CANTERBURY REGIONAL ENERGY STRATEGY PROJECT

Work Stream 02: Non-Grid Connected Energy System

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Approved by:

RJ (George) Hooper

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Project Details

Project Sponsor Canterbury Regional Energy Forum

Project Name: Canterbury Regional Energy Strategy Project **(CRESP)**

Work Stream: WS02: Non-Grid Connected Energy System

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Glossary

CRESG	Canterbury Regional Energy Strategy Group / Canterbury Regional Energy Forum
CRESG Members	Canterbury Employers' Chamber of Commerce, Environment Canterbury, Meridian Energy, Orion Networks and Transpower, and invited representatives from the Canterbury District Health Board and the Christchurch City Council
CECC	Canterbury Employers' Chamber of Commerce
Non-Grid Connected Energy	Non-electrical sources of energy
GHG	Green House Gas
ECan	Environment Canterbury or the Canterbury Regional Council
RMA	Resource Management Act
RPS	Regional Policy Statement
DTI	Department of Trade & Industry
NEECS	National Energy Efficiency and Conservation Strategy
LGA	Local Government Act
NES	National Environmental Standards for Air Quality
CAP	ECan's Clean Air Policy
CHP	ECan's Clean Heat Project

Contents

LIST OF TABLES & FIGURES

Tables

Figures

EXECUTIVE SUMMARY

The Canterbury Regional Energy Strategy Project (CRESP) is an initiative sponsored by the Canterbury Regional Energy Forum, which is aimed at securing the future of energy supply in the Canterbury Region through the development of a new paradigm that will facilitate cooperation and collaboration among regional stakeholders.

This Report summarises the results and key findings from work stream 2, which encompassed the Non-Grid component of the Canterbury Energy System.

In its recently released consultation summary, the Greater Christchurch Urban Development Strategy Forum stated, inter alia:

> *"A secure and reliable electricity supply is essential for economic prosperity and for health reasons. Affordable and sustainable energy solutions are required to meet the future energy needs and address climate change issues." [1]*

This sentence first alludes to the importance of a secure and reliable electricity supply and the essential contribution that electricity makes to the well being of society. This importance is recognised in Work Stream 01 of this project.

> *"Affordable and sustainable energy solutions..." goes on to include the other (dominant) energy forms and sources, oil (products), natural gas, coal, and perhaps wind, solar and even light energy.*

One could infer from this that the "security" and "reliability" concerns of non-electricity energies are relatively minor, and that affordability and sustainability issues have greater currency. Given the alternative channels and infrastructure through which these non-grid energies can be delivered to consumers in a competitive market, this study concludes, broadly speaking, that there are no pressing concerns, at least at a regional and operational level.

Our high level analysis and our compendium of data and information would also suggest that energy consumption (within the Canterbury region) will continue to increase along with population and economic growth. This leads to the issues of affordability and sustainability.

Significant price increases in virtually all energy types, notably for electricity and transport fuels, in recent years suggests that "affordable" energy has become a more urgent concern for some members of society and various levels of government, notwithstanding that this is a somewhat nebulous and selective concept.

Whilst not specifically examined in this work, it can also be anticipated that national policy directions in support of renewable energy forms may well exacerbate these price pressures. As the Canterbury region is characterised by its strong dependence on electricity and transport fuels for economic activity when compared with other regions in New Zealand, the outlook for economic development within the region may thus be more subdued than generally assumed and accordingly, consumers should be preparing themselves for a higher cost energy future.

Of resurgent concern are the negative environmental impacts of energy production, transportation and consumption, especially as it relates to climate change. This report case studies a number of both renewable and non-renewable energy opportunities in the Canterbury region to provide the reader some measure of the likely potential future energy sources available to the region. As will be seen, there are no easy options and even some of the suggested renewable options could have negative environmental consequences and are not a panacea to our many energy challenges.

Key Findings:

1. Energy consumption within the Canterbury region will continue to increase along with population and economic growth. This leads to issues of affordability and sustainability
2. Significant price increases s combined with

strong environmental standards for home heating in particular has resulted in an increasing proportion of the community vulnerable to becoming "energy poor"

3 The Canterbury region, compared with many other regions in New Zealand, has limited opportunities for regional energy production. Resources are largely untapped (exception the Waitaki river system – which has limited additional potentials under current planning regimes).

4 The Canterbury basin offers the most significant prospective opportunity for the region with any oil and gas discovery likely to improve the overall prospectivity of the basin. Values attributed to a probable commercial find in the basin are of the order of NZ$1 billion.

Any such discovery would transform the energy supply picture and energy infrastructure of the Canterbury region.

5 However, a significant oil and gas discovery will be necessary to stimulate further exploration activity. The development of an oil and gas industry in the region will require a series of discoveries rather than a single major find.

6 In other transport fuels, supply chain vulnerabilities are becoming increasing apparent. With rapidly increasing consumption of LPG to meet reticulated demand in Christchurch and other major population centres, regional storage levels have now declined to less than 10 days consumption. Capacity expansion will be required in the near term.

7 Export of West Coast coal through Lyttleton Harbour has significantly increased in recent times and now accounts for over 25 percent of the port's throughput volume.

The West Coat rail link is thus a vital link and a critical export lifeline. The considerable vulnerability of earthquake risk is a major issue, and becomes an extreme economic risk for the region and South Island users. The capacity to import of coal through Lyttleton is the most obvious response option.

8 Canterbury is a relatively small player in the NZ forestry sector. Forest harvest is likely to decline in future years with conversion of parts of the forest estate to pastoral use – depending on irrigation. Domestic use continues to dominate the use of woody biomass for energy, but is actively discouraged as a future option. Pellet fuel alternatives are generally more expensive than competing technologies.

9 Whilst there is opportunity for small scale regional hydro development the potential for such schemes is tied upon in the politics of water, and irrigation. Under current pricing regimes the economic returns for small-scale hydro is marginal at best.

10 Canterbury will continue to have a heavy reliance on imported fuels and in future remain a price taker with added cost from transport and distribution charges.

11 Regional initiatives/action need to give support to energy infrastructure investment and improvement programmes that will secure for the region reliable and affordable energy services across the entire supply chain.

12 Beyond this, a lack of coordination at regional level leaves Canterbury exposed to a range of risk factors arising from changing demand patterns, land use changes and demographic shift.

1 INTRODUCTION

The Canterbury region is one of the fastest growing regions in the country. To propel this development, energy from various sources and types is utilised to power industry and agriculture, and support business, development and lifestyle. Energy survey information illustrates the overall trend of increasing (as the trend is nationally), rather than stabilising or decreasing energy use, and continued dependence on oil products. Our ever-increasing dependence on energy for both 'stationary' and 'mobility' purposes coincides at a time when the region [2] faces significant future uncertainty in the area of availability and prices of some energy sources.

Energy has become both a national and a local issue due to factors such as electricity industry reforms of the last decade, a growing community reliance on high quality energy services and, increasingly, climate change and other environmental issues. This shift in focus is supported by the growing policy emphasis towards sustainable development and associated actions; of which a vital component is addressing energy security and supply and demand issues within the framework of creating for the country and its regions, a sustainable energy system.

Increasingly, as evidenced by the Canterbury regional energy seminars held in late 2005, individuals and communities are looking for solutions and to influence policy so as to mandate better outcomes, as they perceive the issues. These issues will need to be dealt with in the context of the Canterbury energy system - which has unique attributes in terms of: energy use patterns, location issues, user issues (e.g. service standards) and network issues.

The 'cross-roads' issues we face are now being reflected in regional communities asking for regional solutions and a seeking an appropriate balance between developing or maintaining macro energy infrastructure versus provision of smaller distributed and 'micro' solutions. There is now more evidence available both nationally (CAE, 2003 [3]) and internationally (e.g. Hoffman and High-Pippert, 2005 4]; DTI, 2006 [5]) to suggest that 'community energy', based on a mix of distributed technologies offers a serious alternative to conventional supply chain models.

Notwithstanding the impact of the NZ Energy Strategy, a number of key programmes and legislation attempt to deal with enabling an effective and sustainable energy system including: the NEECS; the RMA; and (indirectly) the LGA [6].

The RMA has greatest significance currently to councils. The 2004 RMA amendments require a taking into account the '*benefits to be derived from the use and development from renewable energy*'. The region's Regional Policy Statement (RPS) is the key means by which the purpose of the RMA can be achieved with a regional energy strategy (RES) [7] being a core method to achieve those RPS requirements.

Further amendments to the RMA in 2005 now require regional and district councils to give effect to the RPS and for regional and district councils to agree upon the consultation process for a review (process is now underway). The relationship between regional and territorial authorities in relation to energy issues has been of little importance until now but this is set to change. The territorial councils are now able to play a stronger role by ensuring that district plans reflect the renewable energy objectives of the RPS (such as making provision for various scale energy generation facilities); and considerable scope exists for flexibility for applying more liberal consent terms (thresholds and duration) when applied to renewable resources.

Energy considerations (in the form of appropriate space heating technology) are also a feature of ECan's Clean Air Policy (CAP). The National Environmental Standards for Air Quality (NES) require improvement in air quality between now and 2013 to avoid impact on the region's economy (driven in large part by growing demand for electricity services). ECan's Proposed Air Plan [52] and Clean Heat

Project (CHP) are the key means of meeting the NES. ECan's CHP is designed to replace the use of old style (pre-1992) fuel burners and open fires; and substitute their use with 'clean' (air emission) alternatives [53].

This report provides a compendium of energy resources, supply and consumption within the Canterbury region, addressing historical supply and consumption, a brief description (and assessment from a security of supply point of view) of the supply chains and infrastructure in place that delivers the energy to final consumers as well as a description of the resource endowments of the region and the ability and potential of those resources to deliver future economic benefits, particularly to the people of the Canterbury region.

2 STUDY OUTLINE

The Canterbury Regional Energy Strategy Project (CRESP), sponsored by the Canterbury Regional Energy Forum, is aimed at securing the future of energy supply in the Canterbury Region through the development of a new paradigm that will facilitate cooperation among regional stakeholders, provide regional input into regulatory decision making processes, and secure industry agreement and collaboration to achieve a desired set of outcomes and options that would ensure the security of energy supply to the Canterbury region for the future.

Central to the development of such a paradigm is having in place effective communication mechanisms between regional stakeholders, so that information related to risks and vulnerabilities of the regional energy system can be communicated to all stakeholders in such a way that they can easily understand what is important and can use the information to make informed decisions, in the face of conflicting and competing public goals, corporate objectives and multiple responsibilities.

Ultimately, this project is intended to contribute towards an integrated Regional Statement of Opportunities that will:

- Articulate the critical energy issues for the Canterbury Region;
- Characterise the risks and vulnerabilities inherent in energy supply to the region
- Critically investigate all viable options to achieve the desired energy balance;
- Align the investment plans and decision making frameworks of the regional stakeholders; and,
- Achieve regional agreement on the effects of trade-offs to reach a balanced perspective that takes account of security, risk, economic opportunity and consumer preferences.

This will provide broad based priorities for improving resilience and investment in the underpinning energy infrastructure to the betterment of all in the region.

2.1 Project Scope

The overall Project was separated into 3 stages and this report summarises the key findings from the work stream into the Non-Grid Connected component of the Canterbury energy system (i.e. WS02):

Stage	*Description*	*Commencement*
1	Characterisation of the Regional Energy System; separated into 2 work streams: a. WS01 – Grid Connected Energy *b. WS02 – Non-Grid Connected Energy*	Aug-Nov 2006
2	Regional Opportunities Analysis	2007
3	Community Consultation and Communication	2008

The broad scope for Stage 1 was to:

- To develop a high-level 'snapshot' or 'Compendium' of the energy system in the Canterbury region; in particular, reviewing system characteristics, vulnerabilities, potential investment opportunities and other relevant issues;
- To investigate the broad parameters and protocols for a framework that would allow major regional stakeholders to collaboratively address critical issues to ensure the future security of energy supply in the region; and
- To review, and at a high level, attempt to align and standardise key concepts, definitions and terminology used by key regional stakeholder to ensure more effective communication and collaboration.

2.2 Deliverables

The specific deliverables for this WS02 or Non-Grid Connected work stream were:

a. A 'Snapshot' of the Non-Grid Connected component of the Canterbury Energy System (resources, assets, supply chains, etc);

b. A Template for an Updateable Regional Energy Compendium based on the above, that would contribute towards Environment Canterbury's Regional Energy Plan and Regional Energy Policy.

Additionally, this work stream was also expected to contribute towards:

c. A Template for a Regional Collaboration Framework that will allow major regional stakeholders to engage with each other to address energy issues in Canterbury;

d. A Programme of Action for Stage 2, that is expected to contribute towards the development of a Regional Energy Road Map and Regional Energy Investment Plan in Stage 3.

2.3 Expected Outcomes

The project is intended ultimately to provide a road map for determining future energy options for Canterbury, and a framework for regulatory decision-making. This road map will identify the critical energy assets for the region, its resources and future utilisation options, and characterise the risks and vulnerabilities of future choices for the region.

2.4 Approach

The tight scope of the project meant that this work stream was dependent on existing publicly available data or data made available to the Study Team by stakeholders.

