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Assessing the economic impacts for outages of HVDC-cables connecting the Nordic area and continental Europe

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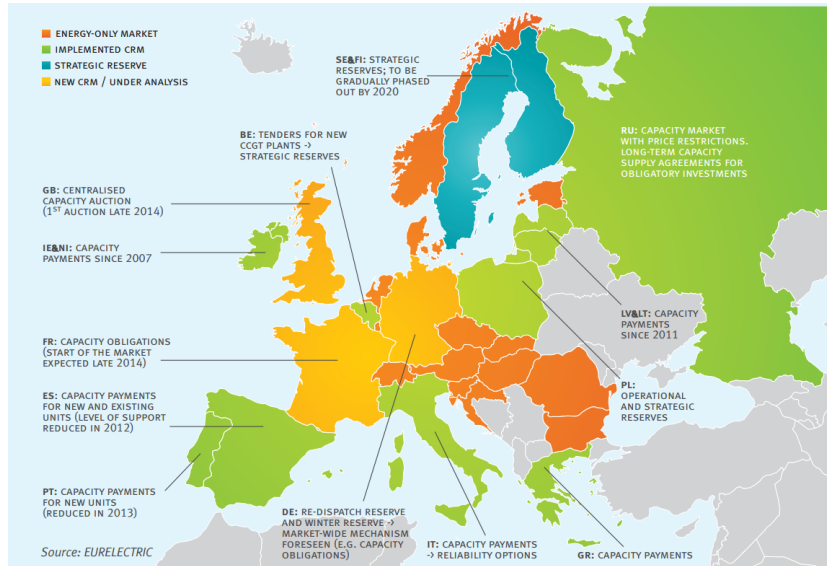
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13th INTERNATIONAL CONFERENCE ON THE
EUROPEAN ENERGY MARKET
Porto, 6-9 June 2016 | Portugal

Outline



Status quo in Northern Europe

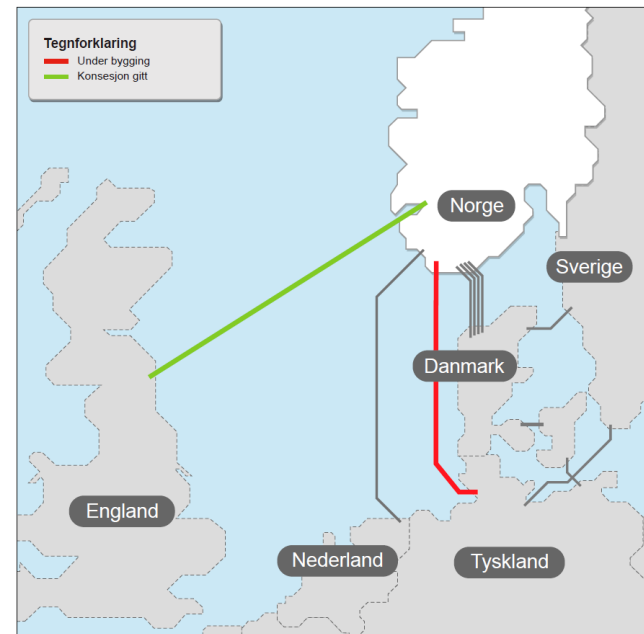


Implementation of CRM in Europe, as of June 2014.

