NSON-DK

WP4: System Adequacy

Wind Europe Offshore 2019 - side event
November 28th, 2017

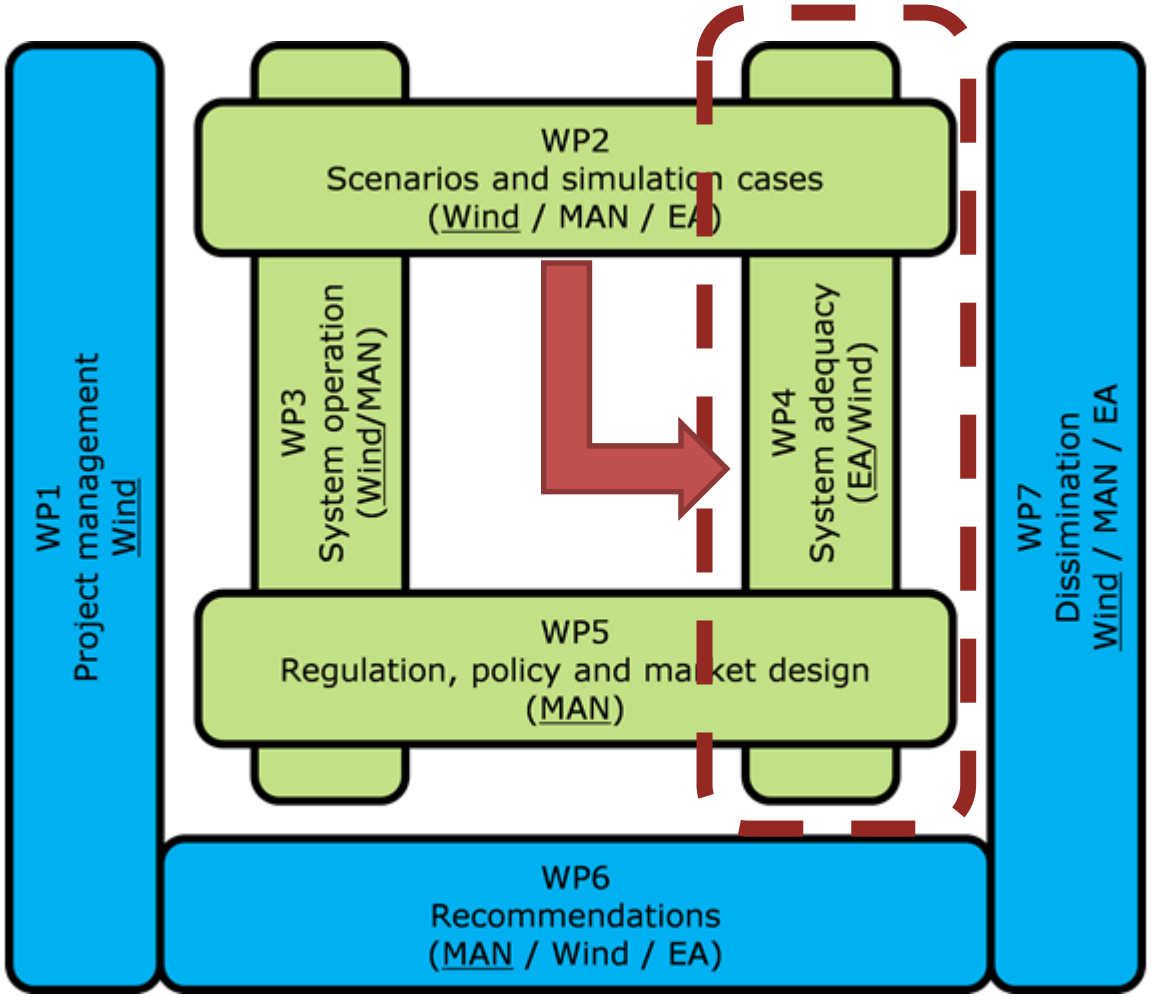
Lars Møllenbach Bregnbæk

Ea Energy Analyses

Ea Energianalyse

Work package objective

