‘No regrets’ power system studies relating to voltage

Common Quality Technical Group

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ELECTRICITY AUTHORITY
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Purpose of ‘no regrets’ power system studies

Study 1

- Assign voltage support obligations to distributed energy resources (eg, by revising the 'point of connection' definition)

Study 2

- Manage the import and export of reactive power at a GXP (eg, by revising the GXP power factors specified in the Connection Code)

Study 3

- Lower the 30 MW threshold for generating stations to be excluded by default from complying with the fault ride through obligations in the Code

‘Point of connection’

Code clause 1.1 **Interpretation**

point of connection means—

(a) a point at which electricity may flow, via one or more phases or conductors—

(i) into or out of a network; or

(ii) both into and out of a network at the same time, where each directional flow is on different phases or conductors; and

(b) for the purposes of Technical Code A of Schedule 8.3, means a grid injection point or a grid exit point

Code clause 8.22 **Voltage range AOPOs**

- *“Each generator with a point of connection to the grid must at all times ensure that its assets are capable of being operated, and do operate, when the grid is operated within the range of voltages set out in subclause (1).”*

Code clause 8.23 **Voltage support AOPOs**

- *“Each generator with a point of connection to the grid must at all times ensure that its assets—*

  (a) when the voltage at its grid injection point is within the applicable range of nominal voltage, are capable of exporting (over excited) when synchronised and made available for dispatch by the system operator, a minimum net reactive power which is 50% of the maximum continuous MW output power as measured at the following generating unit terminals:”

CQTG Voltage Subgroup feedback

- Is "Point of Connection" still valid to determine the voltage range and voltage support AOPOs?
- Need to have common standard across grid or distribution connected generation (including aggregators?)
- Voltage control mode: Var or voltage control?
- Technical requirements vs real-time operation
- Study should include:
  - "do nothing" option
  - looking at historical data
- Need to include distribution network in our study
- Point of compliance is on the LV side of the transformer

Requirements in other jurisdictions

Table 7 **Capacity thresholds for power-generating modules of four types, depending on the synchronous system they are connected to**

Type	Baltic	Continental Europe	Great Britain	Ireland	Nordic
A	0.8 kW	0.8 kW	0.8 kW	0.8 kW	0.8 kW
B	0.5 MW	1 MW	1 MW	0.1 MW	1.5 MW
C	10 MW	50 MW	50 MW	5 MW	10 MW
D*	15 MW	75 MW	75 MW	10 MW	30 MW

* Units connected to a voltage level of 110 kV or higher are always Type D, regardless of capacity.