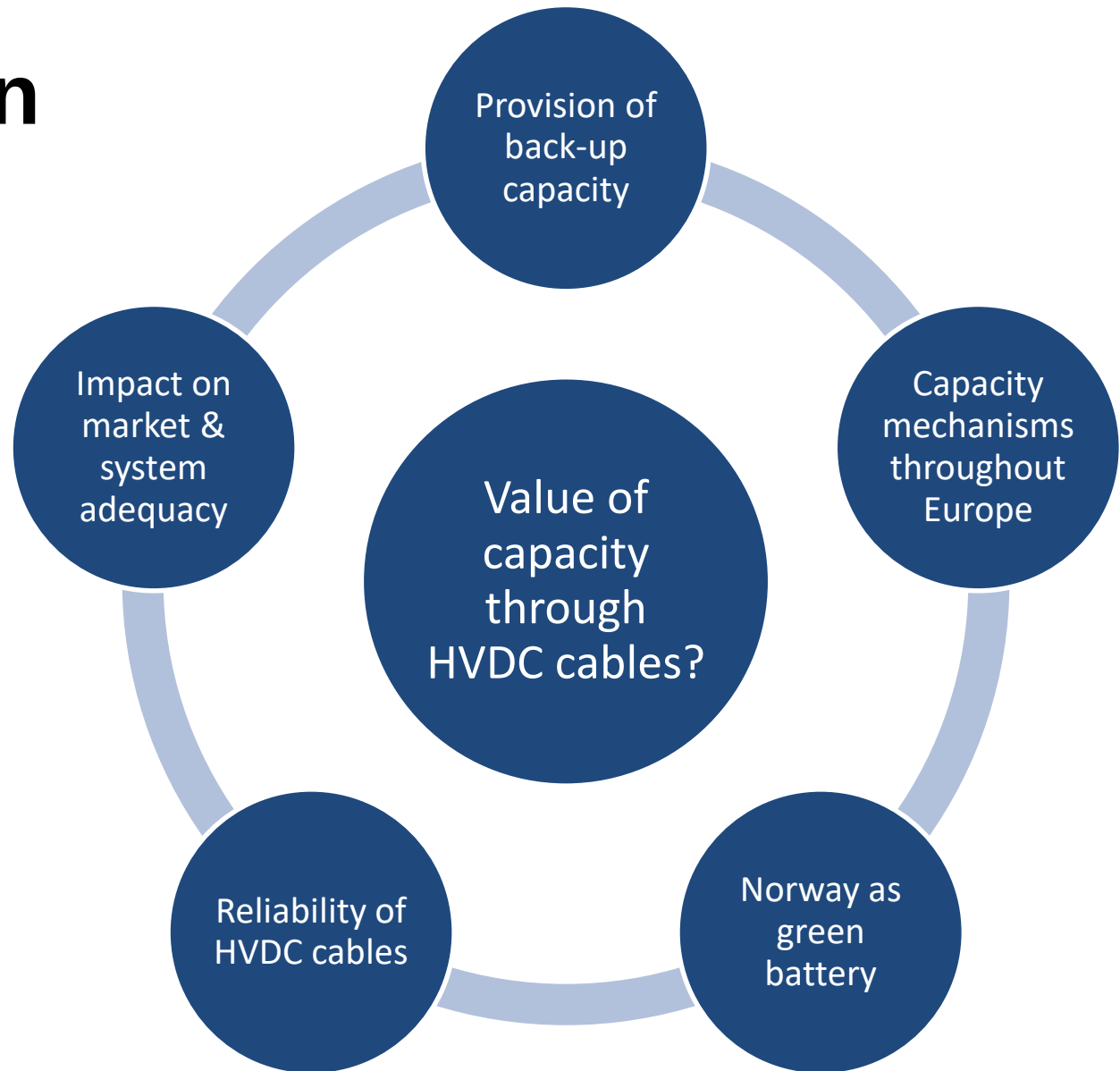
Source: Eurelectric, "Renewable energy and security of supply: Finding market solutions.", 2014

New cables to Germany and the UK.

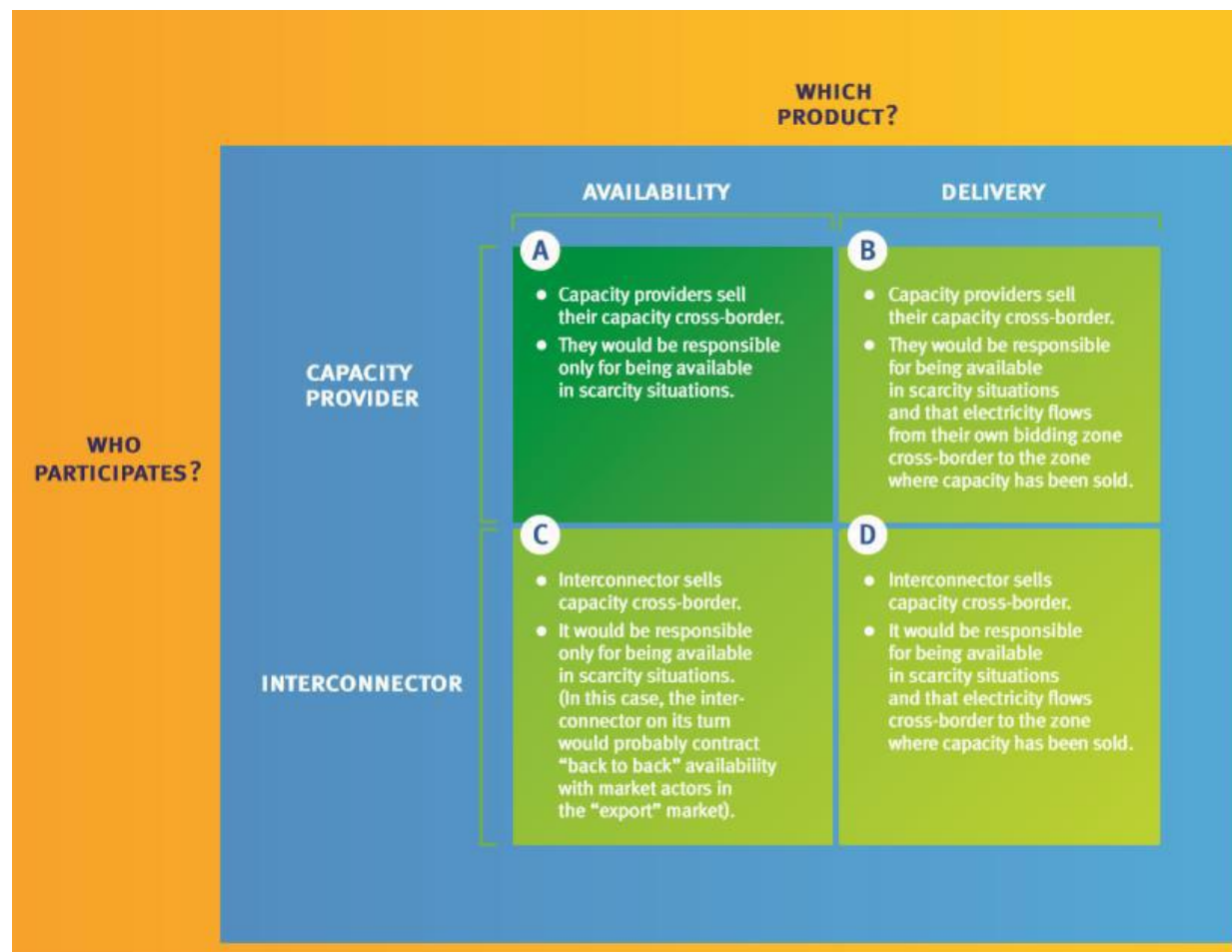
Source: Statnett, "Grid development plan 2015", April, 2015