Following an initial data gathering and literature review process that focused specifically on high-level data, a draft model for a 'Regional Energy Compendium' that characterised the non-grid connected energy resources and infrastructure in the Canterbury region was tabled and discussed at a workshop that involved representatives from a wide range of regional stakeholder organisations.

The 'Energy Compendium' model considered the following:

- Availability, Production and Consumption of specific energy resources at a regional level;
- Supply Chains; and
- Prospects or Potential of the energy resource.

Gaps in the model were then addressed consistent with the scope, and the populated 'Regional Energy Compendium' was tabled and discussed at a second stakeholder workshop.

Feedback from this second workshop was incorporated in this Report. A list of participants at both workshops may be found in Appendix 1.

3 REGIONAL DESCRIPTION

The Canterbury region comprises eleven local government districts: Kaikoura, Hurunui, Selwyn, Waimakariri, Christchurch City, Banks Peninsula (merging into Christchurch), Ashburton, Timaru, Mackenzie, Waimate and Waitaki. This is the region north of the Waitaki River, south of the Clarence River and extends from the Main Divide of the Southern Alps in the west to the east coast (Figure 1).

Figure 3.1: Map of the Canterbury Region (Source: Environment Canterbury (Ecan))

3.1 Demographic Profile

The Canterbury region has a population totalling 526,300 (in 2004), which comprises around 13% of the New Zealand population, as shown in Table 1. Based on a projected annual growth rate of between 0.6 and 1.0%, a population of 584,400 is expected by around 2026.

Table 2 shows that the region is older and less multi-ethnic than the New Zealand average. However, the percentage of the regional population that is of working age is very similar to the New Zealand average.

Table 3 shows that incomes in Canterbury are lower than that generally in New Zealand. This is without consideration to the expenditure side of the ledger, that is, purchasing parity consideration, as property prices and many other cost of living items are lower in Canterbury than in some other major population centres.

Also, importantly for overall residential energy consumption considerations, the average household size in Canterbury is around 2.5 persons, significantly below the national average of 2.7, although this may reflect the age distribution of the region.

3.1.1 Population Growth Prospects

In its recently released report, the Greater Christchurch Urban Development Strategy Forum included some projections on population growth and household formation out to 2026 and 2041 [9].

The Strategy assumes a population growth of less than 1% per annum to 2026. Household formation is projected to grow faster at 1.3% per annum with the result that the number of inhabitants per house falls from the current 2.54 to 2.35 by 2026. In line with an aging population, the labour force is projected to growth by only 0.8% pa. However, it is important to note that the greater Christchurch urban area comprises around 82% of the overall Canterbury region by population.

	Canterbury Region	New Zealand
Males	234,525	1,822,986
Females	246,924	1,914,282
Total	481,446 (12.9%)	3,737,268
Change since 1996		118,974
% change since 1996		3.2%

Table 3.1: Population Summary – Canterbury and New Zealand (Source: NZ Census of populations and dwellings (2001) [8])

Age Range	Canterbury Region		New Zealand
0-14	97,557	20.3 %	22.7 %
15-64	317,364	65.9 %	65.3 %
65+	66,504	13.8 %	12.1 %
Ethnic Group	**Canterbury Region**		**New Zealand**
European	434,670	92.8 %	81.3 %
Maori	31,632	6.8 %	14.7 %
Pacific	9,081	1.9 %	6.9 %
Asian	19,629	4.2 %	6.7 %
Other	2,385	0.5 %	0.7 %

Table 3.2: Age and Ethnic Make-up – Canterbury and New Zealand (Note: Some people are multiple ethnicities)

Income Range	Canterbury Region		New Zealand
Loss	2004	0.5%	0.6%
Zero Income	14,439	3.8%	4.2%
$1 - $5,000	33,225	8.7%	8.3%
$5,001 - $10,000	49,002	12.8%	11.7%
$10,001 - $15,000	58,548	15.3%	13.7%
$15,001 - $20,000	34,797	9.1%	8.4%
$20,001 - $25,000	30,642	8.0%	7.2%
$25,001 - $30,000	30,261	7.9%	7.4%
$30,001 - $40,000	42,237	11.0%	10.8%
$40,001 - $50,000	23,097	6.0%	6.3%
$50,001 - $70,000	19,071	5.0%	5.7%
$70,001 - $100,000	7,221	1.9%	2.4%
$100,001 or More	6,093	1.6%	2.2%
Not Stated	33,231	8.7%	11.1%

Table 3.3: Income Strata – Canterbury and New Zealand

While no projections of regional economic growth were made or are available, a working basis would be that the Canterbury region as a whole, and the greater Christchurch area will grow at least as fast as the national average, say 3% per annum. By virtue of the fact that the Auckland region is projected, by Statistics New Zealand, to have by far the fastest population growth out to 2026, then this region will almost certainly have the highest economic growth [10].

3.2 Economic Profile

The Canterbury economy accounted for 14.6% of total economic activity in New Zealand in the year to March 2004.

Its regional GDP in the same year totalled $19.9 billion, with a per capita nominal GDP of $35,650 in the year to March 2003, compared to a national figure of $32,100. Canterbury's per capita real GDP grew at an average of 3.7% between March 1998 and 2003, well above the New Zealand growth rate of 2.3%.

Canterbury's unemployment rate averaged 4.1% over the year to June 2004, compared to a national rate of 4.3%. The region's labour force participation rate is the highest in New Zealand, suggesting that the vast majority of able and willing workers are actively employed. This is reflected in the relatively high GDP per capita in the region. It also indicates that any additional economic growth will have to stem from population growth or labour and capital productivity gains.

Labour productivity (real GDP per employee) in Canterbury grew at an average of 0.8% between 2000 and 2004. Nationwide, labour productivity growth averaged 0.9% per year over this period.

Canterbury spends an above-average amount on economic development relative to its GDP ($1,300 per $million of GDP), compared to New Zealand as a whole ($1,100 per $million of GDP). Despite this expenditure, the region's enterprise creation and destruction rates are not vastly different to the national averages.

3.2.1 Economic Growth Prospects

Canterbury's economic growth between March 2000 and 2004 averaged 4.8%, compared to a national average of 3.5% for the same period, making Canterbury the second fastest growing region of those covered by NZIER's regional economic dataset.

The steady growth in the Canterbury economy of the past few years is, however, expected to slow in the near term. Current forecasts indicate that the South Island economy is cooling, with the annual rate of economic growth forecast to fall from 3.8% to 3.2%. Although this cooling trend is expected to continue for a few years, economic growth is still predicted, but at a slower rate than the past few years. In the Canterbury region, there has most recently been a decline in economic growth, with growth of 2.2% (quarter for quarter) in quarter 1 of this year, giving way to a 0.4% drop in quarter 2. This has been primarily attributed to the Canterbury economy's exposure to manufacturing and tourism, which are particularly vulnerable to recent high exchange rates and increased oil costs.

3.3 Industry Profile

Figure 3.2 compares Canterbury's regional economic structure against the broader New Zealand economy. Plots to the right side of the dotted line (e.g. trade and tourism) indicate that the specified industry accounts for a greater proportion of the Canterbury GDP than it does at a national level; i.e. the industry is more 'important' to the Canterbury region than to the New Zealand economy as a whole.

The figure above suggests:

- A high reliance on various manufacturing sectors, relative to the national economy
- A relatively high dependence on faster-growing sectors (e.g. food, beverage, trade, tourism and other services)
- An under representation, relative to the New Zealand economy, in the business services, agriculture, natural resources and government sectors, which apart from business services, are all relatively slow-growing sectors at the national level.

Fast-growing regions tend to have a high proportion of their regional economies focused on fast-growing sectors, which may explain in part why the Canterbury economy has grown rapidly in recent years.

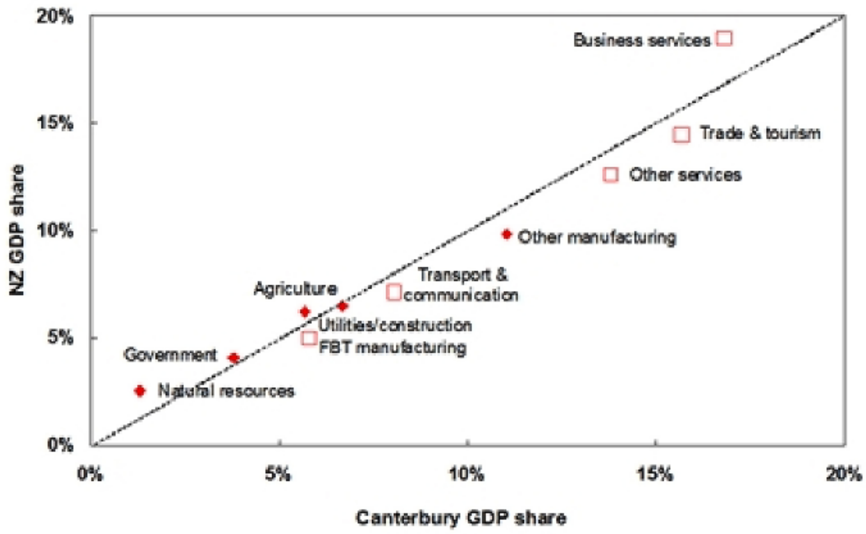


Figure 3.2: Canterbury's Industrial Profile (Source: NZ's Regional Economic Performance - Regional Highlights 2006. NZIER for MED: p17)

Key: The square scatter plots are industries that are fast-growing at a national level
The black diamond scatter plots are industries that are slow-growing at a national level.

4 OUTLINE OF REGIONAL ENERGY SITUATION

Of current energy supply, the Canterbury region can at best be described as selectively endowed. The region produces around 28% of New Zealand's electricity supply from Meridian Energy's stations in the Waitaki system. Around 50% of the (net) production is consumed within the region with the remaining 50% being exported. However, the bigger picture also indicates that Canterbury, and the South Island in general, is becoming increasingly reliant on electricity deliveries from North Island thermal generation. In 2006, for the first time, the NZ Minzone was centred in the Upper South Island and not the Lower North Island. This southward shift simply reflects the dry year risk to South Island generation.

The region does not have any hydrocarbon production aside from a small coalmine. All liquid fuels, gas and coal consumption, together comprising around 75% of total energy consumption, are imported, either from other regions within New Zealand or (originally) from overseas.

A fuller description of energy supply, especially non-grid supply, into Canterbury, forms part of the ensuing discussion.

Environment Canterbury already conducts a biennial regional energy survey, the most recent of which was up to 2004 and published in May 2006 [11].

Table 4.1, Table 4.2, Figure 4.1 and Figure 4.2 sourced from the ECan Survey summarise energy consumption by type and by sector, respectively. The total energy consumed has just about doubled in 22 years with the biggest increases being in Wood and Oil Products consumption. Consumption by sector

	Oil Products	Electricity	Coal	Wood	Total
	TJ	TJ	TJ	TJ	TJ
1982	20,863	8,565	3,562	1,425	34,416
1983	20,708	9,023	3,286	1,473	34,489
1984	22,322	9,426	3,309	1,521	36,577
1985	22,462	9,477	3,332	1,568	36,839
1986	22,907	10,031	3,354	1,634	37,927
1987	23,392	9,862	3,377	1,942	38,573
1988	22,808	10,223	3,400	2,006	38,436
1989	24,186	10,564	3,445	2,067	40,262
1990	26,035	10,725	3,402	2,124	42,286
1991	26,593	11,405	3,531	2,174	43,702
1992	27,912	11,189	3,590	2,241	44,931
1993	29,637	11,325	3,515	2,061	46,538
1994	31,520	12,236	3,197	2,173	49,125
1995	32,014	12,633	3,367	2,330	50,344
1996	33,663	12,902	3,442	2,697	52,705
1997	35,060	13,222	3,518	2,770	54,570
1998	38,513	13,218	3,594	2,925	58,248
1999	37,568	13,405	3,669	3,096	57,738
2000	37,484	14,369	3,745	3,286	58,883
2001	36,977	14,357	3,820	3,365	58,518
2002	38,137	15,489	3,828	3,445	60,899
2003	38,927	15,626	3,824	3,405	61,782
2004	41,058	16,040	3,824	3,405	64,327
Increase % p.a.	3.13%	2.89%	0.32%	4.04%	2.88%

Table 4:1 Canterbury Region Energy Consumption by Energy type [12]

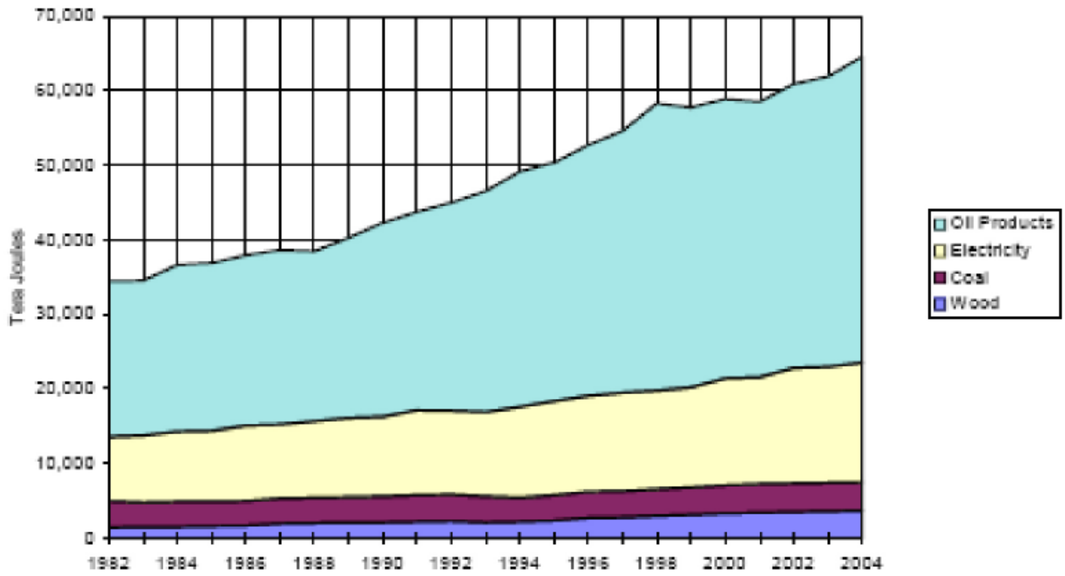


Figure 4.1: Canterbury Region Energy Consumption by Energy Type [13] (Source: Ecan Regional Energy Survey, Fig 3.1, p3).

