Sustainable Energy Watch
2005/2006

Energy and Sustainable Development in New Zealand

Report by :
Molly Melhuish

Email:
melhuish@xtra.co.nz

Summary of report

New Zealand is moving away from the climate change goals it adopted in 2002. The present government appears to have traded away sustainability in favour of growth and short-term wealth. Moreover it shows little appetite for the patient, consultative processes needed to generate short-term benefits from policies directed towards long-term sustainability.

Preface

This report was written by Molly Melhuish, with assistance and review by Malcom Souness and Ian Shearer.

Molly Melhuish came to New Zealand from the United States in 1963. She has worked with environmental groups since the late 1960s, first on community environmental work and forestry issues. She used her physical chemistry experience to support the public campaign against nuclear power generation in 1976, and has specialised in analysis of energy demand and supply. Her privately published journal "Energywatch" was influential during the 1980s; it has been resurrected by the Sustainable Energy Forum, of which she is an executive member. She was an elected trustee of an electricity lines company trust during its restructuring and privatisation in the late 1990s. Her current interests are in regulation and governance issues of all aspects of sustainability.

Ian Shearer spent 20 years designing and constructing thermal and geothermal power stations before switching to a focus more on his personal passion for energy efficiency and renewable energy systems. He has managed several renewable energy industry associations including the New Zealand Wind Energy Association and the NZ Photovoltaic Association – and also the NGO, Sustainable Energy Forum. Ian has a passion for technical engineering training issues, and is chairman of the Engineering Associates Registration Board. In 2004 he was made a Fellow of IPENZ for services to IPENZ and renewable energy developments.

Malcom Souness spent 7 years in manufacturing and product development, switching to energy during Master's research into market opportunity for an environmentally friendly heat pump. Since then he has evaluated a number of high-value technology investment opportunities, ranging from mass-market metering, solar water heating, biogas cogeneration to icebank technologies. Malcolm is currently working to improve energy cost and reliability for the primary sector of New Zealand.

Molly Melhuish 42 Waitohu Rd, York Bay, Eastbourne, NZ Tel +644 568-4873 melhuish@xtra.co.nz	Ian Shearer Energy Information Services Ltd PO Box 576, Wellington, NZ Tel +644 586-2003	Malcolm Souness Rural Energy – Energy to Dairy™ PO Box 24411, Wellington, NZ Tel +644 472-1944 www.ruralenergy.co.nz

Acknowledgements

This study was made possible only through the outstanding cooperation of officials from several government departments, who promptly supplied data and spreadsheets that were not available from the departments' websites. Some of the simplest data were the hardest to find – New Zealand's GDP for the year 2004 was unavailable on any website, and took the Statistics

contact person some 15 minutes to unearth – but statistical discrepancies in that data set did not make sense.

Librarians at the Energy Library and Information Service have been very helpful in guiding me through their huge collection for the few data that were really needed.

Several data series date back only to the mid 1990s, and others changed their reference points part way through. Statistically correct use of data from NZ Statistics would require purchase of the data. Energy data series are often incomplete, and have been adapted as carefully possible to the present task. Similar problems plagued the Energy Data File in its early years - the data are now improved, but problems remain particularly with wood ajd geothermal energy data.

Energy demand information is still sparse. Manufacturing statistics are highly aggregated – with aluminium and steel smelting and some manufacturing in a single category, and rubber and plastics aggregated with energy-intensive chemicals. End-use electricity statistics aggregate hunting, fishing and agriculture into a single category. Trends in energy demand, arguably more important than trends in energy supply, are therefore very difficult to interpret. Probably the most difficult problem was to define the categories used here so as to aggregate data in a consistent manner.

Particularly in the subject of sustainable management of resources, the "whole-of-government" approach has not led to consistency of definitions; rather, reports may be prepared section by section by different departments, using different data sets which cannot be combined with any validity.

Disclaimer

While every attempt has been made to ensure the accuracy of the material in this report, Molly Melhuish, Rural Energy, and Energy Services Ltd make no warranty as to the accuracy, completeness or usefulness for any particular purpose of the material in this report; and do not accept any liability for errors of fact or opinion in this report, whether or not due to negligence on the part of any party.

Acronyms

CAFCA	Campaign Against Foreign Control in Aotearoa (New Zealand)
CNG	Compressed natural gas
ECNZ	Electricity Corporation of New Zealand
EECA	Energy Efficiency and Conservation Authority
LPG	Liquefied natural gas
MAF	Ministry of Agriculture and Forestry
MED	Ministry of Economic Development
MFE	Ministry for the Environment
MoT	Ministry of Transport
NGO	Non Governement Organisation
PM10	Particulate matter measuring less than 10 microns

Table of Contents

Executive Summary

New Zealand is moving away from the climate change goals it adopted in 2002 – to make significant reductions in expected greenhouse gas emissions, and to move to a permanent downwards path in terms of emissions. Indicator 1, Per Capita Energy Sector Carbon Emissions shows this trend clearly.

The indicator chosen to reflect local environmental impact Most Significant Energy-Related Local Pollutants is air polluting particulate matter (measured as PM10) from household wood burning. The data show no clear trend to date, but there is much more hope of reducing PM10 levels through programmes, now being implemented, to remove inefficient wood burners. There is a risk however of such policies making fuel poverty worse, as many houses today are considered too cold to be healthy, and wood is one of the lowest cost heating fuel in many parts of the country.

These environmental indicators of energy sustainability are supplemented by social, economic and technical indicators selected by HELIO International. New Zealand has natural advantages in its low population, high human development index, temperate climate and abundance of rainfall and wind. Social indicators – access to electricity, and employment from small-scale and renewable energy development – are already largely benign – indeed Indicator 3, Households with Access to Electricity, is zero in both 1990 and 2004. Recently deployed wind farms are now very large-scale, and use imported turbines. They produce "Clean Energy", Indicator 4, but offer little employment.

The near-depletion of the giant Maui offshore gas field made gas-fired electricity generation so expensive that wind generation is economic with no subsidy. This has led to good results for indicator 8, Renewable Energy Deployment. But the sudden drop-off in indigenous oil and gas production causes indicator 5, Energy Resilience: Energy Trade Benefits to decline.

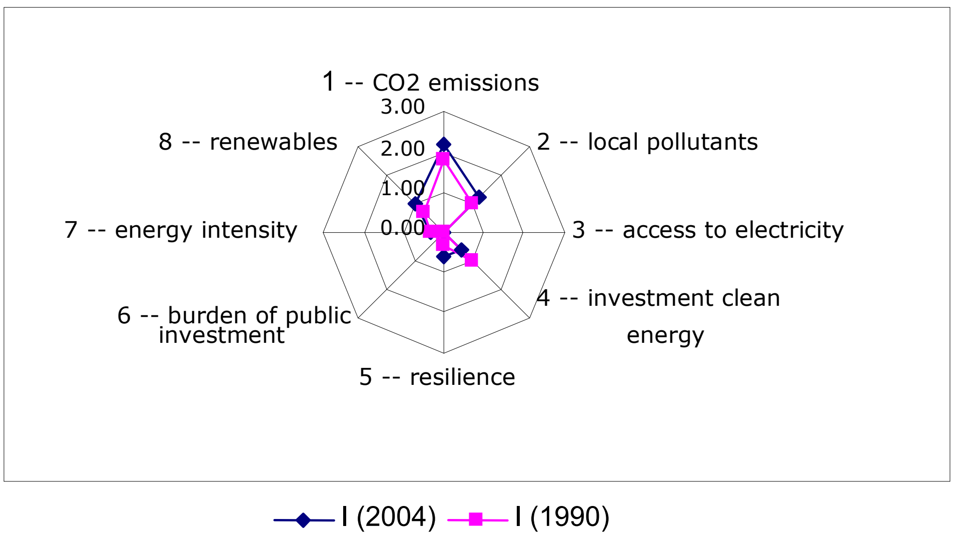
Indicator 6, Burden of Public Energy Investment, is not particularly useful in the New Zealand context, as public investment in the energy sector is profitable. Indeed state-owned electricity companies are so profitable that they contribute significantly to the government's fiscal surplus. New public investment compared to GDP is very small in any case. The real burden is from energy companies that have been privatised – the export of their profits overseas is a significant drain on our balance of payments.

Indicator 7, Energy Intensity, worsened when Maui gas dominated New Zealand energy supply, but improved when the GDP grew rapidly after 1993. It is influenced, of course, equally by GDP and energy consumption. Fishing has recently replaced metal smelting as the most energy-intensive industry, due to reducing catch volumes and improvements in smelting efficiency. But the sheer volume of transport makes its energy intensity the most important of all. The increasing use of private cars has led to a steady increase in dependence on oil imports, and also in CO2 and other harmful emissions.

The table below gives New Zealand's performance in terms of the 8 indicators: High values of the indicators denote a relatively large "ecological footprint", whereas values of 1 or less show an approach toward sustainability. It can be seen that New Zealand's relatively good position on the world scale (excluding CO2 emissions) is changing for the worse. Government's recent retreat from the principles of the Kyoto Protocol can only entrench this trend.

The HELIO Star, also gives the footprint based on two alternative indicators which better reflect New Zealand energy sustainability. Although virtually all householders are connected to electricity, or have their own generators or renewable electricity systems, high prices are depriving some of reasonable use – indeed, some are disconnected for non-payment. The alternative indicator chosen here is the percentage of income spent on household fuel and power by the lowest income group. The burden of energy industries on the economy is alternatively indicated by the amount of profit going to overseas shareholders in private companies.

Energy Sustainability Indicators



Energy Sustainability Indicators	1 (2004)	I (1990)
1. CO2 emissions	2.20	1.82
2. local pollutants	1.26	1.00
3.access to electricity	0.00	0.00
4. investment – clean energy	0.68	1.00
5. resilience	0.60	0.33
6. burden of public investment	0.01	0.00
7. energy intensity	0.35	0.35
8. renewable	1.03	0.71

New Zealand's "footprint" comes out to be larger in 2004 than in 1990 in both graphs, with the exception of indicator 4, which reflects the economic advantage that was gained by wind generation when gas prices rose.

Sustainability is about investing today's resources for benefits for the very long term. More attractive politically is to degrade natural capital (energy resources and CO2-absorbing capacity of the atmosphere) in pursuit of economic growth and personal wealth. The present government appears to have traded away sustainability in favour of growth and short-term wealth, by abandoning the proposed carbon tax, and subsidising costs and risks of developing gas from small and costly gas fields. Government shows little appetite today for the patient, consultative processes needed to generate short-term benefits from policies directed towards long-term sustainability.

Geographic and Economic Setting

New Zealand comprises two main islands and several smaller ones, with a land area approximately equal to Great Britain or Japan.1 Like Japan, some 40% of New Zealand's area is mountainous. The population of New Zealand was 4.1 million in 2004; the large majority of which live in urban areas. As in other OECD countries, the "baby boom" has left a population bulge which will reach pension age during the two decades after the year 2000.

The New Zealand economy is largely dependent on exports and imports. Agricultural products provide half of New Zealand's $30 billion exports (MAF 2005); which are critically dependent on the availability of transport fuels and reliable rural electricity supply. Forest products, fishing, and tourism are also highly dependent on energy. Aluminium exports worth about $1 billion per year are in effect nearly pure energy.

Twenty five years ago the majority of export goods were destined for the UK. Now Asia accounts for some 30% of New Zealand export earnings. Many of the larger energy businesses, as well as almost all our banks and financial institutions, are now overseas-owned. As profits flow overseas, New Zealand's burden of debt increases. All these factors make New Zealand vulnerable to world economic cycles.

New Zealand was relatively wealthy following World War II, but was hit hard by the OPEC oil crises of the 1970s, as well as the highly protectionist policies of the government. 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. The Government removed subsidies and controls, and restructured its trading departments into corporations. This was designed to allow the forces of enterprise, self-interest and competition to generate efficiency and economic growth.

New Zealand's economic performance declined after the free-market policies began in 1985. It recovered briefly but the stock market crash in 1987 hit the economy hard. In 1992 New Zealand suffered its most prolonged recession since the Second World War. Economic growth increased again from 1994 and unemployment fell, and New Zealand began to run fiscal surpluses. However in 1997 New Zealand's Asian export markets were hit again, by drought and the Asian fiscal crisis.

Economic growth rose to 4-5% after 2001 (Bollard, 2005), leading to an increase in inflationary pressures. World oil prices have risen to equal those of the mid-1980s in terms of real New Zealand dollars (Bumby, 2005). This, together with the importing of capital goods by the business sector, and household spending, has widened the current-account deficit to its highest ever.

Householders are increasingly borrowing against the equity in their homes to finance their spending, and banks are competing to provide the cheapest loans2, and are on average actually reducing their capital worth by 12% of their income per annum - the worst savings performance of any OECD country (Ballard, 2005). Government, by contrast, has maintained fiscal surpluses since 1991, partly through the increased tax take arising from the rapid economic growth. However government spending is set to increase as a result of the generous election promises from the recent election.

The Reserve Bank is required by law to manage the Official Cash Rate to keep inflation below 3% over the medium-term. Inflation exceeded 3% in 2005, partly fuelled by international oil price rises (Reserve Bank, 2005). The Bank intends to raise the Official Cash Rate until its desired squeeze on household spending takes effect. This perversely makes the NZ dollar very attractive to overseas investors, thus driving the exchange rate up.

The cultural impact of the free-market revolution of the mid 1980s has perhaps overshadowed the impact measurable in monetary terms. Today's "children of the free market" know nothing of public policy, or even planning privately for the long term – concepts utterly rejected by their parents. They are mortgaging their houses to buy consumer goods, and their consumption is driving up inflation and therefore wage demands. Employment levels are now the highest in the OECD, but balance of payments as a percentage of GDP are the lowest. The present Labour led Government appears to be preaching (but not practicing) fiscal prudence. It has abandoned the ecologically driven carbon tax. The Opposition party is promoting tax cuts. Sustainability practices appear to be off the political agenda today.

