NIWA
Taihoro Nukurangi

Climate-Energy Matters

a quarterly newsletter from the National Centre for Climate-Energy Solutions

New Zealand needs demand-side management initiatives

The re-determination of the Maui gas field has brought the debate over New Zealand's electricity needs over the next 5–10 years into sharp focus. We must develop new generating capacity to fill the looming gap.

Meridian is playing a central part in this with its Project Aqua proposal for the Lower Waitaki – a low environmental impact initiative which is a new approach to hydro, with a 62 km canal diverting part of the Waitaki River through six 90 MW power stations, without the need for dams and large storage reservoirs. With new gas-fired generation now on hold, Project Aqua is the only major new development on the horizon. Power is expected by 2008.

We need new generating capacity, but we also need greater awareness of the role of energy conservation by industrial, commercial, and domestic consumers in a tight electricity supply situation; i.e., "demand-side management".

We waste about 20% of the electricity we generate, through inefficient lighting, heating, appliances, and industrial processes. If we could substantially reduce that, we could off-set much of the cost of developing new generation – good for Meridian, good for consumers, good for everyone.

The potential of demand-side management was highlighted in 2001, when record low inflows into the country's hydro catchments led to a dramatic tightening of electricity supplies in winter. Most large industrial users felt the blow when they went to renew electricity supply contracts, and were confronted by some extremely unattractive prices. That was the signal that the years of relatively low, stable electricity prices – largely due to plentiful Maui gas – had ended. We needed a whole new way of thinking about electricity supply.

We are now seeing a greater awareness of electricity pricing, the electricity spot market, and the factors that affect prices. We see a new willingness to explore ways of managing energy consumption. For its part as an electricity retailer, Meridian is keen to explore new products and services which can show customers the movements in spot prices and give them incentives to better manage their energy use.

An example of such a product is a "fixed/floating" package which Meridian developed to enable customers to secure part of their energy requirements for a fixed price, but to leave some of their load exposed to spot market movements. When spot prices go high, they have the option of shedding load and avoiding the high prices. When spot prices are low, they can make considerable savings.

This truly gives "power to the people" – not only the power to drive commercial and industrial processes and systems, but also the power to actively manage energy requirements and save money. We are working with many customers to help them make better use of electricity to better protect their bottom lines against rising energy prices.

Householders can also play a big part in demand-side management. Obvious and inexpensive measures can make a big difference – hot water cylinder wraps, ceiling insulation, underfloor insulation, draught excluders – and maybe things we haven't even thought of yet! Meridian is supporting an exciting programme run by Christchurch's Community Energy Action group to retrofit older houses, making them more energy-efficient and healthier.

What do we need to ensure that demand-side management has its rightful place in New Zealand's energy future? Our commitment, your commitment, government support, consumer support, tools, and information. This is all starting to happen, and Meridian is pleased to be a part of New Zealand's sustainable energy future.

Keith Turner
Chief Executive, Meridian Energy

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Renewable energy – can we do better?

The supply of energy underpins economic development. As the availability of different resources fluctuates and demand changes, there can be massive political, economical, and environmental effects. In the last 50 years, various forms of renewable energy have gone from being futuristic to realistic. The question now is whether or not we can expect them to become major power producers with a long-term place in the global market.

New Zealand's electricity comes mainly from renewable hydropower, with other renewable sources and fossil fuels also making notable contributions (Figure 1). In comparison with other industrialised countries, New Zealand's electricity supply is dominated (more than 70%) by renewable sources (Figure 2).

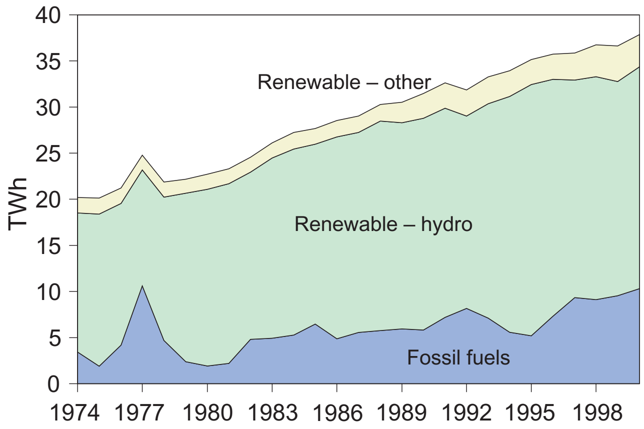

Figure 1: Sources of electricity in New Zealand.

Much of our favourable position in sustainable electricity production is due to hydro developments and a wide variety of natural and renewable energy resources. But we should put this in context with the amount of power actually generated – compare Denmark's 3400 MW of wind power with our 36 MW. So, what are the barriers restricting development of other renewable resources (wind, solar, geothermal), and can they be overcome?

