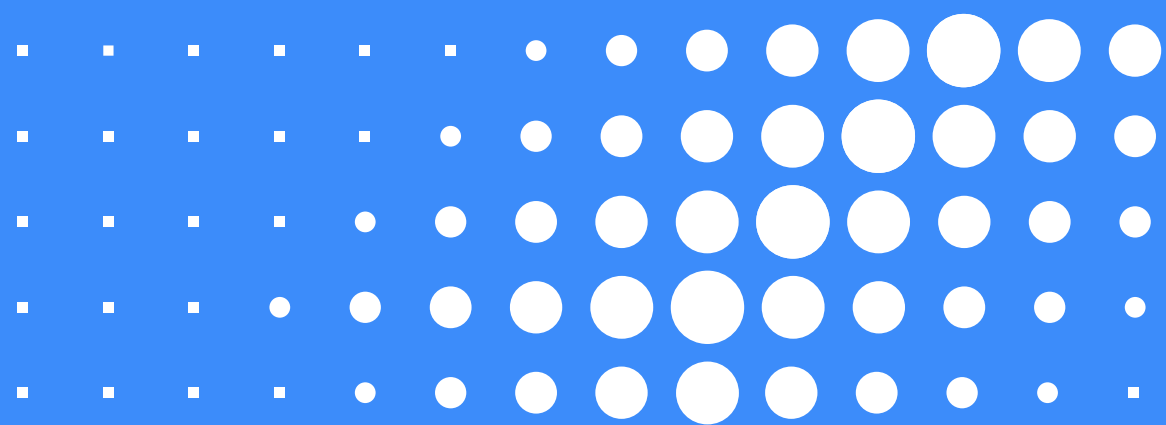




Challenges in regional PV

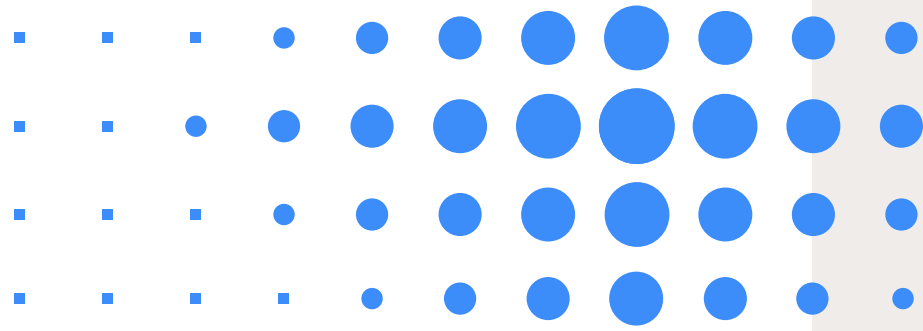
A perspective of the Dutch grid operator

Laurens Stoop, Wouter Tromp & Simon Veldkamp

Weather & Climate Specialist

2026-09-15





A moment for safety

Together we provide a safe working environment. We learn from mistakes and sharing ideas, concerns and asking questions are a matter of course.

We also draw attention to the following safety measures in case of evacuation of the premises.



Follow the escape route as indicated



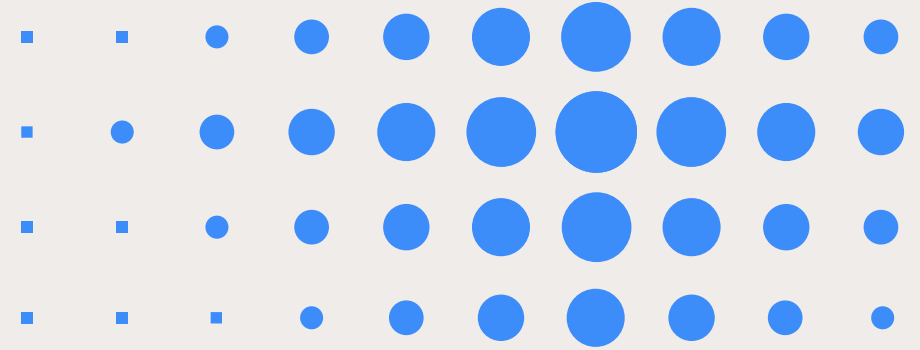
Use the stairs instead of the lift



Go to the assembly point



Follow the instructions of the in-company emergency responder



- Transmit electricity

Why is weather important?



Transport

How much power will be produced and where?

How much power can our assets transport



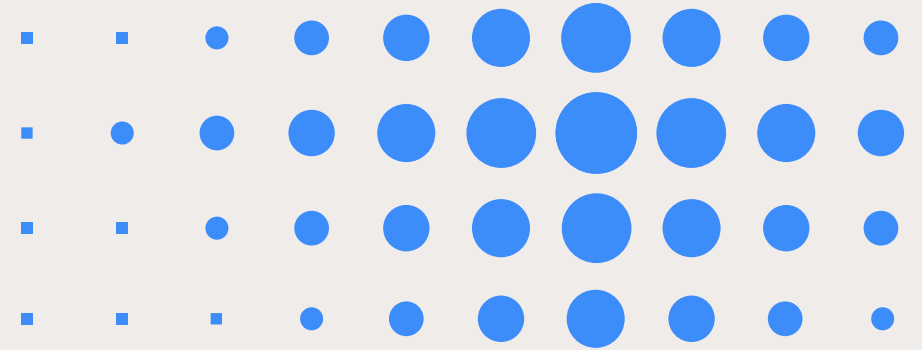
Balancing

How large should our balancing reserves be?

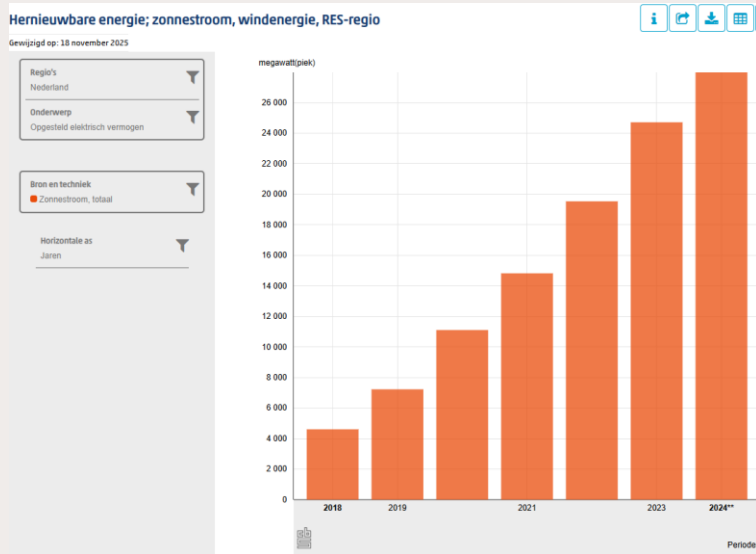
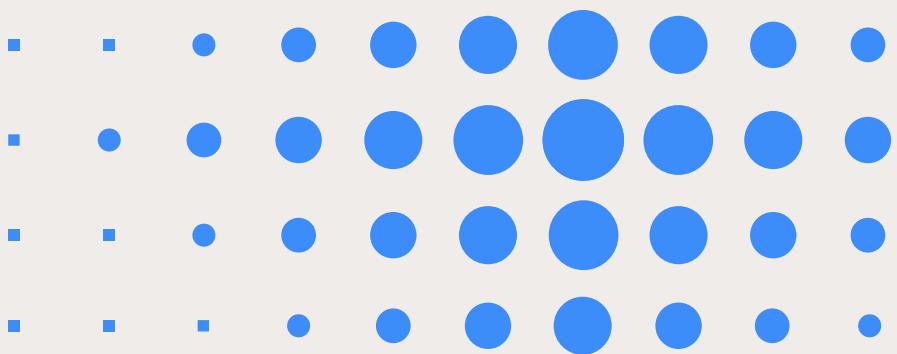


