

System Constraints



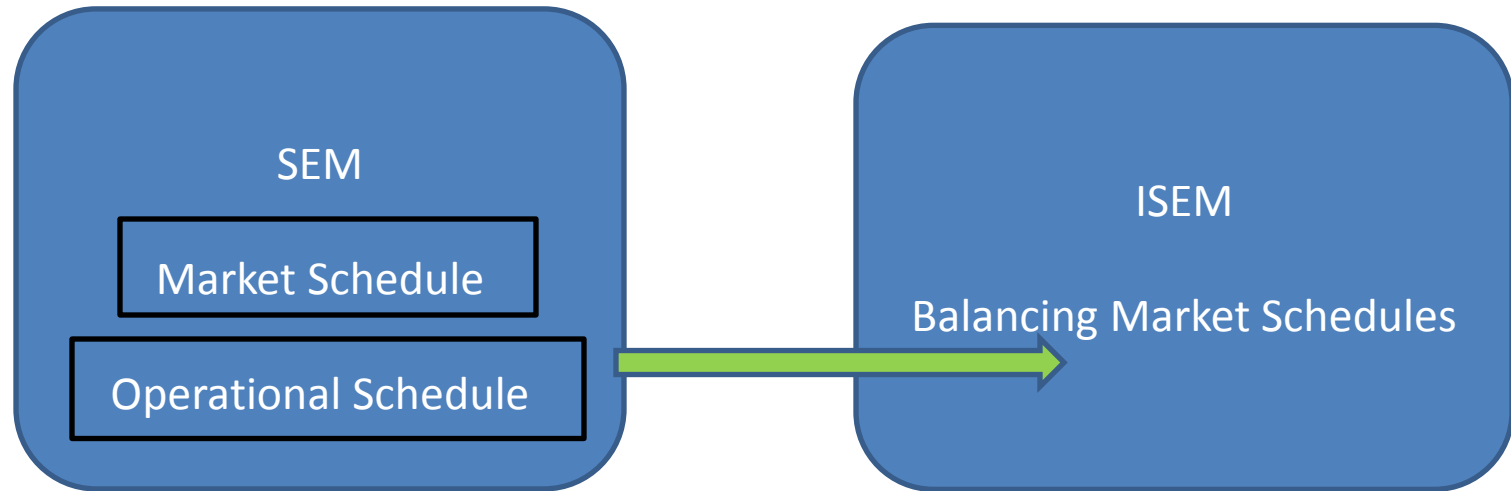
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SEM to ISEM



- Now system **constraints** that were considered as part of operational schedule are part of the Market Schedule

Updated monthly with longer term changes due to transmission upgrades or policy updates

Operational Constraints Update
05/07/2019

Operational Constraints



Updated on weekly basis with changes to constraints that vary due the outage program

Weekly Operational Constraints Update

Applicable from 26 August 2019 to 1 September 2019 (Week 35)

23 August 2019

Disclaimer

EirGrid plc, the Transmission System Operator (TSO) for Ireland, and SONI Limited, the TSO for Northern Ireland, support the provision of information to the marketplace by publishing operational data, processes, methodologies and reports. This information is key to a well-functioning market and as a transparency measure, assisting understanding of our decision making processes. EirGrid plc and SONI Limited make no warranties or representations of any kind with respect to this document, including, without limitation, its quality, accuracy and completeness. EirGrid plc and SONI Limited do not accept liability for any loss or damage arising from the use of this document or any reliance on the information it contains. Use of this document and the information it contains is at the user's sole risk.



Overview of Constraint Types

Constraints impose limits on the physical operation of units in order to maintain operational security requirements under normal and contingency (failure of an item of equipment, e.g. transmission line or unit) conditions.

Reserve (Frequency Limits)	Thermal	Voltage	Dynamic Stability
<ul style="list-style-type: none">• All Island OR Requirement• NI / IRL Min OR Requirement• NI / IRL RR (OCGT) Limitation• NI / IRL Negative Reserve• Ramping	<ul style="list-style-type: none">• North-South Tie-Line Limit• Various Dublin Must Run• Cork Export Limit	<ul style="list-style-type: none">• Coolkeeragh Must Run• Various Dublin Must Run• South West Must Run• Moneypoint Must Run	<ul style="list-style-type: none">• Inertia• RoCoF*• SNSP**• NI 3 Units Must Run• IRL 5 Units Must Run

