Mercury

Via email: fsr@ea.govt.nz

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Future Security and Resilience - Review of common quality requirements in Part 8 of the Code

Mercury welcomes the opportunity to provide feedback to the Electricity Authority's (Authority) on its issues paper *Future Security and Resilience - Review of common quality requirements in Part 8 of the Code,* 4 April 2023, (Issues Paper). No part of this submission is confidential.

The Authority is seeking stakeholders' views regarding how the common quality requirements in Part 8 of the Electricity Industry Participation Code 2010 (Code) should enable the uptake of inverter-based variable and intermittent resources alongside current technologies.

Mercury agrees with the Authority adopting a first-principles approach to reviewing the Code's common quality requirements, as it should result in a more complete and coherent set of requirements that promotes the Authority's statutory objectives.

Mercury considers that a first-principles approach should be forward looking and technologically neutral. This includes stepping back from the current common quality requirements in the Code in order to specify requirements in such a way that they can be applied to legacy and forward-looking technologies.

Mercury's concern, though, with focusing on inverter-based variable and intermittent resources is that any Code amendments may be technologically specific. This would likely increase the complexity of the Code and reduce its flexibility to accommodate future technological developments, raising the risk that further amendments would be required. Having to amend the Code further could then create a drag on the adoption of new and innovative technologies.

Mercury carries these themes through the present submission, focusing on a selection of issues raised by the Authority and proposing that the Code should:

- Be brought up to date, taking a first-principles, technology neutral approach to both non-synchronous and synchronous generation
- Enable greater collaboration between generation asset owners, distribution owners and the grid owner to manage voltages, frequency fluctuations, and harmonics across networks as energy flows become more two-way by allowing these stakeholders to consider the different strengths and weakness of the different technologies
- Be forward-looking, setting key common quality requirements that are not tied to specific technologies, which enable the adoption of new, innovative technologies
- Protect original equipment manufactures' (OEMs') asset performance information that is shared with the system operator

Each of these points are addressed across the topics raised in the Issues Paper.

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Inverter based resources do not cause any more or less frequency fluctuations than seen already
Mercury does not agree with the Issues Paper's first proposed common quality issue, that inverter-based resources cause frequency fluctuations that are any more problematic than frequency fluctuation caused by the current suite of technology connected to the network.

Mercury considers that in general it is the energy resource behind an inverter that contributes to an increase or decrease in frequency fluctuations, and not the inverter *per se*. An appropriately tuned battery is likely to reduce frequency fluctuations due to the speed and accuracy of its response. On the other hand, a wind farm may increase frequency fluctuations as its output varies regardless of whether or not it is connected to an inverter.

Mercury supports the system operator ensuring that response characteristics, including deadbands, are reasonable for the technology employed and challenging these when necessary. To enable this outcome, we consider that the common quality requirements should allow sufficient flexibility to accommodate different technology and energy resource characteristics while providing guidance to the system operator and the energy resource operator. Different technologies have different response characteristics, so attempting to draft detailed technologically specific requirements across all technologies may not be efficient.

The different response characteristics of different technologies extends to the cost of headroom to increase power output in response to a fall in frequency. The peak efficiency for many hydro generators is less than the maximum output, so such a generator running at peak efficiency will inherently have headroom to increase output. In contrast, wind, geothermal and solar generation are typically designed to capture the maximum power from the available resource at any one time and thus would need to spill potential generation in order to provide headroom to supply an increase in output. Therefore, providing headroom to increase power in response to a fall in frequency is significantly more costly with these technologies.

We also note that the 45 Hertz for 30 seconds frequency requirement in the Code for South Island generators is outside of the range of equipment supplier norms. This limits suppliers that are able to provide generation equipment for the South Island. We suggest that this requirement be assessed to see whether it remains appropriate.

Following the first-principle approach noted above, Mercury proposes that the specification of common quality requirements be sufficiently high level to address this growing variation in technologies while providing guidance on the operating envelope.

Where performance, be it related to say voltage or frequency response, is equivalent the system operator should continue have the flexibility to grant equivalences as they will continue to be able to maintain their principal performance obligations.

The Issues Paper notes that the system operator has granted dispensations for frequency related obligations. Many of these dispensations are likely to be in effect equivalences that are treated as "dispensations" because the Code's current focus does not accommodate non-synchronous, inverter-based generation technologies, but instead relies on requirements for synchronous generation specific technologies such as governors and exciters. Non-synchronous, inverter-based generation relies on a different technology set to provide equivalent frequency support performance.

Inverter based resources do not cause more or less voltage issues than other technologies generally
The Issues Paper leaves the general impression that inverter-based resources have an adverse impact on voltage performance of the system. As a general response, Mercury does not agree.