	Transport	Ind/Comm	Residential	Total
	TJ	TJ	TJ	TJ
1982	16,946	10,397	7,073	34,416
1983	17,812	9,520	7,157	34,489
1984	19,585	9,860	7,132	36,577
1985	19,881	9,805	7,153	36,839
1986	20,696	9,781	7,449	37,926
1987	21,602	9,712	7,259	38,573
1988	21,202	9,906	7,328	38,436
1989	22,020	10,584	7,657	40,261
1990	23,667	10,933	7,687	42,287
1991	24,402	11,188	8,112	43,702
1992	25,987	10,788	8,155	44,930
1993	27,380	11,343	7,815	46,538
1994	28,981	12,147	7,998	49,126
1995	29,983	12,213	8,147	50,343
1996	32,274	11,988	8,443	52,705
1997	33,487	12,380	8,704	54,571
1998	32,663	16,902	8,683	58,248
1999	32,705	16,023	9,010	57,738
2000	33,215	16,712	8,957	58,884
2001	33,687	15,690	9,141	58,518
2002	34,069	17,421	9,409	60,899
2003	34,635	18,018	9,129	61,782
2004	36,801	18,319	9,206	64,326
Increase % p.a.	3.59%	2.61%	1.21%	2.88%

Table 4.2: Canterbury Region Energy Consumption by Sector [14]

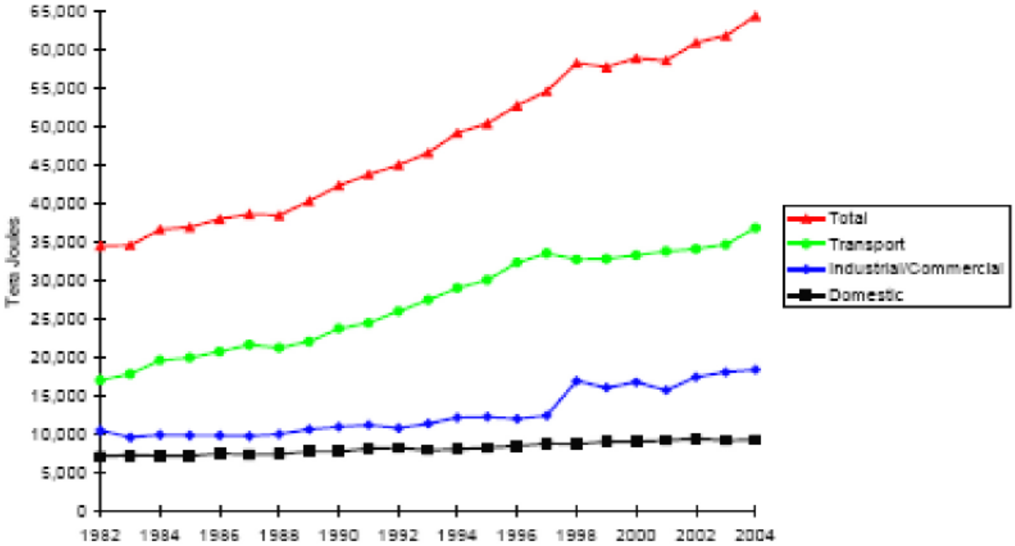


Figure 4.2: Canterbury Region Energy Consumption by Sector [15]

shows an increase of 3.59% in energy use for transport compared to an overall energy consumption increase of 2.88%.

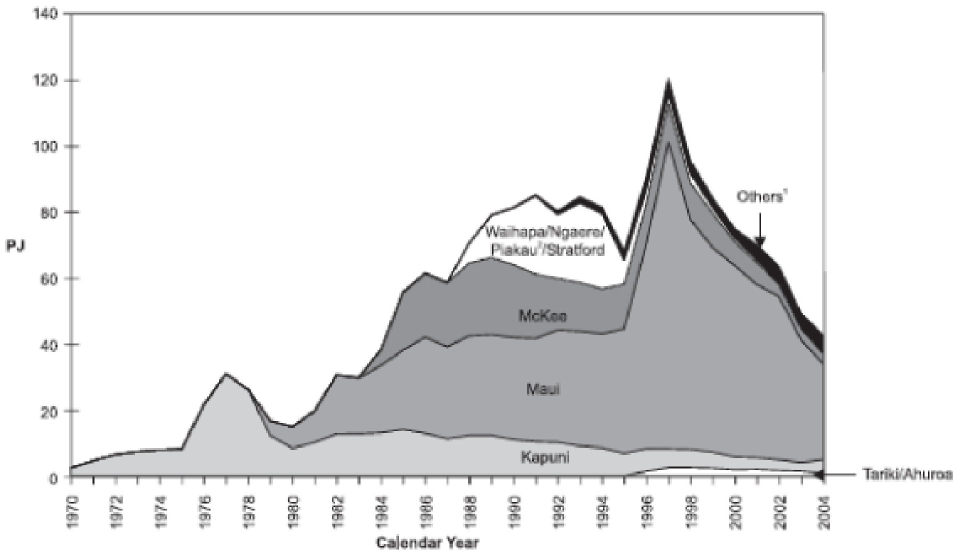
They highlight the importance of oil products (over 60% share as shown in Figure 2), almost all of which is consumed in the transport sector (around 57% of consumption in 2004) [54]. Furthermore, the consumption of oil products and transport consumption has been the strongest growing over the period of the survey.

It is no surprise then that the greatest challenges to energy conservation and containment or reduction of greenhouse gas (GHG) emissions pertain to petrol and diesel consumption in the transport sector.

5 STOCK-TAKE OF CANTERBURY'S ENERGY USE & ENERGY RESOURCES

5.1 Transport Fuels

Production



Notes:
[1] Includes Cheal, Kaimiro, Mangahewa, Ngatoro (including Goldie well), Radnor, Rimu (including Kauri well) and Stratford fields.
[2] Piakau has not produced gas since September 1999.

Figure 5.1: Indigenous Crude, Condensate and Naphtha Production by Field (PJ)

Figure 5.1 above shows indigenous crude oil, condensate and naphtha production produced in New Zealand, specifically the Taranaki production theatre, since 1970. Production has been dominated by the Maui Field, and to a lesser extent, the McKee Field, since the early 1980s.

Indigenous production peaked in 1997 at around 120 PJ but has now declined to less than half of the amount that prevailed during the 1990s.

A combination of increasing consumption (as approximated by "indigenous production + imports – exports"), as shown in Table 5.1 below, together with declining indigenous supply, means that import dependency has increased from less than 50% in 1985 to over 80% today.

Consumption

Table 5.2 below shows the breakdown of transport energy fuels by mode. The greatest increases have been in marine (7.10%) and aviation (8.40%) with both having increases far greater than the total increase in transport energy consumption of 3.6%.

Supply Chain

This section provides an analysis and description of the liquid fuels supply chain as it applies to the Canterbury region. That is, the supply chains described here include both transport and non-transport fuel supply (and includes LPG).

Four companies dominate petroleum distribution and retailing; BP, Mobil, Shell and Caltex. These companies have interests in the Marsden Point oil refinery and between them they own most of the bulk storage facilities and many of the country's petrol stations. Petroleum fuels are predominantly shipped to Lyttleton Port from Marsden Point with smaller amounts being shipped to Timaru. There are tank farms

Calendar Year or ptember Years	New Zealand Production	Imports	Refinery Intake	Exports	Stock Change	Discrepan
1985	55.73	40.18	64.56	29.02	2.56	-0.23
1986	61.50	48.65	103.76	8.38	-1.58	-0.41
1987	58.69	104.34	152.68	4.66	4.80	0.90
1988	70.66	112.81	170.32	14.46	-0.30	-1.02
1989	79.17	137.88	188.46	27.56	1.35	-0.32
1990	81.55	143.28	188.48	40.24	-3.84	-0.04
1991	85.28	143.84	182.52	44.88	1.97	-0.26
1992	80.36	141.52	182.36	40.53	0.50	-1.51
1993	84.70	158.38	192.28	47.58	0.25	2.97
1994	81.51	175.84	202.02	51.35	3.82	0.16
1995	68.33	169.37	196.28	44.11	-2.05	-0.64
1996	90.74	165.55	189.61	56.83	5.84	4.00
1997	120.56	168.30	212.29	77.70	-1.11	-0.02
1998	95.67	202.51	217.72	70.97	7.72	1.77
1999	84.36	198.77	212.72	63.45	3.14	3.82
2000	74.96	203.30	221.03	55.07	0.98	1.17
2001	70.02	191.46	208.93	58.12	-6.61	1.05
2002	63.55	205.31	219.94	50.50	-2.28	0.69
2003	49.20	217.66	220.10	41.85	5.47	-0.57
2004	42.54	200.89	214.02	33.45	-3.58	-0.46

Table 5.1: Crude Oil, Condensate, LPG and Naphtha Production in New Zealand

	Vehicle	Aviation	Marine	Rail	Total
	TJ	TJ	TJ	TJ	TJ
1982	13,910	1,550	1,077	409	16,946
1983	13,962	1,768	1,656	425	17,812
1984	14,456	2,038	2,695	396	19,585
1985	14,066	2,341	3,043	431	19,881
1986	14,478	2,768	3,041	409	20,696
1987	14,495	3,380	3,308	418	21,602
1988	14,575	3,538	2,699	391	21,202
1989	14,831	4,014	2,802	374	22,020
1990	15,330	4,300	3,667	370	23,667
1991	15,627	3,919	4,502	354	24,402
1992	16,503	4,061	5,025	397	25,987
1993	17,186	4,542	5,255	397	27,380
1994	18,042	4,689	5,719	532	28,981
1995	18,586	4,987	5,817	594	29,983
1996	19,264	5,404	6,958	649	32,274
1997	19,879	5,436	7,525	647	33,487
1998	20,015	6,019	5,970	660	32,663
1999	21,243	6,026	4,763	674	32,705
2000	21,857	5,997	4,674	687	33,215
2001	22,521	5,552	4,914	701	33,687
2002	23,465	5,216	4,678	711	34,069
2003	24,096	5,490	4,320	728	34,635
2004	25,133	6,548	4,412	709	36,801
(1983-2004) Mean Incr (%p.a	2.70%	7.10%	8.40%	2.90%	3.60%

Table 5.2: Canterbury Transportation energy consumption by mode (TJ) [16]

located at both of these ports that comprise the main bulk storage facilities.

From Lyttleton Port, products destined for the Christchurch market are transported through a pipeline, owned by Mobil, over the Port Hills to Woolston. Product destined for elsewhere within the region or the West Coast are moved from the port by road transport.

From Table 5.3 and Table 5.4, bulk storage facilities are capable of holding around 49.5 days of regional consumption in 2004 [55]. Timaru Port has about around a quarter of the region's storage capacity and thus has much more capacity relative to local consumption than does the Christchurch region.

5.2 LPG

Liquefied petroleum gas (LPG) is the only available gaseous fuel (typically a combination of propane and butane) in the South Island. Table 10 shows the LPG storage facilities in the region. There are no storage facilities at Lyttleton. LPG is sent via pipeline over the Port Hills to the Liquigas storage site near the Woolston liquid fuels depot. Rockgas' and Ongas' storage facilities are adjacent.

Annual consumption in the region in 2004 was estimated to have been around 50,000 tonnes. This suggests that available storage was around 10-11 days' consumption in 2004. With rapidly increasing consumption, this coverage is decreasing rapidly in the absence of some capacity expansion.

This (maximum) consumption coverage stands in contrast to the amount of coverage for other petroleum fuels.

Prices

Figure 5.2 gives some indication of escalation in oil prices in the last 2-3 years, with the subsequent retracement back to around US$60 per barrel being a relatively small adjustment given the increase from less than US$30 per barrel to over US$70 over the period.

Figure 5.3 shows how New Zealand crude and transport fuels prices have moved since April 2004. Consumer prices are muted because government taxes and levies comprise a significant share of the overall pump price and these do not vary much in the short term. For example, a price of $1.44 per litre for regular petrol is comprised of around $0.52 (41.7%) of taxes and levies.