Security of supply

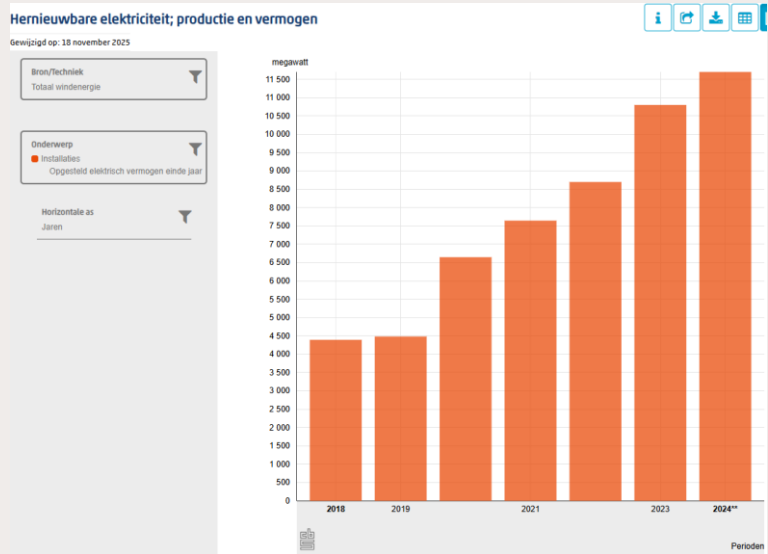
Are there enough generators available to meet demand?



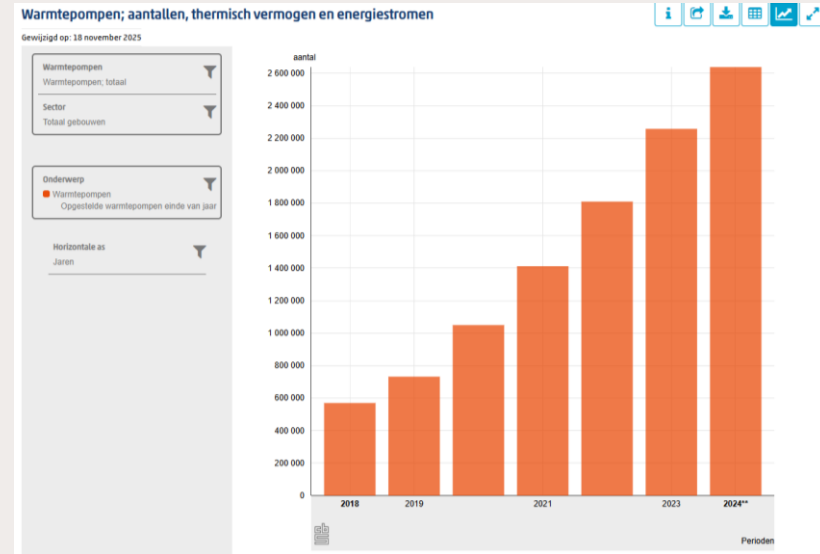
A summary of the last few years



28.6 GWp

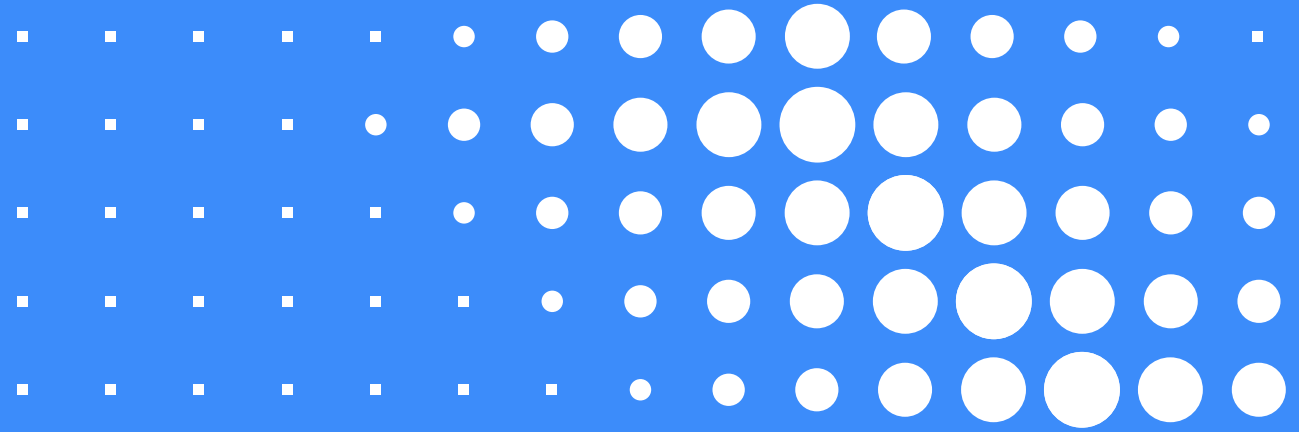


11.8 GWp



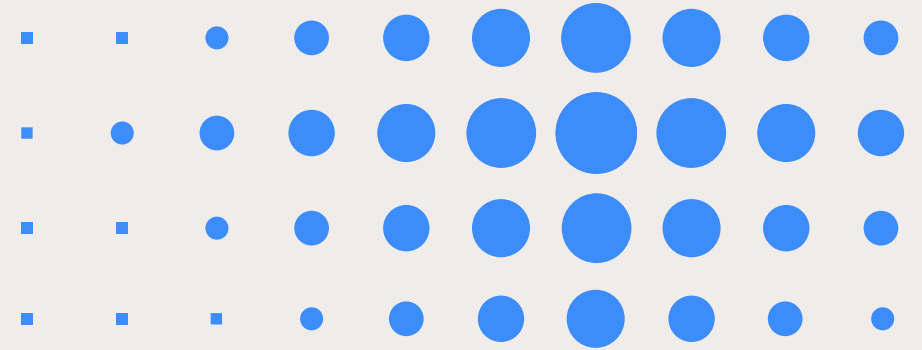
7.8 GWp





Power forecasting at TenneT

A glance on the topic on power forecasting



Time:

