NEW ZEALAND Report for GEO Project

Energy for Economic, Environmentaland Social Sustainability

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Abstract

This report is one of a group being written for the Global Energy Observatory, a project organised by Helio International. The report evaluates the contribution of New Zealand's

energy sector to genuine sustainable development, in terms of environmental, social and economic indicators developed by Helio, utilising New Zealand statistics. The trends are discussed in terms of both energy/climate policy and economic restructuring policies. The conclusion is that the outlook for sustainability of New Zealand's energy sector is not optimistic given the present style of government, incentives for energy supply businesses, and the lack of incentives for energy conservation or renewable energy supply.

Preface

The Sustainable Energy Forum has joined an international project of Helio International, a research-oriented NGO based in France, whose goal is "to assess, monitor and publicise the contribution of energy systems to genuine sustainable development". Helio International has launched the Global Energy Observatory (GEO), a worldwide network of energy experts and grassroots leaders, who will provide a comprehensive assessment of energy developments in their countries, and their impacts on society.

This report is New Zealand's contribution to the GEO project. It follows the brief given on the website: http://www.globenet.org/helio. Eight indicators assess the progress towards sustainability in ecological, social, economic, technological and cultural/ political dimensions. These indicators are:

- CO_2 emissions per capita
- Local environmental impacts of energy supply and use
- Rural electrification (or other indicator of social benefit of energy)
- Jobs in the energy sector
- Resilience to external impacts
- Burden of energy investments on development
- Energy productivity in PJ per unit of GDP
- Sustainable energy and energy efficiency.

The brief focuses on changes in the indicators between 1990 and the present, so as to track the country's response to climate change policy. Our discussion focuses more on the effects of economic and energy restructuring than on climate change policy, which we consider to be a much less important driver for sustainability in New Zealand.

Data sets relating to energy sustainability from about 1975 to 1995 or 1996 have been extensively analysed by the Energy Efficiency and Conservation Authority. We use this work where relevant, and then put specific numbers to the 1990-1996 trends, as the brief requires.

Additional issues relevant to New Zealand are also presented, including transport energy, energy efficiency programmes, and reliability of electricity supply. We then discuss two underlying issues which have been particularly important in development of the energy sector - the attitude of Government towards risks in both engineering and restructuring decisions, and the quality of information and public participation.

Our conclusions are drawn from the indicator trends and from commentaries from sources with some standing - notably New Zealand's Parliamentary Commissioner for the Environment. We conclude that the outlook for sustainability in New Zealand's energy sector is not optimistic so long as the present style of government and incentives for energy businesses do not change.

Summary Table: Helio Sustainability Indicators

	Indicator	1990 Score	1996 Score	% Change 1990-1996	Source
	Population - Million	3.363	3.658	8.8%	New Zealand Yearbook 1998
	GDP at 1991-92 prices ($NZ billion)	73.5	84.6	15.1%	New Zealand Yearbook 1998
	GDP/capita at 1991-92 prices ($NZ)	21,855	23,127	5.8%	calculated figures
	Net disposable income ($NZ billion)	60	77	28.5%	New Zealand Yearbook 1998
	Net disposable income/capita ($NZ)	17,871	21,104	18.1%	calculated figures
	Total primary energy supply PJ	604	696	15.2%	Energy Data File 1998
	Total primary energy supply/capita, GJ/person	180	190	5.9%	calculated figures
1	Global Envt Impacts - energy sector CO_2				Climate Change the NZ Respo
	Total produced - million tonnes	23.090	26.260	13.7%	the Environment, 1998
	per capita - tonnes	6.87	7.18	4.6%	
2	Local Environmental Impacts				
	Christchurch smog			no trend	Canterbury Regional Council,
3	Social Impacts				
	percent people paying more than 10% of income on fuel and power	2.10%	3.60%	71.4%	New Zealand Department of St
4	Jobs in the Energy sector				New Zealand Department of St
	Electricity	11,240	8,215	-26.9%	
	Gas	1080	885	-18.1%	
	Energy Efficiency & Renewables (est)	600	800	33.3%	Ian Shearer, SEF, pers. comm.
	Total	12,920	9,900	-23.4%	
5	Resilience - Energy Self Sufficiency		(1995)	(90-95)	Energy Efficiency Trends in NZ,
	Net self sufficiency	81%	74%	-8.6%	
6	Burden of Energy Investments		(1995)	(90-95)	calculated from ESANZ submis
	central government, (NZ$ million)	409.14	113.3	-72.3%	Commerce Select Committee,
	local government, (NZ million)	155.1	456.5	194.3%	Electricity Industry Reform Bill,
7	Energy Productivity, total primary energy supply PJ per mil. NZ$ of GDP @82/83 prices	(1990) 99	(1995) 92	(90-95) 5.1%	calculated from Energy Efficiency Trends in NZ
	Energy Productivity transport	(1990)	(1996)	(90-96)	Energy Efficiency Trends in NZ
	Passenger: passenger-km/MJ	0.505	0.538	6.5%	
	Freight: tonne-km/MJ	0.459	0.483	5.2%	
	Transport demand				Energy Efficiency Trends in NZ
	Passenger: billion passenger-km/year	43.7	56.6	29.0%	
	Freight: billion tonne-km/year	21.7	26.7	23.0%	
	Energy use by transport sector				Energy Efficiency Trends in NZ
	Passenger: PJ/year	86.6	105.5	22.0%	
	Freight: PJ/year	47.2	55.4	17.0%	
8	Sustainable Energy Sources - PJ				New Zealand Yearbook 1998
	Total Renewables (incl hydro and geothermal)	211	222	5.2%	
	Fuelwood	31.0	31.4	1.3%	
	Biogas	1.6	2.8	70.4%	
	Wastes	3.2	3.3	1.9%	
	Solar Heat	0.075	0.090	20.0%	
	Wind	0.001	0.03	2900.0%	1990 wind figure is SEF estim
	Total Renewables excl hydro	35.9	37.5	4.6%	
	Energy Savings - reduced industry energy intensity 1994-6			5.3%	Energy Efficiency Trends in NZ

1. Introduction

1.1 Geographic, demographic and economic context

New Zealand comprises two main islands and several smaller ones, with a land area approximately equal to Great Britain or Japan. Like Japan, some 40% of the land is mountainous. New Zealand's distance from energy exporting countries, together with its wealth of both renewable and non-renewable energy resources and low population makes it a "natural" for becoming self-sufficient in energy.

At the time of the last census, 5 March 1996, the population of New Zealand was 3.7 million people, of whom 85% lived in urban areas. As in other OECD countries, the "baby boom" has left a population bulge which will reach pension age in the two decades after the year 2000.

New Zealand lay at 15th place in 1990 and 9th place in 1994 according to the ranking by the UNDP by the Human Development Index (HDI). This index measures socio-economic progress by longevity (based on life expectancy), knowledge (educational attainment measured by adult literacy) and mean years of schooling, and income (standard of living based on real GDP per capita).

New Zealand's economy is very dependent on exports, giving a special importance to policies that influence the balance of trade.

