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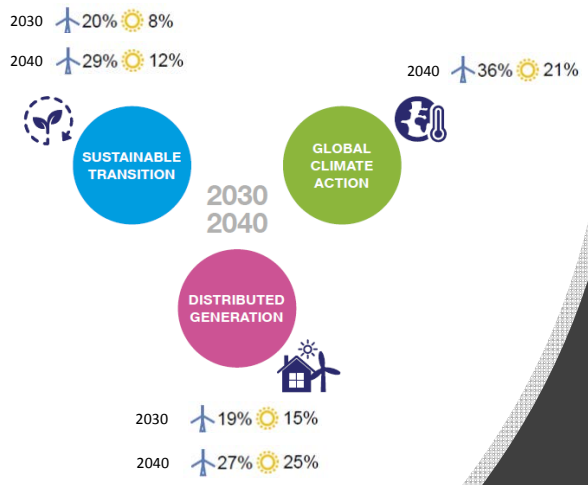
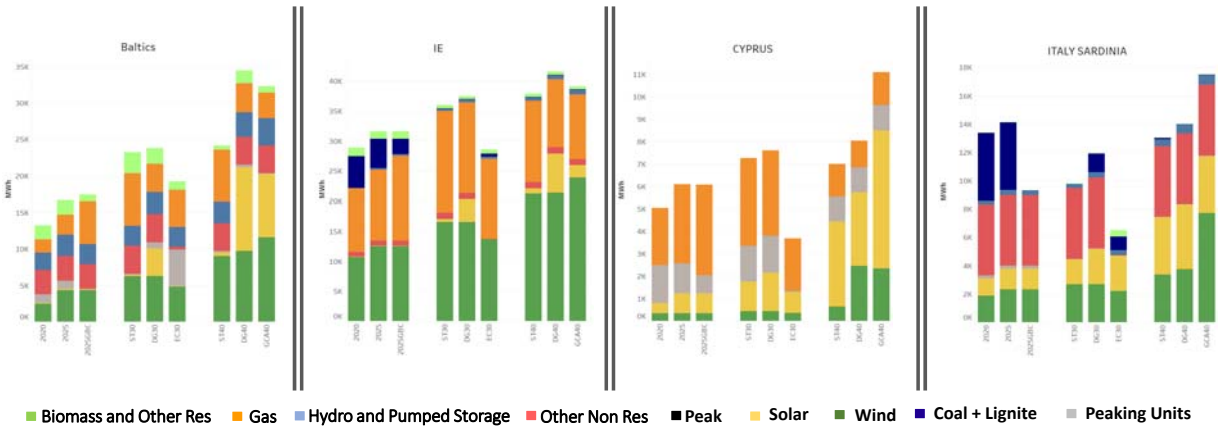
Introduction

- Dante Powell – ENTSOE – National Grid Secondee
- Frequency stability study performed by ENTSOE
- Looks at 9 synchronous areas in Europe
- Based on ENTSOs Future Scenario
- This presentation focus' on 4 small synchronous areas
  - Cyprus Sardinia Ireland Baltics
- Energy, Inertia and ROCOF