- Forecasting horizon
 - Week-1, Day-2, Day-1 & Intraday
 - Longer horizons expected (D-14)
- 15 minutes temporal resolution
- Hourly update frequency

Values:

- Deterministic

Assets:

- ~1.000 DSO connection points
- ~75 Conventional generation connection points
- ~50 Load connection points
- ~100 RES connection points

Type:

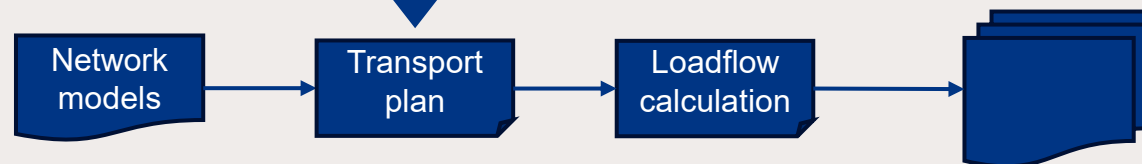
- Active power (MW)
- Reactive power (Mvar)

Processes:

- Short term adequacy (W-1 – ID)
- Grid capacity calculations (D-2)
- Grid security calculations (D-1 - ID)

Providers¹:

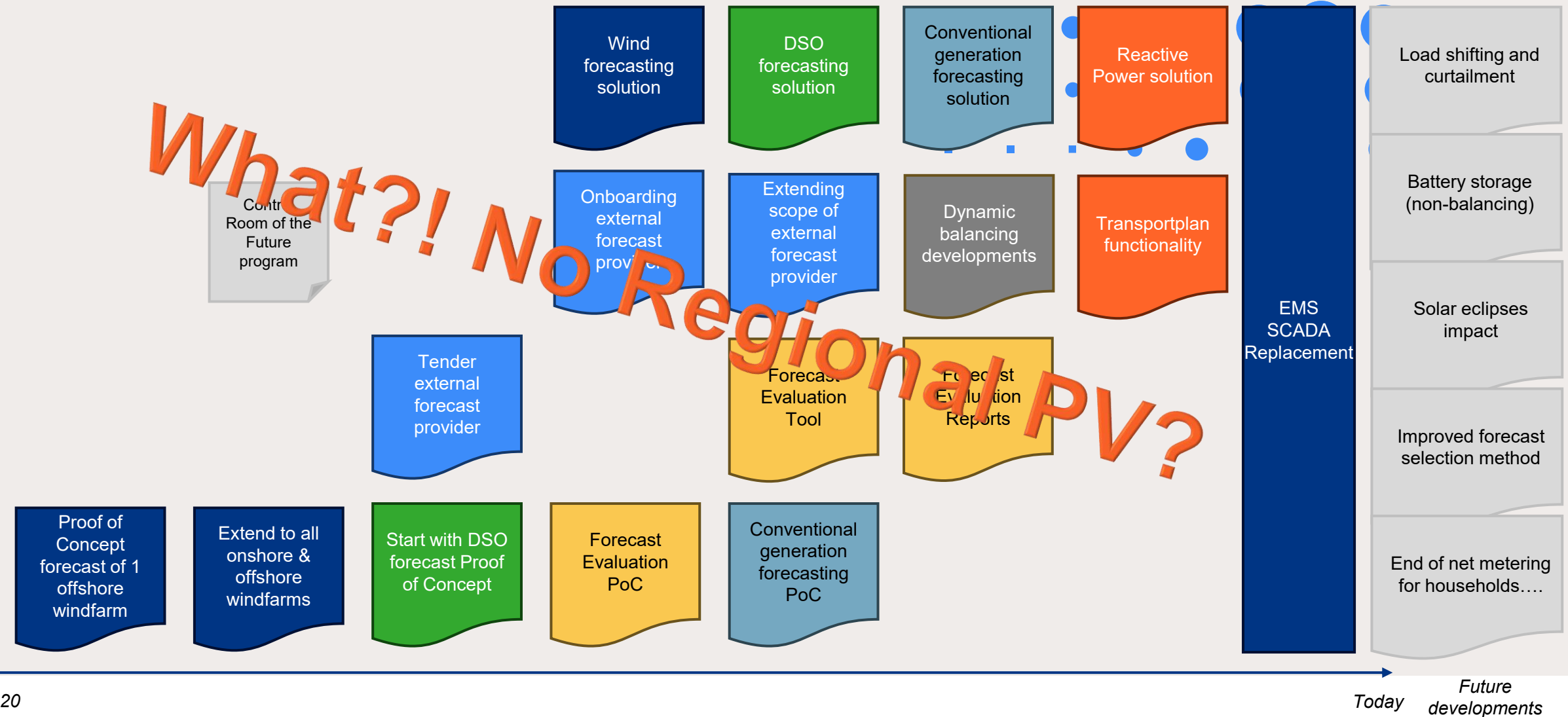
- Connected parties (DSOs / BRPs)
- Internal forecast provider
- External forecast provider²



1) Not every provider makes forecasts for all assets and/or time horizons and/or types

