Taking more: How the grid can integrate variable renewable energy

System Reliability in Renewables-driven Power Systems – Think Tank Workshop

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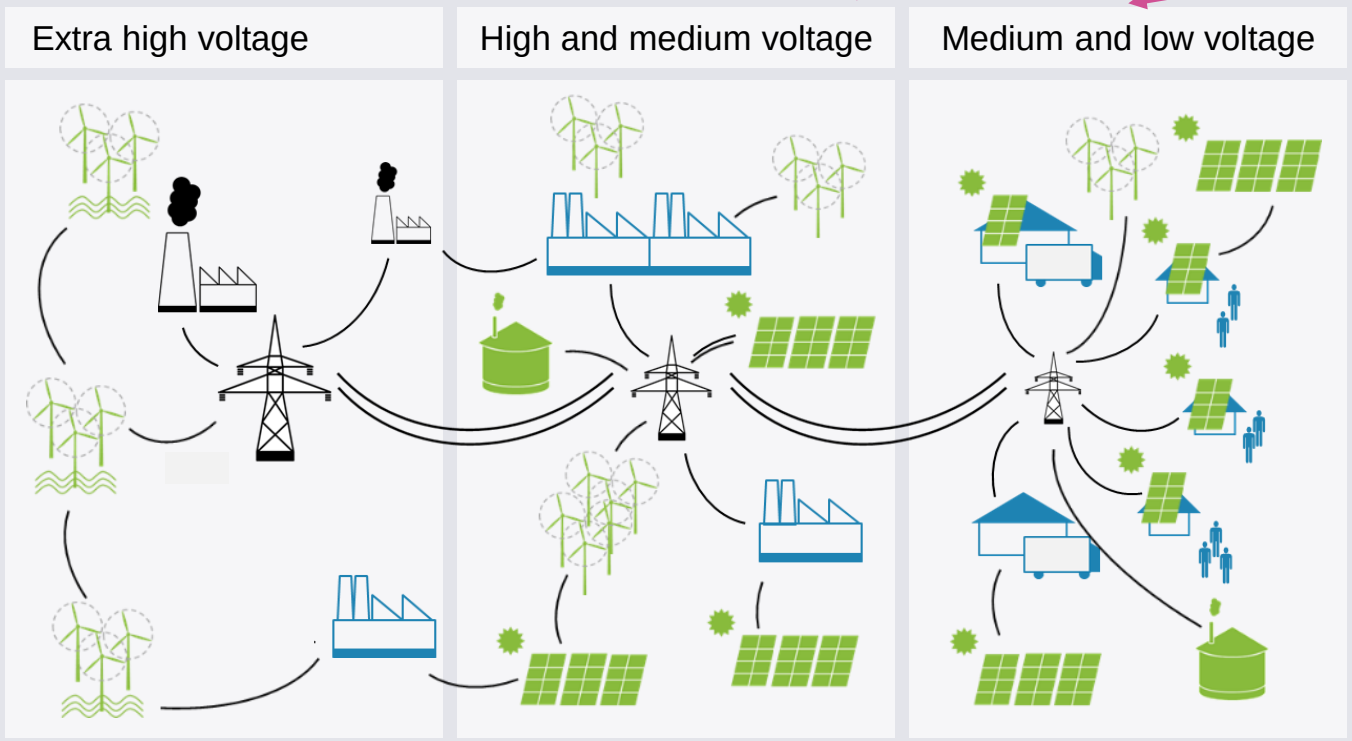
Electricity is increasingly fed into the distribution grid.

Transition from a centralized "top-down" to a more distributed system.

Illustration of the old and the new electricity system

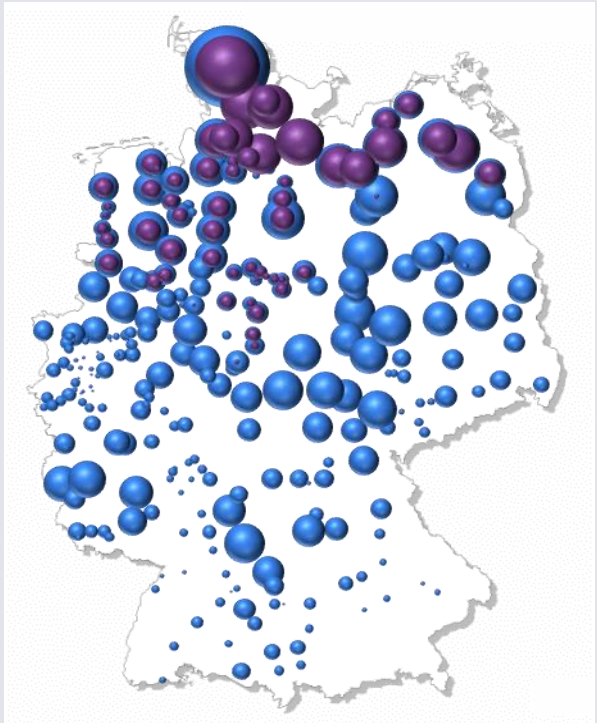


Own illustration

Best resources may not be where demand is.