Paragraph (4.13) in the Issues Paper indicates that generators would rather embed in the distribution network than connect to the transmission grid in order to avoid voltage and/or reactive power issues. Mercury does not consider this is a determinant of where it locates or connects generation assets. In fact, connecting to distribution networks can be more complex than connecting to the transmission grid. Reactive power has to be carefully managed so that it does not cause unacceptable voltages particularly on distribution networks where the network impedance tends to be high.

Paragraph (4.15) suggests that when wind and geothermal generation is operating at their maximum power capacity ratings they may have little headroom to produce or absorb reactive power in order to help regulate voltage on the transmission network. Plant operating at its maximum power does not change its requirement under the Code to provide or absorb reactive power. Unless it has a dispensation, the reactive capability envelope in the Code applies across the power range of the generation asset including at maximum power.

Paragraph (4.17) indicates that generation owners might be incentivized to limit distribution network connected generating stations to less than 30MW in order to avoid the cost of fault ride through (FRT). Mercury does not consider that there is significant incentive to embed less than 30 MW to avoid FRT requirements as FRT is generally included in equipment by default (wind turbines, solar inverters, battery inverters and the like), so any avoided cost is likely to be minimal.

Paragraph (4.21) claims that the*".. first voltage-related problem is that inverter-based variable and intermittent resources cause greater voltage deviations, which are exacerbated by changing patterns of reactive power flows.*" Mercury notes that setting inverter based intermittent resources to voltage control mode should reduce voltage deviations in its vicinity. As such, inverter-based variable and intermittent resources do not necessarily result in greater voltage deviations if the appropriate operating settings are applied.

Paragraphs (4.22) and (4.33) suggest that the forecast increase in the proportion of inverter-based variable and intermittent generation will cause a fall in the transmission network's system strength. Mercury considers that an increase in inverter-based resources *per se* does not reduce system strength. It is the reduction in connected synchronous generators that reduces system strength.

Mercury notes that New Zealand has a large hydro fleet, much of which is capable of running in synchronous condenser (tail water depressed) mode. In this mode of operation these units provide system strength and inertia. In Tasmania this mode of operation is used to address system strength and inertia shortfalls. We would support a mechanism that enables the system operator to contract with plant owners to operate plant in synchronous condenser mode to address identified system strength and inertia shortfalls. In addition, inverter-based generation might also be able to provide "virtual inertia" to cover inertia shortfalls if required in some circumstances.

Paragraph (4.27) proposes that the system operator is expected to continue to grant non-synchronous generating stations dispensations from assisting in maintaining voltage as well as frequency obligations for the foreseeable future. Mercury considers, as similarly raised above, that many of these "dispensations" are essentially "equivalences" where the need for a dispensation reflects the wording in the Code not accommodating non-synchronous generation rather than any inherent lack of performance. A first-principles approach that accommodates both non-synchronous and synchronous generation should mitigate the need to grant dispensations where there is not an inherent lack of performance.

Voltage support obligations currently apply to transmission-connected generators only

Managing voltages on distribution networks is complex due to network impedances and requirements to maintain voltage for other customers on the network. As networks become more two-way, Mercury would welcome greater collaboration between generation asset owners, distribution network owners, grid owner and the system operator to manage these growing complexities in maintaining voltage.

An example where greater collaboration may be desirable relates to the current requirement on distributors to maintain power factor. As power flows become more multidirectional, these requirements may start to conflict with the system operator maintaining voltages on the grid. In other words, the current requirements for generators to provide reactive support and distributors to maintain power factor might have been suitable when distributors were mostly load, but this may not be optimal in the future.

Paragraph (4.56), furthermore, notes that the Code does not define technical requirements for inverters to limit the risk of inverter-based resources from disconnecting during power system faults. Although not in the Code distributors often call on AS4777 for small scale generation, which addresses some of these concerns.

Inverter-based resources and harmonics
Mercury considers that the claim in paragraph (5.27) oversimplifies the relationship between inverter-based resources and harmonics. It states that the " *… size of this harmonics problem is directly related to the uptake of inverter-based resources. The more inverter-based resources within the power system, the more acute the harmonic distortion will become*."

In Mercury's experience inverter-based resources can have good harmonic profiles and can in fact absorb certain harmonics. Therefore, depending on the existing levels of harmonics, overall harmonic distortion (THD) may in fact reduce with the connection of some inverter-based resources.

Almost all power system components – lines, transformers, cables, capacitors, generators, and loads – have a harmonic signature or interact with harmonics. Harmonics are therefore always present and differ with network configuration, loads, and generation, which can evolve and change over time. This can make harmonics challenging to analyse and mitigate, particularly as both of these processes take time.

