuit of both these possibilities is likely to generate beneficial synergies through the interaction of research programmes with local industry.

Creation of a centre for Bioenergy Research

Through the Bright Economy Board and its programme, Rotorua has identified renewable energy as a priority area to focus on for economic development. Scion is New Zealand's lead bioenergy research organisation, having had a government-funded research programme for much of the last 20 years. Scion is also New Zealand's contracting agency for IEA Bioenergy, an international research and implementation collaboration involving 23 OECD nations and which gives direct access to over $1 billion of bioenergy-related R&D globally. This R&D capability, linked to the broad range of forestry and biomass handling expertise within the region and the potential to increasingly utilise biomass for energy, makes this area highly desirable for establishing a "Centre of Excellence" for bioenergy development and implementation.

The Clean Energy Centre, an initiative of the Lake Taupo Development Company, has recently received approximately $2 million government funding (Major Regional Initiatives funding from Trade and Enterprise) to support its development and promote Taupo's energy capabilities across a broad range of energy options, including geothermal. In the case of bioenergy, there is an opportunity for Rotorua and Taupo to collaborate and create a national "hub".

An "end-user" strategy for growing a Bioenergy industry Rotorua

International case studies show that growth in the uptake of bioenergy and the creation of a bioenergy industry begins with small entrepreneurial businesses moving into new opportunities. This is also likely to be the case in New Zealand. Rotorua already has a number of such entrepreneurial businesses working at the forefront of bioenergy developments in New Zealand (some of these have been discussed above). These companies face many challenges creating new bioenergy markets. In order to promote bioenergy as a sustainable form of locally generated energy and to develop a bioenergy industry in Rotorua, an

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[99] 2020: Energy Opportunities-Report of the Energy Panel of the Royal Society of New Zealand, 2006.
[100] Dairying has an average annual gross margin of $1200/ha or more
[101] K. Snowdon, personal communication.

environment should be created where these initiatives can grow. Two specific "end-user-oriented" steps that the Rotorua District Council could take to promote these initiatives are:

1. Acting as an early adopter of bioenergy themselves, e.g., running council fleet on biofuels, using bioenergy for heating council buildings, utilising bioenergy solutions for waste management.

2. Promoting the uptake of bioenergy by end users such as schools, hospitals and hotels by, for example, mail box flyers with rates demands. Support cogeneration initiatives at sawmills and district heating schemes that could use a combination of biomass and geothermal.

The long-term result of this approach would be to grow industry experience and expertise from a "grass-roots" level that can then be applied outside Rotorua.

7.4 Hydro Electricity

River systems directly associated with the Rotorua area are the Kaituna and Tarawera, with the Waikato River on the southern boundary of the District, the Wairoa to the north-west and the Rangitaiki to the east of the District.

There are a number of existing hydro power stations on the Rangitaiki, Waikato and Wairoa river systems, and a very early (1901) hydro power station at Okere Falls supplied Rotorua until it fell into disuse in 1936.

Existing power station schemes can be considered by their owners as candidates for enhancement if the outcome is cost-effective.

7.4.1 Hydro Opportunities – 1982 Report

As well as investigations of potential hydro power stations schemes in the Rotorua area during the 1950's to 1970's that, among other initiatives, resulted in a decision by the Rotorua Area Electricity Authority to construct the Wheao/Flaxy hydro scheme, an assessment of hydro potential in part of the Rotorua area was carried out in 1982 by the Ministry of Works and Development (MWD 1982)[102]. The Rotorua Area Electricity Authority was a member of the Steering Committee overseeing this reporting.

This assessment considered the catchments of the five main river systems in the Bay of Plenty Catchment Commission's Region. These river systems are (from west to east); Wairoa, Kaituna, Tarawera, Rangitaiki and Whakatane.

The MWD 1982 report includes comprehensive listings of 68 possible schemes with outputs of between 0.5 and 50 MW for the river systems. The information on these schemes was largely derived from previous studies and "desktop" studies, including examining topographical maps of the area.

These lists were then ranked on the basis of indicative economics and feasibility resulting in some 44 schemes identified for further study.

The third phase of the study isolated 28 schemes that appeared to be able to be developed for less than $4100/kW (1982 $ terms). A reproduction of Table 6.1: Summary of economic schemes, from the MWD 1982 report is included as Appendix 5.

Seven of those schemes (effectively four schemes with variations) were assessed as being able to be developed for less than $2100/kW (1982 $ terms). The costings are indicative. These seven schemes had all been previously studied.

There are some aspects of these results that are of note:

- Of the 28 schemes, ten have outputs of less than 10 MW with a combined total of 12 MW.
- Seven of the 28 schemes are associated with the Kaituna River but, as some are mutually exclusive options, there are effectively three schemes with variations using three sections (reaches) of the river.
- The report's authors comment that their report should be considered a regional inventory of schemes requiring further specific study.

[102] Assessment of Local Hydro-Electric Potential – Bay of Plenty Catchment Commission Region; Ministry of Works and Development, Hamilton District office, Civil Engineering, December 1982

7.4.2 Hydro Opportunities – 1990 Report

In 1990 the Ministry of Commerce (now the Ministry of Economic Development) commissioned a report titled "Hydro Resources of New Zealand.[103]. This report included schemes greater than 10 MW using remaining hydro-electric generation potential throughout New Zealand that had been described in previous work.

The report identifies schemes in the Rotorua area including those above 10 MW output on the Kaituna, Tarawera and Rangitaiki river systems reported on in the MWD 1982 report. The report also includes a possible scheme on the Waikato River at Parariki at the head of Lake Ohakuri, noting that it would inundate the Fulljames Rapid.

Kaituna Hydroelectric Power Scheme

Bay of Plenty Electricity is proposing a 13.5 MW Kaituna Hydroelectric Power Scheme at an estimated cost of $40 million that will have the capacity to generate power sufficient to supply approximately 10,000 homes or 15 per cent of Rotorua's energy needs and will be embedded close to where the energy is needed. The present focus of this project is to obtain a concession from the Department of Conservation to allow the use of a small part of a reserve for the scheme before then seeking resource consents.

7.4.3 Small hydro

Small hydro opportunities are generally of a size that is within the capability of the local electricity supply network at around 5 – 10 MW of generation. Most of these projects have not been investigated in recent years because they have previously been considered too expensive relative to gas generation elsewhere. However as embedded generation within the area's electricity network under current Rotorua area electricity prices small hydro would appear to warrant further investigation although it is not expected to be economic in the short term.

7.4.4 Rotorua Small Hydro Opportunities

Although there have been a number of opportunities investigated in the Rotorua district and surrounding areas before 1982, the criteria for such investigations were often narrow and may no longer be applicable today.

Recent studies by some potential developers have focused more closely on optimising the unit cost of generation by reducing the installed capacity, applying "value management" principles to reduce costs without reducing functionality, and by undertaking more comprehensive cost estimates involving civil contractor and machinery supplier input. The result generally has been a dramatic reduction in unit cost of generation, more than 50% in some cases.

This analysis demonstrates the significant advances that have been achieved in lowering the cost of generation of the hydro schemes studied during the recent phase of investigations. This is attributable to a number of factors such as a move away from a philosophy of maximising resource utilisation (i.e. high installed capacity/low plant factor) to one of optimising unit cost of generation, lower costs of generation equipment, more cost effective design, specific attention given to transmission (including proximity and access to existing electricity distribution or transmission lines with adequate capacity), technological advances in both the permanent works design and construction equipment and productivities, and a more competitive construction industry.

The 13.5 MW Kaituna Hydroelectric Power Scheme that Bay of Plenty Electricity (BOPE) is progressing is an example of this. An earlier project (Scheme D1b in Appendix 5) used water over the reach of the river below Trout Pool and included a canal capable of delivering water to a 37.5 MW power station. BOPE decision to use only part of the reach of the river that the original scheme extended over and adopt a higher plant factor (increasing the utilisation of the canal) has resulted in a much more cost-effective outcome from the one reported on in 1982.

It is likely that a number of other potential schemes throughout New Zealand have not been subject to the process outlined above and some have (noting that the results are most unlikely to be in the public domain).

The 1982 study of hydro-electricity potential in the Bay of Plenty area indicated there could be of the order of 110 MW of feasible generation from the Kaituna and Tarawera river systems. Because developments are likely to make more cost-effective utilisation of the water resource (flow and head) as

[103] Hydro Resources of New Zealand – Prepared by Works Consultancy Services (G W Mills, R J Aspden and R E Stewart); edited and published by the Ministry of Commerce, April 1990

Bay of Plenty Electricity are with its proposed 13.5 MW scheme, this figure of 110 MW should be considered “high” in the present day context.

The critical aspects for any development will be overall economics and acceptability of environmental effects and mitigation measures.

It is recommended that new investigations should be encouraged.

7.4.5 Micro Hydro

Some parts of the Rotorua district have areas where micro hydro electric generation may be attractive in the future. Such generation, when configured as distributed generation, would avoid the need to upgrade old or undersized distribution lines where there are few electricity users. Another use would be to operate on a stand-alone basis for a specific need where connection to the network is a more expensive option.

The key aspects of a micro hydro plant are:

- Height of head of water from source to turbine.
- Water flow.
- Length of electricity line to energy user.
- Synchronisation with other electricity sources.
- Maintenance.
- Backup electricity or pumping source during maintenance, low water flow, or fault.

The economies of scale for micro hydro plant is such that few schemes are economic unless included in part of an isolated integrated electricity scheme with other electricity sources such as solar and wind. Unless operating as stand-alone equipment not connected to the network, the need for synchronisation creates significant additional cost and complexity to integration with grid commanded electricity supply.

7.4.6 Barriers to Hydro

The most significant barriers to any of the schemes possible in the area are potential environmental effects. The schemes referred to are all technically possible but the mitigation measures that may have to be taken for some schemes may increase the costs so that they are uneconomic. The potential environmental effects of the schemes listed are however possibly less significant than is likely with many other alternative projects that may have to be considered within the next decade if the community wishes to increase energy use.

The distance of hydro sites from existing transmission lines is a significant cost impost that results in a number of schemes not being economic.

Hydro has high upfront costs for investigation and consenting. Investors are unlikely to spend the large sums necessary for investigating a hydro project if there is a low probability that the scheme would obtain resource consents. If the community wishes to have hydro as a source of secure electricity supply then the community needs to signal to investors that hydro projects are welcome. Landowners’ involvement in projects is essential if projects are to proceed.

7.4.7 Opportunities for Hydro

Hydro energy can be accessed in a more benign way than some other sources of energy, which will be the focus of the future.

Construction of hydro electricity generation schemes can be undertaken in harmony with the environment and meet community expectations. The establishment of District and Regional Policies and Rules that ensure a mitigation of effects will assist potential developers of schemes to feel encouraged to become involved.

Further hydro energy development will only proceed if the community accepts that modification of land use for such projects is acceptable (provided this is done properly).

One area the council should investigate is where water supply schemes in the district have high head and in-line hydro turbines could be installed to generate electricity.

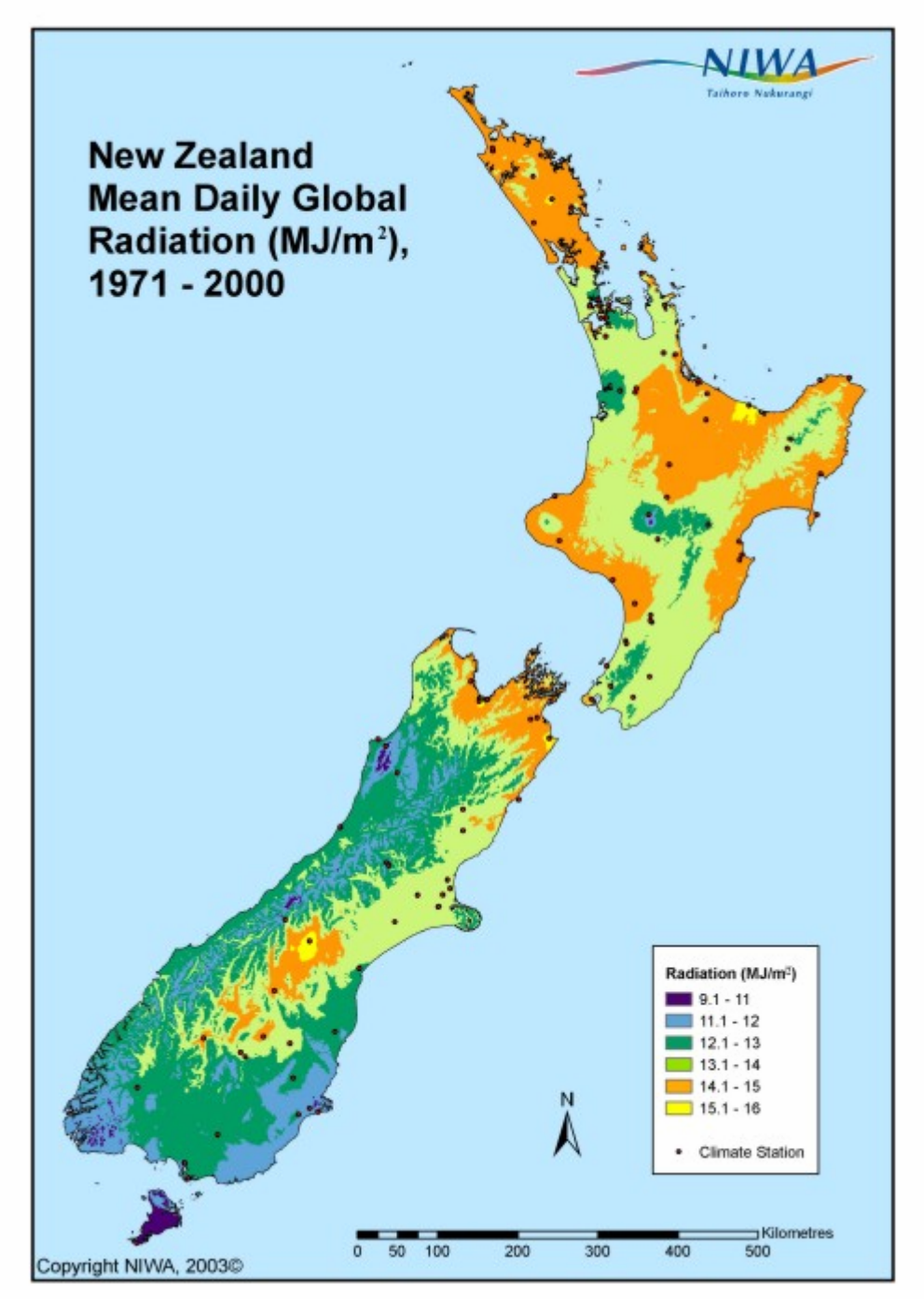
7.5 Solar

There are two solar technologies available to the district: solar water heating and the production of electricity using photovoltaic cells.

