Meeting Date: 27 May 2021

# FIT-FOR-PURPOSE REVIEW: REGULATION AND MONITORING - GENERATION

SECURITY AND RELIABILITY COUNCIL

This paper summarises the current regulatory arrangements relating to generation reliability and assesses whether current regulatory arrangements provide effective controls on the risk of generation failures that result in an economic loss of more than $10 million. The paper suggests that some of the regulatory arrangements in the Code could be amended to provide more effective controls on the risk of unplanned generation outages.

**Note:** This paper has been prepared for the purpose of enabling the Security and Reliability Council to formulate advice to the Authority on whether regulatory arrangements provide effective controls on the risk of generation failures that result in an economic loss of more than $10 million. Content should not be interpreted as representing the views or policy of the Electricity Authority.

# Contents

# 1 Review of whether regulatory arrangements provide effective controls on the risk of generation failure

1.1.1 The Security and Reliability Council's (SRC) functions under the Electricity Industry Act 2010 (Act) include providing advice to the Electricity Authority (Authority) on:

a) the performance of the electricity system and the system operator, and

b) reliability of supply issues.

1.1.2 In pursuit of its purpose, the SRC developed a risk management framework to identify key arrangements for managing risks to reliability of supply. The framework identified the regulatory arrangements for electricity generation as warranting the SRC's attention periodically.

1.1.3 The purpose of this paper is to enable the SRC to formulate advice to the Authority on whether regulatory arrangements provide effective controls on the risk of generation failures that result in an economic loss of more than $10 million.

1.1.4 To inform that advice, the paper:

a) summarises the current regulatory arrangements relating to generation reliability, and

b) assesses whether current regulatory arrangements provide effective controls on the risk of generation failures that result in an economic loss of more than $10 million.

# 2 Regulatory arrangements for electricity generation reliability

2.1.1 This section describes the current regulatory arrangements governing the reliability of electricity generation in New Zealand.

## 2.2 The Authority is to promote reliable electricity supply by generators

2.2.1 The second limb of the Authority's statutory objective says the Authority is to promote reliable supply by the New Zealand electricity industry for the long-term benefit of consumers.

2.2.2 The primary way in which the Authority does this is through the development and enforcement of Code provisions. The Code contains a mixture of market-based and administrative mechanisms that contribute to the reliable supply of electricity by generators.

### Part 13 of the Code promotes reliable supply by generators through the price mechanism

2.2.3 The wholesale electricity market arrangements in Part 13 of the Code promote reliable supply by generators offering into the market. They do this through the price mechanism, which provides an incentive on generators to minimise failure of their assets. Quite simply, a generator makes money by generating electricity. Generation outages cost a generator money, through:

a) foregone sales and/or payments to other generators to supply the generation shortfall on the generator's behalf, and

b) any costs incurred repairing damage to generation assets associated with the outage.

2.2.4 The incentive to minimise generation failures is stronger during periods when electricity prices are, or tend to be, higher (eg, New Zealand's winter months). Depending on a generator's net supply position and offer stack, the incentive is likely to also be higher if the generation failure were to lead to high short-term prices.

## Part 8 of the Code specifies performance obligations and technical standards for generators, which act as controls on the risk of generation failures

2.2.5 Part 8 of the Code specifies performance obligations and technical standards for generators (including in relation to commissioning and testing), which assist the system operator to comply with its principal performance obligations (PPOs) in relation to common quality and dispatch.

2.2.6 Performance obligations and technical standards that act as controls on the risk of generation failures (where 'failures' is defined to include electrical disconnection from the network to which the generator is connected) include:

a) grid-connected generators must operate within a range of voltages,[1] and voltage imbalance levels must be maintained below a certain limit,[2]

b) electrically connected generation assets must ride through faults on the grid, as follows:

   i. remain stable and electrically connected during and immediately after a short circuit on the grid or a trip of the HVDC link, provided system voltage remains within a defined under- and overvoltage range/envelope,[3]

   ii. generate reactive current to oppose voltage changes (dips) that occur during and immediately after faults on the AC grid,[4] and

   iii. provide active power output during and immediately after a short circuit on the grid,[5]

c) grid-connected generating units and associated voltage control systems must support the system operator in meeting the PPOs—eg, avoiding cascade failure during voltage excursions,[6]

