Development of Grid Infrastructure

John Fitzgerald

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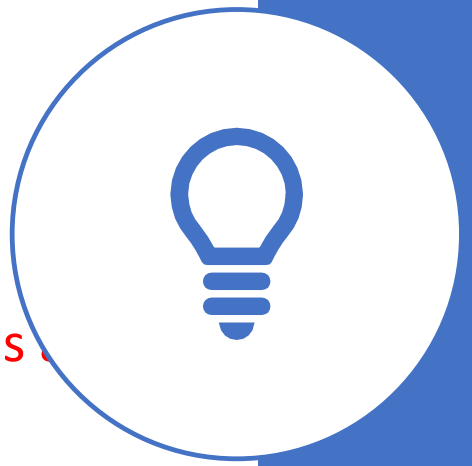
John Fitzgerald

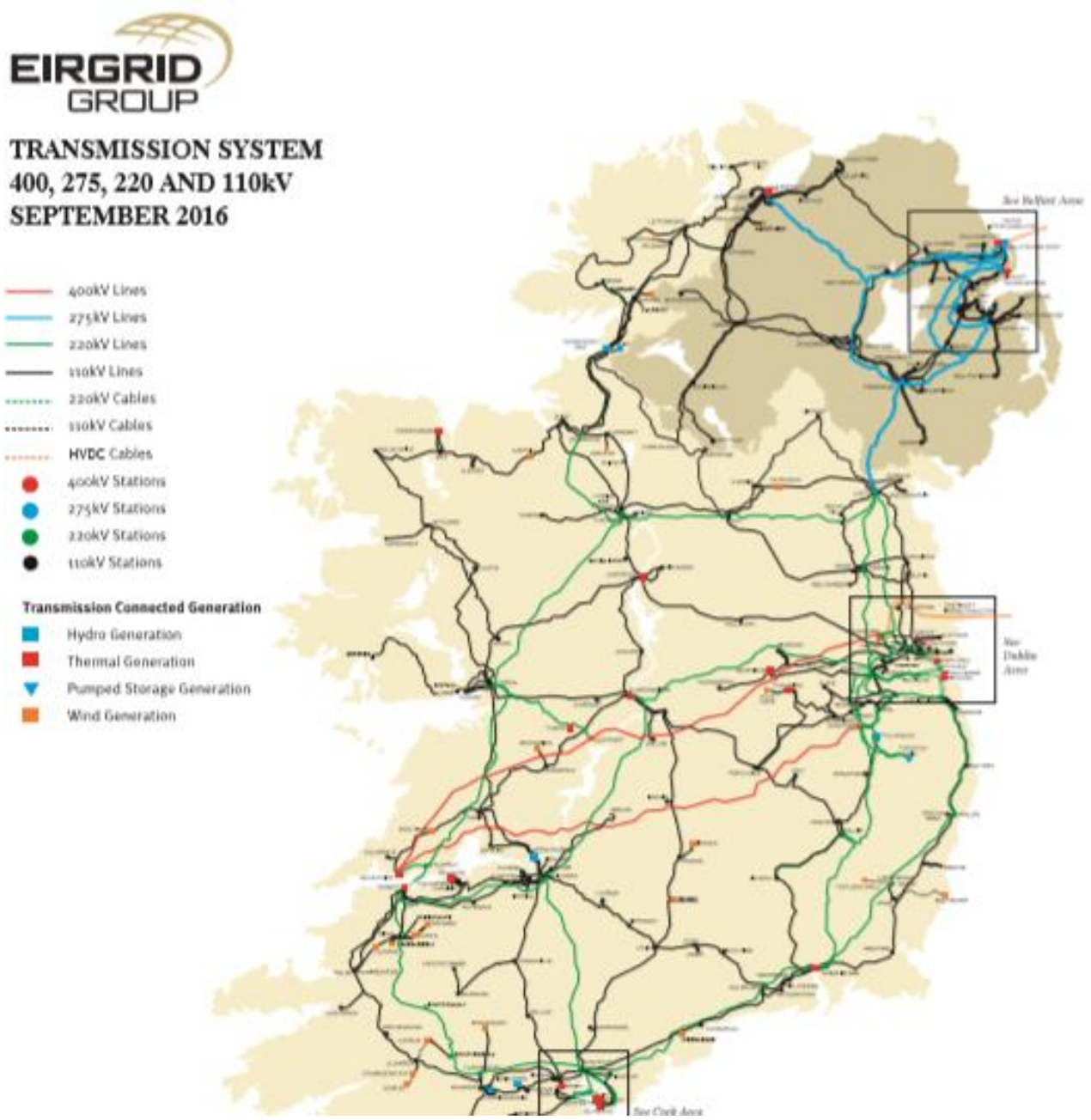
- CEO of SuperNode
- Director for Grid Development & Interconnection from 2013 - 2018
  - Responsible for all new connections and reinforcements to the Grid
  - Transmission Engineering Standards
  - Oversight of Contestable Build & Maintenance
  - Operation and Development of Interconnection
- Development of IPPs and Interconnectors
- Electrical engineer - joined ESB (Irish Utility) in 1991 as a Power System Control Engineer in the National Control Centre.
  - Circa 150 shifts in the Control Centre as Shift Charge Engineer
  - Responsible for Power System Restoration Plan and Training
  - Responsible for Grid Code Version 1.0
  - Interconnection between Ireland and Northern Ireland

What is the same and what is different?