7.5.1 Resource

Figure 7.10 below shows that the Bay of Plenty region is attractive for solar energy being one of the better areas in New Zealand with Rotorua having a Mean Daily Global Irradiation of 14.1 MJ/m^2 (although less than Tauranga which has a figure of 14.6 MJ/m^2). Rotorua is the same as Hamilton and greater than Wellington. The 2,117 annual sunshine hours is greater than Christchurch (2,100) and Auckland (2,060).

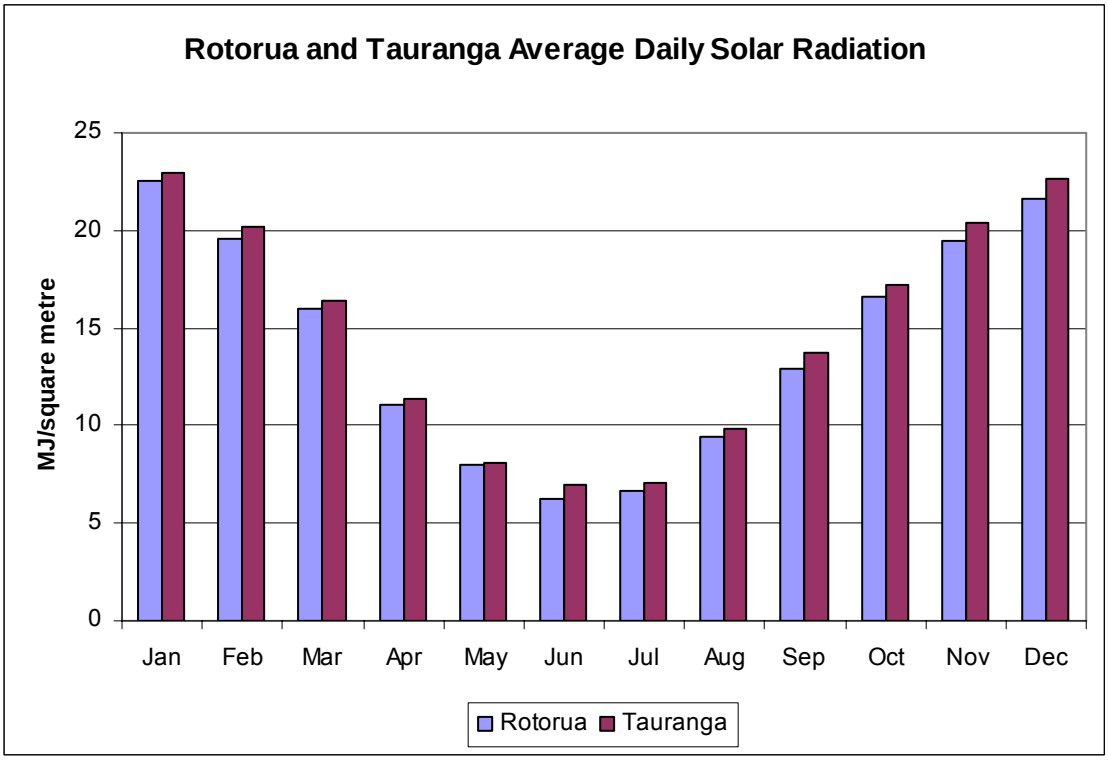
Figure 7.10 Mean Daily Global Irradiation (MJ/m^2), 1971 – 2000.[104]



The seasonal variation in solar irradiation for Rotorua is shown in figure 7.11 which includes a comparison with Tauranga. From the graph it can be seen that Rotorua has lower daily radiation than Tauranga each month of the year except for May when it is almost the same.

[104] Source NIWA web-site.

Figure 7.11 Comparison of Rotorua and Tauranga Monthly Average Solar Irradiance[105]



7.5.2 Solar Water Heating

Solar hot water heating systems are readily available in New Zealand and their performance is well established. While systems have been around for a number of years the market has not been developed because of the lack of strong industry players and public perception. The Government is currently promoting and supporting the expansion of the solar water heating market and this is having a marked effect in several regions of the North Island.

For a 2-4 children family, approximately 40% of household electricity is used to produce hot water. The installation of a solar hot water system can annually save approximately 70% of the electricity otherwise used to produce the hot water. This means that approximately 30% of household electricity (8,000kWh pa) can be saved by installation of a solar hot water system.

A solar hot water system can be installed in existing and new buildings. Costs of installation can be reduced if the system is incorporated in initial building design.

Solar water heating can be used as a pre-heater for industrial / commercial applications using significant volumes of hot water, e.g. fast food outlets, bakeries, food processors, rest-homes, motels, motor camps etc. There are a number of these applications where the installation of solar water heating can provide financial benefits to facility owners, while having a significant effect on the electricity supply to the district.

In a large commercial application, hot water can be available from solar systems at around 5c/kWh.

The installation of solar hot water systems has an up front capital cost but on-going electricity costs are reduced by 30% in a residential application. This results in the capital expenditure being paid off within about 10-12 years for 2-4 children residential dwellings, and approximately half this for industrial commercial applications.

The most significant barrier to uptake of the use of solar water heating in the district is the lack of knowledge and experience locally.

The New Zealand solar industry has been extending its capacity in areas such as Auckland but this has only now commenced in areas such as Rotorua. National solar industry capacity building has been based on implementation of quality systems, knowledge and experience, and development of trained personnel. The area needs to build on this national industry capacity building. This also is an opportunity for providers such as Waiariki Institute of Technology to supply the training.

[105] Source NIWA web-site

The district can speed up the time before the solar water heating industry expands to the area by taking local initiatives. These could include:

- Local promotion of solar water heating by 'mail-out' with Council rate demands,
- Distribution of information on solar water heating with building consent information,
- Public seminars on solar water heating,
- Encouragement of local plumbers to be agents for system suppliers and
- Adoption by an existing community Trust of a solar water-heating programme.

The capital cost of a solar hot water system can be a significant barrier for many people. An attractive option is to make a monthly payment to an electricity bill rather than have an upfront capital expenditure with benefits occurring in the future. This can apply to both residential and commercial applications. In some overseas locations, this has been addressed by the electricity supply company, or another party such as a Trust or municipal council, installing the system and having a lease to buy arrangement with the building owner. This can be of particular benefits for rental property where the tenants of a property obtain benefits from reduced electricity costs but the investment is a fixture on the dwelling. The district may be able to set up such a scheme.

Housing NZ has a house modernisation programme which in some areas includes installation of solar water heating. Current joint EECA - Housing NZ initiatives are focussing on how a greater number of solar water heating systems can be installed in Housing NZ properties. A District energy champion as proposed by this assessment would therefore also need to work closely with local Housing NZ staff to attract any installations to the district.

There is currently a shortage of solar water heating system installers throughout New Zealand despite the increase in demand for this technology. Therefore, it is reasonable to expect that significant business opportunities may exist. However, it is also recognised that there is a role for skills development and this may be an initiative that the Waiariki Institute of Technology may wish to pursue.

The value of a solar hot water heating system may not be reflected in the property value. Bright Economy should support the work of EECA on their proposed Home Energy Rating Scheme (HERS) and encourage its introduction on national basis so that the value of a solar water heating system is reflected in the value of a building.

7.5.3 Solar (Photovoltaic) production of electricity

Solar energy can be used to produce electricity at around 105-150c/kWh. In isolated applications such as on farms where long electricity lines would otherwise have to be built this is very cost effective. However, while photovoltaic equipment costs are reducing annually the technology has not yet reached the maturity level for wider mass-market application such that it could affect electricity supply to the district, particularly for on-grid applications. The difference in cost between on-grid and off-grid depends on the need for batteries or rectifiers.

The production of electricity from solar energy by use of photovoltaic (PV) cells is well established within a number of niche applications throughout New Zealand. These applications are generally in off-grid situations where the option of installing a power line for mains power would be uneconomic.

The main applications are:

Consumer products – e.g., calculators, watches, toys. They also included individual power supplies (caravans, mobile homes, boats) and individual supplies for novelty products (home security, garden lighting, car sunroofs, fans and battery chargers).

Industry applications – PV systems can be used in "professional systems" provided by companies active in the communication industry and the cathodic protection industry. New Zealand's electric fence industry is a substantial and a good example.

Standalone Power System (SPS) applications – These are applications in the watts to kilowatt size range located at sites remote from the main distribution grid. This will be a pivotal growth area for applications like water pumping, water treatment, electric supply to rural uses and communications links.

Grid connected distributed supply system applications – These systems are simpler than SPS as they require only PV panels and inverter to provide AC voltage and connect to the local distribution grid. The main electricity supply acts as a storage facility, receiving electricity at times of PV surplus and supplying it at times of PV deficiency, hence there is no need for a battery system.

The competence of design and installation will be critical for the public gaining confidence in PV systems. Similarly, it is essential that owners know how to properly monitor the system. Throughout the assessment, the authors found installation that would fail through poor design or maintenance. If the public gain a poor perception of early PV installations from some failure, then the uptake of PV will be put back a number of years.

Currently, on-grid PV generated electricity costs around 105c/kWh. However, the unit cost is dropping rapidly such that over the period to the end of the decade, PV is likely to mature and enter the domestic-level grid-connected market. As such, PV will be competing against the retail cost of electricity (~20c/kWh) rather than wholesale alternatives (~8 c/kWh). As for other solar energy options, there is significant development in the area of PV energy technologies and related energy management systems and costs and efficiencies are being improved to the point where in some situations this technology may be a viable option for embedded energy requirements.

It is assessed that by 2012 and based on current technology the unit cost will be in the 31-48c/kWh range, and by 2025 in the 14-21 c/kWh range for grid connected applications.

7.5.4 Barriers to PV technology uptake

The main impediment to the uptake of PV technology has been its high cost compared to grid electricity prices.

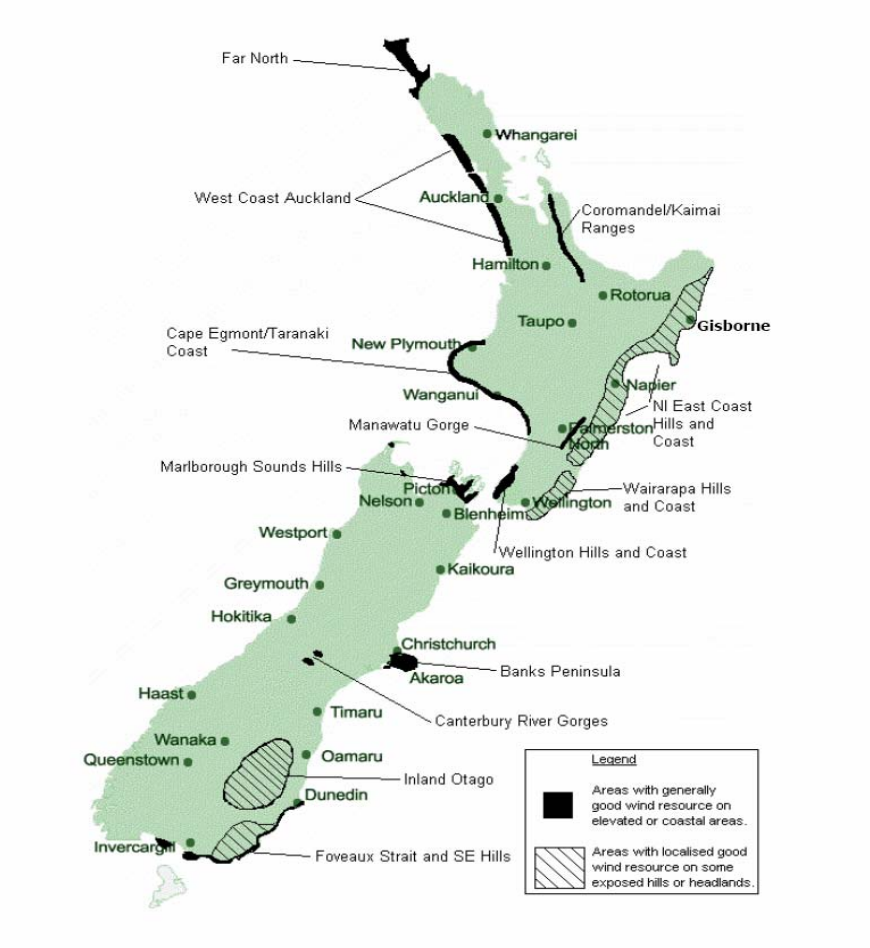
It is recommended that the district establishes a photovoltaic electricity programme to assist potential users to properly install and monitor their systems. The programme should also develop demonstration sites so that potential investors in PV can gain first hand knowledge of good design and maintenance skills. This is also an area where the Waiariki Institute of Technology in Rotorua may wish to introduce skills training.

