Ireland and Northern Ireland's Journey to 75% Non-Synchronous Renewable Generation Levels

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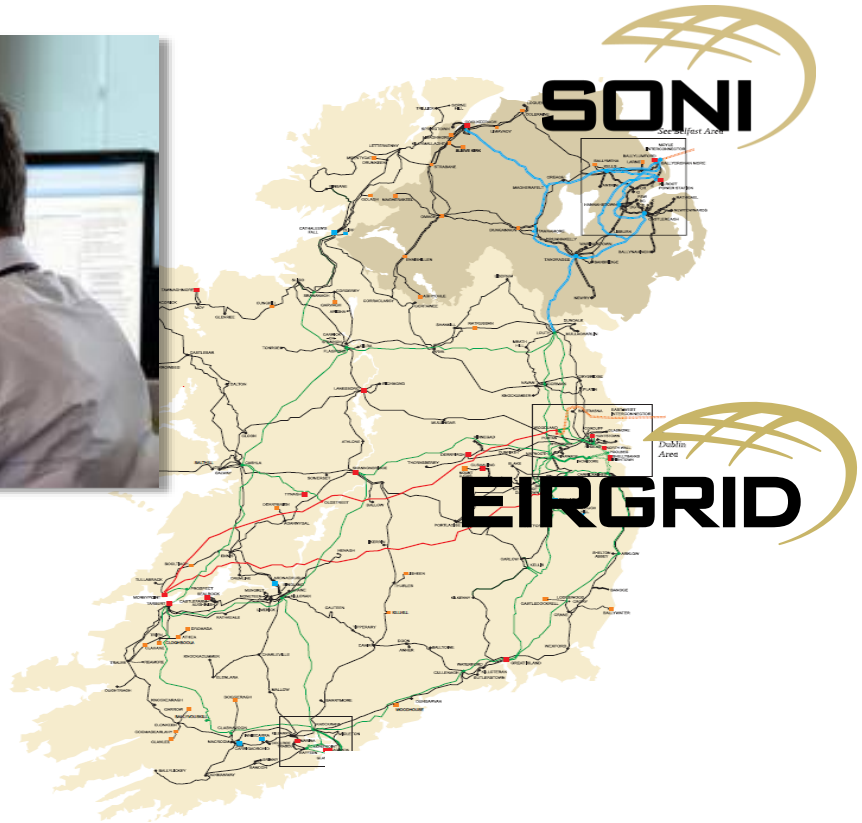
G-PST/ESIG Webinar, 15 November 2022

EIRGRID SONI

The TSOs of Ireland and Northern Ireland



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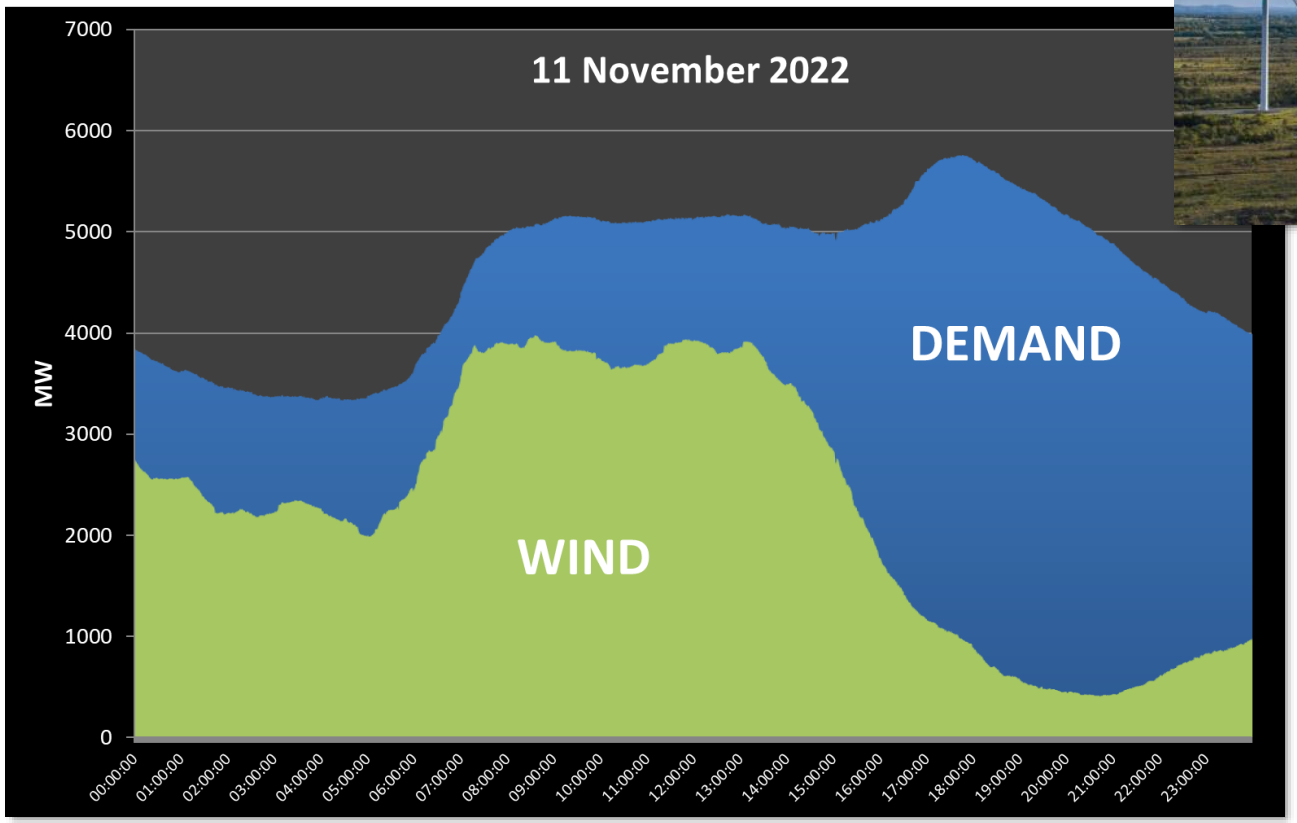
Key Challenge – Integration of Wind