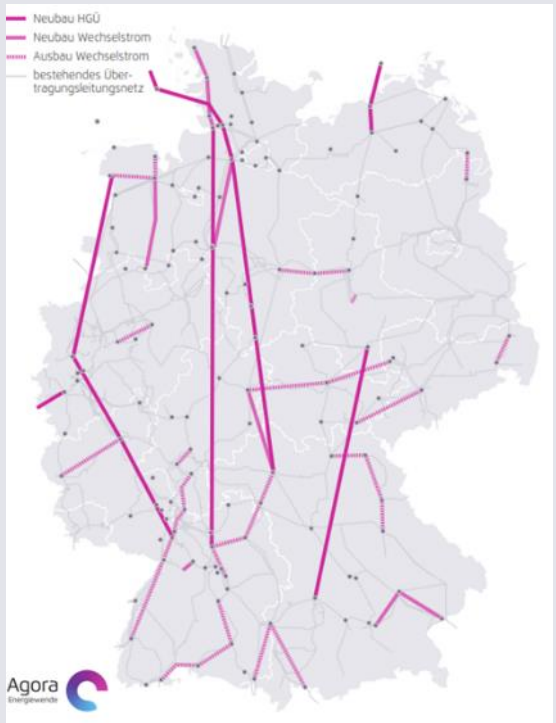
Planning is key to provide sufficient grid capacity!

Planned generation



Fraunhofer IWES (2013)

Planned transmission grid expansion by 2022



Bundesbedarfsplangesetz (2013)

Power generation:

- Less large-scale conventional generation.
- Wind deployment especially in the North.

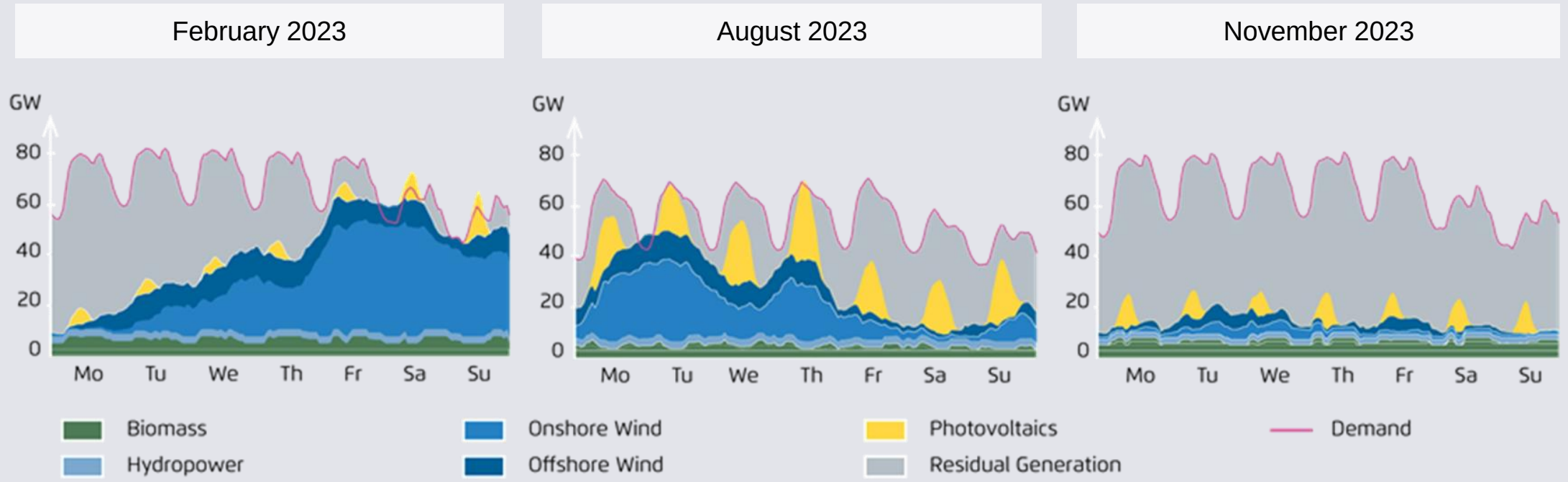
Power consumption:

- Drivers: Population density and distribution of load centers.
- New types of demand: heat pumps, electric vehicles, power-to-heat.