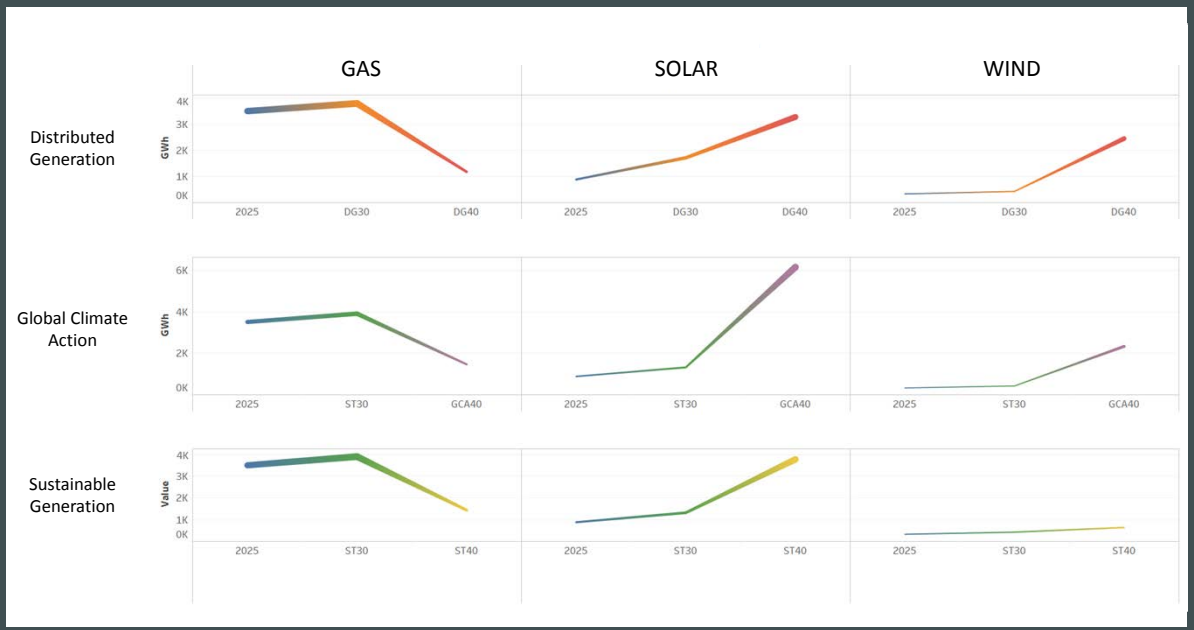
Scenario Building

- Scenarios created in conjunction with ENTSOG
- Bottom up – 2020, 2025, ST 2030
- Top Down – DG 2030, DG 2040, ST2040, GCA 2040
- External Scenario – EUCO
- DSR, Batteries, P2G
- Stakeholder engagement – asked to vote on scenarios