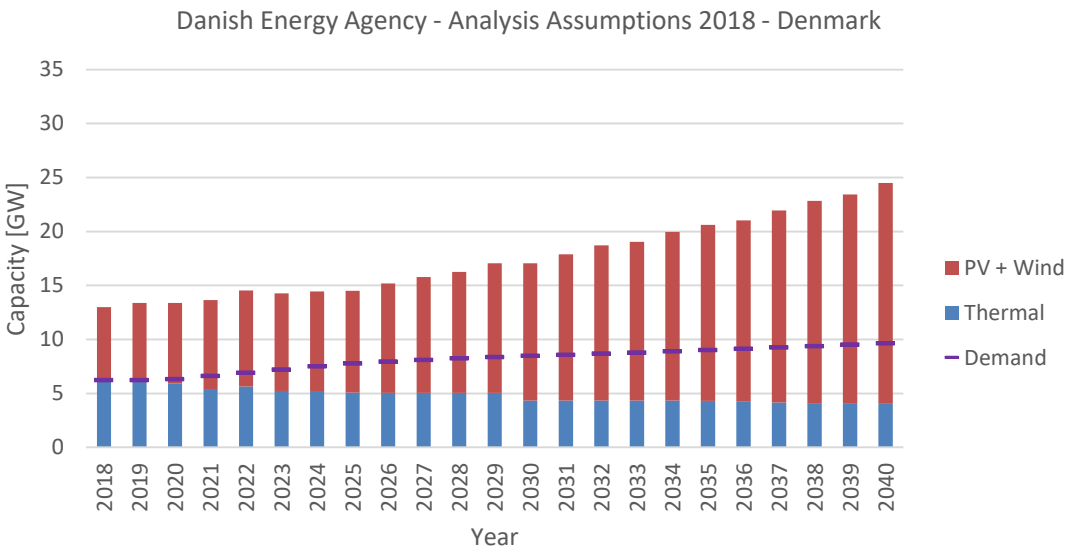
- Assess impact of offshore scenarios on adequacy
- Assessment performed on the two NSON-DK scenarios
- 2020, 2030, 2050
- Denmark in including neighbouring countries