EirGrid and SONI's experiences can be used to benefit other power systems

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System Overview

System Overview

System

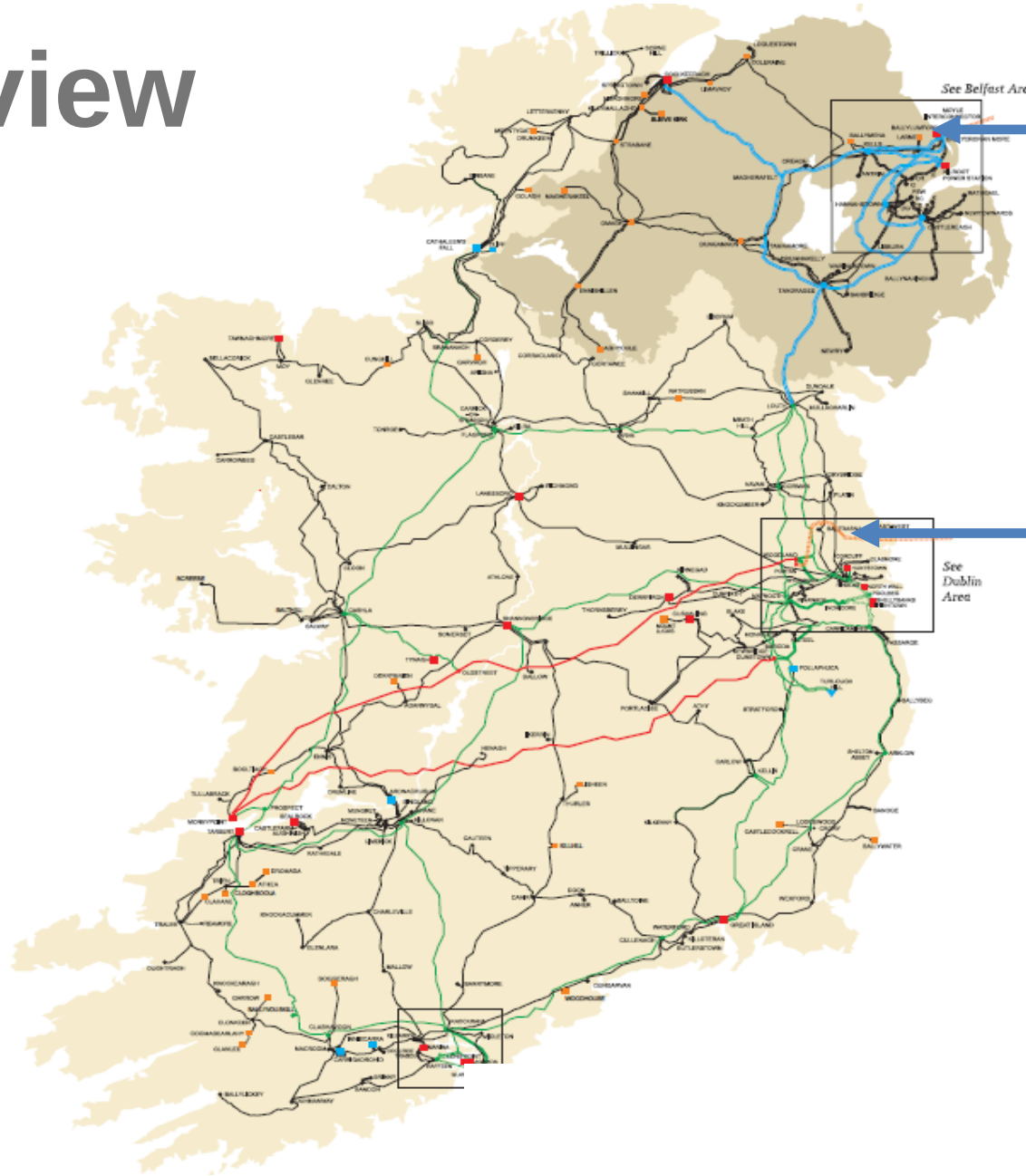
Transmission: 110/220/275/400 kV
Two Jurisdictions / TSOs
Single Synchronous Area & Market

Demand

Peak: 6.8 GW (Winter 2021)
Minimum: 2.5 GW (Summer 2021)
Many global tech./pharma. companies

Generation

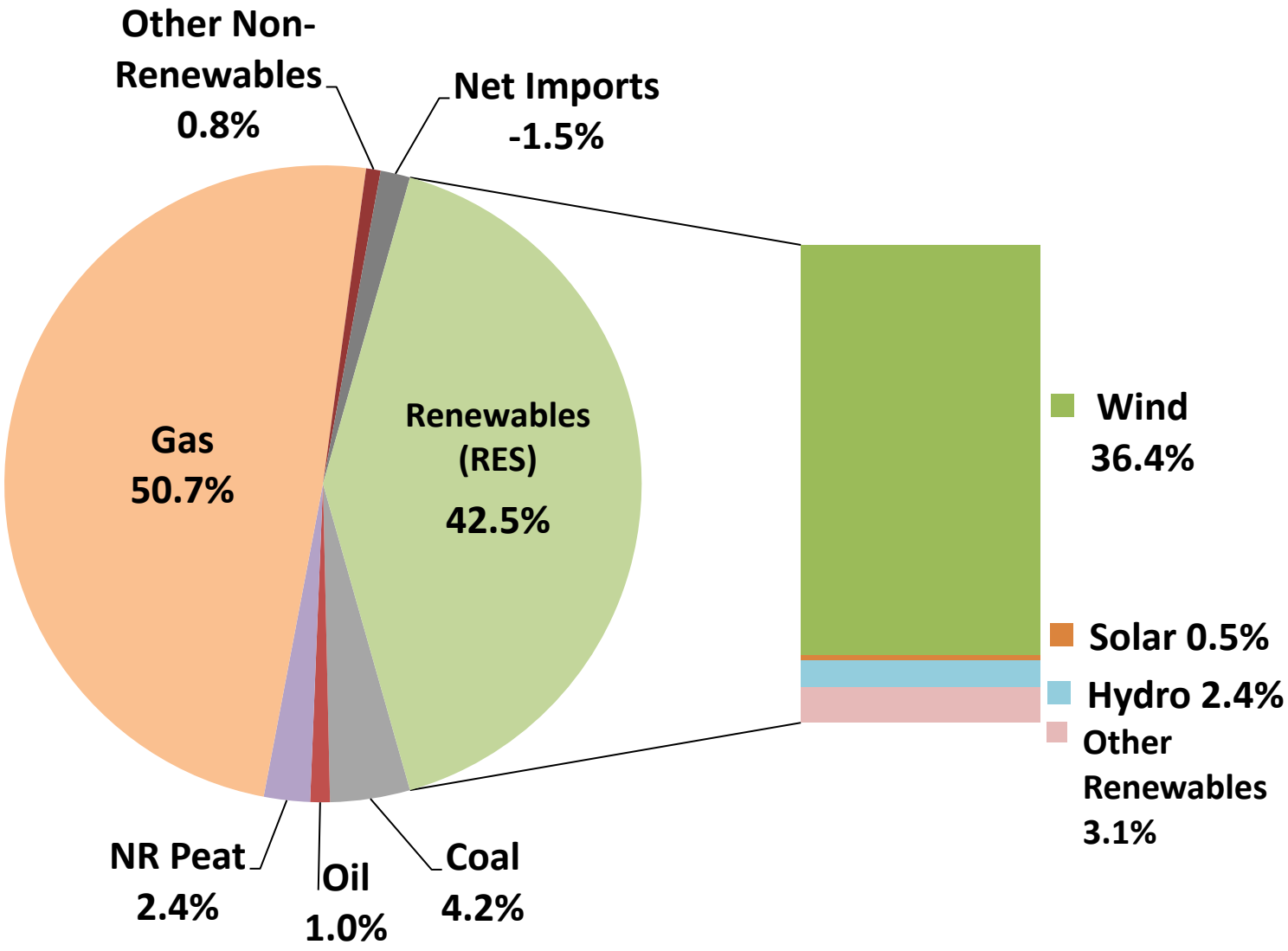
Installed Wind: 5.7 GW (2021)
Peak Wind: 4.5 GW (2021)
Small amount of hydro (2%)
Gas/Coal/Oil mostly imported
Largest Single Infeed: 500 MW