The two major factors that affect the short-term price of transport fuels such as petrol, diesel and aviation fuel are the price of crude oil and the exchange rate with the US dollar. A third component that varies with the vagaries of the oil-refining sector is the so-called refining margin.

For example, at an exchange rate of NZ$1:US$0.65, a US$1 per barrel change in the price of crude "flows" through to (around) a 1c per litre change in the pump (retail) price of petrol or diesel, excluding GST. A 1c change (depreciation/appreciation) in the exchange rate also affects the retail price of petrol by

Petroleum Product	Lyttelton	Woolston	Chch Airport	Timaru	Total
	000 l	000 l	000 l	000 l	000 l
91 Octane Petrol	22258	4071	0	13026	39355
95/96/98 Ocatane Petrol	8913	2835	0	9500	21248
Diesel/AGO	23031	5009	9	17661	45710
Light Fuel Oil	9191	0	0	0	9191
Heavy Fuel Oil	4716	0	0	0	4716
Jet Fuel - A1	25427	2999	3586	0	32012
Avgas	4640	0	58	0	4698
Kerosene/DPK	606	0	0	50	656
Additives		25	0	27	52
Lubricating oil		342	0	0	342
Slops	108	92	0	101	301
Bitumen Products	7921	0	0		7921
Total	106811	15373	3653	40365	166202

Table 5.3: (Maximum) Bulk Storage Capacities in the Canterbury Region [17]

	2004
	million litres
Transport	1077
Non-transport	143
Total	1220

Table 5.4: Liquid Fuels Consumption in Canterbury [18]

	Maximum Storage
	000 litres
Lyttelton Port	0
Woolston	2000
in Lyttelton-Woolston Pipeline	130
From Woolston	
- Rockgas Storage	
Rockgas Ltd	20
Underground Storage	500
Harewood	40
Ferry Rd	20
Bryon St	25
- Ongas	
Ongas Ltd	20
Tumara Park	20
Canterbury Spinner Ltf	20
Total	2795
Total (tonnes)	1500

Table 5.5: Gas (LPG) Storage in Canterbury [19]

around (an increase/decrease of) 1c per litre, excluding GST.

Current retail prices also include a relatively high refinery margin, the fee that a refinery, such as that at Marsden Point, charges for refining crude into products. Worldwide refinery capacity expansion in the last few years has not kept up with the increase in (worldwide) products demand, resulting in refineries being able to charge more for their services. Thus, a situation of refining being a “bad” business has turned around to a lucrative one until such time as capacity becomes more plentiful. As an illustration, the refining fee can range between 3c and 9c per litre and currently is at the top end of this range.

An indication of the price components of (regular) petrol is shown in Figure 7. It is similar for premium petrol and also for diesel if the road user charge is included.

There are little in the way of regional price differences within New Zealand. That is, freight costs to major population centres tend to be averaged out and consumers face the same prices in essentially all the urban centres. Some small centres and rural areas do face higher prices, which not only reflect some additional freight costs but also diseconomies of scale and possibly also a lack of competition.

Despite the fact that the petroleum industry is wholly privately owned and, therefore, subject to commercial competitive practices and pressures, there is virtually no inter-company price differentiation at the retail level. For any price, change, there is usually an initiator and prices usually converge to an identical one within a short time.

Prospects

It is probable that the days of (regular) petrol prices being below $1.30 per litre are behind New Zealand. With refining costs making up approximately 50% of the petrol price, as shown in Figure 7 below, and taxes being approximately 40% of the petrol price, the likelihood of prices falling significantly is much reduced. Although crude prices may fall significantly below US$60 per barrel in the medium term, a very likely lower exchange rate and a “refinery margin” that is more sustainable for the refining industry, above the levels for much of the 1990s but perhaps slightly below current levels, are likely to put an effective floor on transport fuels prices. The possibility of a carbon tax would be an additional impost for the consumer.

The consumption analysis of transport fuels shows it to be “inelastic”, especially in the short term. This suggests that consumer demand is relatively unresponsive to price changes, particularly price increases. Consumers are slow to react to higher prices, both in changing their behaviours and in changing their energy consuming “assets”. All consumers have legacy assets and behaviours that take time to change. For example, plant machinery and buildings can only be replaced slowly, usually after some “use by” date, which may be influenced by energy prices in a minor way.

For private motorists, the shift in recent years

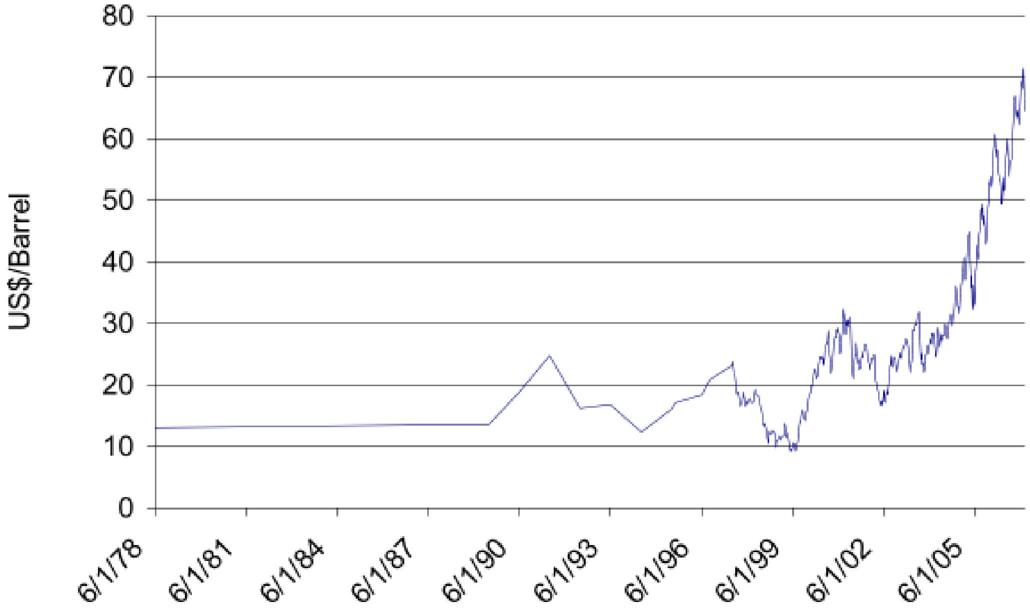


Figure 5.2: Crude Oil Price (Average weighted by volume) [20]

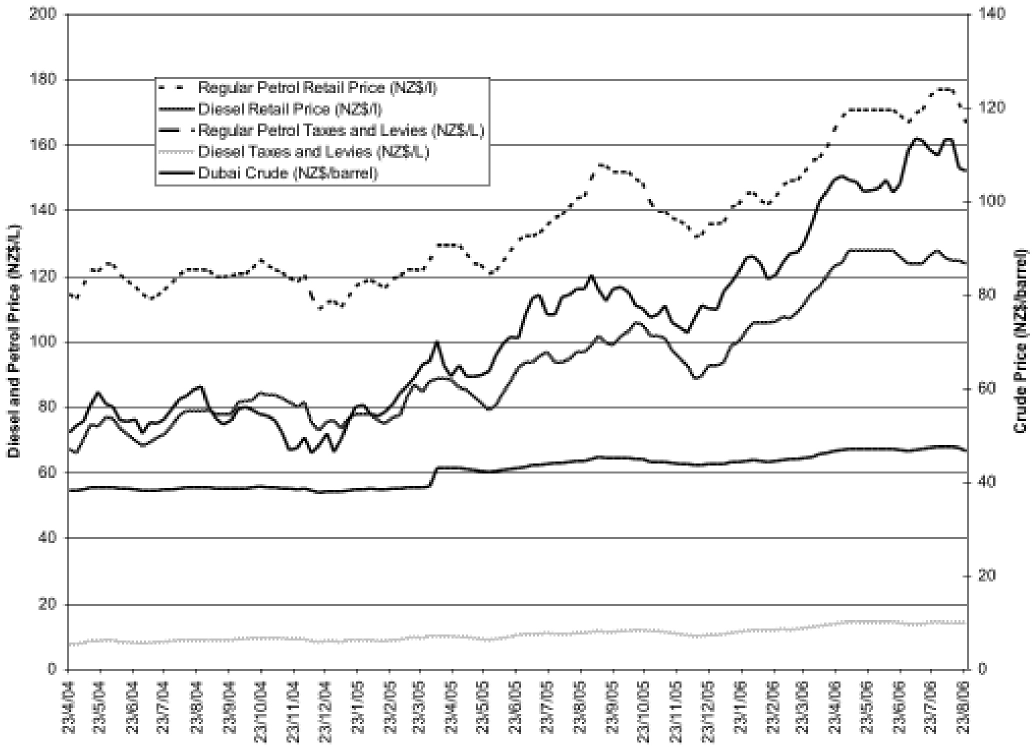


Figure 5.3: Crude and Transport Fuels Prices in New Zealand since 2004 [21]

to more multi-vehicle households and to less fuel-efficient sports utility vehicles (SUVs) has proven costly in the face of very high fuel prices. In response, the shift to smaller vehicles and a decline in vehicle ownership intensity (where New Zealand is the third highest in the world behind the USA and Australia) and also to a lower usage of the private vehicle fleet, is and will be slow. Some consumers will be reluctant to forego the benefits that more and bigger vehicles provide.

After a period of ostensibly non-responsiveness to higher prices, there is now likely to be some falls in the consumption of transport fuels as consumers have taken some time to adjust.

Even so, the trend for the consumption of transport fuels is likely to remain upwards as wealth and the demand for access to recreation and life style choices both increase.

In the longer term, any shift to supplement traditional transport fuels by biofuels, other synthetic fuels or electricity will require either high oil prices to occur or government mandate. Any mandated measures are likely to create further upward pressures on prices.

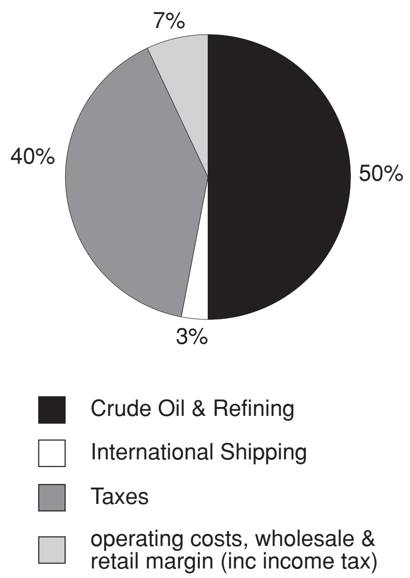


Figure 5.4: Breakdown of Petrol Prices [22]

Potential for Development

Case Study 1: Oil Exploration

The occurrence of oil and gas in the Canterbury region has been well documented. The Canterbury Basin (figure 8) has a proven petroleum system with large mapped structures. and, so far, one significant (off-shore) discovery. The first exploration well was drilled to a depth of 661m at Chertsey between 1914 and 1922. A further 2 wells were drilled onshore in 1969, reaching basement rocks at depths of 1650m (JD George-1) and 1159m (Leeston-1). Offshore, Resolution-1 was drilled by BP in 1975. Kowai-1 was drilled in 1978in North Canterbury by the newly formed state oil company, Petrocorp.

Clipper-1 was drilled offshore by BP in 1984. With a total depth of 4742m, this is the deepest well that has been drilled in the Canterbury Basin, and recorded gas and condensate shows. Galleon-1, drilled immediately following Clipper-1 in the North Otago sector of the basin, successfully tested for gas and condensate. Both these discoveries were adjudged by BP to be sub-economic, mainly because of size.

Recent exploration has included further seismic surveys both onshore and offshore, and 2 wells were drilled in 2000: Ealing-1 in Mid Canterbury and Arcadia-1 in North Canterbury.

A further offshore prospect, Cutter-1, is scheduled to be drilled off North Otago starting in October 2006, by Tap Oil on behalf of a joint venture of Australian companies. Figure 5.5 shows the location of the Cutter-1 and Barque-1 prospects in the same permit area.

Tap Oil indicate potential reserves, if Cutter-1 is successful [56], of 50-80 million barrels of oil. They have also identified a potentially large (Maui-scale) gas and condensate prospect, Barque-1, in deeper water, east of Cutter-1. As yet, there is not a timetable for the exploration of Barque-1.

Besides the Tap Group's PEP 38259 offshore North Otago, there are two onshore permits and two other offshore permits in force in the Canterbury Basin, and two areas under application. TAG Oil has announced plans to drill two wells onshore in late 2006 or early 2007.

Economic Significance

While the Canterbury Basin has drawn the attention and investment of oil and gas exploration ventures over many years, until a discovery of commercial scale is made and developed, the potential resources that are thought likely to exist can make no contribution to the regional energy system. Conversely, a discovery of scale sufficient to justify development could transform the regional energy situation.