*RoCoF: Rate of Change of Frequency

**SNSP: System Non-Synchronous Penetration

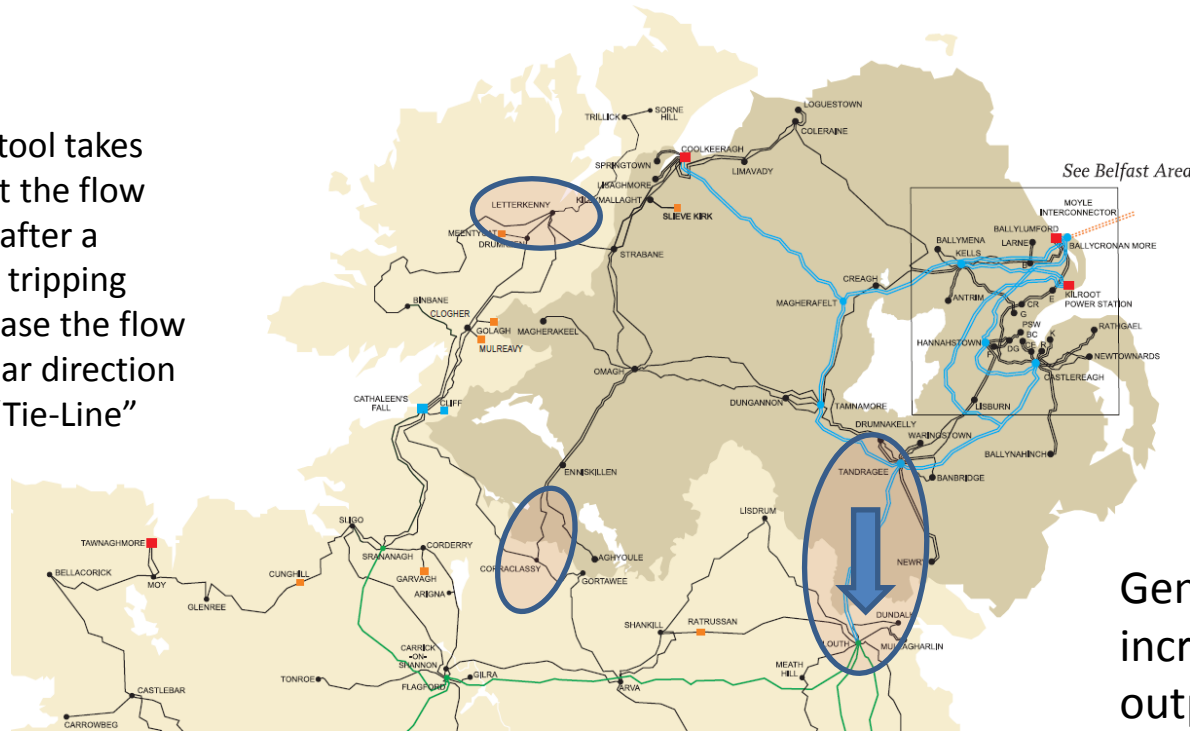
3.4.1 Active System Wide Constraints

Name	TCG Type	Limit Type	Limit	Resources	Description
Inter-Area Flow (S_MWR_ROI)	MWR	X:<=	400 MW (There is a margin of 20MW on this limit for system safety)	Ireland and Northern Ireland Power Systems	<p>Ensures that the total MW transferred between Ireland and Northern Ireland does not exceed the operational limits of the North-South tie line. It takes into account the rescue/reserve flows that could occur immediately post fault inclusive of operating reserve requirements.</p> <p>This is required to ensure the operational limits of the existing North South tie line are respected.</p>
Inter-Area Flow (S_MWR_NI)	MWR	X:<=	450 MW (There is a margin of 20MW on this limit for system safety)	Ireland and Northern Ireland Power Systems	<p>Ensures that the total MW transferred between Northern Ireland and Ireland does not exceed the limitations of the North-South tie line. It takes into account the rescue/reserve flows that could occur immediately post fault inclusive of operating reserve requirements.</p> <p>This is required to ensure the limits of the existing North South tie line are respected.</p>

[Inter Area flow modelling in scheduling tools](#)

North-South Inter Area Flow

Scheduling tool takes into account the flow that occurs after a tripping – A tripping would increase the flow in a particular direction across the “Tie-Line”



Generators increase their output providing reserve in response to a tripping on the system.

Max Limit North to South on Tie Line is 450MW (actual + reserve) which is linked to the Largest Single infeed in each jurisdiction