Moyle
+/- 500 MW
HVDC (LCC)
to Great Brittan

EWIC
+/- 500 MW
HVDC (VSC)
to Great Brittan

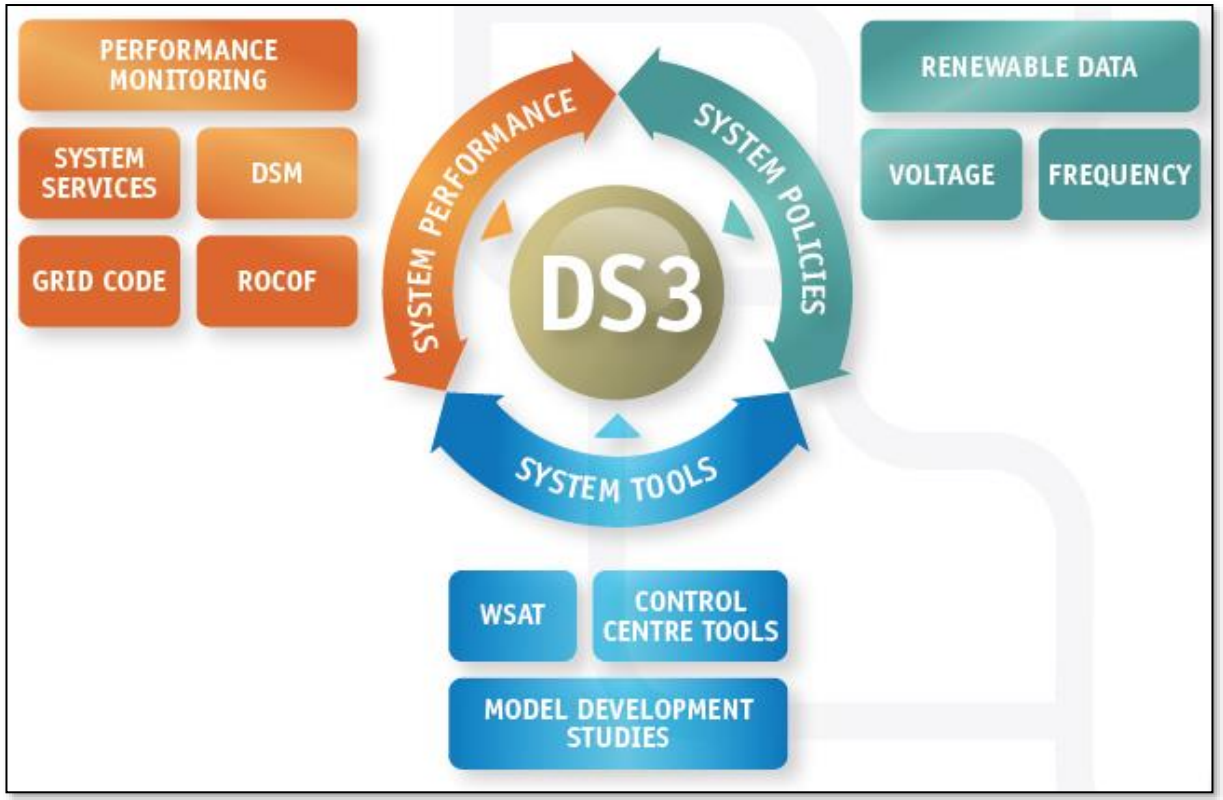
Energy Sources 2020, >40 % Renewables



The Journey to 75% Non-Synchronous Renewable Generation Levels

DS3 Programme Established in 2011

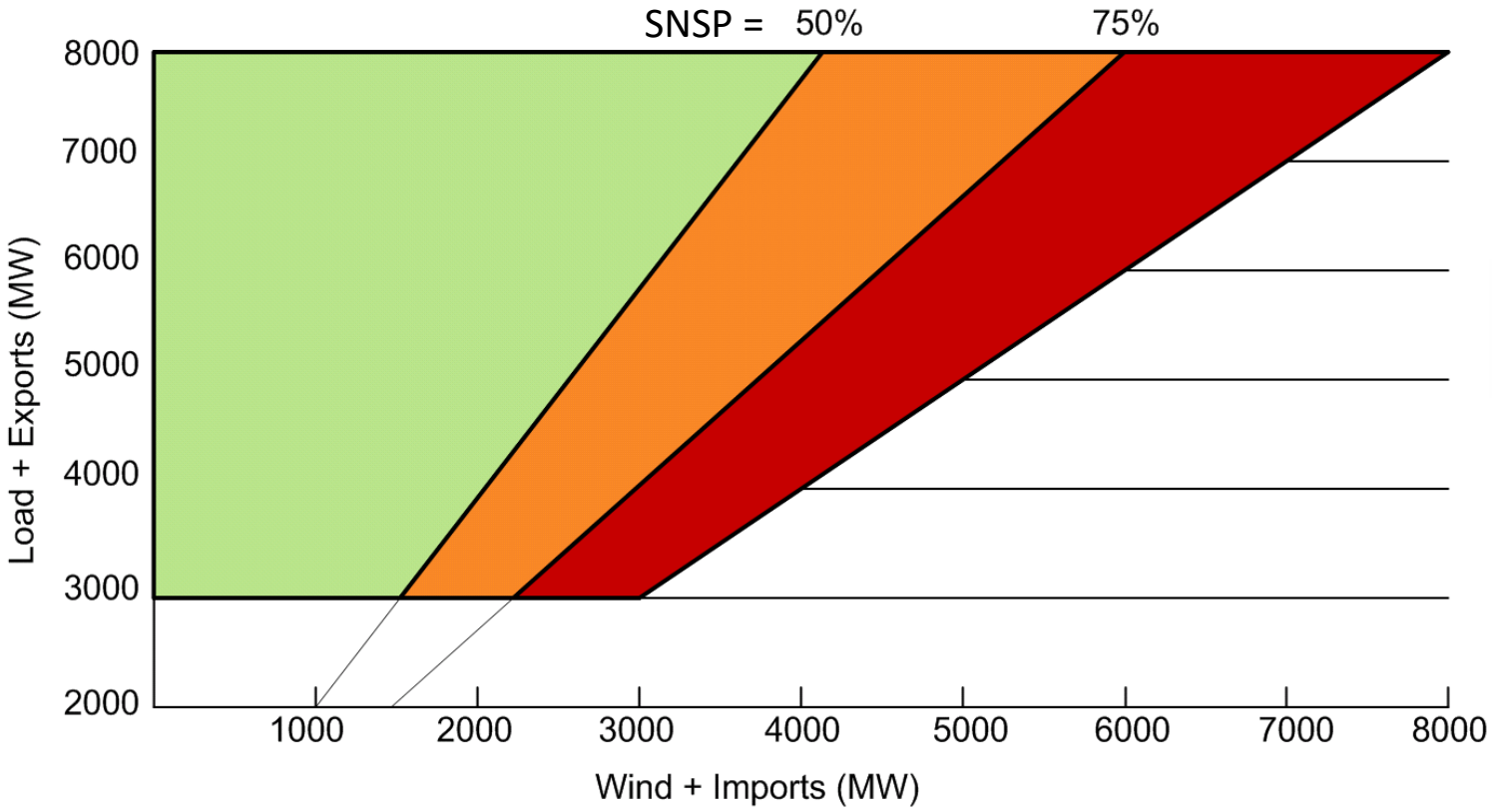
DS3: Delivering a Secure, Sustainable Electricity System



Challenges Identified Through Analysis

System Non-Synchronous Penetration (SNSP) metric developed.

In 2011 this was our view of the SNSP limit for 2020:



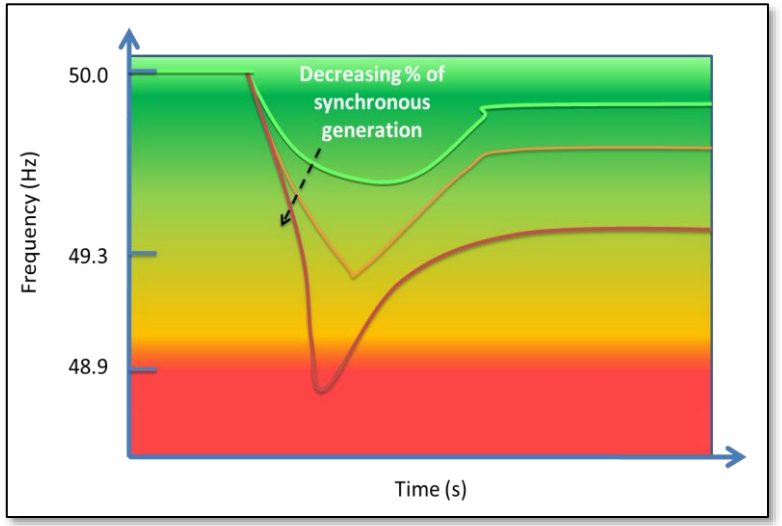