The promising results of Galleon-1 in particular, and the resumption in serious exploration investment represented by the pending drilling campaigns (both off and on shore) attest to a reasonable level of oil and gas industry confidence in Canterbury's potential. Realisation of that potential needs to overcome significant risks and costs, not just in making a

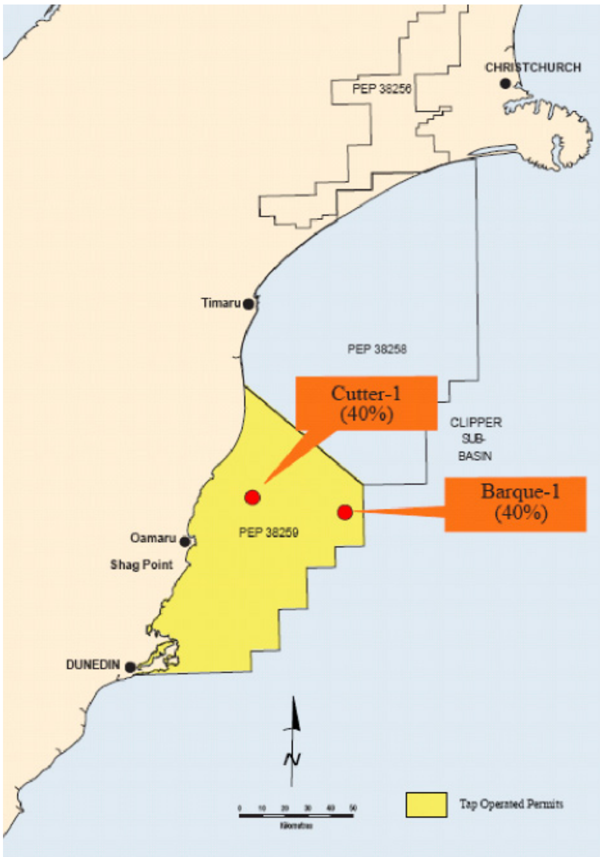


Figure 5.5: Location of Current Exploration Prospects in the Canterbury Basin [23]

discovery but in its subsequent appraisal, development, and the associated development of an infrastructure for the processing and/or utilisation of production in the region.

An indicative economic assessment assuming a successful discovery of 80 million barrels of oil at the Cutter-1 prospect has been made for this study [24]. Some input assumptions, amongst others, include an oil price of US$45 [57] per barrel, a gas price of NZ$5 per GJ and an exchange rate of NZ$1:US$0.60.

A production profile for oil with associated gas and water based on Taranaki Basin "F-Sands" type reservoirs, is assumed, resulting in an economic field life of at least 8-10 years.

Since Cutter is just 23km offshore east of Oamaru and in around 75 m water depth, it may be regarded as a "near shore" prospect. Thus production could start as soon as 2010 should a commercial find be made.

Based on development costs of US$410 million and operating expenditure of US$90-100 million p.a., the success case NPV for Cutter is estimated at around US$610 ((around NZ$1 billion) with a field value in excess of US$7.50 per barrel.

Even though the oil is likely to be directly loaded on to tankers from a floating production, storage and offloading (FPSO) facility and shipped elsewhere for further processing, these figures clearly imply significant economic benefits for the region from the exploration, appraisal and, especially if successful, production phases of such discoveries.

More importantly, any successful discovery is likely to improve the prospectivity of the Canterbury Basin, eventually leading to more successful discoveries. It is the aggregate effect of such discoveries that may transform the energy supply picture and energy infrastructure of the Canterbury region, in particular, and that of the South Island.

5.3 Oil (Non-Transport)

Table 5.6 summarises oil products consumption in the non-transport sectors. The non-trans-

	Ind'l/Comm	Residential	Total	% of Total Oil
	TJ	TJ	TJ	
1982	3,840	78	3,918	11.4%
1983	2,808	88	2,896	8.4%
1984	2,662	75	2,737	7.5%
1985	2,506	76	2,582	7.0%
1986	2,132	78	2,210	5.8%
1987	1,711	80	1,791	4.6%
1988	1,529	77	1,606	4.2%
1989	2,077	89	2,166	5.4%
1990	2,279	90	2,369	5.6%
1991	2,081	110	2,191	5.0%
1992	1,786	138	1,924	4.3%
1993	2,089	167	2,256	4.8%
1994	2,338	201	2,539	5.2%
1995	1,797	235	2,032	4.0%
1996	1,118	271	1,389	2.6%
1997	1,244	329	1,573	2.9%
1998	5,466	383	5,849	10.0%
1999	4,423	440	4,863	8.4%
2000	3,751	518	4,269	7.2%
2001	2,747	542	3,289	5.6%
2002	3,465	603	4,068	6.7%
2003	3,711	581	4,292	6.9%
2004	3,645	612	4,257	6.6%

Table 5.6: Estimated Canterbury non-transport oil product energy (TJ) [25]

port sectors consume only 6-7% of overall oil consumption, with the other 93-94% being consumed in the transport sector.

Since the South Island does not have reticulated natural gas available, the only available thermal fuels are coal and oil products. Notably, the consumption of LPG has been increasing strongly in recent years as shown in Figure 5.6. The share of LPG in non-transport oil consumption has increased to around 50%, i.e., over 2000 TJ per year, of the total.

5.4 Coal

Production and Consumption

Over 120 coalmines have operated in Canterbury since 1866, producing a total of about 2 mt [27]. It is estimated that slightly over half of the total economically recoverable resource remains (Table 5.10). There is only one mine currently operating producing around 2000 tonnes per annum, or roughly 0.05 PJ, for local use and , anecdotally, there appears little interest in further expansion of the industry within the region.

This is in contrast to the overall national picture, where domestic production, as shown in Table 5.8 below, has increased from 52 PJ in 1980 to 137 PJ in 2004, an average increase of 4% pa since 1980. National consumption, however, has been fairly static during this period at around 50 PJ pa. That is, until 2002, when since that time, the Huntly gas/coal power station has generated extensively with coal, resulting in domestic consumption rising to 97 PJ in 2004, with the balance of production being exported, almost totally through Lyttleton Port (see supply chain aspects below).

In turn, this was caused by the downward revision in recoverable reserves from the Maui gas field, which has resulted not only in a sharp decline in natural gas production but a concomitant increase in prices for this fuel.

Table 5.7 summarises coal consumption in Canterbury. Over the years, slowly increasing industrial/commercial consumption has been substantially counterbalanced by a rapid decline in household consumption where, in Christchurch, coal fires are now banned.

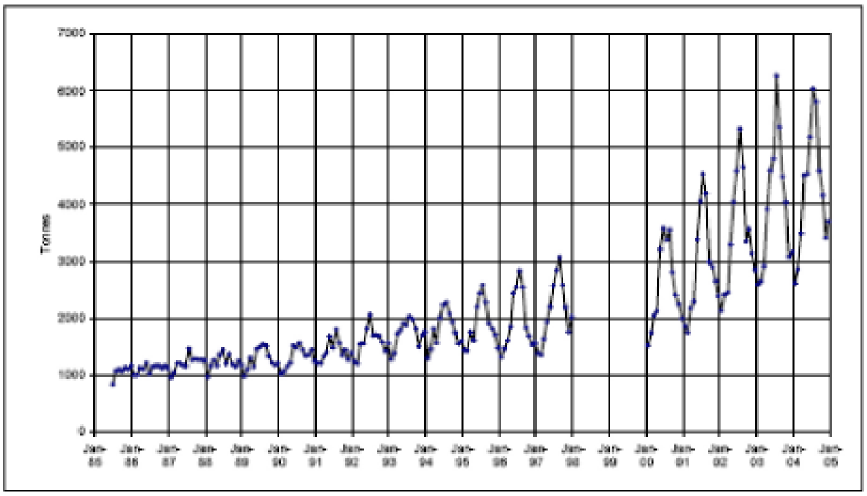


Figure 5.6: Monthly LPG Imports into the Canterbury Region [26]

Industrial consumption is dominated by Fonterra's Clandeboye dairy plant.

Supply Chain

Coal transported into the Canterbury region, for either local consumption or export, arrives by rail.

As shown in Table 5.8 exports of coal have increased strongly in recent years, aided in no small part by buoyant world commodity markets, significantly caused by the strong economic growth in China.

Lyttleton Port Company's 2006 Annual Report

	Ind/Comm	Residential	Total
	TJ	TJ	TJ
1982	2,612	950	3,562
1983	2,530	756	3,286
1984	2,598	710	3,309
1985	2,667	665	3,332
1986	2,735	620	3,354
1987	2,803	574	3,377
1988	2,871	529	3,400
1989	2,955	490	3,445
1990	2,974	428	3,402
1991	3,074	457	3,531
1992	3,014	575	3,590
1993	3,100	415	3,515
1994	2,887	310	3,197
1995	3,051	316	3,367
1996	3,156	287	3,442
1997	3,260	258	3,518
1998	3,364	229	3,594
1999	3,469	200	3,669
2000	3,573	171	3,745
2001	3,678	143	3,820
2002	3,729	99	3,828
2003	3,703	121	3,824
2004	3,703	121	3,824
Increase % pa	1.60%	-8.00%	0.40%

Table 5.7: Canterbury Coal Consumption by sector (TJ) [28]

	Production	Exports	Imports	Consumption
	PJ	PJ	PJ	PJ
1982	53.21	5.29	n.a	47.92
1983	58.97	5.87	n.a	53.10
1984	62.34	11.68	n.a	50.66
1985	58.64	13.04	n.a	45.60
1986	61.24	8.84	n.a	52.40
1987	57.47	9.40	n.a	48.07
1988	58.84	11.44	n.a	47.40
1989	66.73	15.24	n.a	51.49
1990	63.01	10.53	n.a	52.48
1991	65.65	19.12	n.a	46.53
1992	73.40	24.15	n.a	49.25
1993	79.24	24.71	0.02	54.55
1994	76.48	32.74	0.02	43.76
1995	91.50	42.71	0.00	48.80
1996	96.21	50.90	0.00	45.31
1997	86.85	38.90	0.00	47.97
1998	84.85	34.18	0.00	50.67
1999	92.13	42.27	0.00	49.86
2000	95.60	48.48	0.48	47.60
2001	103.57	56.85	0.91	47.63
2002	119.32	61.27	2.29	60.34
2003	136.16	69.82	11.93	78.27
2004	136.70	59.98	20.04	96.76

Table 5.8: Coal Production and Consumption in New Zealand (PJ [58]) [29]

(June years) shows the volumes exported through the port (Table 5.9).

	tonnes
2002	1834000
2003	2031300
2004	2086000
2005	2156800
2006	2505100

Table 5.9: Coal Export Volumes through Port Lyttleton (June years) [30]

When synchronized with the data in Table 5.8 (and adjusting for some discrepancies), these figures show that over 90% of New Zealand's coal exports, and sometimes near 100%, are sent through Port Lyttleton.

This underlies the importance of the West Coast-Lyttleton rail link for transporting coal from the West Coast for export, making it likely the most important export "lifeline" in the country. Similarly, Port Lyttleton is pivotal to the coal export industry, especially as alternatives are not available in the short term. Coal exports now account for over 25% of Port Littleton's throughput volume.

The Fonterra diary plant at Clandeboye is the Canterbury region's major industrial user of coal. The coal is railed in from Ohai.

Resources and Potential for Development

As can be seen from Table 5.10 and Figure 5.7, the Canterbury region contains an inconsequential amount of New Zealand's coal resources. At current production rates of around 6 million tonnes per annum and ignoring coal grade and quality, New Zealand has around 1440 years of recoverable reserves.

5.5 Natural Gas

The South Island currently does not supply nor consume any natural gas in any form, and so it is also the case for Canterbury.