7.6 Wind

7.6.1 Wind Potential

The Rotorua area has generally low average wind speeds (Figure 7.12) and therefore it is unlikely to be a suitable area for the installation of wind farms that will be economic.

Figure 7.12 Wind Map of New Zealand[106]



7.6.2 Small Wind Turbines

There is a market for small wind turbines to supply electricity in rural locations; however the wind resource is likely to be low. Examples include the supply of electricity to remote locations such as houses, farms, pumps and telecommunications facilities. Small wind turbines for remote applications are usually optimised for battery charging. Inverters to generate AC electricity can in turn use this battery power.

7.7 Biogas

Biogas is commonly produced by anaerobic digestion as part of the treatment of wet organic waste. This occurs in municipal wastewater and sewage treatment plants, industrial operations that have liquid wastes containing organic material, and on farms using animal waste.

In many cases, because of small waste volumes and relatively high capital costs, treatment of the waste to produce biogas is not economical in itself but is carried out for other reasons such as waste management, or reduction in greenhouse gas emissions. Also, small-scale generation of biogas is rarely economic because of the high labour requirements and dilute nature of the effluent being treated. However, for larger volumes, as is the case with large dairy farms or industrial processing, the production of biogas can be economic, particularly if waste cleanup that would otherwise be required is avoided.

Biogas from the digestion of crop materials is typically 55% methane and from animal manures typically 65% methane.

The biogas can be used as a fuel in a number of different types of plant such as reciprocating gas engines, mini-gas turbines, Stirling engines, and fuel cells or by direct combustion in boilers or other combined heat and power heat plant.

[106] Source: Review of New Zealand's Wind Energy Potential to 2015, Energy Efficiency and Conservation Authority (EECA).

Anaerobic digestion is a mature technology and is used worldwide, particularly for municipal wastewater treatment. Here the scale of treatment can justify the costs of installing and operating the equipment needed. Biogas from anaerobic digestion is essentially a continuous process so it requires a reliable continuous feed of material.

There are significant environmental benefits from waste digestion. These include reduced impacts of the effluents and solid waste disposal. Sludge from the digesters can be returned to the soil as fertiliser.

Dairy Waste—The estimated cost of electricity generated by a 20kW biogas unit on a large (460+ cow) dairy farm is around 17 c/kWh. Cost savings from avoided effluent disposal would reduce the effective cost of electricity generation. However, there has been very little work undertaken on this technology since the 1960-80 period. It is suggested that a work programme be initiated to investigate the environmental and financial opportunities, resulting from installation of digesters on large dairy farms particularly new operations, as they are converted to dairying.

Municipal Wastewater—Analysis of municipal waste indicates that around 55% of it is composed of organic waste that could be converted to energy in a digester. An assessment should be undertaken of the Rotorua sewage scheme (referred to in section 7.3.4 in relation to cogeneration) to identify if it would be suitable for production of biogas for electricity generation.

Industrial Liquid Waste—An assessment should be undertaken to identify if there are several industrial agricultural product processing sites where the liquid waste could be put in a digester to produce energy.

8 Efficient Use of Energy

The balance between supply of and demand for energy can be affected by either increasing the supply or decreasing the demand for energy. There are a number of demand side initiatives that are available to the district. A key aspect about them is that many are within the ability of the district to implement without the need for involvement of external parties.

8.1 Ripple Control

Ripple control is a means for the control of electricity use in electricity supply networks i.e. control of the electricity consumption using an existing electricity network as a signal transmission path. The system enables remote on or off switching of different loads, typically hot water heating.

The Rotorua area has fully operational ripple control that has been used very effectively in managing peak electricity demand. Ownership of the signalling equipment and receivers lies with Unison. Ripple control is one of the area's most valuable energy management tools as the Unison Transpower connection costs are determined by the 12 highest half hour peak demand levels in a rolling 12-month period.

The district should seek from Unison regular reports on how it is using ripple control. From this data the district should be able to assess whether the technology is being used for the benefit of the district.

8.2 Energy End-Use Efficiency

Investment in energy efficiency opportunities is one of the best investments that a community can make. By ensuring energy use is optimised, the home or business owner is able to use the expenditure saved on other things. Business costs can be reduced, or as most often happens, the money released is used to invest in other home or business equipment.

Investment in energy efficiency does not always lead to a reduction in the total energy used, but may result in reduced costs of production and increased productivity. Improving energy efficiency results in using less energy to achieve the same 'benefits'. If the end user can achieve greater benefits from using the same amount of energy, there is a possibility they will do just that. In industry, they may chose to increase production whilst energy use remains unchanged. In housing, they may chose to increase their comfort whilst energy use remains unchanged. The result is that personal or business objectives are maximised at a lower cost, or conversely less energy is required to achieve greater benefits.

Investment in energy efficiency is a key recommendation of this assessment as it will result in a freeing of currently inefficiently used energy to improve Rotorua business activity, thus leading to greater business growth, and the attraction of new business opportunities.

There is very little information on how energy is used in Rotorua. However extrapolation of information obtained from EECA studies of other areas and nationally gives an idea of how energy is used in Rotorua

and of the opportunities available. The Rotorua NOW Home[107] provides an example of energy efficiency application in the home. Design principles and equipment used in this home could be applied to other new homes in the District.

A key recommendation of this assessment is that the district works with government agencies to establish a sound database of energy end use in the district. This may include extension of the BRANZ Home Energy Efficiency Project which has been monitoring home energy use throughout New Zealand. Similar work should be undertaken for commercial and industrial energy users.

Some information is available from previous studies and these should be collated and disseminated as case studies to other similar energy users. Too often valuable information is not shared with the result that the community at large does not benefit.

8.3 Energy Efficiency Improvements for Business

Businesses and significant electricity users are generally in the situation that they use energy without having thought of the most efficient ways, or not having reviewed the way in which additional electricity using equipment has been added over the years.

Many companies also don't have anyone on staff taking an interest in the electricity contracts they have signed. For a number there may be a more appropriate contract for them.

Two initiatives can be taken by the Rotorua business communities. The first is to organise a series of seminars to increase the knowledge base on electricity contracts and energy efficiency improvements available. Improved knowledge of alternative energy contracts available may reduce electricity supply costs.

Secondly, and at the same time, a programme of energy audits should be undertaken. Funds are available from EECA to assist with the undertaking of audits and support may also be likely for a seminar programme. Economies of scale of bringing appropriate personnel to the district are possible if seminars and audits are undertaken as a block programme.

Opportunities for improving energy efficiency in the industrial sector span a range of technologies such as motors, heat exchangers, process heating and cooling optimisation, mechanical vapour recompression, cogeneration, and infra-red heating, amongst others.

EECA reports indicate that by employing readily available technologies and behavioural changes, the following magnitude of savings could be expected in the general New Zealand industrial sector. Around 20% of the current electricity used could be saved, mostly in electrical motor drive systems.

- About 55% of the coal currently used could be saved. The major source of this potential saving is from improvements in the combustion efficiency of boilers and in the efficiency of medium temperature process heating.
- About 25% of the current wood fuel use could be saved, mostly in medium temperature process heat production.
- Approximately 4% of the oil currently used could be cut, mostly in the areas of low temperature process heating, medium temperature process heating and in mobile motive power.

With monitoring of electricity use, the power factor on industrial sites can be identified and if low adjusted to achieve cost savings. The installation of electricity time-of-use meters can provide the energy use information that managers need in order to identify opportunities for cost savings.

The large energy intensity variations across companies within any given group of the industrial sector indicate sizable benchmark energy saving opportunities. For example, in the forest processing industry, if all of the companies which consume more energy per unit of physical production than their respective sub-sector averages are lifted to their sub-sector average levels, then the forest processing industry as a whole could save up to 14% of its current energy use.

EECA also has a Fleet Transport Audit Programme that should be utilised for commercial transport fleets.

[107] http://www.nowhome.co.nz/the+rotorua+now+home.aspx

8.4 Energy Efficiency Improvements for Residential Housing

The government has a number of home energy efficiency programmes available. Funding for these is available on a contestable basis and is best accessed by energy trusts or other similar type entities that have the ability to negotiate contracts and manage their implementation. Funding was increased in 2004.

In addition to possibly achieving electricity demand reduction and reducing household electricity costs, the improvement in residential energy use has major benefits for health and welfare. Energy efficiency usually increases the winter household temperature and warm people are likely to be healthier.

The Rotorua Now Home[108] is an example of energy efficiency application in the home.

Implementation of some or a mix of these however will only defer the timing of transmission line upgrade – it will still be needed at some time in the future.

8.5 Electricity Demand Management

Business energy users are often able to purchase a component of their electricity based on electricity spot price and have the ability to structure their operation to reduce load at peak times.

9 Residential Energy

The energy issues facing the residential communities in the Rotorua District include:

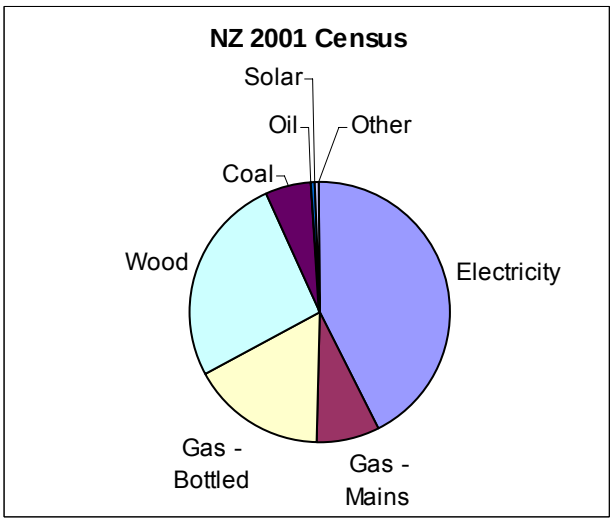
- the availability of basic quality of warm housing,
- high electricity and energy costs in the district,
- the reliability and quality of electricity supply in the area,
- the utilisation of alternatives to electricity for heating and cooking etc,
- the delivery of electricity to remote areas post 2013, and
- the use of single-phase lines to meet rural electricity users needs.

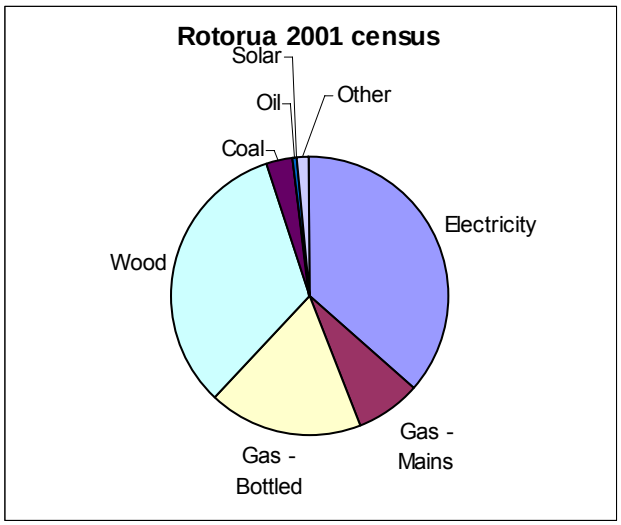
9.1 Residential Energy Programmes

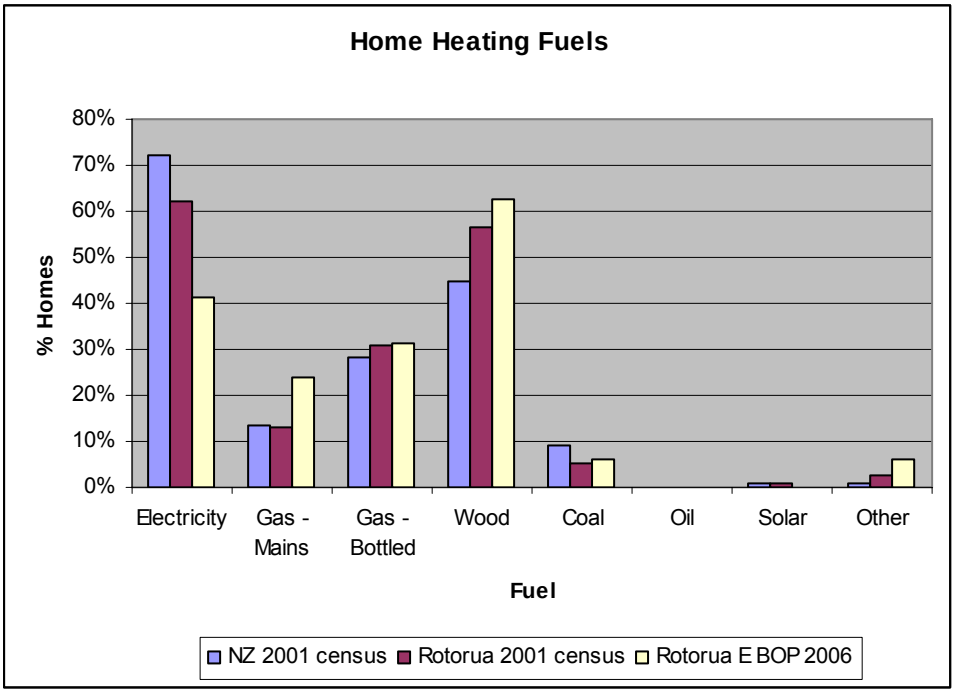
When compared to the national situation for residential heating, the Rotorua District uses more wood and more gas (mains and bottled) for home heating. For New Zealand as a whole, electricity is the dominant source of heating though this is considerably less in the Rotorua district. Geothermal heating is also a characteristic of residential heating. Solar heating nationally and in Rotorua District is less than 1%. This is illustrated in Figure 9.1 using pie charts and a graph.