Indicators of sustainable development

Indicator	**Value**
Human Development Index (and ranking)	0.917 in 2001 , 20th in world
Human Poverty Index (and ranking)	19th from top out of 177 countries
Environmental Sustainability Index	60.9, 9th in the OECD
GHG Emissions 2004 from energy sector	30.6 Mt CO2
GDP calendar year 2004	$NZ 139,225 million
GDP per capita 2004	$NZ 34,271

[2] Dominion Post 17 December 2005. At least one bank sets a quota for staff to sell loan products, against which the salary is benchmarked – thus driving them to sell imprudent loans

Sustainable Development Strategy

New Zealand's sustainable development strategy is being treated as a counterbalance to the commercialization of its government trading departments. Following the restructuring of government trading departments from 1985, the first major legislative move to promote sustainability was the Resource Management Act 1992. Its single purpose is "sustainable management of natural and physical resources". But loopholes and conflicting provisions in the Act obscure its priorities and reduce its effectiveness. In particular, fossil fuels and minerals are excluded from the definition of "natural and physical resources", and a 2002 amendment excludes control of CO2 emissions, which were intended to be controlled by a broad carbon tax – but that approach has been recently abandoned.

Sustainable development policy showed much promise in 2002, with an "experimental" approach by Statistics New Zealand (2002). This adapted indicators developed by the United Nations to criteria particularly appropriate to New Zealand. The criteria were based on the Bellagio Principles developed by the International Institute of Sustainable Development in 1997. The report did not use some indicators because of a lack of statistically robust data. The report is seldom if ever quoted in subsequent sustainability consultation documents. In particular the Ministry of Economic Development's consultation documents "Sustainable Energy" does not refer to it.

Central government made a commitment in 2003 to a "Sustainable Development Programme of Action" (DPMC 2003), to strengthen the way government operates by applying a set of guiding objectives and principles across the government sector.3 Four priorities were identified for the first programme of action: water quality and allocation, energy, sustainable cities, and child and youth development.

For energy, the overarching goal is "to ensure the delivery of energy services to all classes of consumer in an efficient, fair, reliable and sustainable manner". The desired outcomes named in the policy relate to energy efficiency, renewable energy and "a secure supply of electricity".

As is characteristic of New Zealand, this commitment was preceded by much lobbying by non-government interests, from both environmental and business groups. The latter have to date had more influence than the environmental NGOs.

The Ministry for the Environment in 2003 developed the "Ecological Footprint" indicator which measures the amount of land appropriated by a person (in a nation, region or city) in supporting their consumption. The Ministry's "ecological footprint calculator" on its website (MFE, 2006a) allows individuals to calculate their personal ecological footprint by estimating their expenditure on household goods and services, energy and transport. Dollar expenditures over very broad categories are taken as a proxy for actual ecological impacts, giving rise to anomalous results in many instances.

Much of the language of the Sustainable Development Programme of Action is repeated in other legislation and regulation - particularly the Government Policy Statement on Electricity which provides the main agenda for the Electricity Commission, formed in 2003 as an industry-led regulator. However the Commission is required only to "have regard" to most of the sustainability issues. In particular, "fair" has given little comfort to small consumers, many of whom have faced electricity price rises of 30% to 40% from 2001 to 2005, while watching the profits of electricity generator-retailers rise significantly.

In late 2004 the Ministry of Economic Development published two Sustainable Energy discussion papers (MED, 2004). The Ministry called for submissions on it, and ran a series of seminars, but no specific outcomes or further processes appear to have been developed from that exercise.

Much more significant was a review in June 2005 (Office of the Convener, Ministerial Group on Climate Change, 2005), of New Zealand's performance relating to its Kyoto greenhouse reduction commitment. A misinterpretation of the Kyoto rules for forest sinks, together with rapid increase in transport and electricity emissions, led to the recognition that instead of being $500M in credit due to our large forest estate, New Zealand is approximately $500M in deficit. This led to a whole-of-government policy review (MFE, 2005), released the week before Christmas 2005.

The policy review notes that two goals were adopted by Government in 2002 - to make significant greenhouse gas reductions on business-as-usual, and to be set towards a permanent downward path of emissions. It says neither was achievable without stringent trade-offs to welfare and growth. In fact the path has led relentlessly upwards, from 60 Mt CO_2 equivalent in 1990 to 75 Mt in 2003.

The review contrasts two approaches to climate change policy. "Top-down mechanisms", the Kyoto mechanisms, are based on quantitative, time-bound emission reduction targets and economically efficient trading to achieve them at lowest cost. "Bottom-up" mechanisms focus on specific policies and measures implemented typically through voluntary measures and business-government partnerships.

These two approaches can be usefully described differently. "Economic mechanisms" implement the principle of "polluter pays" in ways that minimise the overall cost to society. "Technology-based mechanisms" cost society not only the subsidies to favoured technologies themselves, but the costs of lobbying and the spin-offs to business of partnerships with ever-closer relationships to government. The losers will be taxpayers and those businesses left out of the "climate partnerships", in particular many or most energy efficiency and small-scale renewable energy businesses. The eventual loser may be the human species, as the planet adapts in its own way to climate change, possibly shifting the ecological competitive advantage towards other species.

Government has decided to drop the proposed broadly based carbon tax (Parker, 2006). So many exemptions had been granted that officials expected a $15 (NZ)/tonne carbon tax to reduce greenhouse emissions by only 4% in the energy (non-transport) sector, and 1% in the transport sector (MFE, 2005 p. 160). Officials suggested a wide range of other options, all but one of which are related to technology development, which had been strongly promoted locally since the Asia-Pacific Climate Partnership was formed. Further consultation with unspecified “stakeholders” is planned before Government decides, in March, on further policies.

Sustainability is about maintaining ecological and natural resource systems in the long and the very long term. Growth and wealth are about meeting immediate and short-term needs and desires, often at the expense of natural capital. The balance, in the energy sector, between those objectives can be expected to change as the economic and environmental impacts of development become apparent.

New Zealand has unwittingly demonstrated the early effects of the crossover between demand and supply of natural gas. Soaring scarcity rents during the run-down of the Maui field have trickled down the energy supply chain according to the business acumen and market power of each player. Government is not a disinterested observer of the resulting change in the energy landscape. It is more than a little pleased at the boost to renewable energy from the rising prices and risks of natural gas, and it benefits from the dividends from state-owned generator-retailers, as well as the tax take from the rising prices.

The Climate Change Review is about managing the environmental half of the sustainability challenge. Policy today is fragmented due to pressure from different quarters. The hope of a consistent, robust policy applying evenly throughout the economy has receded with the demise of the proposed carbon tax. Worldwide, technology-based climate partnerships will scramble for funding for futuristic technologies such as hydrogen economy, carbon sequestration, and even nuclear power (rejected on political grounds by New Zealand). New Zealand would be better to focus its technology funding on improving current technology, to maximize the multiple benefits particularly from energy efficiency and efficient use of biomass.

Energy Sector

New Zealand’s energy sector faces major challenges with perceived shortages of indigenous energy resources, rising CO_2 emissions, and questions of security of electricity supply. An outline of demand and supply issues has recently been prepared by the Sustainable Energy Forum (Anon, 2005a).

New Zealand’s main indigenous energy resources (MED, 2005c) are hydroelectricity, natural gas, condensate, coal and a small amount of oil. In 2004, hydroelectricity supplied 95 PJ out of a total electricity generation of 148 PJ, whilst wind supplied 1.1% of total generation.

In 2004 natural gas production was 156 PJ, having declined rapidly from 179 PJ in 2003 and 235 PJ in 2002. LPG production was 9 PJ. Some 259 PJ of oil was imported, whilst 58 PJ of oil was produced from New Zealand fields. High-value coal is exported for steel making, while some lower grade coal is imported for electricity generation. Condensate that comes from the gas fields is more valuable as an export product than as a feedstock for New Zealand's refinery.

An early decline in production from the giant offshore Maui gas field had been predicted by some in 1985, but denied by the field's operators until 2001. The operators then moved to terminate the Maui contract several years earlier than planned, enabling them to raise the wholesale price of gas from the field early. Wholesale gas prices rose from around $2.50/GJ in 2000 to around $6/GJ. This has helped to drive investment in wind farms, the output of which rose from 0.004 PJ in 1996 to 1.28 PJ (335 GWh) in 2004. Government is now stimulating gas exploration effort through concessional royalty and taxation regimes. Only modest discoveries have been achieved to date.

Electricity is used extensively for home heating and water heating, as well as lighting, motors, electronics and other applications. Firewood, both purchased and gathered, is now believed to account for some 15% of domestic energy nationwide, three times as much as had been believed previously (Isaacs et. al, 2005, p. 51). Natural gas is reticulated to main population centres in the North Island. LPG is used for home heating and some commercial and industrial use, and is returning to favour as a vehicle fuel. LPG is reticulated in small areas of the South Island.

Energy-intensive industries include an aluminium smelter that uses a constant 600 MW, pulp, paper and fibreboard, and dairy processing. The burgeoning dairy industry now exports $6 billion per year, 20% by value of merchandise exports, and contributes 7% of GDP (MAF, 2005, p. 20). Its peak electricity demand on farms is considered to be in excess of 260 MW. Counting resistance and power factor losses, dairy farming accounts for 9% of New Zealand's electricity demand at peak times (Souness, 2005). Most of the new land for dairying comes from the clearing of plantation forests, thus turning a presumed carbon sink into a generator of methane emissions.

Until two decades ago, electricity was generated and transmitted by a government owned electricity department. A levy of 25%, or sometimes more, on the bulk electricity tariff provided the money to expand the electricity system. Government was also heavily involved in coal and gas production. The Ministry of Energy published annual energy plans from 1981 to 1985, giving information on resources of fossil fuels and sustainable energy resources, and government's plans for development.

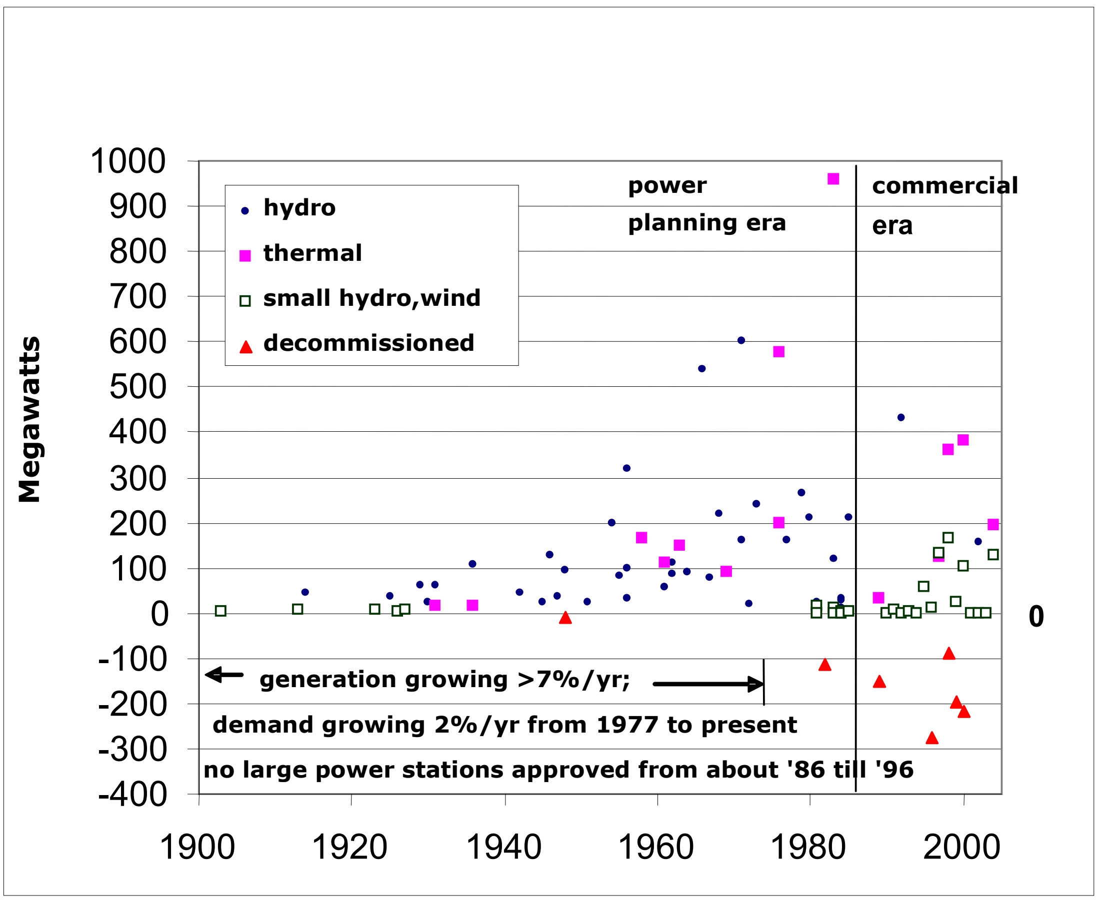
The public sector was drastically restructured from 1984 onwards (MED 2006). All government trading departments were converted to state-owned commercially-driven corporations. The Ministry of Energy was abolished in 1989. However, there remains a Minister of Energy, who is advised by officials in the Ministry of Economic Development.

The contrast between the era of power planning and that of commercially driven electricity investment is graphically shown in Figure 1. Hydro workforces were built up in both islands, and power stations were built sometimes before they were needed. The North Island workforce built a 400 MW base load power station followed by a 1000 MW one, and were expecting to build another. Growth in generation capacity outstripped growth in demand, leading to a capacity surplus of up to 40% by the mid 1980s.

Restructuring spelled the end of new builds for a decade; the first large private investments, of combined cycle power stations, were commissioned in 1997 and 1998. Small hydro and geothermal power stations built mostly by local power companies filled the gap before 1997.

Under commercial incentives several power stations that were run too seldom to justify remaining on the books were decommissioned. This helped reduce electricity surpluses, and drove wholesale power prices up. They were replaced by much more efficient combined-cycle gas-fired generation.

