

The security of supply framework

Information paper

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1 New Zealand's security of supply framework

- 1.1 The Authority's statutory objective is to promote competition in, reliable supply by, and the efficient operation of, the New Zealand electricity industry for the long-term benefit of consumers.
- 1.2 New Zealand's security of supply framework is designed around the second limb of the Authority's statutory objective, which is to promote reliable supply by the electricity industry for the long-term benefit of consumers. Our *Interpretation of the Authority's statutory objective*¹ explains that we consider reliable supply to encompass both reliability and security. In the context of continuity of supply:²
- (a) reliability refers to the rate and duration of outages
 - (b) security refers to the resilience of the system to adverse events (ie, avoiding outages despite significant adverse events occurring, where it is efficient to do so).
- 1.3 The design of the New Zealand electricity market recognises that all parties in the electricity industry contribute to, and are responsible for, reliability of supply. Supply interruptions can impose very large costs on consumers and suppliers, particularly when these interruptions are sudden and unpredicted. Uncertainty about future power supply can also be very costly if it undermines investment incentives and consumer confidence in the electricity industry, even if actual interruptions do not occur.
- 1.4 We have interpreted 'reliable supply for the long-term benefit of consumers' to mean efficient levels of reliable supply, where efficiency includes dynamic efficiency gains from adopting time-consistent arrangements. That is, arrangements must be resilient to adverse events over the long term.

Wholesale market arrangements contribute to reliable supply

- 1.5 There are three features of the wholesale electricity market that foster the efficient levels of generation and demand response capacity that make for efficient levels of reliable supply. These three features are:
- (a) spot prices that are allowed to rise and fall according to market forces
 - (b) the inherent incentive for buyers and sellers in the wholesale electricity market to trade their gains and losses to reduce the impact of price rises and falls on their revenue and costs; ie, the incentive to hedge their risk
 - (c) administrative mechanisms that reinforce spot prices when they do not reflect market forces.

Spot prices are allowed to rise and fall according to market forces

- 1.6 To be efficient, spot prices must be allowed to rise during periods of scarcity and fall during periods of plenty to achieve an efficient level of generating capacity and demand response capability. The Authority facilitates a workably competitive wholesale market and efficient spot prices. By monitoring the performance of trading in the market it continues to identify and implement ways to lower barriers, increase competition, deliver

¹ Located in the 'Foundation documents' section of our website, at <http://www.ea.govt.nz/about-us/strategic-planning-and-reporting/foundation-documents/>.

² As opposed to the 'quality of supply' component of reliability, that relates more to aspects of reliability such as system frequency and voltage.

appropriate reliability, and drive greater levels of efficiency. This provides confidence to market participants the market is designed to be efficient and competitive and drives them to prepare for periods of both high and low prices.

Inherent incentive for buyers and sellers to hedge their risks

- 1.7 Buyers and sellers in the wholesale electricity market understand that spot prices can rise and fall, and appreciate the effects that large price swings have on their costs and revenue. This fosters an incentive for wholesale market traders to trade the extra profit in good times against the losses in hard times—this is referred to as hedging.
- 1.8 To reduce the transaction costs associated with this trading, and to facilitate forward price discovery, the Authority actively encourages the development of financial instruments. These instruments enable trading between parties who stand to gain when spot prices are high and lose when they are low (eg, generators), with those in the opposite situation (eg, retailers and consumers). This trading promotes more efficient levels of hedging and, in turn, a more efficient level of generating capacity and demand response capability.