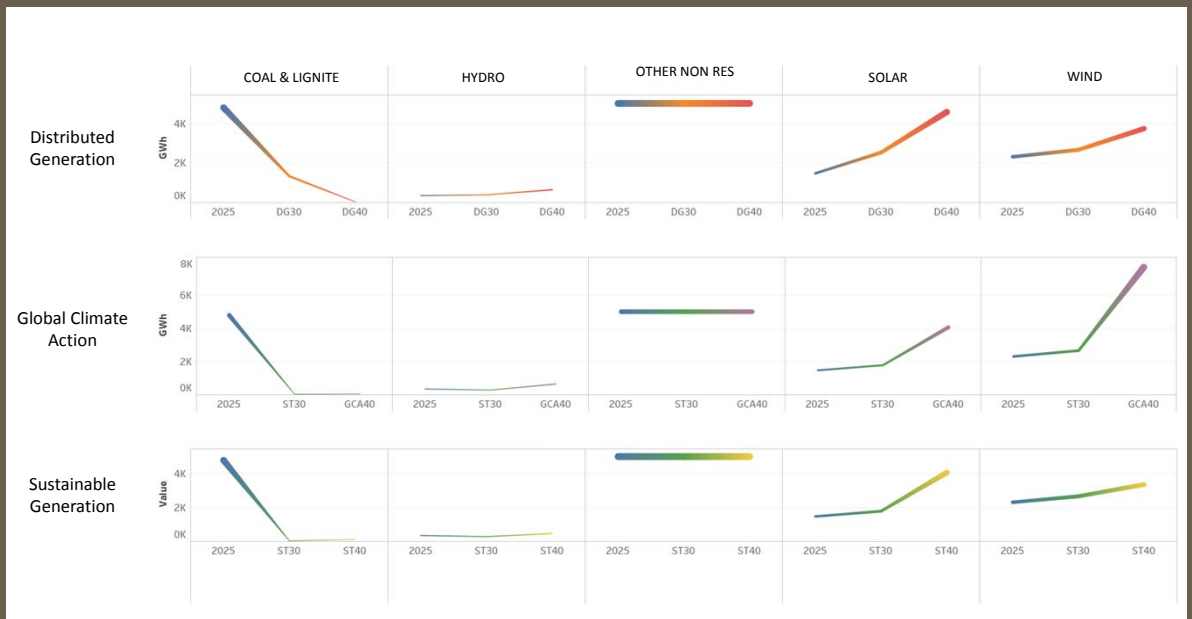
Generation Mix

CYPRUS Generation CYPRUS

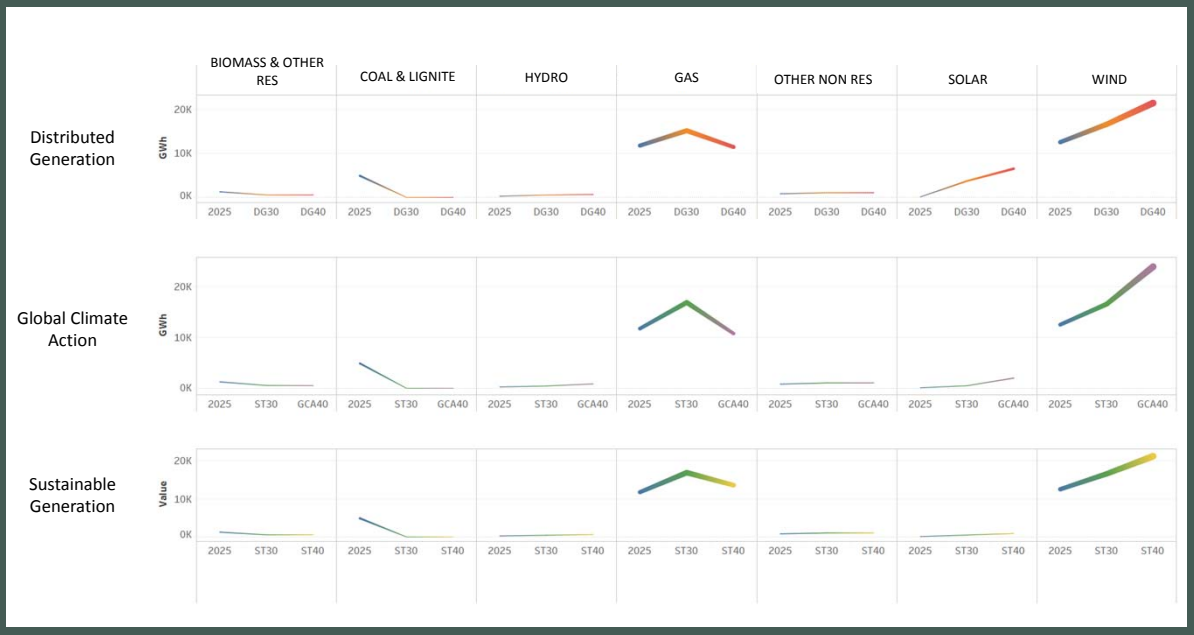


BALTICS — Generation — EE, LV, LT

ITALY — Generation — SARDINIA

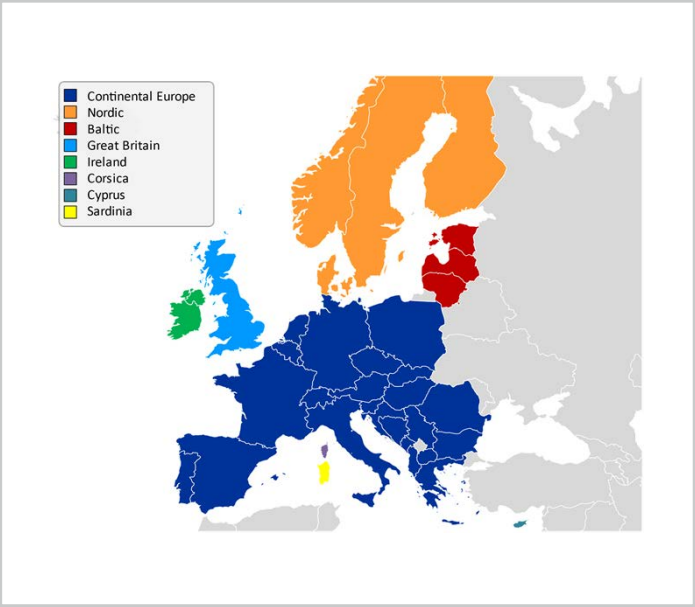


IRELAND Generation IRELAND



Inertia study Scenarios

- Study was done on 2030 and 2040 Scenarios
- Study was done for 9 synchronous areas
- This presentation focus' on small synchronous areas:
  - Cyprus
  - Baltics (Latvia, Estonia, Lithuania)
  - Ireland
  - Sardinia



Inertia Collection & Market Modelling

- Created a Pan-European database of inertia
- Inertia Data Collection directly from each TSO in Europe
  - Inertia constant of each unit in country for 39 sub categories of Nuclear, Coal, Gas & Oil
  - Nominal Capacity of each unit in country
  - For each country, value for each category were averaged to give a final value.