Figure 1: Power Station Capacity



Energy Data File table G.7a

In 1992 the local power distributors were restructured into companies. Government intended these to be privatized rapidly, and although a majority of communities campaigned successfully to keep them in public ownership, some were sold to international investors. Asset valuations rose because the Government-mandated methodology was based on replacement costs not historic costs. Prices rose to give "adequate" rates of return on the revalued assets. Prices charged by private companies rose still more, because mergers and takeovers were giving market values even higher than the new valuations.

Both private and public energy businesses are highly risk-averse, as fits their commercial objectives. Investment in power generation became sporadic, and investment in transmission and distribution almost stopped. Inevitably there were network failures and electricity shortages. The public was then exhorted to "save electricity", yet there was little if any assistance for energy efficiency. In fact the incentives are perverse – shortages of energy drive high prices and profits, whereas energy efficiency reduces sales and therefore profits.4

Legislation in 1998 required local power companies to sell off either their retail and generation businesses or their local networks. Network values rose yet again. Amended legislation in 2000 allowed network owners to own renewable generating plants, but it was too late to prevent the "fire sales" of all their small hydro power stations and wind farms (see discussion under indicator 4) to the large generating companies who had also purchased almost all the retail customers formerly served by the local power companies.

A competitive wholesale electricity market (Electricity Commission, 2005), a mandatory gross pool with a separate nodal price for each of the 244 nodes, was developed by EMCO (now M-co), a company originally owned by the power companies, later sold to a South African company. The wholesale electricity market was launched in 1996. It is only "half a market", because the demand side cannot effectively participate. There is no day-ahead market. Contracts are traded on an over-the counter market, which is very illiquid (Hansen, 2004). Government requires the Electricity Commission to contract for reserve energy in case of hydro shortages, effectively capping the spot price at 20c/kWh. At that price it is usually not worth making arrangements for consumers to sell back reductions in demand.

In 1998, market participants began to design ways to buy and sell security of transmission services, but financial transmission rights are not yet implemented. Industry parties recently planned a sale of M-co to Transpower, but the Commerce Commission disallowed it, perhaps recognizing the blurring the distinction between monopoly and competitive activities. Transmission pricing methodology must be approved by the Electricity Commission – at present pricing for the long-distance component of transmission is "postage stamp" except for the use of the DC link that joins the two islands. This means that generators effectively transport electricity anywhere in the country at the same price, save for the Cook Strait crossing – and even that pricing is being challenged. Thus the detailed and precise

[4] The Greenhouse review (MFE 2005) notes in four separate footnotes, p279 ff, the loss of profitability resulting from electricity savings.

location price signal for gigawatt-hours of electricity is accompanied by a less discriminating signal for megawatts of power.

In 2000 Government carried out a major review of the electricity system, which concluded that self-regulation by the industry players would be more effective than relying on a regulator MED, 2000). In winter 2001 and autumn 2003, shortages of hydro energy sent spot prices soaring, and government campaigned for all consumers to save electricity (MED, 2001).

Coincidentally in 2003 the participants in the system of industry self-regulation failed to agree on a governance system, so as provided for in legislation, Government set up the Electricity Commission. This has conflicting duties including administration and regulation of the electricity market rules, contracting for "reserve generation" in the case of hydro shortages, deciding whether to approve major transmission upgrades or rely on alternatives, and administration of "electricity efficiency' programmes. These mixed agendas have given rise to endless debate on how the functions should be prioritised and carried out.

The Commission is funded by a levy paid by all electricity market participants. Its advisory groups are made up of sector representatives, except for the Retail Market Advisory Group which has a minority of small-consumer and small-business representatives. That group has been instructed to leave the detail to the experts, and focus only on high-level issues. It is easy to assume that the Commission, as it assumes the role of a regulator, is independent (OECD/IEA, 2005, p. 60). But it seeks submissions on its work programme priorities only from the market participants that fund it (Electricity Commission, 2005b).

The Energy Efficiency and Conservation Authority (EECA) was established in 1992 as a government agency to implement practical measures for achieving greater energy efficiency in New Zealand. Its brief was soon extended to the promotion of new renewable energy resources. It established a voluntary energy-efficiency programme for companies, now involving some 700 businesses. For residential energy efficiency it distributed $9M over five years to supply low-cost energy efficiency improvements in some 48,000 homes. Many of these programmes were operated by local power companies or the trusts that owned the companies, and separate local trusts supporting energy efficiency have also been formed.

In 2000 EECA was given legal status as a Crown Entity, and its funding increased to $46M for a 5-year period. In 2001 its National Energy Efficiency and Conservation Strategy set targets: to improve New Zealand's energy efficiency by 20% between 2002 and 2012, and to acquire 30 PJ more annual renewable energy supply. In its first three years, it has failed to achieve noticeable improvement in end-use efficiency, and the 4 PJ of new renewable energy has been overshadowed by the additional 46 PJ of fossil fuel energy, of which nearly 30 PJ was transport fuels.5

EECA's effectiveness appears to have been compromised by overlapping responsibilities of the Electricity Commission and government departments. Policy on energy efficiency is developed by the Ministry for the Environment – policy on "electricity efficiency" has been taken over by the Electricity Commission.

Development of new renewable electricity generation has always been keenly supported by some local power companies. Between 1996 and 1999, they installed enough wind power, geothermal, and landfill gas generation to meet 2/3 of the electricity demand growth in that time. But legislation in 1998 required them to sell off either their generation-retail businesses or their lines networks. Most kept their networks and sold off their customer bases and any generators. This led to a new vertical integration of generating and retail, and also stifled local involvement in generation. That restriction was partly lifted recently, and one network company now has resource consent to build a large wind farm.

Energy research and development now receives public-good funding of approximately $4.5M p.a., down from $6M in 2000, and now only 1% of the public-good research funding. In earlier years research on petroleum and coal resources had received by far the greatest share of energy funding.

The future of New Zealand's primary energy supply is very uncertain. A major gas find would confirm a government-supported return to large-scale thermal generation – Government has already underwritten the risk of gas supply for a new 400 MW combined cycle gas plant. Importing of LNG is assumed to be the backup if insufficient new gas resources are found. But since the Maui discovery of 1973, only small gas fields have been discovered, and their flow rates are very slow compared to Maui. At today's wholesale gas prices, wind generation is fully competitive with new combined-cycle gas generation.

A $1.2 billion hydro proposal in the South Island was abandoned because of public pressure and geotechnical risks. More recently the invasive alga Didymo (Didymosphenia geminata) has threatened the major hydro dams upstream of the proposed development. Talk of giant lignite power projects in the south of the South Island has been largely replaced by the generating companies' new enthusiasm for wind generation. What is most disappointing is the continuing failure to integrate energy efficiency into planning for both supply and demand, particularly in small-scale applications.

Commercialisation (not privatisation) of electricity and other formerly state-owned energy businesses has undoubtedly reduced the worst excesses of energy development up to the present time. It stifled the development of "Think Big" energy projects in which government took all the risks. Major supply projects were delayed until demand was confirmed - usually tied up under contract. Energy prices have risen progressively following restructuring, to pay director's fees, to support expensive merger and takeover activity, and as a direct result of monopoly and oligopoly opportunities. This has caused grief to energy-intensive businesses and many residential consumers, but not massive disruption. On the whole, the higher prices have supported new renewable energy, and could also encourage energy efficiency investment – but only if major barriers can be overcome.

Time is running out for the small-scale alternatives, which require time and progressive development to reach their potential. At present the large electricity retailer-generators are building most of the new wind farms, and the state-owned solid energy company has picked up most of the business in manufacturing wood pellets and fire logs, especially in the very large South Island market. Postage-stamp transmission pricing promotes building of generation where resources are concentrated, remote from load. "Alternatives" remain supply-side not consumer-focussed, and driven by the companies' focus on shareholder value not sustainability.

In the author's opinion, a return to central planning, as called for by many engineering interests, would be retrograde. Central planning favours large projects, whereas the small-scale sustainable alternatives require a fair market and less-distorted pricing of resources and the environment, so that the myriad of small decisions reflect real costs. Small-scale energy providers and consumers can only get a fair share of "subsidies and "measures", but will achieve that only if they are allowed full participation in the design of policies and regulations in the energy sector.

Large market players today dominate not only the regulatory systems but also relationships with government. Proposed changes to the Resource Management Act, for example, would treat transmission lines and possibly even power stations as part of New Zealand's "natural and physical resources", to be provided for as part of national policy. This, like transmission pricing discussed above, treats infrastructure as a good in itself, not as a means for providing services to consumers. Consumers pay for the infrastructure whether or not they want the services. And the "market' is treated as a virtuous end in itself, not a neutral means, amongst other means, for making decisions on consumption and investment.

Consumer spokespeople cannot engage in the highly technical consultation required by the Electricity Commission and the Commerce Commission; they retreat to their usual demands for lower energy prices (not lower bills). Government has shown little appreciation of the flaws in the present pricing and regulatory systems (which deliver attractive returns from its state owned companies), much less the flawed governance structures. Until this changes, the engineering culture has the potential to drive the energy sector further into economic as well as environmental unsustainability.

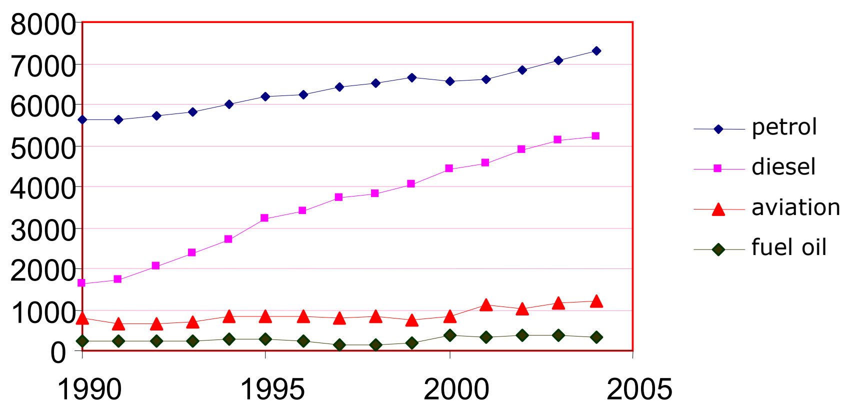
Environmental Sustainability

Indicator 1: Per Capita Energy Sector Carbon Dioxide Emissions

New Zealand's reported carbon dioxide emissions (from the energy sector) amounted to 30,589 kT C02 in 2004 (MED 2004, p iii-iv.). This sector includes thermal electricity generation, domestic (not international) transport, processing including aluminium, steel, cement and chemicals, and use of fossil fuels by other sectors. Methane emissions in 2004 added a further 794 kT CO_2 equivalent (using the conventional 100-year basis), and nitrous oxide emissions, 265 kT CO_2 equivalent. The annual growth rate of CO_2 emissions from the energy sector between 1990 and 2004 was 2.1% per year.
In 2003, carbon dioxide from energy consumption and transformation, excluding transport, generated 10.1 percent of New Zealand's gross greenhouse gas emissions (MFE 2005, p 62). Transport emissions were greater, at 18.3 percent of gross greenhouse emissions. Transport emissions have grown by 3.7% per year since 1990, and road transport accounted for 89% of that growth.

The graph shows reported emissions from each of the types of transport fuels (MED 2004, p. 59). Demand for diesel has risen at a far greater rate than other reported transport fuels, which reflects directly on the emissions.

Figure 2: CO_2 Emissions from Transport Kilotones CO_2

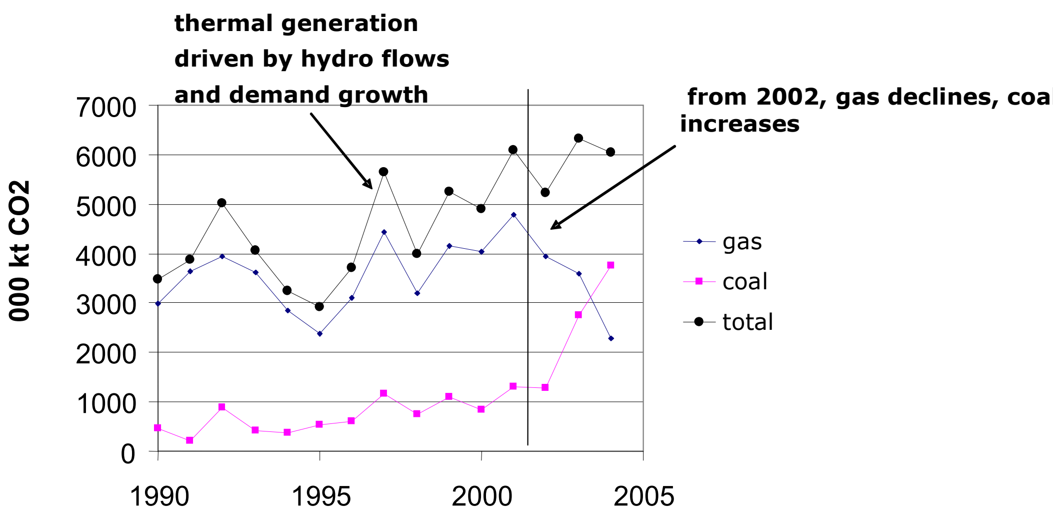


Until 1989, rail freight was protected by a prohibition of road freight transport over distances greater than 150 km. Trucks up to 44 tonnes have been allowed on roads since 1989. In 2003, 85% of the freight payload was carried by trucks weighing more than 10 tonne and travelling more than 20,000 kilometres per year.

By far the greatest variation in reported energy related CO2 emissions in different years comes from electricity generation, because hydro energy must be supplemented in dry years by thermal generation. Until recently, gas-fired generation took up most of the variation, but as production from the Maui field has declined rapidly since 2001, much of the variation is being taken up by coal. The gas fields that will replace Maui have so far proved to be much smaller and less free-flowing, so imported coal could be expected to form much of the supplementary generation in years of poor hydro flows.

The graph shows CO2 emissions from both coal and gas-fired generation; there was a rising trend of use of both fuels from 1990 through 2003. In the subsequent three years coal fired electricity generation grew rapidly whilst gas fired generation declined somewhat less slowly, leading to total emissions rising at a somewhat greater rate than before.