- Laws of Physics
- Objectives of keeping the lights on securely and economically
- Investments in electricity are lumpy so you need to plan for the future
- Climate Change has been recognised as an existential threat
- Innovation and Competition are bringing new participants, technologies and capital into what was a centralised electricity system
- Most new Renewable Sources are asynchronous and non- dispatchable whereas the thermal generation displaced is synchronous and dispatchable
- Consumers want to manage their electricity consumption and production so distribution networks are no longer passive.
- The Future is uncertain



What differentiates Ireland from other EU Countries




Countries 34
TSOs 41
network of
Continental
Europe

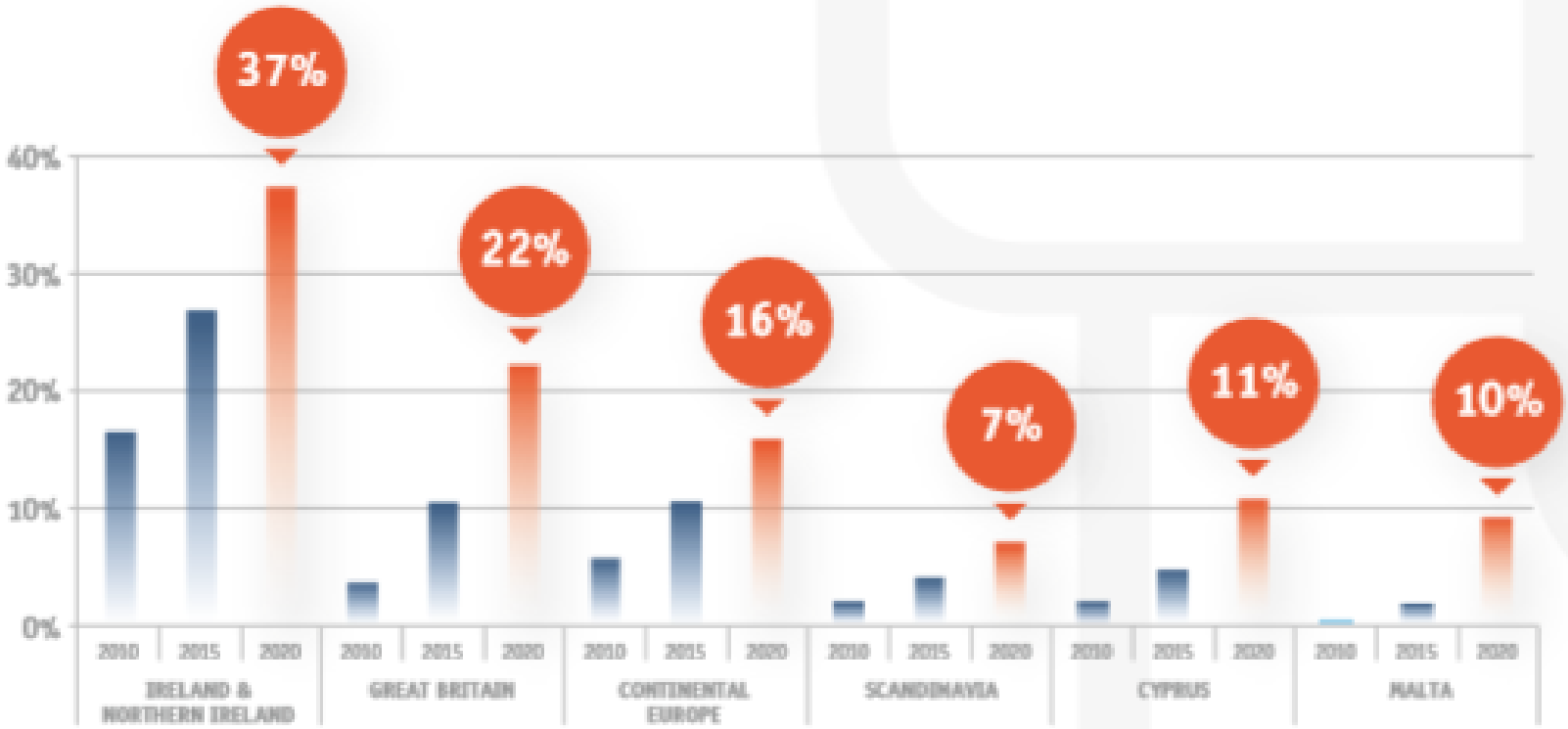
Irish Power System

- Peak System Demand c. 6,500MW
- Conventional Generation 8,000MW
- +/- 1,000MW of HVDC with Britain
- Largest Single Infeed is 500MW
- Installed Wind c.5,000MW
- Current SNSP 65%
- Target SNSP for 2020 is 75% to get 40% of electricity from renewable sources

