

Smart Grid Forum matters relating to security and reliability

Implications of the work of the Smart Grid Forum
on the Security and Reliability Council and
security and reliability matters

19 June 2015

Background

The Security and Reliability Council's (SRC) functions under the Electricity Industry Act 2010 include providing advice to the Electricity Authority (Authority) on reliability of supply.

The Smart Grid Forum (Forum) was commissioned in early 2014 by the Ministry of Business, Innovation and Employment with the support of the Electricity Networks Association (ENA). The Forum's objective is "to advance the development of smart electricity networks in New Zealand through information sharing and dialogue, supported by analysis and by focussed work-streams where these are considered to be appropriate."¹

The Forum approached the SRC to open a dialogue about the security and reliability related recommendations in the Forum's first year report to the Minister of Energy and Resources.

The purpose of this paper is to present the Forum's key findings and recommendations to the SRC and seek the SRC's advice (if any, at this stage) to the Authority Board. The Forum's paper to the SRC is attached. That paper summarises and provides links to six reports that helped to shape the Forum's conclusions.

The SRC may wish to consider the following questions.

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| Q1. | Does the SRC wish to challenge any of the key facts or conclusions in the reports as summarised by the Forum's attached paper? (reports from the system operator, the ENA, EnerNOC, the Authority and two reports from John Scott) |
| Q2. | Does the SRC agree with the Forum's recommendation that the Government should establish an information and advisory service to help consumers transition to new technologies? |
| Q3. | Does the SRC agree with the Forum's recommendation that the SRC should monitor and report on this transition over time? In order to be consistent with the SRC's role, this monitoring and reporting would need to be in the context of security and reliability outcomes, and not, for example, the penetration levels of a particular technology. |
| Q4. | Does the SRC agree with the Forum's recommendation that the Forum ought to continue to operate, but with the goal of phasing itself out of existence in a way that embeds its experience into the relevant permanent industry organisations? |
| Q5. | Is the SRC willing to hear directly from the ENA's Smart Technologies Working Group once its investigation is sufficiently developed? |
| Q6. | What advice, if any, does the SRC wish to provide to the Authority? |

¹ For more information about the Forum, including the list of members and meeting minutes, see <http://www.med.govt.nz/sectors-industries/energy/electricity/new-zealand-smart-grid-forum>

Quality and reliability impacts of distribution edge technologies – briefing for SRC

The Minister of Energy wrote to the Forum Chair in December 2014 asking for ‘clear conclusions and strong evidence supporting any recommendations’ addressing challenges of both:

- how to facilitate sufficient multi-party coordination to achieve national benefits not available to any one party acting alone; and
- maintaining acceptable reliability and supply quality in the face of emerging technologies and behaviours which the existing power system was not originally designed to accommodate.

The adoption of technologies such as rooftop PV, battery storage, fast EV charging and intelligent home automation systems have the potential to change the way the electricity industry maintains system balance and security, particularly at the distribution level. This brings different quality, reliability and security risks.

The Forum has explored these challenges through a number of papers:

- Issues paper from John Scott - [The Challenge of Disruptive Technologies](#),
- System Operator response – [Management of Embedded Technologies](#),
- Distributor perspective – [Stability of the NZ electricity grid – cause for concern?](#)
- Demand side comment from EnerNOC – [Our electricity system is changing](#),
- Electricity Authority position paper – [Maintaining reliability in the face of emerging technologies](#) and
- [Disruptive Technologies - Overview Thoughts](#) – a summary letter from John Scott reflecting on responses to his issues paper.

A key finding has been that the industry’s governance and regulatory structure appears robust to the security and reliability impacts of smart grid technologies, in particular the Electricity Authority’s confirmation that:

‘the governance arrangements in New Zealand are perfectly designed to allow whole systems thinking to be applied across the whole electricity system without the need for legislative changes. Specifically, the Electricity Authority has the remit, the tools and is legislatively obliged to ensure that the advent and growth of new technologies such as distributed generation and electric vehicles does not undermine the reliability of the electricity system.’

Forum members have confidence in the flexibility of New Zealand's policy settings: the overall accountability of the Electricity Authority for reliability of supply and the recent announcement of a **Smart Technologies Working Group by the Electricity Networks Association** to investigate the detailed effect of distribution-edge technologies on local power networks.