The wholesale market enables consumers to contract for the supply they want

- 1.9 New Zealand is well-placed to adapt to the uncertainties and challenges driven by new technologies, new business models, and increasing consumer participation. Spot prices that reflect market forces, combined with an effective hedge market and greater demand response, can provide an efficient level of security of supply now and into the future.
- 1.10 Spot prices will become more volatile as generating capacity from variable renewable energy sources grows. Very low prices will occur more often, and very high prices will ration demand. This is because these sources, such as solar photovoltaic (PV) or wind, have low operating costs and—in particular—no fuel costs. The spot price they set when they are the marginal supplier reflects these low costs, in contrast to the prices set by traditional thermal generation.
- 1.11 As these effects on spot prices become more prominent, we think suppliers will increasingly seek longer term contracts to recover their fixed costs and underpin new investment. We are acting to ensure the hedge market is well-suited to meet this need—the hedge market can be characterised as a market for contracts. In our view, prices in the spot market will increasingly evolve to reflect the price of contracts in the hedge market, rather than primarily operating costs. In fact, we can observe a similar dynamic today in other markets with low operating costs but substantial fixed costs, such as prices for hotel rooms.
- 1.12 In our view, the spot and hedge markets working together in this way enable consumers to contract with suppliers for the supply and reliability they want. They support the flexibility needed as the power system adapts to new technologies, new business models, and greater consumer participation. There is no reason why inadequate supply will develop during this transition, as contracts in the hedge market can provide the confidence for parties to invest. Greater demand response further supports these markets by helping to manage periods of scarcity signalled by high spot prices.
- 1.13 The Authority continues to actively develop and improve the wholesale market to promote an efficient security of supply. Refinements to the spot market to deliver settlement on dispatch-based real time pricing will foster further demand-side response

by making prices more actionable and resource efficient. Two new financial exchange-traded price cap products are planned for listing in mid calendar 2017. These price cap products will provide new opportunities for retailers, generators, and larger direct-purchase consumers to manage their spot price exposure.

Administrative mechanisms that reinforce spot prices when they do not reflect market forces

- 1.14 Spot prices may not be efficient and can need reinforcement when administrative actions are required to keep the power system secure. For example, if left alone, spot prices tend to be too low during a shortage or potential shortage of generation, especially when the system operator must intervene to reduce demand.
- 1.15 The Authority's concern is that prices during a shortage of generation should reflect the costs experienced by consumers when they have their electricity use curtailed. If they do not, wholesale market participants will have inadequate incentives to invest in generation capacity or demand response capability that avoids these costs.
- 1.16 Security and reliability arrangements need to be durable in the face of events that have high impact but low probability, or where there is a reasonable prospect of those events occurring in the immediate future. If they are not, periods of high prices and supply shortages can lead to demands for ad hoc interventions in the market or even new regulatory arrangements to provide electricity. Such interventions might result in an over-investment in supply capacity, unnecessarily increasing the costs faced by consumers.
- 1.17 Consequently, the Electricity Industry Participation Code 2010 (Code) contains mechanisms that help ensure prices remain competitive and efficient within the broadest range of situations.

2 There are six administrative mechanisms that promote reliable supply

- 2.1 Administrative mechanisms will typically be needed in two related but separate circumstances to ensure the market continues to support a secure power system and efficient spot prices: shortages of capacity and shortages of energy. There are currently six administrative mechanisms that support the market in these circumstances:
- (a) emergency load shedding
 - (b) scarcity pricing
 - (c) rolling outages
 - (d) official conservation campaigns (OCC)
 - (e) the customer compensation scheme (CCS)
 - (f) the stress test regime.

Mechanisms to manage capacity shortage

- 2.2 A capacity shortage is a situation where there is not enough generation to meet demand. It is a form of 'supply emergency'.
- 2.3 Ideally, as spot prices rise, demand for electricity would reduce and ensure capacity shortages do not occur. However, this is not always the case and capacity shortages do occur on occasion.
- 2.4 In the event of a capacity shortage supply emergency, the system operator will commence **emergency load shedding**,³ instructing loads to disconnect from the system to restore energy balance and avoid system collapse. In this situation, prices should increase further but the intervention of the system operator to reduce demand tends to cause spot prices to fall as less supply is now needed to meet the forced reduction in demand.
- 2.5 When load shedding is required in an entire island, **scarcity pricing**⁴ provisions are triggered to ensure involuntary load curtailment does not 'artificially' suppress the spot price. Without these provisions, spot prices would be too low, weakening the underlying signal of the value of last-resort generation capacity or voluntary demand response, and lead to lower investment in these facilities.
- 2.6 Scarcity pricing scales generation-weighted average spot prices up to a floor of \$10,000/MWh, or down to a ceiling of \$20,000/MWh. These price spikes are high but should be of relatively limited duration (ie, hours). A 'stop-loss' mechanism in the Code also means scarcity pricing is not applied if spot prices in an island have averaged more than \$1,000/MWh in the previous week.
- 2.7 Usually, the underlying cause of a temporary capacity shortage can be expected to be resolved relatively quickly. However, if the shortage conditions are prolonged and the likelihood of unplanned outages is greater than 50%, the system operator will declare a 'supply shortage', as a condition of 'extended emergency' (due to an 'immediate event').⁵

³ See Technical Code B of Schedule 8.3 of the Code.