---

1 Clause 8.22 of the Code.

2 Refer to clause 4.9 of the Connection Code.

3 Clause 8.25A.

4 Clause 8.25B.

5 *Ibid*

6 Clause 5(1)(a)(i) of Technical Code A of Schedule 8.3.

d) generators that inject at least 30 MW into the grid, and which are not wind powered, must be tested periodically—typically every 4–10 years depending on the type of equipment—to ensure their assets comply with the asset owner performance obligations set out in Part 8 and Technical Code A of Schedule 8.3,[7] and

e) during the occurrence of extreme variations of frequency or voltage at its grid injection point, a generator must act to minimise the grid emergency—eg, by increasing/decreasing energy injection, synchronising/re-synchronising and loading generation units.[8]

2.2.7 The system operator monitors, in accordance with the policy statement, the ongoing compliance of generators with their asset owner performance obligations and the technical codes in Part 8. The system operator has the discretion to not dispatch a generation asset or configuration of generation assets that it is not satisfied:

a) complies with the relevant asset owner performance obligations or provisions of the technical codes, or

b) has/have a valid equivalence arrangement or dispensation from the relevant asset owner performance obligations or provisions of the technical codes.[9]

## The 'event charge' for under-frequency events is intended to promote reliable generation

2.2.8 Under Part 8 of the Code, the primary causer of an under-frequency event must pay an administered charge for power lost at grid connection points because of the under-frequency event. The administered charge is known as an 'event charge'.[10]

2.2.9 The event charge seeks to provide generators and grid owners with an incentive to have reliable assets by requiring them to pay an administered charge if their assets trip and cause an under-frequency event.[11]

2.2.10 However, after completing a broad 'first principles' review of the event charge and the approach to allocating the cost of instantaneous reserves, the former Wholesale Advisory Group concluded that the regime provides no meaningful incentive for asset owners to be more reliable.[12] The Authority is still to decide if it will initiate a review of this regime.

## Under Part 6 of the Code connection and operation standards act as controls on the risk of unplanned distributed generation outages

2.2.11 Part 6 of the Code specifies a framework to enable distributed generation to be connected to a distribution network, or to a consumer installation connected to a

---

7 Clause 8(1) of Technical Code A of Schedule 8.3 and appendix B of Technical Code A of Schedule 8.3.

8 Clause 9 of Technical Code B of Schedule 8.3.

9 Clause 8.27

10 The event charge is $1,250 / MW for every MW of power lost above a 60 MW de minimis threshold applied across all connection points affected by the under-frequency event. Refer to clause 8.64.

11 Wholesale Advisory Group, 11 October 2016, Instantaneous Reserve Event Charge and Cost Allocation – WAG discussion paper, p. 13.

12 Wholesale Advisory Group, 4 April 2017, Instantaneous Reserve Event Charge and Cost Allocation: Recommendations of the Wholesale Advisory Group, p. 5.

distribution network, provided this is consistent with connection and operation standards determined by the distributor.[13] These standards act as controls on the risk of unplanned distributed generation outages.

2.2.12 The standards include requirements relating to the planning, design, construction, testing, inspection, and operation of distributed generation. The standards must reflect, or be consistent with, reasonable and prudent operating practice. They include the following:

a) the distributor's congestion management policy,

b) the distributor's emergency response policies, and

c) the distributor's safety standards.[14]

2.2.13 Connection and operation standards are therefore subject to individual distributor policies and preferences. It is the secretariat's understanding that, when setting connection and operation standards, most distributors broadly follow a national good practice guide developed by the Electricity Engineers' Association.[15]

2.2.14 Note that the discussion in this paper excludes distributed generation connected to a consumer installation that is connected to a distribution network. SRC members are referred to the separate paper on the agenda of the 27 May 2021 meeting, titled 'Fit-for-purpose review: Consumer Premises Equipment, for this discussion.