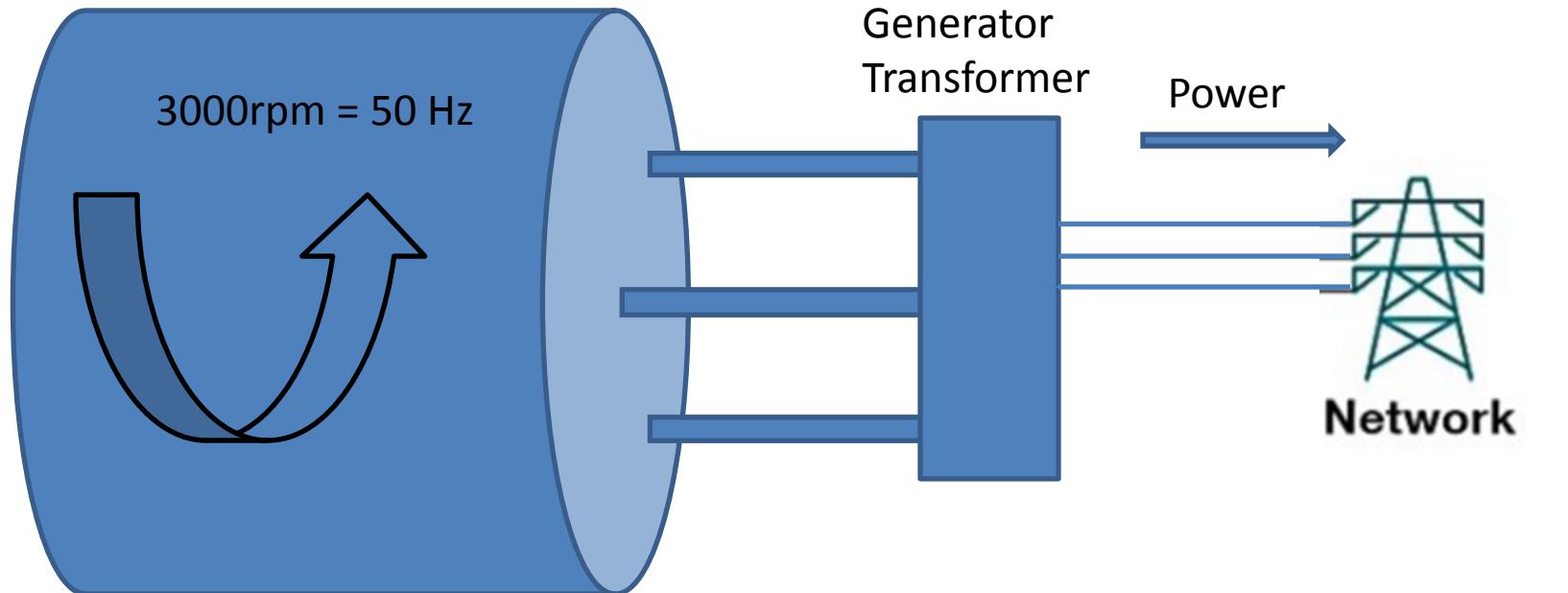
Generator trip in ROI

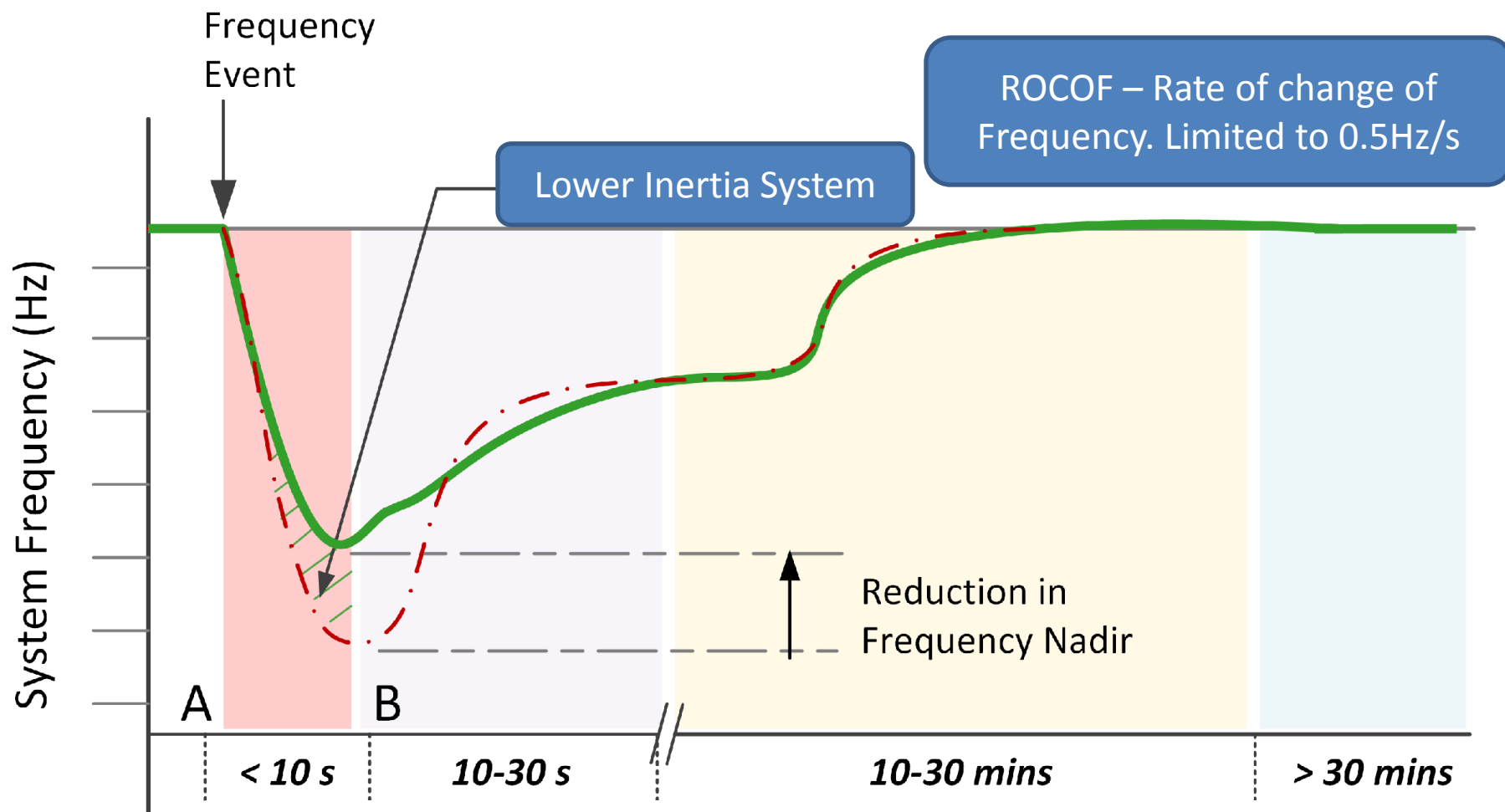
[Info note on Inter Area Flow](#)

Non-Synchronous Generation (S_SNSP_TOT)		$X \leq$	65%	Wind, Moyle Interconnector, EWIC Interconnector	Ensures that the SNSP is kept below 65%.
Operational Limit for RoCoF (S_RoCoF)		$X \leq$	0.5 Hz/s	Ireland and Northern Ireland Power Systems	Ensures that RoCoF does not exceed 0.5 Hz/s.
Operational Limit for Inertia (S_INERTIA_TOT)		$N \geq$	23,000MWs	Ireland and Northern Ireland Power Systems	Ensures that all island Inertia does not fall below 23,000 MWs.