$$\text{SNSP} = \frac{\text{Wind + Solar + HVDC Imports}}{\text{System Demand + HVDC Exports}}$$

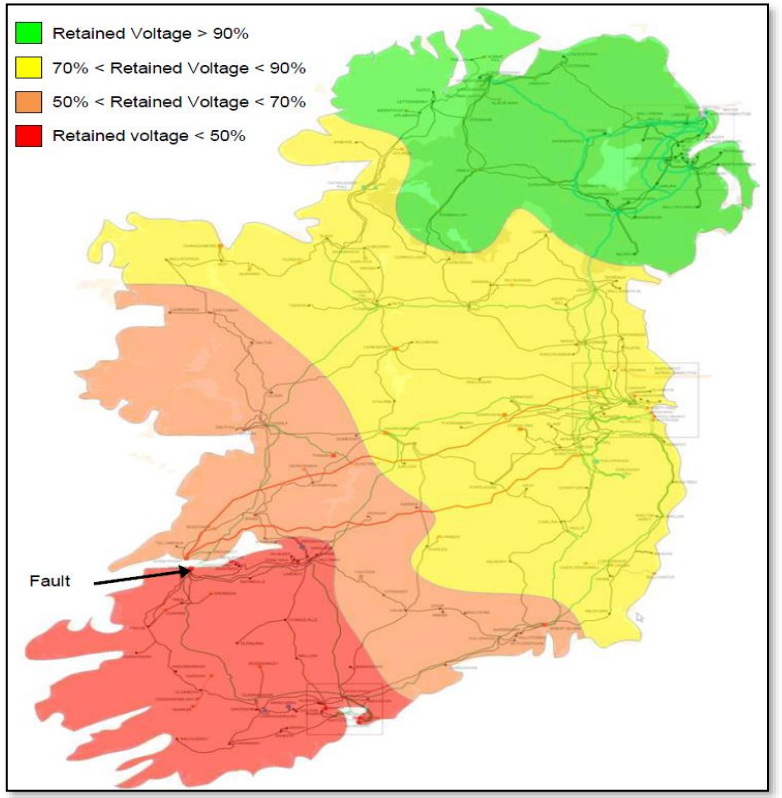
Key Technical Challenges

- **Increasing the Rate of Change of Frequency (RoCoF)** standard from 0.5 Hz/s to 1.0 Hz/s took many years due to concerns of conventional generation and the need to roll-out protection changes on the distribution networks.

- **Scarcity of some system services** (frequency response, voltage control, inertia, ramping) continue to require minimum levels of conventional generation to remain on resulting in curtailment of wind at times.