$$SNSP = \frac{Wind + Imports}{Demand + Exports}$$

Penetration of Non-Synchronous Renewables

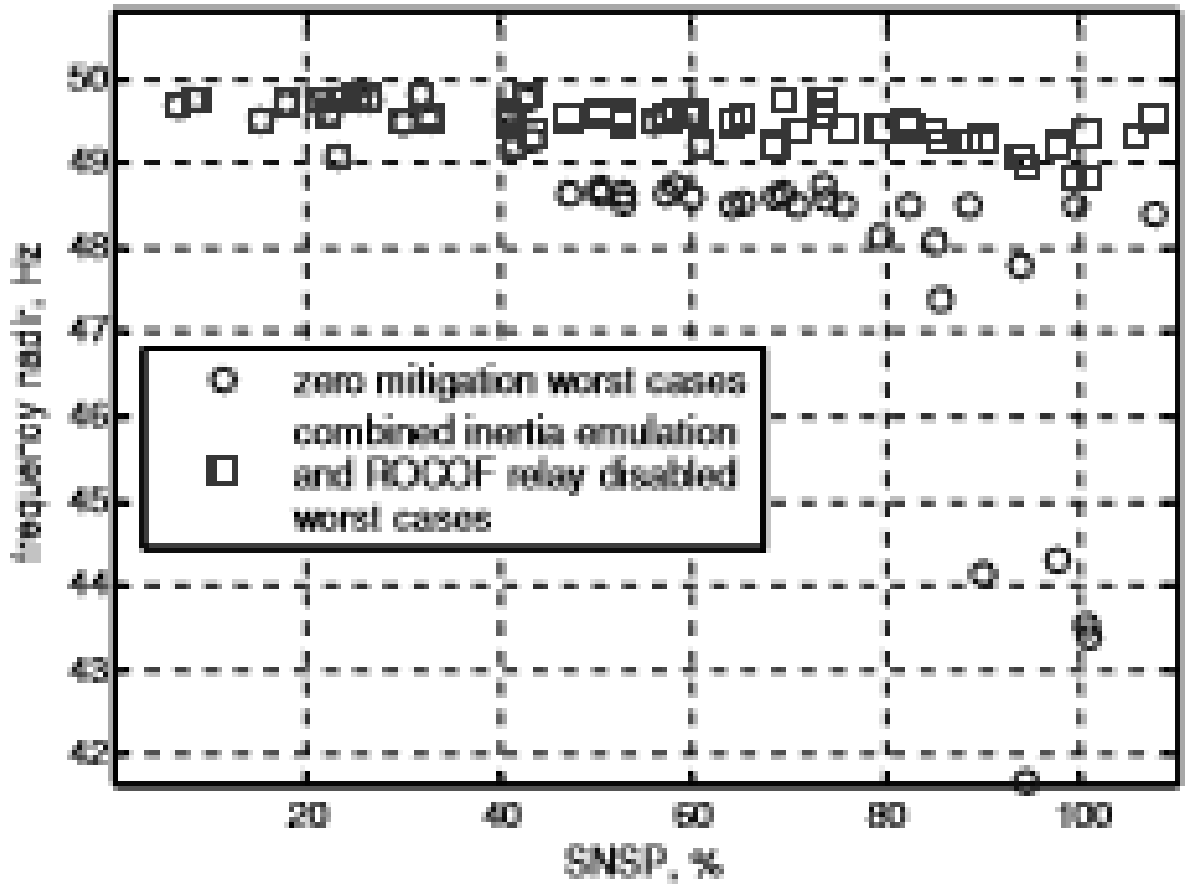
IN EACH EUROPEAN SYNCHRONOUS SYSTEM 2010-2020



Source: The National Renewable Energy Action Plans (NREAP 2010)

