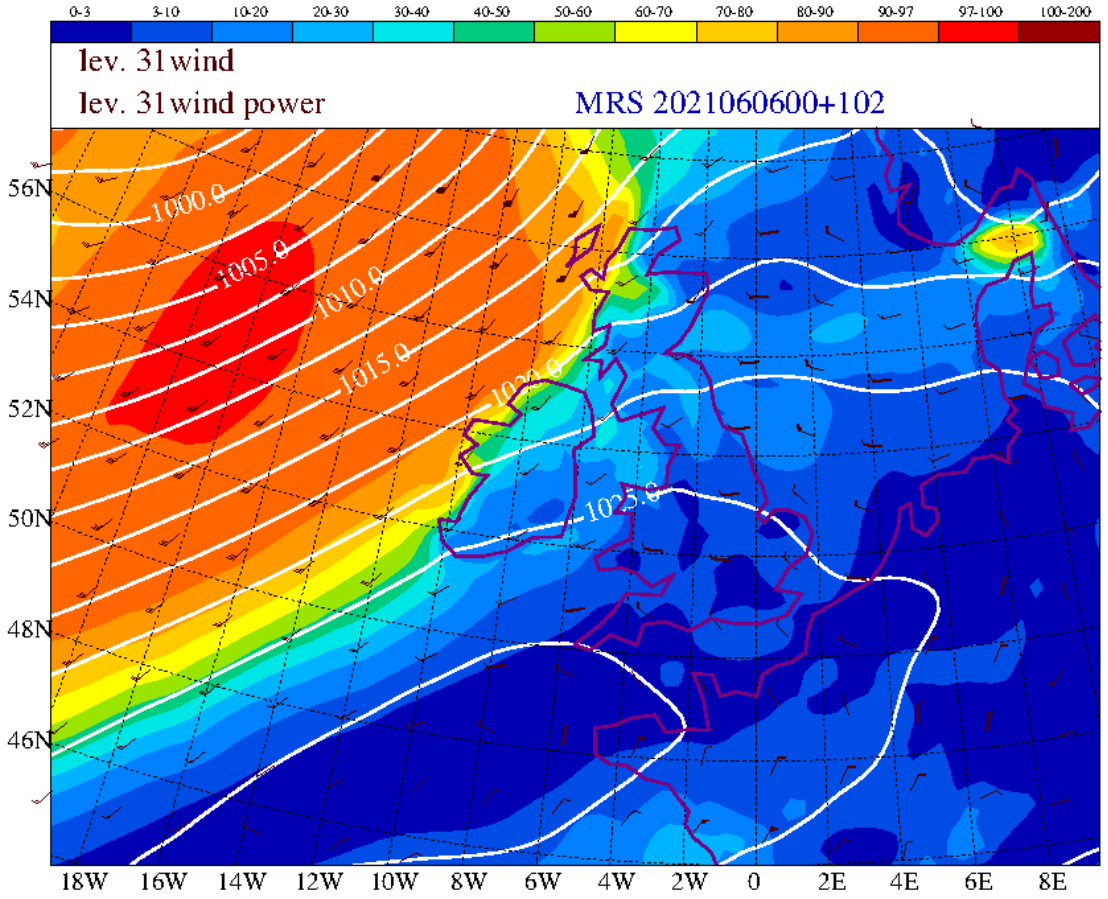
METEOROLOGY & MARKET DESIGN
FOR GRID SERVICES WORKSHOP
ONLINE
June 2021

Ensemble-Based Dynamic Ramping Reserve Forecasts: the Irish Case

Session 3: Probabilistic Forecasting: State-of-Art and Use in Operations



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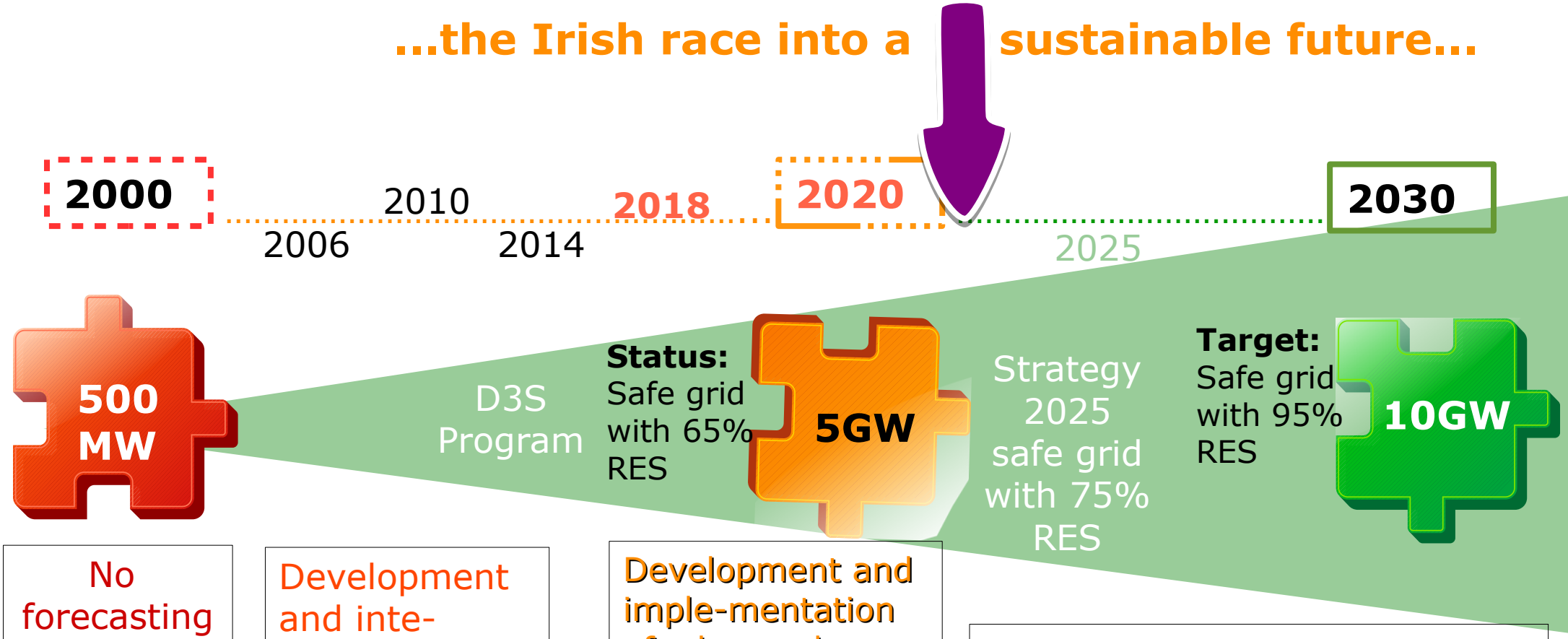
A brief history of time...

...the Irish race into a sustainable future...



No forecasting --> Moratorium ...

Development and inte-gration of forecasting tools into operation:
- Day-ahead
- Short-term

Development and imple-mentation of advanced forecasting tools:
- HSSD* Tool
- Probabilistic Ramping Reserve Tool

* High Speed Shut Down

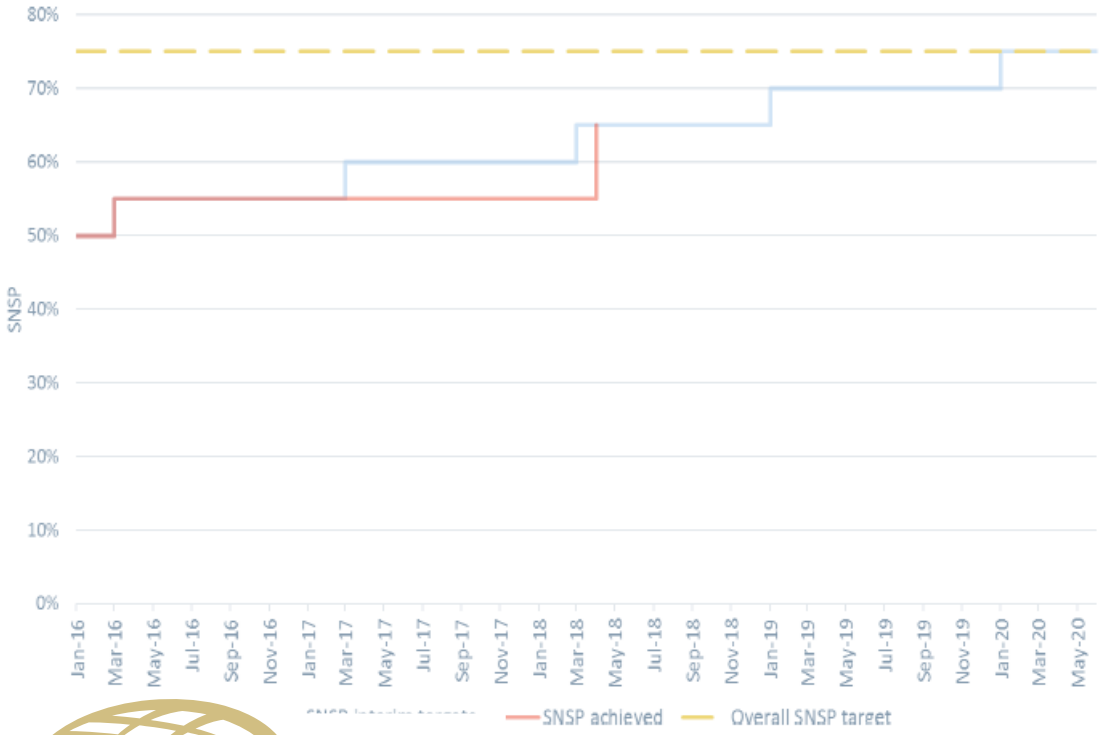
Implementation of probabilistic forecast tools into operation:
- gaining experience
- adjusting
- analysing
- trusting
- improving