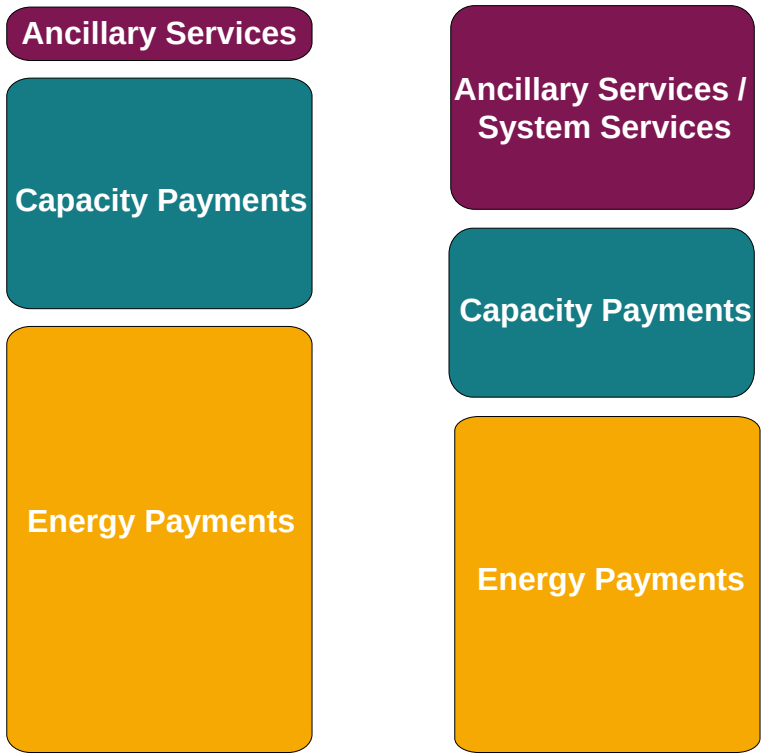
- **High wind constraint levels** due to wind connecting to weaker parts of the grid especially as we take outages to maintain and reinforce the grid.





Development of System Services

60 €m
7 Services



Starting Point in 2015

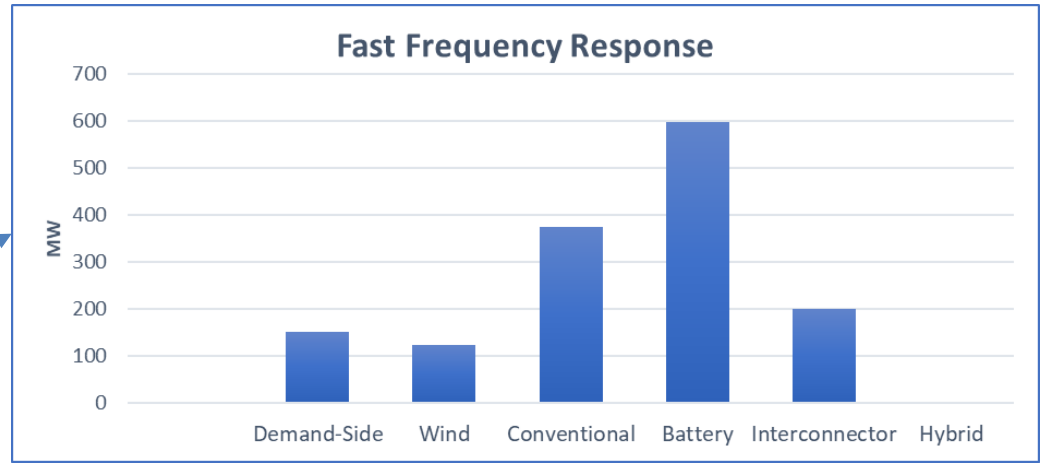
2021/22

235 €m cap in 2021/22
14 Services

Existing Services		New Services	
SSRP	Steady-State Reactive Power	**SIR**	Synchronous Inertia Response
POR	Primary Operating Reserve	**FFR**	Fast Frequency Response
SOR	Secondary Operating Reserve	**RM1**	Ramping Margin 1
TOR1	Tertiary Operating Reserve 1	**RM3**	Ramping Margin 3
TOR2	Tertiary Operating Reserve 2	**RM8**	Ramping Margin 8
RRD	Replacement Reserve De-Synchronised	**DRR**	Dynamic Reactive Response
RRS	Replacement Reserve Synchronised	**FPFAPR**	Fast Post Fault Active Power Recovery

Illustrative

System Services



Incentivises response times down to 150 ms

NEW FFR

SOR

TOR2

NEW RM1

NEW SIR

POR

TOR1

RR

NEW RM3

NEW RM8

Inertial response

Reserves

Ramping

0 sec — seconds — minutes — hours — 16 hrs

NEW DRR

NEW FPF-APR

SSRP

Transient post-fault response

(Not procured yet)

Voltage regulation

Existing Services		New Services	
SSRP	Steady-State Reactive Power	**SIR**	Synchronous Inertia Response
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Wind Providing System 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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Control Centre Tools

2010

- ❑ Wind visibility and control from EMS
- ❑ Wind forecasting
- ❑ Wind dispatch tool
- ❑ Real-time dynamic stability assessment tool
- ❑ Wide Area Monitoring - PMU

2020

- ❑ Look-ahead security assessment tool
- ❑ Ramping margin tool
- ❑ Look-ahead voltage trajectory tool

2030

- ❑ Control Centre of the Future…….

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Wind Visibility and Controllability

Visibility:

- Status (on/off)
- Availability (MW)
- Actual Output (MW / MVAr)
- Forecast availability (MW, 5 day, 30 min granularity)

(All Windfarms > 5 MW)

Controllability:

- Active Power Setpoint (MW)
- Frequency Response (on/off)
- Frequency Sensitivity (-/+200 mHz or -/+15 mHz deadbands)
- Reactive Power Modes and Setpoint (PF / MVAr / kV)