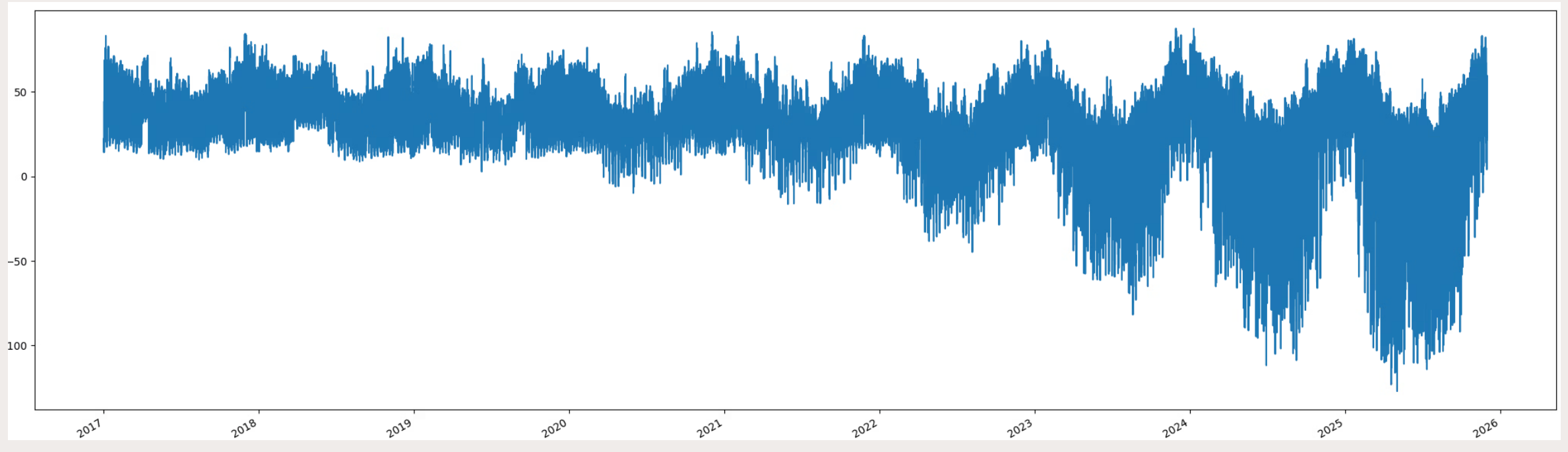
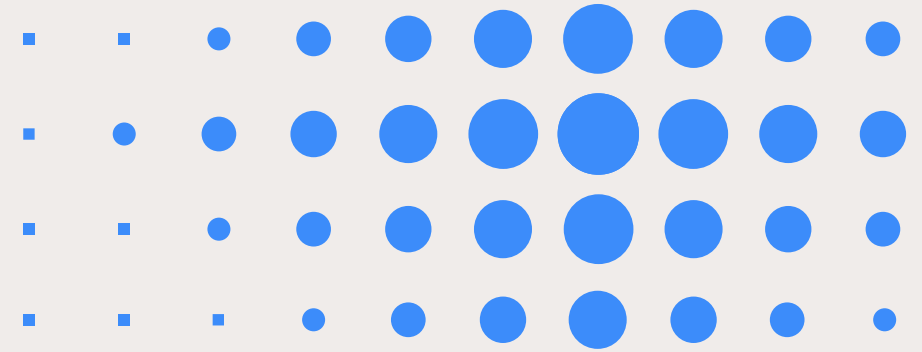
2) Via tender process

