Operating Ireland's power system at high non-synchronous renewable generation levels

WinGrid Workshop, 18 June 2021

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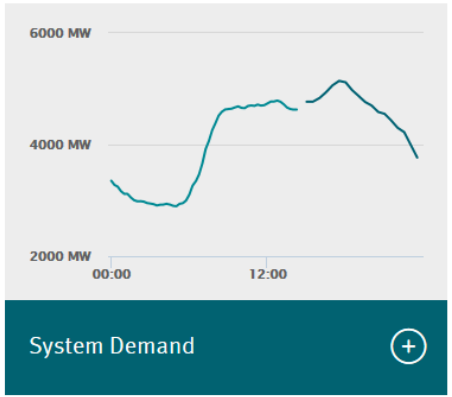
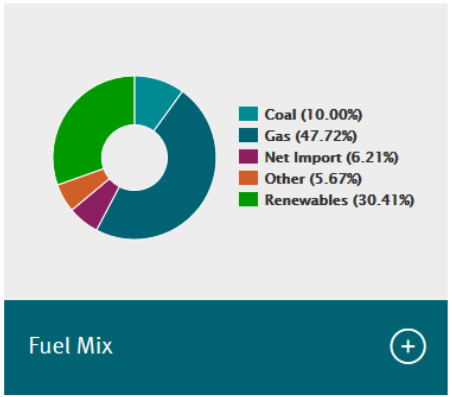
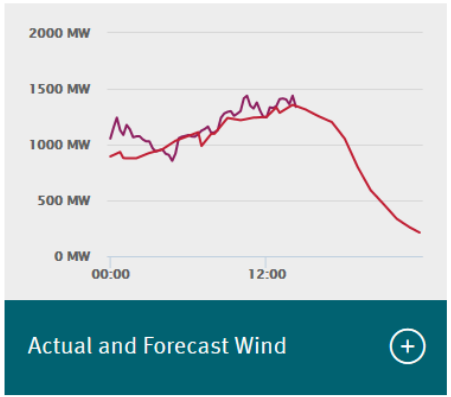
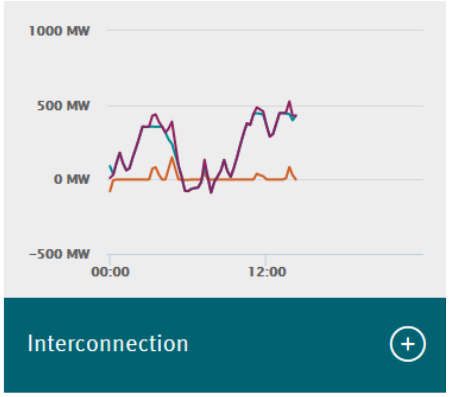
Presentation Overview

- To provide an insight into how EirGrid and SONI operate the power system of Ireland and Northern Ireland today with high levels of wind and how this will evolve in the future.