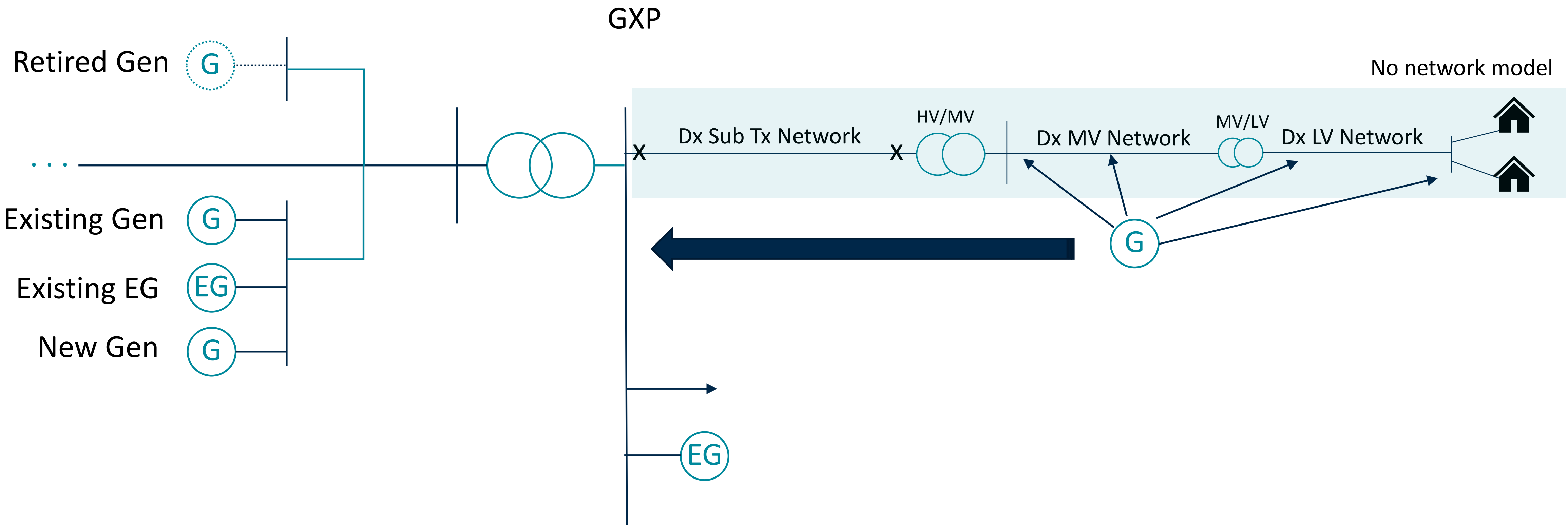
Source: System operator

With this strategy in place, a 10 MW wind power plant in the smaller Irish synchronous system has to fulfil the same requirements that only generators of 75 MW and above would have to fulfil when connected to the much larger Continental synchronous system, accounting for the higher system impact of individual units in smaller systems. Key requirements for different generator categories are given in Table 8.

Table 8 **Main requirements in the EU NC RfG and where they apply**

	Type A	Type B	Type C	Type D	
Frequency range	X	X	X	X	
LFSM-O	X	X	X	X	
LFSM-U			X	X	
LVRT		X	X	X	
Dynamic fault current		X	X	X	
LVRT to 0 voltage				X	
Protection co-ordination		X	X	X	
FSM			X	X	
Black start			(X)	(X)	Non-mandatory
Island operation			(X)	(X)	Non-mandatory
Fault recorder			X	X	
Simulation models			X	X	
Voltage ranges				X	
Reactive power		(X)	X	X	Type B: synchronous only

Studies 1 & 2 – Impact of distributed generation on GXP voltage



‘Excluded generating station’

