Development of a Capacity Adequacy Standard

Overview

May 2008

Purpose of this paper

This paper is a companion document to *Development of a Capacity Adequacy Standard - Consultation Paper,* published by the Electricity Commission in May 2008.

The consultation paper is fairly technical, due to the complex issues it addresses. This paper is intended for those who don't want to deal with all the technical detail. This paper seeks to place the consultation paper in a wider context, and explain the key conclusions of that paper.

What is meant by capacity adequacy?

Capacity adequacy refers to the ability of an electricity system to maintain secure supply during periods of higher demand even if there is a major power station or transmission failure, or there is little wind for wind generation. Major power station or transmission failures are by nature infrequent and tend to be short-lived – often lasting no more than a few hours.

Capacity is measured in megawatts (MW) or kilowatts (kW). By way of comparison, a small one bar heater is rated at around 1 kW, and 1,000 such heaters would generate demand of 1 MW.

Energy is measured in megawatt hours (MWh) or kilowatt hours (kWh). A one bar heater running for an hour will consume 1 kWh, and 1,000 such heaters would use 1 MWh. To provide a sense of scale, each household in New Zealand uses about 9,000 kWh (the "units" on a power bill) of electricity each year.

Historically, the New Zealand power system has been well-placed to respond to short duration power station or transmission failures because of its substantial hydro generation resources, which can be called upon at very short notice.

To date, the main security of supply challenge in New Zealand has come from prolonged periods of low rainfall – often referred to as "dry years". During these events, the challenge is to ensure that the demand for energy over an extended period can be met from the available 'energy' supplies – such as hydro inflows, and stored energy in lakes and fuel stocks for thermal power stations.

Even during these events, there has generally been no difficultly in providing MW capacity to meet electricity demand – this simply involves running down 'stored' energy in a lake or using thermal fuel stocks. However, such use reduces the energy available for utilisation at a later date. For this reason, New Zealand's system is often referred to as being 'energy constrained', rather than 'capacity constrained'.

Why develop a standard for capacity adequacy?

While capacity adequacy has not historically been an issue in New Zealand, the Electricity Commission is mindful that the system is changing. Less flexible hydro generation is being built to meet increasing electricity demand.

One of the most important trends resulting from the emphasis on renewable supply is the expected rise in 'uncontrolled' supply from sources such as wind generation. Because the level of output from these sources fluctuates in response to natural factors, there is less assurance that they will be operating during the periods of higher demand.

Another factor is the rise in the number of new power stations that run continuously – such as geothermal and co-generation plants. These plants are often referred to as "base-load" power stations.

The more base-load and uncontrolled power stations we have, the more we need flexible power stations to supply the peaks in demand. Flexible power stations designed to vary their output in response to changes in electricity demand can be challenging for new suppliers to justify as investments because their utilisation tends to be low and unpredictable. Investments in new uncontrolled and base-load power stations without some investment in flexible power stations could reduce the level of capacity adequacy.

In light of these factors, the Commission concluded that it would be prudent to develop a standard for capacity adequacy, against which the actual capacity of the power system can be compared.

How would a capacity standard be used?

Once a robust standard is developed, the Electricity Commission will include an assessment of capacity adequacy within its annual review of security.

If a future assessment does highlight concern with projected capacity levels, the Commission could respond in a number of ways. These include:

- signalling the emergence of a tight capacity situation, and monitoring the extent to which it is addressed by the development of new generation or demand-response resources;
- seeking to address any factors that are impeding the provision of capacity; and/or
- procuring capacity itself (new generation or firm demand-response contracts) using the powers in the Electricity Act.

The extent to which the Commission uses any of these tools (or others) will depend on the particular situation at the time, and be influenced by factors such as the time available to act, the magnitude of any possible shortfall, and the extent to which actions (e.g. new power projects) already underway by others will correct the situation.