Between 1975 and 1985, New Zealand's public debt increased sevenfold, inflation mounted, growth slowed and overseas debt grew. This helped stimulate the free-market policies that were introduced by the Labour Government after 1984. Government removed subsidies and controls, expecting the forces of enterprise, self-interest and competition to generate efficiency and economic growth.

Economic performance measured in terms of output and employment growth deteriorated during the early years of the transition, and recovery was further stalled by the stock market crash in 1987. In 1992 the economy was in the trough of the most prolonged recession since the Second World War. The rate of economic growth then increased, and unemployment fell, and New Zealand began to run fiscal surpluses.

Principal Aggregates, 1990-1997,

year	Gross domestic product	Gross national income	Net national product	Net disposable income	GDP at 1991/2 prices
1990	70.8	66	59.8	60.1	73.5
1991	72.2	68	61.5	61.6	73.2
1992	72.3	67.9	61	61.1	72.3
1993	74.6	71.5	64.1	64.2	73.2
1994	80.8	76.8	69.1	69.4	77.7
1995	86.6	81.4	73.2	73.4	82
1996	95.8	85.7	77	77.2	84.6
1997	95.8	88.1	78.8	79.6	86.7

The amounts are in NZ$ thousand million

In 1997 the Asian fiscal crisis impacted severely on our export markets, and this, together with our balance of payments deficit has put our international credit rating at risk. Overseas debt now stands at $99 billion, equal to one year's GDP.

The provisional national accounts for the March 1998 quarter confirm that economic growth in New Zealand has turned negative, and most forecasters are predicting very low growth for the rest of the year. Unemployment is back above 7.5 per cent, and is expected to increase.

The success of the economic reforms is still being debated. One academic group reported in 1996[i] that real per capita income has risen above its pre-reform trend, overseas debt has fallen, and poverty is no greater than before the reform programme. A critique of that study claims that the data used were not reliable[ii], and that there is no clear-cut measured improvement in New Zealand's growth performance, overseas debt has risen since 1984, and the number of households in poverty has doubled since 1988. It is widely believed that New Zealand's vulnerability to international shocks is in part a result of a decade of reforms aimed at opening the economy up to globalisation.

A very recent academic study[iii] of distribution of household incomes, based on official statistics, showed that since 1983, only those people who are in the top 10% income bracket gained an increased share of the national income. The share going to the bottom 80% of householders was reduced. Over the past 12 years, inequality overall has increased by over 1.4%. The rate of growth of inequality has been amongst the fastest in the OECD countries.

i	Evans, L., et. al. 'Economic Reform in New Zealand 1984-95: The Pursuit of Efficiency.' Journal of Economic Literature,
ii	Dalziel, P., paper to Annual Conference of the New Zealand Association of Economists in August 1997, summary on website
iii	Podder, N and Chatterjee, S, "Sharing the National Cake in New Zealand", available on website http://econ.massey.ac.nz

1.2 Energy, environmental, and electricity industry restructuring

Until 1984, electricity was generated and transmitted by a Government department. Expansion was funded by a levy of 25%, or sometimes more, on the bulk electricity tariff. The Ministry of Energy published annual energy plans from 1981 to 1985, which gave information on resources of fossil fuels and sustainable energy resources, and government's plans for their development. The Ministry was abolished in 1989. There remains a Minister of Energy, who is advised by divisions within the Ministry of Commerce.

During the late 1980s, Government separated policy and operational activities in the environmental area. The Resource Management Act, passed in 1991, streamlined the planning consent process for developers of land and natural resources, and devolved decision-making to local authorities. The Act did not cover fossil fuel or mineral resources.

The Energy Efficiency and Conservation Authority (EECA) was established in 1992 as an independent government agency, to implement practical measures for achieving greater energy efficiency in New Zealand. Its brief is "to monitor, promote and facilitate energy efficiency and conservation to improve the productivity of New Zealand's energy use taking the social, economic and environmental considerations into account."

The 1986 State Owned Enterprises Act changed the Electricity Division of the Ministry of Energy into a state owned company, ECNZ (Electricity Corporation of NZ), making it subject to company law and the incentives of private sector corporations. In 1992 the local power

distributors were restructured into companies. Government expected these to end up in private ownership, but the majority of communities opted for continuing public ownership.

In 1994 Government split off the national transmission grid into a separate company, Trans Power. In 1995, ECNZ was split into two competing generating companies, and in 1998, the larger generator was further split into three. Probably the most radical restructuring was the requirement in the 1998 legislation for local power companies, whether publicly or privately owned, to divest ownership of either their lines business or their retailing and (if applicable) generating business. This was to prevent cross-subsidies between the monopoly business and the competitive one. Also, the industry is required within one year to create a system for every consumer to choose between retailers; otherwise Government will impose such a system.

Deregulation has been more complete in New Zealand than in other countries. There is no regulator for electricity or other essential industries. Generic regulation is maintained under the Commerce Act, but the sole purpose of the Act is to promote competition. Light handed regulation of electricity and gas networks is by way of "information disclosure" rules first promulgated in 1994, designed to expose prices and profits of the local power companies to public scrutiny. Although the Commerce Act has a mechanism to invoke price control, this is viewed as a last resort measure.

A competitive electricity market was developed by EMCO, a company owned by wholesale market participants. The market was launched in 1996. In 1998, industry working parties designed additional market mechanisms to cover security of transmission services. These exercises follow Government's philosophy of "industry self-regulation". There is no participation by final consumers other than those major electricity users who participate in the wholesale market, nor by environmental or community representatives.

2. Energy Sustainability Indicators

2.1 The Indicators

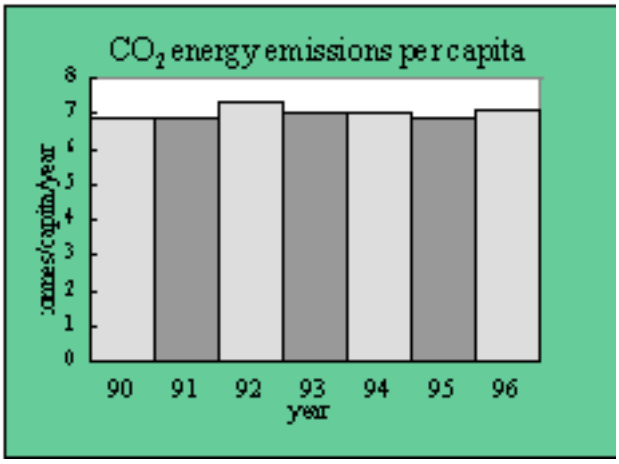
Indicator 1

Global environmental impact: CO_2 emissions per capita from energy sector

New Zealand's energy sector emitted 26.26 million tonnes of carbon dioxide in 1996, 13.7% more than in 1990. The transport sector produced 45% of the emissions.

Compared to other OECD countries, New Zealand has relatively low CO_2 emissions, because nearly 80% of its electricity is generated from hydro or geothermal energy.

With the exception of 1992, per capita CO_2 emissions from the energy sector rose gradually to 1993, and then began to decline gradually. The graph shows the per capita emissions from the energy sector from 1990 to 1996.