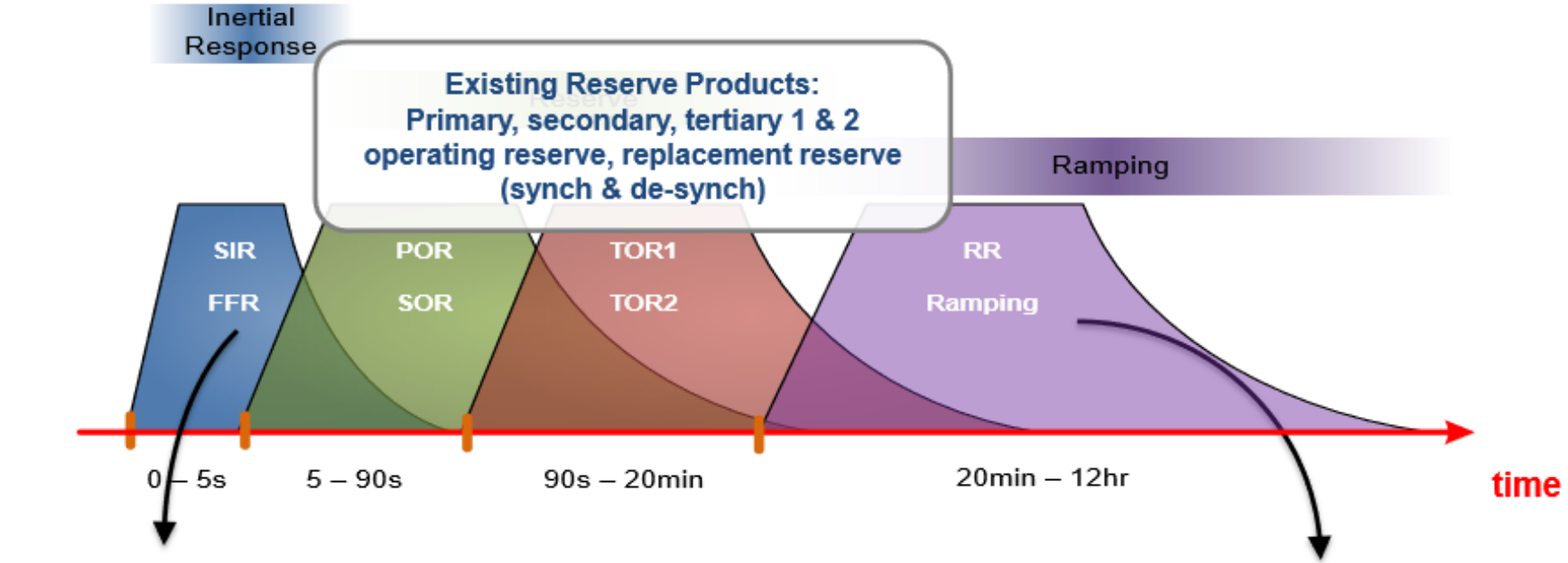
Main Challenges of Increased System Non-Synchronous Penetration

- Reduced Inertia leading to greater ROCOF (df/dt) and lower frequency nadirs.
- System Protection
  - Lower Short Circuit fault current levels
  - Islanding detection
  - ROCOF relays relaxed
  - Special Protection Schemes (is N-1 required for a WF?)
- Reduced power output of WF post voltage disturbance (SC Fault)
- Forecasting Wind and to a lesser extent Solar
- New System Services required and revised Grid Code for wind
- More solid state devices therefore new challenges and risks (e.g. cyber security)



Potential benefits of combined wind inertia emulation and ROCOF relay relaxation on frequency nadir for different levels of SNSP - Ireland

New System Services



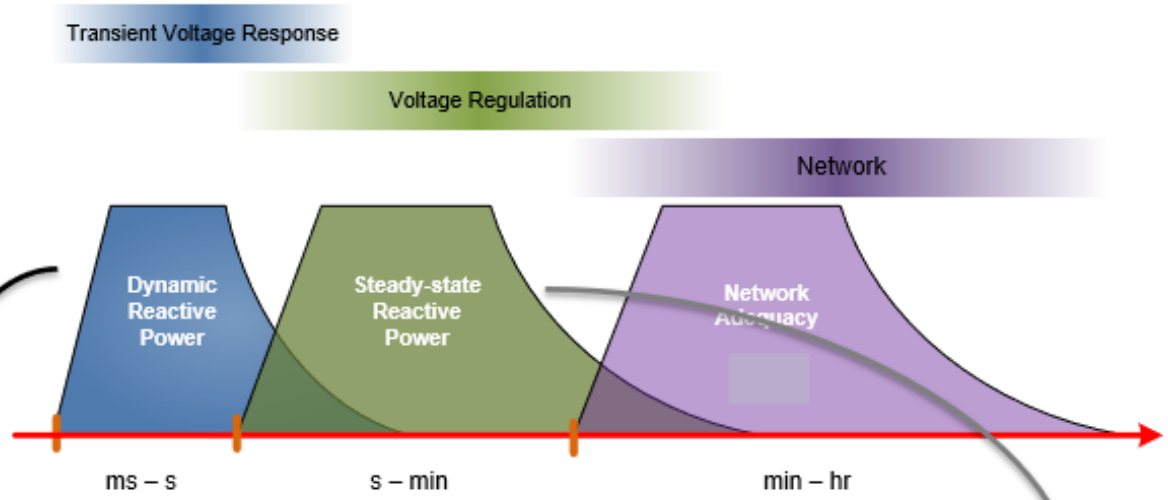
- Synchronous Inertial Response
- Fast Frequency Response
- Fast Post-Fault Active Power Recovery