http://www.eirgridgroup.com/how-the-grid-works/system-information/

System Overview

Peak Demand: 6878 MW

Installed Wind: 5600 MW
Peak Wind: 4437 MW

Installed Solar: 120 MW
Peak Solar: 112 MW

Moyle
+/- 500 MW
HVDC (LCC)
to GB

EWIC
+/- 500 MW
HVDC (VSC)
to GB

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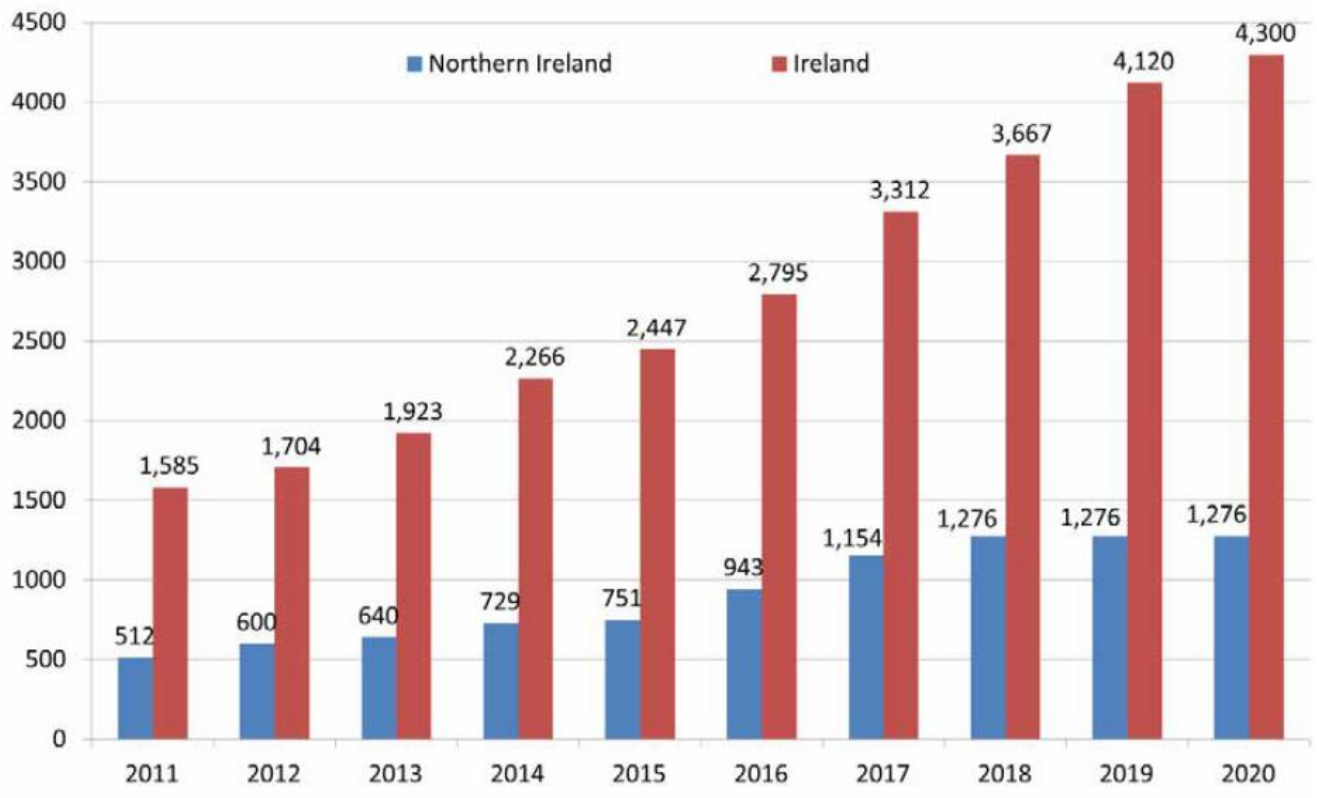
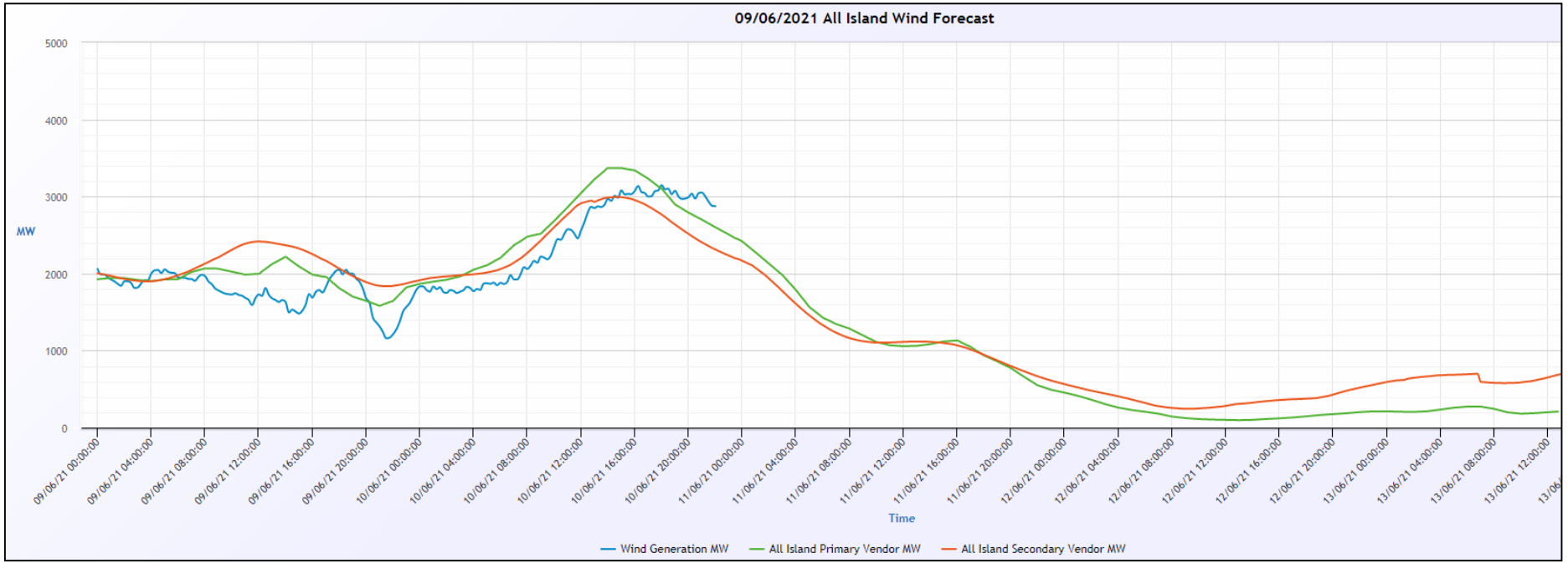
Installed Wind Capacity (MW)



Operations Today