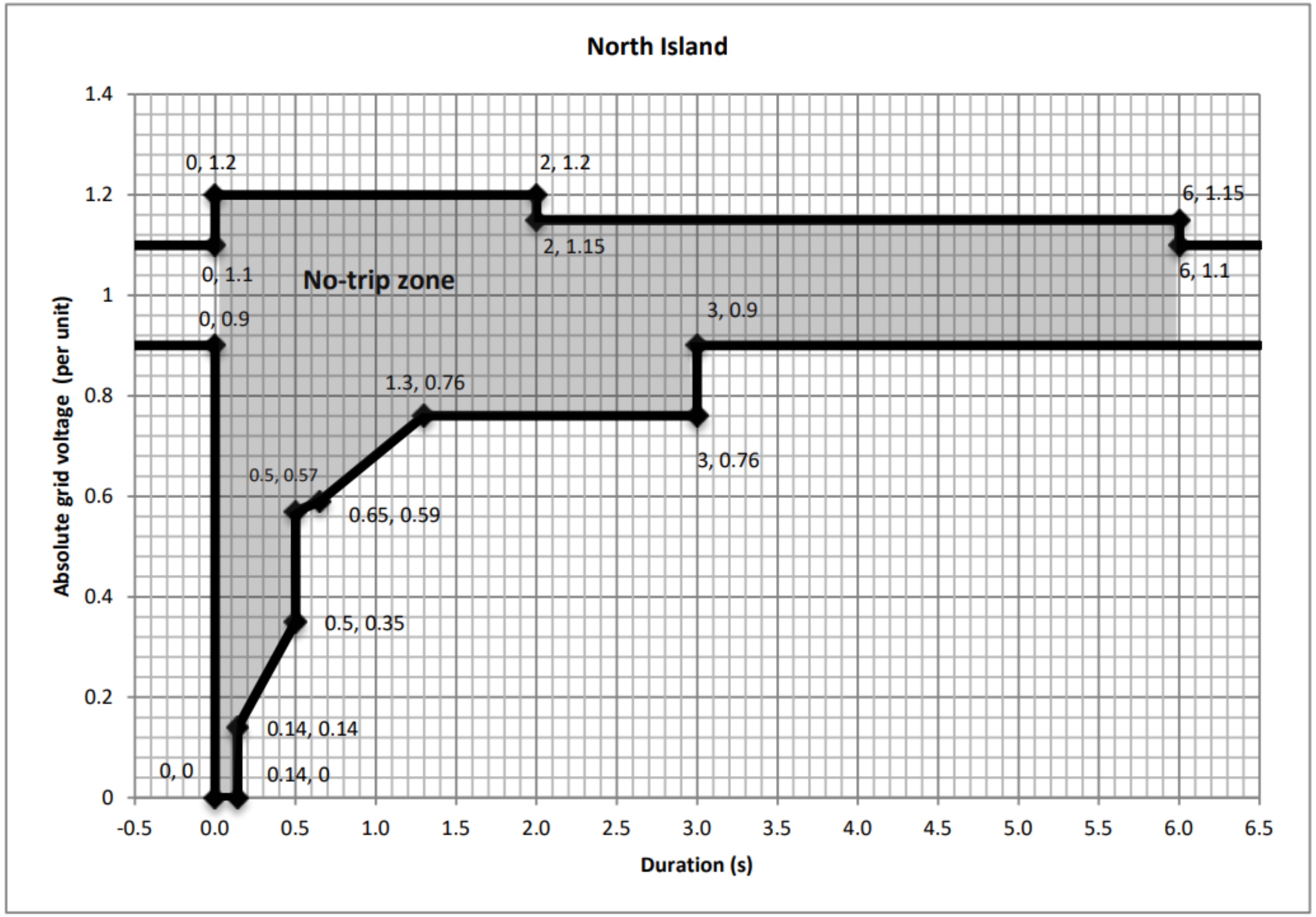
Code clause 8.21 Excluded generating stations

- *“For the purposes of clauses 8.17, 8.19, 8.25D, and the provisions in Technical Code A of Schedule 8.3 relating to the obligations of asset owners in respect of frequency, an excluded generating station means a generating station that exports less than 30 MW to a local network or the grid, unless the Authority has issued a direction under clause 8.38 that the generating station must comply with clauses 8.17, 8.19, 8.25A, and 8.25B and the relevant provisions in Technical Code A of Schedule 8.3.”*