By far the greatest variation from year to year comes from electricity generation and petrochemicals. The graph shows the effect of a "dry year", 1992, when extra gas was burned to generate electricity because of very low hydro flows.

Total CO_2 emissions from the whole energy sector rose by 7% in 1992, but emissions from the transformation of one form of energy into another, which includes thermal electricity generation, rose by 24%.

The actual tonnage of CO_2 emissions rose over the same period, 1990-1996, but it rose less than the population growth.

A group of New Zealand environmental NGOs has called for a coherent action plan to reduce CO_2 emissions to 80% of 1990 levels by the year 2005, and to 50% by 2020. They support economic instruments including a substantial fiscally neutral carbon tax, and a National Greenhouse and Sustainable Energy Policy under the Resource Management Act. They estimate that a fiscally neutral tax of $58.20 per tonne of carbon linked to a reduction in goods and services tax from the present 12.5% to 10% could reduce CO_2 emissions by 26%, increase GDP by 1.4% and create 32,000 extra jobs.[iv]

New Zealand is a signatory to the FCCC, and signed the Kyoto protocol in May 1998. New Zealand government ratification of the protocol depends largely on an international emissions trading regime being put in place. At Kyoto New Zealand negotiated a stabilisation of emissions at 1990 levels, after going in to the conference seeking a 5% cut in emissions from 1990 levels. However, CO_2 emissions are projected to be up by 22% on 1990 levels by 2000.[v]

Currently New Zealand is considering policy options, but has no greenhouse gas policy in place, and no policy to prevent growth in emissions. The emissions trading regime sought by the government will involve international credits, so that New Zealand emitters buying credits will have to buy them at international prices. This would mean that New Zealand sinks would not be available as a cheap localised option for domestic emitters to offset their emissions.

iv	*Election 96: Vote for the Environment*, Environment and Conservation Organisations,1996
v	Ministry for the Environment, NZ Response II, National Communication Under FCCC. Note that emissions from energy and industrial sources alone increased by 8.5% in 1997 over 1996 levels. Mininistry of Commerce Energy Modelling Statistics unit: Energy Greenhouse gas emissions 1990 - 1997.

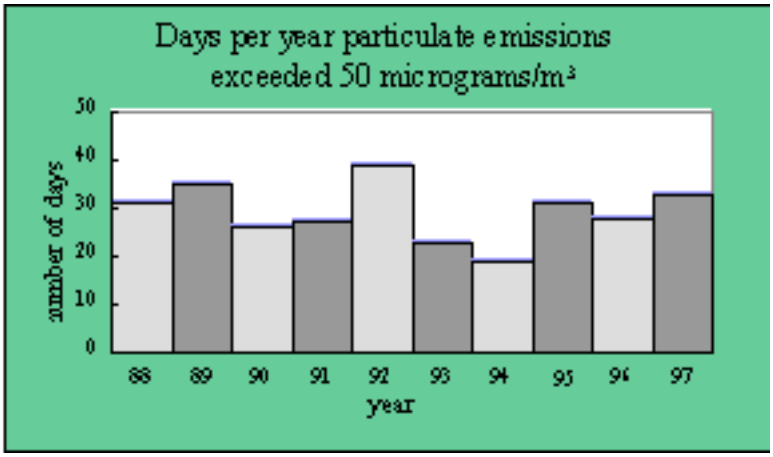
Indicator 2 Local environmental impacts

The brief for this report calls for the most significant local environmental impact of the energy sector to be described. There are impacts on land and water from some opencast coal mining, and there are substantial effects on the Waikato River from heat from a 1000 MW station, and some heating and toxic emissions from geothermal power stations.

We choose particulate emissions as the most significant local pollutant from the energy sector. Its effect has been quantified in Christchurch, where a temperature inversion traps pollutants on winter nights. Some other city suburbs, especially of Wellington and Dunedin, are also particularly subject to winter air pollution.

The Canterbury Regional Council (CRC) has measured air quality in the Christchurch basin continuously since 1988.[vi]

The graph shows the number of days per year the CRC target level of 50 micrograms of particulate matter per cubic metre (averaged over 24 hours) has been exceeded.



The target is expected to be revised downwards, as the World Health Organisation recommends a zero tolerance guideline.

Home heating from inefficient wood burning appliances and open fires is estimated to cause 90% of the particulate emissions in the Christchurch region, where some 44% of households use solid fuel heating on typical winter evenings. Many of these people use electricity or gas as well as solid fuel for heating, so the reduction of air emissions is a realistic goal.

The Regional Council intends to forbid open hearth fires for home heating, and to require improvements in the performance of solid fuel heaters. Emissions from industry and from open-air burning of rubbish and agricultural wastes will also be controlled.

Another significant local pollutant arising from energy use has not been studied quantitatively. This is the use of natural gas, LPG, or kerosene heaters without flues, which discharge combustion products directly into the living space, which may be poorly ventilated because people want to keep the heat in.

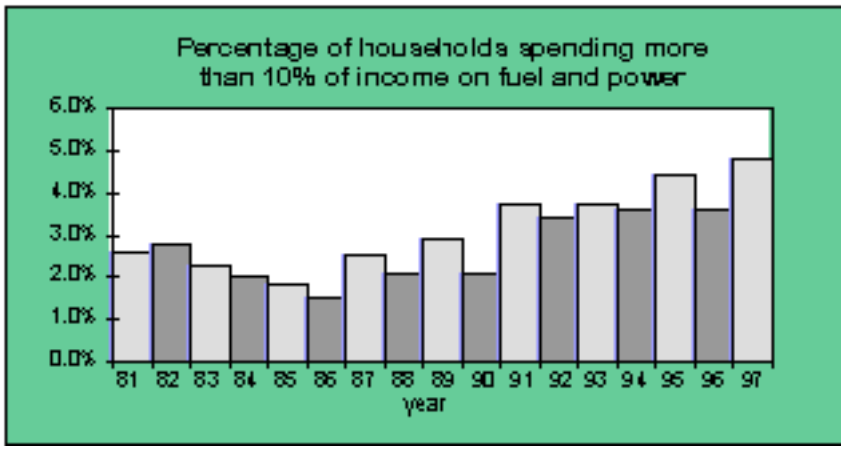
Carbon monoxide and oxides of nitrogen are the obvious toxic pollutants. Probably more significant is the moisture produced in burning, which may lead to severe dampness in the house. Damp furnishings can support high populations of dust mites, which are considered to be a major causative factor in asthma, a serious health problem especially in low-income areas. Dampness often leads to deterioration of house furnishings and contents, and even of the structure of the house itself.

Indicator 3 Social impacts: rural reticulation, fuel poverty

New Zealand rural areas are almost 100% reticulated. Some of the lines were subsidised under government schemes, and many more were once economic but are no longer so in the present commercial environment. Most houses which are not supplied by power lines generate their own electricity, usually from diesel generators, but in an increasing number of cases backed up by solar cells, wind turbines, "micro" hydro turbines, or a combination of these.