[108] http://www.nowhome.co.nz/the+rotorua+now+home.aspx

Figure 9.1 Home heating fuels in Rotorua compared to National usage.[109, 110]







It is often estimated that up to 8% of annual residential energy use could be saved through adoption of basic, widely available, low to medium cost energy efficiency measures. Many of these savings could be achieved quickly and at very little cost. This estimate has been reinforced during 2001 and 2003 when Government promoted savings were of that order. An 8% saving in Rotorua's residential electricity use would be about 37 GWh per annum.

A summary of some of the benefits from home energy efficiency improvements is shown in Table 9.1. For comparison with other supply opportunities it can be considered that over a ten-year period that investment in the residential energy efficiency items shown in Table 9.1 is equivalent to electricity supply at around 9c/kWh.

[109] Source: Statistics New Zealand, Census Data 2001, Regional Council and Urban and Rural Area by Fuel Type Used to Heat Dwellings.

[110] Environment Bay of Plenty Domestic Heating Survey, September 2006

Table 9.1 Estimates of Benefits from Residential Energy Efficiency Measures[111] [112]

Energy Efficiency Measure	kWh saved/yr	Average Installed Cost*	Est. cost savings/ yr at 17 c/kWh ***	Est. cost savings over lifetime of measure	Simple payback (years)	Net benefit over lifetime of measure	Lifetime CO_2 emissions reductions (tonnes of CO_2)
Hot water cylinder wrap (R value 1.1; 1970's cylinder)	525	$120	$89	$714	1.3	$594	2.62
Hot water pipe lagging	120	$25	$20	$163	1.2	$138	0.60
Compact fluorescent light bulb (6 - 10,000 hour life)***	83	$8	$14	$68	0.6	$60	0.25
Low flow shower head (reduction in flow of 4 l/min.)	440	$50	$75	$598	0.7	$548	2.20
Weather stripping (all windows, doors and gaps)	168	$150	$29	$140	5.3	-$10	0.51
Under floor insulation	287	$900	$49	$512	18.4	-$388	1.88

Residential energy programmes can be thought of in terms of short-term, medium term and long-term activities as follows:

- ***Short term activities***

There is a number of immediate solutions that can be employed to improve the comfort and warmth in the homes of people in the district. Alongside measures required in some localities to upgrade properties to acceptable standards, initiatives include draft proofing windows and doors, heavy curtains (for low income people these can be from curtain banks) and retrofitting insulation in the ceiling and floor and pipe and water heater lagging.

Other savings can be made by homeowners seeking a low-user electricity tariff. Home owners need to check to see if they are on the appropriate tariff.

- ***Medium term activities***

In the medium term, there are several initiatives that the individual and groups can be exploring to reduce their electricity usage (through efficiency and use of alternatives) while planning for what may or may not happen in 2013. In addition to those short-term measures outlined above, people could consider retrofitting existing houses with an alternative more efficient heating source than they currently use. Other measures include the installation of solar water heating systems (currently supported through government grant schemes). Currently, for homes connected to the national grid, electicity from photovoltaic (PV) cells is not an economic option. If, however, a new house is being built, the cost of PV may be comparable to the costs of network connection depending on the property location.

The tradition of the Maori communities in the area is to live in groups and clusters and these homes would be well placed to share the costs and benefits from such co-operative living. This is an exciting possibility for housing clusters in the area.

- ***Longer term Activities***

In the longer term and in light of the lines companies not being required to maintain rural lines post 2013, PV cells may be an attractive option for new off-grid homes and for homes in remote areas. Cluster

[111] Data source: EECA
[112] Notes:* Installed cost estimates are mid range averages for a single residence job. ** All savings estimates based on 110m^2 house, Gisborne climate zone and domestic energy charges of 17 cents/kWh.*** Lights are assumed to be installed by householder.

housing especially in the more remote locations in the district could combine PV with other renewable resources such as small or micro-hydro and small wind or with diesel gensets or bottled gas.

- ***Programme of Activities***

Table 9.2 Summary of Activities per Period

	Meeting current and future energy and electricity needs		
Period	**Short term**	**Medium Term**	**Long Term**
Solutions	• Advice and understanding on ways to use less energy and be more efficient • Develop a curtain bank • Take advantage of insulation programmes • Draft proofing • Consider alternative heating sources • Solar water heating option and the organisations that can help • Retrofitting alternative heating options (eg wet back wood burning stoves)	• Small scale renewables option • Cluster housing and possible economies of scale for technologies such as PV	• PV for off-grid new build homes and those in remote areas.
Difficulty/Cost	Minimal difficulty and no to low to medium cost	Medium to high cost	High cost
Funding Opportunities from Central Government	Insulation programmes for Community Card holders. Solar water heating grants/loans		

9.2 Programme Funding Problems

The district has been a recipient of some energy programmes to assist the provision of warm and healthy homes. However success in obtaining further funding is often constrained by local delivery problems. Some previous home energy related projects in the district have suffered from short project lifetimes with the resultant difficulty of trying to maintain continuity between the various rounds of central government funding. This shortfall and lack of continuity in funding in itself means that it is difficult to maintain a team. Projects not only need a longer lifetime, they also need money in advance to be able to secure materials and teams.

The need for training and access to a skilled workforce is also a significant issue in the area. A shortage of trades skills is a national problem as well as in the Rotorua area. BrightEconomy could play a significant role in securing supportive funding for community residential projects linked to training initiatives.

Currently government agencies such as EECA have to deal with a number of parties all claiming to represent their local communities. Not only is this inefficient but it doesn't assist agencies to respond positively for funding assistance. The more coordination that can be provided locally through a single energy champion the more effective Rotorua community will be in securing central government assistance.

While government grants are available for a number of types of projects, typically opportunities for funding will be limited because of a lack of experience and demonstrated delivery capability. An ad hoc approach of piecemeal projects does not built up the capability to deliver on a sustained basis.

Government funding assistance often requires a 50% contribution from other parties. It is unrealistic to seek this directly from many beneficiaries of the energy improvement initiatives yet from a District perspective benefits may be lost. A coordinated approach to seeking co-funding would assist procurement of government funds. This is a role the BrightEconomy Advisory Board and the council can assist with as they represent the collective interests of the district's communities.

Implementation of energy efficiency programmes also requires proven delivery capability and failed delivery taints future funding possibilities. To maximise the amount of funding from government requires the district to look to how it is structuring requests and then implementing delivery. Poor delivery performance by one can jeopardise the opportunities for many others.

9.3 Local Strengths for Delivery of Residential Programmes

While there are issues raised as disadvantages with regard to delivery of residential energy improvements, the issues are not insurmountable problems and the district has many advantages to outweigh them.

The communities in the Rotorua district have a number of advantages over and above other areas in New Zealand. Alongside the extent of resources mentioned throughout this report, several individuals are already well informed and are pursuing practical and realistic solutions to improve the efficiency of their energy use and alternative supply options are already being employed.

The networking ability of the iwi authorities in the area, in particular Te Arawa, Ngati Whakaue and Ngati Pikiao could be very effective. Both organisations have websites which could be very effective means of sharing understanding and opportunities around energy efficiency. Initiatives such as the Poutama Business Trust[113] (a charitable trust set up to provide business development services to Maori) could also be an effective means to helping communities develop the skills and trades the area needs to realise the energy efficiency opportunities.

The Huntly Energy Efficiency Trust[114] is an example of a local non-profit initiative that can have a positive impact on the local community through a subsidised home insulation service for families in the Greater Waikato area and South Auckland areas. This model could be applied in the Rotorua area as well.

Another positive worth noting is the commitment that the Rotorua Energy Charitable Trust recently donated more than $210,000 to groups throughout the Rotorua area. The Trust has funded a range of projects, from talking books, fences to resources for new buildings and Healthy Homes. The Trust also assisted in the newly completed Rotorua Events Centre. ($12.5 million) Greater use of the trust fund for energy projects would be advantageous as these are a long term investment for the community.

9.4 Sources of Further Information

The region has taken part in a number of energy related research projects over the years. Some projects have focussed on residential energy efficiency opportunities in the region, and others have focussed on health and housing issues and also how homes in the area are using energy. It is essential that the results from research projects are used for the maximum benefits of the wider district communities and not just put on shelves.

The most notable of the projects conducted in the area include:

- *Home Energy End-use Project (HEEP)* –The Household Energy End-use Project (HEEP) being undertaken by the Building Research Association of NZ (BRANZ) and financially supported by EECA has studied household energy use in a number or regions.
- The HEEP results provide a valuable database of information on household energy use and should be analysed specifically from the Rotorua perspective. At present analysis is on a nation wide basis. Analysis and use of the data can assist evaluation of opportunities to manage electricity supply to reduce peak loadings, for appliance suppliers to understand how consumers use their products, and assist prioritisation of investment options.

  In the areas studied to date, average household energy use is around 10,500 kWh/year, including electricity, natural gas and LPG. Average New Zealand residential electricity consumption is 7,800 kWh/year.

  National average expenditure on domestic fuel and electricity energy (excluding transport energy) is 3.1%[115] (2.4% in 2004) of household expenditure that results in energy being a low priority item for homeowners. However, this is an average across the country. Analysis of the Rotorua area may indicate that there will be some households where this percentage is much higher and therefore for whom energy action is more significant.

  Building insulation is a key investment opportunity and while this is best addressed in the original building construction, it is still a very effective investment opportunity for existing buildings.

[113] http://www.poutama.co.nz/
[114] http://www.heet.co.nz/Home.html
[115] NZ Energy Indicators: MED August 2006

9.5 Funding Opportunities

A key component in ensuring the delivery of efficient and warm healthy homes in the area is securing funding. Funding opportunities can be separated into national and local categories as follows:

9.5.1 Central Government Funding Opportunities

Central government funding opportunities focussing on residential energy efficiency initiatives include the following:

Energy Efficiency and Conservation Authority (EECA)—EECA's residential programmes aim to assist homeowners to improve the energy efficiency of their house and to improve the way they use energy in their behaviours at home, through providing information to middle-to-high income homeowners, and also the provision of information and financial assistance to low-income homeowners. In particular the EnergyWise Home Grants Scheme provides funding to organisations to improve the energy performance of older uninsulated homes by installing whole house retrofits. This work includes installing ceiling and underfloor insulation as well as other energy-saving products. EECA has a Strategic Partnerships initiative and a contestable grant funding scheme. The ratio of EECA funding to third party or other funding varies for these projects. Supportive funding typically is sourced from third parties such as Energy and Community Trusts and electricity retail and lines companies for example.

The Warm Home Energy Check (WHEC) is another EECA initiative. A WHEC is a detailed house assessment that gives a star rating to a house based on its energy efficiency. It is a useful tool for people to get advice on how they can improve the comfort of their home and make it a warmer, drier, and healthier house which is easier to heat. This initiative was trialled in Christchurch in 2002 although a planned national project has not yet eventuated. It is possible that the initiative has been overtaken by the work being done on a Home Energy Rating Scheme (HERS).

The government has stated its intention to introduce HERS in 2008. HERS is a significant programme and would result in a scheme that measures the energy efficiency of residential homes. There are several ways in which the scheme could be implemented but essentially it would be an energy rating that sellers of homes would present to potential purchasers when selling. The scheme is likely to be voluntary initially but as occurs in a number of locations eg Canberra in Australia, district councils could make a HERS rating compulsory.

Housing New Zealand—Housing New Zealand have an extensive range of national programmes targeting energy efficiency of state and rural housing programmes, healthy living environments and modernisation projects. Housing NZ works in partnership with EECA to deliver warm home outcomes.

Housing NZ energy efficiency initiative is a 10-12 year project to improve the living environment of all HNZC homes built before 1977. The programme, which began in November 2001, involves checking all properties built before 1977 to see if the following energy efficiency features can be improved, or installed if they are not already in place:

- ceiling insulation,
- hot water cylinder wrap,
- insulating hot water pipes in the cylinder cupboard,
- under floor insulation,
- adjusting the hot water cylinder thermostat.

The programme also involves improving the heating and ventilation of the houses to promote a healthy living environment. This includes fixing draughty windows, and addressing condensation and dampness under houses. In many areas, community-based organisations are contracted to provide energy efficiency retrofits. Other properties also benefited from insulation installation through the Healthy Housing, Rural Housing and Community Renewal programmes. The energy efficiency programme aims to employ community-based work groups and people sourced through Work and Income.

Housing NZ's modernisation programme aims to improve HNZC homes built before 1980. The programme aims to:

- provide a more comfortable, healthy home with a more modern layout,
- be more energy efficient,
- reduce future maintenance costs and
- maintain the value of a public asset.

Housing NZ is one of a number of agencies involved in a "whole of government" response aimed at eliminating substandard housing in Northland, East Coast and Eastern Bay of Plenty. The *Rural Housing*

Programme in Northland, East Coast and Eastern Bay of Plenty programme is a five year project, which started in 2001. It involves communities in the target areas, HNZC, iwi social service housing providers, the New Zealand Fire Service, Te Puni Kokiri, Community Employment Group, Skill New Zealand, Local Government, health agencies and the Ministry of Social Development. The District Council should work with the programme to extend it to Rotorua.

Housing Innovation Fund—The Housing Innovation Fund supports councils to provide more housing in their areas. Housing New Zealand administers the Fund, which was set up in 2003.

The Fund aims to help community organisations, Māori and local authorities to increase their involvement in providing social housing. A number of communities have already benefited from council housing projects funded by the Housing Innovation Fund.

Electricity Commission—The Electricity Commission has, as a key goal the efficient provision and use of electricity. Electricity efficiency and demand side management help reduce demand for electricity, thereby reducing pressure on prices, scarce resources and the environment. The research programmes funded by the commission should be monitored to ensure that Rotorua is included wherever possible.

9.5.2 Energy and Community Trusts

New Zealand has a wealth of national and locally focussed Energy and Community Trusts all of which support a range of community needs some of which may be energy related. The major trusts in the area are the Rotorua Energy Charitable Trust and the Bay of Plenty Community Trust.