Liquefied petroleum gas (LPG) is available and used mainly in the industrial and commercial sectors but also in households and for transport. The latter application was popular in the

Region	Coal-in-ground resource (Million tonnes)	Recoverable resource (Million tonnes)
Canterbury	3.6	2.2
New Zealand	15,563.7	8,643.7

Table 5.10: Coal Resources in New Zealand [31]

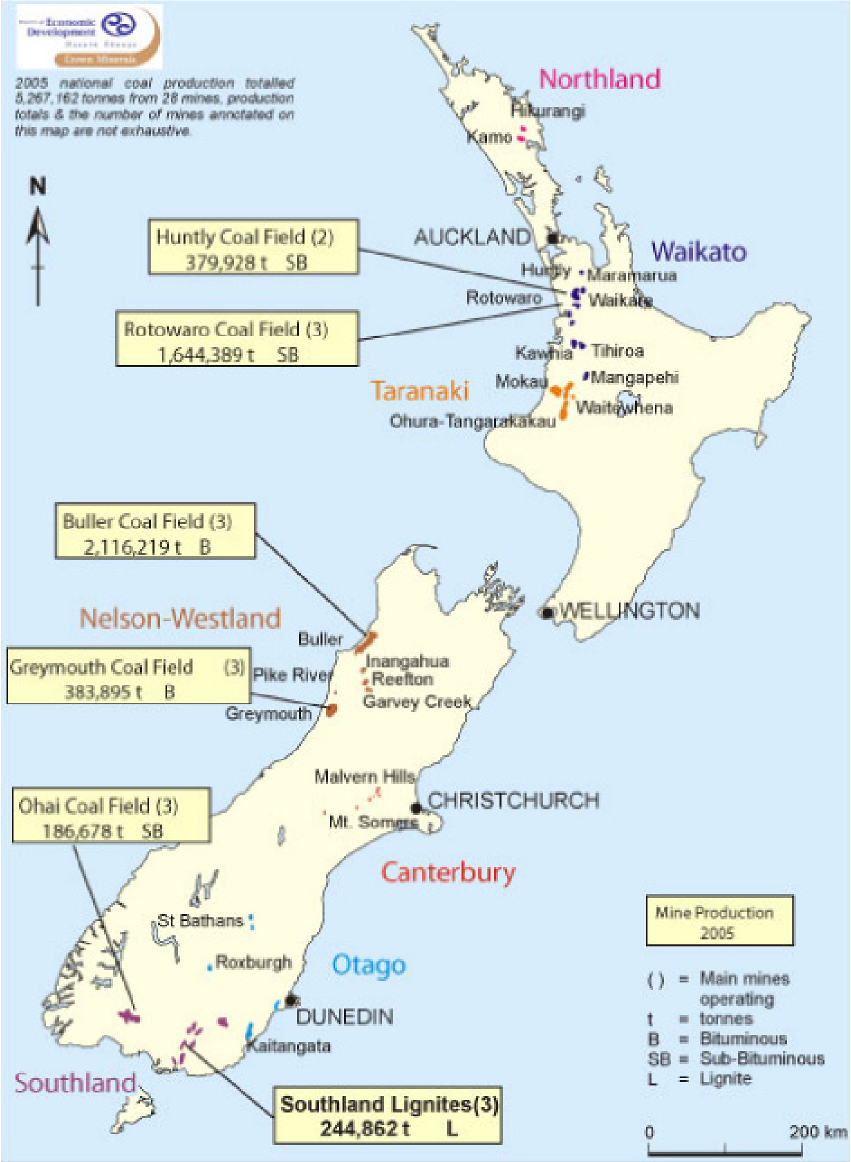


Figure 5.7: Coal Resources in New Zealand [32]

1980s in the aftermath of the oil crises of the late 1970s. However, with the withdrawal of government subsidies, the transport use of LPG has declined substantially. There is now a resurgence in interest due LPG prices becoming more competitive due to sustained high oil prices.

LPG , is regarded as an "oil" in standard energy accounting and further/other discussion is left to the oil sections of this report.

Potential for Development

Case Study 2: Natural Gas

The Cutter-1 prospect off the coast of North Otago has been described in the Oil section above.

Whilst Cutter-1 is an oil play, the oil reserves indicated might extend to around 50-80 PJ of associated gas. Flaring of the gas is not an option, (partial) re-injection might be costly even though it would likely enhance oil recovery, and so, ideally, a market should be found for the gas, if the prospect becomes a commercial oil discovery.

This amount of gas, of itself, is not sufficient to develop any high-pressure gas pipeline infrastructure locally or within the South Island. Production averaging around 6 PJ per year for less than 10 years does not provide a basis for the development of any enduring applications except on the assumption that a successful commercial discovery will likely lead to others.

One potential use of the associated gas is to make it into CNG (offshore?) and for the CNG to then be shipped ashore for a variety of applications. Piping ashore may be an option if appropriate localised customers are found.

Thus assessed in isolation, a discovery such as Cutter-1 is unlikely to materially improve Canterbury's or the South Island's natural gas markets. However, any successful discovery is likely to improve the prospectivity of the Canterbury Basin, eventually leading to more successful discoveries. It is the aggregate effect of such discoveries that may transform the energy supply picture and energy infrastructure of the Canterbury region, and of the South Island. In particular, the Barque-1 field and in the same permit area east of Cutter-1 has been identified as a gas and condensate prospect.

A key aspect of energy security is energy diversity. The availability of natural gas would add to the (long term) energy security of the region.

Case Study 3: Coal Bed Methane

New Zealand has the beginnings of a coal bed methane industry where suitable coal resources are available (refer Figure 10) and cost competitive with similar and potentially substitutable fuels such as traditional natural gas and LPG. Manhire [33] recently presented the case for the production of methane from some coalfields in Otago and Southland. Potential uses for the gas include small-scale power generation, in increments of around 5 MW, and direct use as CNG in competition with LPG and diesel (for transport).

While the analysis presented implies that potential production is small at less than 300 TJ per year, and that the gas can be (cost) competitive if used within around 100km of the source, larger scale production and suitable applications could mean that gas from such sources may eventually be available to Canterbury consumers.

5.6 Wood

Supply and Consumption

The Canterbury region has a considerable forestry estate, very much in line with most other regions of New Zealand that contribute to this important industry, with 6.3% of area, 4.2% by volume and 4% by production, for the year ending 31 March 2005., The Central North Island dominates the New Zealand industry with 31% of the total forest estate by area, 35% by volume and almost 50% by production.

Some forestry statistics, focusing on the Canterbury region are shown in Table 5.11.

Reliable data or statistics on wood as a source of energy are understandably difficult to obtain. This has to do with a multitude of factors. One area is the quality of the resource that is used such as the species and, importantly, wood's (effective) energy content is highly dependent on moisture content.

For domestic firewood, the wood is usually obtained from small-scale merchants, some of which may be cash-based suppliers, and possibly operating in the informal economy. Many consumers may be self-providers [35] obtaining supplies from sources such as demolition lots, land clearing, forest arisings, wind thrown wood and general scavenging. Here, even for commercial supplies, quality may be uneven and quantities inexact.

In the residential sector, the use of firewood for space heating is undoubtedly common and significant. Its share of (input) energy for Canterbury households is estimated to have increased from around 16.7% of consumption in 1982 to some 21.6% in 2004 [36].

	Area (ha)	Standing volume (000 m³)	Area-weighted average age (years)
Canterbury wood supply region			
Hurunui District	39 632	5 901	13.71
Waimakariri District	14 840	2 207	13.17
Selwyn District	15 761	2 998	15.68
Christchurch City	2 648	509	16.45
Banks Peninsula District	7 788	762	13.31
Ashburton District	3 855	653	15.62
Mackenzie District	5 135	682	14.86
Timaru District	12 091	1 482	12.57
Waimate District	12 981	1 510	12.90
Region total	**114 731**	**16 704**	**13.85**
South Island total	**540 167**	**86 682**	**13.61**
New Zealand total	**1 811 180**	**400 356**	**13.93**
Production		**(000 m³)**	
Canterbury region		**760**	
South Island total		**4 600**	
New Zealand total		**19 261**	

Table 5.11: Canterbury Forestry Statistics [34]

The use of wood residues in the industrial sector, likely almost entirely by wood processors themselves, is estimated to have increased substantially [37] in the last 20 years or so, increasing from around 2.3% of industrial/commercial energy consumption in 1982 to some 7.7% in 2004 in the Canterbury region. Table 5.12 shows the generally strong growth in the use of wood as an energy source between 1982 and 2004.

	Residential	Industrial & Commercial	Total	As % of Total Energy
	TJ	TJ	TJ	
1982	1,184	241	1,425	4.1%
1983	1,222	251	1,473	4.3%
1984	1,259	261	1,521	4.2%
1985	1,297	271	1,568	4.3%
1986	1,335	299	1,634	4.3%
1987	1,373	569	1,942	5.0%
1988	1,410	595	2,006	5.2%
1989	1,448	619	2,067	5.1%
1990	1,486	639	2,124	5.0%
1991	1,523	651	2,174	5.0%
1992	1,561	680	2,241	5.0%
1993	1,361	700	2,061	4.4%
1994	1,434	739	2,173	4.4%
1995	1,496	834	2,330	4.6%
1996	1,807	890	2,697	5.1%
1997	1,824	946	2,770	5.1%
1998	1,855	1,070	2,925	5.0%
1999	1,886	1,210	3,096	5.4%
2000	1,918	1,368	3,286	5.6%
2001	1,964	1,401	3,365	5.8%
2002	2,011	1,434	3,445	5.7%
2003	1,987	1,417	3,405	5.5%
2004	1,987	1,417	3,405	5.3%
Mean Increase % pa	2.50%	8.90%	4.00%	

Table 5.12: Wood Consumption in Canterbury by sector (TJ). [38]

Supply Chain

Due to generally diverse sources of comparatively localized supply, and a large number of small suppliers, including scavengers and users themselves, the supply of fuelwood to the residential sector can be regarded as quite secure, especially considering its diversified nature.

For the consumer, especially those with woodburners already installed, the use of wood provides a convenient security feature by diversifying away from an almost total reliance on electricity, which is not only increasing in price but also perceived by many as a source of energy that is becoming less reliable.

Given the diversity of potential sources of supply and the number of suppliers, including self-helpers, wood can be considered to be quite secure.

Prospects

ECan's Clean Heat (CHP), designed to meet The National Environmental Standards for Air Quality (NES) by 2013 requires the replacement of old style (pre-1992) fuel burners and open fires; and substitute their use with 'clean' (air emission) alternatives.

Already there is evidence to show that around 60% of conversions have been to heat pumps. This has the effects of reducing the consumption of firewood and increasing the consumption of electricity, the latter effect particularly impacting on the important aspect of peak load.

On the other hand, of the estimated 50-70% of firewood that is "self-collected" firewood effectively means that this tranche comes free with some own transport cost and own labour. Increasing prices for other energy types, may well work in wood's favour.

An emerging fuel type, with a local focus, is the supply of wood pellets into the domestic home-heating market. The Solid Energy subsidiary, Natures Flame, is at present the only supplier to the region. Costs per 20kg bag of pellets for bulk delivery art of the order of $8.20n which is approximately a 50 percent premium over other conventional wood sources.

5.7 Electricity [59]

Production

The Waitaki River system on the southern boundary of the Canterbury region represents a third (1738 MW) of New Zealand's hydro generation capacity.

The chain of 8 hydro stations generates around 9,500 GWh (34,200 TJ) annually, depending mainly on inflows.

Hence, somewhat less than 50% (net) production is consumed within the region with the rest being exported.

Consumption

Electricity consumption comprises around 25% of overall energy consumption in Canterbury.

Table 5.13 shows electricity consumption in Canterbury since 1982. Regional consumption growth averaging 2.9% per annum between 1982 and 2004 has exceeded national consumption growth of around 2.7% per annum for the same period. Similarly, strong industrial and commercial growth averaging 4.4% per annum has significantly exceeded national growth averaging 3.2% per annum. However, residential growth of 1.3% per annum has been lower than the national figure of 1.8%.

Environment Canterbury's Clean Air Policy (CAP) formulated to achieve national air quality standards requires the eventual elimination of older style solid wood burners in homes. Evidentially, most conversions have been to heat pumps. Although the running costs of heat pumps are comparatively low, their increased use has exacerbated peak load issues on an already strained grid, another example of unintended consequences.

Projections made by the Electricity Commission [40] show that they expect Canterbury (not including South Canterbury) electricity demand growth to be quite strong at around 2.32% per annum between 2005 and 2025, ahead of the national average of 2.09% per annum and well ahead of average South Island growth of 1.53% per annum and South Canterbury growth of only 1.21% per annum. However, as described in the Work Stream 1 report the basis for these estimates are open to scrutiny and may well be unduly optimistic.

	Residential	Ind/Comm	Total
	TJ	TJ	TJ
1982	4860	3705	8565
1983	5092	3931	9023
1984	5087	4339	9426
1985	5115	4362	9477
1986	5416	4615	10031
1987	5233	4629	9862
1988	5313	4910	10223
1989	5630	4934	10564
1990	5684	5041	10725
1991	6022	5383	11405
1992	5881	5308	11189
1993	5871	5454	11325
1994	6053	6183	12236
1995	6101	6532	12633
1996	6078	6824	12902
1997	6293	6929	13222
1998	6216	7002	13218
1999	6483	6922	13405
2000	6349	8020	14369
2001	6492	7864	14357
2002	6696	8793	15489
2003	6440	9187	15626
2004	6486	9554	16040
Mean Increase % p.a.	1.32%	4.40%	2.89%

Table 5.13: Canterbury Electricity Consumption by sector (TJ) [39]

Potential for Development

Case Study 4: Hurunui Irrigation And Power Project

In addition to Meridian Energy's abandoned Project Aqua proposal (280 MW), the region undoubtedly holds the potential for further hydro development subject to economic, environmental, social and recreational acceptability, amongst other considerations. Along with new wind farms, such developments may be able obtain carbon credits, in a similar way to the landfill methane case described above.

Most potential development schemes are likely to be smaller scale than historically with non-electricity aspects such as irrigation adding to the ultimate economics, in addition to the protection or enhancement of recreational and environmental values. Locational benefits are also likely to figure highly with some developments aiming to substantially bypass the grid in the style of distributed generation, in effect augmenting the grid or deferring its expansion.

The Hurunui Irrigation and Power Project is an example of the (energy) potential that remains in the region.

The Hurunui Irrigation and Power Trust [41] are promoting a development scheme on the Waipara and Hurunui Rivers. While most of the scheme involves the development of irrigation, a part of the scheme includes a dam and hydroelectric station on the Hurunui River.

Overall, the whole scheme is planned to irrigate an area of around 510 square kilometres and generate more than enough power for consumption in the MainPower supply area, with more generation potential in the higher demand winter months than in the summer months.

With an estimated capital cost of around $550 million, neither the hydro proposal nor the overall scheme is "small" [42]. Annual electricity revenues are estimated at around $50 million and irrigation revenues at around $90 million, with substantial "downstream" economic benefits.