The challenge will be one of implementation: whether existing and new institutions in New Zealand are able to accumulate adequate knowledge, data, modelling and process to accommodate the transition to a smarter grid at what will be an unpredictable rate. The Forum has recommended to the minister that there would be merit in **tasking a permanent but independent reviewer such as the Electricity Authority's independent Security and Reliability Council to monitor and report on this transition over time** as the function of the Security and Reliability Council is to provide independent advice on the performance of the electricity system and the system operator, and reliability of supply issues.

This paper summarises the key points of the papers presented to the Forum and its recommendation to the Minister with reflections for the SRC.

Impact of embedded generation on frequency overseas

John Scott, formerly Director of Engineering at National Grid UK and Technical Director of the UK energy regulator Ofgem briefed the Forum in February on emerging challenges caused by unconstrained customer investment in new technologies at the distribution edge ("beyond the meter"). Forum members were particularly interested in an event in 2008 where the near-simultaneous loss of 4 gensets with a combined capacity of around 1.7GW resulted in a drop in system frequency to 49.15Hz.

90 seconds later, system frequency fell again to 48.795Hz when a further 279MW of embedded generation tripped, generation of which the system operator was unaware. John Scott concludes

the real concern here is that a serious event took place that had not been foreseen and was not part of established system modelling. Small distributed generators are generally not 'visible' to a national system operator .. The wake up call was the clear evidence that .. changes span distribution and transmission and are not under the jurisdiction of one party.¹

NZ situation

Transpower as the NZ system operator has reviewed the UK under-frequency event for the Forum and contrasted UK and NZ industry structures and discusses issues raised by members about the NZ context, identifying issues resulting from the integration of smart grid technologies into today's power system. It concludes² that *the current framework for monitoring the addition of new generation and obtaining the necessary information is adequate*. But notes that *to meet its obligations the SO anticipates there will be greater and more frequent exchange of information between participants*, in particular

- *uptake of demand response and response capability (SO, EDBs);*
- *ongoing currency with frequency and fault capability of small scale DG installed in NZ (SO, EDBs);*

¹ *The Challenge of Disruptive Technologies*, Chiltern Power. P.6

² *Management of Embedded Technologies*, Transpower – System Operator. P. 20

- ongoing EV uptake and capability, as previously outlined (EDBs, SO, GO);
- voltage management within distribution networks (EDBs);
- impact of distribution network voltage management on GXP voltage management (EDBs, GO, SO);
- integrity of protection systems with proliferation of small scale DG (EDBs, GO, SO); and
- uptake of stationary storage and utilisation (SO, EDBs).

Implication for NZ distribution businesses

ENA Members on the Forum provided a commentary on the System Operator paper which notes³ that

- *The information that the SO assumes distribution utilities will be able to provide is not necessarily available to distribution utilities. For example, it is unlikely that distributors will be advised by all consumers who purchase electric vehicles, or even connect a solar system to their house (in spite of this being a requirement). In addition, distributors have little means to track the movement of EVs – either on a day to day basis (EVs are not necessarily only connected at their home base), or when owners move home.*
- *Distributors may have insight into larger distributed generation connection, but may not have the required detail on the frequency response, behaviour under unstable voltage conditions, etc. of the generators.*
- *Distributors are likely to implement various forms of network automation and control to counter the impact of variable local generation, in particular to counter voltage regulation problems. There is no mechanism to ensure that these systems would not compete against similar systems applied by the SO, leading to “hunting” between systems and even greater instability.*
- *At present many distributors are not actively monitoring the performance of low voltage networks, and would not have insight into voltage disturbances – and would therefore not be in a position to manage this (without incurring substantial cost). Many would also not be in a position to model the networks to determine the stage at which newly connected devices could start to contribute materially to system instability.*
- *No consensus exists on how to protect networks (or distributed generators) from inadvertent livening from distributed generation sources, when these networks are deemed to be disconnected. In addition, the required response of such generators to situations where the grid is disconnected is also not defined.*

The paper suggests that a representative group of distribution businesses form a working group to test the general degree to which the potential future grid instability is viewed as a problem in the industry and further investigate the problem. The ENA Board established a Smart Technologies Working Group to this end at its meeting in May.

Role of the demand side

To provide a balance from supply side views, Enernoc were invited to provide a response to the papers from John Scott and the System Operator. They note⁴ that *NZ system inertia is going to decline rapidly as base load thermal stations continue to be retired .. and replaced with smaller gas turbines and renewable assets. Geothermal, wind and PV provide little inertia. Higher inter-Island transfers are indeed very likely in the future with the exit of aluminium production. Our*

³ *Stability of the future New Zealand grid – cause for concern?*, ENA Members of Smart Grid Forum. Pp. 6-7

⁴ *Our electricity system is changing*, Enernoc. P. 2

frequency control is binding both Islands on the HVDC to a single control point and we haven't had a lot of operating experience in how this will cope with contingent events.