Figure 3: CO2 Emissions, Thermal Electricity

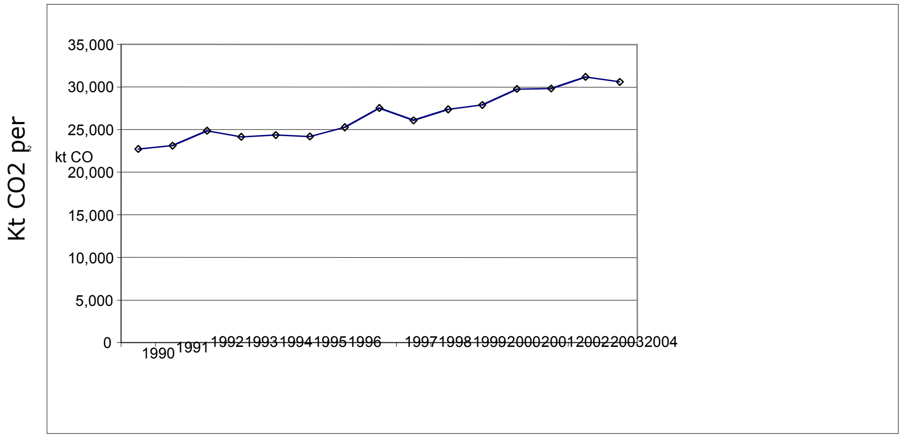


Geothermal energy is not free of greenhouse gas emissions - it releases CO2 and methane dissolved in the geothermal fluids at rates ranging from 0.62 kT CO2 equivalent for Wairakei, to 15.05 kT/CO2 equivalent for Kawerau6. It appears that the more recently developed fields are emitting the most gases, with methane outweighing CO2 by almost ten to one in most cases.

New Zealand's other greenhouse gas emissions are high in comparison to those of other countries. They come mainly from the agricultural sector, as methane from anaerobic digestion in ruminant livestock, and nitrous oxide from application of urea to soils. The rapid growth of dairying has kept pace with the increase in fossil fuel demand, so the proportion of agricultural greenhouse emissions has remained fairly constant in recent years.

Figure 4: Energy CO2 Emissions Per Capita

[6] CO2 and CH4 emissions data from MED (2005 p. 87, generation data from Electricity Commission Centralised Data Set, Brian Kirtlan, pers. comm..



Data source: MED 2005, Energy Greenhouse Gas Emissions 1990-2004.

Indicator Calculation

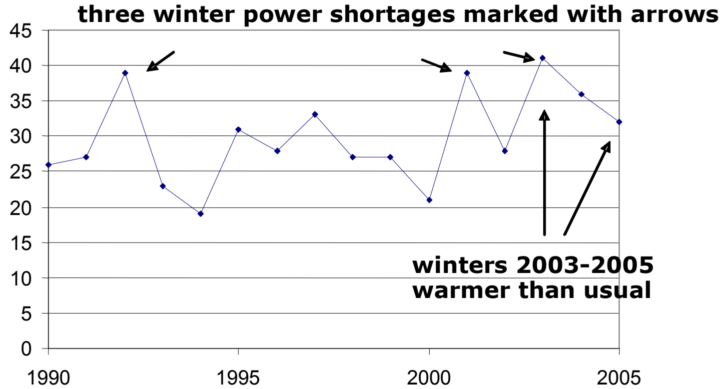
The value 1 of this indicator is the global average of emissions per capita in 1990 of carbon dioxide expressed as carbon, namely 1130 kgC/cap. The value 0 is 30% of that value, or 339 kgC/cap. The indicator value in 2004 comes to 2.202, a worse result than 1.80 in 1990.

Indicator 2: Local Environmental Impacts from Energy Sector

Local environmental impacts from New Zealand's energy production include the loss of environmental and cultural values from the damming of almost ever major river system and many smaller ones. Low lake or river levels, variations in river flows, and occasional serious flooding are matters of continuing concern. Past geothermal power proposals have also given rise to major cultural concerns, but consultation with Maori has overcome concerns in most recent projects. Cooling water discharged from a 1,000 MW thermal power station raises river temperatures and generation is constrained in summer months. Local impacts from onshore gas and oil production are generally well contained, but development of coal mines for export is expected to cause some severe local impacts.

The environmental impacts from energy use affect many more people in New Zealand than those from energy production, because of its largely urban population. A recent study commissioned by the Ministry of Transport suggests that as many people are killed by fine particles in air, as are killed in road accidents (MoT, 2005). In 2005 a National Environmental Standard (NES) for air quality came into force, banning polluting activities such as burning at landfills, and setting standards for air quality for fine particles (PM10) and four other air pollutants. Local authorities are expected to set bylaws as necessary to ensure the standards are met.

Figure 5: Number of Days WHO Air Quality Guideline Exceeded in Christchurch



Christchurch and other cities and towns in the east of the South Island suffer very high air pollution levels on still winter mornings. The regional council now prohibits open fires and requires closed wood burners to meet a stringent emissions standard of 1.5grams of fine particles per kg fuel burnt. A proposal in 2002 to progressively remove even efficient wood burners from the Christchurch clean air zone was vigorously opposed, as wood is substantially cheaper than any other form of home heating (other than coal) in most South Island districts. The new NES reinforces the pressure for a ban.

The cost-benefit analysis of reducing wood burning failed to take account of the fact that many houses are inadequately heated. Economic calculations were based on household electricity prices of 2001, which have since risen by up to 40% on average. Systematic studies have not been done to separate the health effects of smoke particles from those of indoor air pollution from LPG heating and cold houses. A third of New Zealand households use portable LPG heaters, which discharge combustion pollutants directly into living areas, causing dampness which is considered an contributing factor to health problems such as asthma, and can also damage the structure and contents of houses.

Central government strongly advocates a strict application of the standards which would force a large-scale removal of wood burners in affected cities and towns. Some Christchurch people advocate banning smoke emissions instead of the burners themselves. The regional council is subsidising the replacement of wood burners – mostly taken up by heat pumps. These, though around three times as efficient as ordinary electric heaters, will still add to peak electricity demand, which in turn is driving very costly investment in new transmission and distribution assets.

Indicator Calculation
The indicator we choose for local pollution is days in a year when the WHO standard for PM10 in Christchurch has been exceeded - not emissions of PM10 per capita. Its value in 2004 was 1.256, indicating a slightly worse impact than the reference value of 1.000 in 1990.

Social Sustainability

Indicator 3: Households with Access to Electricity

All New Zealand's houses use electricity, with the possible exception of a handful of remote rural households. Households not connected to the grid almost invariably generate their own electricity, usually from diesel generators but increasingly from micro-hydro dams, wind generators or photovoltaic cells, or a combination of these.

Rural reticulation was subsidised between 1945 and 1990, from a small levy on the revenues of local power companies. Some of the later schemes were very ambitious and would be considered entirely uneconomic today. Electricity network companies are required to maintain uneconomic lines until 2013, but it is considered likely that in some of these areas, prices will rise so high that community or private generation will be preferred. For practical purpose electricity supply is universal, so the HELIO indicator as defined has the value of 0.

One major access issue in New Zealand is temporary loss of supply, either due to faults in the network, or because power station failure or shortage of hydro energy requires cutbacks in consumption. In February 1998 (in the NZ summer), the entire Auckland central business district lost electricity supply for five weeks as four underground cables failed in quick succession. Remaining smaller transmission lines together with diesel generators in the streets provided partial supplies for a few hours per day, but many businesses had to close down. The power company had been held up by the business community as an example of aggressive and successful corporatisation policies7, but its focus on management of financial rather than physical assets had allowed managers to ignore the signs of incipient failure of the cables.

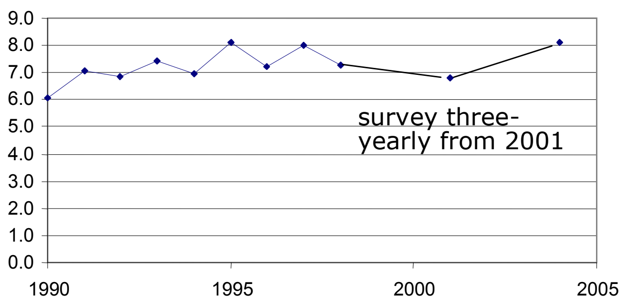
Security of electricity supply is now the responsibility of the Electricity Commission. Major transmission projects cannot be approved until the Commission considers whether "alternatives" including energy efficiency improvements are likely to eventuate. This "Grid Investment Test" is recognised as favouring transmission investment over energy efficiency investment, a problem which is unresolved to date.

Another major security issue is the lack of inflows to the hydro lakes. In winter 2001 and autumn 2003, hydro shortages led to spot market prices to 100c/kWh for brief periods, and 25-50 c/kWh for days at a time. Spot prices were typically between 2-5c/kWh before then.. After each shortage event, generators drove hard bargains for long term electricity prices, thus locking in the profitability driven by shortage events. On average, residential electricity prices have risen by 40% since 2001, causing hardship for consumers on fixed incomes.

Consumer representatives have complained strongly and in the end successfully about the ever-increasing profits of the retailer-generators, and the Commerce Commission has begun an inquiry into retail and wholesale electricity prices (Business New Zealand, 2005). However there is no legal or regulatory bar to the companies raising the prices, only vague and often contradictory statements in the Government Policy statement on Electricity.

The indicator of "access to electricity" most relevant to New Zealand is a measure of energy poverty - the proportion of household income of low-income earners that is spent on energy, which includes gas, wood and coal. It is power bills, not power prices, that matter, and these ought to be kept in check through energy efficiency investments and sound demand management, even as prices rise. Ideally, intelligent meters should be used, that inform householders of real-time prices, facilitating tariffs that reward price-responsive demand, allowing consumers to receive accurate billing information, more so than bi-monthly or even quarterly electricity readings, improving cash-flow, the lifeblood of small business and residential consumers alike. These are being implemented several countries including Norway and Australia. In Sydney, 25,000 customers on time-of-use metering are reported to have saved an average of 10% on their power bills, and up to 30%. However customers with high air-conditioning loads are paying more. The supplier, Energy Australia, is hoping to cut its ballooning capital works programme by moving away from a flat tariff, and intends to pass savings onto consumers (Frew, 2006). The Electricity Commission has a project on load management, though domestic consumer representatives have played little part to date.

Figure 6: Lowest Decile Income Group: percentage income spent on fuel and power



We define "low income" as those in the lowest decile income bracket. In 2004 the median income in that group was 88% of the upper bound of the bracket; as an approximation we apply the same correction for other years.

Indicator Calculation
The value of our alternative indicator was 6.1% in 1990 and 8.1% in 2004. It is not desirable for that value to go to zero, or even a value so low as to require subsidy from taxpayers. The goal chosen here is 5%, a reasonable value even for low-income earners, and likely to be achievable even as energy prices rise.

Indicator 4: Investment in Clean Energy

This indicator measures the ratio between investment in "clean energy" and total investment in the energy sector, for each year. The data requirements for a full series are very large, so the calculations have been done for 1990 and 2004 only.

"Clean energy" is defined for this report as including hydro generation from stations less than 10 MW, geothermal power stations less than 100 MW, and new renewable energy sources. Actually, small hydro is not necessarily "clean" – most stations built under a 1977 subsidy were extremely costly, and two canal schemes suffered major collapse with flooding of adjacent farmland. (Rennie, 1989). The subsidy was removed after only a few years.

All wind generation will be denoted here as "clean energy", though it does have significant environmental impact when near urban areas. A wind farm near Wellington has recently gained its resource consent; it is expected to comprise 70 turbines of 3 MW each, some of them less than 1 km from houses, with over 100 houses affected along two rural roads.

The employment opportunities in large-scale wind generation are little better than those in large-scale hydro. At present a high exchange rate works against New Zealand wind turbine manufacturers, whilst large European turbines are imported under favourable contracts. A publicly listed New Zealand wind turbine manufacturer has developed and tested two-bladed turbines with synchronous generator, giving the potential to generate New Zealand employment. Market rules now under negotiation could allow owners of synchronous generators to profit from "ancillary services" related to power quality, as well as energy generation.

During the mid 1990s small-scale renewable electricity generation was on track to become very significant in meeting the still-modest growth in demand. Some 350 MW of such power stations were built by local power companies during this brief period when there appeared to be an imminent shortfall of generation.

The commissioning of almost 1000 MW of large-scale gas-fired generation after 1998 kept wholesale electricity prices low - some 2.5-5c/kWh at most times, in effect delaying the planned expansion of two wind farms, as described in Energy Sector section (page: 11).

Clean energy also includes the conversion of industrial wastes, particularly forestry wastes, to heat. This is increasing progressively, and now produces a large proportion of New Zealand's renewable energy other than hydro and geothermal.

Domestic fires remain an important energy source, but at present are the largest contributor to particulate air pollution in three cities and 26 towns, most of them in the South Island which are subject to temperature inversions in winter. We would count only pellet heaters and very-low emission wood burners as contributing "clean energy".

Energy efficiency investment is also counted as "clean energy", and has the potential to substitute for a great deal of power generation that is now being planned. Here we describe four current initiatives.

EECA's budget of $11M is entirely directed to energy efficiency and renewable energy (EECA, 2005). Its main programmes in 2004 were encouraging energy efficiency in energy-intensive industry, specific measures in transport energy including fleet management by businesses. It expects to leverage other expenditure, of twice to four times as much.

In 2004 EECA's programme of household retrofits for energy efficiency were applied to 3,400 low-income households; at a typical cost of $2,000 per household this amounted to $7M invested. Its solar water heating programme led to installation of 1,700 systems; assuming a per-system cost of $4,000, this was an investment of $7M. EECA's programmes for commercial and especially industrial energy savings were not accounted for similarly, presumably for reasons of commercial secrecy, but here we assume that a similar amount was invested in the commercial sector, and that industrial energy efficiency and renewable energy programmes have been disclosed in annual reports.

Ministry for the Environment has budgeted $50,000 per year for its "warm homes" project to reduce air pollution from wood burning through home insulation and replacing old wood burners by other heating appliances (MFE, 2006). All these developments are employment-intensive, but are small in comparison with the continuing capital investment in inefficient energy-using equipment in all sectors - household, commercial and industrial.