Wind Generation on the Island of Ireland

Area	Installed MW Capacity	% System Demand (2018)
All Island	> 4900MW	31%
Ireland	> 3700MW	30%
Northern Ireland	> 1200MW	32%

Forecasts are crucial for system security – Up to 65% system non-synchronous penetration (SNSP) on All Island System in 2020!

Figure 1: Current progress against SNSP targets



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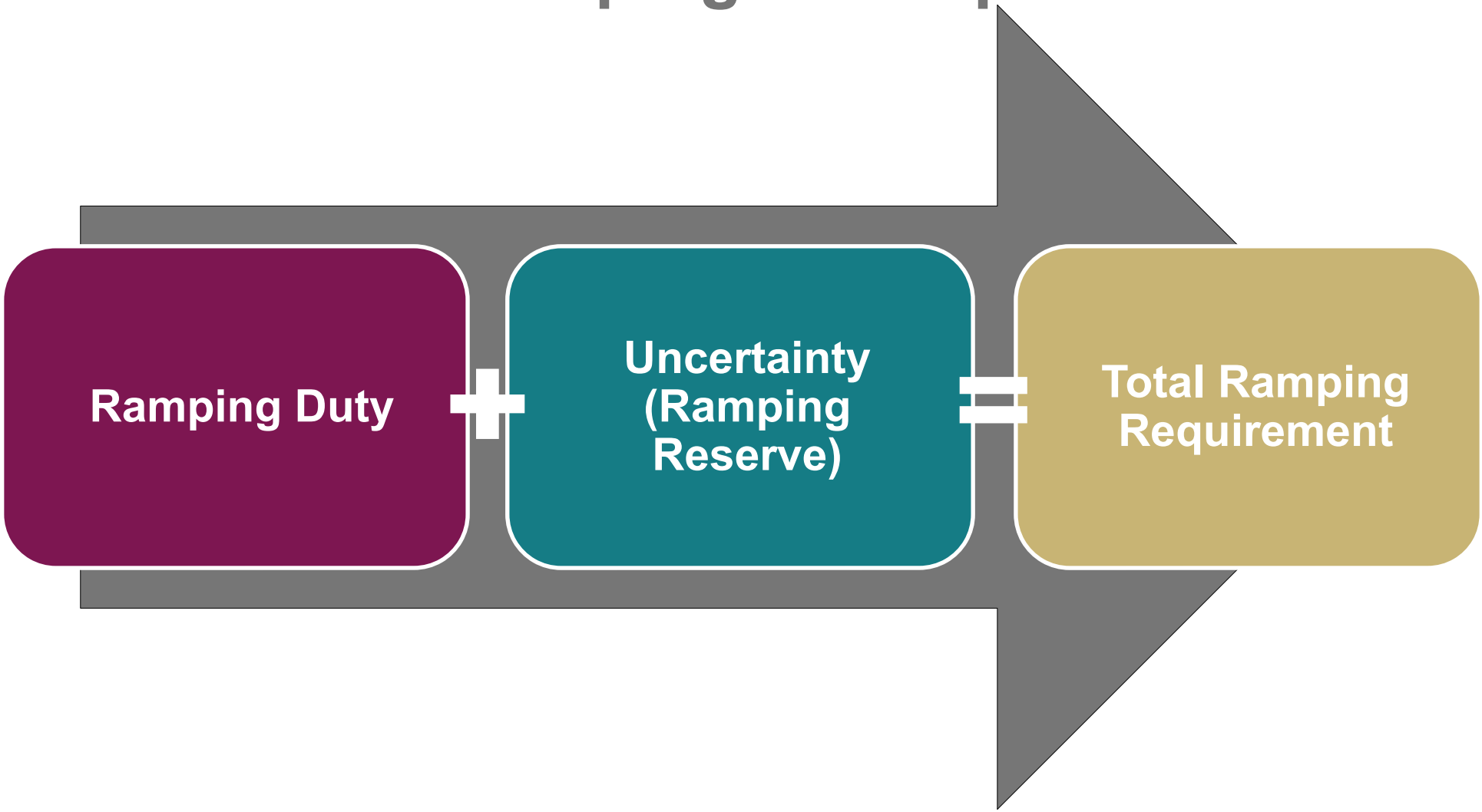
Ramping Concept



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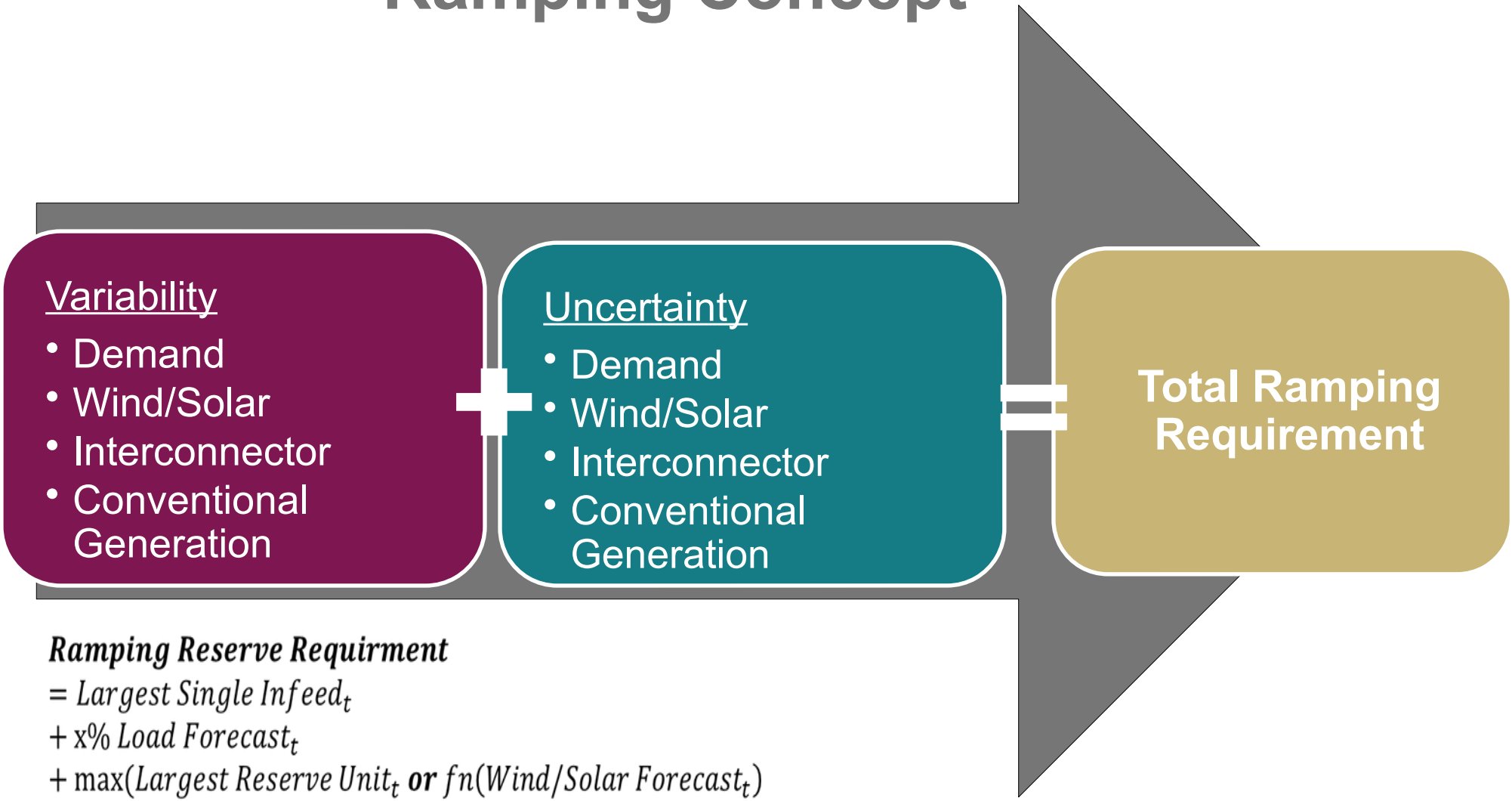