Internal forecasts development path

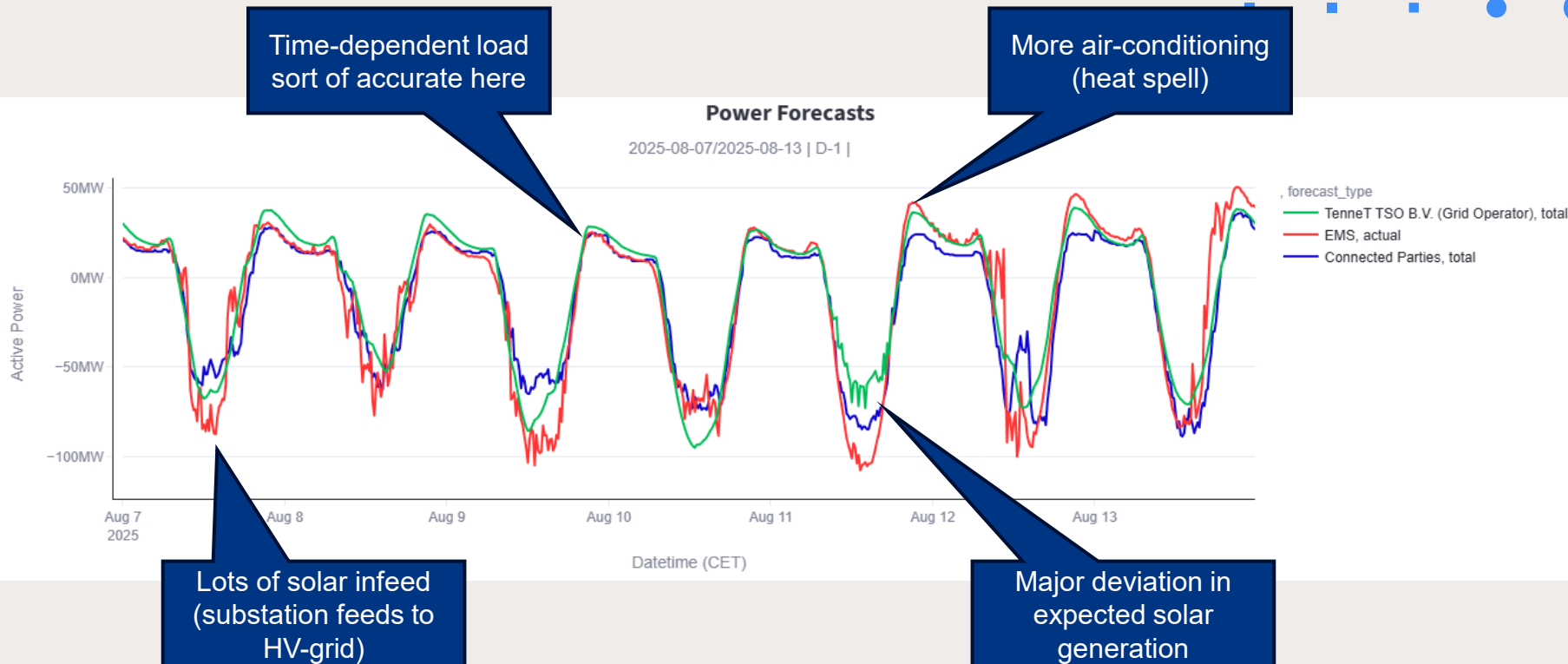


DSO forecasting solution

An example a substation



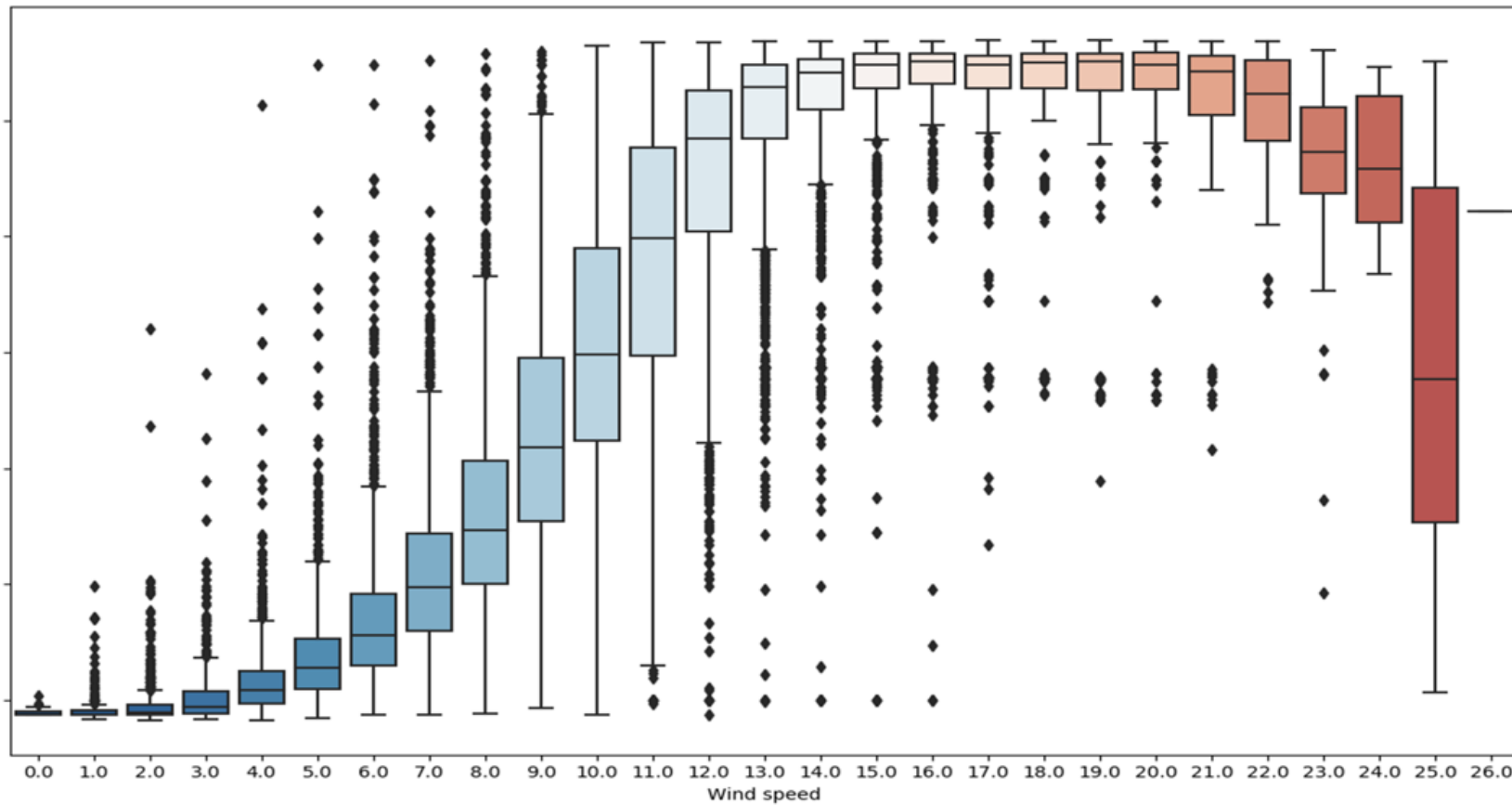
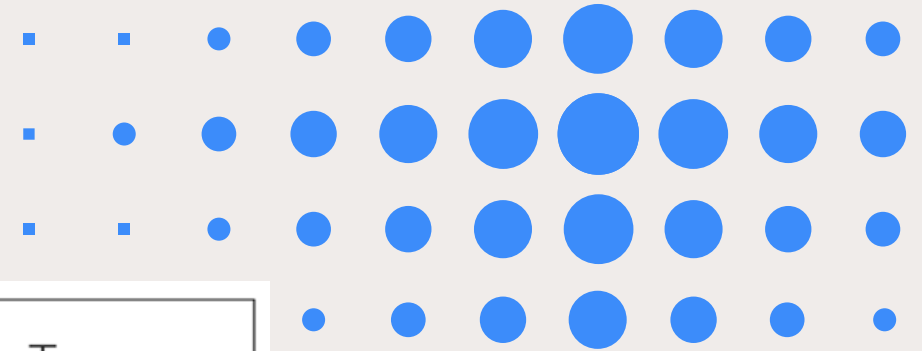
Example of a DSO Substation forecast



Our findings:

- Same model but different NWP: up to 6GW infeed difference in just solar.
- TenneT does not know anything below substation-level.
- Relying on third-parties for installed capacity of solar and wind not preferred.
- **Conclusion:** separate wind and solar from substation loads

Wind forecasting

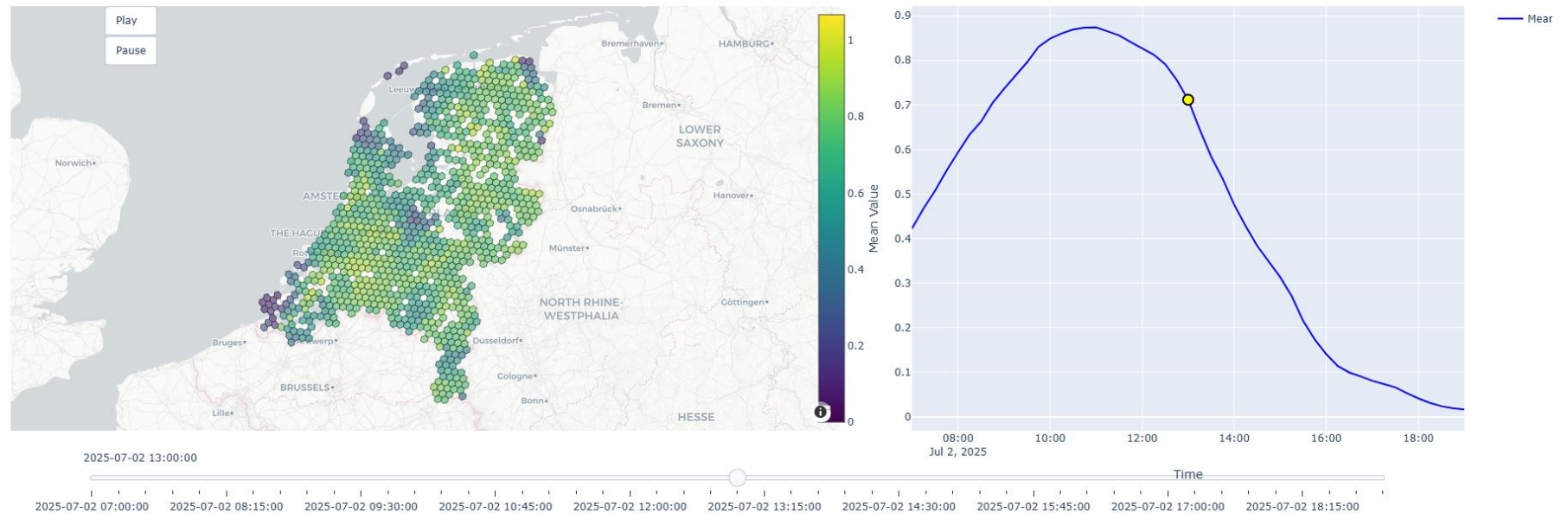
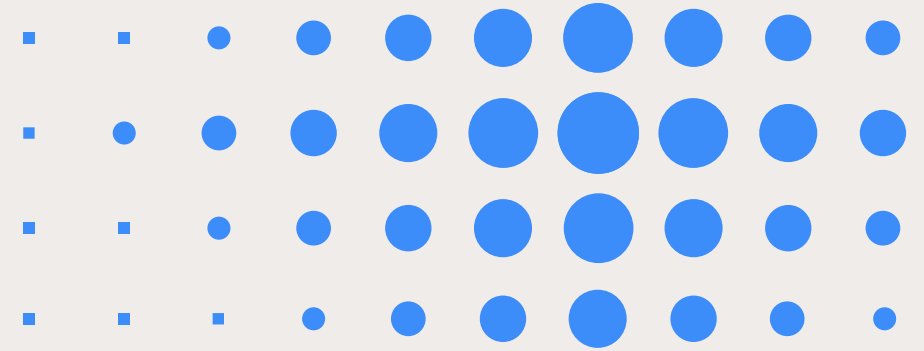


