

Increased Penetration of Intermittent Generation – Package 4 Overview

SKM

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Purpose

- > An overview of findings of Work Package 4

Scope of Package 4

The scope is with reference to the existing Technical Rules and is guided by the forecast renewable generation mix from Work Package 1.

Evaluation of the appropriateness of rules for:

- > Fault Ride-Through
- > Frequency Excursion and Rate of Change of Frequency requirements
- > Ramping Rate requirements
- > Voltage Excursion and Post Fault Voltage Control requirements

Scope of Package 4

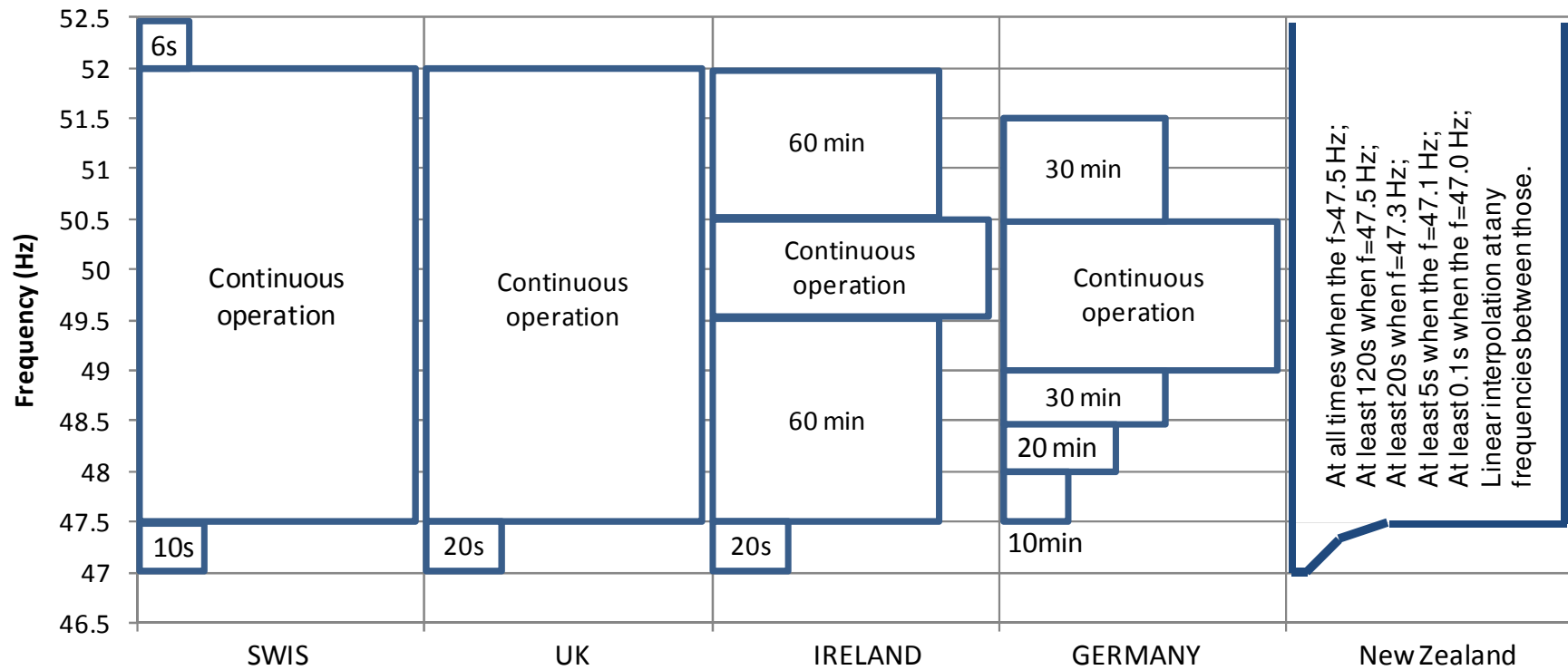
- > Evaluation of adopting communication requirements for data transmission and control specifically between System Management and wind farms.
- > Evaluation of market based alternatives to an intermittent generator meeting the fault ride through rules.