Ramping Reserve Requirment

$= Largest\ Single\ Infeed_t$

$+ \text{x\%}\ Load\ Forecast_t$

$+ \max(Largest\ Reserve\ Unit_t\ \textbf{or}\ fn(Wind/Solar\ Forecast_t)$

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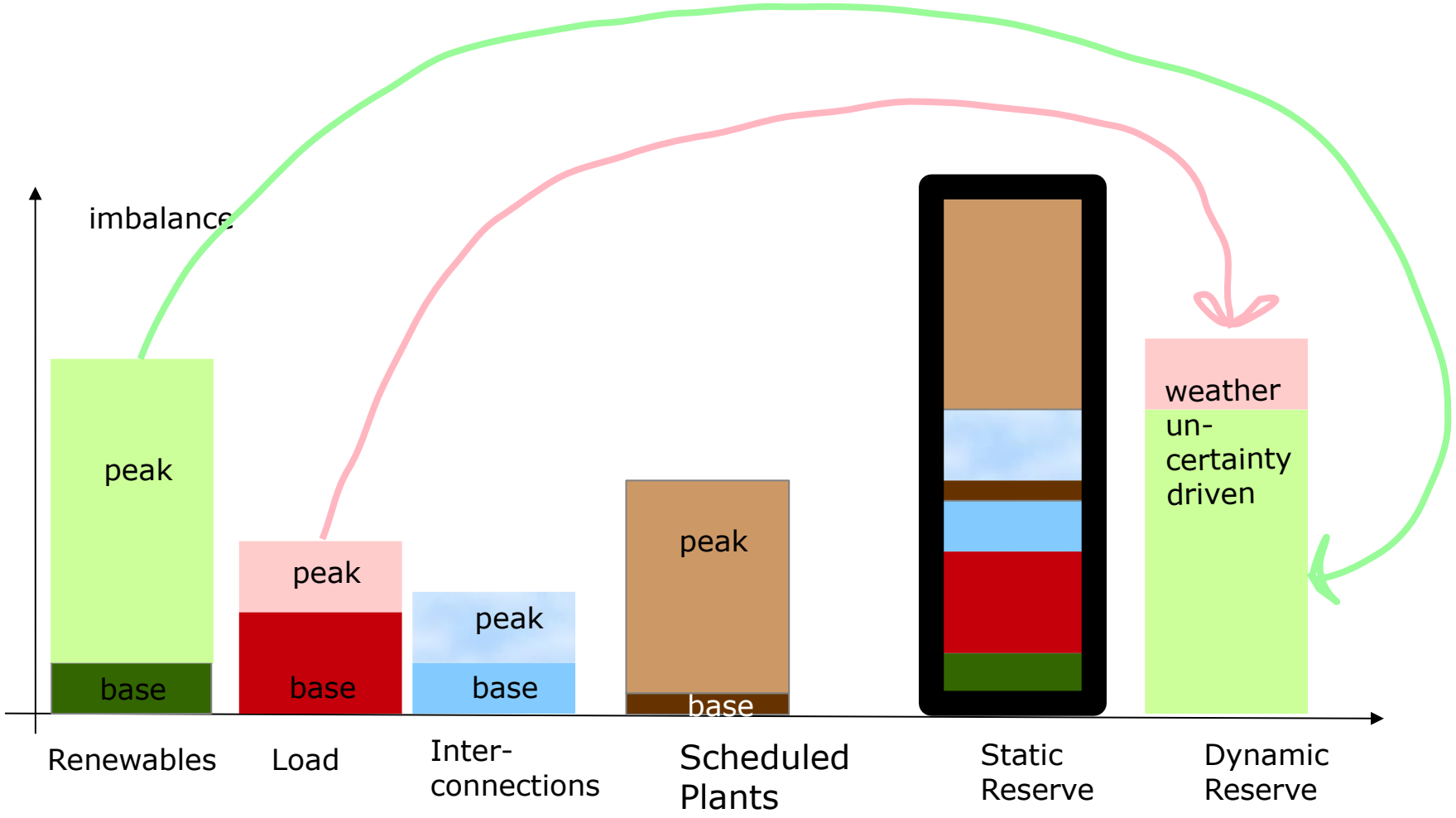
Decomposition of Reserve requirments



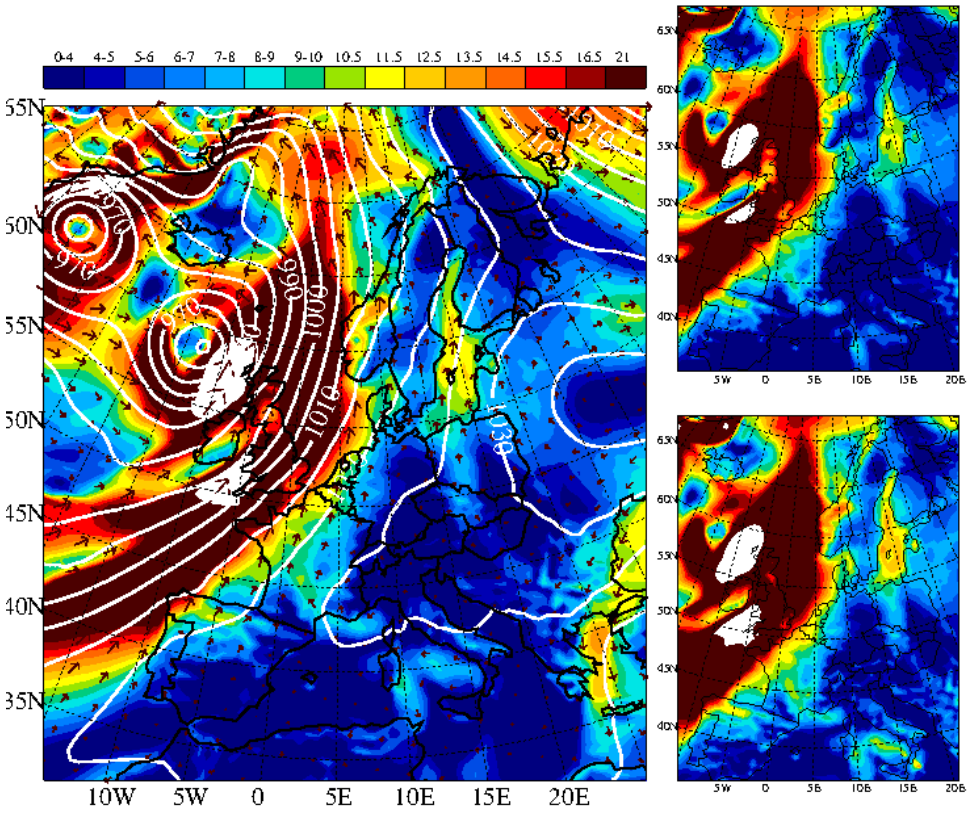
Background of Forecast Uncertainty in Ireland

Large-scale Uncertainty Sources

- (Atlantic) storms propagate from west to east
- High uncertainty growth rate in storm events
- Information on track and intensity of low pressure systems (in Atlantic) is sparse

Small-scale Uncertainty Sources

- baroclinic instability (T, ps dependent vorticity)
- barotropic instability (ps dependent vorticity)
- symmetric instability/slantwise convection
  (upward displacement of air parcels)
- instabilities from sea-air interaction
  (cold air over warm water...)