One indicator of the effective availability of energy for New Zealand's citizens is the level to which their houses are heated. The Department of Health has advised that a safe minimum temperature for living areas in houses is 16 degrees Celsius. Below this, the health especially of elderly and very young persons is put at risk. Nationwide surveys carried out in 1971 and 1986 found average winter temperatures in homes' living areas to be at or below this level. To investigate the outcomes from low living temperatures, monthly mortality statistics were studied. Mortality of people under 5 years and over 65 years was greater in winter months than in summer months, a finding consistent with the survey of living area temperatures. [vii]

We consider that the most relevant indicator of accessibility and affordability of energy is the proportion of households which spent more than 10% of their income on domestic fuel and power. The data below are supplied by the NZ Department of Statistics, and are based on information from the Household Economic Survey that was instituted in 1981. Data for earlier years are not available.



The trend began to increase in the third year after the reforms began, and increased again sharply 1991 when welfare benefits were cut. Today about 5% of New Zealanders spend more than 10% of their income on fuel and power.

We expect fuel poverty to increase markedly as a result of the 1998 electricity reforms. The new electricity retailers are expected to pass on network costs almost entirely as fixed charges.

At present network prices are partly fixed and partly variable; different companies set fixed charge ranging from about $100 to $330 per year. Some rural companies say fixed costs are as high as $5 per day, so unless they continue to cross-subsidise their country customers from town customers, fixed charges could rise to over $1500 per year in some rural districts.

We estimate that nearly half the household consumers use 6000 kWh per year or less, and many of these consumers even now pay over half their power bill as fixed charges. Increasing fixed charges will affect these people severely.

vii	Isaacs, Nigel and Donn, Michael, Health and housing - seasonality in New Zealand Mortality, Australian Journal of Public Health, March 1993

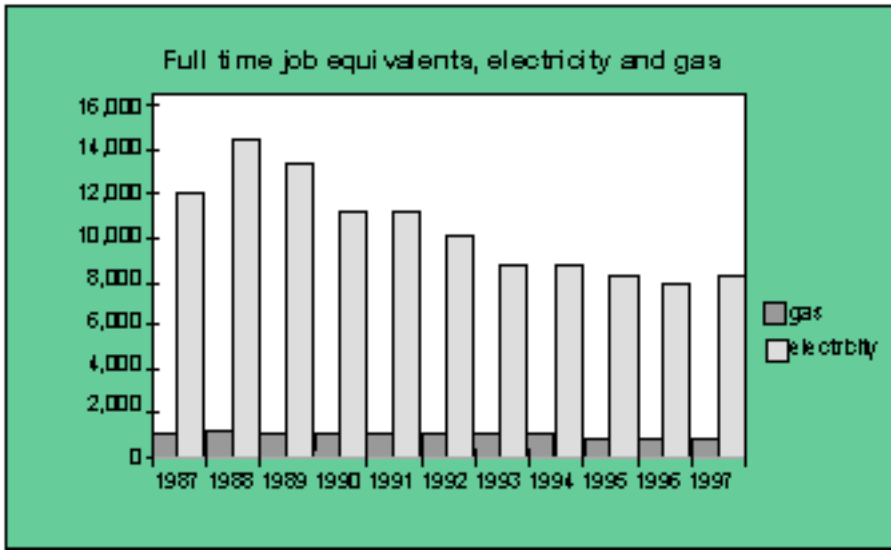
Indicator 4 Jobs in the energy sector

Statistics on the number of jobs in business enterprises have been maintained since 1987.[viii] The definition used does not include electrical or gas contracting businesses such as electricians.

There are about one tenth the number of jobs in gas supply as in electricity supply.

The trends in both sectors are extremely close - jobs in gas rose from 1060 in 1987 to 1180 the following year, and then declined gradually until 1997, when they rose from 800 to 820.

In 1987, the first year for which statistics are available, energy restructuring had just begun, and its impact on jobs had probably not been strong. The graph evidently just captures the end of an era of massive power station construction and expansion of gas reticulation.



What these data do not show is the shift from permanent jobs to contracting for services. ECNZ cut its permanent jobs by about half during the period of restructuring, and most local power companies have also cut staff as much or even more. These cuts have reduced operating costs of the companies, which must mean a reduction in either hours worked, or wage rates, or both.

There are no statistics available on jobs in energy efficiency or renewable energy. EECA maintains a database of renewable energy suppliers and contractors, with somewhat over 100 entries. Many of these are single-person organisations; few if any employ large numbers of people. Their database of energy management consultants includes some substantial firms; we estimate there are several times as many employed as in renewables.

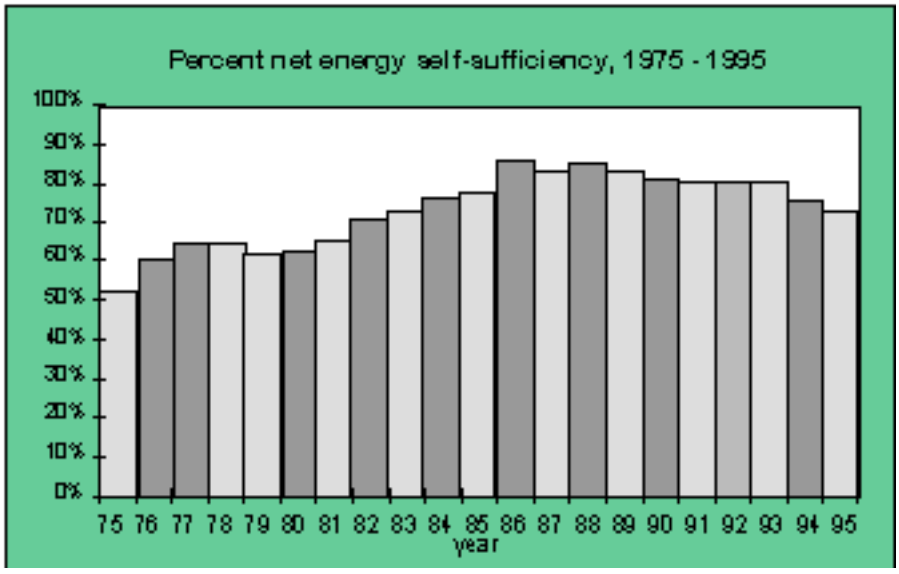
Over the last 5 years, we suspect that EECA's activities has stimulated almost a doubling of the work force involved in energy efficiency and renewable energy. In the absence of any survey, best guess of total numbers is around a thousand full time job equivalents in energy efficiency and renewable energy supply, and growing in number.

viii	The definition of business enterprises was changed in 1994, so the data prior to that date are not comparable to subsequent data. However the change made only a tenth of a percent difference to the number of electricity industry jobs as defined in the year 1994, and no change in the number of gas industry jobs.

Indicator 5 Resilience to external events - energy self-sufficiency
New Zealand's only significant energy imports are crude oil and imported oil products. The single refinery in the country was converted to hydrocracking in response to the 1978 oil crisis, so that diesel fuel as well as gasoline could be produced. Gasoline is now being imported by competitors to the oil companies which jointly own the refinery.

Net self-sufficiency in total primary energy peaked at 85% in 1988, when the condensate from the offshore Maui gas field, together with opening of the synthetic gasoline plant, displaced oil imports. It fell back to 81% in 1990 and 73% in 1995, as condensate production fell and primary energy use increased.