Wind energy and solar PV with high degree of variability

Steeper ramp rates and hours with "excess power" and "too little power".

Electricity generation* and consumption* in three sample weeks, 2023



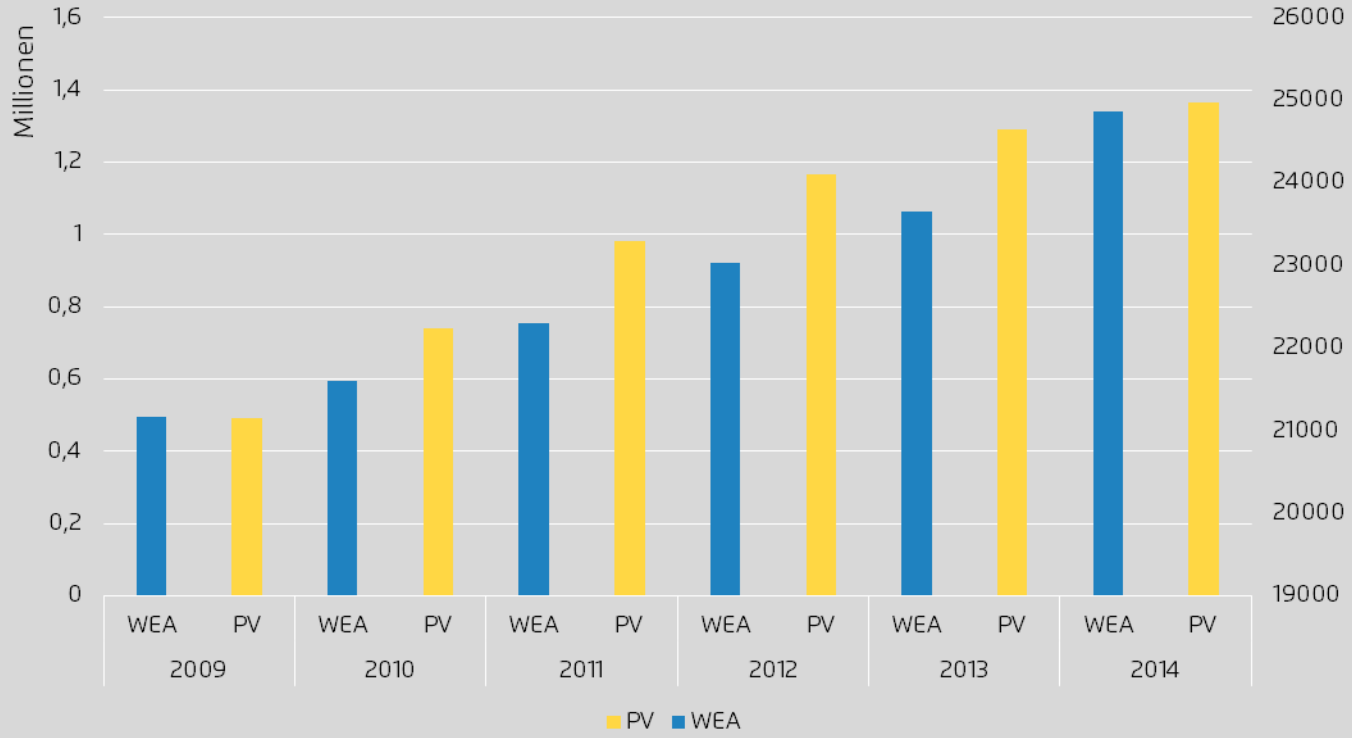
Fraunhofer IWES (2013)

* Modelling based on 2011 weather and load data

Increasing number of actors makes things more complex

Coordination between many producers, consumers and prosumers.