Environment Canterbury (2005) has budgeted $52M over 12 years to subsidise clean (mostly electric) heating to replace old log burners, and to insulate houses, to be spent over 12 years; this will account on average for about ¼ the cost of an installation, but low income earners will be fully subsidised. The uptake of replacement burners has been 3,675 in two years, the majority of which have been to low-income households and therefore fully assisted for insulation also. Assuming a total value of $4,000 invested per household, and assuming 2,000 houses, it is estimated that $8M invested in 2004.

The Electricity Commission (2005) has just released a consultation paper on its $2M plan to subsidise compact fluorescent bulbs for household use, aiming to see 3.5 million bulbs (mostly 20 Watt), expecting to save 300 GWh of electricity per year and 200 MW during winter demand peaks. For the subsidy of $2M the Commission expects a total public/ private investment of

$26M, including the cost of the CFLs and marketing cost. Householders are expected to save $500M including saved electricity and reduced expenditure on replacing tungsten bulbs. The bulbs will be required to have a power factor of 0.9 or better, and very low harmonics – earlier compact fluorescent lamps on the New Zealand market had power factors around 0.5 and disturbed radios and electronic equipment.

In contrast to the above, "conventional energy" is taken to include oil, gas and coal production, and large hydro. Detailed records of expenditure on both exploration and development of oil and gas fields are kept by the Crown Minerals department of the Ministry of Commerce, as part of the petroleum licensing regime. In 2000-2004, expenditure on offshore exploration drilling and seismic analysis averaged $100M per year, and another $100M was spent on onshore exploration. Drilling of production wells offshore cost $110M per year, and onshore production wells, $72M. No clear trend of expenditure was evident over those years.

Offshore drilling in 1990 was also substantial, with 6 wells drilled onshore and 6 drilled offshore. Expenditure data on these is not available, but by comparing metres drilled and number of wells with the more recent data, expenditure is estimated at $360M.

Similar data are not available for expenditure on coal mines. Solid Energy, a State Owned Enterprise, produces about 80% of New Zealand's coal, and its 2004 Statement of Cash Flow indicates $30M cash to purchase plant, property and equipment. The book value of all its mines in production is $24M; that of mines in development is $30M.

Transmission and distribution investment are in the nature of "conventional" energy, but equally important for small-scale and renewable energy as for large power stations. .Therefore network investment will not be counted for the HELIO indicator.

The 1990 investment in small-scale renewable energy was almost non-existent. Local power companies were busy learning how to be "successful businesses" and no longer focussed on increasing local generation. A few maintained advisory services for householders, but no significant investment in energy efficiency resulted. One small-scale renewable energy development led on from a research grant to develop the manufacture of firelogs from sawdust and other sawmill wastes; actual investment in this project in 1990 is estimated at $0.1M.

Transmission and distribution investment are very important. Lines were greatly overbuilt in the 1980s, so probably no significant capital investment was made in 1990. Energy efficiency usually is neutral or reduces pressure on networks, thus network investment would be attributable to "unclean" energy – large scale remote generation. However in New Zealand, this is more than offset by the ability of networks to smooth outs intermittent generation from wind farms. Since the two effects tend to cancel each other, network investment will not be counted for the HELIO indicator.

Indicator Calculation
The HELIO indicator value of 0.54 in 2004 is excellent compared with previous years, reflecting the commissioning of 127 MW of wind generation.

Economic Sustainability

Indicator 5: Resilience: Energy Trade

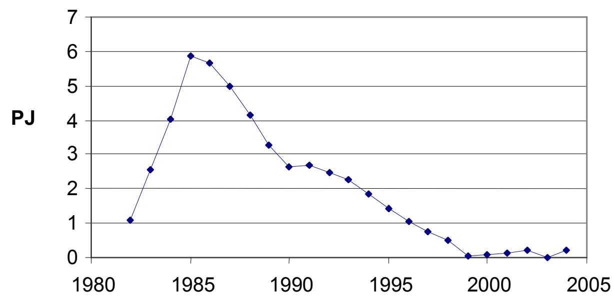
The HELIO indicator for "resilience" for oil importing countries is conceived on the basis that importing makes countries economically vulnerable to international oil price hikes. The indicator generalizes this dependence to include imports of all fossil fuels.

In New Zealand, imports of oil are the best single indicator of resilience, as only transport fuels are severely affected by international energy prices. Oil self-sufficiency peaked at 45% when an oil reservoir in the Maui field was tapped in 1997, but has dropped to 15% of total transport fuel in 2004 (Bumby, 2005). During the 1970s oil price shocks oil made up 20% of New Zealand's import bill; this dropped to around 5% as New Zealand production rose and prices fell, but has returned to 20% in 2004. Indigenous oil is priced at international oil prices, and ownership of the indigenous resource is almost entirely foreign. Therefore New Zealand's ratio of imported oil to total oil consumption – the closest approximation to a HELIO indicator – still says little about New Zealand energy prices.

Coal is in abundant supply - it is carbon emissions rather than ability to import or export that will determine what role coal will play in New Zealand's energy mix. Gas is not currently abundant, as the Maui field has declined suddenly, as predicted in 2002 – indeed New Zealand is in the throes of "peak gas" already. But New Zealand's gas is not appropriate as a HELIO indicator of resilience, as gas is not currently imported, so comparisons between 1990 and the present are not meaningful. The Maui field recently provided most of New Zealand's indigenous oil, as a separate offshore platform tapped an oil-rich part of the field in 1996but that source is now nearly depleted.

"Resilience", in its ordinary meaning, suffers when there is excessive dependence on a single source of supply, whether it be natural gas, OPEC oil, or local rainfall in the case of hydro generation. Renewable energy is of course not subject to direct fuel price hikes. This gives it a commercial advantage, and in fact with rapid gas price rises, development of wind-generated electricity is surging ahead. This helps to improve the resilience of lectricity supply.

Figure 7: CNG Sales, PJ Per Year



New Zealand wasted its opportunity to develop a truly resilient transport sector. Onshore gas, then offshore gas, was developed just in time to offset the economic impact of the first OPEC oil crisis. Gas fields of about 1,000 PJ and 5,000 PJ were commissioned in 1973 and 1979 respectively. It was easy to believe that other large discoveries would follow - but after 30 years of further exploration, only another 140 PJ of recoverable gas reserves have been developed, with a further approximately 1360 PJ now considered commercially attractive at forecasted future gas prices.

From 1979 through to 1984, the government promoted compressed natural gas (CNG) and LPG (liquefied petroleum gas) as a move towards self-sufficiency in vehicle fuels. Subsidies paid half the cost of installing CNG filling stations and a proportion of the cost of converting cars to CNG. LPG was promoted for use in areas not reticulated for natural gas. A network of almost 300 CNG filling stations ensured wide availability, and about 5% of cars were converted at the peak.i The technology to convert large truck engines to CNG was developed and commercialised. But in 1985, Government according to its new philosophy removed the subsidies "so the industry could stand on its own feet". Car conversions slowed to a trickle thereafter, and CNG filling stations gradually lost business and closed down. Over $20M of government funds, and several times that amount of private investment in CNG were discarded, as CNG equipment was sold at salvage value, mostly to Pakistan, or simply thrown away. Sales of gas for CNG peaked at 5.85 PJ in 1987, and by 2000 had declined to 0.073 PJ/year.

A gas field currently in development, Pohokura, is assessed as a quarter the size of Maui. If dedicated to New Zealand use instead of export industries, it could be the basis for continuing supply for 20 to 30 years, augmented by the remaining gas in existing fields, and gas associated with oil fields that would continue to be discovered and developed in the absence of subsidies. This could markedly improve New Zealand' resilience and enable a transition to fully renewable biogas supply from wastes and low-cost biomass resources. However the government consistently supports oil and gas exploration hoping to find enough resources to maintain New Zealand's international position a low-price energy regime.

Pohokura cannot vary its flow easily from month to month to make up for seasonal shortages of hydroelectricity. Coal, some of it imported, is now relied on both in dry years and to meet electricity demand growth. Greenhouse gas emissions are increasing accordingly, as discussed in Indicator 1. That does not contribute positively to resilience.

Biomass energy could be more than adequate to supplement hydro energy in dry years (see discussion, indicator 4). New Zealand's remaining gas could be increasingly shifted to highly efficient uses, ranging from CNG for vehicles, to cogeneration of heat and electricity, to fuel cells. This would be a true sustainable development path, using competition in fact, not rhetoric, to keep prices close to costs. Prices would be higher but not a lot higher than current prices. But true competition is anathema to the private owners of the electricity system - and their bankers want firm contracts for both fuel supply and sales of power for any new power station. The government, which owns the majority of hydro generation, appears more than happy to take its share of the higher profits from today's deregulated industry.

It is counterintuitive, but undoubtedly true, that New Zealand could become more resilient - and possibly even lessen the expected electricity price hikes - by abandoning all promotion of petroleum exploration, and relying on the existing smaller fields alone to provide the bridge from fossil fuels to truly sustainable energy.

Resilience in a physical sense requires not only adequate primary resources, but reliability of the systems that convert them into consumer energy. In this respect, the commercialisation of formerly publicly-owned local energy businesses has raised serious concerns. The failure of the Auckland power cables has already been noted (Indicator 3).

These physical aspects of resilience are impossible to quantify; they have more to do with business planning and geological prospectivity than with trends in production of already-developed resources. As a guide to the financial impact of imported energy, the subsequent indicator, "burden of investment" actually says much about resilience.

Indicator Calculation
But the HELIO indicator does give a useful picture of trends in self-sufficiency in fossil fuel, and is reported here as defined in the brief: 0.60 in 2004, a decline in resilience compared to 0.33 in 1990.

Indicator 6: Burden of Public Energy Investments

The indicator defined by HELIO is based on the premise that government investment in energy supply displaces higher priority government expenditure, such as health and social welfare. This premise does not apply in the deregulated New Zealand energy market. Energy assets owned by central or local government are not currently a burden as they can often extract high profits.

New Zealand's burden of energy investments is perhaps better indicated by the flow offshore of profits and capital transfers from partly- or fully-foreign owned energy supply businesses. If foreign-owned businesses used their capital more efficiently than New Zealand-owned ones, there would be less concern. But for those assets that were sold, the specifics of asset sales, enabled by weak regulation, have allowed their overseas owners to extract significant profit and capital gain.

A comprehensive analysis of the behaviour and financial performance of Contact Energy, a company split off from ECNZ, and privatised, was made by the Campaign Against Foreign Control in Aotearoa (CAFCA 2005).

Contact was formed in 1996, and borrowed to pay the Crown some $1.6 billion for its assets and liabilities. Its 1998 annual report reveals an investment of $100M in Australian generation assets. Contact sold a 40% share in 1999 to a "cornerstone shareholder", Edison Mission Energy, and floated the rest of its shares on the New Zealand share-market. The share issue was oversubscribed. The terms of the float gave a greater commission to share-brokers selling to overseas investors, compared to local ones. After the initial float, the percentage of overseas ownership was estimated at 62% (Gaynor 1999). The sale delivered a total of $2.3 billion to the Crown, counting sale price, fees, and ordinary and special dividends.

Edison changed the accounting policy, converting its Maui gas rights, formerly written-off, into an asset of $60M. This immediately appeared on Contact's bottom line as a profit. Edison also changed the valuation of Contact's generating assets from book value to one based on anticipated future cash flows. This is a basically circular definition, because the higher valuation means a reduced rate of return on assets – thus justifying an increase in prices to give an acceptable rate of return. These changes more than doubled Contact's asset value compared to the amount the company had paid for the assets originally.

The cash flows rose as anticipated, not only because of the circular valuation, but because generation was no longer sufficient to meet demand in very dry years. Contact helped create that scarcity. It announced closure of a 200 MW generator in 1999, and sold off another 125 MW generator in 2001 for $200M to its parent, Mission Energy. This latter generator was subsequently replaced in 2004 by a $150M generator purchased by the Crown and leased to Contact, funded by a levy on all electricity consumption. It was a clear example of the cornerstone shareholder taking a major benefit, and New Zealand electricity consumers paying the cost.

Edison sold its 51% shareholding in Contact in 2004 to the Australian company Origin Energy, which is an oil and gas explorer as well as an electricity generator and retailer, for a $240M gain on its original purchase price. In its five years it reported profits of $750M, paid out dividends of $670M, and repurchased shares of $73M. It paid capital expenditure of $430M, some of it in Australia, and investments of $60M also partly in Australia.

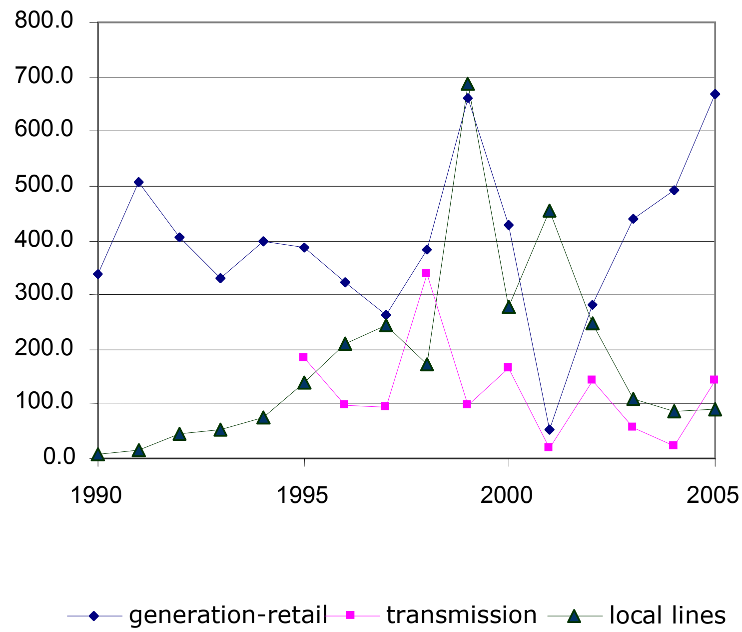
CAFCA reflects as follows on Contact's activities and behaviour. The company has given preferential treatment to its dominant "cornerstone" shareholder, enabled by naïve public policy processes. It has increased its generation and customer bases, enabling it to increase its profits without threat of dampening electricity prices. It has disposed of older power plants, helping to keep the wholesale price firm. Its 2004 Annual Report (p. 6) asserts "the investment needed to satisfy energy demand will not continue if investors sense that policy makers are unwilling to allow necessary price adjustments to occur."