Motivation

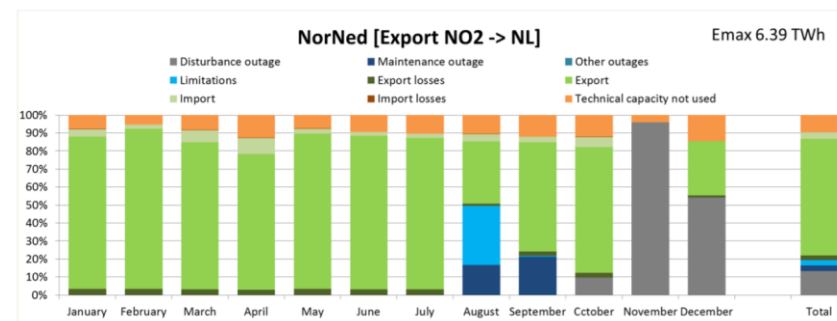
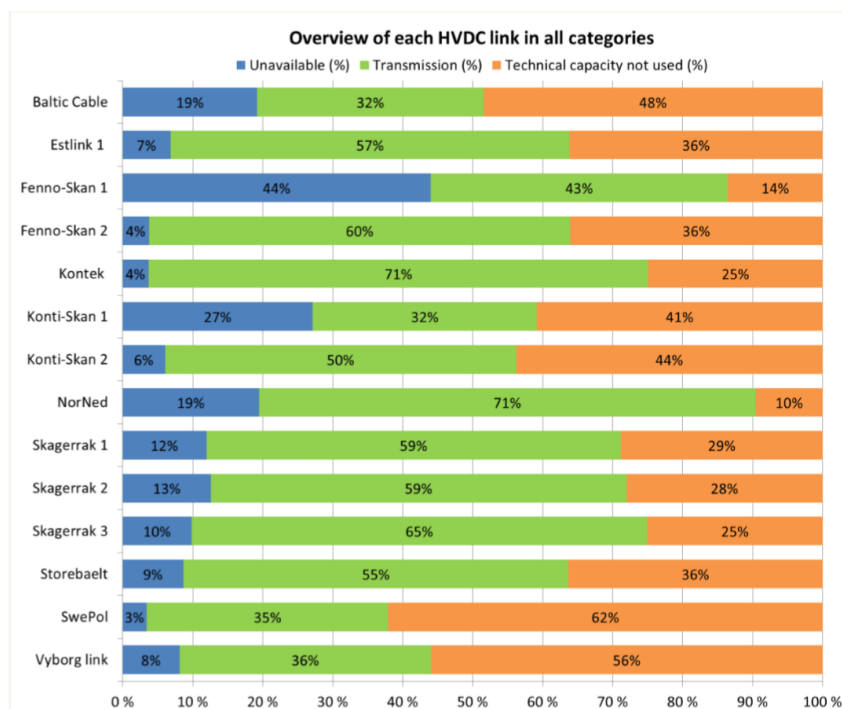