NEW

- Ramping Margin 1/3/8 hour

NEW

New System Services



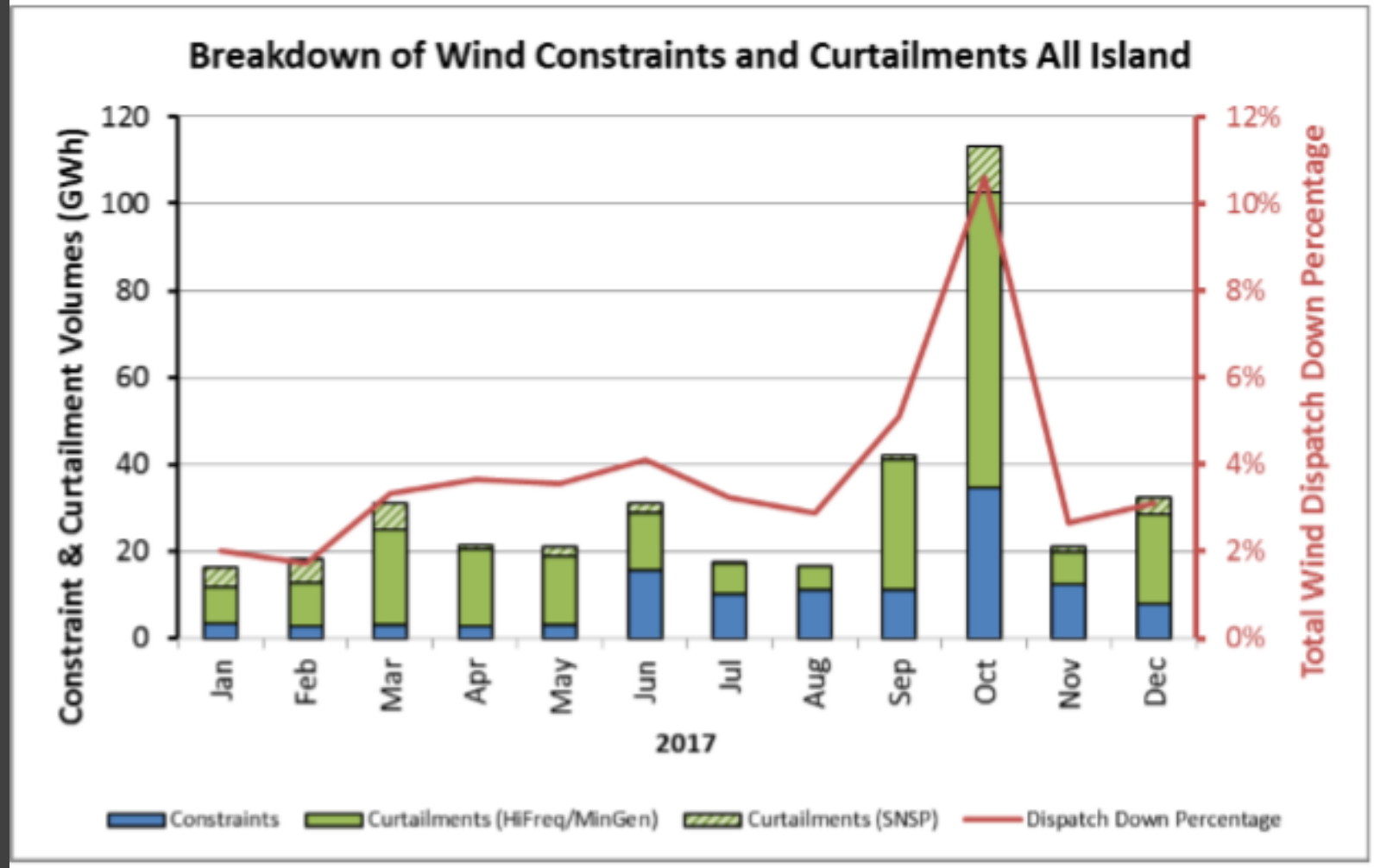
- Dynamic Reactive Response

NEW

- Steady-State Reactive Power

2017 Wind Data for Ireland

- In 2017, the total wind energy generated was 9,280 GWh,
- 386 GWh of wind energy was dispatched-down.
- This represents 4% of the total available wind energy in 2017, and is an increase of about 159 GWh on the 2016 figure.



2018 Wind Data for Ireland

- In 2018, the total wind energy generated was 11.076 GWh,
- 707 GWh of wind energy was dispatched-down.
- This represents 6% of the total available wind energy in 2018, an increase of about 321 GWh on the 2017 figure.