CAFCA concludes that "Contact's drive to secure its future earnings has contributed to New Zealand's 'new reality' of an uncertain and insecure electricity supply which will, of course, cost more, and more, and more. The costs to us as consumers have little to do with generation costs incurred by electricity generators, and everything to do with prices that consumer and policy makers will tolerate in an effort to avoid the spectre of major electricity disruptions."

A simplistic analysis of the profits (reported net profit after tax) made by New Zealand's major energy companies can be carried out using the annual survey of New Zealand's "Top 200 Companies" published every December by the magazine NZ Management. This is an important data base, in the public arena, which gives financial information for each of the companies and which has been carefully defined to avoid inconsistencies, and separately audited by a major firm of auditors. The major oil, gas distribution, electricity generator-retailers and electricity network (local lines and transmission) companies feature almost annually. A very few gaps are made up by referring to annual reports, though the benefit of separate auditing is lost. The smaller energy supply and distribution companies are left out except for where they were listed in the top 200 companies.

As the graph shows, local companies made low profits until 1993, when new legislation required them to make a commercial rate of return. Valuations and prices increased accordingly.

Figure 8: Electricity Sector: net profit after tax, million NZ$ of the day



The 1998 law that required them to break up into separate retail and network businesses led to a frenzy of mergers and takeovers, and the already-high valuations of the companies were further inflated. Most local companies sold their retail business to the four generators formed from the split of ECNZ. High profits in the years 1999 and 2000 reflect the benefits of those asset sales, a good proportion of which went offshore.

Private companies took losses as well as gains. In the autumn 2001 hydro shortage, wholesale spot prices rose dramatically. The Natural Gas Corporation, which had been 90% sold to an Australian company AGL, had set itself up as a generator-retailer as well as a gas company. But in 2001 it had insufficient generation to cover customer demand, and lost $312M of shareholder value. In this case it was indeed the private sector that was burdened by the extraordinary risks of the wholesale electricity market. Its main shareholder, AGL, guaranteed the loss, which showed up in the AGL (mainly a gas company) bottom line the following year.

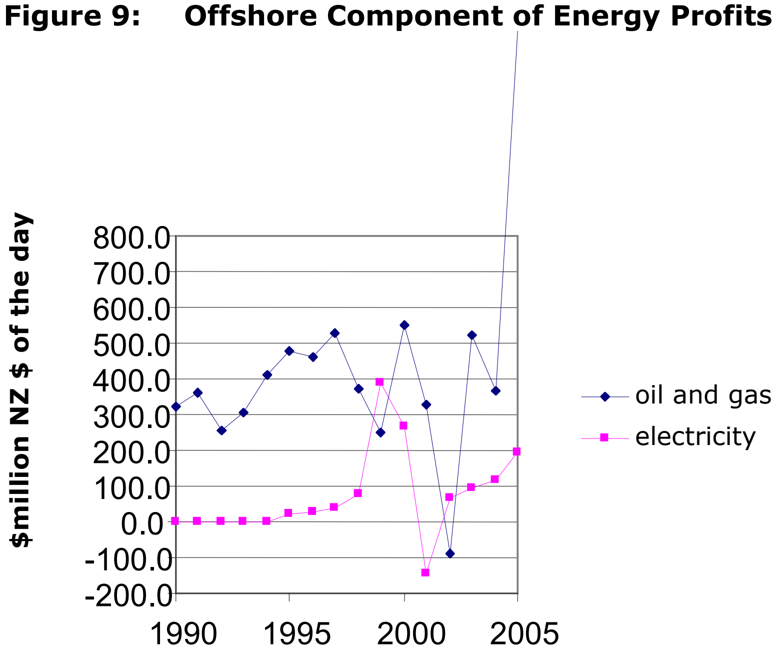
Companies quickly concluded that the risks of retailing needed to be offset by generating most of the electricity that would be sold to customers, so the companies generally purchased blocks of customers that matched their generating assets as closely as possible. This greatly reduced the transparency of the wholesale electricity market, and shifted risk from supplier to consumer. Subsequent retail prices have risen significantly each year following the 2001 shortage.

Profits can be beneficial if kept within New Zealand and used fund further energy development, or at the very least support the national economy.

Only the remitting offshore of profits is described here as a "burden". However even to estimate this would be a massive research task. Instead we use a simple proxy for the funds remitted offshore, namely the net profit after tax multiplied by the estimated percentage of foreign ownership. In the case of Contact Energy, this underestimates the actual value transferred offshore, as described in the CAFCA analysis.

Even the percentage of shares owned offshore is difficult to confirm; estimates used in the graph were made by Campaign Against Foreign Control Aoetearoa (CAFCA).

Figure 9: Offshore Component of Energy Profits

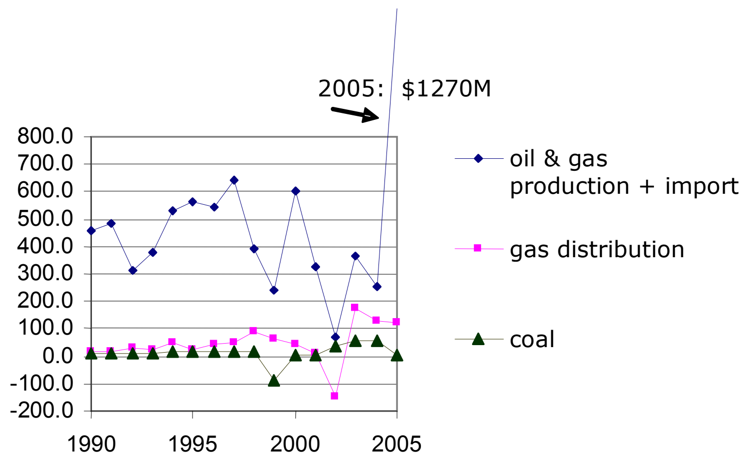


Most local electricity network companies are still owned by local trusts or councils, but by far the largest, United Networks, was overseas owned until 2004, when it was purchased by the largest trust-owned company, Vector. This is likely to reduce the drain of remitting profits overseas on New Zealand's balance of payments. Powerco, the second largest, is now the only major privately-owned lines company.

High prices and profits made by electricity companies in 1998 and 1999 put electricity on the agenda of the 1999 election. The then Minister of Energy emphasised that wholesale prices had "halved" (actually reduced by around 50%) (Bradford, 1999), and promised that competition would control excessive retail prices. The Minister of the new government in 2000 announced the launch of a wide ranging inquiry into the electricity industry, with consumer issues on the agenda (Hodgson, 2000). Both prices and profits declined under this political pressure, only to rise again following the hydro shortages of 2001 and 2003. "Targeted price control" of lines companies and Transpower was introduced in 2003. It is clear that network company profits have remained lower than in the mid 1990s. However generation and retail prices are left entirely to the market, and profits increased sharply in 2003 and 2004 (and again in 2005).

Transpower has just announced its intention to progressively increase its prices, to gather revenue for its planned large-scale expansion of the transmission system. The Commerce Commission has challenged that intention and intends to "take control" of Transpower's electricity transmission service unless it gives a more satisfactory explanation than it has to date. (Commerce Commission, 2006)

Figure 10: Fossil Fuels: net profit after tax, million NZ$ of the day



The oil and gas production sector has been even more profitable than electricity, and it is almost completely overseas-owned. The year 2005 saw the profits of Shell Oil (NZ) go off the scale, as it sold its production business to Shell Exploration for $829M.(Anon, 2005b) Further significant profits seem likely as world oil shortages become more frequent, leading to market excursions similar to those of New Zealand's electricity spot prices. The only anomaly in this graph is the loss made by AGL in 2002; AGL is both an electricity and a gas company, and in 2002 it made good on its guarantee of NGC's massive loss of $311M in the year before.

In conclusion, before electricity was restructured in the 1980s, the burden of excessive electricity and gas development (Figure 1, section VI) fell on taxpayers, who in effect subsidised the energy intensive industries developed to utilise surplus capacity. Today the burden is one of high electricity and petroleum profits available to suppliers in markets of low elasticity. These are economically inefficient, and the proportion that goes offshore adds to the balance of payments deficit. Residential consumers at present have full retail choice, but cannot avoid price hikes by retailer-generators, as all the companies behave similarly. Industrial consumers are vulnerable to instances of market power of generators which appear to occur at times on the wholesale market, and to Transpower's unilateral decision to raise its transmission prices.

"Threat of regulation", as shown in 1999, appears to have been more effective than regulation itself. Regulation to date, designed in consultation with industry interests, has been very light handed and weak. Continuing concerns about market failure in electricity have led the Commerce

Commission to investigate wholesale and retail electricity markets and the behaviour of generator-retailers. The inquiry, under Part II of the Commerce Act, will not be public, and unlike the Electricity Commission, the Commerce Commission is independent of Government. "Market power" is not defined in New Zealand law or regulation, so the findings may only relate to future regulation, not profit-seeking behaviour today.

Indicator Calculation
To calculate the indicator as defined by HELIO, we take the actual expenditure on publicly owned fossil fuel projects in 1990 and 2004. The numbers are very small in comparison to GDP, so the value of the indicator came out to 0.0 in both years.

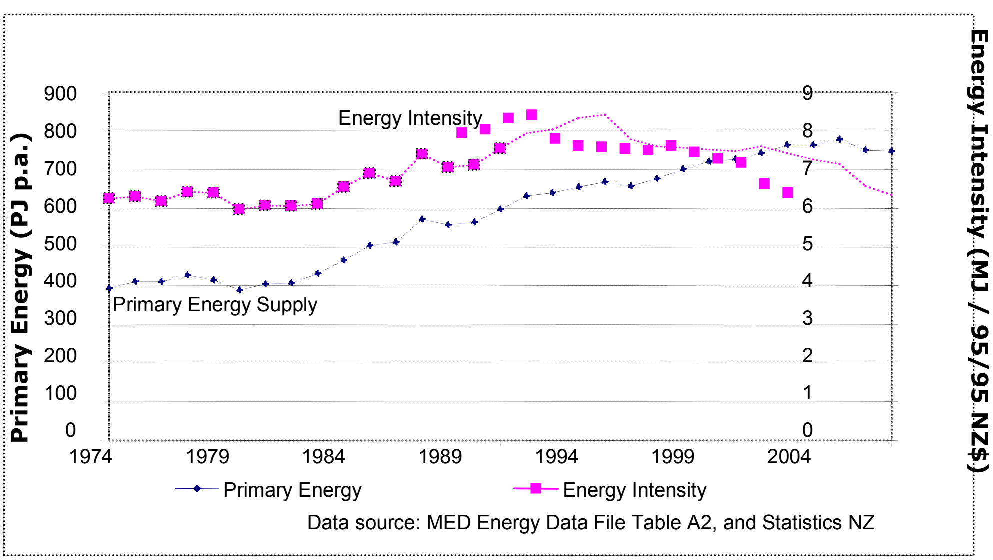
An alternative indicator can be defined as the amount of profit from the energy sector that has been remitted offshore. We set a goal of zero profits remitted offshore (Y), and take 1990 as the reference figure (W). The value of I in 1990,was $383M; in 2005, $1,544M, both expressed in real NZ $ of March year 2004. The profit values are so volatile that the values on the linear trend line will be used instead of actual values: value in 1990, $350M, value in 2004, $730M. This gives an indicator value of 1.0 in 1990 and 2.1 in 2004 – a "footprint" more than doubled in this dimension.

Techonological Sustainability

Indicator 7: Energy Intensity

Energy intensity is related in this section to total primary energy supply, to enable comparison to be made to 1990 figures. Primary energy is a very relevant indicator in New Zealand as there are very high losses in transforming geothermal energy to electricity, and much of the wasted low-grade heat could well become useful, whether for greenhouse heating or drying of biomass. The GDP series provided by New Zealand Statistics is an annual chain-volume series expressed in 1995/96 prices. For the graphs, the data were used as is, but for the indicator the GDP was converted to real 2004 NZ dollars, and converted to US$ using published exchange rates.

Figure 11: Primary Energy and Energy Intensity



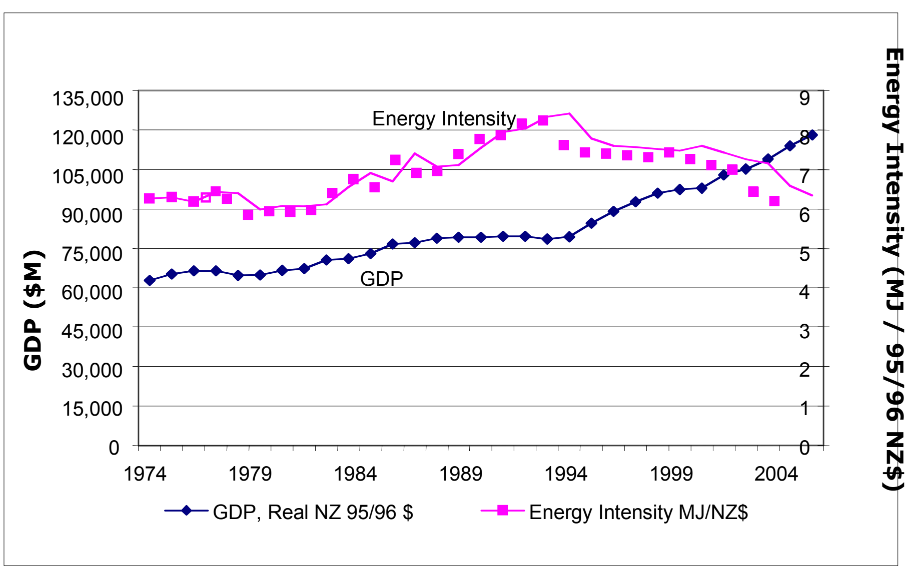
The Energy Data File records for consumer energy begin only in 1995. Primary energy supply grew slowly until 1982 when the first petrochemicals were produced from the Maui Gas field, and then grew faster, with one dip, until 2002 when the gas field began to wind down its production. Electricity and particularly transport fuel grew steadily over the period. The downturn in primary energy from 2003 reflects the shutdown of the last major petrochemicals project, a methanol plant.