Inertia and Rate of Change of frequency

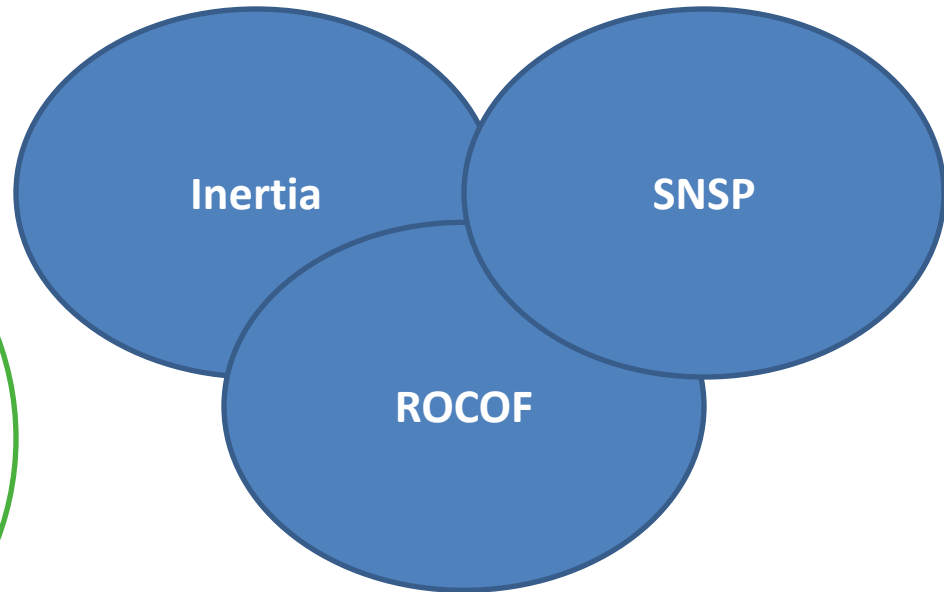
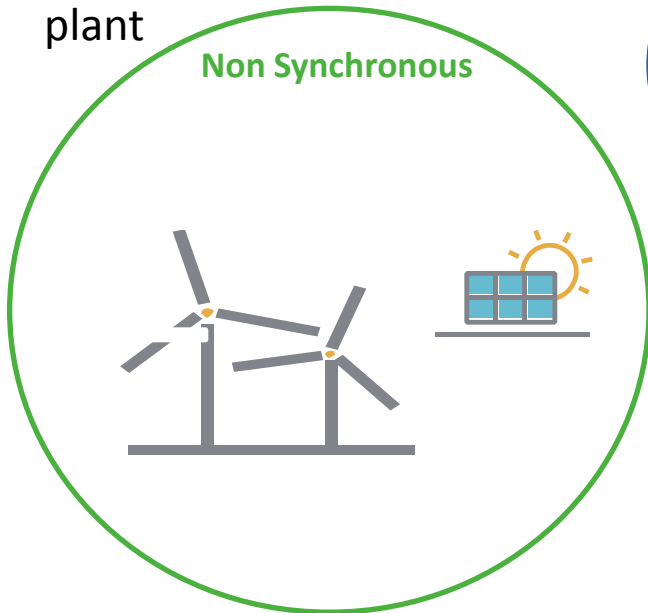
Heavy metal shaft of spinning turbine connected to electrical generator – High Inertia





Non Synchronous Generation

Additional metric to limit
amount of non synchronous
plant



- Units connected through a power converter are not counted as Synchronous (including Interconnectors Moyle and EWIC)

System Stability Constraints

3.4.2 Active Northern Ireland Constraints

Name	TCG Type	Limit Type	Limit	Resources	Description
System Stability (S_NBMIN_MINNIU)	NB	N:>=	3 Units at all times	B10, B31, B32, C30, K1, K2	There must be at least 3 machines on-load at all times in Northern Ireland. Required for dynamic stability. (This TCG is temporarily disabled while S_NBMIN_MINNI1 and S_NBMIN_MINNI2 are enabled)

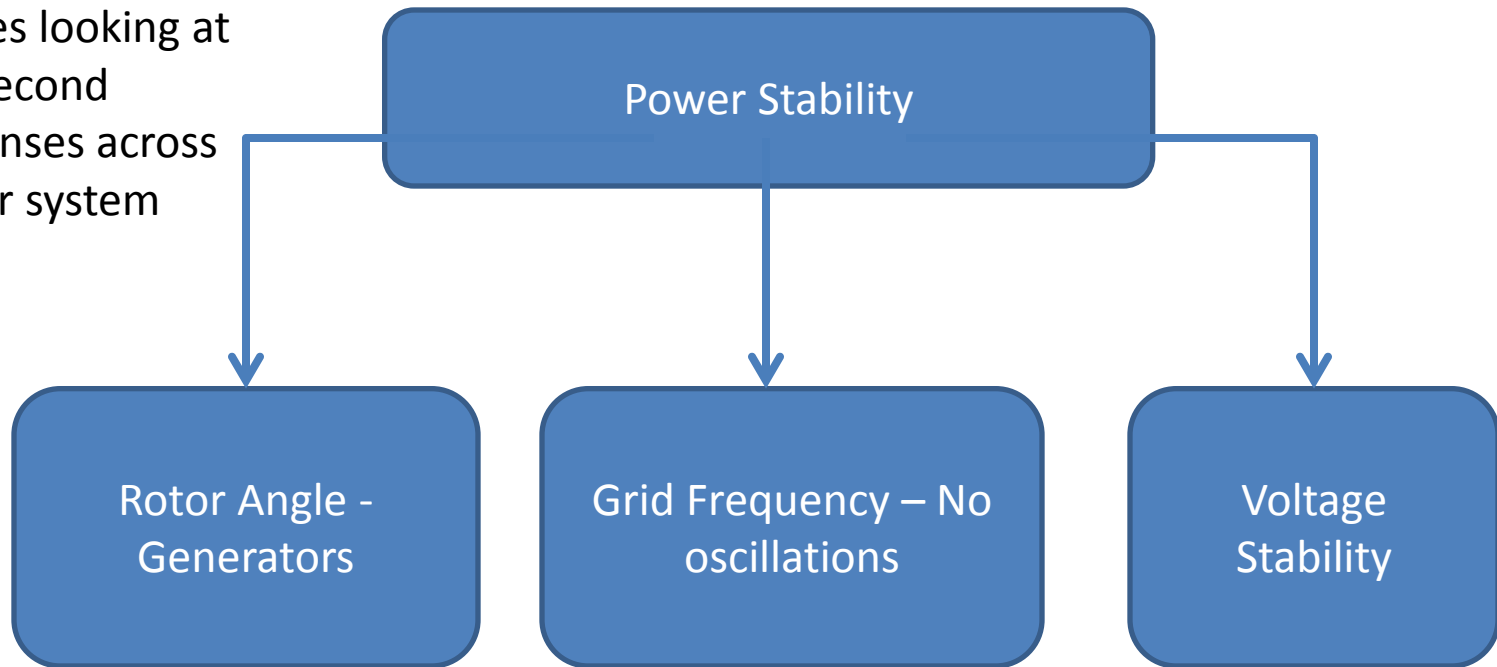
3.4.3 Active Ireland Constraints

- [A] Scenario A: In this scenario if PBA or PBB are operating in combined cycle mode they will be considered as constraint resources
- [B] Scenario B: In this scenario if PBA or PBB are operating in open cycle mode they will be considered as constraint resources