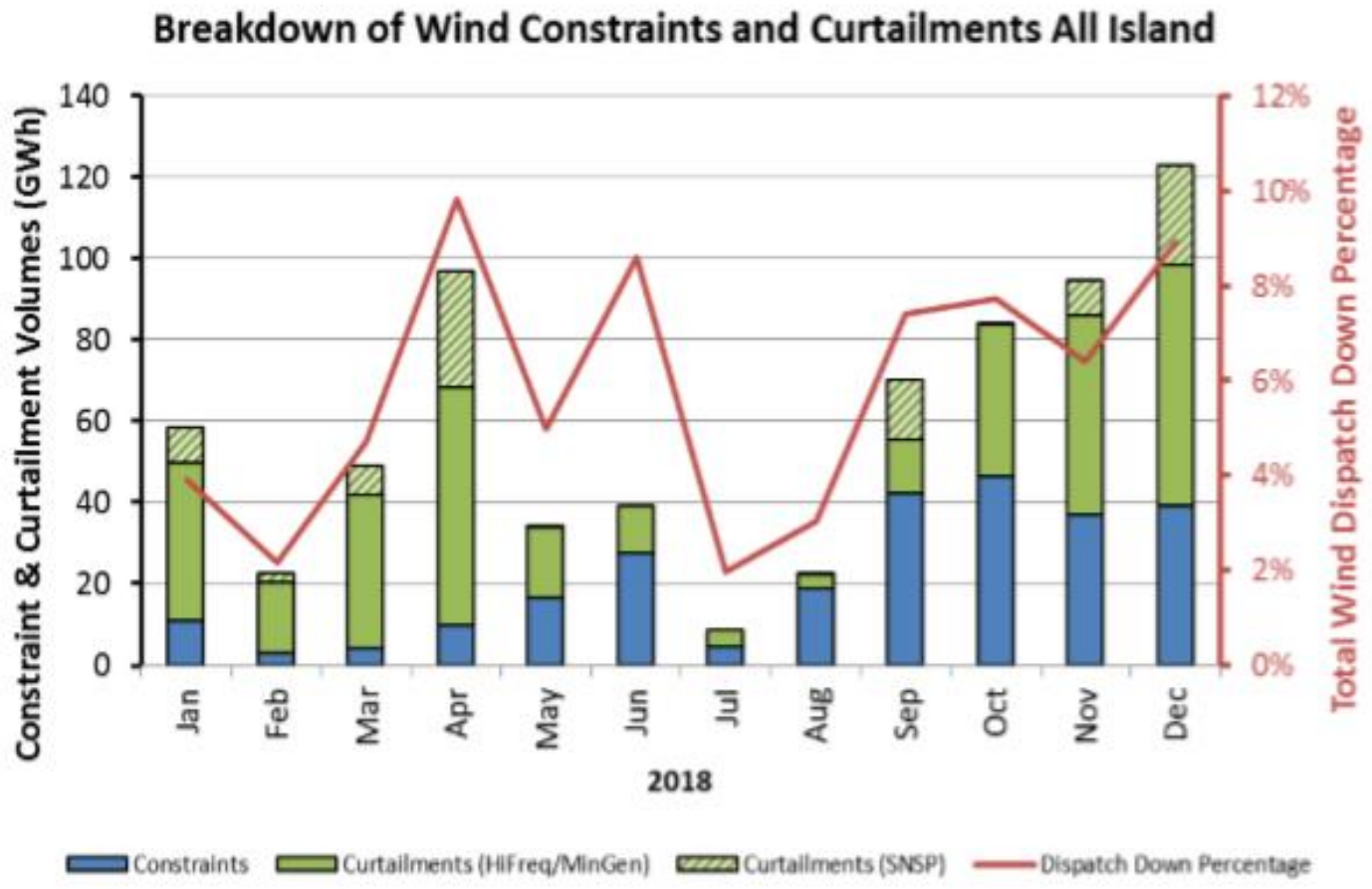
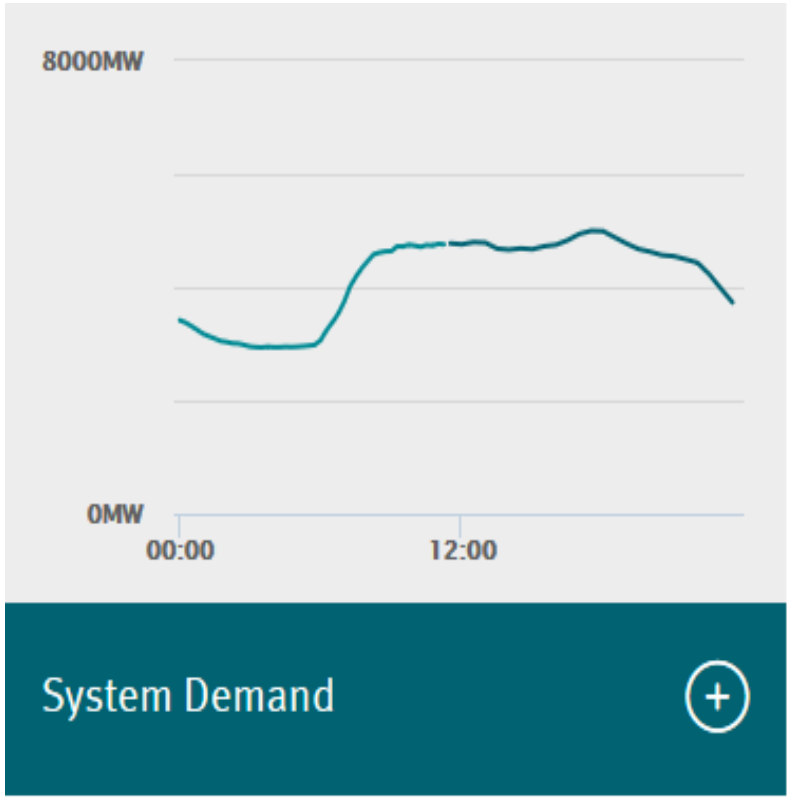
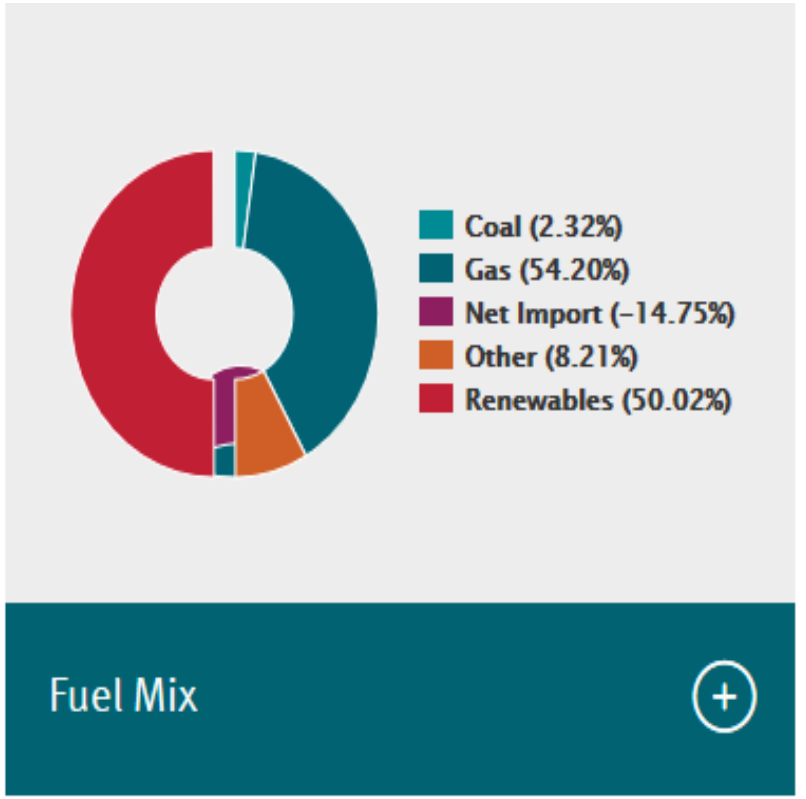