The graph shows the % net self-sufficiency since 1975.



The New Zealand yearbook reports the gross self-sufficiency in 1996 as 89%. The gross figure includes condensate and synthetic petrol which are exported because it costs less to blend them into large gasoline pools than to process them for the New Zealand market.

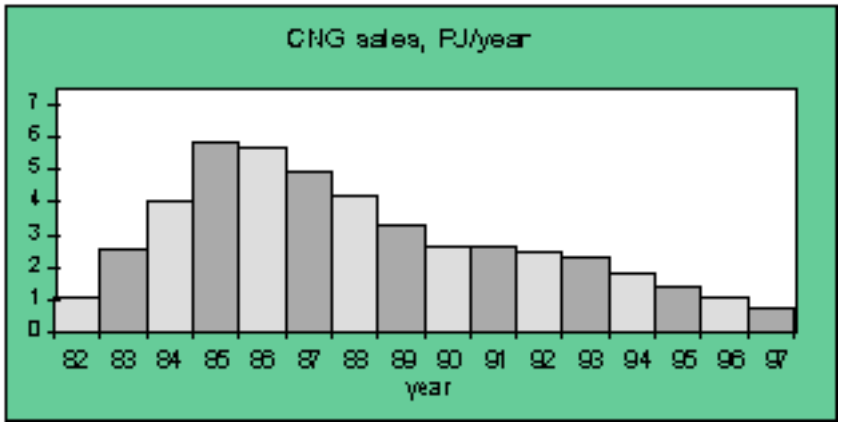
Government is encouraging petroleum exploration in new basins in the hope of improving self-sufficiency in liquid fuels from 41% at present to 75% by 2005, and perhaps even becoming a net exporter before 2010 [ix]. This self-sufficiency policy is based solely on non-renewable fuels.

Compressed natural gas (CNG) was introduced as a vehicle fuel in 1980, as a cost-effective and energy-efficient response to the oil crisis.

It is twice as energy-efficient as synthetic gasoline. Substantial subsidies were available for the conversion of existing petrol vehicles to CNG, and for the creation of a network of service stations through most of the North Island.

The technology to convert heavy diesel vehicles to CNG was well developed when Government eliminated the excise tax on diesel in 1985. From then on, public perception that Government did not support CNG led to a rapid drop in numbers of vehicles converted. CNG sales declined

progressively, and CNG dispensers are now being removed from service stations where fuel sales fail to meet the costs of maintaining them. Liquefied petroleum gas (LPG) is available also but its overall cost is little different from the cost of petrol today.



Many environmentalists support measures to halt the decline in use of compressed natural gas (CNG) for transport fuel. Use of CNG in petrol vehicles reduces their CO_2 emissions by 20% [x], as well as increasing the resilience of the transport sector. Also, CNG is readily substituted by biogas, available from landfills, sewage treatment, or purpose-made on farms, all of which have been used to drive CNG vehicles in the recent past. Biogas is readily produced and used on small scales, and this could improve resilience of the rural economy.

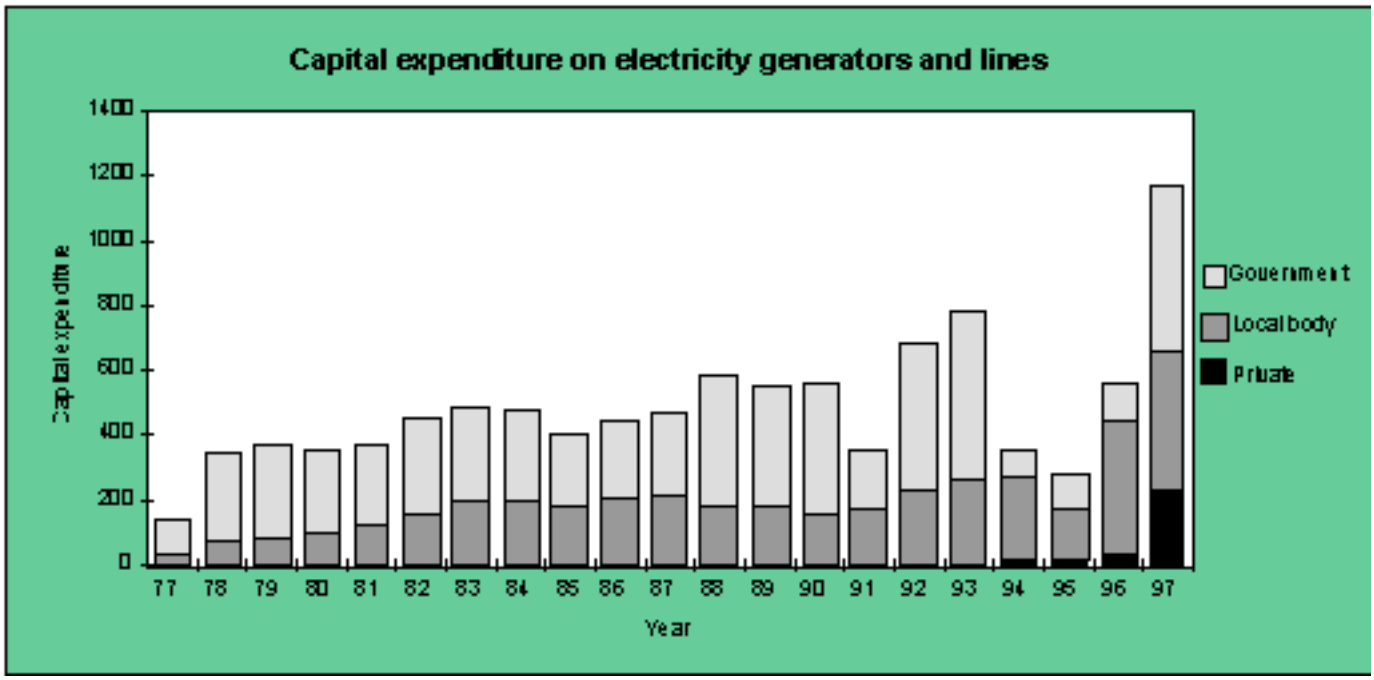
ix	New Zealand's Basins of Opportunity, Proceedings of 1998 New Zealand Petroleum Conference (Principal Sponsor, Fletcher Challenge Energy), Minister of Energy's speech, 30 March 1998.
x	Jeanette Fitzsimons, Member of Parliament, personal comment.

Indicator 6 Burden of energy investments on development

Government capital investment in energy projects ranged from 30% to 45% of total New Zealand capital investment in the 30 years preceding the economic reforms of the 1980s. A very influential analysis commissioned by Treasury in 1984 [xi] argued that inefficiencies or errors of judgement by Government can have a significant effect on New Zealand's long term prosperity. This report estimated that about $1 billion NZ 1983 dollars was spent unnecessarily on just three power stations, and concluded the economic cost of this was about $3 billion.

The report's criticisms included the building of costly hydro stations before cheaper alternative generation. The rationale for this had been the maintenance of skilled work forces, and the fact that hydro energy was clean and renewable. Cost overruns of over 100%, and long delays in commissioning, were also criticised. The analysis concluded that errors were so big that they affected the economy as a whole as well as being a financial burden on both taxpayers and electricity consumers.