While investigations have been ongoing since 1999, more research needs to be undertaken and consultations concerning non-irrigation and non-hydro issues such as environmental, recreational and Iwi issues are yet to be resolved.

This proposal illustrates the energy potential that is still available within the Canterbury region and the spin-off benefits that might accrue. The slow progression of the proposal and the cancellation of Meridian Energy's Project Aqua do, however, illustrate the hurdles that such schemes need to overcome in order to proceed.

5.8 Other (Emerging) Energy Resources

Biofuels

Alternative transport fuels were "all the rage" after the oil crises of the late 1970s. New Zealand was to build and briefly operate the synthetic petrol plant at Motonui as part of the then Government's "Think Big" strategy. Use of LPG and CNG as transport fuels was subsidized and, partly for this reason, was popular until the subsidies were withdrawn.

Biofuels were also then offered as a substitute for high priced oil. However the collapse of oil prices in the 1980s made alternative fuels uneconomic against oil prices that only occasionally rose above US$20 per barrel during the 1980s and 1990s (see Figure 5) and effectively put off extensive research and development of these fuels until recently. It is only Brazil, and to a much lesser extent, the USA, that have built up significant ethanol industries to help fuel their transport fleets.

However, the double imperatives of seemingly enduring higher and increasing oil prices and the need to control and reduce greenhouse gas emissions, especially from transport sources, has resulted in renewed and likely enduring interest in the development of biofuels, in the form of either bioethanol or biodiesel, as a substitute for traditional transport fuels.

To this end, the Royal Society of New Zealand (RSNZ) has recently released a study offering an environmentally more benign future for New Zealand energy [43].

The RSNZ Energy Panel presents a case for New Zealand not only replacing its current transport fuels with bioethanol but also developing the industry for exports. They claim that New Zealand has around 3 million hectares of low value agricultural land that could be more profitably used to grow biofuels crops. Of this area, 2 million hectares are in the South Island, much of it in the Canterbury region.

While the description of their case is ambitious and seems over-optimistic, there seems little doubt that biofuels, initially made from sources such as tallow from dairy processing and "waste" oils from food preparation, will play an emerging role in New Zealand's transport fuels sector, assured given government mandates and tax concessions but perhaps with some niche applications being economic in their own right.

As an indication of the interest in biofuels, ECan is trialling 4 buses on 4 different Christchurch bus routes on biodiesel blends starting at 5% and rising to 20% [44]. The biodiesel is made from vegetable oil and animal fats, supplied form Auckland.

It is beyond the scope of this study to offer an authoritative analysis of biofuels, the merits and economics of various feedstocks and the merits of bioethanol vis-à-vis biodiesel. However, biofuels are fuels of the future and the Canterbury region potentially may well be one of the more promising regions within New Zealand for the growing of bioenergy crops.

The core question remaining unanswered is whether such an industry is likely to emerge without substantial increases in irrigation loads and, if irrigated, whether such land can truly be classified as of "low-value". It seems unlikely that once water is costed into the equation that the economics of crop-based biofuels will be at all favourable.

Landfill Gas

The Christchurch City Council recently announced the sale of 200,000 carbon credits to British Gas, which will return around $3 million to the Council between 2008 and 2012 [45], the first commitment period of the Kyoto Protocol. This is believed to be a first for New Zealand.

The credits have been awarded for the capture of methane from the closed Burwood Landfill. The methane is to be piped to QEII Park to heat and power facilities.

Since methane is one of the worst greenhouse gases, and seemingly less amenable to mitigation than carbon dioxide, this scheme represents a win-win situation, albeit on a small scale. Not only is there a revenue gain from the sale of credits, the capture and use of the methane will, from March 2007, replace around 1.5 million litres (40 TJ approx) of LPG per year.

6 ENERGY PRICES

Energy prices have been somewhat discussed in this report and electricity issues, including prices, are discussed in the grid connection energy section of this report.

This section summarises and compares some energy prices, particularly as they are faced by the household consumer. These have widespread interest and are available in some form or other in the public domain. Consumers are generally price takers in the sense that they cannot influence the prices that they pay although they can influence their own technology choices and the amount of energy that they consume.

In contrast, consumers in the industrial and commercial sectors are larger scale users. Some of these will have some buying power and energy use profiles with which to influence the prices that they pay. Also prices for these sectors are often commercially sensitive and analysis of available information is less robust. This is an area that requires further examination.

Residential Heat Demand

Table 6.1 shows the heating modes installed in Canterbury households in 2001. The data below shows a heavy reliance on electricity for heating in Canterbury dwellings compared to the rest of New Zealand. This is most likely influenced by ECAN's Clean Air Policy where around 60-65% of log and coal burner conversions have been to heat pumps. There is a much lower level of mains gas used as there is very little reticulated gas in Canterbury. Consequently the use of bottled gas is higher than the remainder of the country. Uptake of solar power and other alternative fuels is on par with the rest of New Zealand.

The region's dependency on electricity as the dominant home heating type leaves many in Canterbury exposed to significant future price risk from failure in the electricity sector to invest in new generation or transmission upgrades. Dry year risk presents a particular vulnerability due to the region's reliance on North Island thermal generation capacity and transmission via the DC link.

The region thus remains vulnerable to supply disruption from extreme weather events, major earthquakes and technical failure. Desired security levels are the subject of more detailed discussion in Work Stream 1.

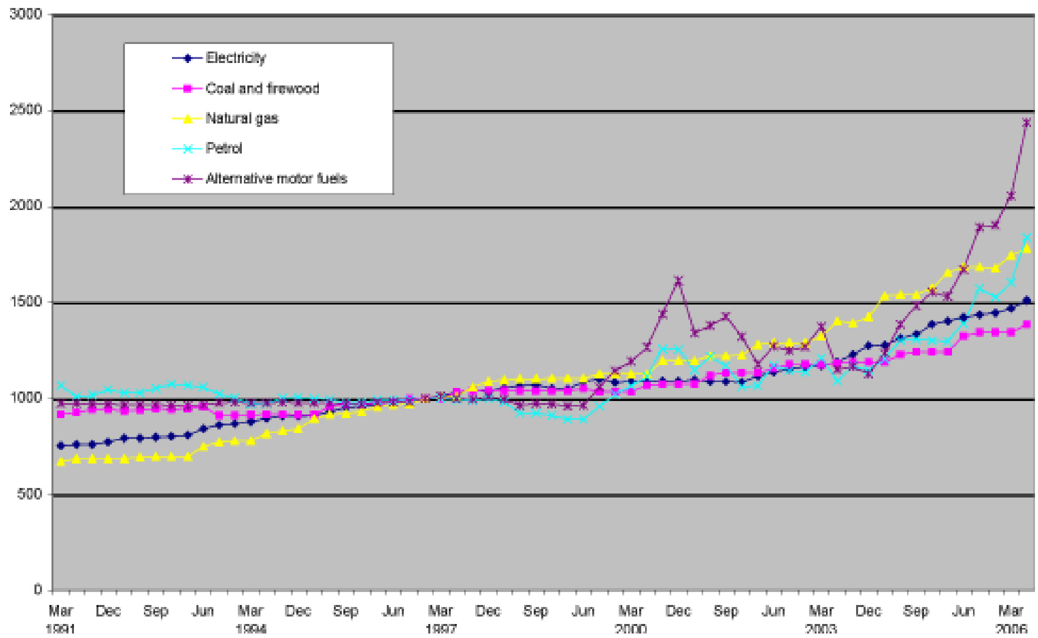


Figure 6.1: Energy Prices: Household Sector [46]

	Canterbury	Canterbury	Total	Total
Electricity	151,791	81.4%	937,719	69.0%
Mains Gas	1,530	0.8%	175,419	12.9%
Bottled Gas	55,716	29.9%	368,121	27.1%
Wood	92,109	49.4%	582,270	42.8%
Coal	17,370	9.3%	121,173	8.9%
Solar Power	1,725	0.9%	12,312	0.9%
Other Fuel(s)	2,691	1.4%	14,124	1.0%
No Fuels Used in this Dwelling	1,839	1.0%	36,216	2.7%
Total Dwellings	186,423		1,359,843	

Table 6.1: Fuel Types Used to Heat Dwelling (Total Responses), for Private Occupied Dwellings, 2001 [47] (Note dwellings can have multiple forms of heating)

The Consumers' Institute last year reported on an analysis of fuel prices for home heating for a range of regions and urban areas of New Zealand [48]. Home heating energy costs generally compare quite favourably with the rest of New Zealand but the cost per day is much higher than the national average in South Canterbury (refer Table 6.3). This can probably be attributed to colder winter temperatures and a longer period of the year requiring heating.

Canterbury Home Heating Costs

Home heating energy costs, home heating fixed costs and heating efficiencies are shown in Tables 6.2, 6.3 and 6.4 respectively.

Adjusting for heater efficiency, Table 6.4, the Consumers' Institute found that running costs were lowest for heat pumps. Modern wood burners were also relatively inexpensive, and presumably somewhat cheaper if the wood was

	Christchurch	South Canterbury	New Zealand
Electric Heater	16.4	12.7	15.1
Night-store	8.0	12.7	9.9
Heat Pump	5.5	4.2	5.1
Gas	14.5	14.1	11.4
Wood Burner	7.3	6.5	6.4
Closed Fire	11.5	10.2	10.0
Open Fire	34.6	30.7	30.1

Table 6.2: Home Heating Energy Costs (c/kWh of Heat Delivered) (Includes efficiency of heating)

	Christchurch	South Canterbury	New Zealand
Electric Heater	63.2	133.9	95.3
Night-store	63.9	133.9	95.3
Heat Pump	63.2	133.9	94.3
Gas	26.3	24.7	62.1
Wood-fired heating	0	0	0

Table 6.3: Home Heating Fixed Costs (c/day) (wood price information was collected during March 2005. Electricity and reticulated gas prices were current as at 4 April 2005)

Heat source	Heater efficiency
Night store electric	100%
Plug-in electric	100%
Heat pump	300%
Flued natural gas (reticulated or cylinder)	80%
Open fire	15%
Closed fire (like a pot belly)	45%
Modern woodburner	71%

Table 6.4: Heating Efficiencies [49]

self-collected and prepared (dried). Use of conventional plug-in electric heaters was relatively expensive.

The apportionment of fixed daily connection charges is somewhat problematic as this is fully incurred once a household chooses to connect for any purpose. For electricity, this can be regarded as an unavoidable cost.

Commercial Sector

Figure 6.2 shows how commercial sector energy prices have changed over recent years. The largest increases have been in petrol and diesel although all prices have had significant rises recently.

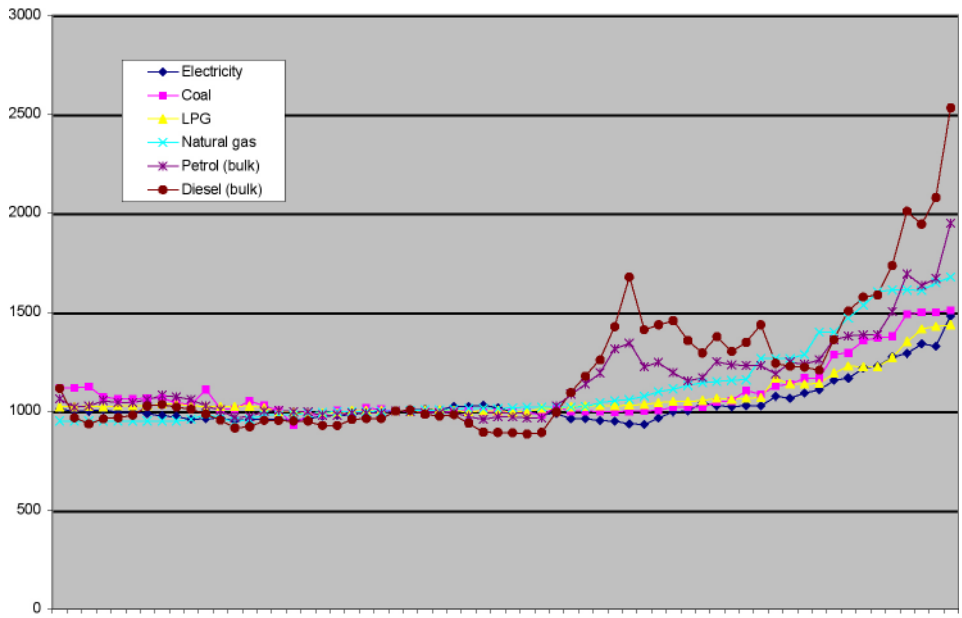


Figure 6.2: Energy Prices: Commercial Sector

7 VULNERABILITY & OPPORTUNITY ASSESSMENT

In this study we have begun the process of assessing the vulnerabilities and opportunities to the Canterbury region for meeting its future energy needs. The discussion in the earlier sections of this report suggests that there is a range of risk factors likely to influence future supply pathways. These factors range from institutional capabilities through to demographic trends and specific location and supply chain issues.

Because of the limited nature of the Stage 1 assessment, it has not been possible to assess these issues in depth, nor have we sought to provide a full assessment of the opportunities potentially available to the region to meet it future energy needs. We are conscious that there is in the public domain a significant body of literature that describes these possibilities, but what is missing is a realistic appraisal of the price points at which individual supply options are likely to become commercially viable. The case studies described in this report thus merely seek to describe the nature of these opportunities and the likely ways forward. Much more needs yet to be done to give effect to these opportunities and to clarify possible pathways.