Forecasts


09/06/2021 All Island Wind Forecast
5000
4000
3000
2000
1000
0
MW
09/06/21 00:00:00
09/06/21 04:00:00
09/06/21 08:00:00
09/06/21 12:00:00
09/06/21 16:00:00
09/06/21 20:00:00
10/06/21 00:00:00
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12/06/21 20:00:00
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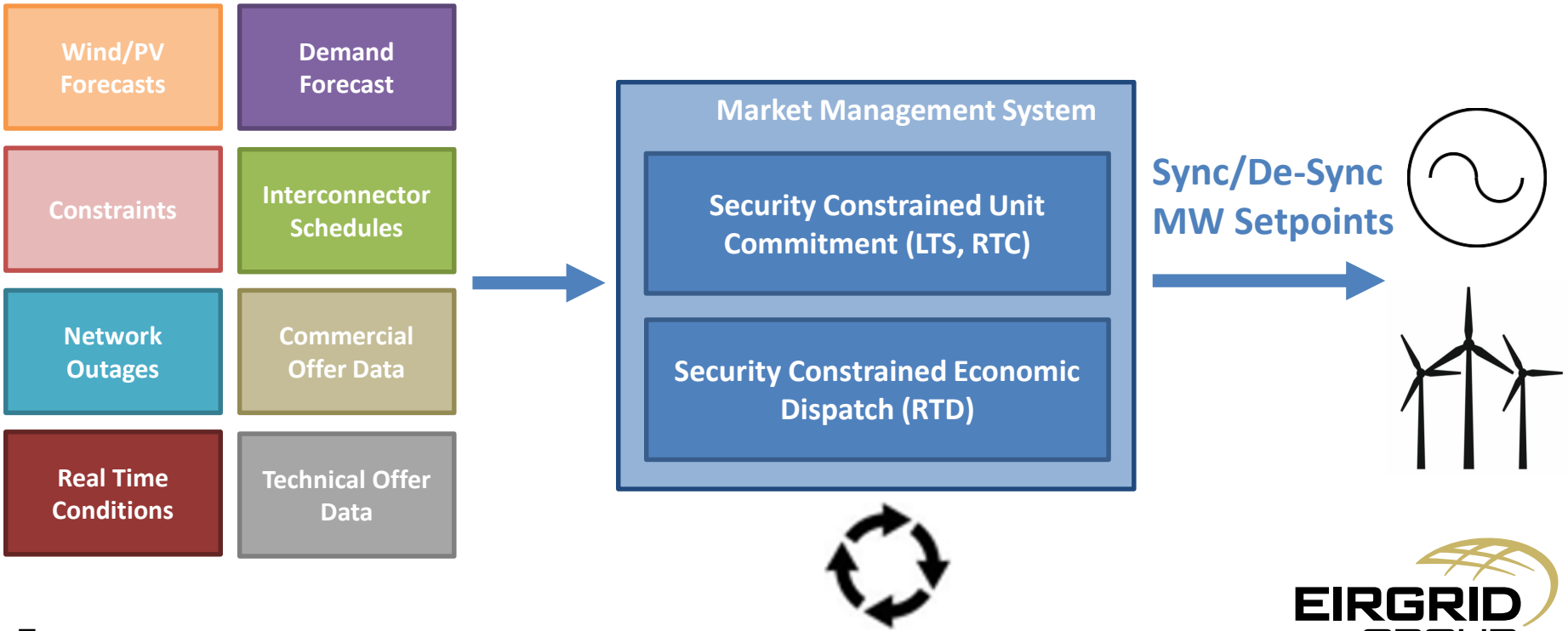
Time
Wind Generation MW
All Island Primary Vendor MW
All Island Secondary Vendor MW