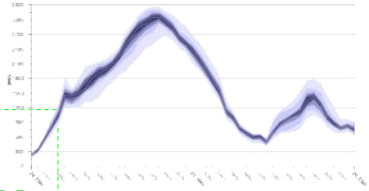


… and at some stage, the growth rate of Renewables penetration limits the available reserve for mitigation actions…

Background of Forecast Uncertainty leading to Ramping Reserve Requirement Forecast

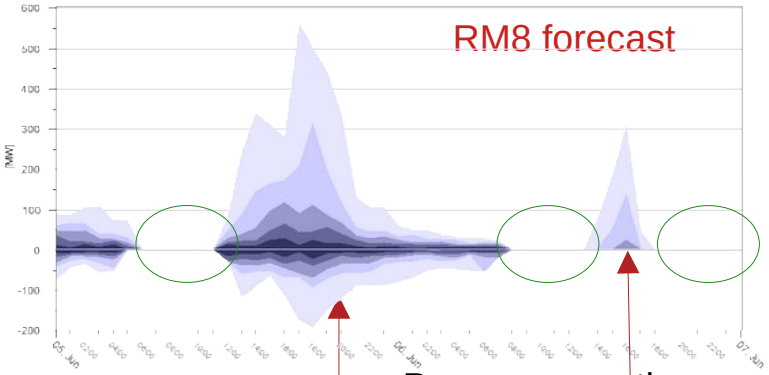
Unstable weather conditions trigger instability mechanisms

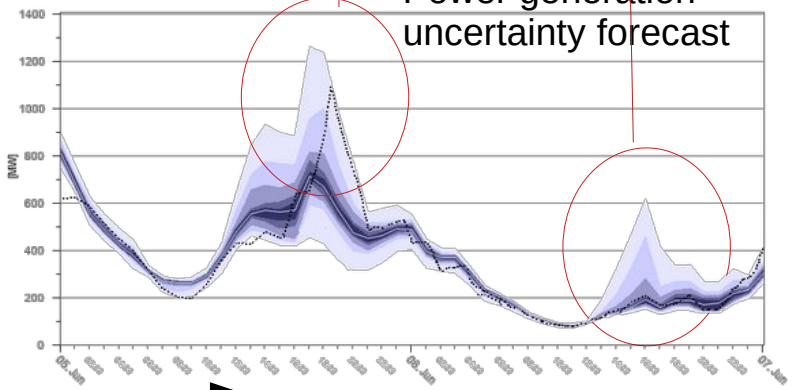
High predictability ***No*** *Ramping Reserve*



Time Dependent Uncertainty *Ramping Services needed*

Low predictability *Primary Reserve*

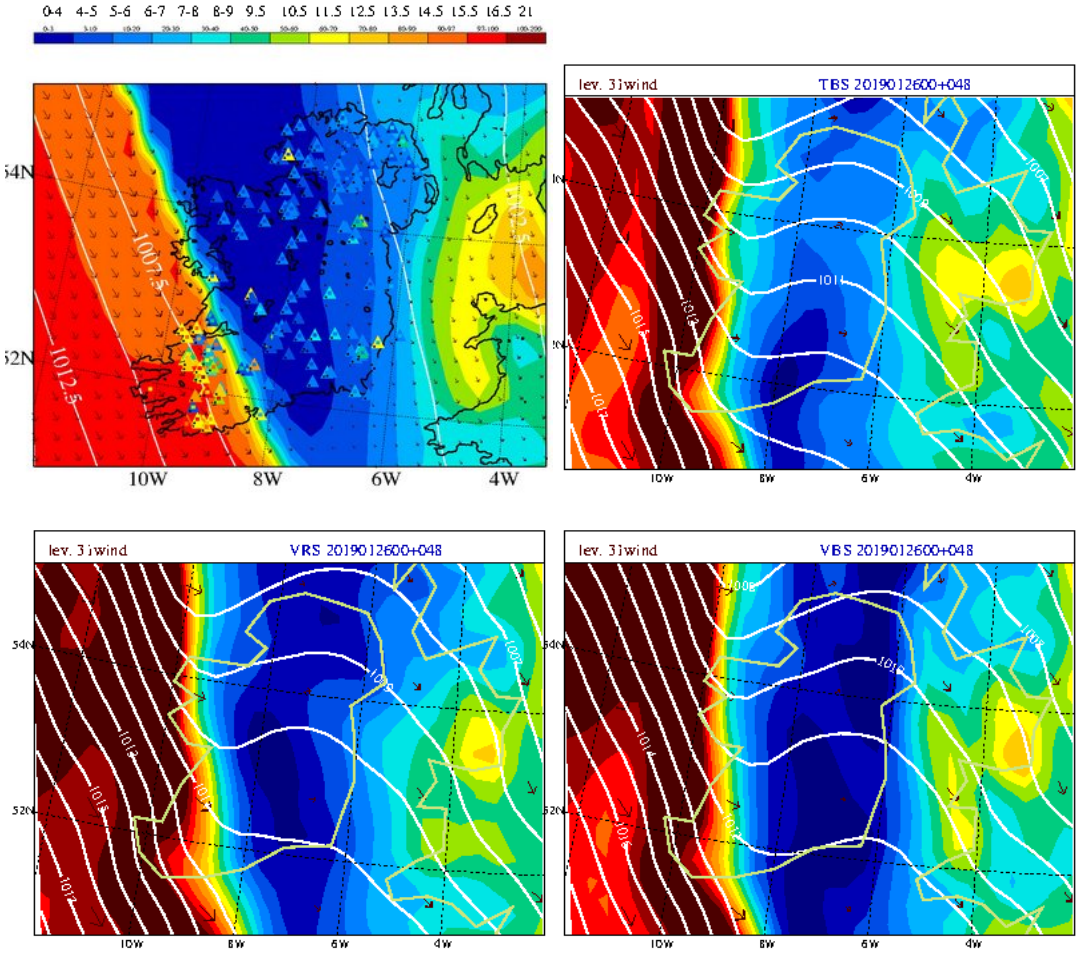




Time Scale

Spatial Scale

Why and when forecasts are uncertain...



4 main clusters of Windfarms
almost empty middle part

...unresolvable small scale phenomena

... small errors in sharp fronts or fast moving lows can cause large errors with uneven distribution of wind farms...

Ramping Reserve Forecast study in 2019 revealed…

Wind generation on the Irish system continuously ramps up and down due to:

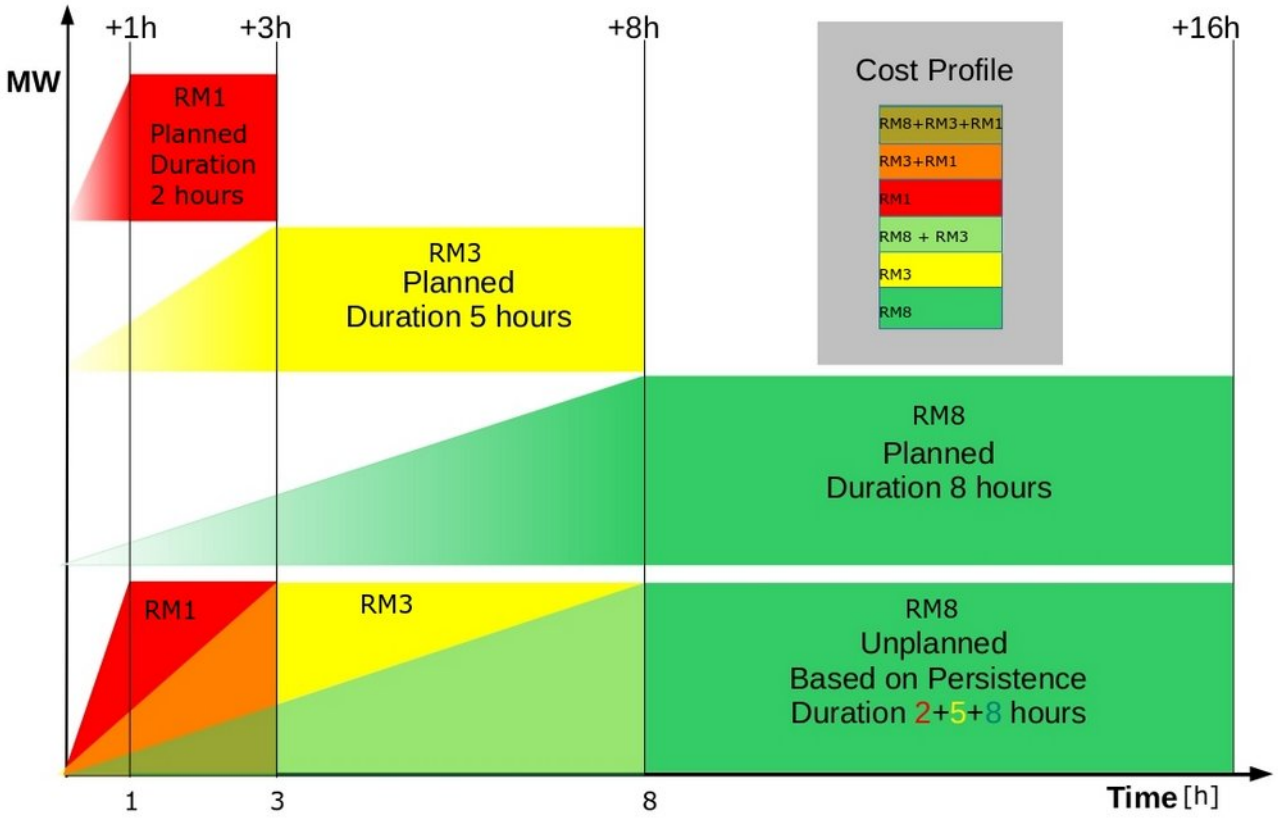
(1) wind speed is seldom constant over large areas
variations of 16 to 27 m/s: Oct/Nov → Feb/March… observed all year round….
(2) density of capacity varies across the Irish system