Market Modelling

- Market modelling simulations done with Powrsym, BID3, Antares
- comparison checks were done to ensure consistency.
- Pan European climate database, based on 34 years of historical data for wind and solar generation.
- Load factors Projected to the future based of evolution of technology

Inertia Methodology – Python Scripting

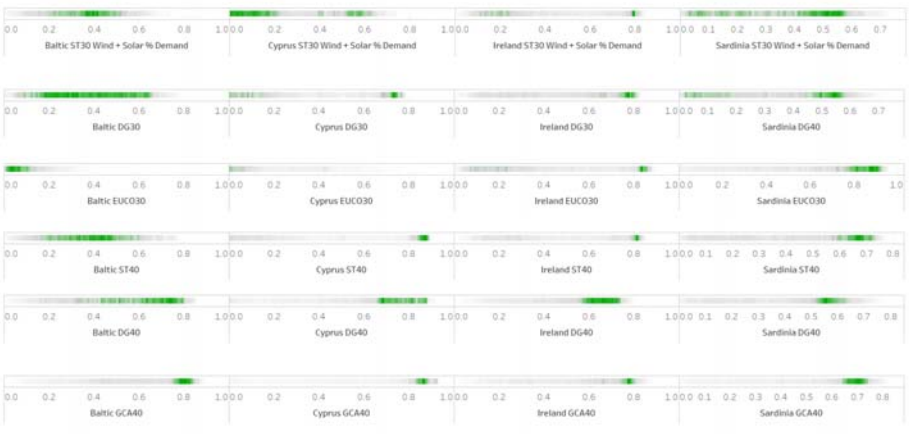
Post process of Market modelling Data

Inertia values were extracted from the Market modelling hourly outputs

Calculations

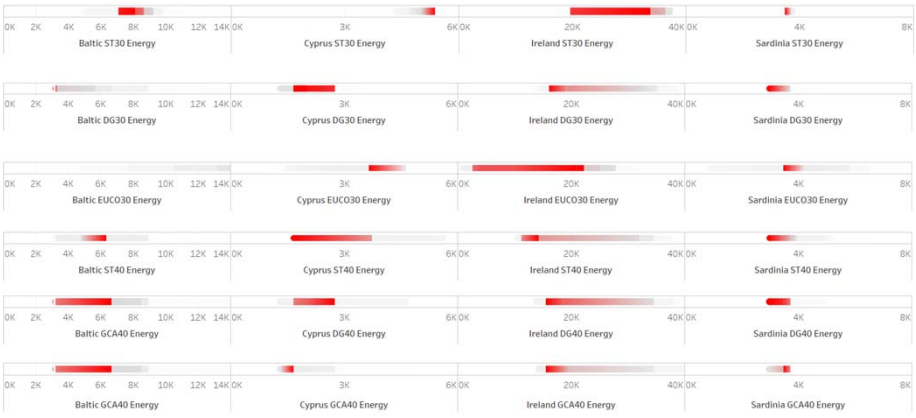
- Amount of energy online per hour
- The seconds of inertia for each country
- Generation loss required to give a ROCOF. Done for 1hz/s & 2hz/s
- Ramping Rates for wind a solar based