The Rotorua Energy Charitable Trust was established on 3 June 1994. It was formed so that some of the funds created by the corporatisation of the Rotorua Electricity Area Authority company could be retained and used for the benefit of the community in Rotorua and the surrounding areas, particularly organisations and projects that undertake charitable or energy-related charitable activities [116].

Income from investments made by the Trust is returned to the community in the form of donations.

The Trust's original capital of $32 million has grown to more than $134 million today, with more than $57 million having been invested back into the local community.

A wide range of community activities have benefited and are benefiting from Trust donations. Much of the recent community donations however appear to go to areas other than those with an energy component. Greater use of the trust fund for energy projects would be advantageous as these are a long term investment for the community.

Bay of Plenty Community Trust—The Trust was formed in 1988 as the Trust Bank Bay of Plenty Community Trust to hold shares in the Trust Bank Group for the benefit of Bay of Plenty Communities. Renamed as the Bay of Plenty Community Trust operating as Bay Trust, the Trust broadly covers the area is from Katikati to Turangi to Cape Runaway including Rotorua, Taupo, Tauranga and Whakatane.

9.6 A Residential Energy Strategy

The highest priority energy investment opportunity for the residential communities in the area is that associated with having warm and healthy homes. The capital cost barrier for such an initiative is very significant for many of those who would gain most from this kind of investment. The Government has recognized this and has established a number of national housing improvement programmes that aim to both improve the basic quality of housing, offer measures to improve the domestic energy efficiency (insulation retrofit programmes) and also to improve the availability of alternatives to electricity heated water (solar water heating grants/loans) and in general improve community well being.

Despite these central government initiatives, the delivery of these programmes in the Rotorua Area appears to be somewhat limited due to:

- the need to find local co-funding (complementary financial support to match central government dollars)[117],
- the lack of locally based service delivery providers,

[116] http://www.rotoruatrust.org.nz/history.htm

[117] While other regions in the country benefit from the support of a committed Energy Trust, the Eastland Energy Community Trust in the Tairawhiti Region focuses on serving wide community needs (but not specifically energy) and believes that this is best achieved through investments and the return of dividends but not through the supply of supportive grant support to retrofit programmes for specific energy projects.

- the need for assistance to establish local programme delivery capabilities (i.e. training and skills development) and
- the need for the region itself to be able to identify the sources of national funding they could be accessing and to successfully pursue and capture them (for example, EECA grants for retrofitting).

In addition to the difficulties in sourcing matching funding for government programmes, often, the nature of the funding that these programmes provide is short term. The lack of continuity in terms of funding duration for existing programmes means that there is an inability to keep trained installers/tradesmen available and involved. Programmes with a delivery horizon of up to three years could go some way to addressing the issue of continuity. In addition, an established delivery agency in the area would be better placed to take on small and large-scale projects for government and non-government projects and also to serve the needs of the wider community (residential and business) on energy use, efficiency and general awareness. It is important that programmes in the area are supported by education and awareness raising on energy efficiency opportunities. The communities need to be better informed about measures that can be taken that are low or no cost in the short term while being able to plan for other solutions in the medium and long term. This report presents a number of options for the format or shape that an energy delivery agency in the Rotorua area could take.

The residential energy initiatives that will contribute to warm and healthy homes are spread throughout the area. They are also such that in aggregate they may contribute to reducing electricity demand through a switch to other energy forms. Because of the wide spread impact on the region, it is recommended that the District develop a residential Energy Strategy within the overall regional Energy Strategy. A key aspect of the Strategy should be the provision of leadership and coordination so that scarce effort and resources are used effectively. The Strategy should also establish a mechanism for engaging with leading central government agencies - so identifying opportunities, and with local entities (groups, organisations etc) - so better quantifying their delivery mechanisms.

The broad objective, specific to addressing residential needs, must be to communicate the current and future energy needs and energy use patterns of the communities in the region and the opportunities from within the region to meet these needs.

Specific objectives could include:

1. Consider the development of coordinated energy services providers (covering insulation, solar water heating and general energy efficiency advice).

2. Consider funding basic levels of energy efficiency advice and information/awareness raising packages.

Strategies should be inclusive of all key community groups as in many cases the commitment of these groups to the communities in which they live prove to be key success factors in achieving the desired change. It is important that information is shared among these groups and opportunities to learn from one another's experiences and knowledge is maximised.

10 Business and Commercial Energy Supply

The highest priority energy investment opportunity for the business and commercial communities in the region is that associated with having a secure electricity supply, high energy/electricity efficiency use strategies and understanding around energy supply contracts.

Typically the wood processors are the largest users of energy in the area. In order to secure future growth in the area and maximise the economic benefits from the businesses in the area, it is important that the primary products produced in the area are also processed in the area. For example, this applies to the processing of logs in local sawmills (rather than have them leave the area as unprocessed logs)

More of the primary production from sawmills should be processed into higher value building components and other products. Rotorua needs a lower cost and reliable electricity supply to encourage such firms to locate here, or for the existing ones to expand.

10.1 Reduction in Energy Costs

Businesses are able to reduce energy costs through a number of the following opportunities:

Energy/electricity audits—An energy/electricity audit evaluates the efficiency of all building and process systems that use energy/electricity. It is the basis of an effective energy management system.

Industry Benchmarking—Where there are similar businesses throughout the area, e.g., wood processors, the establishing of benchmarking of energy utilisation can assist movement of those businesses towards best practice.

Industrial/Commercial Energy Auditing—Energy auditing can produce significant savings in energy cost. The cost of auditing can be reduced if a number of businesses are audited as a group. This can reduce the cost of obtaining the most appropriate auditors through the reduction of transport and accommodation costs.

Cluster Activities—There are economies of scale from industries clustering together to negotiate energy contracts and to share expertise. Co-location around a shared energy cogeneration facility can allow optimisation of each party's energy demand to reduce costs.

Energy Contracts—With the introduction of spot electricity prices and more complex energy supply contracts, many businesses may no longer be obtaining energy on the most favourable terms to their requirements. Seminars and assistance on the range of contracts available can assist reduce energy costs. This is an area that is often not addressed by business, as they are often not aware of alternatives. Energy audits are usually the first identification that costs are unnecessarily high.

10.2 Barriers to Implementation

The capital cost and level of knowledge of energy matters are barriers to many initiatives in the commercial/industrial sector that cannot be underestimated. Despite the central government initiatives targeting the business/commercial sector to improve energy efficiency (EECA grants for audits etc), the delivery of these programmes in the Rotorua Area appears to be somewhat limited. It is presumed due to:

- the difficulty for businesses/groups to financially match EECA audit grant funding,
- the lack of awareness of energy/electricity use as an issue, and
- the need for the region itself to be able to identify the sources of national funding they could be accessing and to successfully pursue and capture them (for example, EECA grants for audits and information materials).

The business community needs to be better informed about the different types of measures that can be employed to reduce energy use. In addition, it needs to be more proactive about securing grant funding from national organisations (in particular EECA) to be able to identify energy savings. Section 15 of this report proposes a number of formats or shapes that a local energy delivery agency in the Rotorua Area could take. While the main focus of a local provider is in meeting residential needs, the basic energy needs of the business community could also be met with such an agency. Alternatively, there is a wealth of Energy Auditors in New Zealand and the Energy Management Association of New Zealand[118] can provide details on these Auditors.

10.3 Funding Opportunities

Central government funding opportunities specific to energy efficiency come largely from EECA. The funding typically comes in the form of grants or loans and key projects are as follows:

- ***Energy Audit Scheme***—The fund aims to encourage organisations to undertake energy audits of their facilities and implement the subsequent audit recommendations. A grant part funds the cost of the energy audit. To qualify for the grant, recipients must complete an audit and achieve energy cost savings by implementing some of the audit recommendations. The resulting energy cost savings must equate to at least 70% of those savings obtainable from implementing all cost effective energy saving opportunities. Grants are generally limited to $10,000 per organisation per year.
- ***Large Electricity User Audit Grant Scheme***—This scheme assists large electricity users to undertake electricity audits of their major sites to identify cost effective energy efficiency projects. Grants available under the scheme are divided into:

[118] Energy Management Association NZ (www.ema.org.nz)

- *Sites consuming over 50GWh/annum*—Fully fund the cost of an electricity scoping study to identify the potential savings at a site and determine what further auditing, if any is required, and fund up to 75% of a detailed electricity audit where a scoping study indicates that this is appropriate.
- *Sites consuming 10 to 50GWh/annum*—Fund up to 75% of a detailed electricity audit.

- ***Crown Loans Scheme***—All Government departments, Local Authorities, Crown-owned entities and public and integrated schools can borrow money under this scheme to carry out energy efficiency related improvements. The loan scheme is intended for the full or partial funding of projects to achieve energy cost savings. At least 50% of the savings must be in direct energy costs, with the remainder in related areas such as maintenance. The payback for the project may not be more than five years, i.e. the annual cost saving must be at least 20% of the loan.

As noted, EECA's audit programmes focus on large electricity/energy users which means that the many small to medium size businesses in the area (and nationally) miss out on these opportunities

The potential for the development of alternative energy sources is assisted nationally by renewable energy associations such as the Solar Industries Association, the NZ Photovoltaic Association and the Bioenergy Association all funded to some degree by EECA. In addition to EECA, businesses are potentially able to benefit from the electricity efficiency initiatives lead by the Electricity Commission.

Other potential opportunities could exist for energy users in the district through contractual agreements with their electricity suppliers or local lines company for the deployment of electricity demand management initiatives. Demand management in the area could help manage the peak electricity demand in the area on which Transpower costs are based. Businesses can benefit directly by direct financial incentives and reduced rates for moving or shifting their electricity use to non-peak periods, and suppliers and lines companies benefit through more efficient use of generation and distribution assets. Companies themselves must pursue such opportunities. A better understanding of how they are using energy and electricity and how this could be improved, or alternative sources employed, is essential. Support from organisations such as EECA and the Electricity Commission given the remit both organisations have in the areas of demand side initiatives.

10.4 Business Energy Strategy

As in the case of residential energy issues, the opportunities for the business/commercial community in the region will only be realised with assistance from a champion coordinating a business Energy Strategy. Engaging with leading central government agencies such as EECA on these matters and with the local energy suppliers and distribution companies is also essential. The future economic growth of the area will depend on ensuring that companies in the area are aware of how to use energy resources efficiently and the type and nature of central government funds available to help them do this.

Specific objectives could include:

1. Carry out a basic survey and develop a database of companies in the area. Organise them according to their annual energy use. Develop a better understanding of who is using what and where in the area.
2. Set targets for annual energy audits, for example, the completion of x energy audits for x small, x medium and x large scale energy / electricity users. Consider the development of an Energy Services Provider (covering insulation, solar water heating and general energy efficiency advice). Secure support from EECA for the initiative and request EECA *'Emprove Sessions'* for local businesses[119].
3. Consider funding basic levels of energy efficiency advice and information/awareness raising packages for industry groups in the area (groups could be created by size or nature of activity).
4. Assist local companies, where possible, to secure central government funding for energy and electricity audits.

As in the case of residential energy, it is important that information is shared among all groups and those opportunities to learn from one another's experiences and knowledge is maximised.

[119] For example from EECA's Emprove Programme (www.emprove.org.nz)

11 Enabling Use of Local Resources / Technologies

11.1 Local Energy Champion

To maximise the opportunities for Rotorua area in the availability and cost of energy, there is a need for a recognised regional Energy Champion. Without a champion many opportunities will be lost and others not recognised.

Initially, the BrightEconomy could pick up this role and this project is the first of its initiatives. It is important that this continue as energy supply is currently undertaken by large national companies who generally won't have a local interest in the region. A regional Energy Champion can monitor their performance with regard to the region and be an advocate on behalf of regional interests when necessary. The BrightEconomy group can pass over the champion roles once a new entity has been identified to take up the challenge.

The energy market is now very complex and it is only active players who can keep up with regulatory and market changes. It is also difficult to keep in touch with the principal energy market players. A regional Energy Champion can keep well informed about market behaviour and assist local business take appropriate actions.

A regional Energy Champion can also facilitate the securing of Government funding and assistance from renewable energy and energy efficiency programmes. Accessing such assistance is often a matter of experience in knowing how to present appropriate projects. It can also be inefficient for a number of parties to be competing locally for the often scarce funds. Regional collective programmes are likely to be most effective in securing funds for the region.

The Energy Champion structure could be modelled on several entities that have been established in other areas. The Energy Champion would focus on activities that are currently not being adequately addressed by existing entities such as Scion. It may be a virtual organisation or it could have a delivery presence such as is provided by Energy Options in Whakatane. It is however important that the district build up its own skill base for delivery of energy outcomes.

11.2 Promotion and dissemination of information

A regional Energy Champion would have a central role in assisting investment in sound energy use within the region. By promoting programmes aimed at promoting public awareness of energy use practices, alternative technology, as well as providing programmes in association with a local provider, to facilitate skill development including trade related programmes. The shortage of trained people, particularly in the trades is a major barrier to the greater introduction of renewable energy and adoption of good energy use practices.

11.3 Local Business

Encouraging local business to take a greater interest in their energy use will unleash part of the opportunity the region has for improving utilisation of energy and thus reducing current or increased demand. As energy costs are significantly higher at peak demand times, obtaining a regional focus on peak demand can bring about a flattening of peak demand and a reduction in energy related costs.

Encouraging business to think about energy use /cost can encourage local entrepreneurs.

11.4 Rotorua Chamber of Commerce

The Chamber of Commerce is an effective organisation for providing views, support and implementation through business activities, particularly in regard to secure and adequate energy supplies. The Chamber provides a useful forum and access to business around which energy use training programmes could evolve.

11.5 Waiariki Institute of Technology

Currently Waiariki Institute of Technology provides courses which include:

- Trades training,
- Business and Tourism
- Computing Technology and Communication
- Forestry, Wood processing and Biotechnology

These provide an opportunity for the institute to extend into energy skills training which are desperately needed if the investment opportunities are to be secured.