Environmentalists shared the concern highlighted by the Treasury paper, that the state had overinvested in electricity projects. But most environmentalists considered that a much lower discount rate would better reflect the long lifetimes of hydro plants. They are less concerned than Treasury about "lost opportunities" for past investment, and far more concerned that the developed hydro resource is being undervalued today, and could be sold to foreign investors at a time when a surplus of new generation is driving market prices down. The hydro stations will continue to generate electricity at low environmental costs, zero fuel cost and very low maintenance costs into the distant future.



That report was much quoted during the economic and energy restructuring of the mid 1980s, to support the idea that government should not be involved in risky projects, but leave them to the private sector. No new power stations were approved for many years after restructuring began, but the existing projects were not completed until 1993.

Local power board investment was very significant and included uneconomic power stations as well as expansion of reticulation, including a small proportion of uneconomic rural lines. Such expenditure declined as the reformers put the spotlight on unwise investments.

Private investment in generation began in the early 1990s and rose sharply in 1996, with two combined cycle power stations, a large geothermal station, and some smaller cogeneration projects. Most of these were committed when wholesale electricity prices were forecasted to be 5c/kWh rising to 6c/kWh. Now the electricity surplus that these stations will create has pushed price forecasts downwards, to somewhat over 3c/kWh for several years, showing that the private sector is not immune to uneconomic investment. Any burden of debt from these investments will be borne, however, by the private sector - and/ or by consumers if competition does not deliver the promised benefits to all classes of consumers.

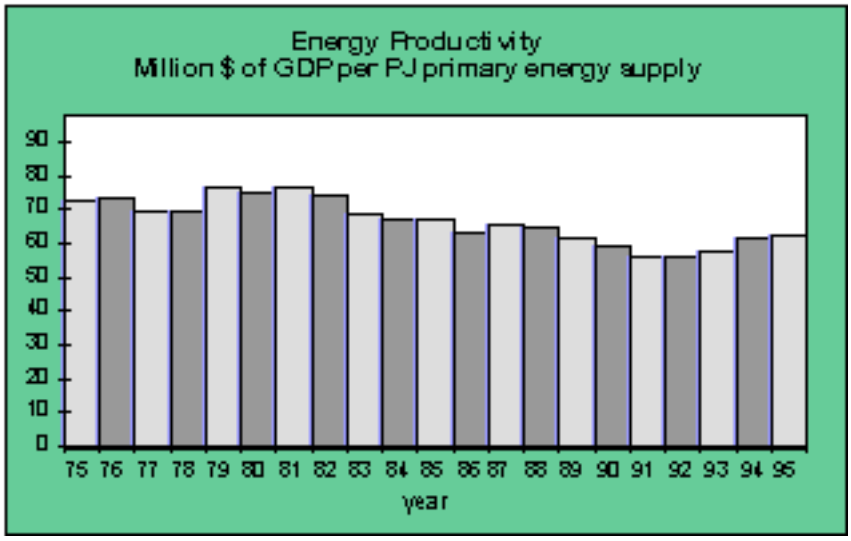
The financial impact of the "Think Big" projects of the 1980s, based on the Maui gas resource, was even greater than that of the power station development. These projects involved several billion dollars of government expenditure, and it took further billions to unwind government's various commitments when government divested its interests in them. To our knowledge there is no analysis of the actual numbers involved. The projects stimulated employment for almost a decade, but left a burden of debt from which the economy has not fully recovered.

xi	McLachlan, Corrie, 1984 paper released by Treasury under the Official Information Act

Indicator 7 Energy Productivity

New Zealand's statistics are given in terms of energy intensity, the reciprocal of energy productivity. The statistics have been extensively analysed by EECA to determine influences on this important indicator.

Primary energy productivity, which had been rising in the mid 1970s, began to fall in 1980, and began to rise again from 1993.



The main influences on energy productivity are:

- the mix of primary fuels,
- "structural" changes in New Zealand's production (e.g. energy-intensive industries, or labour intensive services),
- improvement in technical efficiency
- consumption patterns.

About 30% of New Zealand's primary energy is lost in conversion to consumer energy or transmission and distribution to consumers. This is low by world standards because in most recent years hydroelectricity has generated around 80% of New Zealand's electricity. But electricity transmission and distribution losses, averaging 11% in 1996, are high by world standards, because the power stations are far from loads. The largest generation losses are in geothermal energy, where only 10% of the primary energy is converted to electricity.

Energy productivity increased during the mid 1970s, but fell during the 1980s when Maui gas became available for petrochemical processing, and for power generation which enabled expansion of pulp and paper industries and inefficient steel and aluminium refining. During these years most OECD countries had completed their industrialisation, and their energy productivity was increasing.

New Zealand's energy productivity increased in 1993, for the first time since 1980. This turnaround occurred at the same time that both energy and GDP were increasing. Thus what is observed is a decoupling of energy from economic growth - a most desirable development.

Transport is the largest and fastest growing of the energy-using sectors, and used 37% of New Zealand's primary energy in the year ended March 1996. Total transport energy demand was nearly stable between 1975 and 1984, then grew at an accelerating rate, reaching 3.6% growth from 1995 to 1996.

The table on the next page summarises the energy intensity, quantity of transport use, and energy of transport use in three selected years - 1975, 1990 and 1996. It gives further information on car and air passenger transport, which in each of the three selected years, used 93% of all passenger transport energy.

Passenger kilometres have increased more rapidly than New Zealand's population and freight kilometres have increased more rapidly than GDP. Deregulation has led to an increasing amount of road haulage at the expense of more energy-efficient rail and shipping, and centralisation of primary processing has also helped increase transport demand.

Transport productivity, demand and energy use

	1975	1990	1996	change 1975-96	change 1990-96
Productivity					
passenger: pass-km/MJ					
car	0.435	0.488	0.524	20%	7%
air	0.223	0.341	0.353	59%	4%
all passenger modes	0.448	0.505	0.538	20%	6%
freight: tonne-km/MJ	0.526	0.459	0.483	-8%	5%
Demand					
passenger: billion p-km/yr					
car	26.354	37.671	49.196	87%	31%
air	1.034	2.126	2.776	168%	31%
all passenger modes	30.412	43.71	56.584	86%	29%
freight: billion tonne-km/yr	18.64	21.704	26.705	43%	23%
Energy use					
passenger: PJ/year					
car	60.61	77.23	93.96	55%	22%
air	4.65	6.23	7.86	69%	26%
all passenger modes	67.8	86.61	105.52	56%	22%
freight: PJ/year	35.35	47.21	55.39	57%	17%

EECA used the large data set from 1975 to 1995 to identify influences on energy productivity in transport. The shift in mode towards private car and air travel accounted for much of the decrease in productivity of passenger transport.

Gasoline price increase over the 20 year period was associated with a small increase in productivity, and the importation of used Japanese cars, many with air conditioning and automatic transmissions, is associated with a small decrease in productivity.

Freight transport productivity reduction was associated with reduced prices of petrol and diesel, and by the reduced percentage of freight carried in coastal shipping.