Scheduling and Dispatch



Constraint - SNSP

SNSP is an operational metric that is used to represent the amount of non-synchronous generation, such as Wind or Solar Generation, on the system at an instant in time. It is the ratio of the real-time MW contribution from non-synchronous generation and net HVDC interconnector imports to demand plus net HVDC interconnector exports. The equation to express SNSP as a percentage is thus formulated as follows:

$$SNSP(\%) = \frac{\text{Non-synchronous generation+net interconnector imports}}{\text{Demand + net interconnector exports}} \times 100$$

Current limit is 70 % (trialling 75% from April 2021)

Constraint - Inertia

Inertia is an operational metric that represents the amount of kinetic energy stored in the rotating masses of generators. The power system's inertia determines the sensitivity of the system frequency towards supply demand imbalances. The higher the power system's inertia, the less sensitive is the frequency to temporary imbalances.

Current floor is 23,000 MWs

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Constraint - RoCoF

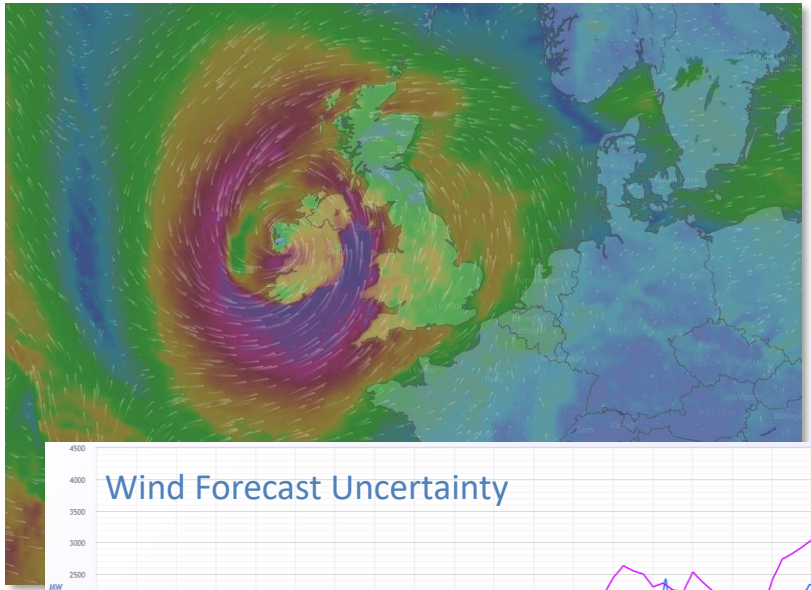
RoCoF (or Rate of Change of Frequency) is an operational metric that represents the rate at which the system frequency changes in the timeframe immediately following a system event which disconnects a generator or load from the system.

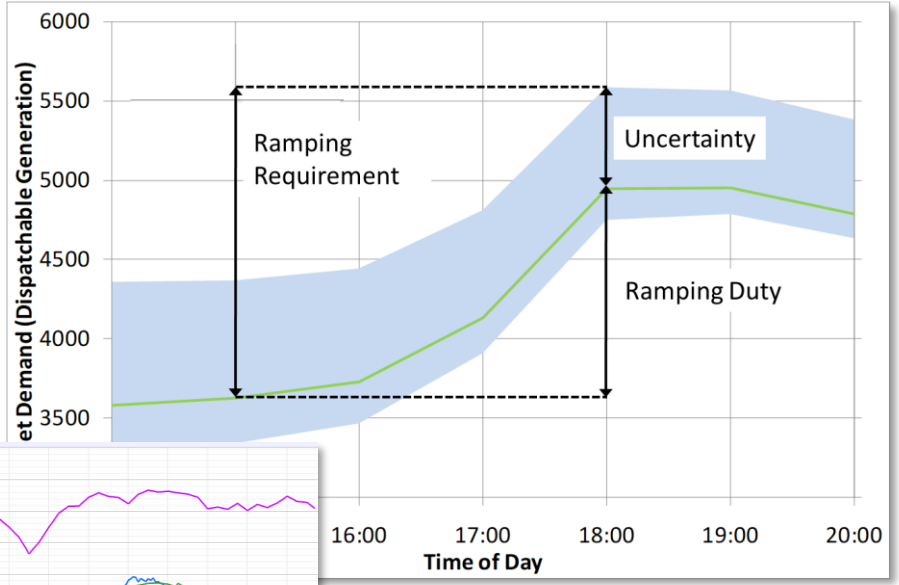
$$RoCoF = \frac{System\ frequency \times Active\ Power_{lost}}{2(Inertia_{system} - Inertia_{lost})}$$