11.6 Scion

Scion is already a well established research entity but could be extended to become more a district Centre of Excellence for bioenergy research and development.

If the district takes energy as a key district strategy then Scion is the natural location for the bioenergy programmes.

11.7 Rotorua Energy Association

There are a number of local energy consultants who are well placed to provide leadership on specific programmes. An opportunity exists to create a local energy association which can assist with the development of specific energy initiatives within the district. The association could be made up of consultants, researchers, investors etc. It can provide a forum for programme development, networking and be a single point of contact for locating energy experts. Funding for the association could be sought from the Rotorua Energy Charitable Trust.

11.8 Community Attitudes

Encouraging the region's energy users to think about energy and recognising that it is an asset that can produce wealth for the area should be a key aspect of a regional Energy Strategy. Many of the energy resources have potential adverse connotations and it is easy to allow these to become barriers to tapping into the energy wealth. The recent construction of geothermal and hydro power stations throughout New Zealand has demonstrated how energy projects can be implemented in environmentally sensitive ways that enhance societal well being. The key to the major success factor associated with community acceptance of energy initiatives is effective local community input and community consultation.

11.9 Electricity Metering

Development of a community having an efficient use of energy requires good information on where and how energy is used. This applies to all users although the larger energy users clearly need the most detailed information. This information can only be obtained from appropriate time-of-use meters.

The electricity market operates at a national level on half hourly production and use data. This level of data is also used by most major energy users, as supply contracts will usually have the price based on half hourly use. This applies for both fixed price and spot market contracts.

Time-of-use electricity meter technologies have advanced to the level of accuracy that half hourly data is easily measured, and through the use of Internet based communication systems, the data can be received in "real time". However, less sophisticated "next day available" monitoring is available with Internet access and this is more appropriate for most large energy users.

Of the large electricity users who have time-of-use meters, it is unknown how many of those are receiving and using the wealth of information that is available from the meters.

It is recommended that for any user who wishes to understand their energy use and take steps to improve efficiency of use, that time-of-use meters be installed. Not only will they have the data from which to analyse how they are using energy, but they will also be able to make decisions that will reduce their energy costs. They then have the option of obtaining (from some meters) Internet based data in "real time" or "next day".

While it can be expected that most industrial and commercial business will have time-of-use meters before the end of the decade, it is unlikely that residential users will do the same, unless there is a strong directive from Government or push from the region. This is because of the cost of meters and the significantly less opportunity that residential energy users have for altering the time they use electricity.

It is recommended that the district establish a metering project to provide large energy users with information on their value and economies of scale for bulk purchase of appropriate quality meters.

11.10 Energy Auditing and Benchmarking

Coupled with the metering of energy use is the undertaking of audits to ensure that it is being used efficiently. This in itself can be undertaken efficiently by having adequate local trained energy specialists and sharing the cost of audits. Many businesses have similar functions and if a specialist auditor has to

come from elsewhere in New Zealand then it is efficient that they audit a number of businesses on a single visit. This can also provide good benchmarking information and identification of best practice.

11.11 Heat Technology

As the number of heat plants increase, there is a corresponding need for trained heat equipment specialists. This is an area that is often overlooked but where skilled personnel can make significant cost savings.

12 The Portfolio of Opportunities

The assessment shows that the Rotorua area is energy rich and is already pursuing a number of energy initiatives however current activities are largely uncoordinated with no short, medium or long-term Strategy or prioritisation of issues and actions. Continuing the current business as usual approach to addressing energy issues in the region is not a cost effective option. Specific and targeted action and a step change in the priority currently given to energy issues in the area will be of value to the district's wellbeing.

In order to reduce energy costs and thus enhance regional business competitiveness, it will be necessary to provide for long term secure electricity supply and the development of alternatives to electricity use by taking proactive action amongst both business/commercial and residential groups.

12.1 Portfolio of Solutions

The future energy needs of the area are likely to be met by a portfolio of opportunities. Some opportunities will be extensions of current programmes while others will require users (residential and business) in the region to think about alternative approaches to managing their energy use. Other opportunities will also require paradigm shifts in thinking about how the same outcomes can be achieved using less and/or different energy sources.

Some energy development opportunities that are economic currently may be easily achievable and while they can have a large positive impact on an individual or an organisations energy use, they will only have a small impact on the region's energy supply-demand situation. Some of the potential high value opportunities may however be more difficult to achieve in the short term, or be at a high risk of not obtaining a good return on expenditure, certainly in the immediate future.

There is no single activity to be undertaken to address the cost of energy supply situation in the region. The pursuit of a portfolio of opportunities within a Strategy that addresses short, medium and long-term issues would be key. It would enable the region to build on those cost effective opportunities immediately available and will lead to a strengthening of the existing commercial base of the region. From this platform, improvements in energy use can be made and new opportunities pursued as they become economic.

In addition to current initiatives that are available, there are several opportunities to pursue new initiatives that can result in improved energy utilisation, reduced energy costs, and enhanced community wellbeing. This approach can be pursued within the existing resources of the district and by building delivery capabilities. It is also incremental with costs spread over the whole community, with benefits captured directly by investors.

A portfolio approach is a sound risk management strategy. A portfolio of future energy supply investment opportunities could consist of a mixture of the following in the short to medium term:

- Improved management of electricity spot prices by use of local generation and demand side management,
- Increased installation of solar water heating systems,
- Development of co-operative community living opportunities,
- Processing of organic waste in biodigesters to produce biogas,
- Use of Council facilities as role models for energy use from solar, geothermal, biodigesters, and small hydro,
- Additional local electricity generation,
    - Rural micro hydro

- Landowner developed geothermal
- Encouragement of adjacent area small hydro schemes
- Increase in number of bioenergy cogeneration plant at wood processor sites,
- Increase in the number of installations of photovoltaic solar electricity generators for off-grid homes,

- Direct heat programme
  - Downhole geothermal extraction- hotels
  - Industrial direct heat programme
  - Training of heating and cooling engineers
- Commercial user Energy Efficiency programme
  - Improved management of electricity spot prices by use of local generation and demand side management,
  - Awareness raising on energy efficiency and use,
  - Reduced costs through energy efficiency and peak shifting
  - Demand management improvements for business,
  - training of skilled trades experienced in energy management
- Residential user energy efficiency programme
  - Energy efficiency improvements for residential housing,
  - Implementation of a warm and healthy home programme,
  - Increased installation of double glazing,
- Bioenergy (woody biomass) programme
  - Use of woodburners with wet-backs (space and water heating),
  - Programme for reducing cost of extracting and processing forest residues
  - Programme for increased use of forest residues as an energy feed stock.
  - Wood pellets in schools, hotels and existing coal boilers
  - Establishment of centre of Excellence for Bioenergy Utilisation
- Transport biofuel
  - Pyrolysis oil from woody biomass and
  - Biodiesel from organic wastes.
  - Link with Clean Energy Centre, Taupo
- Processing of organic waste in biodigesters to produce biogas,
  - Manufacturing waste
  - Community sewage
- Publicise and make use of existing information sources on energy technologies, energy efficiency and the behavioural changes needed such as those in Energy Efficiency and Conservation Authority (EECA) reports.
- In the longer term, deep geothermal

12.2 A Local Energy Strategy

To maximise opportunities it is recommended that BrightEconomy develops a Rotorua Energy Strategy. This would encompass specific implementation strategies and action plans prepared by BrightEconomy in conjunction with key stakeholders.

A Rotorua Energy Strategy would sit alongside other district based strategies such as for tourism, forestry, transport and employment.

The Strategy would be developed on the basis that tourism and agriculture are significant activities that dominate the economic landscape of the Rotorua area. Although energy developments need to be sensitive to the potential effects on that economic landscape, as well as the potential effects on the cultural and ecosystem environments, this should not be seen as preventing appropriate energy developments. Energy development can also enhance the tourism and agricultural activities if sustainable energy use is taken as one of the themes of the area.

The Strategy would ensure that energy, as an issue, becomes embedded into current and future planning processes for the Rotorua district.

It is recommended that a District Energy Strategy based on the following principles be established:

- Improving community wellbeing through warm home programmes.
- Reducing costs of energy through implementing energy efficiency, solar water heating and efficient fireplaces.
- Development of programmes that actively encourage industry and commercial enterprises to have energy management plans and investment in energy efficiency initiatives.
- Establishment of an energy services delivery organisation to meet the needs of local residential and business energy/electricity users.
- Assistance for greater investment in solar electric, hydro and geothermal exploration.
- A programme of engagement with Central Government Agencies responsible for the delivery of national programmes on security of energy supply, energy efficiency (industrial and commercial), residential retrofitting programmes etc in order to secure supportive funding for programmes, to maximize the opportunities for the area and ensure economic growth and community well-being.
- Policies that assist the Rotorua District Council being energy developer friendly.

The District Energy Strategy should be a fundamental component of the Long Term Council Community Plans for Rotorua District and so ensure community buy-in and that it is established as a key component of the area's future planning focus.

The opportunity exists for an Energy champion to be established under either the BrightEconomy Advisory Board or the Rotorua District Council

12.3 Promotion of Energy in Rotorua

Rotorua is energy rich and has a large amount of untapped energy much of which is accessible and of adequate quantities that can provide a large number of small opportunities. Promotion of the region's energy will encourage utilisation and entrepreneurial development. Provision of an attractive investment environment in the region will enable a competitive edge over other regions. This approach can assist in the reduction of energy costs, deliver on energy innovation and efficient use and encourage economic growth.

Promotion of Rotorua energy should of course also cover utilisation so that the community is conscious of how its wellbeing and costs of production can be improved by the wise use of energy.

The district needs to take action to coordinate activities and establish an Energy Champion that can provide leadership and facilitation of energy projects. This is a key success factor in the delivery of a Regional Energy Strategy. New Zealand's energy industry is fragmented and power is concentrated in the hands of a few larger electricity companies who are supply driven. No one else has the region's energy interests at heart except the region itself. An Energy Champion will be able to coordinate resources and be a focal point for energy issues in the region. It should be a source of information and advice and a convenor of meetings/discussions and project implementation.

It is clear that Central Government wishes to financially assist the promotion and uptake of energy efficiency and renewable energy across the country. For reasons of efficiency, national agencies like to work through local groups, industry associations or regional clusters. The Energy Champion needs to be in a position to become experienced in accessing Government funds for specific programmes and to encourage and help potential investors. The champion can also coordinate and assist individual initiatives to be successful.

The Energy Champion needs to be able to work with other parties on a comprehensive series of programmes relating to all aspects of energy efficiency and conservation in the district. It is recommended that by active consideration and involvement with appropriate parts of the government's

programmes that the outcomes can be easily used to assist improved energy utilisation in the region. By active participation, the region will also be able to ensure that the expenditure of Government funds within the Region is maximised.

12.4 District Council/BrightEconomy Initiatives

The Councils have the opportunity to provide the leadership and role models for establishment of an enhanced energy future for the area. The Council policies and actions can provide encouragement and reduce implementation costs.

The following areas are key:

District Plan Policies—Councils can include encouragement for good energy utilisation through District Plan Policies. These may include:

- The rules for subdivision,
- Avoidance of shading effects on receipt of solar radiation by neighbours,
- Good energy utilisation in building design,
- Recommendations on building energy efficiency standards, and
- Rules for energy use in specific areas.

Both Environment Bay of Plenty and Rotorua District Council have stated in various planning documents (Regional Policy Statements, District Plans, and their LTCCPs) that effort needs to be focused on energy efficiency and the effects of new generation in the region. The information provided is however high level. Several Councils across New Zealand are providing energy related information to their ratepayers proactively through their web sites and through monthly newsletters, articles in the local papers and annual reports on what has been achieved

Long Term Community Council Plans—The LTCCP is a distinctive form of strategic plan to map future activities for regions - including work to develop and implement other plans. An LTCCP is the key mechanism that councils can use to promote outcomes.

The Rotorua LTCCP makes reference to energy issues in their Environmental Well-being Statement. The Statement includes sustainable waste management issues, geothermal and energy resources. Management and protection of the district's unique geothermal energy resources is a strategic issue for the Environmental Group.

The council will have a key role in raising awareness amongst the community of energy efficiency and energy alternatives that contribute to a better quality of life.

Building Design—Councils can provide information on good building design that will improve energy use in buildings at the design stage. This is the most cost effective time to introduce change. The Council can make available to all ratepayers information on a number of initiatives that the ratepayer can take including:

- Building orientation to the sun,
- Design to capture and retain passive solar energy,
- Double glazing,
- Solar water heating,
- Installation of high efficiency space heaters,
- Installation of efficient wood burners for space and water heating,
- Good insulation, and
- Internal energy distribution.

This information can be provided with rates demands, through building inspectors, and at the time enquiries are made with regard to building consents. Distribution through these channels can be low cost and will encourage good energy design in buildings to become a way of life.

Council Facilities–Councils can provide a good role model by including energy efficiency measures such as solar water heating in their own facilities. If ratepayers see the Council using solar water heating, for their own use (office buildings), council owned services and other properties such as schools, hospitals and doctors surgeries and community swimming pools, then they are going to be more likely to consider it themselves. ECCA provides financial loans (Crown Loans Scheme[120]) to encourage Councils to be role

[120] http://www.eeca.govt.nz/programmes/businesscosts/crownloans.aspx

models. Councils must be aware that these funding opportunities exist and actively and persistently pursue them.

Building Consent Processes—Many energy efficiency initiatives often require modification of building structural elements and thus require a building consent. The requirements of obtaining the consent and compliance monitoring can some times be more costly than the cost of the equipment and installation. Installation of solar water heating systems is a case in point. Councils are encouraged to adopt standard acceptable solutions for installation that means that if complied with result in a near automatic issue of a building consent. Such processes will greatly reduce the cost of installation of many energy efficiency measures. Recent developments in the Building Code aim to deliver on an improvement in the sustainable energy aspects of new home building.