Energy intensity peaked in 1993, after which the steady upwards trend reversed, significantly influenced by a resurgence of GDP growth. The latest greenhouse policy review (Ministry for the Environment 2005) contains some official commentary on energy intensity trends. It notes that our "resource endowment" has led to low energy prices, which have encouraged energy-intensive industries such as aluminium and steel. It comments that New Zealand's energy intensity is relatively high by OECD standards.

The review also reports on detailed analyses of the trend, which separate the contribution of structural change (output from different industries), technical efficiency (of different industries), and energy quality (including that of liquid fuels). It did not comment on influence on energy efficiency of the "Think Big" petrochemical projects built to utilise Maui Gas, or the fact that they did not contribute proportionately to GDP. A significant part of the review's discussion was deleted - as is allowed under the Official Information Act for sections that may contain information relating to government budget policies, or international trading negotiations.

The review comments on difficulties in decoupling emissions from economic growth, and notes that decoupling will be difficult for several reasons including the fact that a good deal of New Zealand's primary energy is already from renewable sources, and that New Zealand has a comparative advantage internationally from its relatively low energy prices. The relevance of recent gas and electricity price increases is not discussed.

Figure 12: GDP and Energy Intensity



Data source: MED Energy Data File Table A2, and Statistics NZ

The review offers little comment on how personal energy consumption in houses and passenger vehicles affect observed energy intensity.

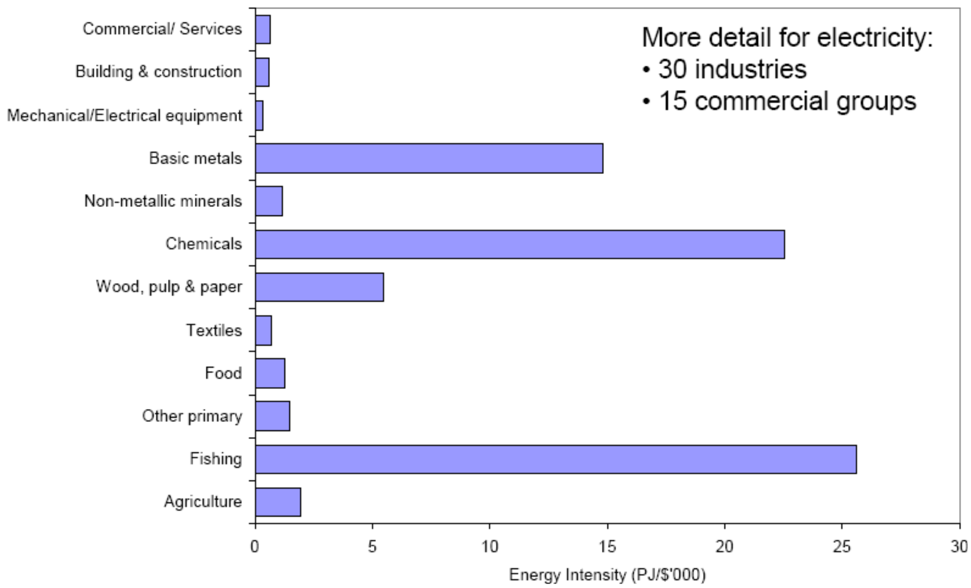
An earlier analysis by EECA (2000) compared New Zealand's energy intensity to that of other IEA countries. It noted that in 1999, the transport sector produced 46% of New Zealand's energy-derived CO_2 - this is the highest proportion in the OECD. Residential energy use has declined in recent years, due partly to a population drift northwards leading to less space heating, partly to better insulation in new houses, and more efficient new appliances, and partly through household response to rising energy prices. Transport technical efficiency has increased but increasing transport demand has overwhelmed the decrease in technical efficiency. EECA appears to have published no significant analysis on energy intensity since 2000.

A study dating from around that time did analyse energy intensity of end-use energy (Schipper et. al, unpublished). It compared New Zealand's energy use and efficiency to those of other countries uses techniques devised by the International Energy Agency. It found that from 1980 to 1994, manufacturing, households and transport became more energy intensive. GDP grew slowly or not at all during the period of economic restructuring, while activities that are more energy intensive than the economy as a whole – trucking output, driving, heated area in houses – grew more rapidly than GDP. The highly aggregated data for end-use categories made it difficult to analyse the energy efficiency of particular end-uses of energy, or the best opportunities for savings. But the report concluded that New Zealand's record of energy savings is smaller than that of other countries. The study, though funded by two government departments, is not in their libraries or on their data bases.

The Ministry of Economic Development now takes responsibility for government policy relating to energy supply and demand. For some years it has used an energy-economy model, SADEM, to support its scenarios (in fact, range of forecasts) for future energy demand and supply. It has recently conducted a review of SADEM with stakeholders, and commented that the energy efficiency assumptions were amongst the strongest criticisms made by stakeholders.

The graph below, taken from the presentation, shows some major challenges to beliefs previously held about the energy intensity of different sectors. Note that methanol (the major part of "chemicals") production has ceased since the graph was drawn. Basic metals (aluminium and steel) are no longer the most energy-intensive sector of the economy – fishing now uses the most energy in comparison to its economic return. And wood, pulp and paper uses much less energy than in the recent past due to the declining commodity prices, leading to a move to export whole logs (at best), or simply cutting down plantations, before harvesting them is economic (at worst) in order to convert to dairy pasture.

Figure 13: Energy Intensity by Industry Sector



A report just published by Statistics NZ (2006) presents detailed trends in consumer energy demand, emissions and energy intensity disaggregated over 25 economic sectors over the years 1997 to 2003. This required removal of energy transformation (such as thermal generation of electricity) to avoid double counting, and also did not attempt to include geothermal energy or wood burning as they are poorly documented.

Regarding energy intensity, the study found petroleum and chemicals to be the most energy intensive (in years to 2003 when exports of methanol were prominent) and fishing the second highest. The major driver of the high energy intensity of fishing is the decline in catch volumes for major species, particularly hoki.

It confirms the improvement of energy intensity in some major industries such as aluminium smelting. Importantly, transport and storage, which accounts for approximately 20% of New Zealand's energy demand and 5% of New Zealand's GDP, has improved by 10% in energy intensity since 1990. In 2003, transport and storage emitted 7.9 Mt of CO_2, being the single largest emitter.

The report included the household sector in its analysis, comparing energy demand not to GDP but to Household Consumption Expenditure. It found householders use 80% of New Zealand's petrol, and emit over 20% of New Zealand's CO_2; both are increasing at "far higher rates" than total spending by households.

Indicator Calculation

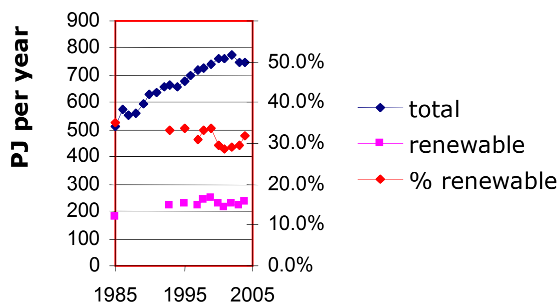
The indicator value for energy intensity relates New Zealand's performance to a world average energy intensity in 1990. New Zealand's value was very similar in 1990 and in 2004; approximately 0.35 – just slightly worse in 2004 than in 1990.

Indicator 8: Renewable Energy

There is no subsidy for renewable energy, nor any regulatory requirement to purchase it. Until the end of 2005, development of renewable energy was encouraged through Kyoto credits available only where the economics would be supported the development of several wind farms. Climate change policy is currently in flux, following the announcement in December 2005 that the proposed carbon tax has been dropped, and no replacement mechanisms have yet been proposed. No more Kyoto credits will be issued until the climate policy is resolved.

In the calendar year 2004, primary energy supply from hydroelectricity was 91 PJ, geothermal energy 87 PJ, woody biomass 32 PJ, biogas and landfill gas 1.6 PJ, industrial waste 16.5 PJ, wind 0.6 PJ and solar water heating 0.16 PJ. Renewable energy provided 32% of New Zealand's primary energy supply, compared to 29% in the previous year. It declined from 35% in 1985, as the Maui gas field dominated primary energy supply in the 1980s and 1990s. Data are available annually only from 1997 onwards.

Figure 14: Total Primary Energy, Renewable Primary Energy



Consumer energy supplied by renewable energy is strongly affected by losses in the conversion from the primary source to useful consumer energy, especially where the energy comes from low temperature heat sources. Hydro and wind energy are assumed to lose 11% between generator and consumer, from transmission and distribution losses. For other renewable energy types, the losses are specified for each year in the supplied data. Averaged from 1985 to 2004, geothermal losses were 85%., and losses from biomass and wastes were 38%.

Wind generation has grown the most rapidly, starting from a very low base. The first wind turbine for public supply was a 250 kW turbine in Wellington in 1993; a 3.5 MW wind farm was built in 1997, and a several wind farms built in a wind funnel region north of Wellington from 1998 to 2004 brought New Zealand's total wind generation capacity to 166 MW. A prototype two-bladed

500 kW turbine designed and built in New Zealand to operate safely at high wind speeds has run for two years near Christchurch, and work has just begun on a 49 MW wind farm using this technology.

Solar water heating is being encouraged by the new Labour government, through interest free loans, and a new programme to install 0.5 million panels. Details of this new support programme are still awaited.

Official statistics put domestic use of solid energy (firewood and coal) at 2.5 PJ per year out of a total of 57.6 PJ. However a10-year project to fully document the actual end-use of energy in 400 randomly selected houses concludes that solid fuel (mostly wood) provides 15 % of the energy used in houses (Isaacs et. Al. 2005). Just over half New Zealand's houses have enclosed solid fuel burners, and much of the wood is gathered rather than purchased. New strict air quality standards will create pressure to ban wood burning, unless a combination of improved burner design, standards for moisture content of firewood, possibly the widespread introduction of super-dry firelogs, and improved education of householders leads to an improvement of efficiency of household wood burning.

The rapid expansion of dairying has fostered the development of on-farm energy systems utilising biogas from waste treatment ponds to cogenerate electricity for cooling and pumping, and heat for washing dairy sheds and bulk milk tanks. Peak electricity demand of dairy farming is in excess of 260 MW. Counting resistance and power factor losses, dairying accounts for 9% of New Zealand's electricity megawatt demand at peak times in summer.

Irrigation demand for electricity, especially for dairying and vineyards, is growing rapidly (not disclosed in statistics). A new proposal is to install micro-turbines, typically a few tens of kW, in the irrigation canals, generating electricity exactly when and where it is needed most to drive irrigator spray systems. The east coast of the South Island is predicted to become drier with climate change, and major irrigation schemes are planned to store water high in the catchment. In one district south of Christchurch some 40 MW may be generated from a single large irrigation scheme.

A very significant use of renewable energy will be in remote rural areas served by very long distribution lines. Power companies now charge typically NZ$20,000 to NZ$50,000 per kilometre for a new connection. To supply a house with photovoltaic panels, inverter, and batteries costs around $30,000-40,000 for a 15-year lifetime, with a further $6,000-9,000 for new batteries giving a further 15 yearsii. This also requires further investment in energy-efficient appliances.

The choice to "go solo" off the grid, must balance the time perspective of the home owner against the cost of connecting to the grid. Life-cycle costings are essential to justify this investment. If one is concerned with immediate cost then the break-even point is at around $40,000. If one looks at one battery lifetime, it will be at around $30,000 or less. If one looks at two battery lives it would be at $20,000 or less.

Any off-grid power schemes to supply existing houses would require major improvements in energy efficiency of appliances and building insulation. The legislation allowing rural power companies to abandon “uneconomic” lines allowed a 15-year transition period, during which remote rural communities could plan the best approach to maintaining their electricity supply. It is unfortunate, though not surprising, that little or no effort appears to be made in this direction.