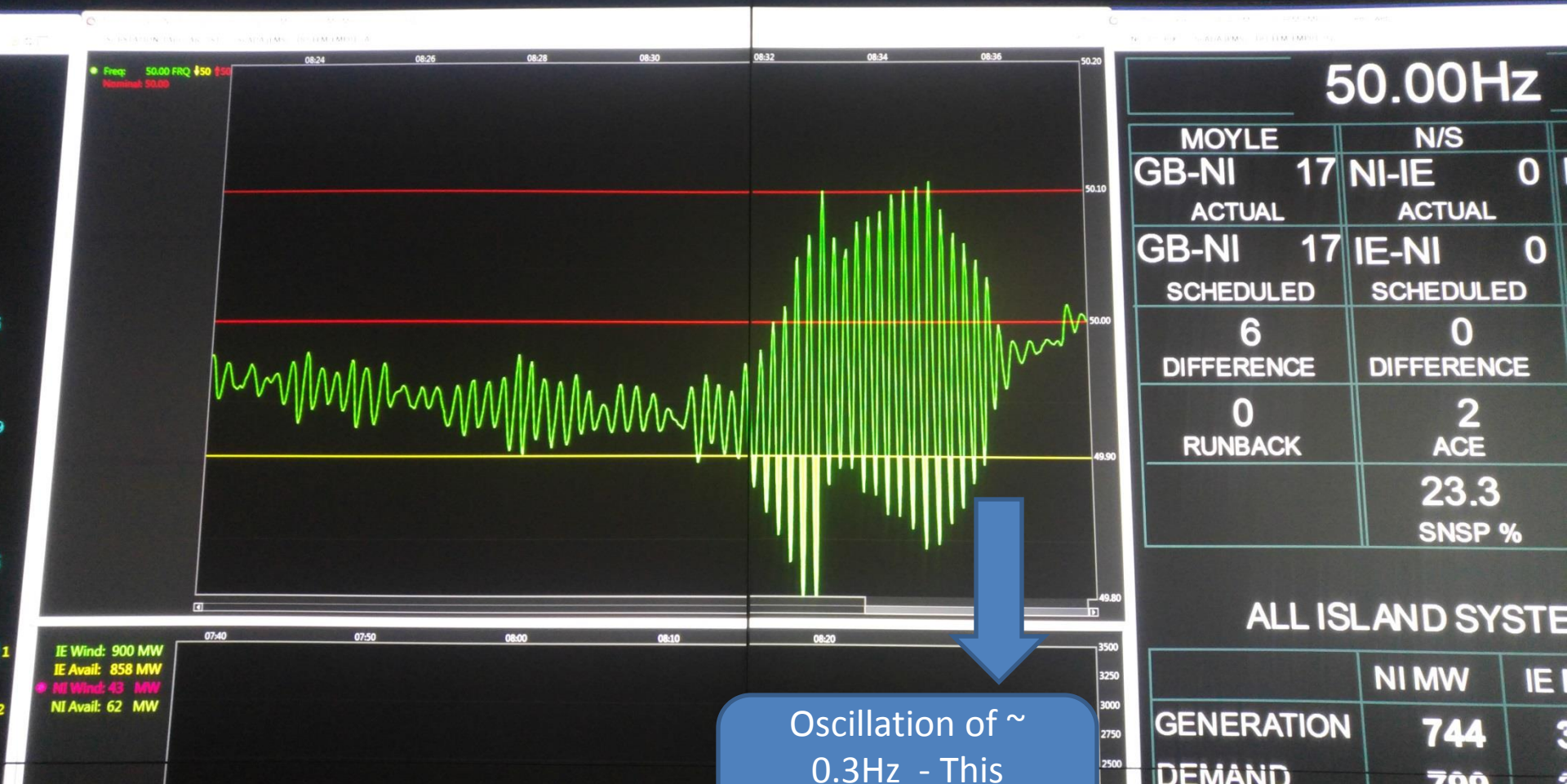
Name	TCG Type	Limit Type	Limit	Resources	Description
System Stability (S_NBMIN_ROImin)	NB	N:>=	5 Units	AD2, DB1, GI4, HNC, HN2, MP1, MP2, MP3, PBA [A], PBB [A], TB3, TB4, TYC, WG1	There must be at least 5 machines on-load at all times in Ireland. Required for dynamic stability. [A] See Scenario A