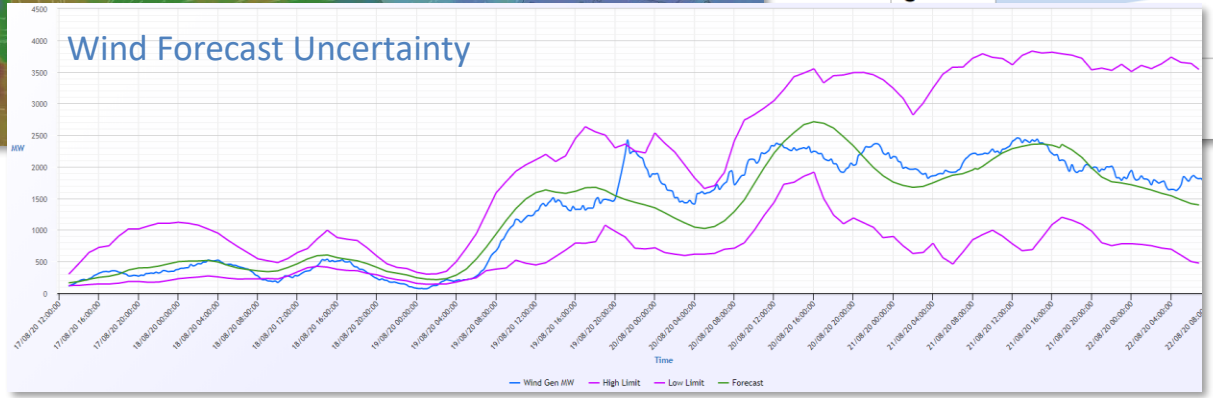
Where: $Active\ Power_{lost}$ = Output of Generator in MW which was disconnected from the System, $Inertia_{system}$ = Total System Inertia being provided as stored kinetic energy by all rotating masses, including generation, on the System and $Inertia_{lost}$ = Inertia being provided by the Generator which was disconnected from the System.

Current limit is 0.5 Hz/s (trialling 1.0 Hz/s limit from June 2020)

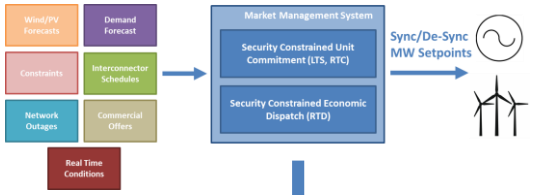
Constraint – Ramping Requirements

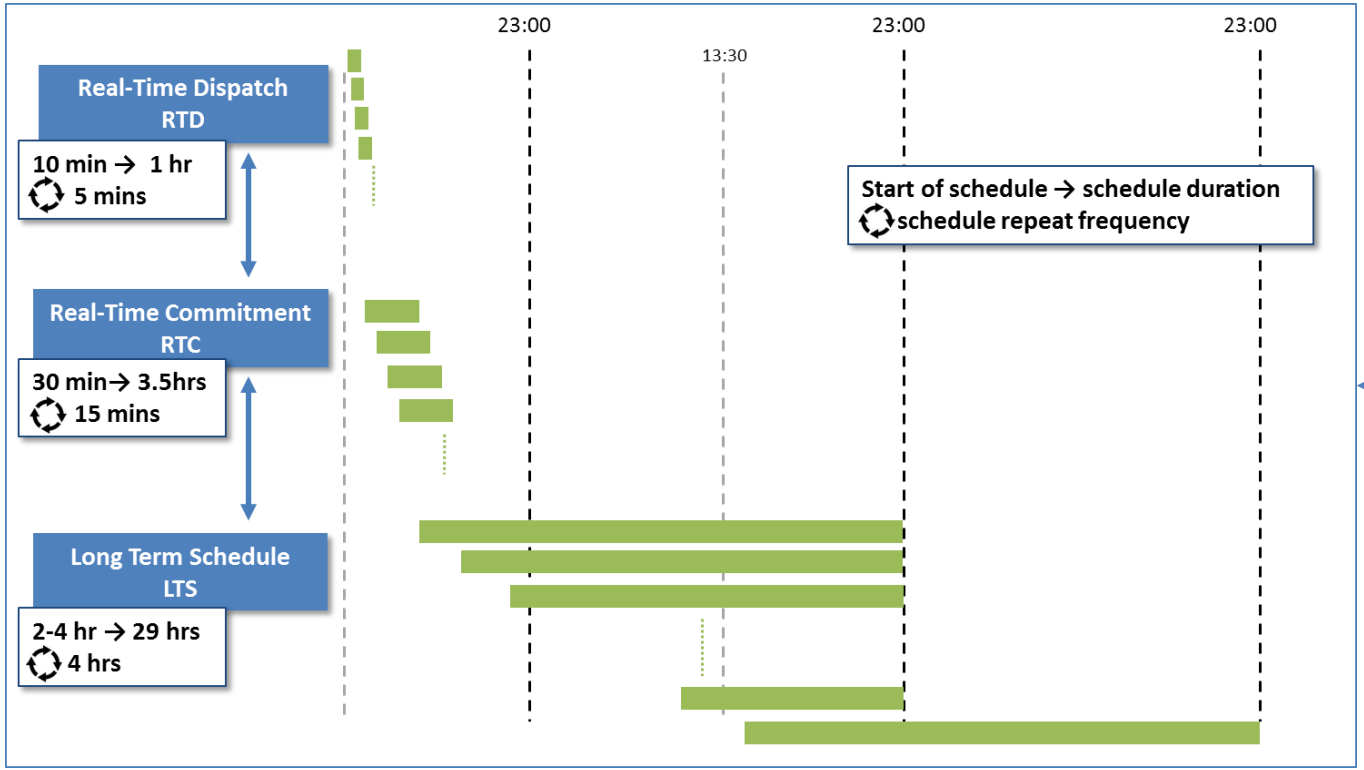






Scheduling and Dispatch





Windfarm Real-Time Controls

MW Setpoint

Frequency Response On/Off

Frequency Deadband 200mHz/15mHz

Reactive Power Control Mode (V, Q, PF)