Figure 2: Monthly breakdown of the main wind dispatch-down categories on the island in 2018

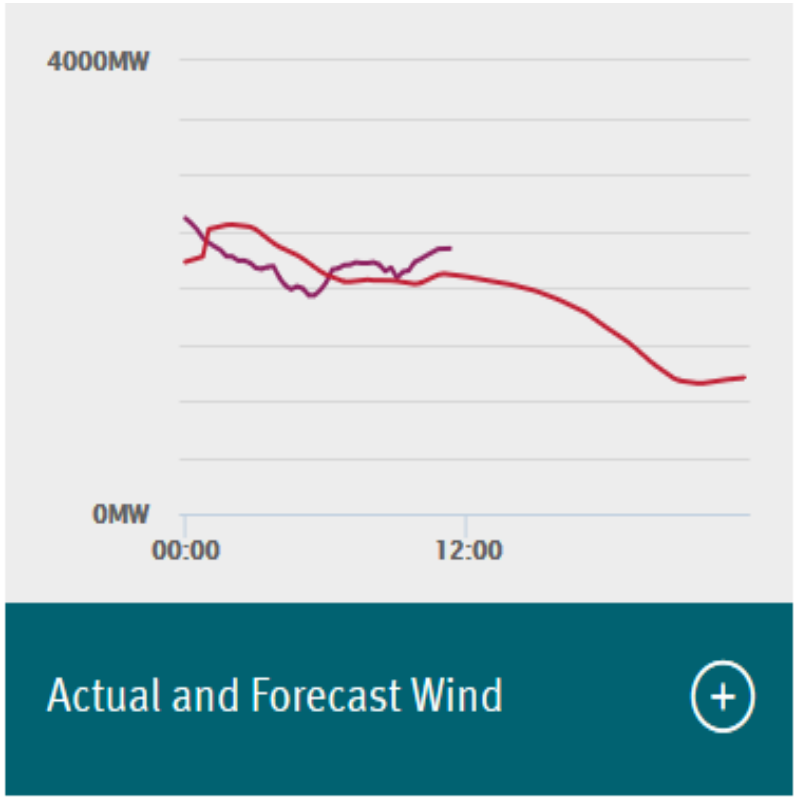
Ireland May 30th 2019



System Demand



Fuel Mix



Actual and Forecast Wind

Connection to the Grid

Applicants > 40MW advised to contact TSO.