Regional Plan Policies—Council can include encouragement for good energy utilisation through Regional and District Plan Policies. These may include:

- The rules for water allocation,
- Establishment of emission standards for heating systems, and
- Liquid waste discharge rules for biogas production.

Resource Consent Processes—The process of obtaining of resource consents for energy projects is often long and expensive. Invariably the energy projects, whatever their size or nature (renewable or non-renewable) have the potential to affect the environment and surrounding communities in some way. Often, for example, they can result in a change in the land use. Regional policies and the use of Rules and Guidelines and other standardised information can reduce processing costs. Making Council expectations clear to prospective developers and directing them to national guidelines (for example the EECA national guideline for wind development) will help the process. Local guidelines can and should be developed from the national guidelines and should be made available through the council's web-sites or through the web-site of a newly established Energy Champion. It is important that the councils are seen to be being vocal about these issues. By saying nothing, the region could be losing valuable opportunities. Finally, securing expertise on energy project details (on an ad hoc basis) can help the council evaluate and process applications efficiently.

Resource Consent Conditions—It is useful when there is potentially a number of similar resource consent applications likely to be lodged that standard format of resource consent conditions be established for the region. This kind of initiative has been spoken about at a national level and could well form part of a recently stated government initiative on the development of National Policy Statements on infrastructure issues (including energy) as part of the recent review of the Resource Management Act[121]. A standard format can assist a developer as they can see from the outset the conditions that they can reasonably expect to be attached to a resource consent. This process also assists those who may wish to object to an application as they will be able to see possible conditions and are then able to focus on the adequacy of the conditions.

Water Allocation—The establishment of water allocation rules, which incorporate hydroelectric generation as well as extraction, recreational uses, and preservation of native fauna and flora would assist consideration of multiple use of scarce water resources. Water allocation is an issue that is increasing in importance on a national level and will be an issue that the councils will need to keep abreast of and be ready to address.

Regional Funding contributions—Nationally, infrastructure issues such as water and sewerage are funded by financial contributions imposed by the Council. This levy is a reflection of the costs to provide infrastructure services. Increasingly there are a number of situations where energy infrastructure upgrades are required and it is appropriate to apply financial contributions to them also. As the regional benefits, of say an electricity line upgrade, may accrue to all in the local community as well as the initiator of the works it is appropriate to consider that the cost should be shared between the developer and the Councils and should not be met solely by the lines company.

[121] http://www.mfe.govt.nz/publications/rma/improving-rma-national-interest-sep04/improving-rma-national-interest-sep04.html

12.5 Access to Energy Information

The establishment of a directory of information sources would assist many individuals and business in the region to identify, consider and implement energy projects. This could be accessible on Council or a special regional energy website (through the proposed Energy Champion. The directory could cover:

- Resource data,
- Technology,
- Suppliers of equipment,
- Energy efficiency opportunities for residential and commercial users,
- Specialist advisors,
- Names of trained installers of energy equipment,
- Links to other information providers, and
- News on current local and national energy initiatives.

12.6 Funding of Energy Efficiency Improvements

The capital cost of many energy efficiency improvements is often a major barrier to their implementation. An example of this is solar water heating systems. In some overseas areas the local council or a special purpose entity has established an innovative alternative to buying the systems outright which is to offer the systems through a lease-to-buy programme. In these programmes the council or special purpose entity installs and owns the system and the building occupiers who gain the benefits make a monthly payment through their rates or electricity bill to pay off the eventual purchase of the system. The level of payment is set according to the level of energy saving that they receive. Such a scheme is analogous to how television sets were often purchased during the initial days of the introduction of television in New Zealand.

The installation of solar water systems could reduce electricity use for many in the region. Water heating using electricity accounts for around 40% of the total electricity bill. It is recommended that such a scheme be investigated for the Rotorua Area.

12.7 Promotion of Demand Reduction / End Use Efficiency / Solar

Residential and business opportunities are usually not pursued for demand reduction opportunities unless it has been a dry year and electricity suppliers are short on supply. The establishment of regional programmes in association with national bodies (for example similar industries like food processing or cold storage in partnerships with electricity retailers or lines companies) will assist the dissemination of knowledge and thus could increase the uptake of these demand-side opportunities.

The promotion of solar hot water systems can have significant payoff for individual hot water users and for the region itself. To achieve the identified benefits there is however a need for both the wider promotion of the benefits and assistance with getting information to potential system users. Councils are in an ideal position to assist this through the provision of information with rate bills, on their website, and when building consents are being sought.

12.8 Attitudes to Energy

The Rotorua area is in the fortunate position of having a reasonable amount of untapped energy resources within its boundary. Promoting the area as being energy rich with support from balanced and informative consent application processes will encourage entrepreneurs to identify and pursue opportunities in the area. This may happen first within existing businesses. For example, farmers pursue interests in small-scale hydro generation on their land. As local trades people gain more experience and confidence in these kinds of developments they too are better placed to pursue them. Setting and proactively communicating a positive attitude frees thinking, encourages innovation, and provides opportunities for managing risk.

There are a number of ways in which energy supply and price certainty can be improved but people need encouragement and information (in a language they understand) to spot the opportunities. For the majority, energy or electricity is a commodity they use as part of their regular business activities. Positive and ‘can-do’ attitudes can subsequently spread to the large energy users considering locating in the region when they see that energy risks can be managed and community attitudes are favourable.

A positive attitude to energy development and use helps recognise the inter-relationship between energy resources, the community and environmental values important to the Rotorua Area as a whole.

12.9 Leadership Programme

If opportunities for energy utilisation are to be pursued and achieved there needs to be recognition throughout the community that many opportunities are already within the reach of energy users. Within communities most opportunities are lost because they are not recognised, they are considered unachievable and in general information provision to these groups is poor. A community needs assistance to be able to recognise and pursue these opportunities for savings. This can be facilitated by an Energy Champion. An example is the ability to benefit from national insulation retrofitting programmes. EECA's retrofitting projects tend to have a minimum of 100 houses per project. Individuals cannot access EECA funds directly but need to be part of a project. This requires coordination.

An Energy Champion would have to be able to build on a sound and realistic experience in the energy market and knowledge of opportunities. Access to Government funding support is very much dependent on knowing 'the system' and understanding how it operates. Organising workshops and training others will broaden the community knowledge base.

The Energy Champion and other regional energy players also need to work with large energy companies to build relationships with key individuals, get a better understanding of their local priorities and ensure that Rotorua's interests are maximised. At present, the energy market is supply dominated and energy suppliers are price setters. This position is reinforced because of the lack of competition and market rigidities arising from supplier risk management approaches. A regional energy programme or 'Strategy' could facilitate the demand side by helping to identify opportunities and thus better balance supply and use in the region.

12.10 Access to Central Government Funding

Central Government has a national Energy Strategy (the 'NEECS' managed by EECA) and other initiatives from the Electricity Commission, from Housing New Zealand and from Trade and Enterprise and WINZ that the region can tap into and build on. Leveraging Government funds by regional initiatives will reduce the cost of implementation of a regional strategy and help Central Government deliver on their objectives for communities (residential and business), for training and employment initiatives etc.

As a 'centre of excellence' in the region Scion could provide a high profile for the region's energy wealth and facilitate utilisation, and a focus for community education.

13 Next Steps

The energy assessment has identified that the district has opportunities to improve energy supply and firm energy costs if it takes proactive and coordinated action building on the existing initiatives being undertaken. The key to coordination and optimisation of regional effort requires leadership from a regional Energy Champion. Currently and because of the ad hoc activities that are being taken, opportunities are being lost and knowledge and experience is not being shared for the wider community good.

A key aspect of coordination will be the establishment of a regional Energy Strategy providing priorities and facilitating action.

The success of the implementation of an Energy Strategy will be through effective collective and inclusive action and capability building within the region.

APPENDIX 1 Additional References

Identification of Potential Hydroelectric Resources, for Ministry of Economic Development, 2004 East Harbour Management Services.

"Assessment of Local Hydro-electric Potential – Bay of Plenty Catchment Region". Ministry of Works and Development Hamilton District Office, December 1982.

Brian White 2006 "An Assessment of Geothermal Direct Heat Use in New Zealand" Report by the New Zealand Geothermal Association

"Availabilities and Costs of Renewable Sources of Energy for Generating Electricity and Heat; 2005 Edition" Report prepared for the Ministry of Economic Development, East Harbour Management Services, June 2005.

Geothermal Reports

GNS Science at the Wairakei Research Centre has over 50 reports from GNS, DSIR and CRI, many of which are confidential, on the following topics:

- Geothermal heating systems
- Hydrological changes in the Rotorua geothermal field
- Geothermal resources survey: Rotorua geothermal area
- Chemistry monitoring for the Rotorua geothermal field
- Heat output surveys
- Monitoring well data, Rotorua geothermal system
- Rotorua geothermal resource
- Changes at Whakarewarewa
- Rotorua Monitoring programme: monitoring of shut down period
- Geophysical surveys
- Management strategies of the Rotorua geothermal system
- Effective use of geothermal heat in Rotorua
- Geochemistry of the Rotorua geothermal system
- Models of the geothermal field

Ministry of Economic Development publications

Electricity Commission publications

Energy Efficiency and Conservation Authority (EECA) publications

Transpower publications

APPENDIX 2 Agencies with Experience and Knowledge Related to Forestry and Bioenergy

Area of Expertise	Organisation Name	Contact Details	Comments
Forestry Consultants and Managers	Bawden Associates	07 347 1863 www.bawden.co.nz	Forest marketing and harvesting consultants
	Blakely Pacific	P O Box 13 980 Christchurch Ph: 03 365 2846 Fax: 03 353 7469 www.blakely-pacific.co.nz	Sustainable forest management, integrity, honesty, and being a good corporate citizen, are four of the springboard values for Blakely Pacific Ltd. A New Zealand forestry company with its roots in the historic Northwest of the United States where its head office resides. In New Zealand the main office is based in Christchurch. There are three branch offices, one in the North Island at Tauranga and at Geraldine and Timaru in the South Island.
	Carson Associates	07 357 4244 www.forest-genetics.com	Specialists in the application of advanced forest genetic technology
	Chandler Fraser Keating Ltd	07 348 8929 www.cfk.co.nz	Forest industry consultants. Forest resource inventory, forest valuation, forest project management, forestry project feasibility studies, environmental audits, forest products industry feasibility studies, forest products market analysis, forest acquisitions and scales, due diligence studies
	Dana Ltd	07 349 2764 www.dana.co.nz	Forestry consulting company with a focus on forest valuations and forest products marketing
	Department of Conservation	P O Box 10 420 Wellington 04 4710726 www.doc.govt.nz	Administers most of the Crown land in New Zealand protected for scenic, scientific, historic or cultural reasons, or set aside for recreation. This is almost a third of New Zealand's land area, including national, forest and maritime parks, marine reserves, nearly 4000 reserves, river margins, some coastline and many offshore islands. Its mission is "to conserve New Zealand's natural and historic heritage for all to enjoy now and in the future".
	Forest and Woodlot	07 357 5800 www.fwg.co.nz	Forest consulting, forest management and forest inventory
	Hancock Forest Management (NZ) Ltd	283 Vaughan Road P O Box 7403 Te Ngae Rotorua 0-7-350 0080	A timberland investment management organisation that develops and manages international timberland portfolios on behalf of investment groups. In New Zealand, Hancock manages the production of pruned sawlogs, unpruned sawlogs and pulplogs, mostly in the central North Island.
	Innovatek Ltd	07 348 1039 www.inovatek.co.nz	Innovative technology, association and event management company specialising in the forest products industry in New Zealand and Australia
	Interface Forest and Mill	07 345 9940 jim@interformil.co.nz	Established 1992 Tree crop evaluations and projections. Assessments of sawmill performance, conversion and stand sampling for pruned log quality

Area of Expertise	Organisation Name	Contact Details	Comments
			Analyses and evaluation of silviculture Log utilisation studies
	Interpine Forestry	07 3457573 www.interpine.co.nz	Forest consulting and data management company specialising in information technology and optimal decision making across the forest industry, specialising in forestry data management systems, resource inventory and stand optimisation; log value recovery and optimal log-bucking decisions; log scaling and quality control; hardware and software development, forest industry training, and standing resource - forest products supply chain initiatives.
	Landcorp	Head Office P O Box 5349 Wellington 04 471 0400 www.landcorp.co.nz	Core business is pastoral farming including dairy, sheep, beef and deer, and operates 104 farming units totalling 369,861 hectares and it has three subsidiary companies, Landcorp Developments Ltd and Landcorp Pastoral Ltd, which are developing and leasing former forestry land, and Landcorp Estates Ltd which develops and sells premium land that is deemed to have a higher value in non-agricultural use.
	Mark Lloyd Ltd	07 345 5368 1/27 Willow Avenue Rotorua	Forestry consultant
	Matariki Forests	PO Box 9283 Newmarket Auckland 09-302 2988	A New Zealand incorporated company owned jointly by Rayonier Inc. and RREEF Infrastructure, the global infrastructure arm of Deutsche Asset Management. Matariki Forests is the owner of 143,000 hectares of mainly Radiata Pine across New Zealand.
	Ministry of Agriculture and Forestry	P O Box 2526 Wellington 04 894 0100 www.maf.govt.nz	Informs, advises, regulates and delivers services relating to the agriculture, forestry, rural affairs, biosecurity and food safety portfolios.
	NZ Forest Managers Ltd	PO Box 304 Turangi 2751 07 386 8757 www.nzfm.co.nz	A specialised contract forest management organisation providing commercial forest owners with a comprehensive management service covering the full range of operations from forest development, protection and investment through to harvesting and marketing.
	PF Olsen & Co Ltd	07 921 1010 www.pfolsen.com	A team of forestry professionals endeavouring to maximize returns to forest owners from their investments in forestry. They help with all aspects of forest establishment and growing, forest management, environmental protection and monitoring and harvesting and marketing. PF Olsen Group was established in 1971 by founder Peter Olsen. The company is now owned and managed by shareholding staff, and employs over 90 staff operating out of a dozen offices in New Zealand and Australia.
	Timberlands	07 343 1070 www.tll.co.nz	Owned and operated by former senior managers of Kaingaroa Timberlands Management Ltd and brings to forest management the full range of knowledge and expertise that has maintained the pre-eminent status of Kaingaroa Forest as a crown jewel of