Jurisdictional Constraints – System Stability

Dynamic/transient studies looking at millisecond responses across power system



Grid Frequency - Oscillation on Power System

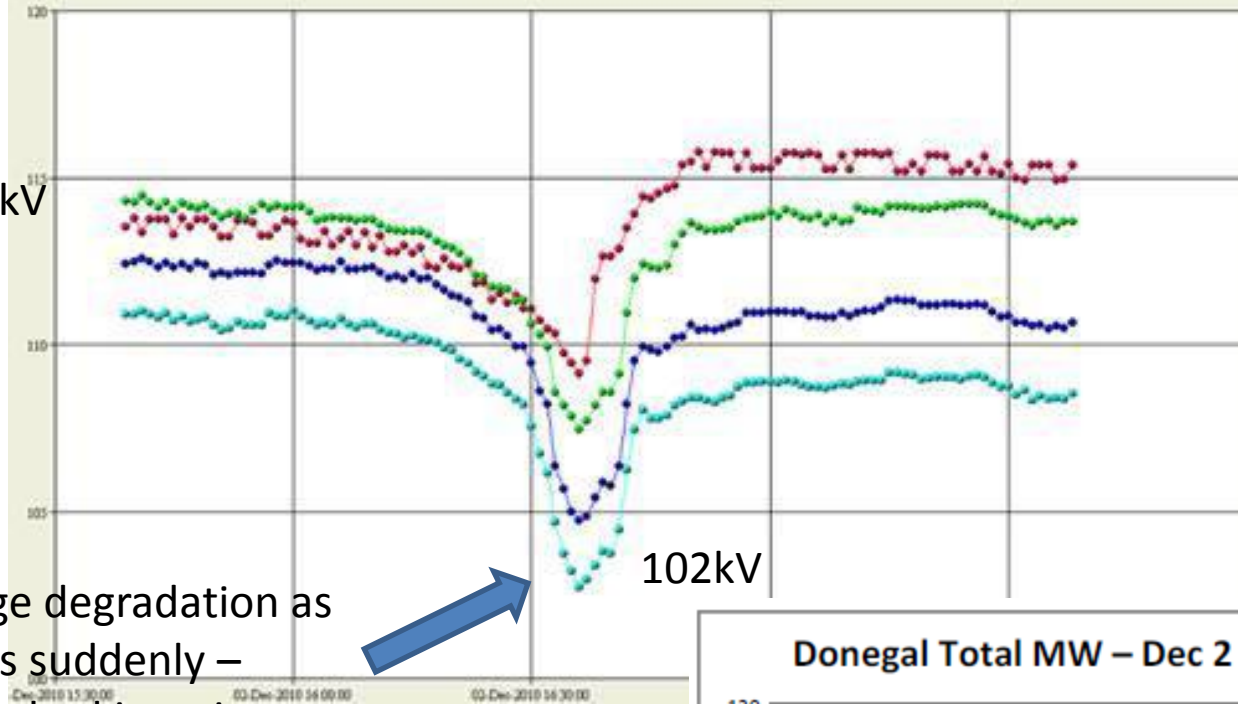


Oscillation of ~
0.3Hz - This
equates to about
150MW

Voltage Instability in Donegal

Start: 02-dec-2010 15:38:42

Healthy 110kV
voltages
~113kV

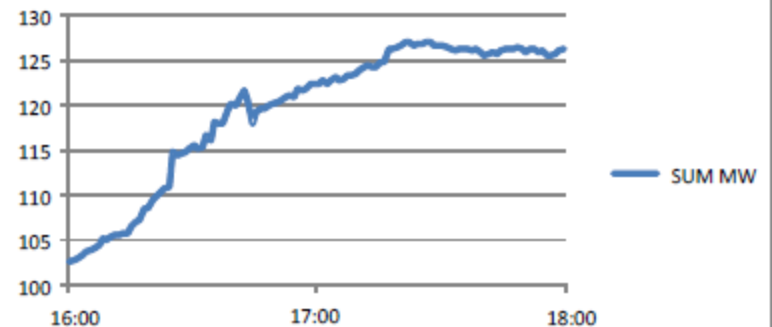


Sudden voltage degradation as
Load increases suddenly –
Capacitor switched in to increase
voltage and avoid cascading
voltage collapse

16:30

102kV

Donegal Total MW – Dec 2 2010



2. Operating Reserve Requirements

The following tables show the operating reserve requirements on an all-island basis and in each jurisdiction.

Category	All Island Requirement % Largest In-Feed	Ireland Minimum ¹ (MW)	Northern Ireland Minimum (MW)
POR ²	75% ³ (S_PRM_TOT)	135/ 75 (S_PRM_ROI)	49 (S_PRM_NI)
SOR	75% ⁴ (S_SEC_TOT)	135/ 75 (S_SEC_ROI)	49 (S_SEC_NI)
TOR1	100% (S_TR1_TOT)	135/ 75 (S_TR1_ROI)	49 (S_TR1_NI)
TOR2	100% (S_TR2_TOT)	135/ 75 (S_TR2_ROI)	49 (S_TR2_NI)

1. Ireland Lower values apply from 00:00 - 07:00 inclusive

2. Minimum values of POR in each jurisdiction must be supplied from regulating sources

3. At times more than 75% POR is held All Island (up to 80%) in order to maintain system security standards based on transient security analysis (this will remain under review by the TSOs).

4. At times more than 75% SOR is held All Island (up to 100%) in order to maintain system security standards based on real-time transient security analysis (this will remain under review by the TSOs).