Applicants receive a connection offer based upon transmission access planning studies – case by case basis connection method

Applicant pays for Least Cost Technically Acceptable with UoS paying for System Operator Preferred Connection Method.

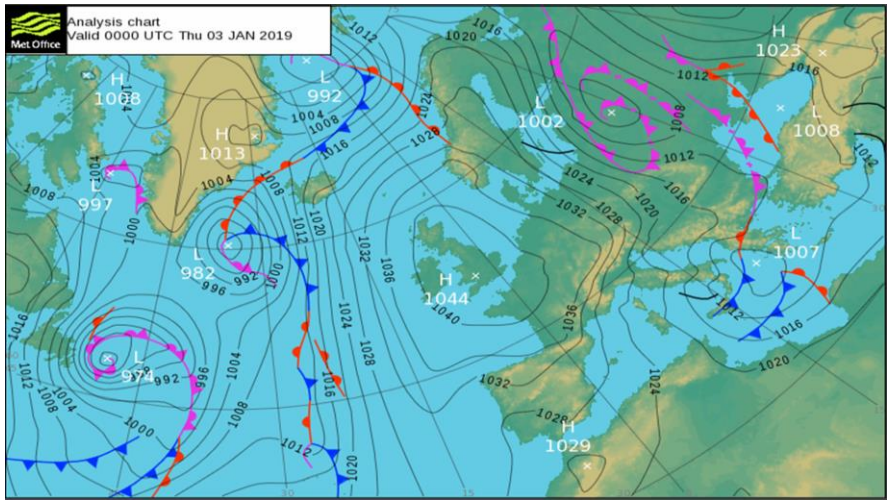
Concept of Special Protection Schemes to give access temporarily or permanently?

Contestable Build of Shallow Works by Developer

Harvest Renewables at Scale

SUPERNODE™

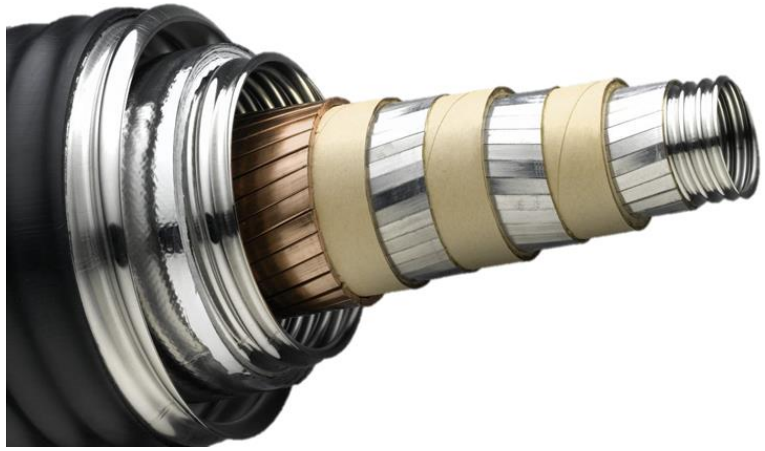
Balanced Resource



- Wind in North
- Solar in Mediterranean
- Match Supply & Demand with Renewables

Free Zero Carbon Fuel

SuperNode



- Larger Power Flows
- Reduces Losses
- Extends Transmission Range

Collects Remote Renewables

DC Grid

- Delivers for people
- Economies of scale
- Facilitates electrified future

100% Decarbonise Energy

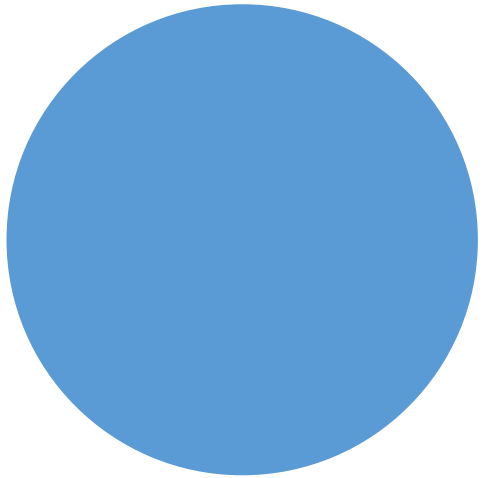
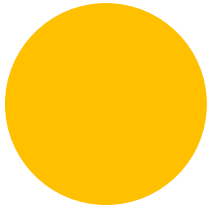
www.supernode.energy

Some Observations

- **System was not designed for the mass deployment of renewables**

- **More innovation is required to decarbonise and keep the lights on!**
  - New services and infrastructures are required.
  - Forecasting renewable generation is key as is the flexibility of conventional plant.
  - Contestable build policed by the System Operator.
  - N-1 is very important for demand but not for renewable gen and can drive up costs.

- **More storage and co-operation with others to match renewable supply and demand.**

Thank You