Challenges:
- Ireland's direct exposure to the Atlantic
- high penentration (> 30% demand + SNSP 65% → 75% from Windpower)
- island grid

---→ **System balance** can only be **maintained economically** with:
- ST forecasts on the 0-2 hour horizon
- dynamic allocation of reserve to balance VG forecast errors

Need: Optimization of **forecast error balancing**

How EIRGRID solves this challenge: 3 Ramp Reserve Products



Overview over the ramp products and time scales of the ramping reserve products:

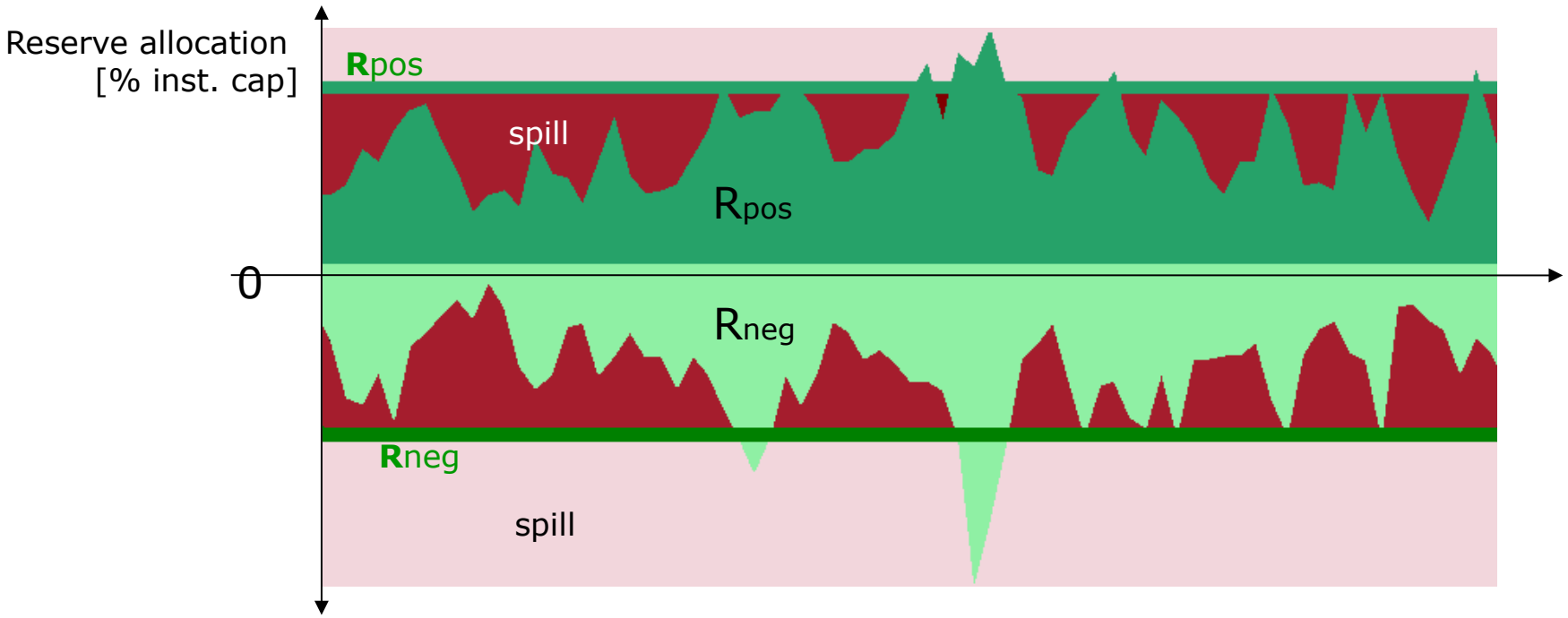
RM1 (red) for the 1-hour ramping,

RM3 (yellow) for the 3-hour ramping and

RM8 (green) for the 8-hour ramping and duration.

The first 3 horizontal bars (red, yellow and green) show planned reserve,
The last multi-coloured bar shows handling possibilities for unplanned ramping needs

Reduction of Reserve Requirements with dynamic allocation of reserves



Rpos: dynamic positive reserve
Rneg: dynamic negative Reserve
Rpos/Rneg: static reserve allocation
spill

NOTE: The goal of dynamic reserve allocation is to reduce the "spill" without reducing security of supply

Ramp-Up and Ramp down are NOT symmetric !!!

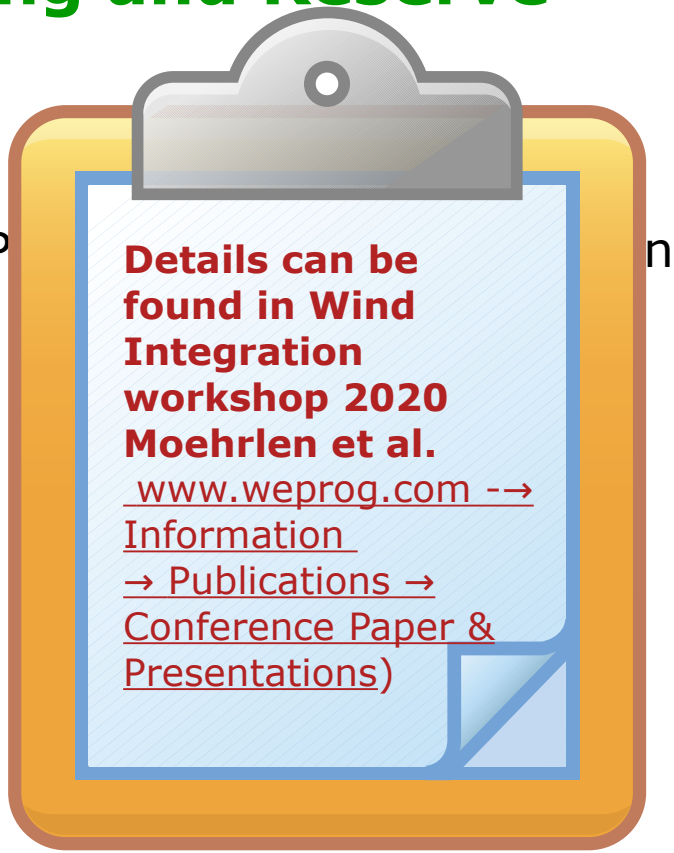
Relationship between Ramping and Reserve

Purpose of RM product:
To ensure balance between Load, VG, Scheduled Primary P nd Import/Export over the product's deployment horizon.

LOAD = VG + SPPG + Import - Export + $RM_{max} \cdot D$

where $RM_{max} \cdot D$ is the deployed reserve
SPPG is the synchronous primary power generation.

….after decomposition …
RMmax = scRM + nsRM



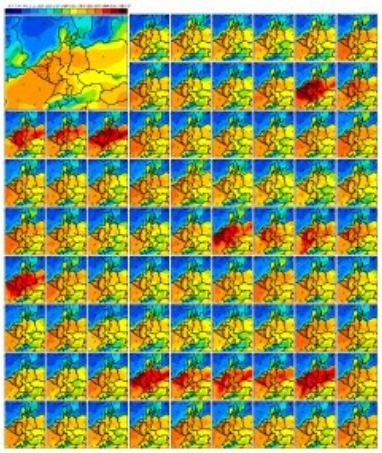
The non-scheduled reserve marginal product nsRM part contains uncertainty around the schedule of all terms in equation [1], thus

nsRM = max(Largest-Single-Point-of-Failure, LOAD - VG - scLOAD + scVG)

Where **all terms in the second part are weather dependent.**

From forecast uncertainty to Ramp Reserve Forecast ...