The data set from 1990 onwards was too small for this type of analysis, but EECA noted the substantial price decrease in petrol prices over the recent period.

Indicator 8 Sustainable Energy Sources: Renewable energy and energy savings

The bulk of New Zealand's renewable energy comes from large hydro projects remote from electricity consumers. Some 78% of power generation and 13% of New Zealand's primary energy in 1996 came from hydroelectricity. Geothermal energy is only renewable at extraction rates much lower than are used for electricity supply, and existing fields are running down.

Small-scale renewable energy developments include wind power, power generation from landfill methane, plantation-grown fuelwood, and solar heating. Wind energy is growing steadily from an extremely low base; biogas (which includes landfill gas and sewage gas) is

also growing. "Total biomass and animal products", which is mainly fuelwood, has been nearly constant since 1990, but grew by 24% in the previous decade. Use of fuelwood for home heating is stimulated by the availability of highly efficient domestic wood burners. The table gives the actual data.

There are no statistics for solar water heating, a significant energy source that we estimate to be providing around 0.09 PJ per year today,xii with a large potential for development. About 300 domestic solar systems are being manufactured and installed per year at present.

Wind generation in New Zealand is favoured by very high average wind speeds, around 10 metres per second or even more on the most favourable sites. Costs are decreasing steadily as technology improves, and now range upwards from around 6c/kWh on the best sites. With wholesale electricity prices averaging around 4.5c/kWh and forecast to fall a further cent or more, wind generation is not attractive except where taxation or other special conditions apply. But in comparison to the cost of the new combined cycle gas turbines, reported to be 5-6c/kWh (without externalities) and especially to the costs of existing hydro dams updated to today's dollars - ranging from 5 to 25c/kWh-wind would appear a reasonably viable resource.

Primary energy supply from renewable sources, PJ
total (incl hydro and geothermal) and small-scale

year	tot. renewable energy supply	fuelwood	biogas	wastes	wind	solar heat	total small scale renew.	% renewable energy from small scale
1990	221	30.96	1.62	3.22	0	0.075	35.88	16.2%
1991	213	30.44	1.88	3.23	0	0.077	35.63	16.7%
1992	209	31.19	1.93	3.23	0.002	0.080	36.43	17.4%
1993	222	31.54	1.93	3.23	0.004	0.082	36.79	16.6%
1994	225	31.39	2.01	3.23	0.004	0.084	36.72	16.3%
1995	228	31.56	2.47	3.29	0.004	0.087	37.41	16.4%
1996	222	31.36	2.76	3.28	0.030	0.090	37.52	17.0%

The wider concept of "distributed energy" is a real key to sustainability, and it is favoured by the wide price variations in the electricity market, which have exceeded $1 per kWh for brief periods. Distributed energy includes use of alternative fuels such as firewood at times when electricity supply is costly. It includes storing hot water or ice to shift load away from peak hours. It even includes automatic switching off when loss of a big generator or transmission line causes the system frequency to drop. This allows the amount of "spinning reserve" carried by the power system to be reduced. Some large electricity users are already being paid to interrupt their load on request. Household water heating has been interruptible for a long time, but his does not replace spinning reserve.

Demand-side management incorporates distributed energy and energy savings, and was the focus of a working party of the electricity market, but the group has not met for nearly a year.

It is reasonably simple to document the amount of energy supplied by renewable sources. In contrast, to assess the amount of energy that has actually become available as a result of energy savings rather than new supply requires a complex calculation.

To do this, EECA used statistical methods to identify key influences on New Zealand's consumer energy intensity (consumer energy to GDP ratio). They studied the changes over two time bands - 1973 to 1996, and 1994 to 1996. The recent time band, though short, is of particular interest because it covers the period when energy productivity began to rise - which is exactly the period over which outputs from EECA's work have become evident.

The analysis enabled EECA to separate the effect of technical improvements in energy efficiency from the structural effect on energy and GDP of the rise of energy-intensive industry. EECA concluded that from 1994 to 1996, technical improvements reduced the energy intensity by 5.3%. Most of this improvement was in the industrial sector, but a modest contribution came from the transport sector.

Technical energy efficiency is likely to improve with the displacement of steam thermal generation by combined-cycle gas turbines. However this may be offset by the economic incentive to run the new plant day and night, and the chance that further energy-intensive industry may be needed to take up that load.

In contrast to the short term trend, the change over the longer period, from 1973 to 1996, has proved adverse - there was a 1% increase in consumer energy intensity.

Results of energy efficiency programmes are noted in section 3.2.

xii	Assuming conservatively that a 3 square meter panel replaces 2500 kWh per year of electricity, New and Renewable Energy Resources for New Zealand: CAE and EECA, 1977

2.2 Trends in the indicators since 1990

- CO_2 emissions per capita. The per capita CO_2 emissions from the energy sector increased by 3% from 1990 to1996. Variations are very significant, as the increase from 1990-1992 was 7%. The measure to limit emissions with the greatest expected impact is voluntary agreements with major industry, whose emissions are projected to be 9% higher in 2000 than 1990, compared to a projected 22% increase for the NZ economy as a whole.

- Local environmental impacts of energy supply and use. The chosen indicator for local impacts, particulate emissions in Christchurch, has shown no clear trend since 1990. The Regional Plan has just been advertised for public submissions, and the regional council expects to put standards in place to reduce these emissions.

- Rural electrification or other social indicator. We use the percentage of households spending more than10% of their income on electricity as an indicator of "fuel poverty", or access to affordable energy services. This percentage rose from 2.1% in 1990 to 3.6% in 1996 and 4.8% in 1997. We expect this percentage to rise further, because competition introduced to force prices down is unlikely to benefit low-income consumers.

- Jobs in the energy sector. A decline of 29% in electricity and gas sector jobs from 1990 to 1996 amounted to a loss of 3200 jobs. Jobs in renewable energy and energy efficiency are not recorded, but the increase, if any, was small by comparison. We expect renewable and efficiency jobs to decline as falling wholesale electricity prices suppress opportunities in both renewable and gas energy supply and efficiency services.

- Resilience to external impacts. Resilience measured by percentage net self-sufficiency has declined from 81% in 1990 to 74% in 1996. Sales of the most important indigenous transport fuel, CNG, fell from a peak of 4.9PJ per year in 1987 to 2.65 in 1990 and 1.06 in 1996. Only a major oil discovery or a policy initiative similar to the earlier promotion of CNG would appear likely to reverse this trend.

- Burden of energy investments on development. Central government investment in the energy sector declined sharply from 1990 to 1994, as construction work on a major hydro station and an undersea direct current cable came to an end. Government investment rose rapidly again in 1997 with investment in new thermal generation, and this plus hydro upgrade will add further investment in 1998. The thermal generation will add to the environmental burden of electricity, and depress the market for renewable energy.

- Energy productivity in PJ per unit of GDP. Primary energy productivity in GDP terms fell until 1992 but rose significantly from 1993 onwards. EECA's analysis was of consumer, not primary, energy productivity;and this concluded that the fall was largely through the "structural effect" of increasing energy-intensive industry, partly offset bystrong economic growth and expansion of less energy-intensive sectors such as telecommunications. The subsequent rise in productivity appears to be largely a result of improving technical efficiency.