2.2 Source of Reserve

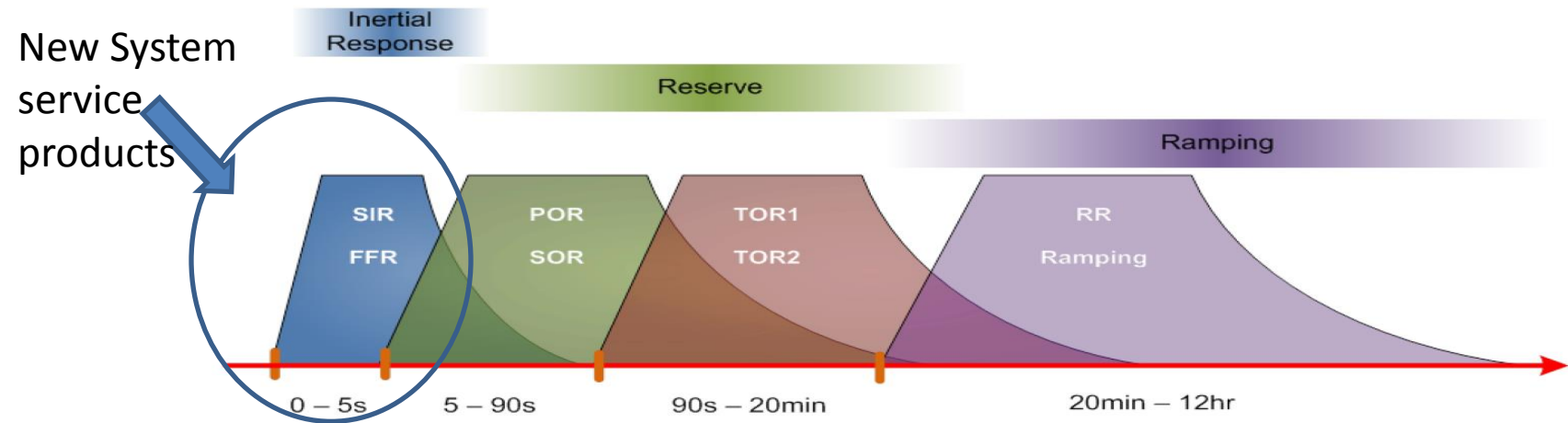
	Ireland	Northern Ireland
Regulating Reserve	Synchronised Generating Units	Synchronised Generating Units
Non or Partially Regulating Reserve	Turlough Hill Units when in pumping mode 23 MW of Response from DSUs EWIC Interconnector (up to 75 MW) ²	10 MW of battery response 2 MW of Response from DSUs Moyle Interconnector (up to 75 MW)
Negative Reserve (Defined as the MW output of a conventional generator above its minimum load)	100MW (S_NEG_ROI)	50MW (S_NEG_NI)

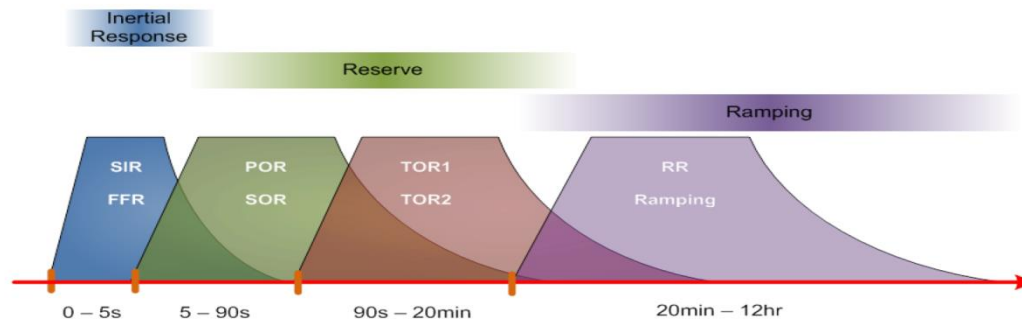
Reserves

Chapter 2 in
Operational
Constraints

Reserve – replace lost power

- N-1 secure – Loss of any single element/Generator
- Concept of Largest Single infeed(outfeed)
- 75% of the largest single infeed is covered





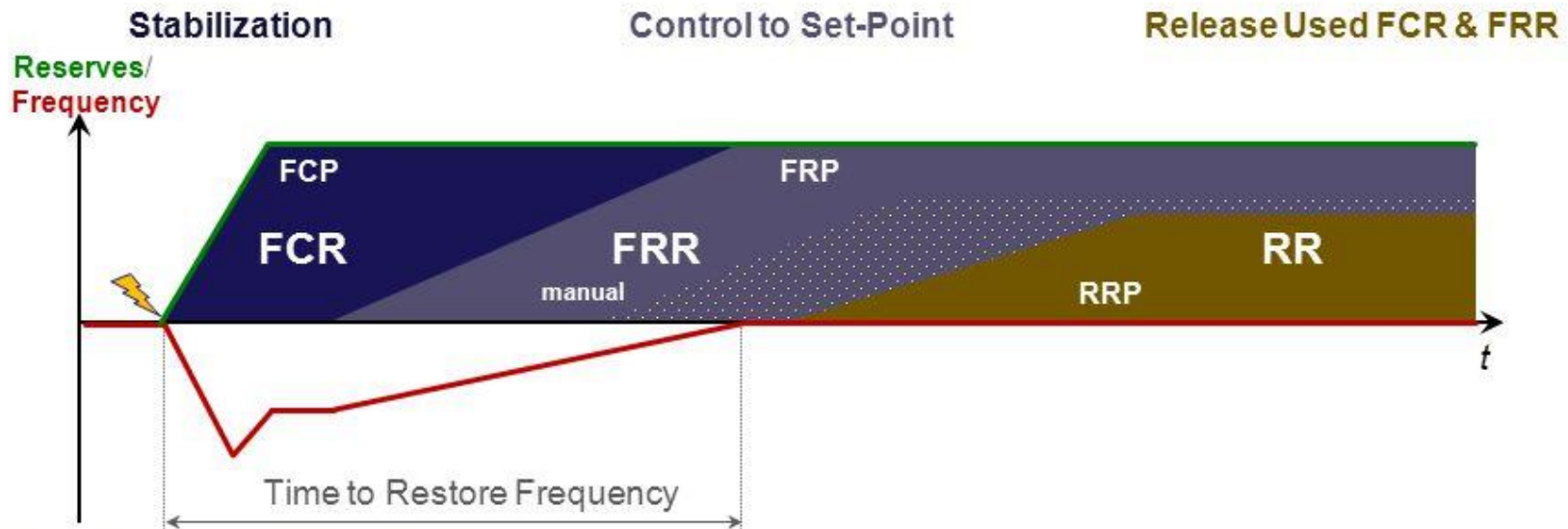
Frequency Containment Reserves



Frequency Restoration Reserves



Replacement Reserves



Replacement Reserve

325MW spare capacity on fast acting plant

450MW
Total all
island to
cover
largest loss

Replacement Reserve (S_REP_ROI) (S_MWMAX_ROI_GT)	MW	X:<=	698 MW [B]	AT1, AT2, AT4, ED3, ED5, NW5, RP1, RP2, TP1, TP3. PBA [B], PBB [B]	Combined MW output of OCGTs must be less than 698 MW (out of a total of 1023 MW) in Ireland at all times. 325 MW required for replacement reserve. The limit is subject to change based on the availability of the units and transmission constraints that may limit their output. [B] See Scenario B
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Replacement Reserve (S_REP_NI) (S_MWMAX_NI_GT)	MW	X:<=	263 MW	BGT1, BGT2, CGA, CGT8, EMPOWER , iPOWER, KGT1, KGT2, KGT3, KGT4	Combined MW output of OCGTs and AGUs must be less than 263 MW (out of a total of 388 MW) in Northern Ireland at all times. 125 MW required for replacement reserve. The limit is subject to change based on the availability of the units and transmission constraints that may limit their output.
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125MW required
in NI