## 2.3 Worksafe regulates reliable electricity supply by generators by regulating electrical safety

2.3.1 Worksafe New Zealand (Worksafe) is a crown agency established by section 5 of the WorkSafe New Zealand Act 2013.

2.3.2 Worksafe has the following functions under the Electricity Act 1992:

a) to carry out inquiries, tests, audits, or investigations that may be necessary to determine whether a person is complying with the Electricity Act,

b) to take all lawful steps that may be necessary to ensure the safe supply and use of electricity, and

c) to perform other functions provided for under the Electricity Act.[16]

---

13 Noting that the Part 6 provisions do not apply to;

- embedded networks and islanded networks that convey less than 5 GWh of electricity per annum and distributed generators connecting, or connected, to such embedded networks, and
- distributors in respect of their ownership or operation of a system of lines that is used for providing line function services only to them.

Refer to clauses 6.2A and 6.2B of the Code.

14 Clause 1.1(1)—the definition of 'connection and operation standards'.

15 Electricity Engineers' Association, July 2018, Guide for the connection of small-scale inverter-based distributed generation.

16 Section 5 of the Electricity Act.

### The Electricity (Safety) Regulations specify a standard for inverters

2.3.3 Worksafe is responsible for administering the Electricity (Safety) Regulations 2010, which regulate electrical safety and related matters.[17] These regulations specify a standard for inverters used in distributed generation, for the purposes of the safe operation of the inverters.[18]

2.3.4 The way an inverter performs its functions, for example through the operation of the electrical protection functions and advanced power quality modes, can have a material impact on external networks. An inverter can provide active control of its input or output that affects local voltage and national grid system frequency. Therefore, coordinated settings of inverters connected directly or indirectly to an electricity network are very important.

2.3.5 WorkSafe regulates only safety-related performances aspects of inverter standards. It does not have the power to regulate aspects of inverter standards that relate to an inverter's functions, modes and non-safety-related performance.

# 3 Are regulatory arrangements for generation providing effective controls on the risk of unplanned generation outages?

## 3.1 Overview

3.1.1 This section:

a) identifies risks that could result in unplanned generation outages that cause an economic loss of more than $10 million, and

b) assesses whether current regulatory arrangements for generation provide effective controls on the risk of unplanned generation outages.

3.1.2 It is suggested that some of the regulatory arrangements in the Code could be amended to provide more effective controls on the risk of unplanned generation outages.

---

17 Sections 169, section 169A, section 169B, and section 169C of the Electricity Act.

18 Section 60(2) of the Electricity Safety Regulations.

**Table 1: Initial evaluation of whether regulatory arrangements provide effective controls on the risk of generation failures**

| # | Risk area | Risk to security of supply | Initial evaluation: Impact threshold met? | Initial evaluation: Likelihood | Initial evaluation: Effectiveness of current regulatory arrangements |
|---|---|---|---|---|---|
| 1 | A thermal fuel supply failure to electricity generators. | A failure in the supply of gas, diesel or coal will reduce the electricity output of thermal generators and their availability to generate, thereby exacerbating supply-side energy and capacity constraints during periods of low hydro inflows and/or low wind/solar and/or high energy demand. | **Impact threshold met**<br>The under-provision of available generation capacity could have a material adverse impact on security of supply and cause significant economic loss. | **Low-to-medium likelihood of risk becoming an issue**<br>The gas transmission system is constructed and operated with security of supply in mind, including equipment redundancy (where economic) and a degree of flexibility around the configuration of the system. However, there are risks to gas transmission supply—principally, corrosion, third party damage and geohazards.[19]<br>Historically the New Zealand gas system has been supported by spare gas available on the day at the Maui gas field. With the decline in the spare gas available from Maui, the electricity system is now | **Effectiveness of regulatory arrangements could be improved**<br>It would appear prudent for the Authority to review its regulatory arrangements that influence the pricing of thermal fuel supply risk in the electricity market and the management of thermal fuel supply risk in the wholesale market.<br>Examples of relevant initiatives the Authority is currently undertaking include its hedge market development project and its wholesale market information disclosure project. |