Reactive Power Setpoint

Constraint and Curtailment management

Frequency Response

Reactive Power / Voltage Support

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Windfarm Services

From Wind?	Service Name	Abbreviation	Unit of Payment	Short Description
	Synchronous Inertial Response	SIR	MWs^2h	(Stored kinetic energy)*(SIR Factor – 15)
✓	Fast Frequency Response	FFR	MWh	MW delivered between 2 and 10 seconds
✓	Primary Operating Reserve	POR	MWh	MW delivered between 5 and 15 seconds
✓	Secondary Operating Reserve	SOR	MWh	MW delivered between 15 to 90 seconds
✓	Tertiary Operating Reserve 1	TOR1	MWh	MW delivered between 90 seconds to 5 minutes
	Tertiary Operating Reserve 2	TOR2	MWh	MW delivered between 5 minutes to 20 minutes
	Replacement Reserve – Synchronised	RRS	MWh	MW delivered between 20 minutes to 1 hour
	Replacement Reserve – Desynchronised	RRD	MWh	MW delivered between 20 minutes to 1 hour
	Ramping Margin 1	RM1	MWh	The increased MW output that can be delivered with a good degree of certainty for the given time horizon.
	Ramping Margin 3	RM3	MWh	
	Ramping Margin 8	RM8	MWh	
✓*	Fast Post Fault Active Power Recovery	FPFAPR	MWh	Active power (MW) >90% within 250 ms of voltage >90%
✓	Steady State Reactive Power	SSRP	Mvarh	(Mvar capability)*(% of capacity that Mvar capability is achievable)
✓*	Dynamic Reactive Response	DRR	MWh	MVAr capability during large (>30%) voltage dips

* Capable but currently not a contracted service

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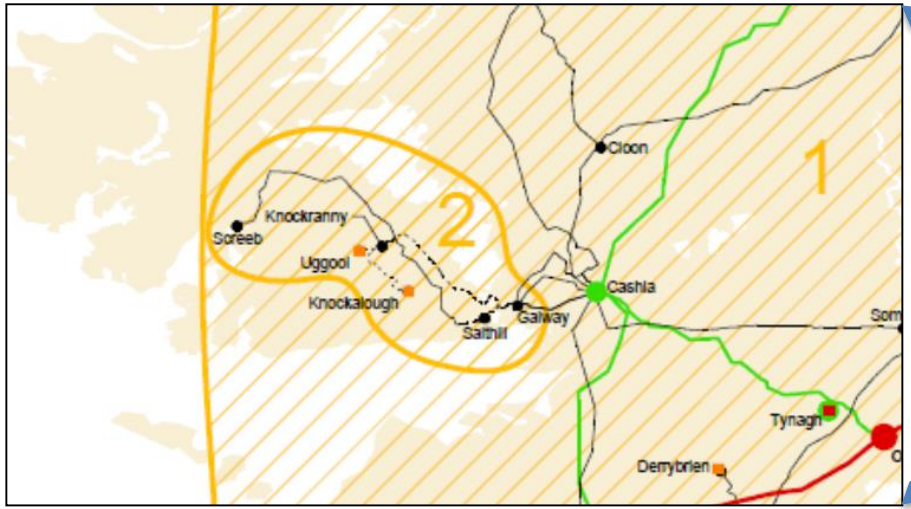
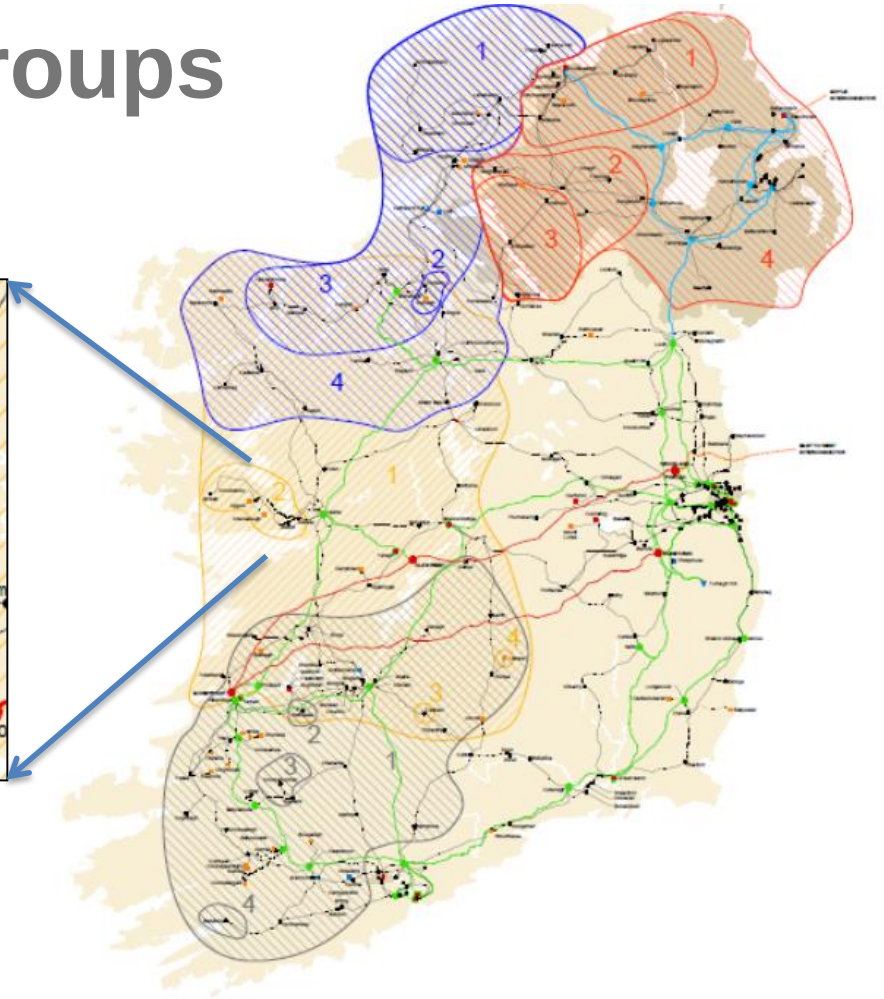
Wind Constraint Groups