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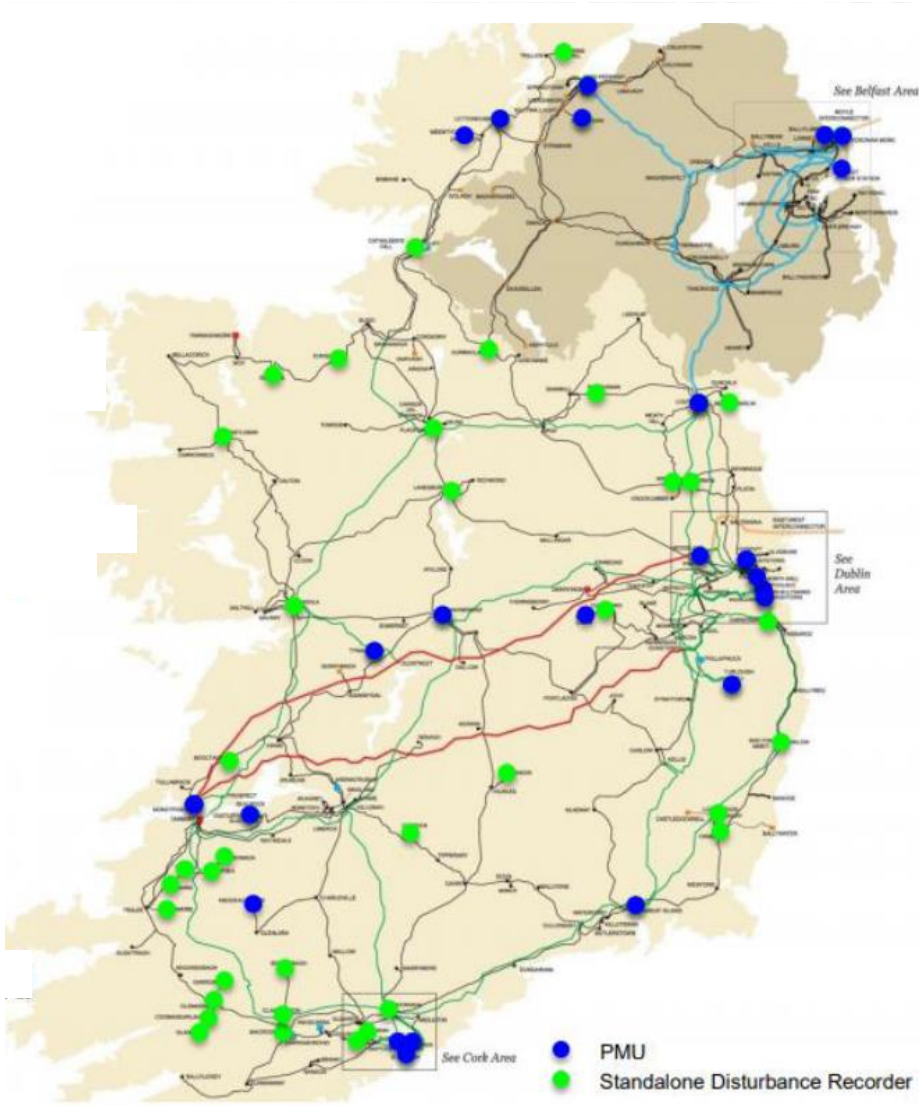
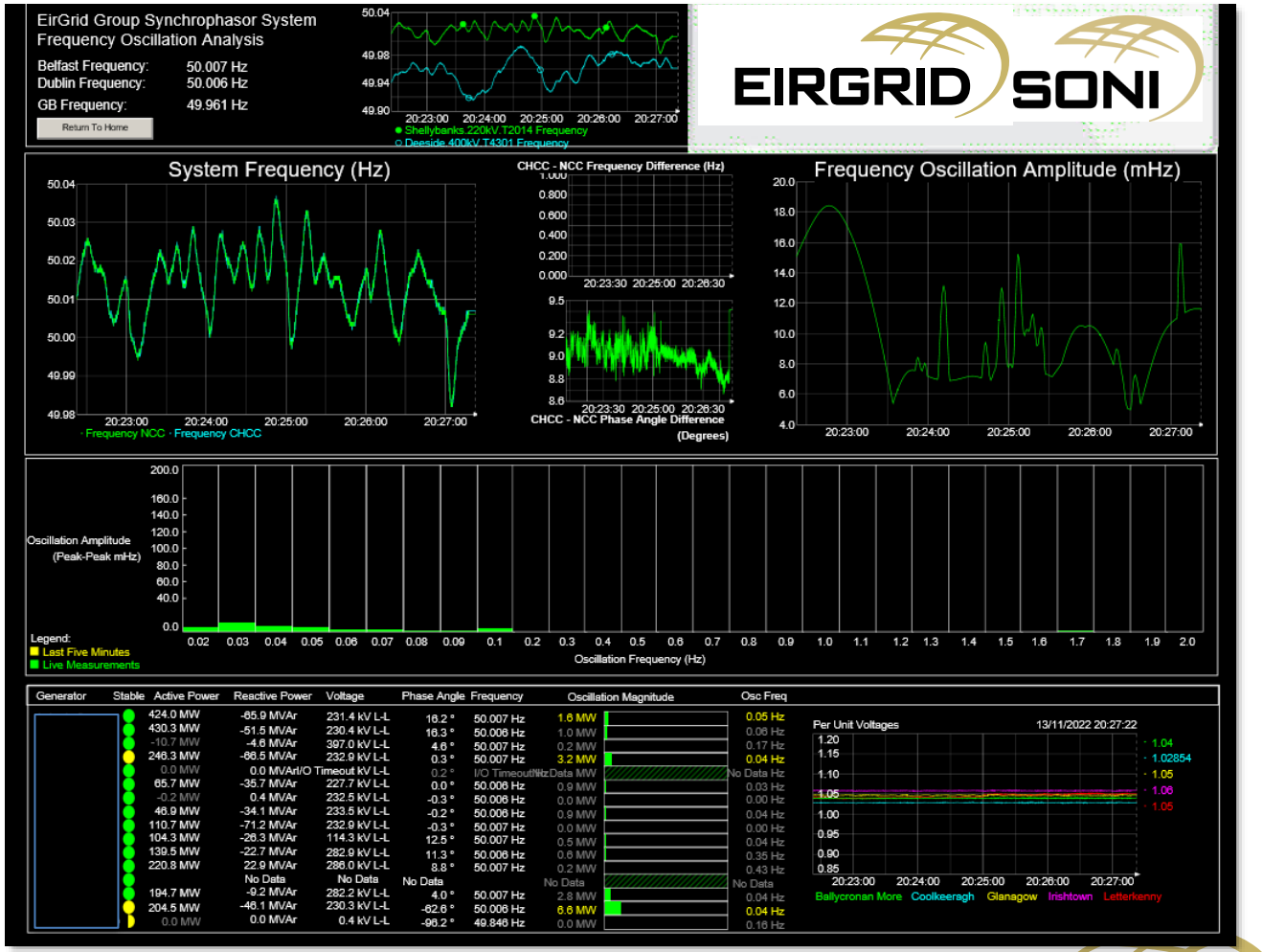
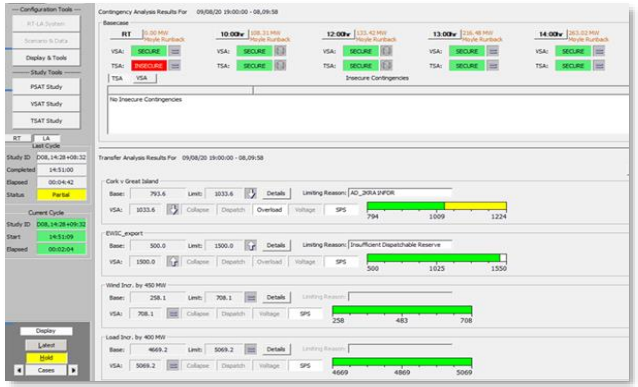
Phasor Monitoring Capability