Typical power curve.
Uncertainty becomes a
lot smaller at higher
windspeeds.

Estimating PV over the Netherlands.

- We have a dataset of about ~6000 measurement (20MW) of household PV.
- We use this to estimate solar production in the Netherlands and for MOS to go from NWP output directly to PV panels.
- PV production during cloudy condition can be very different between ICON and Harmonie for similar global radiation forecasts.

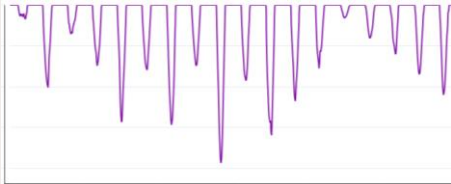
28.6 GWp



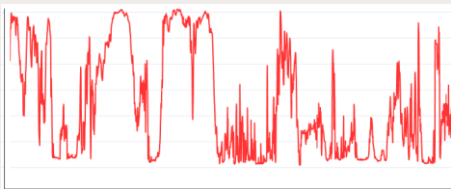
DSO Substation forecasting

Estimating capacities

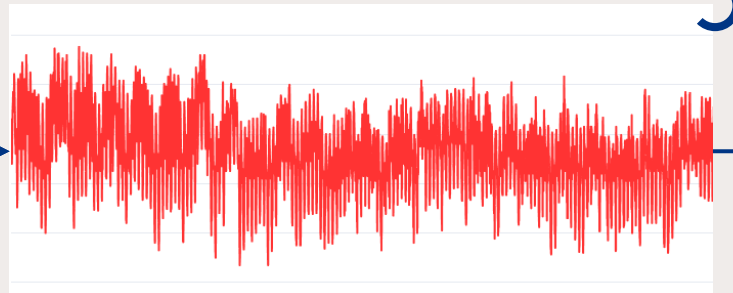
Solar PV profiles ✗



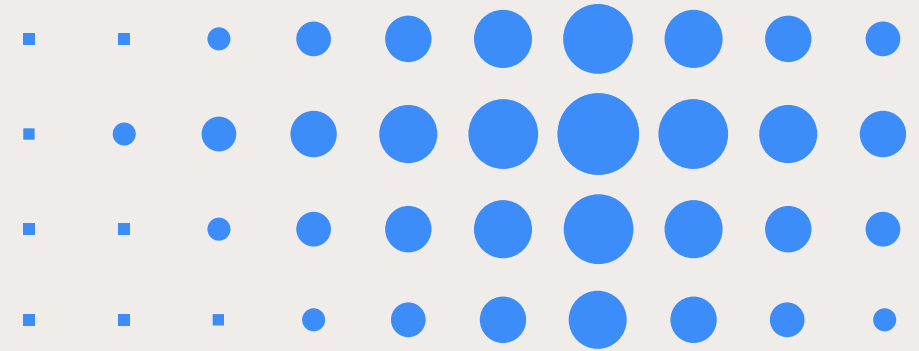
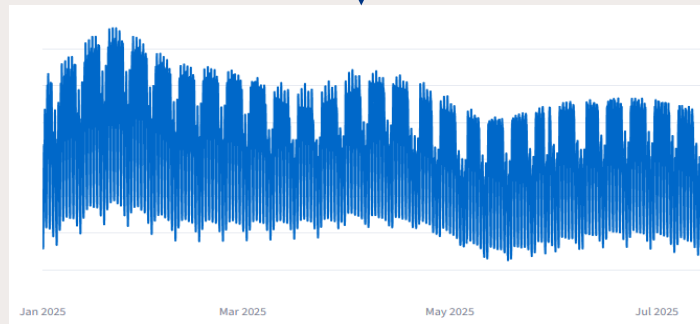
Wind profiles ✓



Gross load



Net load



Installed PV
capacity over
time

+

Installed wind
capacity over
time

Active power
forecast

Time
decomposition
& temperature
sensitivity

Reactive power
forecast

Curtailment of RES

~ 20%

Of solar is curtailed at DA prices below approx. -25 (€/MWh) (2025)