Source of Data

- > Technical Rules
 - o NEM
 - o New Zealand
 - o Ireland
 - o UK
 - o Germany

- > Stakeholder Feedback
 - o Verve
 - o Western power
 - o Pacific Hydo
 - o Carnegie
 - o Landfill Gas and Power

Fault Ride Through - Frequency

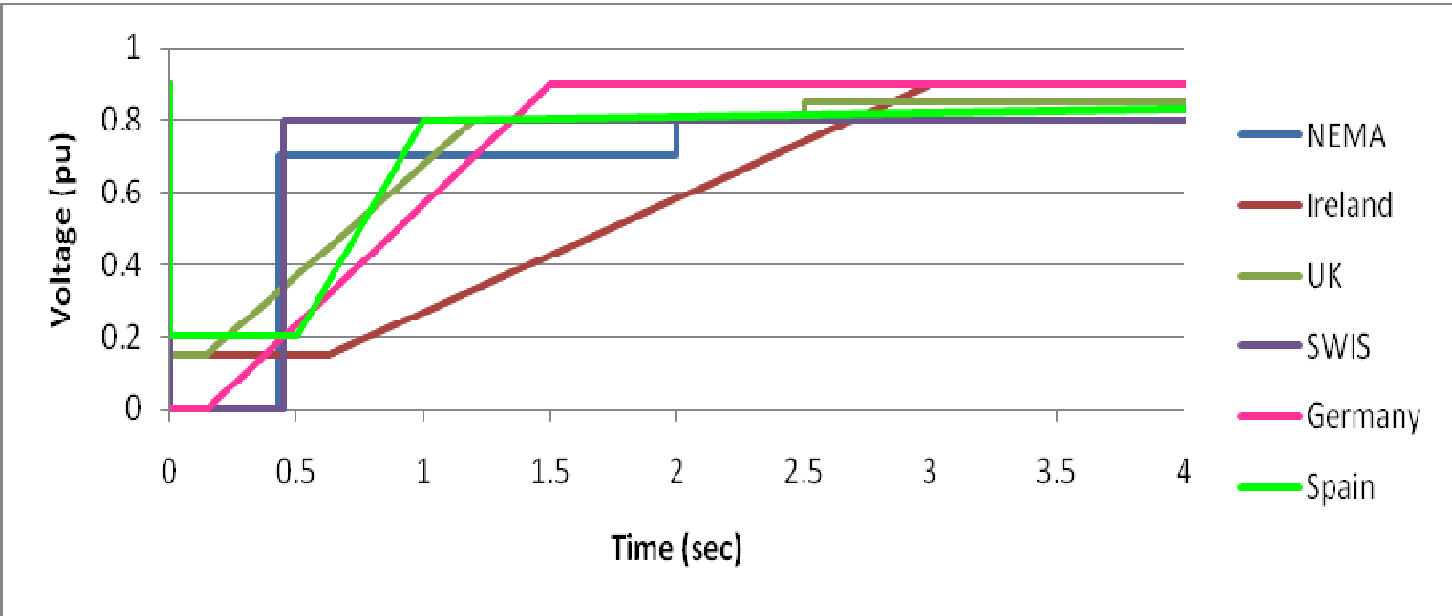


•Figure 1: Frequency operation capability for Intermittent Generation in Different Grid Codes

Fault Ride Through - Frequency

- > Analysis has identified no plausible event that would result in frequency above 52 Hz (load rejection above 50% of system load)
- > Stakeholder Feedback
 - o 52.5 Hz is higher than required in the NEM and does present an issue. 52 Hz and lower is okay.
 - o It is not possible to meet the frequency ride-through criteria in the technical rules but all developers ask for an exemption.
 - o Typically it is necessary to get a derogation but the process can be difficult.
 - o A derogation is normally sought and obtained for the frequency ride through criteria. Experienced developers will be familiar with this and so it is not a significant impediment.
- > Preliminary Finding: ride through above 52 Hz be revisited