Negative Reserve (S_NEG_NI)	NB	>50 MW	Varies	B10, B31, B32, BGT1, BGT2, B5, C30, CGT8, K1, K2, KGT1, KGT2, KGT3, KGT4	Number of units on above minimum load for negative reserve.
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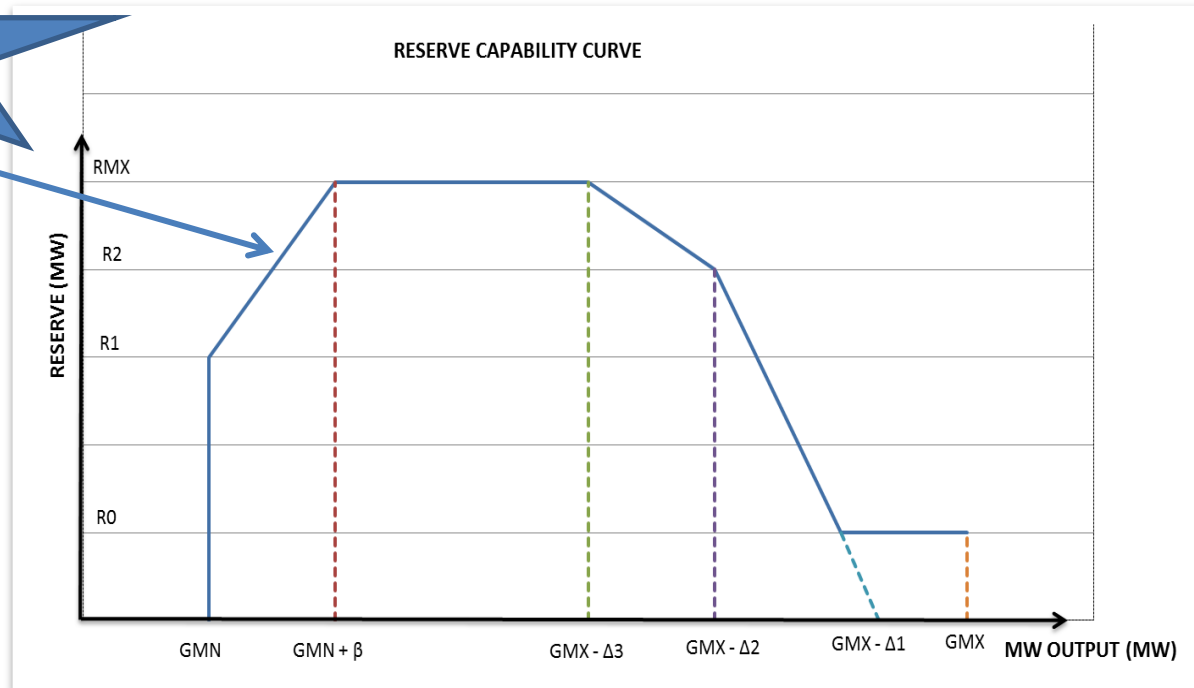
Negative Reserve (S_NEG_ROI)	NB	>100 MW	Varies	AD2, AT1, AT2, AT4, DB1, ED3, ED5, GI4, HN2, HNC, MP1, MP2, MP3, NW5, PBA [B], PBB [B], RP1, RP2, SK3, SK4, TP1, TP3, TYC, WG1	Number of units on above minimum load for negative reserve. [B] See Scenario B
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Negative Reserve

- Traditionally held to deal with scenario where generators are at min gen and the system load is lower than forecast (frequency moves > 50Hz)
- Interconnection and wind forecast error also feed into this
- Can interact with other constraints(requirement overnight to hold primary reserve) – some generators need to be above min to provide reserve

Illustration of Reserve Curve

Defect



Constraints binding when?

Constraint Type	Operational Constraint is Binding if ...	Unit is Bound by this Constraint if ...
Inertia	\leq Limit	Provides inertia and is at LOL
SNSP	$=$ Limit	Wind < HOL, IC < HOL, TH pumping
RoCoF	$=$ Limit	Loss would lead to the RoCoF limit
MW	\leq Min Limit \geq Max Limit	As per constraint
MWR	\geq Limit	All units in jurisdiction that is exporting power. There are exceptions to this.
NB	\leq Min Limit \geq Max Limit	At LOL
Reserves	$=$ Limit	Is at a point in its reserve curve where a change in output would reduce provision

[Determining System Operator and Non Marginal Flags](#)

Monthly Operational Constraints

- Underlying constraints on network or global system constraints that can arise on intact network
- Looks at all types of constraints (voltage, thermal, security)

Weekly Constraints

- Entire week of outages studied
- Low/High Wind
- Varying demand
- Exports/Imports

Network model in Scheduling Tool

- Thermal only
- DC Load flow (doesn't capture voltage issues)
- Per scheduling interval over study horizon with relevant inputs (outages etc)

- Operationally cannot create explicit constraints for every thermal contingency as the constraint may arise only for a short period
- Any longer term recurring constraints will be added to the scheduling system