⁴ See clauses 13.135A-C of the Code.

⁵ See section 3 of the System Operator Rolling Outage Plan (SOROP):
<http://www.systemoperator.co.nz/security-supply/security-supply-policies/rolling-outage-plans/>.

The system operator will then initiate planned **rolling outages**,⁶ directing certain parties to curtail their load. Rolling outages will continue until the probability of unplanned outages falls below 50%.

Mechanisms to manage energy shortage

- 2.8 Power systems are typically subject to capacity shortage risk, and managing that risk is a fundamental concern of security of supply. However, New Zealand's power system also has an energy shortage challenge. In this context, an energy shortage refers to a situation where the risk of running out of water to generate electricity becomes unacceptably high.⁷
- 2.9 The risk is that, if preventive action is not taken, and the situation does not improve (eg, rain falls, snow melts, or more thermal generation becomes available), load may have to be curtailed involuntarily until energy supplies are restored. This curtailment could potentially last for several weeks, perhaps longer. Unlike a capacity shortage, which would normally begin and end within hours or days, an energy shortage is a slow-onset security threat characterised by spot prices rising over days and weeks as supply becomes increasingly constrained.⁸
- 2.10 New Zealand's energy shortage challenge stems from two characteristics of our power system:
- (a) The dominance of hydroelectric generation from lake storage means that rain and snow-melt inflows to those lakes are a critical influence over the energy supply. This is compounded by the relatively low level of storage capacity in these hydro lakes. Water in New Zealand must be carefully managed all year round.
 - (b) Our geographical isolation means there is no practical ability to connect to other power systems for backup supplies.
- 2.11 Depending on other generation capacity available, trends in load, and how hydro storage lakes are managed, a 'dry' year with low inflows can result in a significant chance of energy shortage during the winter months. Therefore, a level of energy supply held in reserve is required to manage this risk—generating capacity and associated fuel that may be used rarely, or not at all, under average conditions.
- 2.12 Spot prices will typically rise as the risk of energy shortage grows, reflecting the increasing scarcity of supply. These high spot prices would be expected to discourage consumption. However, because the vast majority of mass-market consumers are not exposed to the spot price (they are on fixed price, variable volume contracts), and do not participate in any explicit demand-response scheme, non-market intervention will be required to facilitate the required reduction in their consumption. Accordingly, the system operator will take action when the probability that energy shortage will occur exceeds some explicit safety margin.

⁶ See Part 9 of the Code.

⁷ With the majority of New Zealand's generation being sourced from hydro generation, the risk of running out of water could relate to either or both of a shortage of available water (from low inflows) or from water being used at higher rates than anticipated as a result of shortfalls in other sources of supply.

⁸ The System Operator Rolling Outage Plan defines energy shortage as a 'developing event' which is a form of 'extended emergency'.

- 2.13 This safety margin is determined by the hydro risk curves (HRC) that the system operator maintains to track the risk of energy shortage.⁹ Each curve indicates the level of controlled hydro storage at which, under the stated proportion of historical inflow sequences (the x% HRC), storage would fall to zero later in the season. If available storage reaches the 10% HRC, for example, controlled storage falls to zero in one in ten of the historical hydro inflow sequences.
- 2.14 The system operator will intervene once controlled storage breaches the 10% HRC threshold and enters the 'security emergency phase'. At that point, the system operator is required to initiate an **official conservation campaign** (OCC) to encourage consumers to voluntarily save energy—again, the vast majority of mass-market consumers are not exposed to the spot price and hence have no signal to reduce their electricity use. OCCs are intended to reduce aggregate energy consumption until rain or snow melt replenishes the hydro lakes, or until high winter demand passes (at which point the OCC will be ended).
- 2.15 Importantly, controlled storage falling to zero does not mean that hydro lakes have been exhausted—significant volumes of water are set aside as 'contingent hydro storage' and become available under emergency conditions, which may be triggered by an OCC.¹⁰ The exact conditions are specific to each lake, governed by factors such as the resource consent granted by the relevant local authority. In general, more water becomes available as the risk of energy shortage increases.
- 2.16 Declaring an OCC in turn triggers an obligation for retailers to pay customers a weekly amount under the **customer compensation scheme** (CCS). The weekly amount is set at a level designed to reflect the financial benefit retailers receive in the wholesale market from reduced purchases as a result of their customers' saving effort, recognising that retailers are exposed to very high spot prices while shortage conditions exist.
- 2.17 However, if energy supply conditions continue to deteriorate to the extent that the probability that unplanned load outages will be needed exceeds 50%, the system operator will declare a supply shortage (in this case, a 'developing event' extended emergency).¹¹ The system operator will then initiate planned rolling outages, as described in paragraph 2.7.¹²
- 2.18 Spot market prices are not stipulated by the arrangements governing OCCs, the CCS, or rolling outages, but are likely to be sustained at high levels, including for some time prior to reaching the 10% HRC threshold. However, spot prices will be lower than the price spikes driven by capacity shortage, and the energy savings driven by OCCs will tend to reduce spot prices somewhat.