Fault Ride Through Voltage

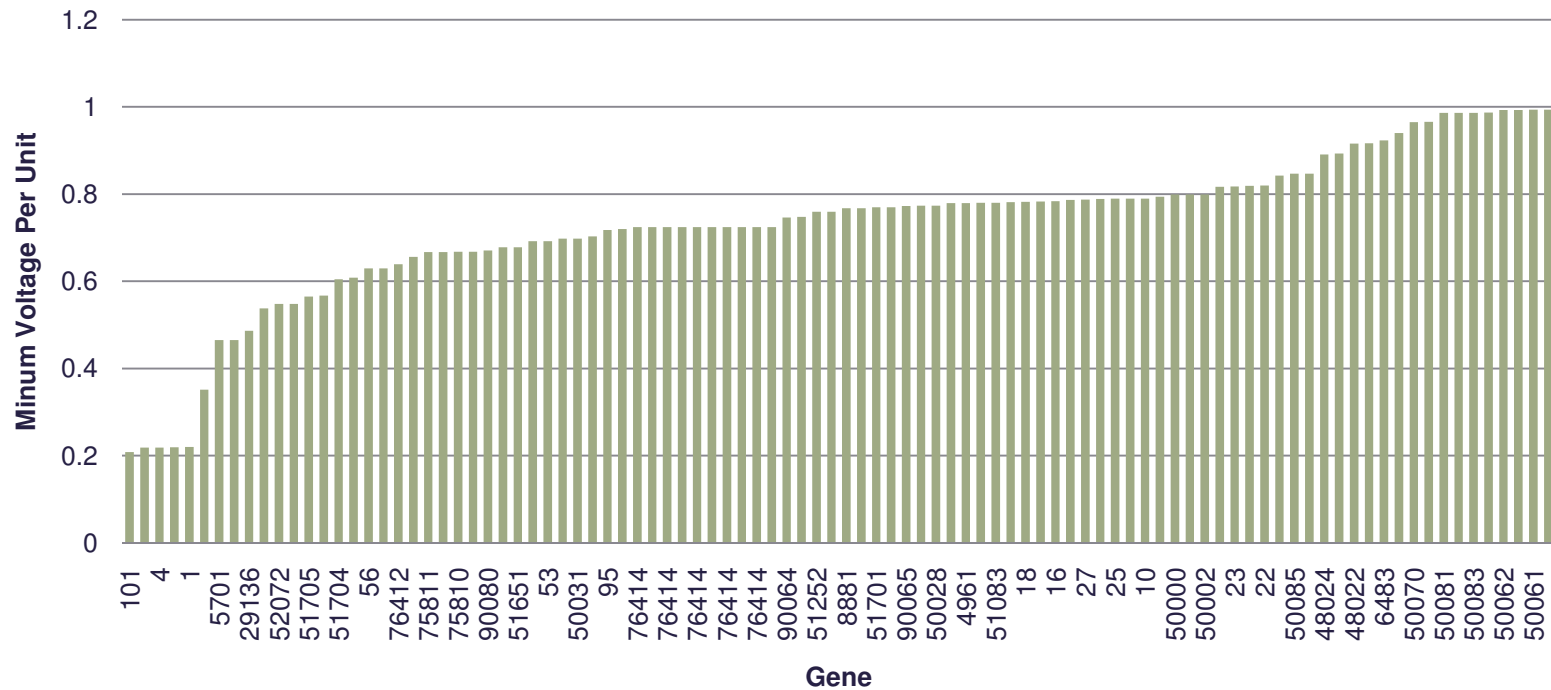


Fault Ride Through - Voltage

- > Voltage transients are a localised effect. The Rules are based on worst case scenario.
- > Depending on connection arrangements, generation at a fault will likely disconnect as worst case fault is cleared.
- > Ancillary services cater for the loss of one generator, voltage ride through must be set to ensure that no generators remote to the fault will trip.

Fault Ride Through - Voltage

Minimum Voltage for Generator Buses given 3 phase fault on all SWIS Network Buses



Fault Ride Through Voltage

- > Stakeholder Feedback
 - The voltage at the connection point or the generator terminals will not be as low as at the point of the fault.
 - This is a big issue and the rules are not seen as appropriate. Again, it is typically necessary to get a derogation and the process can be difficult.
 - Western Power is able to provide voltage ride-through curves that are specific to each new connection or alternatively for predetermined locations on the network.

Fault Ride Through - Voltage

> Preliminary Findings

- There is flexibility in the Technical Rules and how they have been applied. More clarity in the process for determining specific voltage ride through requirements would be beneficial.