MSEPS 75 Member Weather Ensemble

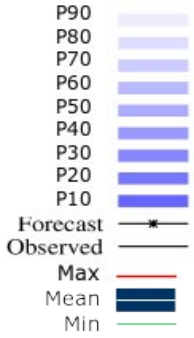


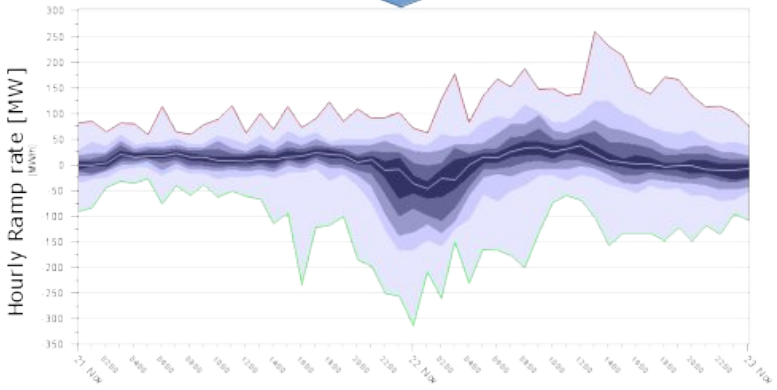
Sorting of forecast members

Uncertainty range is between minimum and maximum forecast value, centered around the mean (P50), but varying in each time step

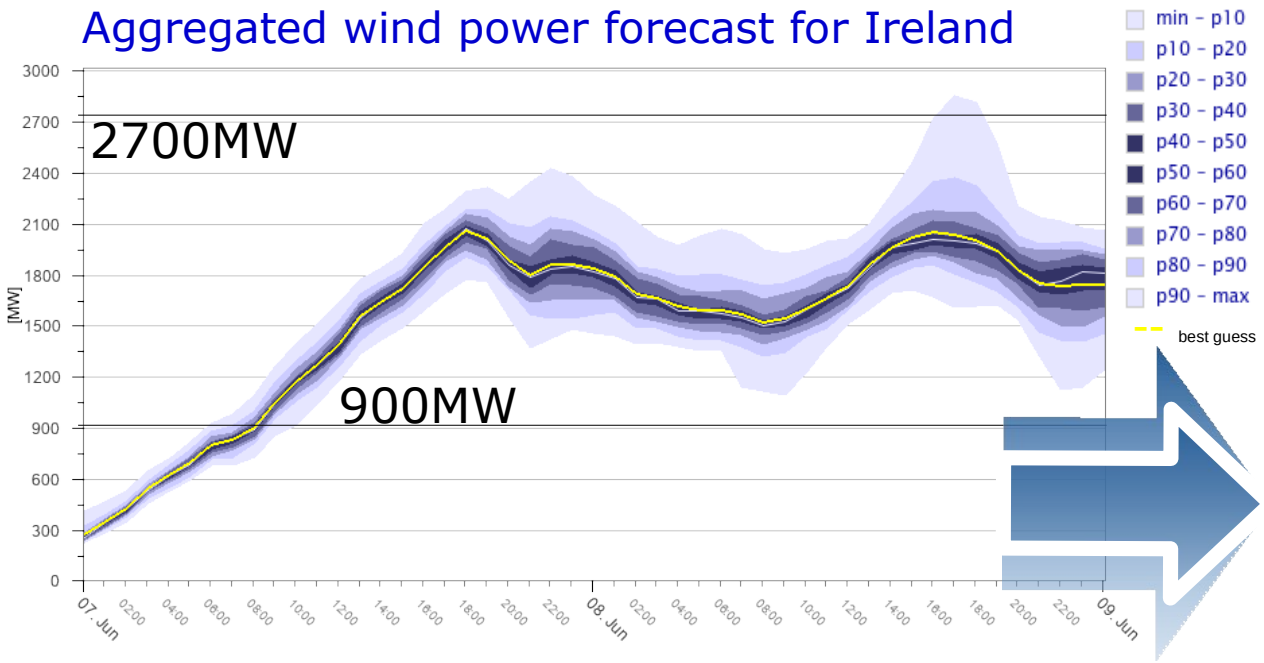
Example: 68 members:
=> 90% probability/confidence
=> percentile 90

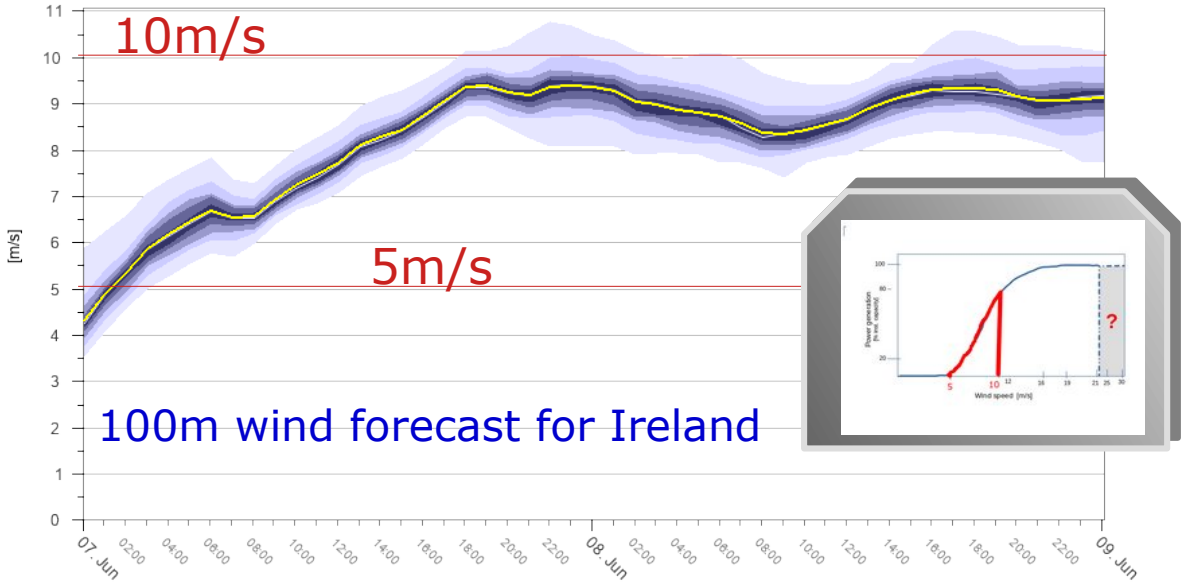
the intervals are generated in that way for every time step of the forecast