Wind and Solar Contribution to Demand

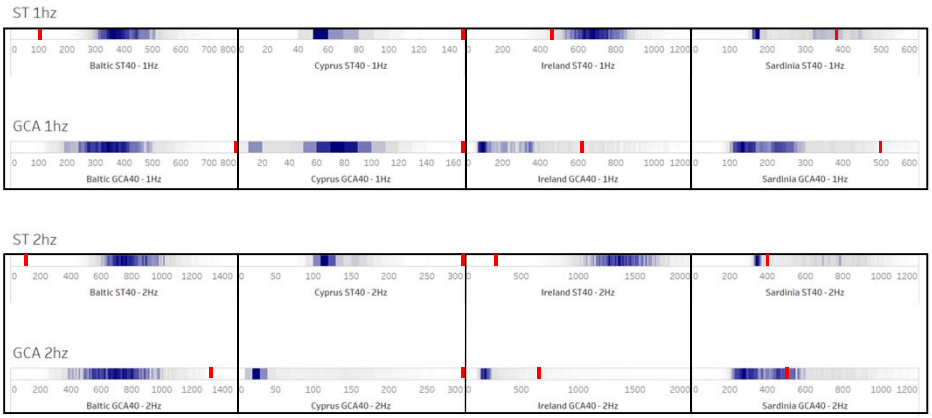


Inertia

Energy

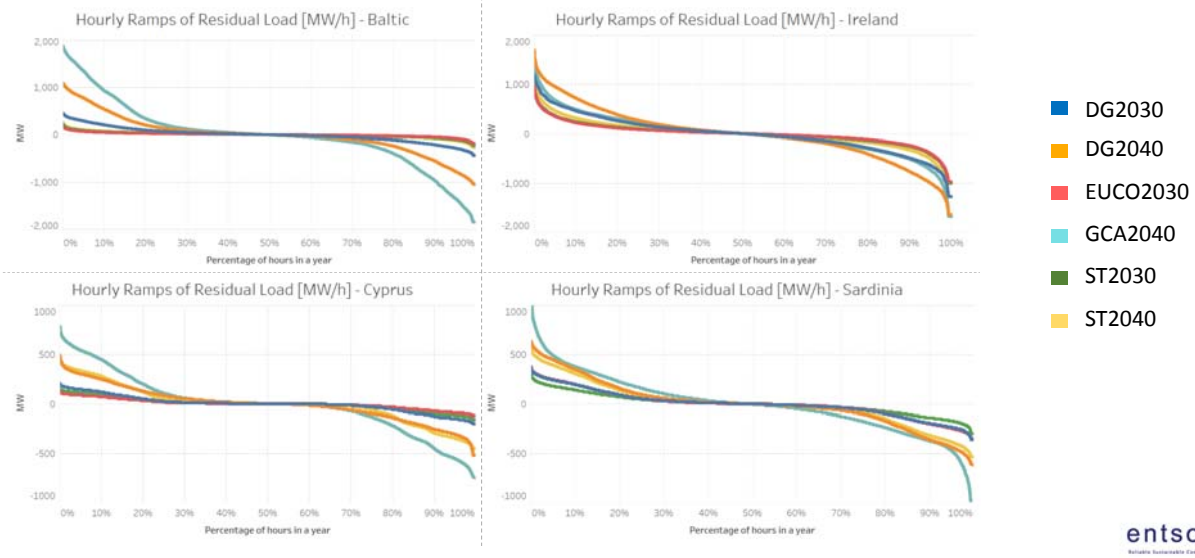


ROCOF



*Red line shows max wind and solar ramping for the scenario and country

Ramping Rates



Key Messages

- Inertia in all synchronous areas will decrease
- Small synchronous areas will see rapid and large frequency excursions following a normal generation loss
- Reduced amount of controllable units lead to high flexibility needs in normal operation.
- Need to guarantee the necessary volume of frequency reserve in all timescales for generation and demand imbalances.
- Strong interconnection between countries can help.

TYNDP 2018 Map

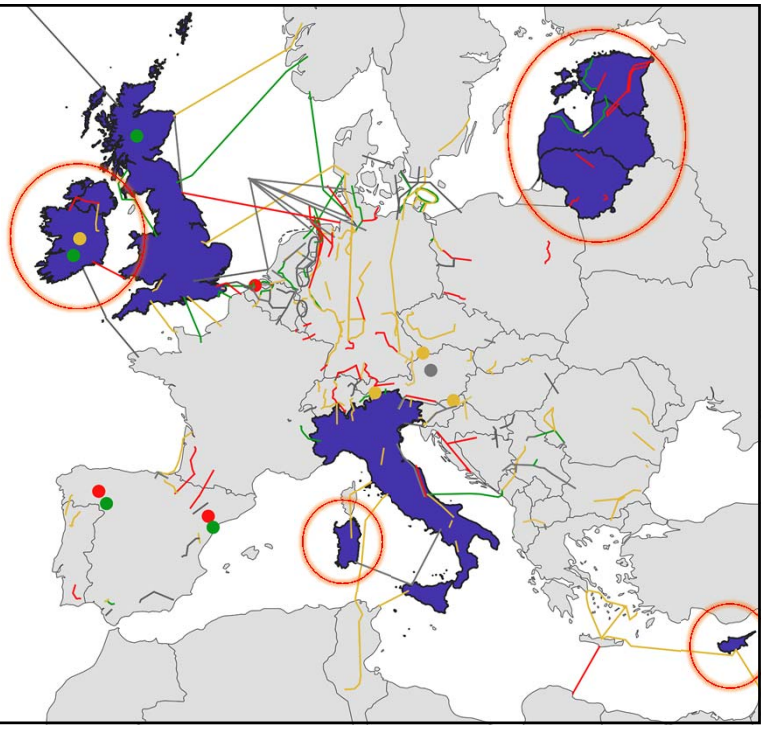
- Shows infrastructure project planned up until 2040.
- All project are DC.

Under Consideration

Planned but not Permitting

In Permitting

Under Construction



Thank you for your attention