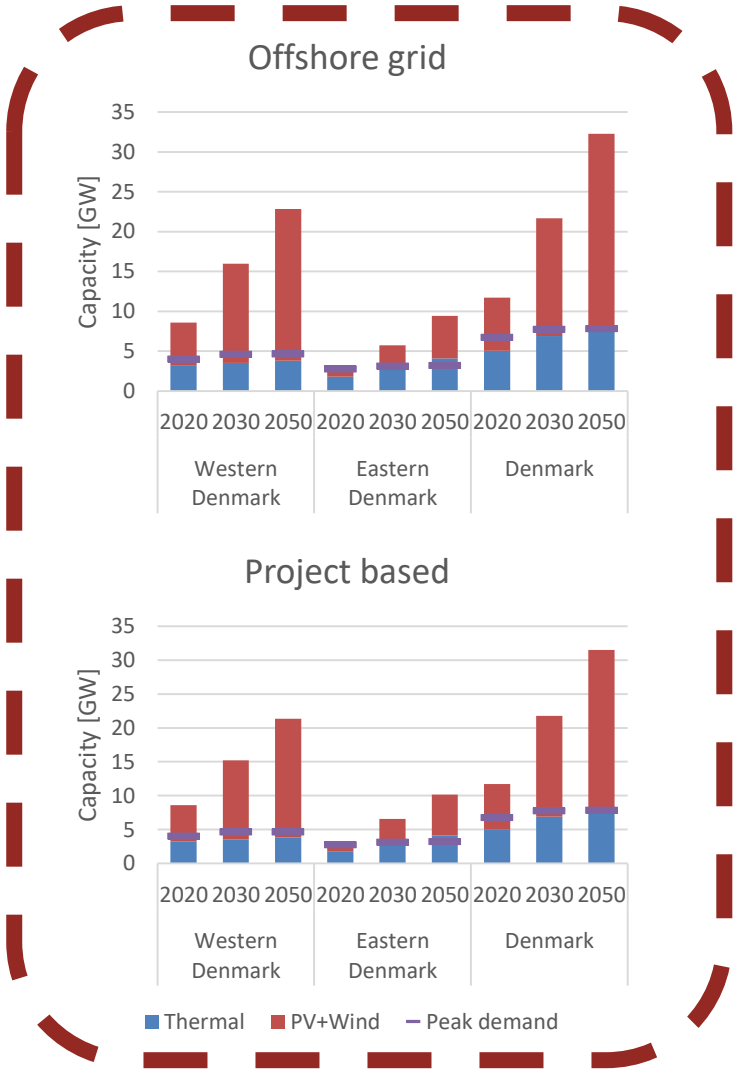
Ea Energianalyse

Two scenarios: Common characteristics

- Large increase in Wind + PV
- Low increase in demand
- Increase in thermal capacity towards 2050
- Large investments in VRE-technologies