Mercury does agree that the harmonic requirements in New Zealand can be particularly problematic and has been subject to change. For example, instead of requiring compliance with NZECP 36 limits, the grid owner began only allocating to new connections 1/3 of the difference between the existing harmonic values and the NZECP36 limit. This is likely to be overly restrictive in many circumstances – i.e. it may require filters to be installed even where harmonic levels are within NZECP 36 limits.

Mercury proposes that harmonics are included in this review of Part 8, and suitable limits are specified and applied that provide for practical assessment and resolution timeframes. The process for developing these requirements should involve industry stakeholders, experts and draw on overseas experience and align with overseas standards where possible.

Sharing of asset-related information with system operator
The Issues Paper notes in paragraph (6.6) that the system operator has observed that some asset owners are reluctant to share information about their assets.

OEMs often consider performance information highly confidential and proprietary so much so that this information is often not available to asset owners. Commonly it can only be supplied to the system operator as required under the Code and with strict confidentiality arrangements.

Mercury agrees that the sharing this information will require careful management and that it is important for studying and modeling the system. Accessing this information will become increasingly complex as a greater range of components are connected to the network. It is expected that OEMs may require assurances that the IP of equipment supplied to the New Zealand market is protected.

Furthermore, the change in generation technologies means that electromagnetic transient (EMT) modelling is likely to be required more frequently in order to inform system operator and asset owners decisions. We would encourage the Authority to consider how system models and guidance suitable for EMT modelling might be provided.

Technology specific and ambiguous terms in Code
Mercury agrees, as already noted above, that areas of the Code are technology specific or ambiguous. Generally, as also indicated above, we would support the Code becoming more performance orientated and applicable to a range of technologies rather than specific to a particular technology.

For example, the Code's intent regarding excitation and governor systems in principle relates to the voltage and frequency sensitive responses of reactive and active power control systems respectively and could be framed in terms that are technology neutral. It may not be necessary to include and distinguish between every possible type of device, such as SVC, STATCOM, grid forming or following inverters, if the performance requirements are written in such a way that they are applicable across technology groups.

We note that there may be an additional ambiguity where reactive support requirements are to be assessed and aspects such as this should be clarified at the same time that requirements are made more technology neutral. For example, the relevant term in the Code is the generator terminals, but for wind farms this is commonly taken to mean the LV side of the main step-up transformer by the system operator.

Other common quality opportunities

While the Issues Paper is related to Part 8 of the Code and thus targets grid scale generation, Mercury suggests that the Authority, system operator and other stakeholders not to lose sight of the increasing role that small scale generation are likely to play on the power system. Small scale generations' role is likely to include commercial and residential solar and battery systems, flexible EV charging, V2G, virtual power plants amongst others.

Such systems should have appropriate frequency, voltage, power quality, and FRT characteristics and standards that should develop and evolve to match changes in technology and the evolution of the power system. Furthermore, these characteristics are usually influenced by standards such as AS4777. Mercury, therefore, encourages the Authority and system operator to be involved in influencing such standards.

Mercury looks forward to engaging with the Authority and industry on progressing this review of Part 8.

Yours sincerely,

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Annex: Issues Paper questions with Mercury's responses

Issues Paper questions	Mercury response
1. Do you agree with the description of the first common quality issue and that addressing it should be a high priority? If you disagree, please provide your reasons.	See discussion above under the heading "Inverter based resources do not cause any more or less frequency fluctuations than seen already".
2. Do you agree with the description of the second common quality issue (ie, first voltage-related issue) and that addressing it should be a high priority? If you disagree, please provide your reasons.	See discussion above under the heading "Inverter based resources do not cause more or less voltage issues than other technologies generally".
3. Do you agree with the description of the third common quality issue (ie, second voltage-related issue) and that addressing it should be a high priority? If you disagree, please provide your reasons.	
4. Do you agree with the description of the fourth common quality issue (ie, third voltage-related issue) and that addressing it should be a high priority? If you disagree, please provide your reasons.	
5. Do you agree with the description of the fifth common quality issue and that addressing it should be a high priority? If you disagree, please provide your reasons.	See discussion above under the heading "Inverter-based resources and harmonics".
6. If you are a distributor, what is your experience of asset owners sharing information with you for network operation purposes?	Not applicable.
7. Do you agree with the description of the sixth common quality issue and that addressing it should be a high priority? If you disagree, please provide your reasons	See discussion under the heading "Sharing of asset-related information with system operator".
8. Do you agree with the description of the seventh common quality issue and that addressing it should be a high priority? If you disagree, please provide your reasons.	See discussion under the heading "Technology specific and ambiguous terms in Code".
9. Do you consider there to be other high priority common quality issues not identified in this paper that are occurring or that you expect to occur because of: a. the uptake of inverter-based resources, and/or b. how the Code enables different technologies?	See discussion under the heading "Other common quality opportunities".