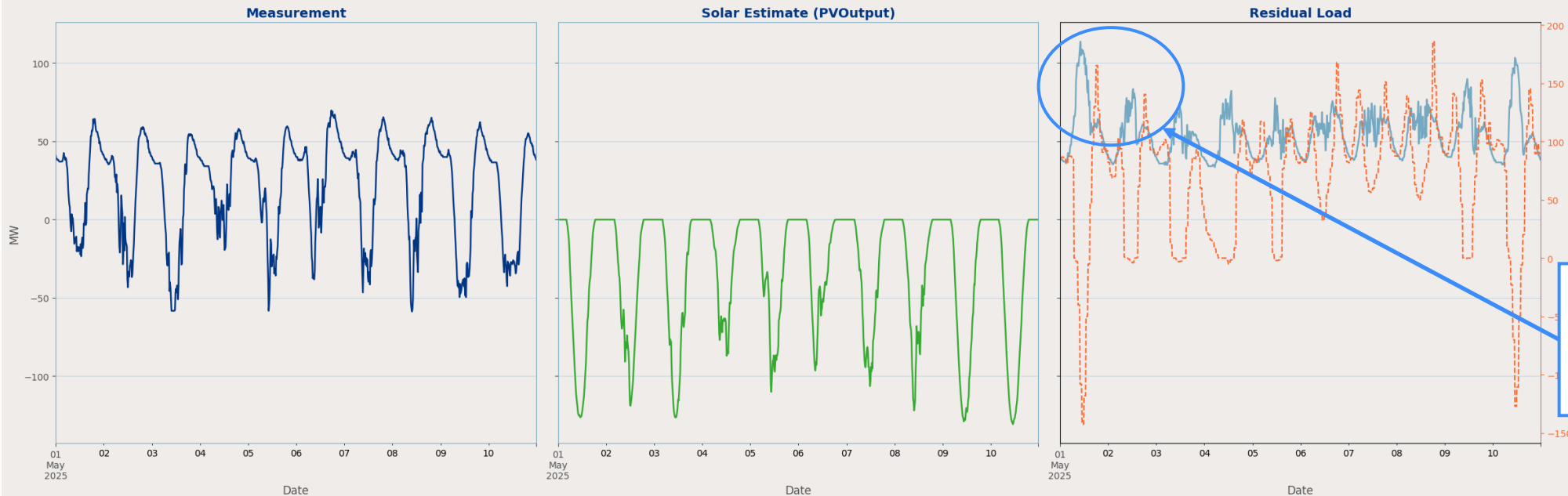
~1GW

Estimate of curtailed PV in 2023

~3.9GW

Estimate of curtailed PV in 2025

EMS vs Solar Estimate vs Residual Load



Large overestimation of solar infeed causes spike in load estimate

New developments

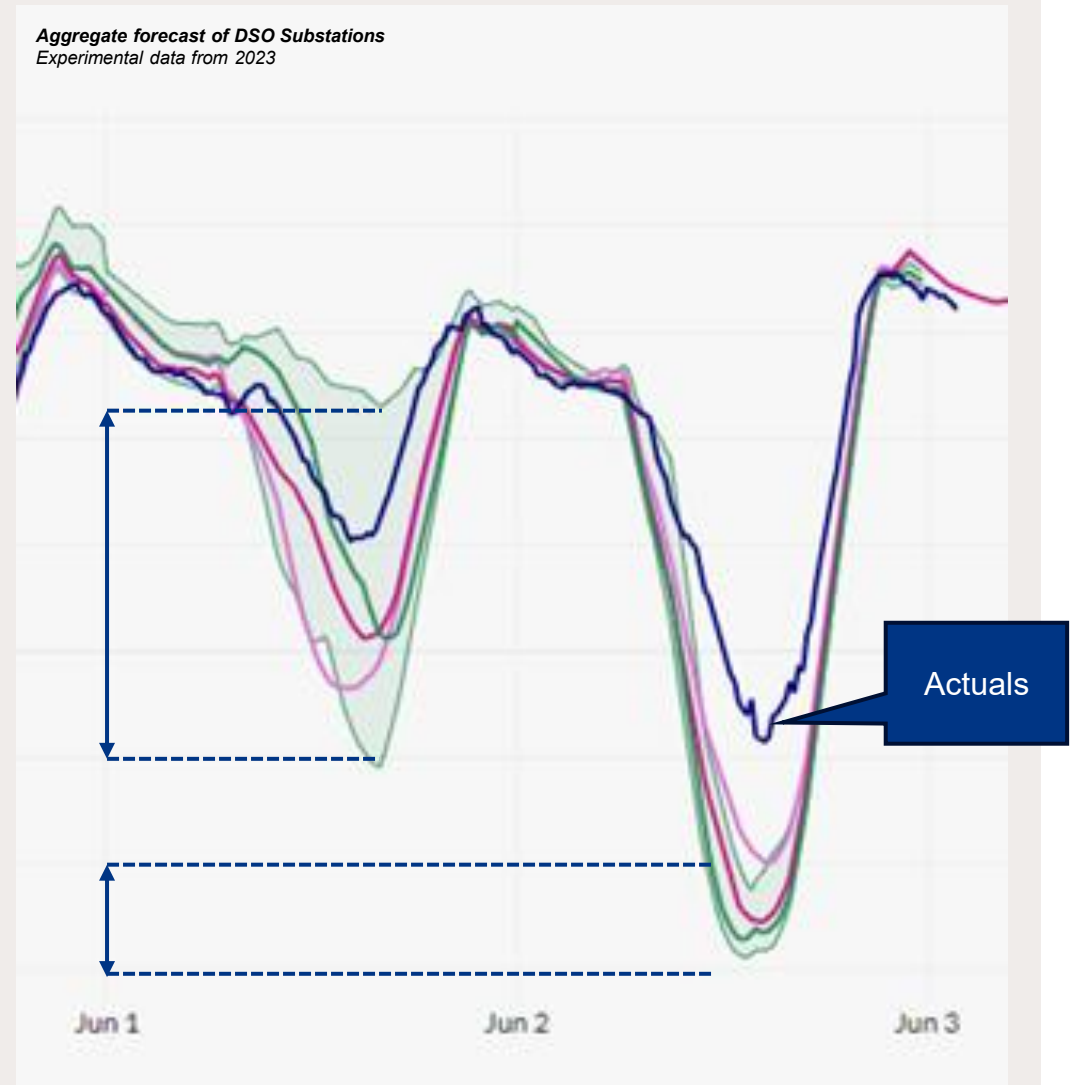
From deterministic to probabilistic forecasting

Global Wind/Solar forecast.

Use EMOS for total solar and wind production in the Netherlands. Important for, for example, balancing needs or security of supply during Dunkelflaute. Which will become a problem in the coming years.