⁹ HRCs are defined in the Security of Supply Forecasting and Information Policy (SOSFIP), <https://www.systemoperator.co.nz/security-supply/security-supply-policies/security-supply-forecasting-and-information-policy>. For further explanation see <http://www.systemoperator.co.nz/security-supply/hydro-risk-curves-explanation>; current HRCs are available from the system operator at <http://www.systemoperator.co.nz/security-supply/sos-weekly-reporting/hydro-risk-curves>, and on EMI at <http://www.emi.ea.govt.nz/Reports/VisualChart?reportName=3UN1KD&categoryName=Environment>.

¹⁰ Contingent hydro storage is defined in the SOSFIP. Further background is available from the system operator at <http://www.systemoperator.co.nz/sites/default/files/bulk-upload/documents/Contingent%20Storage%20%20additional%20information.pdf>, and each lake is detailed in the hydrological modelling dataset at http://www.emi.ea.govt.nz/Datasets/Environment/Hydrological_modelling_dataset.

¹¹ See section 3 of the SOROP.

¹² That is, rolling outages may be triggered either by rapidly developing capacity shortage events or by extended conditions of energy shortage (and an OCC has not been able to reduce the risk adequately).

Conservation campaigns can be an efficient response to the risk of dry years

- 2.19 It is important to appreciate that OCCs do not in and of themselves represent a failure of New Zealand's energy market and regulatory arrangements. Energy shortage risk can be managed, but it cannot be eliminated.
- 2.20 A level of energy reserve (generating capacity and demand response capability) that guarantees energy shortage *never* occurs would be extremely reliable but it would not be efficient. The cost of holding so much unused generating capacity (and associated fuel) in reserve is likely to be greater than the cost of foregone consumption during supply shortages. The combined costs of investing in generating capacity that is likely to be used extremely rarely (and perhaps never) and curtailing consumption through demand response schemes would exceed the value that mass-market consumers obtain from their continued electricity use during tight supply conditions. All of these costs are ultimately borne by all consumers.
- 2.21 Consequently, an efficient level of energy reserve will not ensure that an OCC never occurs, and OCCs need to be effective when they are called.

Mechanism to reinforce incentives for buyers and sellers to hedge their risks

- 2.22 The New Zealand electricity market relies on incentives for buyers and sellers to hedge their risks and take the financial gains and losses associated with their actions in order to promote efficient competition and reliability outcomes.
- 2.23 However, prices in the wholesale electricity market are typically more volatile than other spot prices, such as equity, currency and other commodity prices, as a result of the need for supply and demand to continually be in balance. The volatility of spot electricity prices, combined with the fact that electricity is an essential and significant input for many consumers, provides the potential for opportunistic lobbying for intervention and for arguments that 'the electricity market isn't working' during periods when supply is tight and spot prices are high.¹³
- 2.24 In tight market situations, it can be difficult for parties to accept responsibility for the risks they took (knowingly or not) and it is natural for them to question the market rules. It is equally hard for external commentators to appreciate that financial difficulties faced by market participants might be due to earlier choices they made rather than a market and regulatory failure. This issue is widely recognised in economic literature as the problem of ensuring time consistency.
- 2.25 We introduced the **stress test** regime to respond to this risk. The regime provides participants with information on the consequences of their exposure to spot market prices during illustrative energy and capacity shortage scenarios. Presenting participants with this information serves two purposes:
- (a) it provides a signal for them to assess their exposure and consider whether it would be prudent to manage this exposure through actions such as investing in

¹³ For more discussion on the risks associated with opportunistic lobbying, refer to the Authority's consultation paper *Proposed refinements to the stress test Code amendments*, 11 October 2011 <http://www.ea.govt.nz/dmsdocument/11660>.