Key elements of capacity adequacy standard

The level of reliability experienced by electricity users depends on the performance of the entire power system – from generation, through to transmission and distribution networks. However, for the reasons set out in the Consultation Paper, the Commission has focused on the capability of the *generation system* relative to *electricity demand*.

In developing a standard for capacity adequacy, it is important to consider both the *unit of measurement*, and the *benchmark* expressed in those units. To use an analogy, the speed limit on the open road is measured in kilometres per hour, and the maximum benchmark is set at "100".

Possible units of measurement for capacity adequacy

Commonly used measures of capacity adequacy include:

- Unserved energy (USE): the volume of demand that is 'lost' due to power supply interruption. For example, an average USE of 0.002% means that 99.998% of demand would be served without incident. USE reflects both the depth and duration of any power interruption;
- Loss of load expectation (LOLE): the expected number of hours of power interruption. For example, some North American systems have a standard of no more than one day in 10 years (equivalent to 2.4 hours per year on average). LOLE does not reflect the severity of any power outage;
- Loss of load probability (LOLP): the LOLE expressed as a fraction of hours per annum; and
- Capacity margin: a measure of the difference between total supply capacity and a measure of peak demand. In effect, this shows the expected 'safety margin' above expected demand. The margin can be based on total installed power station capacity, or a derated number to take account of station reliability etc.

A standard expressed in any one of these measures can be converted to the relevant equivalent in another measure, provided the underlying assumptions are known. This is analogous to converting a speed limit of 100 kilometres per hour to 62.5 miles per hour – they are the same speed measured in different units.

The Electricity Commission has concluded that the standard should be expressed as a capacity margin because it is easier to measure and understand in the context of the New Zealand power system.

Basis for defining a standard

Absolute security of supply is not a sensible objective because it would require massive redundancy in power stations and fuel supply, and be prohibitively expensive to achieve. Instead, the focus should be on finding the optimal point of balance, where the cost of improving security just equals the value that consumers place on the additional reliability. Any move to improve security beyond that point will cost more than it yields in benefit, or in other words, cost more than consumers are willing to pay.

A similar 'economic' logic can be applied to decisions about investment in electricity appliances. For example, for most households, the cost of buying and running two refrigerators would outweigh the expected benefits from having more reliable refrigeration capability.

A framework of weighing relative costs and benefits is used in the consultation paper to derive an 'economic standard' for capacity adequacy. In particular, the paper uses a well-established mathematical technique (see the consultation paper for detail) which seeks to take account of:

- the expected reliability of different power stations – to reflect factors such as breakdowns rates, maintenance outages, and wind variation;
- uncertainty about the level of 'peak' electricity demand – especially due to temperature variation;
- the cost to consumers of any supply shortfall (arising in the form of lost production, inconvenience etc). This is estimated at up to $100/kWh (compared to an average residential price of around 20 cents/kWh), and depends on the extent of any shortfall; and
- the cost of building and maintaining new power station capacity (estimated at approximately $120/kW/yr[1]).

Modelling results

The initial modelling work on an economic standard indicates that the "expected MW margin" is the most appropriate measure to use as a standard. Using this measure, the economic optimum for the North Island is around 600 MW or 13% of expected winter demand.

The consultation paper also sets out sensitivity analysis to test the effect of varying certain assumptions. This indicates that the results are relatively robust to differing assumptions, with results remaining within a range of +/- 60 MW.

[1] Based upon the cost of open cycle gas turbine technology.

The 600 MW margin measure can also be expressed in other terms. It is equivalent to a loss of load expectation (LOLE) of 2-3 hours per annum, or 0.002% unserved energy (USE). These results are broadly comparable with the standards adopted in electricity markets in Australia and North America.

Next steps

The Electricity Commission invites submissions on the Consultation Paper. This feedback will be valuable as the Commission progresses the work on the development of a security standard.

Submissions should be in writing and received no later than 5.00pm on 6 June 2008. Further details on the submission process are set out in the Consultation Paper.