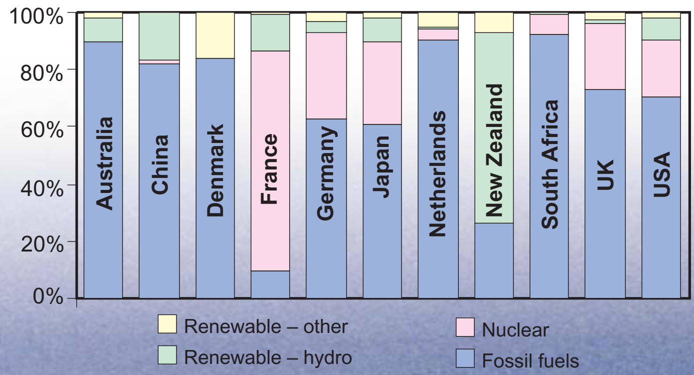

Figure 2: Proportions of electricity generation methods (Source: CIA World Factbook 2002)

New generation technology is expensive, but the cost is decreasing as the technology and markets develop.

Planning and policy requirements and public concerns can slow down development, but sensitive management and consultation should allow development to continue.

The electricity distribution network also imposes constraints. The national grid was built to take power from large central stations to the demand in cities, with smaller lines out to remote areas. It does not work well in reverse. Connecting smaller plants in remote locations creates added costs. Wind farms, which do not supply continuous power, need to be located in a windy area, and use expensive technology. They cannot currently compete on price and security of supply with large fossil fuel (or nuclear) stations.

What does the future hold?

Whether new sources of renewable energy can become major contributors to power generation in New Zealand depends on how competitive they can be with the giants of fossil fuels and the centralised system.

Renewable energy's advantages of low emissions and ongoing supply are beginning to outweigh the drawbacks of expensive technology and variable output. The dangers of relying on individual energy sources were again demonstrated by the recent price fluctuations caused by the problems at Maui.

The future of renewable energy depends partly on social change, and a move away from the centralised system. In New Zealand, where many people can remember when power in remote areas depended on an inefficient diesel motor chugging away in the barn, a return to local generation might seem a backward step, and any "new-age" local generator would have to show significant advantages. Lack of pollution is one, price stability and long-term security are others, but complete independence from the national grid is likely to become increasingly attractive.

So, can we change the way we use power? Yes, we can become more energy efficient, and we can develop more community-based systems, even though they might be slightly more expensive at first. We can change our attitudes, so that "reliable" means that power will be available for future generations, not just that we can turn the washing machine on whenever we want to. Unless we alter our way of thinking about what "reliable" and "sustainable" mean, we are unlikely to get maxium benefits from the further development of renewable energy sources.

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How much wind have we got?

We've all been battered by the wind and know that there is a lot of untapped energy in it. The idea of turning that energy into something useful, like electricity, is also common, and it is increasingly practical, as wind turbines improve.

The "but" is, as in most things, money. To pay its way, a wind turbine has to return enough to not only pay for operating costs, but also to provide an adequate return on the investment. Time without generation is time without income. It is also time during which some other form of generation must provide the electricity required. So, wind turbines must be put in places where strong winds blow for as much of the time as possible.

The wind climate of any place comprises a few storms, calm and low wind periods that can occur on many nights and during anticyclones, and in-between conditions that fill in the rest of the time. The ensemble of all these different speed conditions is described quite well by a simple average. Wind turbines do not generate in low wind periods, and the energy obtained from a generator over a year is very small in places with mean speeds of 3 m/s (10.8 km/h) or less. But the energy output rises steeply with increasing wind speed. For example, a site with a mean speed of 9 m/s will have about twice the wind resource of a place with a mean speed of 6 m/s.

The best way of ensuring that wind turbines are optimally sited is to use places with the highest mean speeds. In Germany, where the world's largest generating capacity has been established over recent years, the good wind sites have mean speeds of 7–8 m/s. There has been a trend for wind turbines produced for that market to become larger and to be placed higher above ground.

In New Zealand, good generating sites with mean speeds of 9–10 m/s at comparatively low heights above ground have been used. However, sites with such high mean speeds appear to be quite limited in New Zealand, and it is not clear how high above the ground we must go to tap the high wind resources.

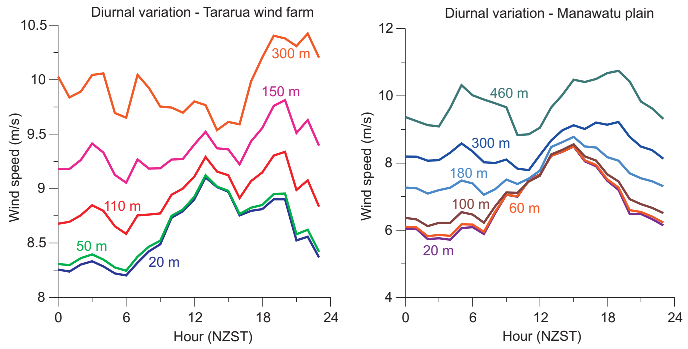


Figure 1: The sodar can measure the wind at up to 20 different heights from 20 m above the ground.

NIWA and other agencies have been improving the network of wind recorders over the country by installing automatic instruments that record accurate hourly wind speeds from a wide range of locations. These instruments are generally 10 m above the ground, so we need additional information on wind resources for the 30–100 m heights above ground that are used for current wind turbines.