19 Firstgas presentation to the SRC on gas transmission security and reliability, 28 March 2018, slide 24.

| # | Risk area | Risk to security of supply | Initial evaluation:<br>Impact threshold met? | Initial evaluation:<br>Likelihood | Initial evaluation:<br>Effectiveness of current regulatory arrangements |
|---|---|---|---|---|---|
| | | | | more exposed to gas outages.[20]<br>The supply chains for coal and diesel have several potential points of failure, including shipping, port/offloading, resource consenting for storage and transport, and pandemics. | |
| 2 | Decarbonisation policies result in insufficient reserve generation. | Ceasing to use coal as an electricity generation fuel would reduce the electricity output and availability of the three Rankine units at the Huntly power station, thereby exacerbating supply-side energy and capacity constraints during periods of low hydro inflows and/or low wind/solar and/or high energy demand. | **Impact threshold met**<br>The under-provision of available generation capacity could have a material adverse impact on security of supply and cause significant economic loss. | **High likelihood of risk becoming an issue**<br>New Zealand's transition to being carbon neutral by 2050 means this risk is expected to become an issue in the longer term. | **Effectiveness of regulatory arrangements could be improved**<br>It would appear prudent for the Authority to review its regulatory arrangements that influence the uptake of new generating technologies and the substitution of generation fuel sources over time.<br>The Market Development Advisory Group's report titled 'Enabling participation of new generating technologies in the wholesale electricity |

20 OMV presentation to the SRC on OMV's perspectives on New Zealand gas supply security, 20 June 2019, slide 13.

| # | Risk area | Risk to security of supply | Initial evaluation: Impact threshold met? | Initial evaluation: Likelihood | Initial evaluation: Effectiveness of current regulatory arrangements |
|---|---|---|---|---|---|
| | | | | | market' identifies a number of key issues in relation to generating technologies participating in the wholesale market. |
| 3 | Reduced system inertia. | In many cases, thermal generation is being replaced by non-synchronous generation, which does not provide inertia. Hence, system frequency will change more rapidly in response to supply / demand imbalances, increasing the risk of adverse grid events (eg, under-frequency events that potentially trigger automatic under-frequency load shedding (AUFLS)). | **Impact threshold met** An AUFLS event caused by a lack of inertia on the power system would have a material adverse impact on reliability and cause significant economic loss. | **Low likelihood of risk becoming an issue** The likelihood of this risk becoming an issue in the short term is low. This is due to the relatively large amount of synchronous generation connected to a network. However, this risk might be expected to increase over time if synchronous generation is replaced by asynchronous generation without the same functionality as synchronous generation. | **Effectiveness of regulatory arrangements may be improved** It would appear prudent for the Authority to consider whether the design of the ancillary services arrangements are likely to remain fit-for-purpose as the mix of synchronous and non-synchronous generation continues to change. |
| 4 | Inadequate security for information and internet-connected generation equipment and control systems. | A 'bad actor' disrupts generation plant operation and/or destroys generation equipment by accessing:<br>• generation information physically or | **Impact threshold met** A cyber attack on generation equipment, on supervisory control and data acquisition (SCADA) systems, and/or on control systems could disrupt the | **Low-to-medium likelihood of risk becoming an issue** A 2018 Deloitte report stated that cyber attacks on utilities are moving from stealing data or launching | **Effectiveness of regulatory arrangements may be improved** Information security and cyber security for generators are not regulated in a prescriptive |