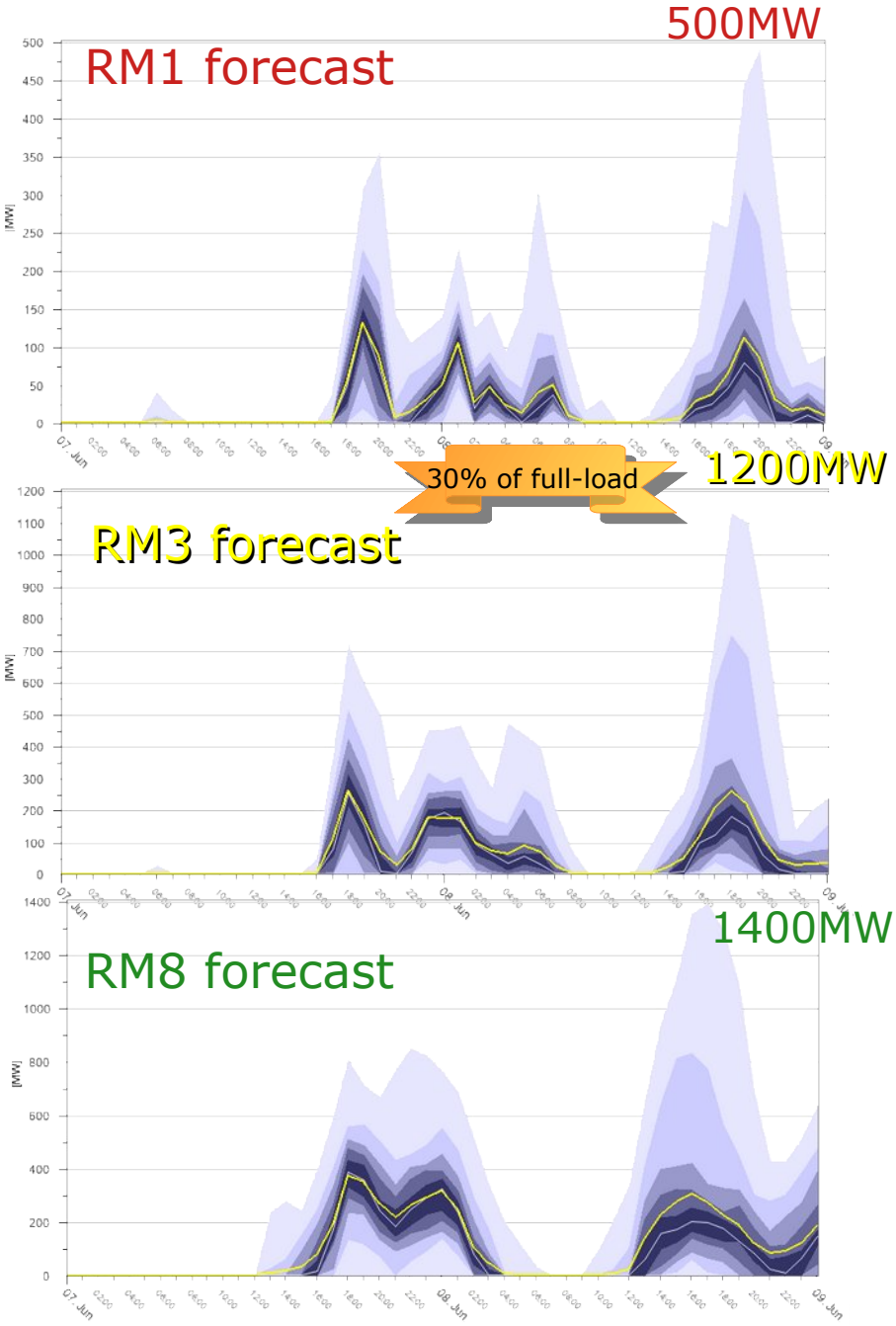




Operational Experience… 7th June 2021 +48h

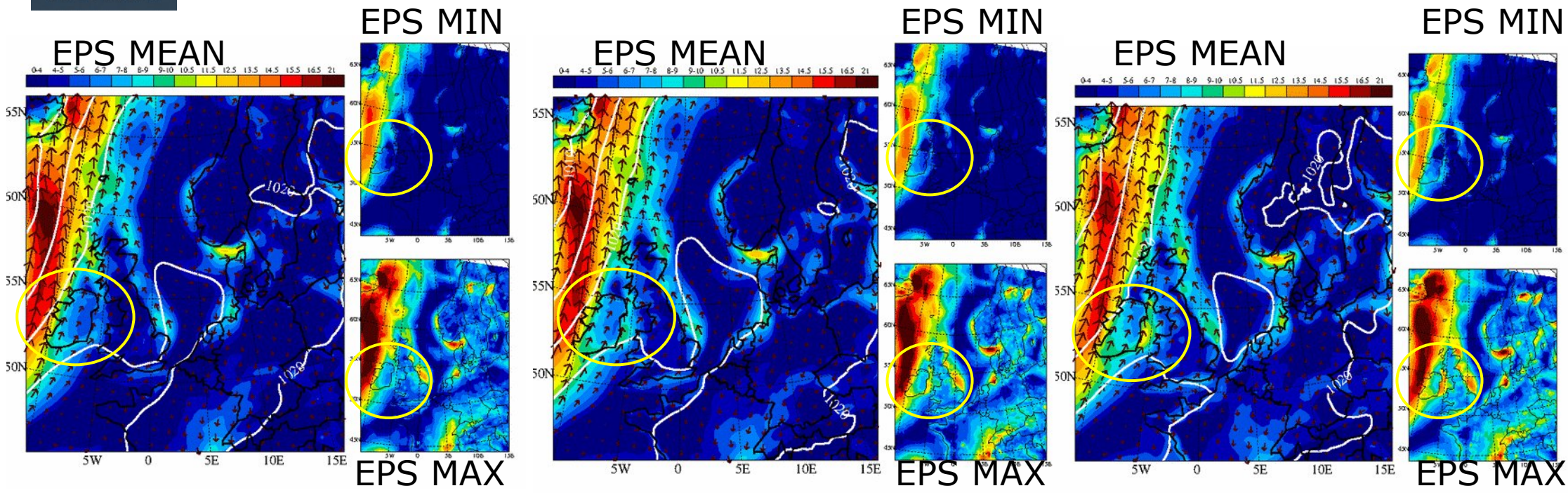


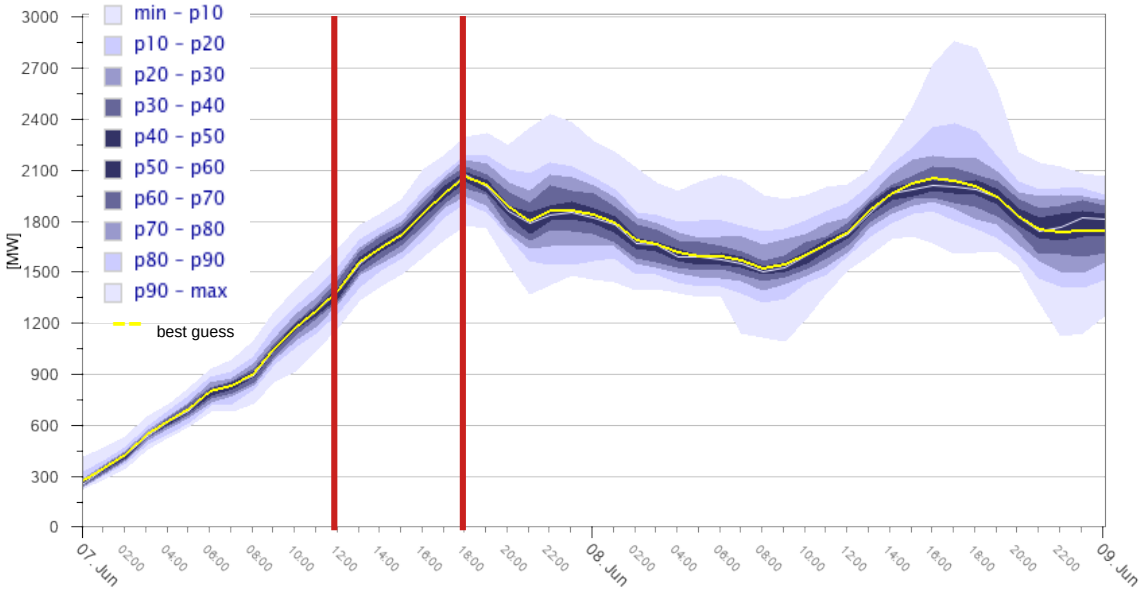


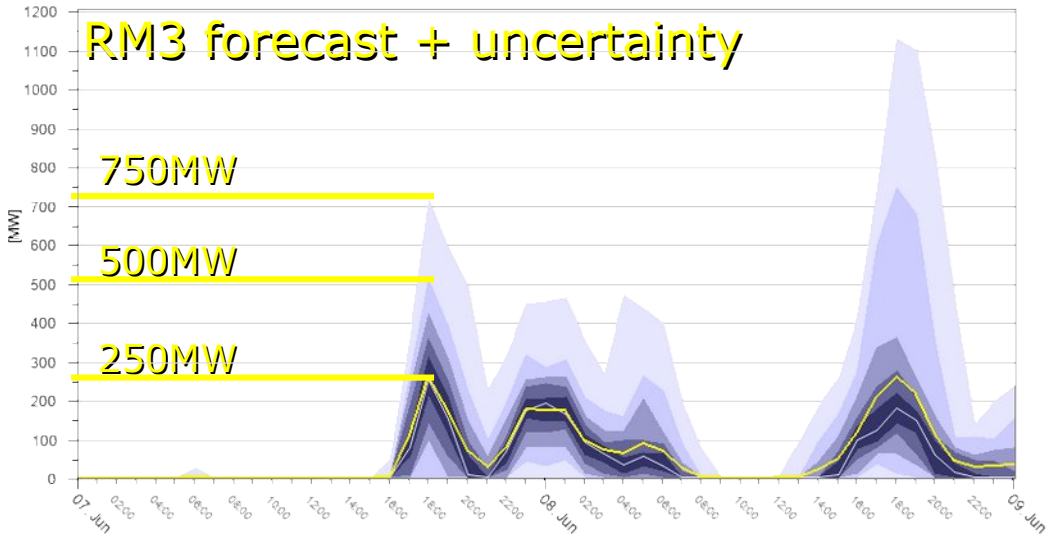


Operational Experience… 7th June 2021 +12h to +16h

Wind speed at 100m



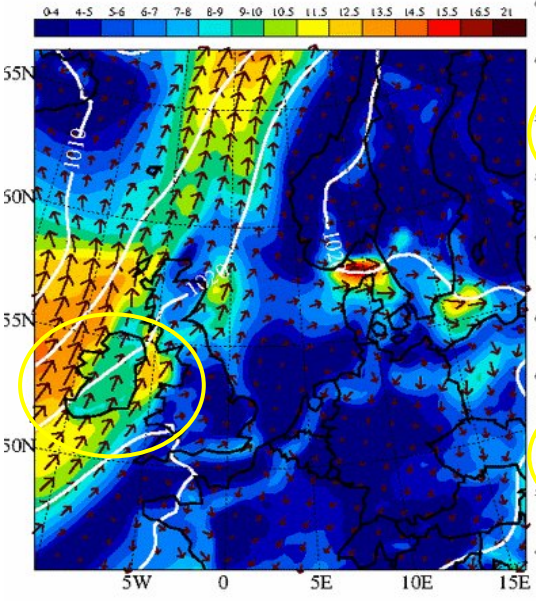




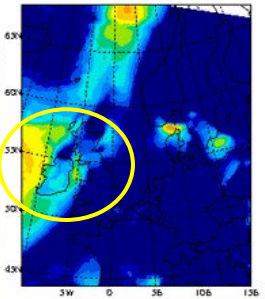
Operational Experience… 8th June 2021 +20h