Ramp Rates

> **SWIS**

- For a scheduled generating unit; minimum 5% of the generator machine's nameplate rating per minute
- For a non scheduled generating unit; maximum 15% of the generator machine's nameplate rating per minute

> **Ireland**

- There shall be two maximum ramp rate settings. The shall apply to the MW ramp rate average over one minute. The shall apply to the MW per minute ramp rate average over ten c2 minutes.
- It shall be possible to vary each of the two maximum ramp rate settings independently over a range between 1 and 30 MW per minute.

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c2

I can't follow the wording

cstonehouse, 21/04/2010

Ramp Rates

> **NEM Australia**

- Ramping down, equal or exceeds the least of:
 - 20% of maximum operating level multiplied by the difference between the system frequency and the upper limit of the normal operating frequency,
 - 10% of maximum operating level
- Ramping up, equal or exceeds the least of
 - 20% of maximum operating level multiplied by the difference between the system frequency and the lower limit of the normal operating frequency,
 - 5% of maximum operating level
 - 1/3 of the difference between the maximum operating level and pre-disturbance level (zero if the difference is negative)

> **Germany**

- 10% of the grid connection capacity per minute

Rate of Change of Frequency

	Rate of Change of Frequency
Ireland	0.5 Hz per second
NEM Australia	4 Hz per second for 0.25 seconds
SWIS	4 Hz per second
Germany	Not explicitly stated
Spain	Not explicitly stated
Canada	0.5Hz Per second

