Energy Resources

Hydropower: innovation based on knowledge

***Dennis Jamieson** charts hydro's central role in powering New Zealand, and looks to the future of the resource.*

Hydropower is a vital component of New Zealand's energy supply. The proven performance of existing hydro, combined with concerns about other fuel sources, is leading to renewed interest in hydropower.

Cheap power?

Hydropower has never been 'cheap'. The facilities to provide it are expensive to construct, have environmental effects to mitigate, and require disciplined maintenance and operation. However, well planned and constructed hydropower provides certainty over operational costs: once the power station is built, the 'fuel' has no ongoing costs. This certainty is a key to providing energy at relatively stable long-term prices.

How our water resources suit hydropower

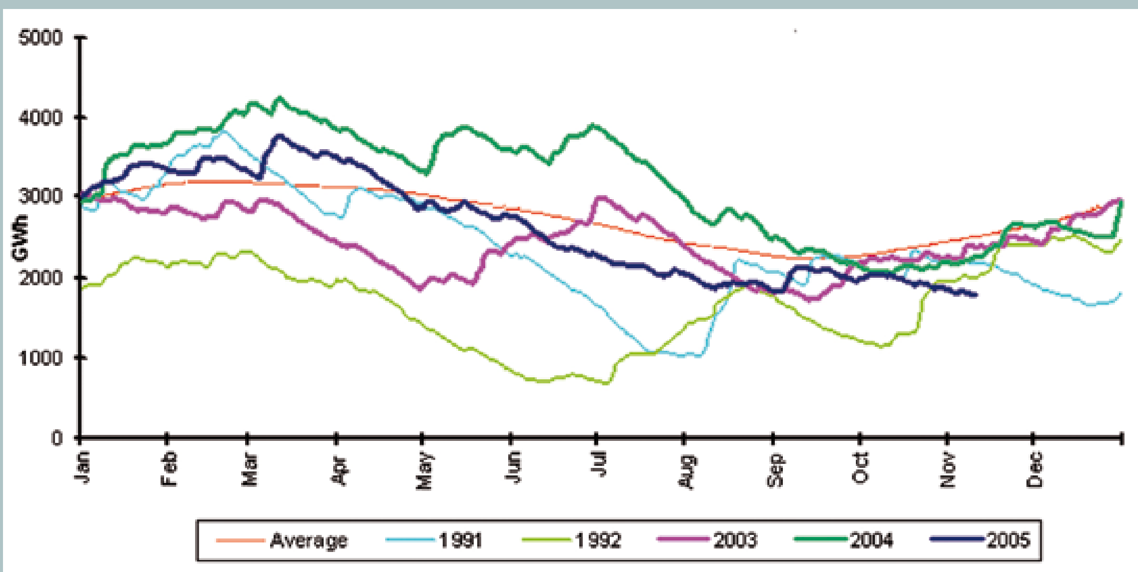
Many countries with hydropower rely on snow or large reservoirs for a good supply of fuel. New Zealand has relatively small-capacity reservoirs (typically up to 60 days of storage) and limited snow cover, so our fuel supply quickly runs low if rainfall is low. This storage is small compared to hydro reserves held in some other countries; for example, Tasmania in Australia has up to 18 months' storage.

Increasing pressure on water resource allocation for a wide variety of uses has highlighted the need for water plans to ensure the most effective use of the resource. A benefit of hydropower is its compatibility with other uses of the resource because the water used for power generation is available for other purposes downstream. The challenge with dual use of water is to ensure its availability at the times when it is needed.

Therefore, there are a number of pressing challenges with hydropower based on New Zealand's water resources. Given our usually dependable supply of inflows into key hydro storages, our water resources are suited to hydropower generation. The key question is not whether water resources suit hydropower, but more a question of having the right mix of hydro and other generation to meet New Zealand' electricity demand. The variability of hydro supply needs to be matched with flexibility in other power generation and careful attention to demand.