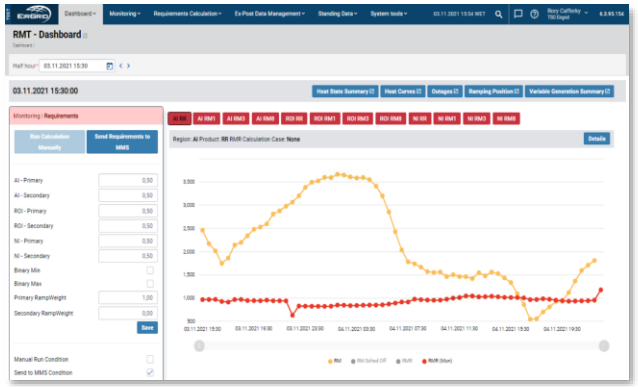


New Control Centre Tools



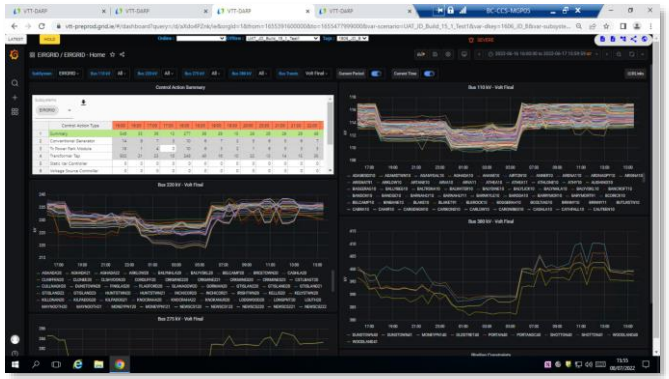
Look Ahead Security Assessment (LSAT)

- Transient frequency and voltage analysis.
- Real-time - running every 5 minutes.
- Forward-looking - analysis based on forecasted system conditions – running every hour, looking ahead 8 hours (configurable).



Ramping Margin Tool (RMT)

- Calculates ramping requirement across multiple time horizons
- Calculation takes into account potential wind/demand forecast errors
- Linked to market systems – output directly impacts generation scheduling



Voltage Trajectory Tool (VTT)

- Decision support tool that schedules reactive power resources and voltage setpoints in the most optimal way over a defined near time horizon.
- Assists in maintaining a healthy secure voltage profile with fewer large generation units online. Under development

Industry / Stakeholder Engagement

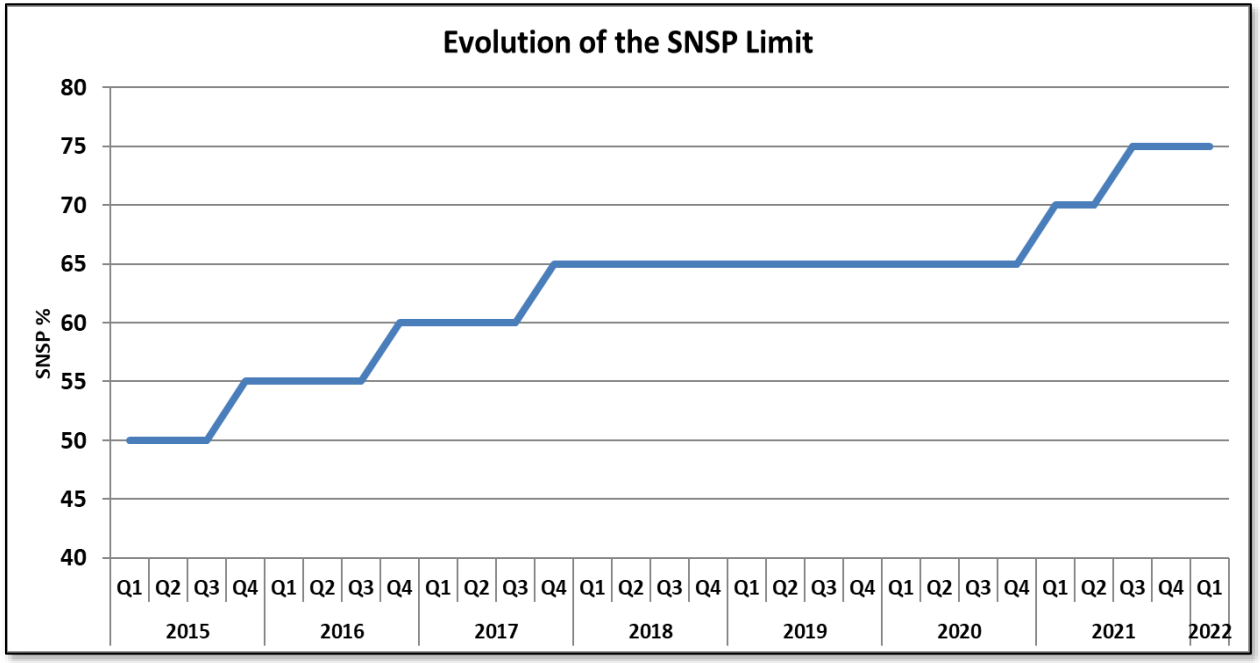
Representation from:

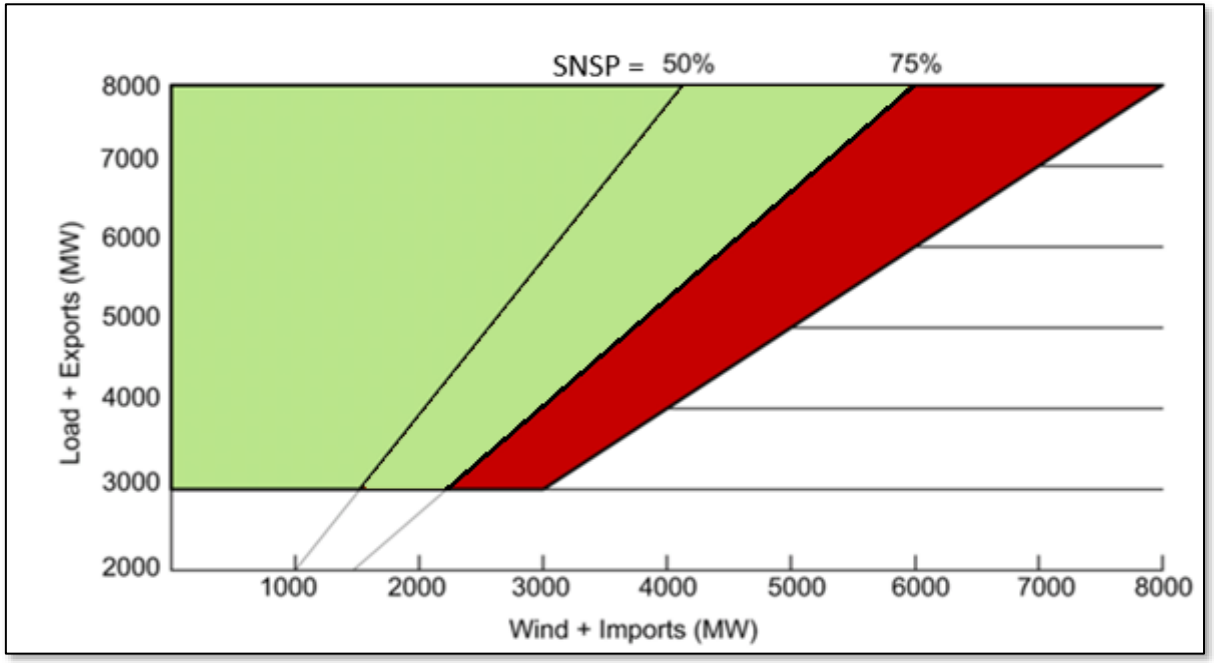
- TSOs
- Wind Energy
- Conventional Generators
- Regulatory Authorities
- Academia
- Equipment Manufacturers
- External TSO
- DSOs

Where We Are Today

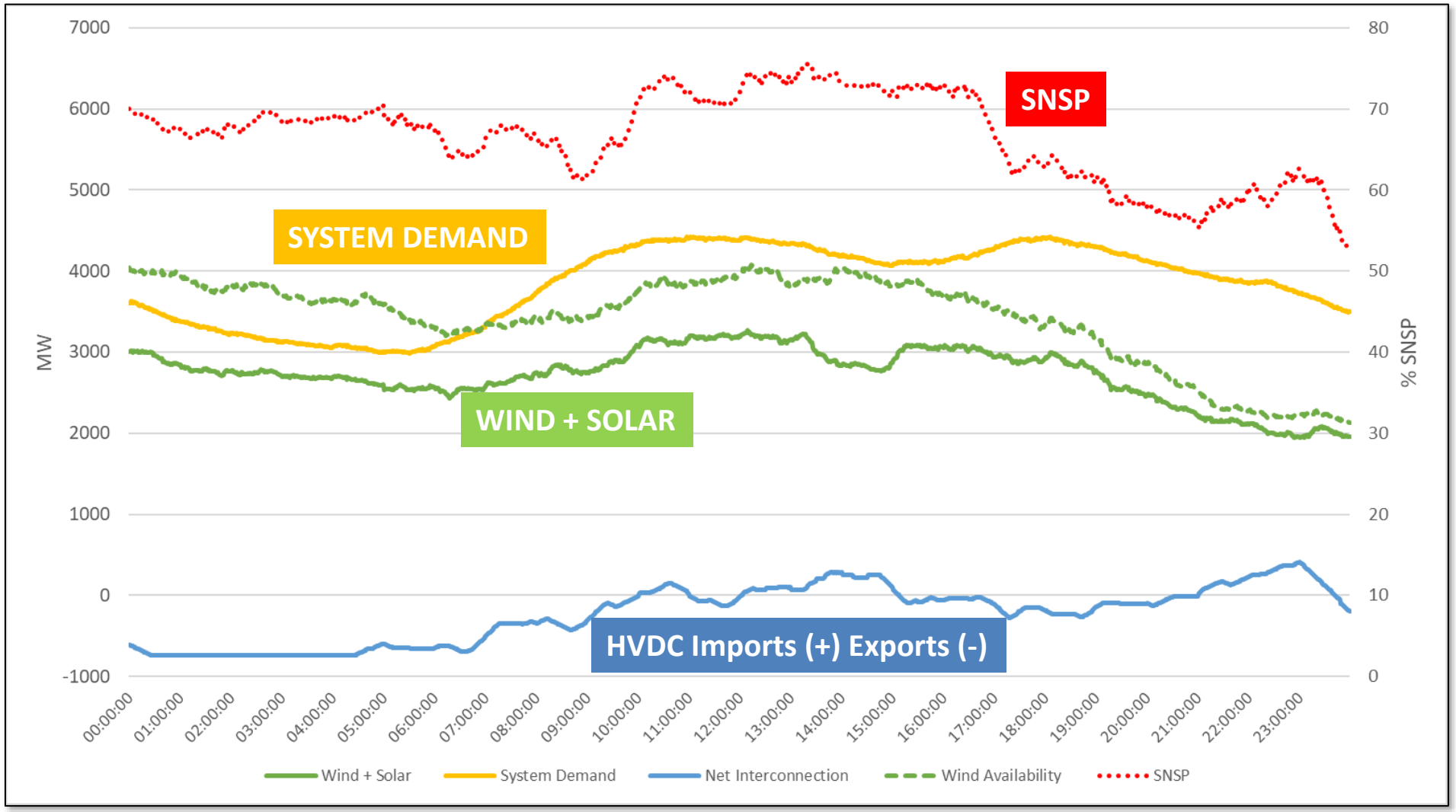
1. Operating up to 75% SNSP
2. Trialling +/- 1.0 Hz/s RoCoF Limit
3. Inertia Floor of 23,000 MW.s

$$\text{SNSP} = \frac{\text{Wind + Solar + HVDC Imports}}{\text{System Demand + HVDC Exports}}$$





Sample High Wind Day – 11 June 2022



$$\text{SNSP} = \frac{\text{Wind + Solar + HVDC Imports}}{\text{System Demand + HVDC Exports}}$$

During This Day:

Max. SNSP: 75 %

Max. Wind + Solar as a percentage of Demand: 88%


….and beyond

The Next Phase

RES-E : Renewable Energy Sources producing Electricity

- To achieve a 80% RES-E energy target we will need to raise **SNSP to 95%.**
- **Shaping Our Electricity Future*** is our plan to achieve this across Networks, Operations, Markets and Engagement.

https://www.eirgridgroup.com/the-grid/shaping-our-electricity-f/

*Version 1 of SOEF refers to the previous RES-E 2030 target of 70%

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