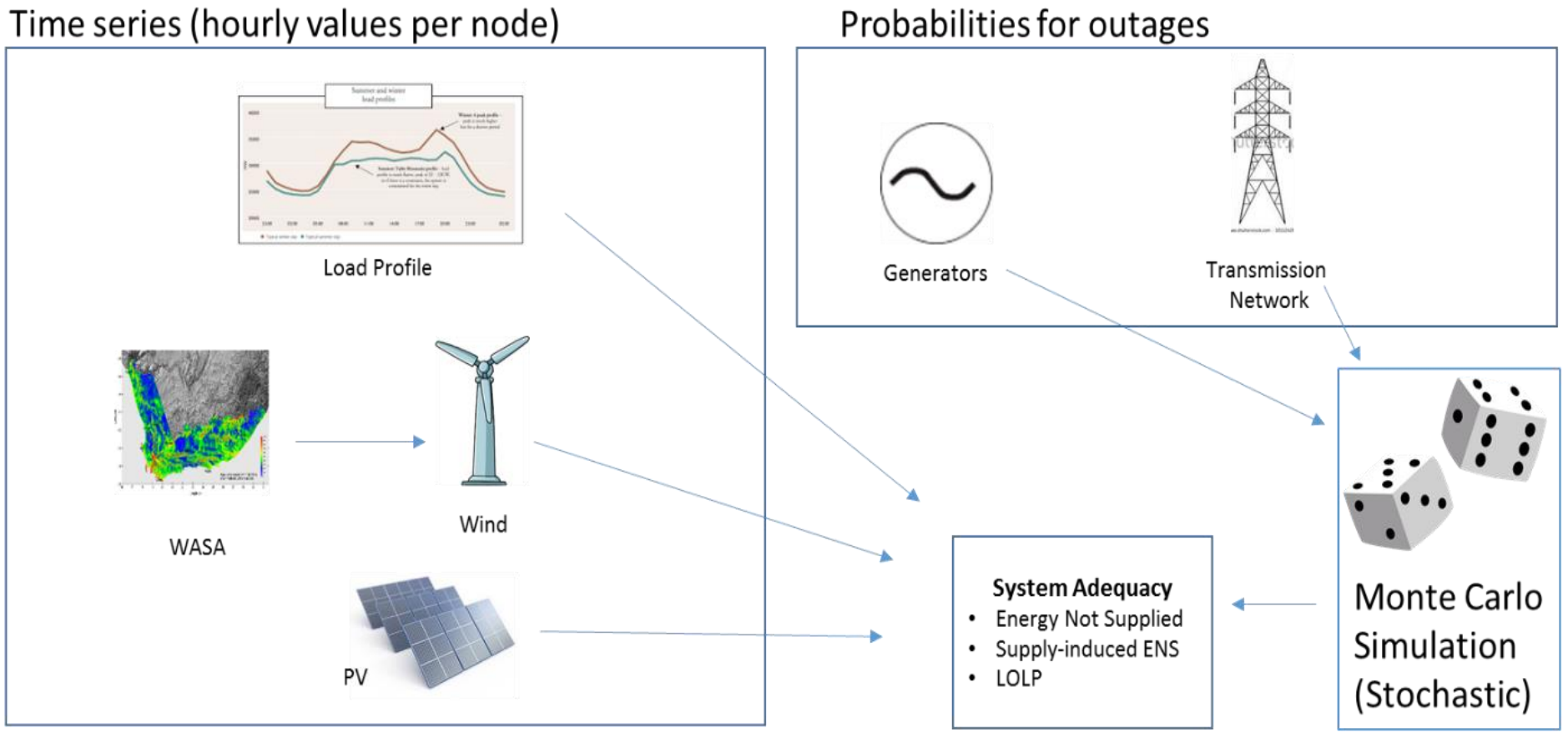


NSON Scenarios



Ea Energianalyse

SISYFOS-R: Assesment of power supply adequacy

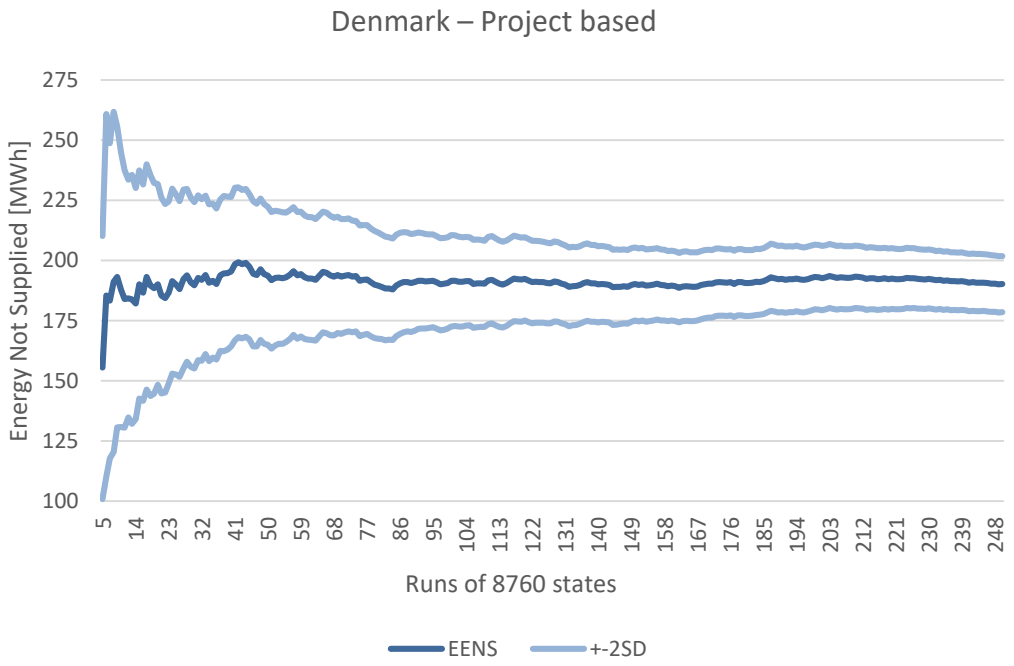


Initially developed by Danish Energy Agency
Now joint development in DEA and Ea

Ea Energianalyse

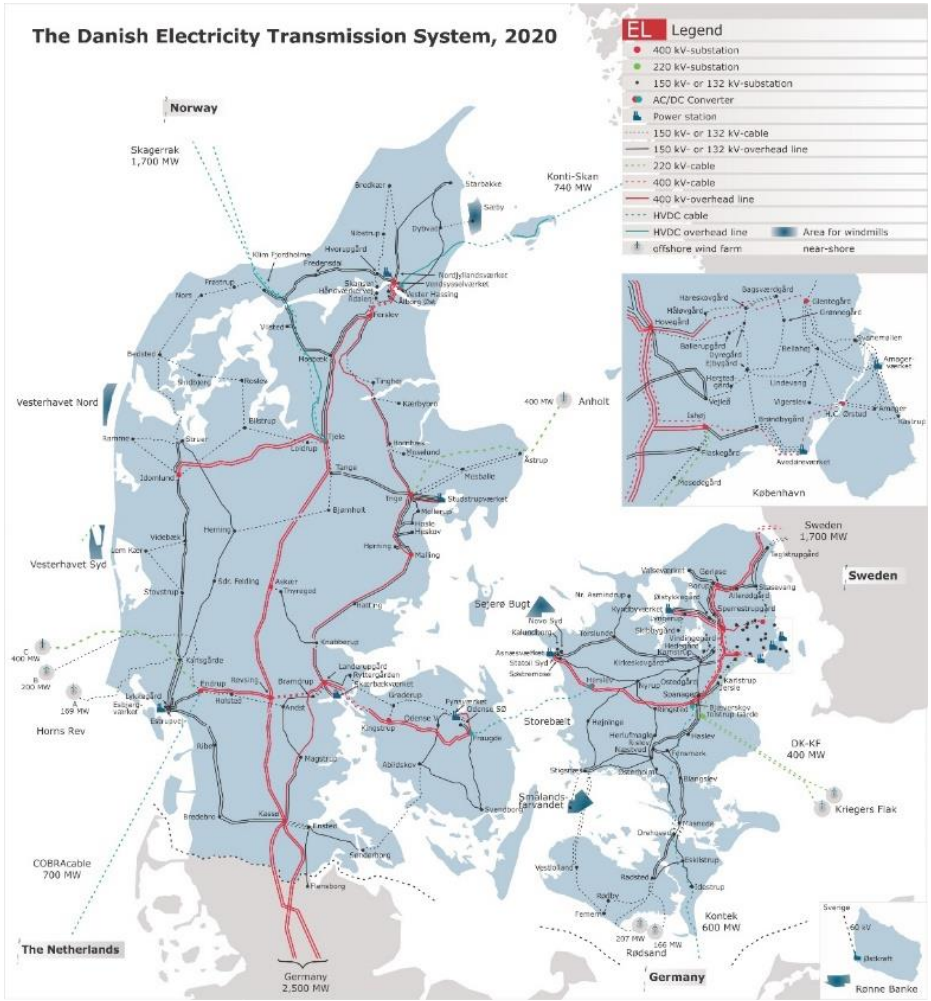
Power System Adequacy Assessment

- Monte Carlo simulations
  - Testing situations with many potential simultaneous outages (different from e.g. N-1)
  - Probability of outages weighted in results
- Per scenario: 2.2 million independent system states simulated
  - Corresponding 250 years