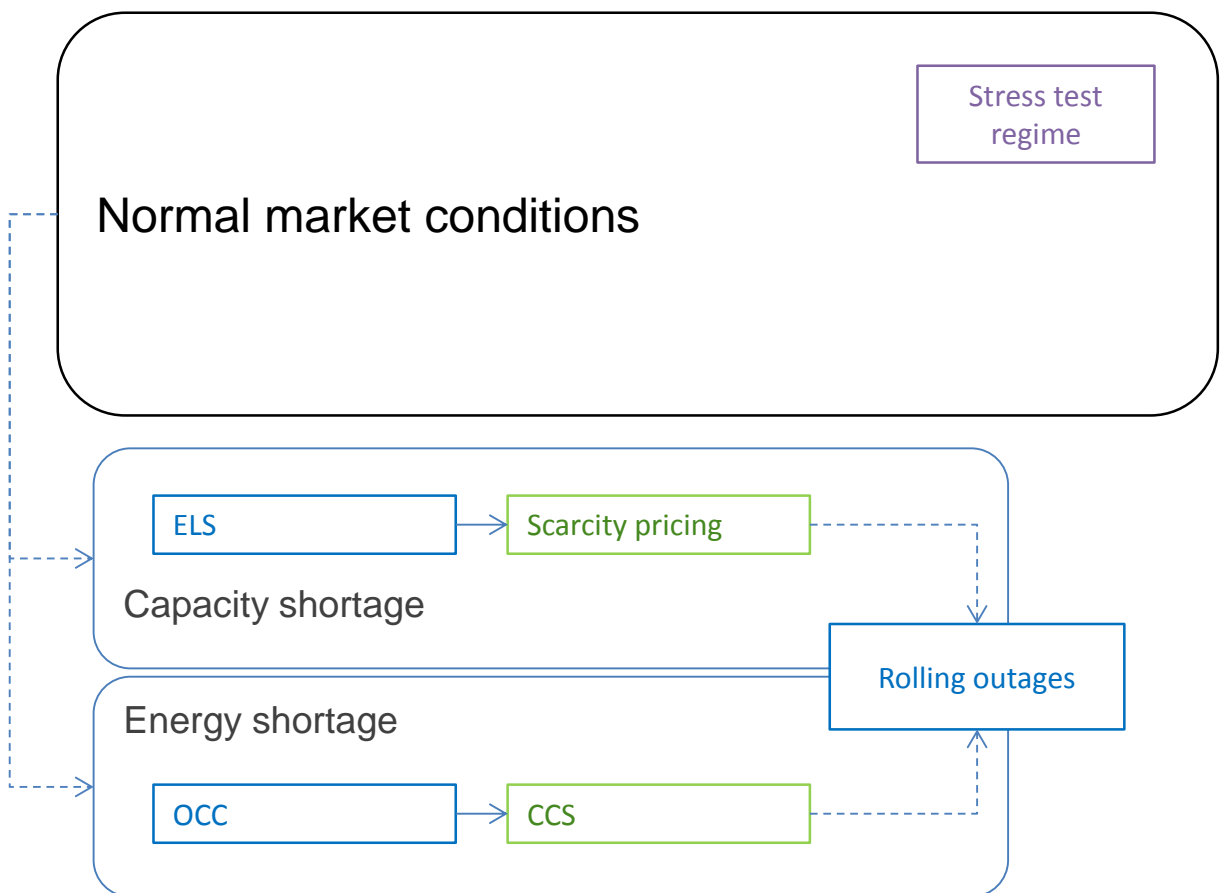
new generation or demand response capacity, or purchasing financial hedging contracts

- (b) they cannot later credibly deny they were unaware of the possibility and financial consequences of capacity and energy shortages.