Enernoc conclude that the best way to fully understand the impact of these changes is to take a top-down approach in modelling. Once we can understand the likely impact of an even lighter inertia grid, we can think through the right design for frequency management products. This would confirm that the present bottom-up approach in being prudent with costs and using the existing Reserve Management Tool architecture makes sense at this time. Then, we have to make sure that the market drivers to build more reserves are in place should they be needed .. without an independent modelling approach we cannot debate appropriate security standards for a potentially rapidly changing electricity system.

Electricity Authority perspective

To support the Forum's investigation, the Electricity Authority has provided a working paper *Maintaining reliability in the face of emerging technologies*. In this paper, the Authority recognises the rapid development of emerging technologies has reliability implications but notes that through the Authority's Code making powers it has the ability to properly account for, and address the reliability implications of emerging technologies at generation, system operation, grid, distribution and consumer levels.

The Authority summarises its position: *the governance arrangements in New Zealand are perfectly designed to allow whole systems thinking to be applied across the whole electricity system without the need for legislative changes.*

Specifically, the Electricity Authority has the remit, the tools and is legislatively obliged to ensure that the advent and growth of new technologies such as distributed generation and electric vehicles does not undermine the reliability of the electricity system.

The Authority's paper also comments on its role in seeking to develop market arrangements that do not impede innovation. This includes making sure new technologies are not hindered by electricity market pricing arrangements or that regulatory frameworks facilitate the emergence of new participants or service providers.

Expert advice from John Scott

Reflecting on the results of its investigations, John Scott has written to the Forum with six observations⁵ about the market-led approach to smart grid implementation in New Zealand:

- Markets risk stalling in the absence of interoperability and open systems – policy makers may need to play a 'convening role' in facilitating market development;
- The materiality of the data specification and collection may be underestimated and should be given further attention;
- Establishing Open Systems for disruptive technologies is not a project: where system security depends on it, a single party should be given this accountability;
- It is important to avoid surprises on the power system: modelling the impact of emerging demand-side changes will require engagement beyond the system operator and include parties from across the supply chain;

⁵ Overview Thoughts, John Scott

- The safe connection of distributed generators will require further exploration to ensure there is no tension between safety and current management practices;
- Government or a regulator should consider whether New Zealand's current use of Automatic Under Frequency Load Shedding to control system frequency will meet end-customer expectations as frequency becomes more volatile.

Smart Grid Forum recommendation to Minister of Energy

The Forum's first year report to the Minister contains a summary conclusion that the regulatory and institutional settings in New Zealand are well designed to accommodate a consumer-driven adoption of the opportunities and business models that new technologies on the power system offer us as a country.

This advice notes, however, that the transition will be challenging and the complexity of the market and the options available to people may be confusing. The report recommends that:

- The Government establishes an information and advisory service to help consumers understand and compare the opportunities for new smart grid technologies and changing commercial arrangements, ideally using existing channels and agencies (such as Consumer NZ, the Electricity Authority or EECA),
- A permanent but independent reviewer such as the Electricity Authority's independent Security and Reliability Council monitors and reports on this transition over time and
- The Forum's work continues, to transition its experience into the various processes that permanent organisations within the industry are establishing to take account of the impact of smart grid technologies and to facilitate communication between organisations within and external to the industry during this time.

Considerations for the SRC

The Forum's advice to the Minister is that, while edge technologies introduce new risks for system security and reliability, they are unlikely to manifest themselves in the short term, provided that the changing state of the system is monitored and forecasts of system security and reliability reflect these changes. To this end the SRC's immediate interest will be the **operational readiness** of existing agencies and industry incumbents to anticipate and respond to the new and different responsibilities that this will entail.

Security and reliability issues in the medium term may include, as seen in the UK, the impact of decreasing system inertia on common quality. However, New Zealand has a history of integrating low inertia generation into an already twitchy power system and may be expected to continue to do so, subject to the need to monitor, forecast and respond to system changes. Equally, the changing use of the power system, particularly towards the edge of the distribution networks will require attention to both the **definition of minimum power quality standards** for shared assets and the appropriate transition path as end-customers complement legacy power solutions with local and community investments. The SRC may wish to engage with ENA's Smart Technologies Working Group as it commences its investigation into the changing technical requirements for local distribution in a smart grid world.

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