Wind speed at 100m

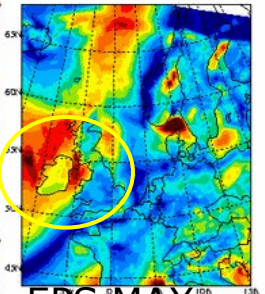
EPS MEAN



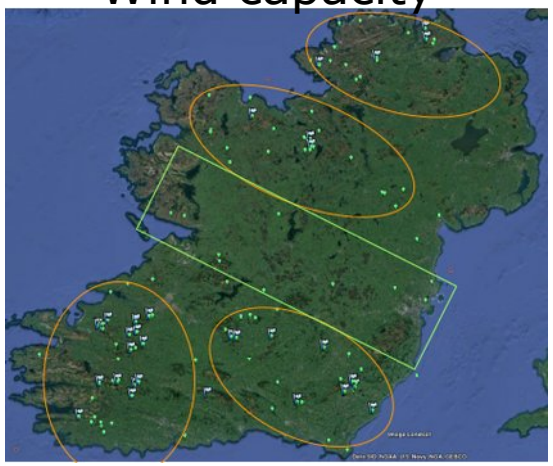
EPS MIN



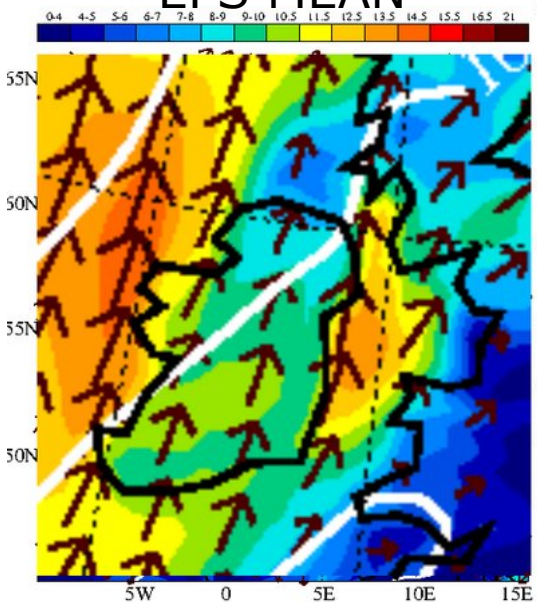
EPS MAX



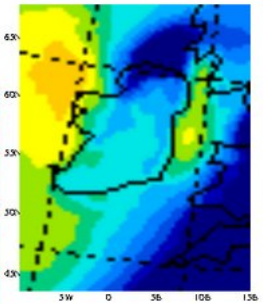
Wind capacity



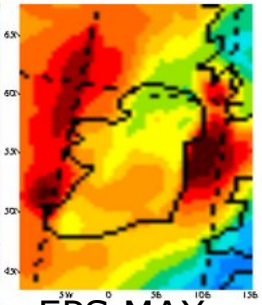
EPS MEAN

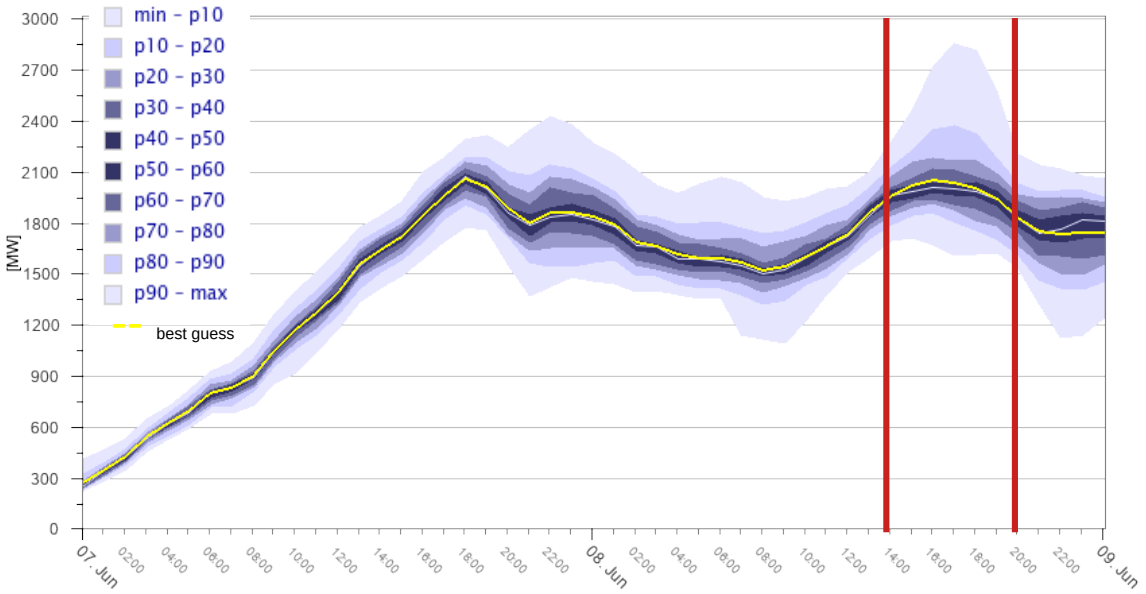


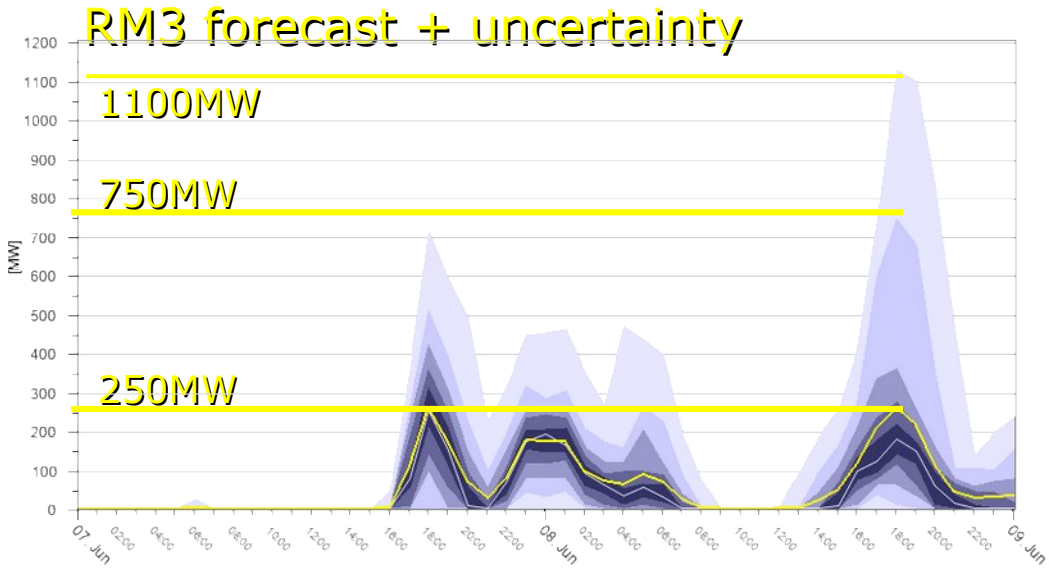
EPS MIN



EPS MAX







Conclusions after the first year of operation…

Key Findings…

Understanding uncertainty is key with increasing penetration levels (>30% of demand)

Uncertainty based dynamic ramping reserves keep operation secure and economic

Dynamic allocation of down-ramping is possible and (economically) beneficial

Dynamic allocation of up-ramping can be supplemented with curtailment to balance to balance security and costs

To built an effective reserve forecasting tool requires analysis of:

- **(1) the weather conditions for up- and down ramping uncertainty**
- **(2) the grid situation**
- **(3) available reserve capacities**
- **(4) realistic load patterns**

Ramp Reserve Forecast for the Irish situation:

Lessons Learned: Forecast paradigm shift from…

deterministic → probabilistic forecasts
EirGrid is being provided with 9 percentiles for the 3 ramp horizons instead of only one value.

static solutions to optimised problem solving
EirGrid can now choose the ”optimal” percentile for the grid situation at hand

from single simulations to strategic scenario analysis
EirGrid are now looking into strategies for use of percentile for various grid situations

…there is still a lot to learn …
Further research work is required to assess tradeoff strategies of cost versus reliability

Thank you for your attention…

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