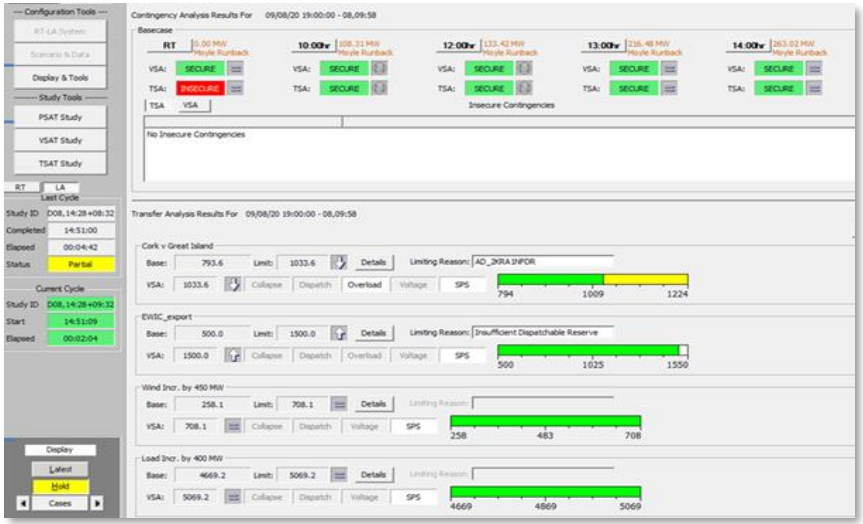
Thermal / Voltage Constraints





Tools

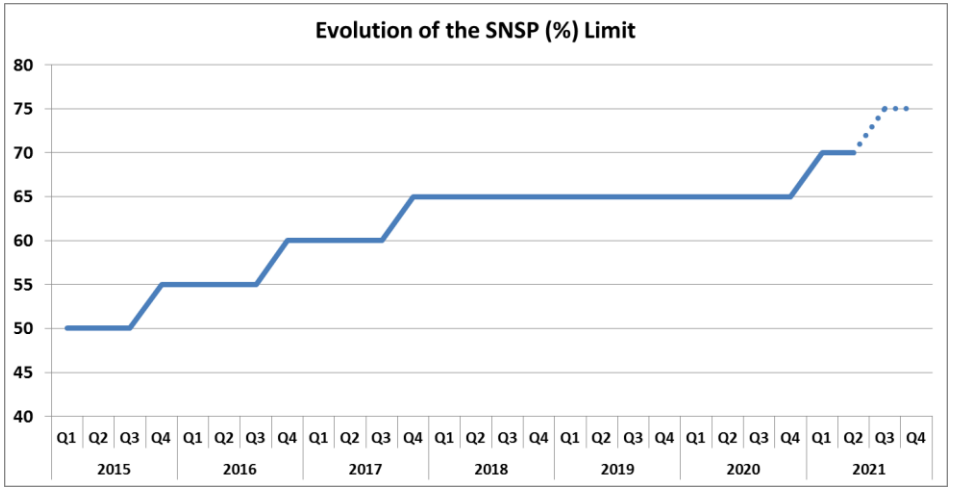
Wind Dispatch Tool

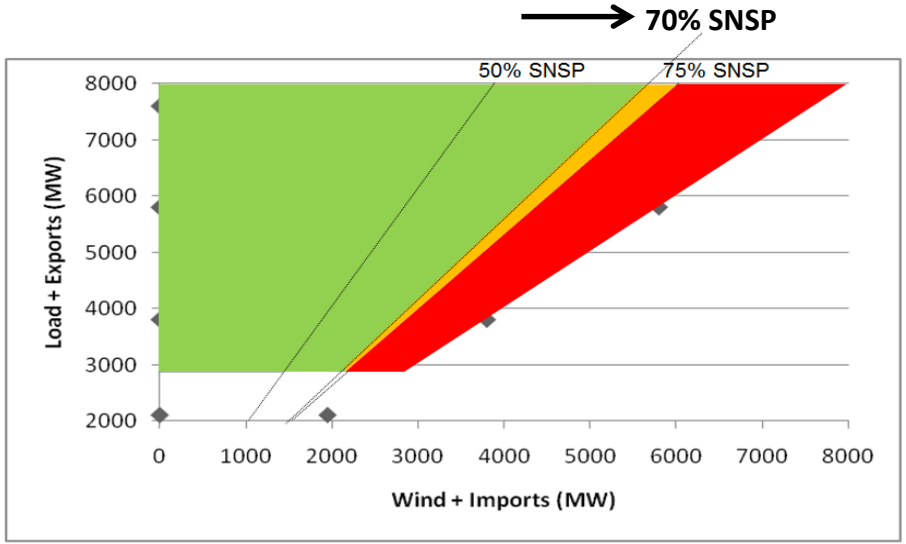


Look Ahead Stability Assessment Tool

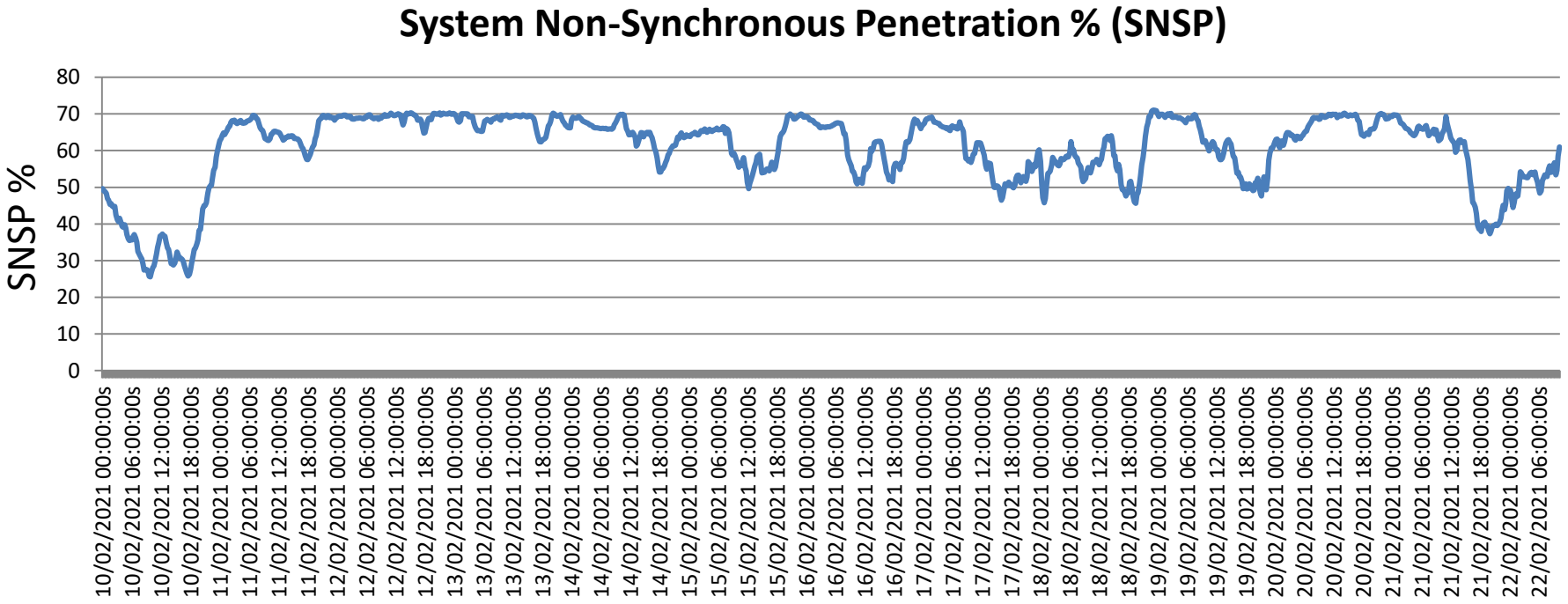
Where we are today

- In April 2021 we raised the SNSP limit to 70% and we are now currently trialling operation up to 75%.





February 2021



Future Operations

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Policy Drivers

- + 10 GW of RES (onshore/offshore wind and solar)
- 700k heat pumps and 1m electric vehicles
- c. 1.7 GW of additional Large Energy User demand
- New transmission network and HVDC interconnection

2030 Operational Challenges

Significant technical challenges will emerge if no action is taken

1. FREQUENCY STABILITY AND CONTROL

- Inertia
- Reserve
- Ramping
- Very low Frequency Oscillations

2. CONGESTION

- Lack of Transmission Capacity

3. TRANSIENT STABILITY

- Reduction in Synchronising Torque
- Reduction in Damping Torque

4. POWER QUALITY

- Harmonics

5. OTHER

- Voltage Dip Induced Frequency Deviation
- Frequency Regulation
- Power System Protection
- Power System Modelling
- Forecasting

CURTAILMENT

Curtailment due to overall power system limitations

6. VOLTAGE STABILITY

- Steady-State Voltage Control
- Dynamic Voltage Control
- Reduction in Available Fault Current