The HELIO Star

Star: energy sustainability indicators

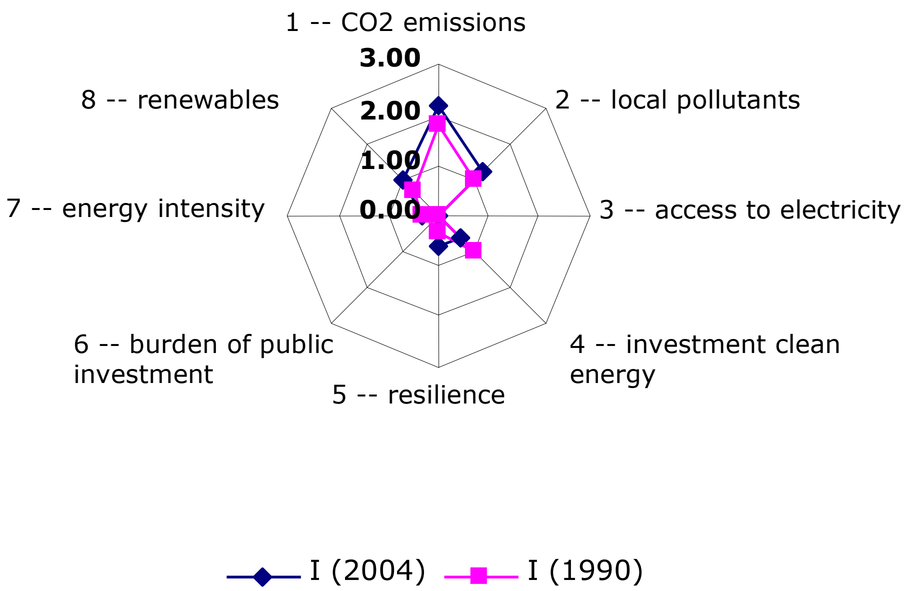


Table 1: Summary of Calculations

Indicator	Unit	X (current)	X(1990)	W (reference)	Y (goal)	Z	I (current)	I (1990)
Ind.1 CO2 emissions	KgC/cap	2081.0	1780.0	1130.0	339	791	2.20	1.82
Ind. 2 local pollutants	days/yr	32.0	26.0	26.0	2.6	23.4	1.26	1.00
Ind. 3 access to electricity	Percent	100.0	100.0	0.0	100	-100	0.00	0.00
Ind. 4 investment clean energy	Percent	30.3	0.0	0.1	95	-94.9	0.68	1.00
Ind. 5 resilience	Percent	60.0	33.5	100.0	0	1	0.60	0.33
Ind. 6 burden of public investment	Percent	0.1183	0.0069	10.0	0	10	0.01	0.00
Ind. 7 energy intensity	MJ/$ US	4.431	4.376	10.6	1.06	9.58	0.352	0.346
Ind. 8 Renewables	Percent	31.7	33.8	9.0	95	-86.36	1.03	0.71

Data sources for indicators:

1. Energy greenhouse emissions from Table 1, p. iii, MED 2005n, Population data from NZ Statistics,
2. PM10 readings, T. Aberkane, Environment Canterbury, pers. comm.
3. (alternate) Data from Household Economic Survey, years 1990-1998, then 2001 and 2004, by email and fax from NZ Statistics.
4. Data from MED 2005n, Energy Data File, Section G: Electricity, Table G.7a, p. 128; Brian Cox, East Harbour Management, pers. comm; MED Crown Minerals information contact site; EECA Annual Report 2004, MFE, letter to Molly Melhuish, 16 January 2006, in reply to an Official Information Request
5. Energy Data File July 2005
6. Energy Data File July 2005, NZ Statistics, Solid Energy Annual Report 2004.
6. alternative indicator: "New Zealand Management" (formerly called "Management"), December issues from 1990 to 2005; Bill Rosenberg, CAFCA, pers. comm..
7. Energy Data File July 2005, NZ Statistics.
8. Energy Data File July 2005.

Star: alternative sustainability indicators

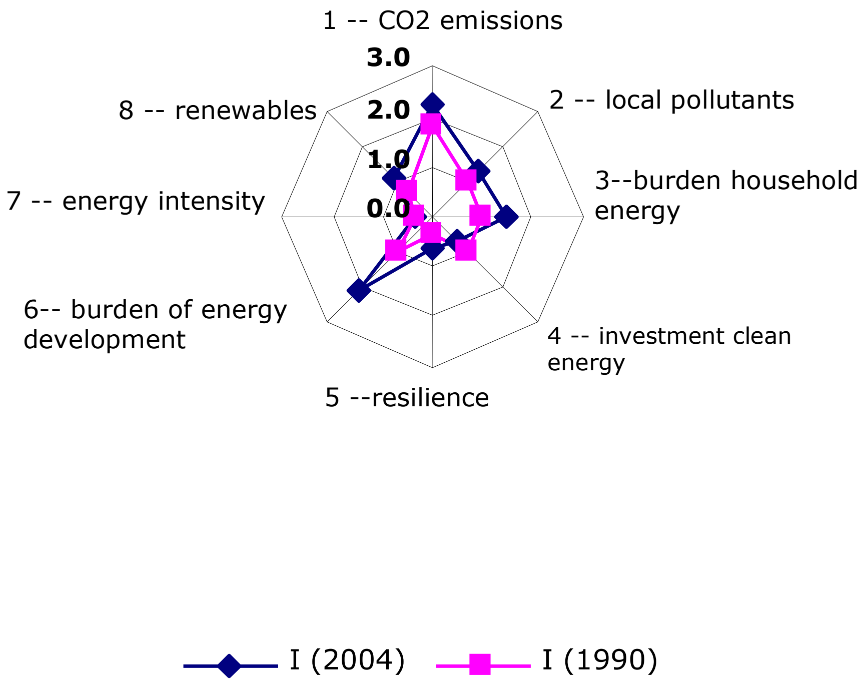


Table 2: Summary of Alternative Calculations

Indicator	Unit	X (current)	X (1990)	W (reference)	Y (goal)	Z	I (current)	I (1990)
1 -- CO2 emissions	KgC/cap	2081.0	1780.0	1130.0	339.0	791.0	2.2	1.8
2 -- local pollutants	days/yr	32.0	26.0	26.0	2.6	23.4	1.3	1.0
Alternate "access to electricity", TREND	percent	8.4	7.3	7.3	5	2.3	1.5	1
4 -- investment clean energy	percent	30.3	0.0	0.1	95.0	-94.9	0.7	1.0
5 -- resilience	percent	60.0	33.5	100.0	0.0	1.0	0.6	0.3
alternate "burden of energy", TREND	$M real 2004 NZ	730.0	350.0	350.0	0.0	350.0	2.1	1.0
7 -- energy intensity	MJ/$ US	4.4	4.4	10.6	1.1	9.6	0.4	0.3
8 -- renewables	percent	31.7	34.5	9.0	95.0	-86.4	1.0	0.7

Bibliography

Anon, 2005a. A Framework for a Sustainable Energy Future for New Zealand. Retrieved February 2006 from http://www.sef.org.nz/papers/NZ_Energy_Framework_1sept.pdf

Anon, 2005b. Cover Story, New Zealand Management, Profile Publishing, December 2005, pp. 68-73.

Bollard, A., 2005. "Imbalances in the New Zealand Economy" Oct 14 2005, Address to the NZ Credit and Finance, Rotorua. Retrieved Oct 2005 from http://www.rbnz.govt.nz/speeches/2111459.html

Bradford, M. Speech: Extremely Disappointed At Power Price Rises, 19 /4 /1999http://www.executive.govt.nz/speech.cfm?speechralph=12619&SR=1

Business New Zealand, 2005, Electricity investigation timely. Press release, retrieved February 2006 from http://www.businessnz.org.nz/doc/974/Electricityinvestigationtimely

Cabinet paper Climate Change – Review of Policy and Next Steps http://www.climatechange.govt.nz/resources/cabinet/cbc-05-394.pdfhttp://www.climatechange.govt.nz/resources/cabinet/cbc-min-05-20-10.html

Chris Bumby, 10/10/05, Energy Security and Alternative Fuels in NZ. Retrieved 20 January 2006 from http://www.peakoilinfo.com/documents/global-oil-market-impact-on-nz.pdf

Commerce Commission, 2006. Reasons for intention to declare control of Transpower's transmission services. Release No. 93, Issued 31 January 2006 Retrieved Jan 2006 from http://www.comcom.govt.nz//MediaCentre/MediaReleases/200506/commercecommissionsreasonsforinten.aspx

EECA, 2000. The Dynamics of Energy Efficiency Trends in NZ, EECA Monitoring and Analysis Unit, 2000, p. iv-v

EECA, 2005. Briefing to Incoming Minister. Retrieved November 2005 from http://www.eeca.govt.nz/eeca-library/eeca-reports/report/briefing-to-incoming-minister-05.pdf

EECA Statement of Intent 2005. Retrieved November 2005 from http://www.eeca.govt.nz/eeca-library/eeca-reports/report/statement-of-intent-05.pdf

List of all departmental briefings to incoming ministers. http://www.beehive.govt.nz/HomepageFeature.aspx?id=12

Electricity Commission, 2005. Briefing to the Incoming Government October 2005. Retrieved Feb 2006 from http://www.electricitycommission.govt.nz/publications/briefing2005/publication.pdf

Frew, Wendy, 2006. Smart meters slash power bills. Sydney Morning Herald, January 28, 2006. Retrieved February 2006 from http://www.smh.com.au/articles/2006/01/27/1138319450051.html

Garry McDonald Dr Murray Patterson, September 2003, Ecological Footprints of New Zealand and its Regions. Retrieved November 2005 from http://www.mfe.govt.nz/publications/ser/eco-footprint-sep03/eco-footprint-cover-exec-summary.pdf

Gaynor, B., 1999. Govt should encourage local investing. NZ Herald, 15/5/99, Business

Hansen, Carl, 2004. Improving hedge market arrangements in New Zealand. retrieved February 2006 from http://www.nz.m-co.com/upload/sectionimages/10581_Improving_hedge_markets_in_NZ.pdf

Hodgson, P, 3 Feb 2000. Press release: Ministerial Inquiry into the Electricity Industry http://www.beehive.govt.nz/ViewDocument.aspx?DocumentID=6801

Hon Max Bradford, 1999. Speech to Institute of Professional Engineers New Zealand, 26 /8 /1999. Retrieved Jan 2006, from http://www.executive.govt.nz/speech.cfm?speechralph=13309&SR=1

Ministry For the Environment, 2006, Scoping a National Policy Statement on Electricity Transmission, retrieved February 2006 from http://www.med.govt.nz/ers/environment/nps/electricity-transmission/index.html

Ministry for the Environment, 2004. Proposed National Environmental Standards for Air Quality: Resource Management Act Section 32: Analysis of the costs and benefits. Retrieved February 2005 from http://www.mfe.govt.nz/publications/air/nes-air-standards-analysis/nes-air-standards.pdf

Ministry for the Environment, 2006a. Calculate your personal ecological footprint. Retrieved November 2005 from http://www.mfe.govt.nz/withyou/do/footprint/

Ministry for the Environment, 2006b. New Zealand sustainable development programme of action. Retrieved February 2006 from http://www.mfe.govt.nz/issues/susdev/programme.html

Ministry of Economic Development, 2000. Ministerial Inquiry into the Electricity Industry. Website with links to issues paper, submissions and final report. Retrieved Feb 2006 from http://www.electricityinquiry.govt.nz/

Ministry of Economic Development, 2001. Electricity Post-winter Review. Retrieved February 2006 from http://www.winterreview.govt.nz/

Ministry of Economic Development, 2004a. Sustainable Energy: Creating a Sustainable Energy System for New Zealand, Retrieved February 2006 from http://www.med.govt.nz/templates/StandardSummary____35.aspx

Ministry of Economic Development, 2005a. Chronology of New Zealand Electricity Reform. Retrieved December 2005 from http://www.med.govt.nz/ers/electric/chronology/chronology.pdf

Ministry of Economic Development, 2005b. Creating a Sustainable Energy System for New Zealand - Discussion Paper, October 2004. Html version retrieved Feb 2006 from
http://www.med.govt.nz/templates/MultipageDocumentPage____10137.aspx
Full 3 Mb document retrieved Feb 2006 from
http://www.med.govt.nz/upload/19824/Creating a Sustainable Energy System for New Zealand - Discussion Paper.pdf

Ministry of Economic Development, 2005c. Energy Data File, July 2005. Retrieved November 2005 from
http://www.med.govt.nz/ers/en_stats/statistics/edf/200507/index.html

Ministry of Economic Development, 2005d. New Zealand Energy Greenhouse Gas Emissions. Retrieved Feb 2006 from
http://www.med.govt.nz/ers/en_stats/statistics/ghg/2004/ghg-2004-01.html
A direct link for the 4 Mb PDF: http://www.med.govt.nz/upload/22235/ghg-2004.pdf
Note that electronic page references are 26 greater than quoted page references.

Ministry of Transport, 2005. Health and Air Pollution in New Zealand: Christchurch Pilot Study. Retrieved February 2006 from
http://www.transport.govt.nz/business/multimodal/environment/vehicle/hapinz/05.php

New Zealand Climate Change Office, November 2005. Review of Climate Change Policies. Page numbers in electronic copy are 2 greater than quoted (hard copy). Retrieved February 2006 from
http://www.climatechange.govt.nz/resources/reports/policy-review-05/index.html

OECD/IEA, 2005. Lessons from Liberalised Electricity Markets

Office of the Convenor, Ministerial Group on Climate Change, 2005. Annual Report on Climate Change Policy Implementation 2004/2005. Retrieved February 2006 from
http://www.climatechange.govt.nz/resources/reports/annual-report-05/annual-report-policy-implementation.html

Rennie, Neil, 1989. Power to the People. Electricity Supply Association of NZ. Page 205.

Reserve Bank of New Zealand, 2005. Monetary Policy Statement, September 2005. retrieved Feb 2006 from http://www.rbnz.govt.nz/monpol/statements/sep05.pdf

Rosenberg, Bill and Newberry, Sue, 2005. Electricity reforms and Contact Energy Ltd. Retrieved February 2006 from http://www.converge.org.nz/watchdog/08/06.htm

SADEM Review Presentation to Workshop: Future Directions for MED's Energy Modelling EffortsTim Denne, John Small, Adolf Stroombergen (Infometrics), June 8 2005 Retrieved Nov 2005 from http://www.med.govt.nz/ers/en_stats/projections/events/20050608/sadem/#P206_7721

Schipper, Lee et.al. (IEA) and Murtinshaw, Scott (Lawrence Berkeley National Laboratory), Indicators of energy use and efficiency in New Zealand in an international perspective: Comparison of trends through 1995. Unpublished.

Souness, M., 2005. Dairying drives power profit. Rural News (web version), retrieved Nov 2005 from http://www.ruralnews.co.nz/article.asp?channelid=140&articleid=9692 Retrieved Feb 2006 from http://www.ruralenergy.co.nz/main/content/dairying_drives_power_profit.pdf

Statistics New Zealand, 2002. Monitoring Progress Towards a Sustainable New Zealand, An experimental report and analysis. Retrieved Feb 2006 from http://www.stats.govt.nz/NR/rdonlyres/2EA4C3CC-816B-4E5F-80CA-CFC4AF1A5530/0/MonitoringSusDevelopment.pdf

Statistics New Zealand, 2002. Review of the Monitoring Progress Towards a Sustainable New Zealand Report. Retrieved Feb 2006 from http://www.stats.govt.nz/NR/rdonlyres/5F36E628-CF68-4DEF-A310-913B897925D6/0/SustainableDevelopmentReportReview.pdf

Statistics New Zeland, 2006. Energy, Economy and Emissions: 1997 to 2003. Retrieved Nov 2005 from : http://www.stats.govt.nz/NR/rdonlyres/701056BB-B81E-4E73-ADF2-5CFDA84E45E5/0/EnergyEconomyandEmissions.pdf