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Not complete

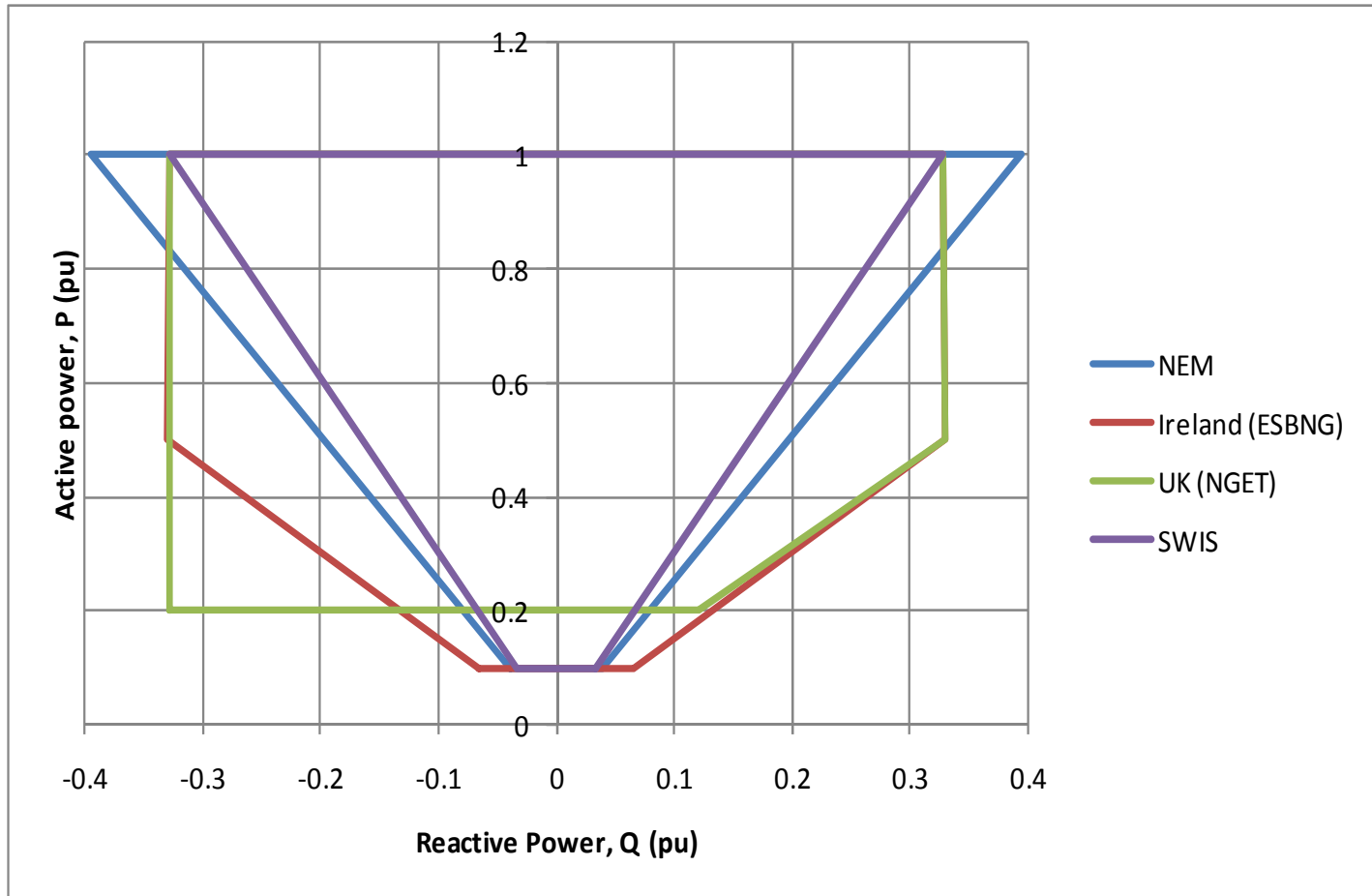
cstonehouse, 21/04/2010

Rate of Change of Frequency

- > Stakeholder feedback
 - The ROCOF criterion of 4 Hz/sec has historically been an impediment and suppliers have not been able to comply. However, this criteria exists in other jurisdictions and suppliers typically have caught up and are now able to comply.

- > Preliminary Finding
 - Analysis indicates that even with large components of intermittent generation modelled with no inertia the largest ROCOF is less than 0.5 Hz per second.

Post Voltage Excursion (Voltage Control)



Post Voltage Excursion (Voltage Control)

	Reactive Current Provision	Timing
Ireland	Maximize the reactive current	600 ms or until recovers to normal voltage, whichever is sooner
NEM Australia	Pre-fault reactive current or 4% rated current for each 1% each percent of the voltage dip, whichever is greater	During and after the fault
SWIS	Reactive power control mode does not change	During and after the fault
Germany	2% of the rated current for each percent of the voltage dip	During 10% or more voltage dip and must be maintained for a further 500 ms
Spain	Linearly increase from 0% to 90% of the rated current for the decreased of remaining voltage from 85% to 50% (of the nominal voltage), and then remain 90% of the rated current for further lower voltage	Within 100 ms of the drop voltage and 150 ms of the grid recovery
New Zealand	Operate continuously in the voltage control mode when synchronised	-

Post Voltage Excursion (Voltage Control)

	Active Power Provision	Timing
Ireland	90% of maximum active power	As quickly as possible and within 1 second of the Transmission System Voltage recovering to the normal operating range
NEM Australia	95% of pre-fault active power	from 100ms after disconnection of the faulted element
UK	90% of pre-fault active power	Within 0.5 second of the voltage restoration to 90% of nominal
SWIS	Pre-fault active power	After the voltage has returned to between 80% to 110% of the nominal voltage
Germany	Increase to the pre-fault active power with a gradient 20% of the rated power per second	Immediately after fault clearance

Post Voltage Excursion (Voltage Control)

- > For NEM Australia, it is noted that an intermittent generator during and immediately after the clearance of the fault may not meet the rules. Consequently the wind farms need to negotiate to meet the minimum requirement
- > SWIS Rules on reactive current following a grid fault (during and after) are not onerous by comparison. Opportunity for more contribution in some cases

Post Voltage Excursion (Voltage Control)

- > Level of network service dependant on technology utilised
- > Scope for additional voltage support to be offered from many technologies
- > Balance between level of service defined in the Technical Rules (for all users) and service levels that can be procured through Network Control Services.
- > Preliminary Finding
 - o There is scope for additional voltage control services to be provided to the grid.
 - o Use of a NCS procurement process is required for locations with support. May be the most appropriate mechanism to procure additional services.

Communication Improvements

- > Technical Rules is not the appropriate vehicle for communication requirements for dispatch control.
- > Reviewing Work Package 3 report to form position on performance based specification for inclusion in market mechanisms.