7. SYSTEM RESTORATION

- Less Black-Start Capable Plant

8. GENERATION ADEQUACY

- Capacity Margin
- Weather-Related Events

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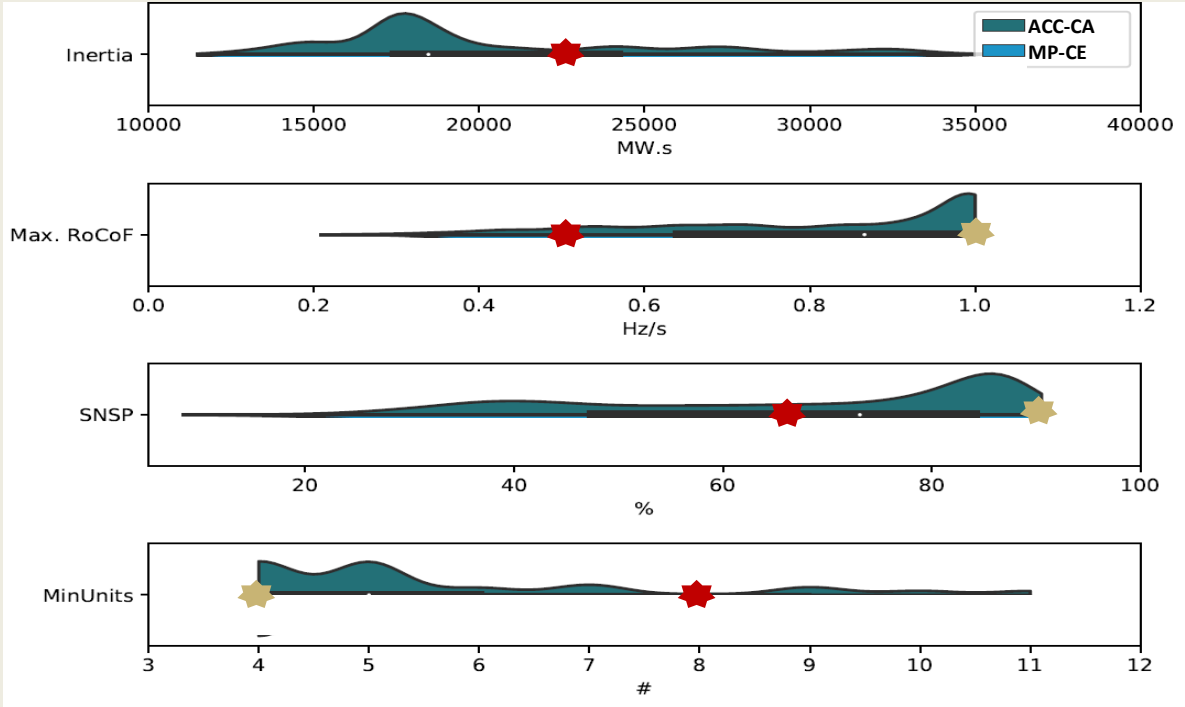
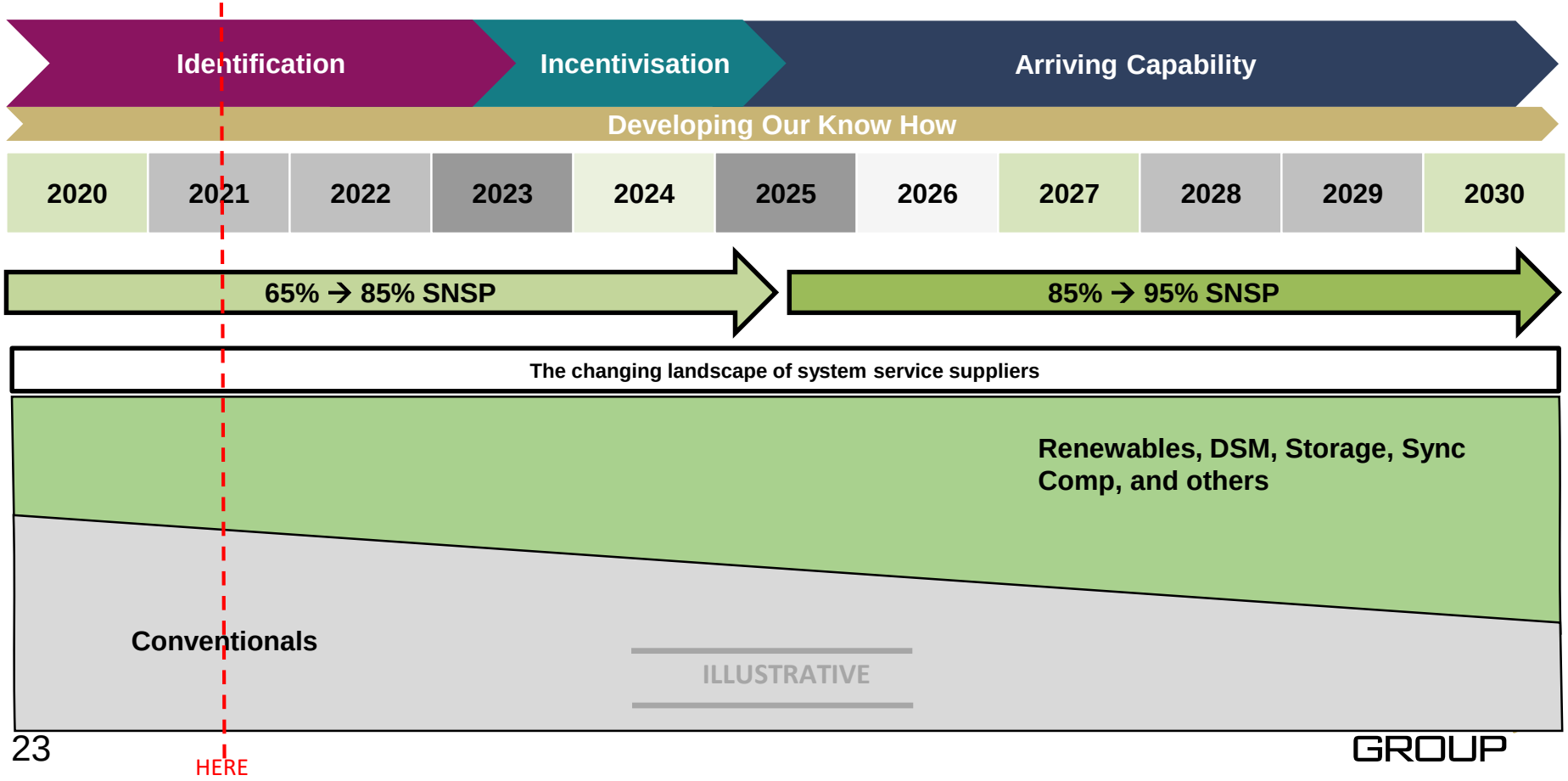
70% RES-E requires operating in a new way



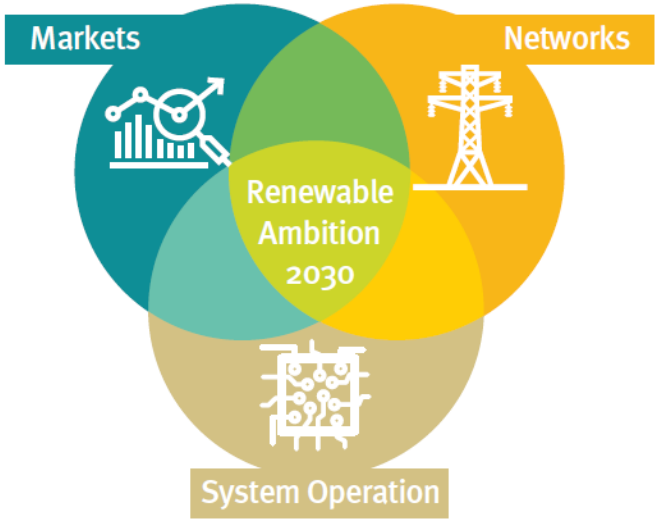
- Inertia levels are below today's minimum allowed level of 23,000 MW.s for ~ 70% of time.
- RoCoF levels are above today's maximum allowed level of 0.5 Hz/s for ~ 85% of time.
- SNSP levels are above today's maximum allowed level of 70% for ~ 60% of time.
- Number of large units online is below today's minimum allowed level of 8 for ~80% of time

Limit today Limit used in TES modelling to satisfy 70% RES-E

Operational Transition



GROUP



https://consult.eirgrid.ie/consultation/industry-consultation-shaping-our-electricity-future