Area of Expertise	Organisation Name	Contact Details	Comments
			plantation forestry. They have particular expertise in forest management and operations on a significant scale to grow both cash return and forest value for owners, with the systems and resources needed to optimise value. Also manages the crown jewel of plantation forests, the 189,000 ha Kaingaroa Forest, for its owners and is keen to develop new business with significant forest owners.
Forestry Associations	Forest Industry Contractors Association	07 921 1382 www.fica.org.nz	Exists to promote business growth and efficiency for the benefit of New Zealand's forestry contracting industry.
	Forest Industry Engineering Association	07 921 1380 www.fiea.org.nz	Has been designing and developing an extensive array of technology programmes and events for the New Zealand and Australian forest and wood products industries since 1998. FIEA, a division of Innovatek Ltd, encourages the adoption of new technologies by the forest and wood products industry. It continues to develop a wide range of independent technology programmes and innovative training and troubleshooting resources. These are being used by a large number of companies throughout Australasia to improve their operating efficiencies and profitability. A full calendar of technical events including conferences, seminars, workshops and on-site technology assessments are being run.
Research	Scion (NZ Forest Research Institute Ltd)	07 343 5899 www.scionresearch.com	Has been recognised as a leader in forestry science since its beginnings as New Zealand Forest Research Institute in 1947. Scion has expanded its research capabilities to meet the growing consumer demand for renewable materials and products from plants. Scion offers wide ranging technical and scientific capability to anyone in the business of producing materials or creating products using renewable plant resources.
	Wildland Consultants Ltd	07 343 9017 www.wildland.co.nz	Ecological Consultancy Wildland Consultants is a progressive ecological consultancy committed to providing high quality ecological information, advice and technical services to a wide range of clients. The company has a very strong focus on the planning and implementation of ecological restoration. Company staff are based in Auckland, Tauranga, Rotorua, Whakatane, Whangarei, and Dunedin and work nationwide.
Training	Eastside Training	07 348 8487 www.eastsidetraining.co.nz	Eastside Training Limited is a Rotorua-based PTE registered with NZQA. Our forestry life skills programme gives 15-18 year olds the training and skills to meet the requirements of a high demand industry, with transport, equipment and lunch provided. We specialize in Personal Development of at Risk Youth, Special Issues and Rehabilitation.
	Waiariki Institute of Technology	07 346 8999 www.waiariki.ac.nz	Waiariki has a vision of learning for life by excellence in provision, relevance to identified needs and capability building, and access to employment. Its mission is to deliver skill sets and intellectual capital needed in our region, nation, and world.
Energy Consultants	Allan Estcourt Ltd	07 347 7261 www.aeltd.co.nz	Allan Estcourt Limited of Rotorua, New Zealand, provides industry throughout NZ and the Pacific Basin with specialist advice in mechanical and process engineering along with the extended capabilities, expertise and resources in pulp and paper available from the Jaakko Poyry Group of Finland. The practice services processing industries based on primary production from forestry, agriculture and the energy production and utilization sectors. General industrial, commercial and local authority projects are also undertaken. Projects range in value from a few hundred to many millions of dollars.

APPENDIX 3 Wood Processing Facilities

Facility	Company/Operation	Size	Comments
		Production m^3/yr Sawn timber	
Sawmills	Mamaku Sawmilling Company	40,000	
	Rotorua Sawmill	80,000	
	McAlpines	40,000	
	Tachikawa	250,000	
	Red Stag	200,000	
	TITC	4000	
	CHH Rainbow Mountain	142,000	Based on 2005 data
Timber Product Manufacturing Facilities	Lockwood		
	Lakeland Timber Processors		
	Hume Pine Ltd		
	CHH Wood Products Remanufacturing		
	Claymark		
	Red Stag		

APPENDIX 4 Rotorua Local Air Management Area (LAMA)

Source: Environment Bay of Plenty

APPENDIX 5 Extract from 1982 MWD Report

Scheme No.	River and Site Name	Installed Generating Power MW	Capital Cost		Electricity Supply Authority[1]
			$ million	$/kW	
	Economic Category A				
B2b	Rangitaiki at Kiorenui[2]	8.5	13.7	1610	BOP
C1a	Tarawera at Lake Outlet[3]	14	21.1	1510	RAEA
C1b	Tarawera at Falls[3]	7	11.3	1610	RAEA
C1c	Tarawera at Te Matae Rd[3]	10	19.3	1930	RAEA
D1a	Kaituna High Level[2]	34.5	73.8	2140	RAEA
D1b	Kaituna Low Level[2]	37.5	69.6	1860	RAEA
D1c	Kaituna at Okere Falls[2]	5.2	10.3	1980	RAEA
	Economic Category B				
A2c	Waimana at Matahi[3]	9	19.4	2160	BOP
B1	Rangitaiki at Mangamako[2]	12.6	27.5	2180	BOP
B2a	Rangitaiki at Murupara[3]	55	130	2370	BOP
B5	Pokairoa at Murupara Rd	1.9	5.92	3120	BOP
C1d	Tarawera at Fenton's Mill	6.2	17.7	2860	BOP
C4	Karaponga at McIvor Rd	0.65	1.91	2940	Bop
D2a	Mangorewa at Otamamariri	5.7	16.6	2910	T.E.
D10	Umurua at Ngongotaha	0.94	2.75	2930	RAEA
D12a	Kaituna High Dam A[3]	38.5	112	2910	T.E.
D12b	Kaituna High Dam B[3]	32	94.2	2940	T.E.
D12c	Kaituna Modified Dam A[3]	29	91.8	3166	T.E.
D12d	Kaituna Modified Dam B[3]	24.5	73.9	3020	T.E.
E3	Te Puna at Whakamarama	0.45	1.4	3110	T.E.
	Economic Category C				
A17	Whakatane at Ruatahuna	3.24	11.0	3395	BOP
B3	Whirinaki at Galatea	25	92.2	3690	BOP
B11	Whirinaki at Central Hut	1.7	5.46	3212	BOP
D4	Waiari at Te Matai Rd	2.9	11.3	3900	T.E.
D5	Waimapu at Hereford Rd	0.91	3.5	3850	T.E.
D7	Tautau at Pyes Pa	0.95	3.43	3610	T.E.
D8	Kopurereroa at Williams Rd	0.88	2.87	3260	T.E.
E7	Uretara at Wharawhara	0.77	3.14	4080	T.E.

Notes [1]Electricty Supply Authority Abbreviations
BOP = Bay of Plenty Electric Power Board
RAEA = Rotorua Area Electricity Authority
T.E. = Tauranga Electric Power Board
[2]Scheme currently under investigation
[3]Schemes previously investigated by MOW or consultant engineers

Table 6.1: Summary of economic schemes

APPENDIX 6. Information Sources that are Periodically Updated

Report	Latest Version	Previous Version	Frequency of Update
Unison Asset Management Plan	August 2006		Annually
Transpower Annual Planning Report	March 2006		Annually
Energy Outlook (Ministry of Economic Development)	October 2006		2 – 3 Years
Census Statistics	2006[122]	2001	5 years
Rotorua District Plan (Operative) Rotorua District Plan (Proposed) - next is in 2008 Rotorua Long Term Council Community Plan (LTCCP) - Ten Year Plan	1996 2006		Plan Changes occur to the Operative District Plan from time to time LTCCP is reviewed every 3 years
Bay of Plenty Regional Policy Statement Bay of Plenty Long Term Council Community Plan (LTCCP) - Ten Year Plan Waikato Regional Policy Statement Environment Waikato Long Term Council Community Plan (LTCCP)	1999 2006 2000 2006		Changes occur to the Operative Policy Statements from time to time
Regional Plans (various)			Plan Changes occur to the Operative Plans from time to time

[122] Information from this reporting that is relevant to this study has yet to be released

APPENDIX 7. Risks and Solutions to Energy Supply

Details of issues relating to energy supply and the actions to manage those risks are extensively reported on in disclosure documents including Asset Management Plans. Information from these documents and other material provided by relevant asset owners has been used to compile the following tables.

Transpower

Item	Status/ Risks	Preferred Action
Owhata Substation	Demand exceeding n-1 scenario rating of supply transformers. Potential loss of supply.	Replace transformers with higher capacity units (proposed date of 2014)
Tarukenga substation	Demand exceeding n-1 scenario rating of the 220/110 kV interconnecting transformers. Potential loss of supply.	Installing 220/110 kV transformers at Tauranga (reduces demand on Tarukenga) (proposed date of 2011)
Tarukenga substation	No n-1 security of supply (only one supply transformer). Potential loss of supply.	Installing a second transformer bank.
110 kV Tarukenga – Rotorua 2 circuit	Loss of this line results in the loss of Wheao generation and may result in overload of 110 kV Tarukenga – Rotorua 2 circuit	Load shifting or upgrading 110 kV Tarukenga – Rotorua circuits

Unison Rotorua Network - Areas of Concern

Item	Status	Risks
Age & Condition		
Overhead Network	Primary sections of the overhead network in the Rotorua urban areas are aged	
Double Circuit Lines	Significant sections of the network backbone are double circuit lines	Incidents on these lines (such as motor accidents) cause significant losses of supply.
Growth (Overloading)		
Security of supply to Rotorua CBD	Insufficient support available from alternative Points of Supply. i.e. Owhata and Rotorua	Security of supply to Rotorua CBD is at risk if Arawa zone substation cables are damaged
Rotorua (Malfroy Rd) Point of Supply	Any significant growth in areas supplied from the Rotorua Point of Supply (Malfroy Rd) will require significant new investment	
Rotorua Sub Feeder capacities	Rotorua Sub Feeder capacities are reaching high load limits. High ground temperatures have potential to cause inadvertent overloading	Raises security of supply issues in the event of an n -1 scenario (i.e. the feeder load cannot be supported by adjacent alternative supplies)
Waipa State Mill Industrial Park Development	Waipa State Mill Industrial Park Development will require significant new infrastructure	
Supply from Atiamuri	Security of supply to the areas supplied from Atiamuri presently do not have n-1 security	Failure of a relevant power transformer at Atiamuri Power Station will affect supply
Rainbow & Fernleaf Zone substations	Rainbow & Fernleaf Zone substations currently do not have n - 1 security (supplied by a long line from Rotorua (Malfroy Rd)	Significant investment will be needed to achieve n-1 security, or to meet any major growth in areas supplied from these substations.
General Maintenance Issues		
Vegetation Effect on Supply	Aggressive vegetation management program in place with an annual budget of $500,000 spent in 04/05 year (this will continue at the same level). Lakes areas provide a real challenge in providing reliable	An extensive $100,000 Aerial Feeder survey program to quickly identify potential fault causing asset defects. This will drive major expenditure on corrective maintenance. It is anticipated that this

	supply due to the extensive and ongoing vegetation issues.	should have a fast and significant impact on Network reliability.
Overhead Line Corrosion	Accelerated corrosion occurs on overhead lines due to the geothermal atmosphere.	Failures occur more frequently These failures are difficult to locate and can cause outages.
Underground Cable and Earth Grid	Inspection regime assesses corrosion of the Arawa substation's aluminium earth grid and 33 kV cable sheaths	Ability to meet design conditions
Earthquake	Earthquakes are a high or moderate risk in the Rotorua part of the Unison network.	Mitigation work has focused on the seismic risk

Actions to Improve Security of Supply

Action	Capital Expenditure	Outcomes
Faster response times for isolation of faulted sections and restoration of supply	Unison is making heavy investment in new remote SCADA automation technologies	Much faster response times for the isolation of faulted sections of the Network and restoration of supply to the majority of Feeder customers.
Faster response times for isolation of faulted sections and restoration of supply	Significant numbers of Auto Recloser devices are being installed across the region	These will improve reliability of supply to large numbers of customers.
Upgrading network system, including a new substation, in the Rotorua and Arawa distribution areas	Investment in new network equipment	Improved security of supply (n -1 scenario (using adjacent alternative supplies) and ability to supply increases in demand.
Long radial feeder configurations supplying much of the rural Rotorua region provide real challenges in security of supply to customers. Unison is currently evaluating new overhead line design technology, which is a fully insulated conductor system.	Being evaluated as a possible replacement for primary sections of existing bare conductor circuits, particularly double circuit sections and for use in environmentally sensitive areas e.g. some Lakes residential areas.	This system has the potential to greatly improve reliability, as circuits will generally remain in service even when a pole is destroyed (e.g. motor vehicle incident or branches falling across lines).
Reduction in corrosion of overhead lines due to the geothermal atmosphere.	Replacing copper conductors with aluminium conductors.	Less failures and outages

Vector - Natural Gas Supply

Item	Status	Risks/Possible Action
Natural Gas Pipeline supply to Rotorua	Modelling of gas delivery during the peak week in the year by Vector shows that both compressors at Pokuru (near Te Awamutu) need to run (but not at full load) to maintain 36 barg[123].	As there is no spare compressor in case of breakdown the BOP pipeline could be considered to be running at full capacity. Potential I Upgrading the compressors at Pokuru would remove this constraint.

[123] barg is the gauge pressure measured in bars. A bar = 100 kPa. 1 bar is approximately equal to 1 atmosphere of pressure