- Sustainable energy and energy efficiency. Traditional sustainable energy sources, mainly hydro, fuelwood, and energy from wastes, have increased slightly since 1990, but "new" renewable energy - biogas and wind, are growing from an extremely low base. The low projected wholesale priceelectricity is expected to stem the growth of wind energy at least for several years.

3. Energy Sector Issues

3.1 Transport Energy

The growth of freight and passenger transport was influenced by transport policies and the microeconomic reforms that led to industry closures. Policies that led to increased road transport included reduction of tax on diesel fuel, and road user charges for heavy vehicles falling far short of the costs of road damage caused by the heavy vehicles. Government reforms included closures of post offices and provincial hospitals. Rationalisation led to closure of many local primary processing factories, leading to very long road hauls of farm and forestry produce. Suburban and rural banks and other private services also closed down.

Uncompensated environmental impacts of roading amount to effective subsidies. Best estimates of the annual monetary values of these impacts, from a 1996 Ministry of Transport report, are NZ$290 million for noise, NZ$700 million for local air quality, NZ$290 million for greenhouse gases and NZ$100 million for reduction in water quality.

Government recently launched a new wave of reform in the funding and possibly private ownership of roads. A substantial public consultation exercise is reminiscent of the earlier consultations on energy and environmental matters, with public consultation being largely ignored. The official consultation document has watered down the recommendations of the broad consultative group that provided early input.

3.2 Energy efficiency programmes

New Zealand like other countries in the 1970s began major energy savings and solar energy programmes following the world oil price shocks. Most of these programmes were abandoned after the 1984 reforms began.

EECA now administers a variety of energy efficiency projects, including:

- A loans scheme available to local and national government organisations begun in 1989, which to date has loaned $10 million for investments which are saving nearly $4.5 million per year and reducing CO_2 emissionsby more than 22,000 tonnes per year.

- Voluntary agreements with industries to limit CO_2 emissions, with 21 participants now planning to avoid emissions of 1.tonnes over the lifetime of commercial and industrial equipment. Agreements in electricity generation plan to avoid 0.9 million tonnes.

- The Energy Saver Fund of $18 million, a five-year fund to save residential energy. Projects sponsored in 1996 will save an estimated 177 million kWh and reduce CO_2 emissions by 110,000 tonnes over the lifetime of the equipment installed. These savings will be achieved, on average, at a cost to Government of 2.8c/kWh and a total cost of 5.8c/kWh, at a time when household electricity prices were 10-11c/kWh.

Energy savings in the household are of particular significance because they can give rise to health benefits as well as to savings of money and greenhouse gas emissions. The Energy Saver Fund was targeted by EECA at the most cost-effective use of Government funds in reducing household energy use.

Community demand has led many projects to change their focus from primarily environmental to primarily social. Many projects involve low-income homes and rental accommodation, and many provide subsidised draught-proofing and roof and floor insulation, which have important health benefits. Most also provide hot water cylinder wraps, which provide savings of kilowatt-hours, CO_2 emissions, and financial savings to the consumer at the lowest investment cost.

Government reduced EECA's funding in the 1998 budget from $5.1 million to $4.6 million, and has accelerated the phase-out of the Energy Saver Fund.

The Public Good Science Fund in 1997 allocated about $1 million each to energy efficiency projects and to small-scale renewables projects, out of a total of $5 million allocated to the energy sector. Aside from this, new technologies for efficient supply and use of energy receive little government assistance, despite the fact that they face costs and risks much higher than "incumbent" supply technologies.

3.3 Reliability of electricity supply

Reliability is an essential component of electricity supply. It involves the whole supply chain, from generation to transmission to distribution. Recently major supply interruptions have focused debate on whether free-market mechanisms have reduced reliability or improved it.

In 1992, a shortage of hydro inflows led to rationing of "controlled load" for hot water, and a nationwide call for consumers to save electricity. A government inquiry into the shortage [xiii] concluded that ECNZ, the state owned generator, was not at fault but that "it would have been more prudent to have started thermal plant earlier." They noted that the "spot prices", set weekly, had been capped and did not reflect the "cost of non-supply", and recommended market mechanisms to improve the situation.

The wholesale electricity market, launched in 1996, removed the cap on spot prices, which have since ranged from zero to over $1 per kWh in the two years' experience of the market. There have been no major droughts in hydro catchments since then to test the influence of the market. But environmentalists are concerned that spot prices only influence wholesales buyers and sellers at the margin, not the final consumers who have been given no price incentives to switch off when costs are high.

In February 1998, the entire Auckland central business district lost electricity supply for five weeks as four underground cables failed in quick succession. A Ministerial inquiry into the blackout criticised the risk management, contingency planning and operations and asset management practices of both Mercury Energy and its predecessor, the Auckland Electric Power Board. Mercury has an unusual governance structure: it is 100% owned by a trust but the trust appoints a minority of directors and had little if any influence on company affairs. The Inquiry found that this lack of accountability did not cause the blackout, but was a key factor in failing to prevent it.

Trans Power's reliability has improved substantially since the reforms began, unlike the reliability of local power networks that show no clear trend of reliability. Trans Power emphasises that it can never guarantee supply, so isolated rural areas are at risk and would have to pay more if they wanted spur lines upgraded with more circuits or more capacity. The Minister of Energy is now considering a nationwide review of security of electricity supply.

The High Court recently declared that electricity is neither a good nor a service, and so is not covered by the Consumer Guarantees Act. This puts the spotlight on customer contracts, which determine responsibility for security, and conditions under which compensation may be paid. Liability for compensation appears to be the only credible mechanism in the present commercial environment to align the interests of electricity suppliers with their consumers.

xiii	Report of the Electricity Shortage Review Committee - 1992 (Published by the Department of Prime Minister and Cabinet, New Zealand, 12 January 1993).

4. Discussion

4.1 Sustainability

Helio's definition of development sustainability with regard to energy [xiv] involves three aspects. In summary, to be environmentally sustainable, energy pollutants should not exceed the capacity of the environment to absorb them, and "user pays" fees should be reinvested within the environmental sector. Economic sustainability requires energy assets to be maintained and renewed where appropriate with renewable energy resources. Social

sustainability requires energy development and use to contribute to social equity and poverty alleviation, and not to harm human health.

Helio considers that sustainability requires environmental, economic and social implications of energy development to be made transparent, and the inevitable trade-offs to be determined by a process involving all stakeholders. Assessed environmental and social costs can be used as an instrument to facilitate discussion, even though final decisions "should not and will not be based only on such monetary valuation."

New Zealand has a long tradition of practice and advocacy of sustainability. The Values Party, founded in the early 1970s, was one of the world's first green parties. Helio's definition is closely echoed by the motto of New Zealand's Sustainable Energy Forum, "Facilitating the use of energy for economic, environmental and social sustainability."

The most comprehensive assessment of New Zealand's performance in terms of these concepts is in a report on urban sustainability [xv] by the Parliamentary Commissioner for the Environment