Code clauses in scope

- 8.25A Fault ride through
- 8.25B Reactive current and active power output

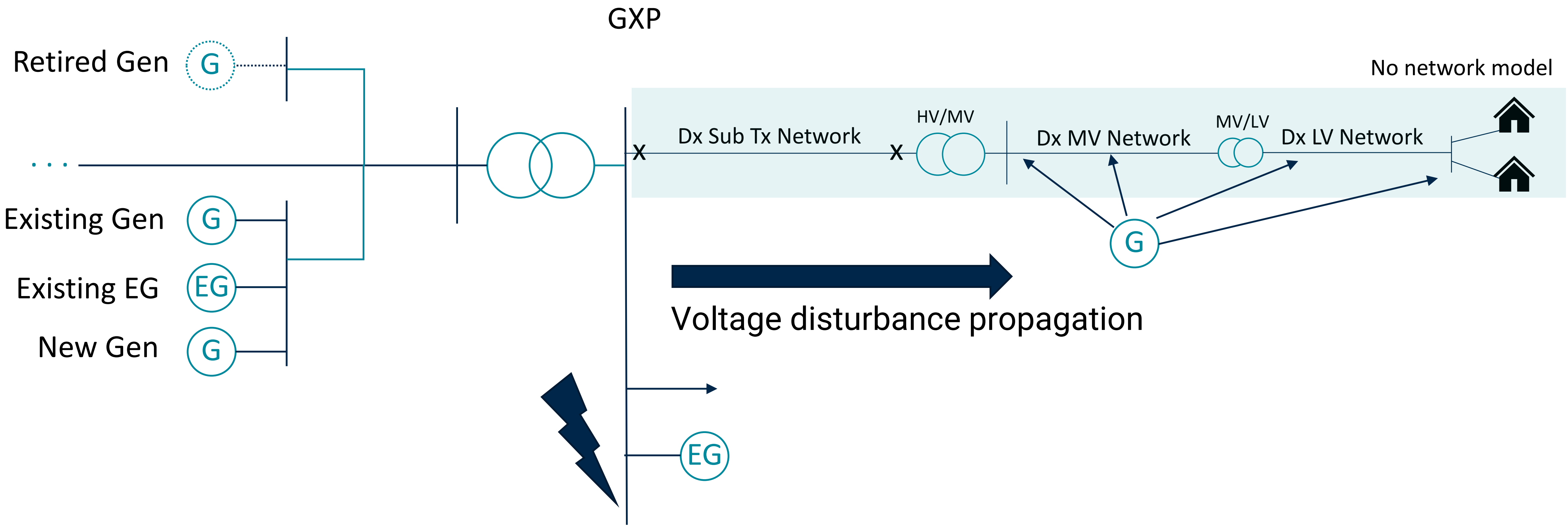
Low voltage fault ride through



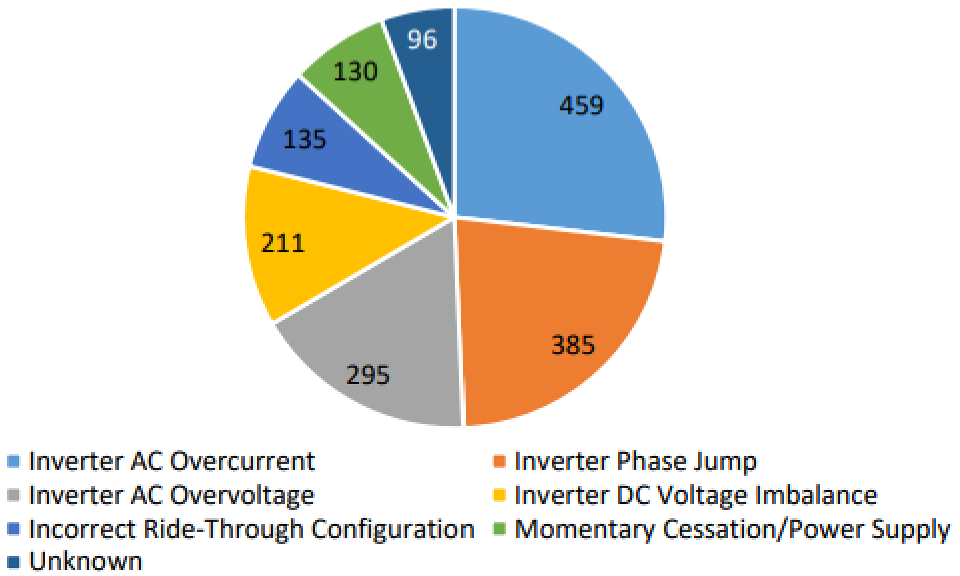
Source: Figure 8.1: North Island no-trip zone during 110 kV or 220 kV faults

Electricity Industry Participation Code 2010

Study 3 – Fault ride through application to low voltage



Other fault ride through issues



Odessa 2022 event

Source: System operator

Table 1.1: Causes of Solar PV Active Power Reductions		
Cause of Reduction	**Odessa 2021 Reduction [MW]**	**Odessa 2022 Reduction [MW]**
Inverter Instantaneous AC Overcurrent	–	459
Passive Anti-Islanding (Phase Jump)	–	385
Inverter Instantaneous AC Overvoltage	269	295
Inverter DC Bus Voltage Unbalance	–	211
Feeder Underfrequency	21	148*
Unknown/Misc.	51	96
Incorrect Ride-Through Configuration	–	135
Plant Controller Interactions	–	146
Momentary Cessation	153	130**
Inverter Overfrequency	–	–
PLL Loss of Synchronism	389	–
Feeder AC Overvoltage	147	–
Inverter Underfrequency	48	–
Not Analyzed	34	–

* In addition to inverter-level tripping (not included in total tripping calculation.)
** Power supply failure

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