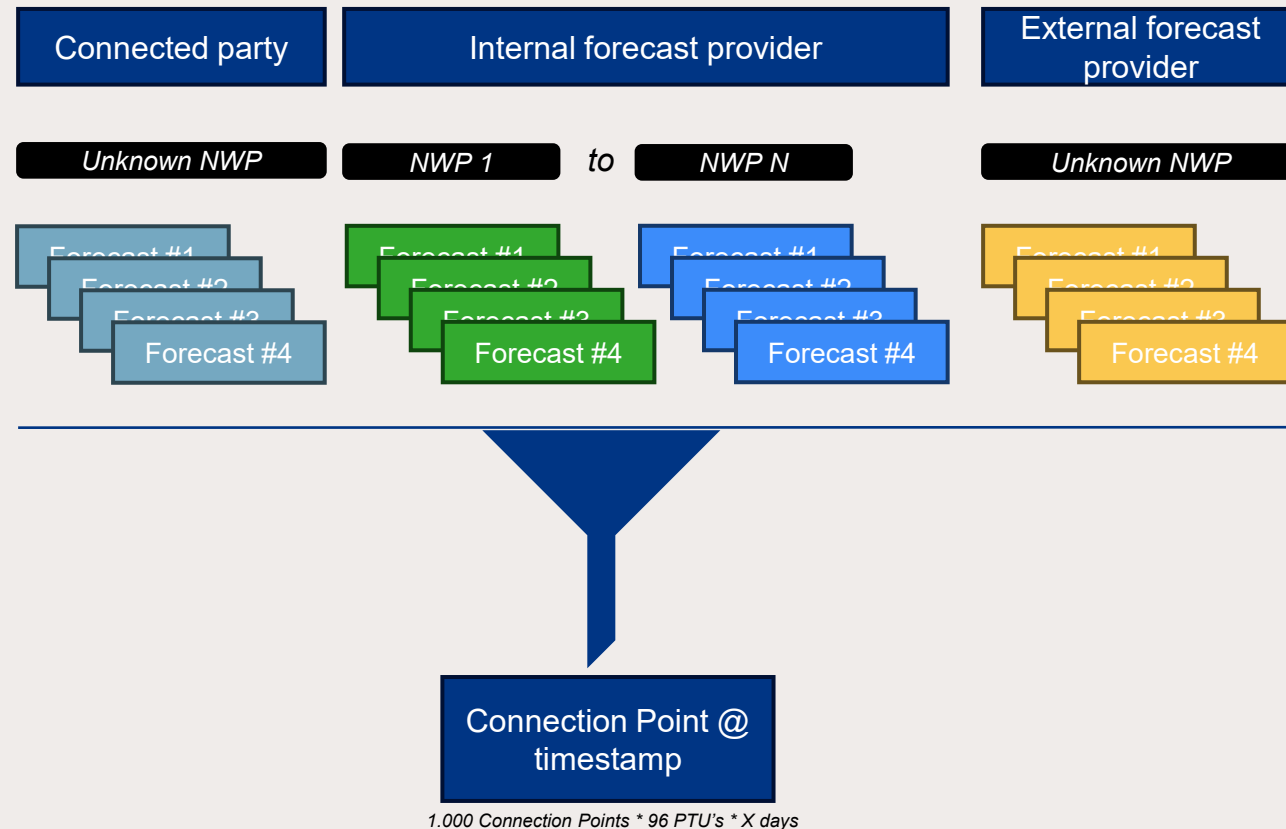
Scenario generation

To understand risks on our grid we need large spatially coherent scenarios that accurately model the strong (anti)correlations between solar/wind/load across all of the Netherlands.

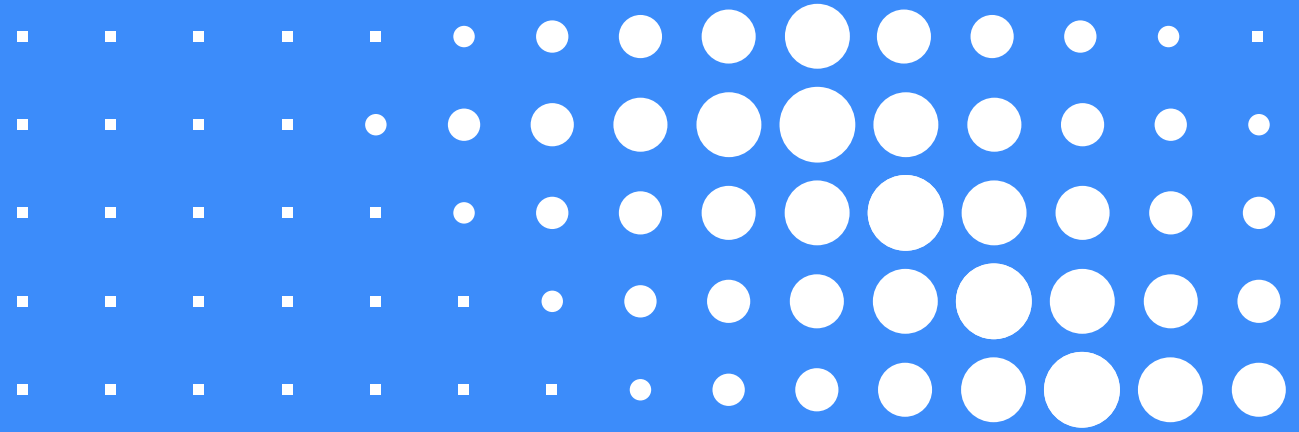


Transport plan developments

Forecast selection improvements

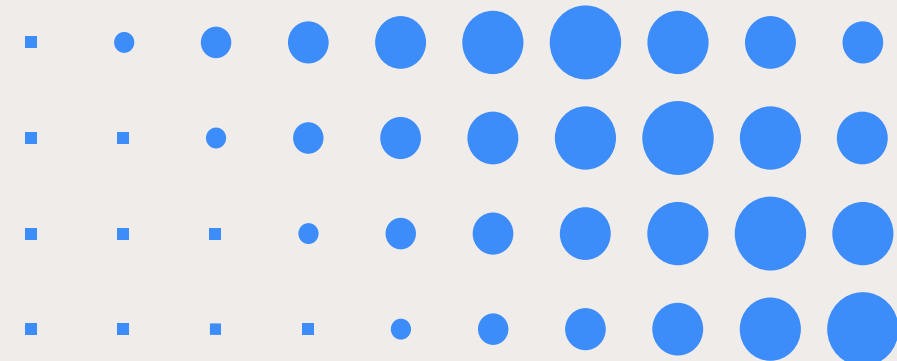


- Condition: 1 provider per connection point & business day (no mixing)
- More NWPs (with longer lead times)
- Currently: manual evaluation and selection
- To be: Optimized & automatic selection?
 - Per lead time?
 - Evaluation criteria?
- Potential reduction in overall forecast error is substantial



Questions? Contact us at:

laurens.stoop@tennet.eu



TenneT is a leading European grid operator. We are committed to providing a secure and reliable supply of electricity 24 hours a day, 365 days a year, while helping to drive the energy transition in our pursuit of a brighter energy future – more sustainable, reliable and affordable than ever before. In our role as the first cross-border Transmission System Operator (TSO) we design, build, maintain and operate 25,000 kilometres of high-voltage electricity grid in the Netherlands and large parts of Germany, and facilitate the European energy market through our 17 interconnectors to neighbouring countries. We are one of the largest investors in national and international onshore and offshore electricity grids, with a turnover of EUR 8.4 billion and a total asset value of EUR 55 billion. Every day our 9,700 employees take ownership, show courage and make and maintain connections to ensure that the supply and demand of electricity is balanced for over 43 million people.

Lighting the way ahead together

Disclaimer

This presentation is offered to you by TenneT TSO B.V. ('TenneT'). The content of the presentation – including all texts, images and audio fragments – is protected by copyright laws. No part of the content of the presentation may be copied, unless TenneT has expressly offered possibilities to do so, and no changes whatsoever may be made to the content. TenneT endeavours to ensure the provision of correct and up-to-date information, but makes no representations regarding correctness, accuracy or completeness.

TenneT declines any and all liability for any (alleged) damage arising from this presentation and for any consequences of activities undertaken on the strength of data or information contained therein.