| # | Risk area | Risk to security of supply | Initial evaluation: Impact threshold met? | Initial evaluation: Likelihood | Initial evaluation: Effectiveness of current regulatory arrangements |
|---|---|---|---|---|---|
| | | electronically (cyber attack),<br>• generation infrastructure electronically (cyber attack). Successful cyber attacks on non-generation plant IT systems may afford access to critical generation business systems. | generation plant in a way that has a material adverse impact on reliability and causes significant economic loss. | ransomware for financial gain, to seeking to potentially disrupt or destroy critical physical assets such as generation plant.[21] | manner. Legislation that prescribes in detail how information must be protected, or sets outcome-based performance standards will quickly become outdated.[22]<br>However, it may be worth exploring the benefits and costs of requiring at least some generators[23] to adopt an internationally recognised cyber security maturity framework, such as the Electricity Subsector Cybersecurity Capability Maturity Model (C2M2).[24] |
| 5 | Underfrequency events caused or exacerbated by generation disconnecting. | Distributed energy resources (DER) connected to distribution networks through DC/AC power inverters (inverters), and generation plant that | **Impact threshold met**<br>An AUFLS event caused by generation not riding through major generation failures would have a | **Low likelihood of risk becoming an issue in the short term**<br>The likelihood of this risk becoming an issue in the | **Effectiveness of regulatory arrangements needs to be improved**<br>The system operator has recognised this risk and |

21 Deloitte, 2018, Managing cyber risk in the electric power sector: Emerging threats to supply chain and industrial control systems, pp. 3–4.

22 Refer to the SRC paper 'Industry arrangements for information security: An overview of arrangements relating to cyber and physical security of information', 22 October 2015, p. 11.

23 There may be economic grounds for putting in place a de minimis on which generators would have to adopt such a framework.

24 EMCa, May 2019. Transpower Regulatory Control Period 3 Proposal: Review of aspects of the proposed ICT expenditure, Report to New Zealand Commerce Commission.

| # | Risk area | Risk to security of supply | Initial evaluation: Impact threshold met? | Initial evaluation: Likelihood | Initial evaluation: Effectiveness of current regulatory arrangements |
|---|---|---|---|---|---|
| | | suffer from unexpected control system behaviour, may not 'ride through' a major generation failure, thereby exacerbating under-frequency events, and potentially triggering automatic under-frequency load shedding (AUFLS). | material adverse impact on reliability and cause significant economic loss. | short term is low. This is due to the relatively small number, and aggregate capacity, of inverters within DER, and the rate at which specialists can install these smaller capacity systems. However, international experience is that the risk likelihood can increase quite quickly to material levels. DER system costs are decreasing rapidly, which will accelerate the number, and aggregate capacity, of installed inverters. | has undertaken relevant investigative work. In cooperation with the system operator, the Authority is scoping a work programme to review the performance aspects of the inverter standards for distributed generation.<br>At the transmission level, the Authority is well underway with a review of Parts 8 and 13 of the Code that has as its objective the enablement of grid-scale (battery) energy storage systems (BESS) to provide instantaneous reserves.<br>It would also appear prudent for the Authority to review whether the asset commissioning and testing arrangements for generation remain fit-for-purpose given the uptake of generation that is asynchronously connected to a network. |

| # | Risk area | Risk to security of supply | Initial evaluation:<br>Impact threshold met? | Initial evaluation:<br>Likelihood | Initial evaluation:<br>Effectiveness of current regulatory arrangements |
|---|---|---|---|---|---|
| 6 | Cascade failure from frequency or voltage excursions. | As the amount of synchronous generation falls over time and more generation asynchronously connects to a network through DC/AC power inverters (inverters) (eg, wind solar and batteries), the risk of cascade failure from frequency or voltage excursions increases. | **Impact threshold met**<br>Cascade failure would have a material adverse impact on reliability and cause significant economic loss. | **Low likelihood of risk becoming an issue in the short term**<br>The likelihood of this risk becoming an issue in the short term is low. This is due to the relatively large amount of synchronous generation connected to a network. However, this risk might be expected to increase over time if synchronous generation is replaced by asynchronous generation without the same functionality as synchronous generation. | **Effectiveness of regulatory arrangements needs to be improved**<br>The system operator has recognised this identified risk and has undertaken relevant investigative work. In cooperation with the system operator, the Authority is scoping a work programme to review minimum standards for inverter protection functions, monitoring capability and stable operating performance. Options being considered include whether this workstream may progress as part of the G2 work programme. |