Illustrating the administrative mechanisms within the security of supply framework

2.26 These administrative mechanisms and the way they work together within the security of supply framework are illustrated in Figure 1.

Figure 1: The administrative mechanisms forming New Zealand’s security of supply framework



Source: Electricity Authority

Notes: ELS = emergency load shedding, OCC = official conservation campaign, CCS = customer compensation scheme.

3 New concerns around security of supply risks led us to consider whether the framework is effective

- 3.1 Recent developments in the market created an outlook of heightened security of supply risk (ie, risk of supply being insufficient to meet demand). These developments included:
- (a) Withdrawal of thermal generation at Otahuhu B (400 MW) and Southdown (140 MW) and Genesis' announcement it would decommission the two remaining dual fuel (coal and gas) Huntly Rankine units (250 MW each). The announcements reduced the margin by which available capacity exceeds typical demand levels.
 - (b) Uncertainty around demand growth and the future of the New Zealand Aluminium Smelter at Tiwai Point. This uncertainty could reduce forward contracting activity and new capacity investment.
- 3.2 Modelling undertaken by the system operator as part of a specific investigation into the impacts of decommissioning thermal plant indicated heightened risk that the country could experience energy shortage conditions should a dry year occur in 2019.¹⁴
- 3.3 At the same time, some participants have suggested that demand for electricity is rising again after many years of limited or no growth. The uptake of evolving technologies such as electric vehicles, solar PV, and battery storage could add to (electric vehicles) or soften (solar PV) this growth.
- 3.4 The magnitude and timing of these developments create the potential for New Zealand to move rapidly from the recent history of flat demand and over supply to a reduced supply margin as generating capacity is withdrawn from the market and demand growth returns.
- 3.5 These developments also increase uncertainty about future spot prices. This uncertainty may make it harder for market participants to justify long-term investments in new generation or demand response capacity or hedging arrangements with other suppliers. While deferred or shelved investment may be a prudent strategy under the present circumstances, decisions around the future of significant capacity—most notably the two remaining Rankine units at Huntly (totalling 500 MW)—take on greater importance. Such decisions have the potential for sizeable regrets, which could then lead to attempts to shift blame and request political intervention.
- 3.6 The Authority had been closely monitoring these developments. While we consider that the security of supply framework is effective, we decided that it would be prudent to review these arrangements in the circumstances. In particular, we decided to review the CCS and stress test regime to ensure that these mechanisms remain effective in this developing market environment.

¹⁴ See <http://www.systemoperator.co.nz/activities/current-projects/impact-thermal-generator-decommissioning>.

4 Evidence suggests the security of supply framework is working as intended

- 4.1 We announced our review of the CCS and the stress test regime before Genesis announced it had entered into commercial arrangements with other participants that are expected to keep the two Huntly Rankine units operational until 2022. The system operator has subsequently confirmed that retaining the Huntly units mitigates the risk of dry-year energy shortage in 2019.¹⁵ Genesis' decision, and the involvement of multiple parties, suggests that suitable signals and mechanisms are in place to encourage participants to respond to the perceived security of supply risk.
- 4.2 Also, after we introduced the scarcity pricing, CCS, and the stress test provisions, the market successfully navigated the driest hydro storage inflow sequence on record in 2012, and a subsequent dry sequence in 2013, without intervention. This is another indication that market participants are managing security of supply in the expected manner, and that the framework, including these administrative mechanisms, is contributing to an effective set of arrangements.
- 4.3 Our reviews of the CCS and the stress test regime conclude that these mechanisms continue to promote the reliability and efficiency limbs of the Authority's statutory objective in the face of changing market conditions. We have published separate consultation papers to provide the detail of our assessment.^{16,17}

¹⁵ Barker, Kate. 'Huntly decision eases 2019 supply risk – Transpower'. *EnergyNews*, 28 April 2016.

¹⁶ See the *Review of the stress test regime* at <http://www.ea.govt.nz/development/work-programme/risk-management/review-of-stress-testing-regime/consultation/#c16205>.

¹⁷ See the *Review of the customer compensation scheme* at <http://www.ea.govt.nz/development/work-programme/risk-management/review-of-the-customer-compensation-scheme-ccs/consultation/#c16203>.