One tool we have used to measure wind at these greater heights is the sodar, sometimes called an acoustic sounder. This can simultaneously determine wind speed and direction at 20 levels set anywhere between 20 m and 1500 m above the ground by using sound waves in the same way that a radar uses radio waves. For example, Figure 1 shows the wind resource at significant heights above the ground for a hill and plains site.

Although the sodar is affected by wind noise, by using a special model, carefully sited, and unique methods of analysing the information, we have developed a technique that can provide the information generators need when assessing a site.

Steve Reid, NIWA (s.reid@niwa.co.nz)

NIWA has programs that model winds around New Zealand and many other countries. These range from large-scale assessments covering the whole country – we intend to produce a new "Wind Resource Atlas" – down to highly specific windflow modelling over individual hills. These models can be used to determine the resource at places where we can't get measurements, to design the layout of a windfarm, and to design the turbines themselves to ensure they don't fly apart in extreme conditions.

A hydrogen economy for NZ?

The energy scene around the world is abuzz with talk about hydrogen becoming the fuel of choice in the near future. On the face of it, there are many attractions – it is potentially abundant, very clean, and safe. But, there are many fundamental issues that need to be sorted out before we start filling up on "H2" instead of "91".

At the National Centre for Climate–Energy Solutions we've been having a look at these issues, and their particular relevance to New Zealand. There is little doubt that hydrogen will become a more important fuel, but just how much, when, and what are the barriers?

Opportunities and advantages

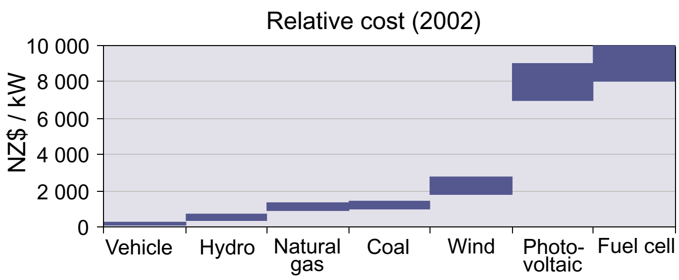
Clean – using it in fuel cells produces just water, and even burning it produces much lower emissions than any other combustion fuel.

Safe – properly handled, it is potentially safer than many other liquid or gaseous fuels; it burns with a "low heat" flame, with little radiative energy, unlike say petrol (it is often said that if we had hydrogen as a fuel today, petrol would not be allowed because it is far more dangerous), and it disperses quickly, so in accidental releases it doesn't form dangerous pools of inflammable gas.

Good supply – it is potentially inexhaustible (the most common element) and can be extracted from natural gas, produced from coal, and produced by electrolysis of water.

Barriers and drawbacks

Cost – we don't yet have a cheap source, nor can we produce the quantity we need. Fuel cells, the major means of converting hydrogen to electricity or heat, are still expensive. Although the costs are falling rapidly, the plant needed to produce 1 kW of power using fuel cells and natural gas costs about $10,000, whereas the plant needed to produce the same power from a petrol fuel vehicle or diesel generator costs about $100.



Energy – it doesn't have a very high "energy density": 1 m^3 of hydrogen, even compressed to 200 Atm, produces 2.5 GJ, whereas 1 m^3 of petrol produces 35 GJ.

Handling – it is difficult to handle: hard to pump or compress, and it leaks through most containers – even steel.

Distribution – no efficient infrastructure, unlike the networks that exist for oil, petrol, coal, and natural gas.

Environmental effects – under investigation.

Social and cultural – the world's transport systems, and much of its other energy needs, revolve around oil, coal, and biomass burning, and the social, political, and cultural upheavals associated with a significant transition to hydrogen will be enormous, possibly the biggest barrier of all.

What's happening now?

Many countries are getting really serious about hydrogen as a fuel:

- all Japanese embassy vehicles will be hydrogen powered by the end of 2003;
- in Europe a new fund of 2 billion euros has been created to study hydrogen as an energy source;
- the USA has created a new US$1.2 billion fund for hydrogen research and development;
- in Australia a fund of A$1 million has been created to run workshops and studies on the prospects for hydrogen.

Perhaps New Zealand could focus on developing a hydrogen-powered ship to get its produce to its markets. We did it before with the first refrigerated ship in the world. Why not the first zero-emissions ship?

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NIWA's Gavin Fisher has been elected President of the Clean Air Society of Australia and New Zealand, the first time a New Zealander has headed the 30-year old society.

The society promotes good air quality, low pollution, and improved environmental awareness. It does this through a popular quarterly journal "Clean Air and Environmental Quality", regular meetings, workshops and conferences, training courses, and submissions on policy proposals.

It has recently taken a new direction, moving more actively into priority areas of interest, such as greenhouse gas emissions, energy effects, and health effects.

Gavin has recently been invited to be a keynote speaker at the annual conference of the Korean Society for Atmospheric Environment and to give a keynote speech and chair a technical workshop on the "South East Queensland Airshed Project" in Brisbane.

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What are your CO_2 emissions?

You can simply calculate the CO_2 emissions of your household and see the large contributing elements you could reduce.
Go to: www.niwa.co.nz/ncces