Dammed if you do

- Hydropower is a key part of New Zealand's electricity resource.
- Hydropower is well suited to support other forms of renewable power generation.
- Innovative designs for hydro schemes are required to meet community environmental expectations and to manage variable inflows and limited storage.



Graph: www.comitfree.co.nz

Daily storage

The storage available for power generation in New Zealand, and how it varies through the year, can be found on the COMIT Free To Air website, where plots such as this are created from data supplied by NIWA.

Note that the scale goes only up to 5000 gigawatt hours (GWh) compared with New Zealand's annual consumption of 40 000 GWh. This indicates that the storage available at any time is less than an eighth of the total annual use!

See www.comitfree.co.nz (and click on Hydrology).


Photo: Alan Blacklock

As one of New Zealand's largest hydropower plants, the Clyde Dam, in Central Otago, represents the big end of the scale. For more on small hydro schemes see pages 18–19.

Complementing other renewable sources

Hydropower has benefits as part of large and small power systems. For large power systems (for example, New Zealand's national grid), hydropower generators can react quickly to changes in demand and, unlike other renewable energy sources such as wind, wave, and solar, there is the ability to store 'fuel' in reservoirs. This allows hydropower to 'firm' supply in networks that are being fed with electricity from a variety of sources. With rapid development of wind generation, there is an issue of how much fluctuation in the supply can be accommodated by the stable hydro generation and the transmission systems connecting the power stations and users.

For small power systems, particularly those not connected to the national grid, small hydro schemes can have minimal effects on natural stream values while providing a continuous supply of power. Although the actual power outputs of such schemes may be small (for example, 0.3 kW), the ability to supply power for battery charging and refrigeration may provide high returns in terms of quality of life, as well as avoiding the high cost of alternatives.

Hydropower and sediment

New Zealand has an actively eroding landscape. While human activity can accelerate erosion, much of it occurs naturally. In the South Island, 68% of the sediment yield is from just 8% of the land area; the eastern side of the Alpine Fault combines steep slopes, heavy rainfall, and easily eroded schist rock.

NIWA works with many hydropower operators to reduce the effects of sediment on their facilities (for example, damage to turbines) and also on areas affected by increased flood risk due to raised bed levels in reservoirs. Examples include the Clutha and Waikato Rivers. In addition, NIWA has provided operational warning systems for high sediment levels in hydro-station inflows due to landslides, lahars, or ash falls that could potentially damage turbines.

Effects on ecology of rivers and lakes

A key feature of hydropower development is the modification of flows in rivers and the creation of reservoirs. Historically, a simple view of residual downstream flows went into scheme planning. However, as our understanding of river and lake ecology has improved, the emphasis has moved to defining flow and level regimes that meet the needs of many community interests. This is a challenge given the wide range of effects that can occur. These include changes in water quality, aquatic vegetation, river channel form, and the ecological food chain.

Effects on native fish, trout, and salmon

For many people, a key test of the health of a river or lake is the presence and abundance of fish. NIWA has a long track record of work on many species, including eels, whitebait, salmon, and lamprey. Recent work with industry support has focused on trialling methods for helping migratory species to cope with obstructions caused by hydropower dams and other structures; these methods include fish passes and 'trap and transfer' programmes to move the fish around the obstruction.

Hydropower schemes likely to find favour in the 21st century will accommodate fisheries' requirements through innovative engineering based on good knowledge of the resource rather than a continuation of past practices. NIWA's primary input to this process is through the development and application of knowledge of the water resource, in particular its variability and the environmental effects of different flow regimes. W&A

Dealing with changing climate

NIWA research on short- and long-term climate cycles is improving knowledge of risks facing hydropower supply – and indicating where improved forecasting of flows and demand could yield significant benefits. For example, see our FRST-funded programme 'Climate-related Risks for Energy Supply and Demand' at www.niwascience.co.nz/rc/prog/c01x0302

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