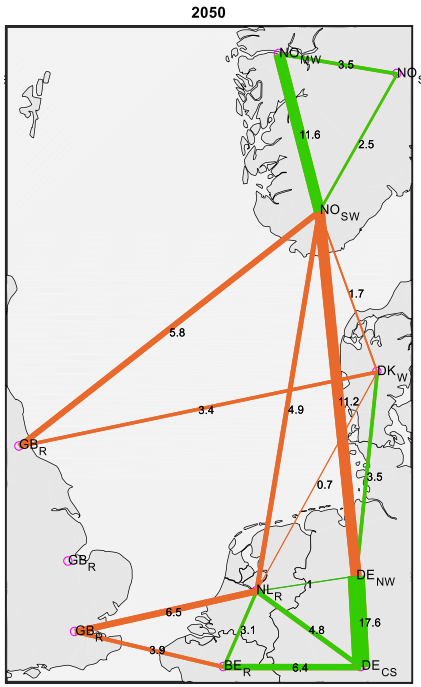


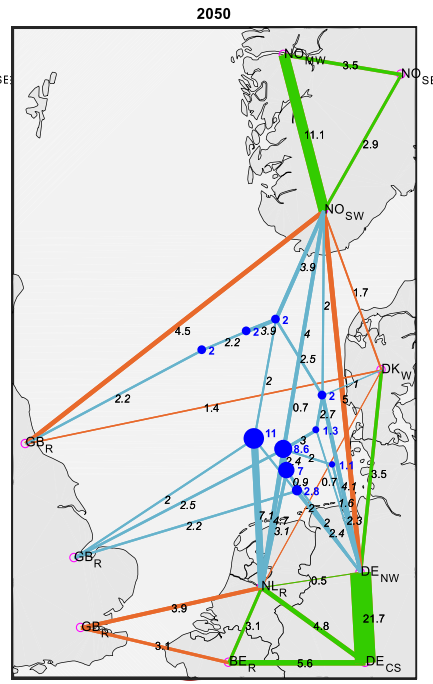
Ea Energianalyse

Focus the Danish grid



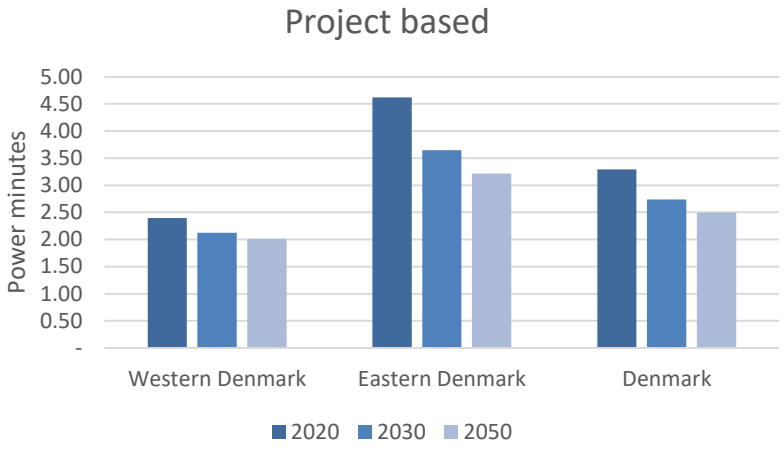
- 100+ kV transmission grid
- Import and export lines included
- Broader region included
  - Baltics, Scandinavia, Northern Continental Europe, Great Britain
- 'Copperplate' assumption with non-DK price regions

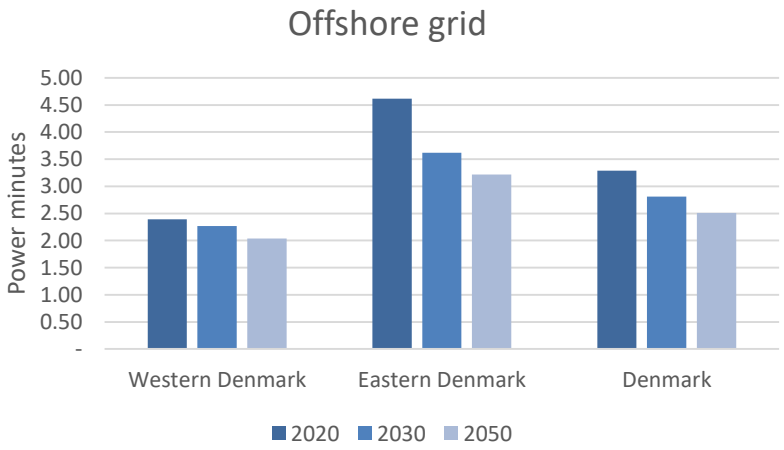




Key results

- Danish power- and grid adequacy not impacted by the introduction of an offshore grid
- Power system adequacy improves toward 2050 due to decentralizing installed power capacity
- Low amounts of unserved energy was found when simulating the two scenarios developed in work package 2