Wind turbines (right axis) and solar PV installations (left axis)

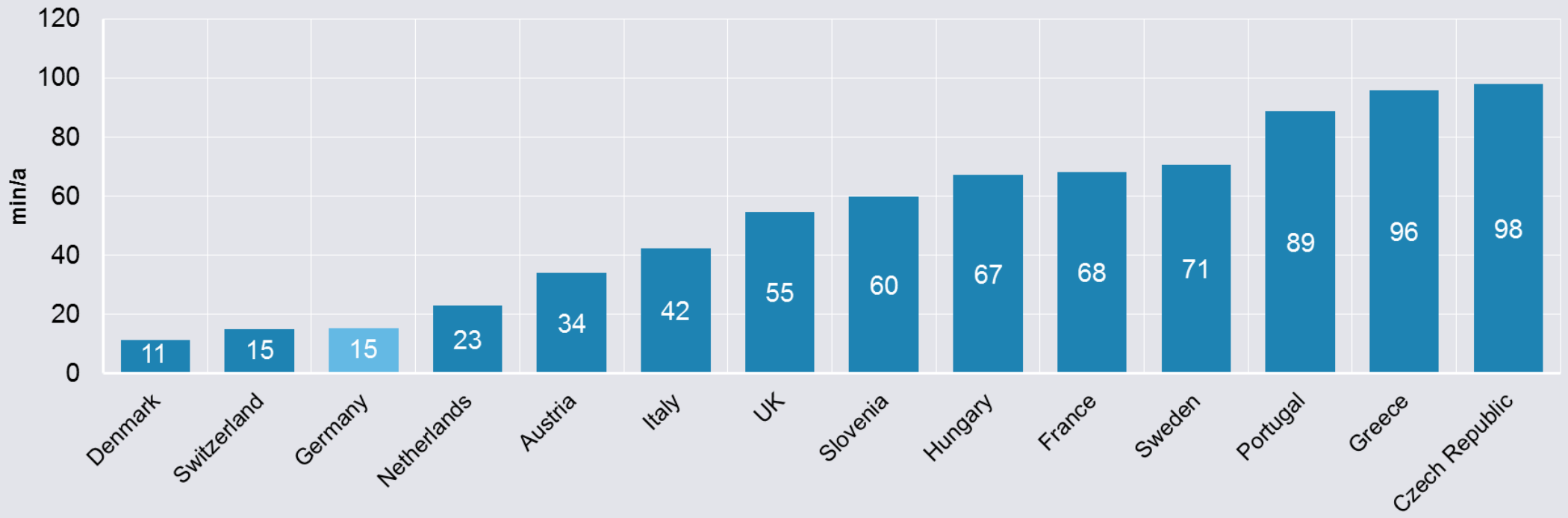


Bundesnetzagentur 2015, BWE 2015

- → Generation: Tremendous increase in number of generators
- → Grid planning and operation: TSOs and DSOs
- → Demand: new demand e.g. by electric vehicles and for heating / cooling

Despite all these changes, power systems expected to provide the same level of reliability!

System Average Interruption Duration Index (SAIDI)* in Europe 2013



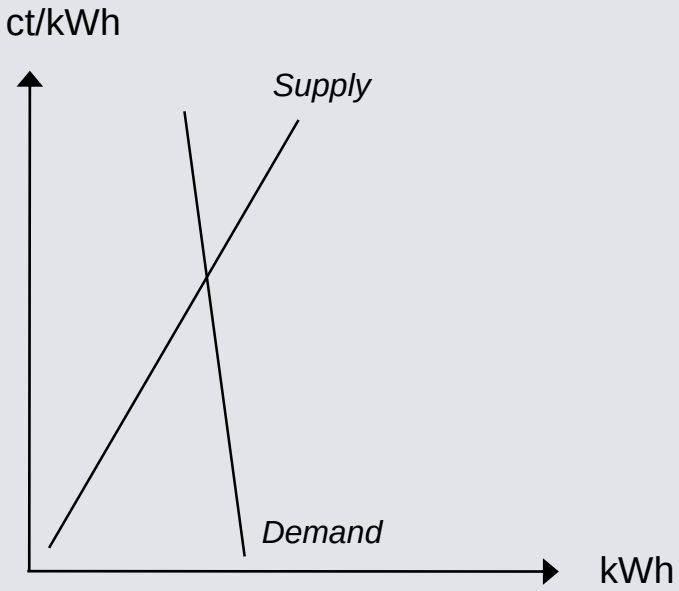
CEER (2015)

* without exceptional events

How do we get there?
Grid planning and grid operation adaptations are key!

The power market (“financial“) and actual operation of the grid (“physical“)

Power market: “copper plate“



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Grid operation

- Insufficient distribution and transmission capacity: Local congestions may occur.
- Avoid exceeding **current**, **frequency**, **voltage** limits
- Secure **ancillary services** in order to ensure grid stability and reliability.

Own illustration

Grid planning

- If there are delays in grid expansion (e.g., in regions with high RES-E deployment), grid bottlenecks may occur.

Grid operation

- In case of congestion grid operators may have to curtail generation to ensure system stability.

→ Find optimum betweeen “classical“ grid expansion and utilisation of intelligent network technologies + flexibility options.