The critical vulnerabilities facing the region are exposure to price shocks from supply disruption and/or increasing capacity constraints. Energy poverty is defined by the number of households that need to spend more than 10 percent of their income on fuels to keep warm and to service an adequate lifestyle. However, we also have to take into account the ways in which we use energy. Residential energy use per household in New Zealand, for example, is around 50 percent of that of comparable economies elsewhere in the world. This low value reflects the low levels of space heating (houses may be energy efficient but are poorly heated) and also the nature of our housing stock.

The comparative higher heating requirement for South Island homes, combined with air quality regulations forcing householders to have a greater reliance upon a formal fuels market and/or appliance upgrades is reinforcing an inevitable trend of a greater proportion of households spending more than 10 percent of their income on fuel.

There is much more work yet to be done to quantify and assess the likely implications of this and the other trends identified by the report. However, in the short term we believe the following trends can be seen right across the fuel supply chain.

- Air quality legislation will drive a higher standard in wood drying and force a shift to a more formal market (including wood pellet) and a greater reliance on a single distribution channel. This situation will have an immediate effect on fuel choices for new home builders/renovators and long term effects on future choices with the likelihood of continued fuel switching to either electricity or LPG.
- Coal is unlikely to be a significant player in the local market. Whilst there is a long-established market in place with relatively lower transport costs, industrial users are coming under increasing pressure to find alternatives. Without incentive towards clean coal technology or assistance to industry users to upgrade current facilities we are likely to see fuel swapping and thus increasing price pressures transferring into the domestic market, or simply the transfer of industry to other regions.
- LPG should be viewed as a critical supply chain. LPG is supplied from sources external to Canterbury and is dependent on specialized equipment and a specialized supply chain. Regional supply is linked to the vagaries of the world's oil markets and thus will always face this exposure and, as well, increasing demands have the potential to place pressure on current storage levels. Public opposition has a serious effect on the ability to increase storage or put in new storage due to the perceived risks of LPG storage.
- Vulnerability to international oil prices manifests itself most in the farming and tourism sectors. The sectors are very reliant on transport fuels and are thus vulnerable

to supply failures. Pricing changes and price shocks, including those incurred by changes in the NZ dollar value will have an effect on economic activity.

- Whilst the Canterbury Basin is seen as an excellent prospective oil and gas exploration opportunity, the economic value of the region's petroleum resource will be dependent on exploration success and international investment. Regional decision makers have significantly undervalued the value of the resource to the region in the past, and this needs to change if exploration investment is to be attracted to the region.

In addition to the above it is also worth reflecting upon the interdependencies that govern infrastructure resilience end our capacity to cope with a major disruptive event. In particular we comment that a secure and reliable electricity supply is essential to our modern lives. Common examples of such dependency referred to in this study and often overlooked include

- Pellet fires require electricity to operate
- Gas hot water systems require electricity for control operations.
- Communication systems require "mains' supply to recharge.
- Water supplies, fuel supplies, control systems and signaling, transport and a myriad of other application all rely on electricity.

Addressing these issues is a lifelines engineering issue, an area that Canterbury has undoubted capacity, but unfortunately our experiences dictates that collaboration and cooperation is essential if we are to appropriately manage these risks. Because of the regions strong reliance on electricity for both manufacturing and domestic use, Canterbury retains a particular vulnerability in these areas.

Finally we comment that Canterbury as a region has available to it substantial opportunities from increased regional energy supply from distributed generation investment and potentially from other non-conventional energy sources. Properly addressed and sensibly progressed these resources have the potential to deliver considerable economic benefit and energy security to the region. The extent of these resources remain largely undefined and their potential contributions uncertain.

These opportunities compete with the economies of scale delivered by larger schemes by supplying energy close to the point of use. The key to any strategy that seeks to encourage local supply is diversity of both location and mix of generation. The benefits of diversity enable economic development while also contributing to resolving the capacity and security issues being driven by demand growth and requirements for improved power quality.

The way forward will require the region to better articulate these critical energy issues and decide on the tradeoffs needed to bring together a portfolio of opportunities deserving of more analysis and investigation. A lack of coordination at the regional level, incumbent players continuing with conventional business modes, and changing demographics and load patterns all combine to leave the region vulnerable to sub optimal outcomes and thus a failure to meet consumer expectations for a reliable and affordable energy supply.

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[38] ECan Regional Energy Study – Table 3.14

[39] Source: Table 3.10, Ecan Regional Energy Survey 2004, p22 (estimated load on national figures since 1996)

[40] Ibid [24], p16.

[41] Work stream 01 separates the Canterbury region into Canterbury and South Canterbury, with these generation assets being located in the latter.

[42] The Electricity Commission in its Statement of Opportunities indicates a project on the Hurunui of 36 MW and generating 160 GWh per annum to be commissioned in 2015 for a number of its scenarios.

[43] Royal Society of New Zealand, Ò2020: Energy Opportunities: Report of the RSNZ, ISBN 1-877264-21-0 & 1-877264-22-2, August 2006.

[44] The Press, 12 September 2006.

[45] The Press, 20 September 2006.

[46] Data - Statistics New Zealand

[47] http://xtabs.stats.govt.nz/eng/TableViewer/wdsview/download.asp

[48] Shivering Timbers – Winter Fuel Prices, Consumer 447, May 2005. Also www.consumer.org

[49] Tables 6.2-6.4, Consumer.org.nz (www.consumer.org.nz/topic.asp?docid=2177&category=Home%20%26%20DIY&subcategory=Heating%20%26%20energy&topic=Heating%20options&title=Fuel%20prices%20compared&contenttype=general)

[50] http://www.eeca.govt.nz/enduse/EEUDBMain.aspx, EECA Energy End-use database

[51] Heat Plant in New Zealand. Heat Plant sized greater than one mega watt Thermal segmented by industry sector as of April 2006. EECA. BIOenergy Association (BANZ) East Harbour Management Services.

[52] Hearings on the Proposed Natural Resources Regional Plan (Proposed Air Plan) were adjourned in January 2006. Council is expected to notify its decisions in 2007 with the Air Plan expected to be in force by late 2007

[53] To date the majority of conversions (about 60%) have been to heat pumps.

[54] ‘gas’ supplied to and consumed in the Canterbury region is in the form of LPG (liquefied petroleum gas). Standard energy accounting classifies LPG as ‘oil’, thus the apparent absence of ‘gas’ in . Nowadays, most of the LPG consumption is in the non-transport sectors.

[55] Assuming an import dependency of around 80%, this is a little more than 60 days coverage of imports, consistent with the national average. New ZealandÕs obligations, as part of its membership of the International Energy Agency, requires it to hold 90 daysÕ imports of products and crude. In the last year or so, the Government has st

[56] Tap Oil announced, on 6 November 2006, that Cutter-1 was unlikely to be commercial – www.petroleumnews.net.

[57] Less a US$1 offset

[58] 1 Petajoule (PJ) = 1000 Terajoules (TJ)

[59] Substantive and detailed discussion of electricity in Canterbury is contained in the companion document, Canterbury Regional Energy Strategy Project: Work stream 01: Grid Connected Energy System

APPENDIX 1: Energy End Use

Fuel (Aggregated List)	Sector (Aggregated List)	End Use (Aggregated List)	Technology (Aggregated List)	MWh
Biomass	Commerce	Heating	Heat Devices	25417.88
Biomass	Household	Heating	Heat Devices	298813.19
Biomass	Industry	Heating	Heat Devices	1662923.99
Electricity	Agriculture	Electronics & Lighting	Electronics & Lights	11126.78
Electricity	Agriculture	Heating	Heat Devices	19446.9
Electricity	Agriculture	Stationary Motive Power	Motors	84624.51
Electricity	Commerce	Electronics & Lighting	Electronics & Lights	282506.82
Electricity	Commerce	Heating	Heat Devices	306121.09
Electricity	Commerce	Heating	Motors	122208.6
Electricity	Commerce	Stationary Motive Power	Motors	303133.27
Electricity	Household	Electronics & Lighting	Electronics & Lights	202007.52
Electricity	Household	Heating	Heat Devices	1307638.16
Electricity	Household	Heating	Motors	6661.04
Electricity	Household	Stationary Motive Power	Motors	172789.74
Electricity	Industry	Electronics & Lighting	Electronics & Lights	45831.49
Electricity	Industry	Heating	Heat Devices	292159.74
Electricity	Industry	Heating	Motors	9585.74
Electricity	Industry	Stationary Motive Power	Motors	836739.26
Electricity	Transport & Storage	Electronics & Lighting	Electronics & Lights	25527.3
Electricity	Transport & Storage	Stationary Motive Power	Motors	17043.06
Fossil-Fuel (Non-Transport)	Agriculture	Heating	Heat Devices	108028.34
Fossil-Fuel (Non-Transport)	Agriculture	Stationary Motive Power	Motors	15745.92
Fossil-Fuel (Non-Transport)	Agriculture	Transportation	Transport	441574.97

Table A1: Consumer Energy Use in Canterbury Region – Source: [50]

Fossil-Fuel (Non-Transport)	Commerce	Heating	Heat Devices	460124.91
Fossil-Fuel (Non-Transport)	Commerce	Transportation	Transport	777.21
Fossil-Fuel (Non-Transport)	Household	Heating	Heat Devices	126483.28
Fossil-Fuel (Non-Transport)	Industry	Heating	Heat Devices	1365337.19
Fossil-Fuel (Non-Transport)	Industry	Stationary Motive Power	Motors	47694.78
Fossil-Fuel (Non-Transport)	Industry	Transportation	Transport	155297.55
Fossil-Fuel (Transport)	Agriculture	Transportation	Transport	257587.32
Fossil-Fuel (Transport)	Commerce	Transportation	Transport	369032.76
Fossil-Fuel (Transport)	Household	Transportation	Transport	3554565.01
Fossil-Fuel (Transport)	Industry	Transportation	Transport	286609.06
Fossil-Fuel (Transport)	Transport & Storage	Transportation	Transport	2,848,153
Total				16,000,000

Table A1: Consumer Energy Use in Canterbury Region – Source: [50] (cont'd)

The following table gives a good coverage of "major thermal energy users" within the region.

Company	Thermal Capacity (MWth)	Fuel Type	Efficiency
Dairy			
Deep South Ice Cream		Oil/Diesel	
Fonterra - Clandeboye	20	Coal	81
	20	Coal	81
	40.8	Coal	81
	40.8	Coal	81
	10.5	Coal	
	33	Coal	81
Fonterra – Kaikoura	5.6	Oil/Diesel	
	2.8	Oil/Diesel	
Mainland Products – Blenheim Rd	6	Oil/Diesel	
	8	Oil/Diesel	
Mainland Products - Russley	1.4	Oil/Diesel	
NZMP Kaikoura Cheese	5.6	Oil/Diesel	
Education			
Burnside High School	0.9	Oil/Diesel	
	0.9	Oil/Diesel	
Christchurch Polytechnic	0.75	LPG/Butane	96
Lincoln University	2.7	Coal	83
	5.4	Coal	82
Shirley Boys High School	1	Oil/Diesel	90
University of Canterbury	5.7	Coal	70
	5.7	Coal	70
	12	Coal	
Food & Beverage Processing Plant			
Barkers	1	Oil/Diesel	
DB Mainland Brewery	5	Coal	82
	5	Coal	
Hi-Tech Foods	1.2	LPG/Butane	
New Zealand Breweries	4.55	Coal	78
	4.55	Coal	81
Tip-Top	1.8	Oil/Diesel	
Talleys*			
McCains*			

Table A2: Commercial Heat Demand – Source: [51]

Heinz*			
Hospital			
Burwood	0.925	Coal	
	0.925	Coal	80
Christchurch Central	1.5	Coal	75
	1.4	Coal	75
	1.4	Coal	70
Christchurch Women's			
Hillmorton	1.5	LPG/Butane	
	1.5	LPG/Butane	
Nurse Maude		Electricity	
		LPG/Butane	
Princess Margaret	1.6	Electricity	
St Georges	0.7	LPG/Butane	
	0.7	LPG/Butane	
Timaru	1.7	Coal	
Meat Processing			
A W Verkerk	1.4	Oil/Diesel	
Canterbury Meat Packer Seafields	7.5	Coal	
	4.5	Coal	
PPCS - Belfast	5.4	Coal	76
	3.1	Coal	64
PPCS - Canterbury	6.2	Oil/Diesel	70
	3.1	Coal	75
	3.1	Coal	70
Tegel Foods - Chch	1.4	Oil/Diesel	
	0.9	Gas	
Other Processing			
Ravensdown - Hornby	11.7	Sulphur	

* These sites have a factory in Canterbury but the information for the factories boilers is not region specific.

Table A2: Commercial Heat Demand – Source: [51] (cont'd)

APPENDIX 2: Participants at WS02 (Non-grid Connected Energy) Workshops

The Study Team gratefully acknowledges the contribution of the following participants at the 2 workshops for this Work Stream that were hosted by Ecan.

[TO BE COMPLETED]