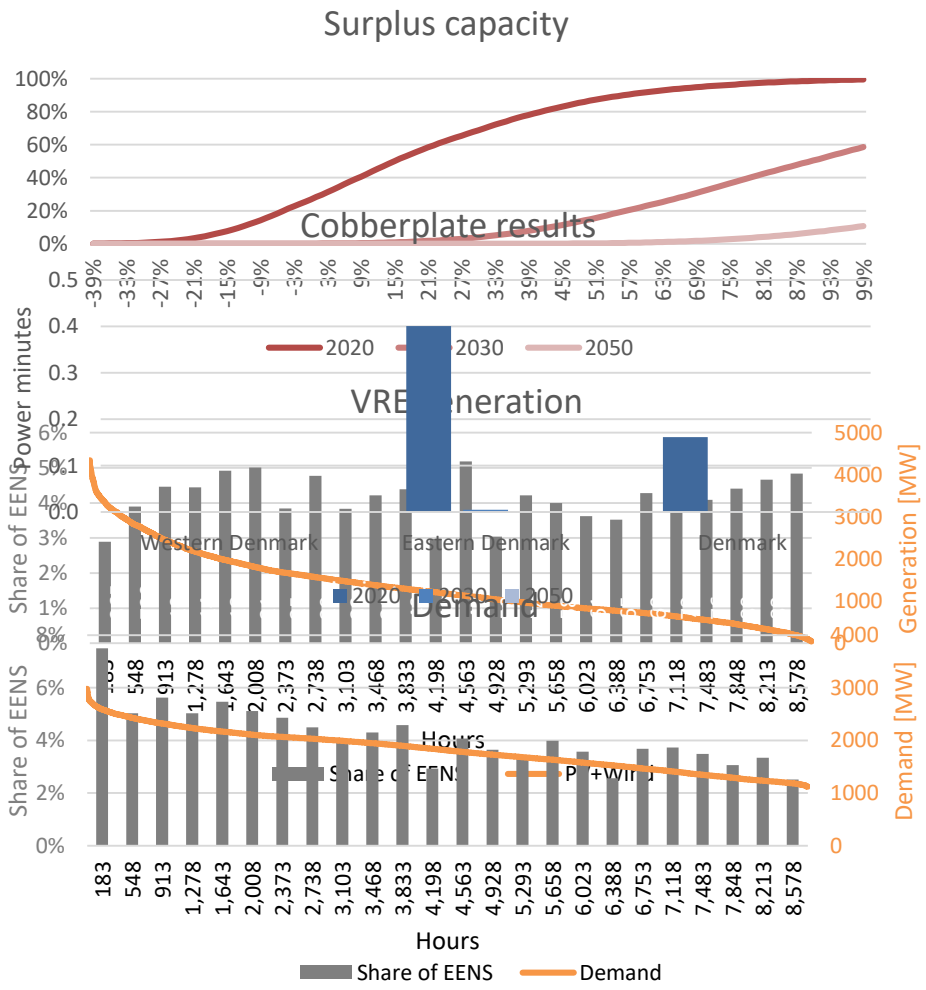




Ea Energianalyse

Additional results and findings

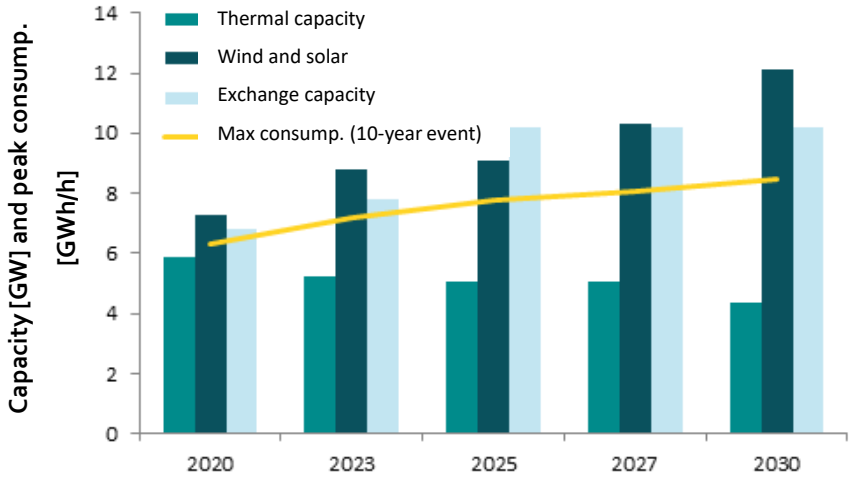
- Assumptions for shown results:
  - Eastern Denmark, Project based, 2050
- Danish regions show large amounts of power available for export
- Internal grid in Denmark is responsible for most outages
- Sufficient capacity to adequately cover demand in hours with low VRE generation
- Energy Not Supplied increases in hours with high demand

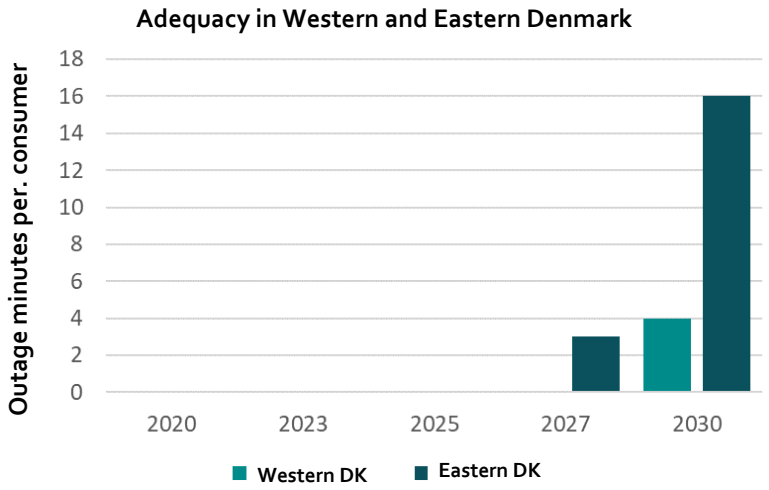


Ea Energianalyse

Comparison with similar analyses

- Simulation results and conclusions depend on your inputs
- Thermal capacity to Peak demand ratio
  - NSON scenarios – increasing
  - Energinet.dk calculations – decreasing
- Opposite observations regarding adequacy, as expected





- Energinet.dk
  Report on Danish security of electricity supply 2019 (in consultation)

Ea Energianalyse

Conclusions on system adequacy 2020-50 (1)

- A massive wind power development in the countries around the North Sea was not found to compromise the Danish system adequacy
- Danish power system adequacy is not impacted by the introduction of an offshore grid.
- Denmark's adequacy indicators improves from about 3.5 to 2.5 "power outage minutes" in both scenarios from 2020-2050.
- The Danish generation capacity in the scenarios is about 5 GW higher in 2030 compared to the Danish Energy Agency's analysis assumptions.

Conclusions on system adequacy 2020-50 (2)

- Capacity is sufficient to fulfill demand during low PV and wind generation.
- Higher demand results in worse energy not served events.
- Most adequacy deficit events on system level occur when system generation capacity is abundant, but power cannot be transmitted to areas with deficit. Unavailable transmission capacity is thus the cause of the unserved energy in scenarios.
- Eastern and Western Denmark simulated as interconnected copper plates show ten times fewer outage minutes in the project-based scenario in 2020 and practically zero in 2030 and 2050.