Options for cross-border participation



Source: Eurelectric, "Renewable energy and security of supply: Finding market solutions.", 2014

Statistics Nordic HVDC cables



Unavailable exchange capacity (E_U) on average 12%

Average E_U due to disturbance 4.7%

Highest E_U due to disturbance 25% ~ 13 weeks

NorNed cable E_U 19%, mostly due to disturbance outages

=> 3 disturbance cases: 4.7%, 12%, 25%

NorNed used as benchmark cable

Source: ENTSO-E Regional Nordic Group, "Nordic HVDC utilization and unavailability statistics 2013.", 2014

The power system model

75 climatic years
(wind, solar, inflow, temperature)

2 hours resolution

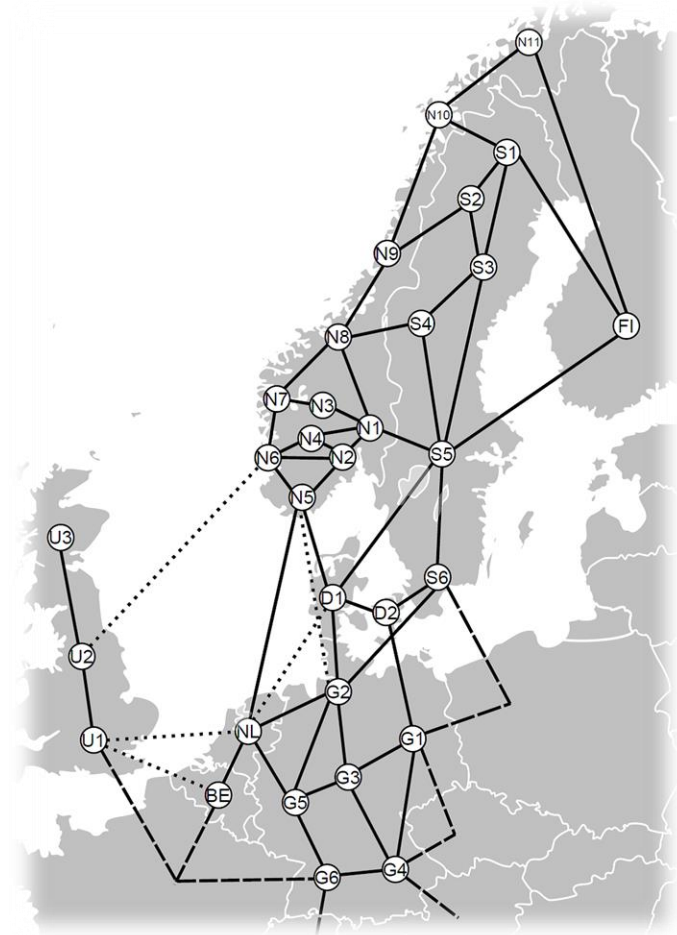
52 areas

about 1500 power plants

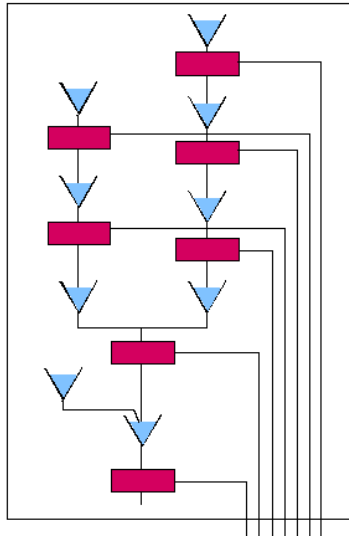
80 transmission corridors

Stochastic optimisation

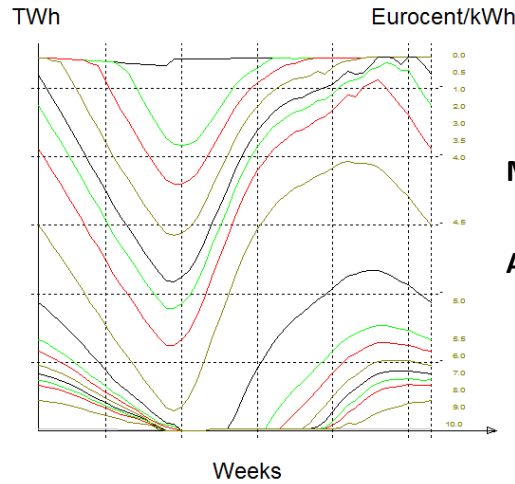
Unit commitment and dispatch



Details for hydropower



Water-value calculation (SDP)



Aggregation

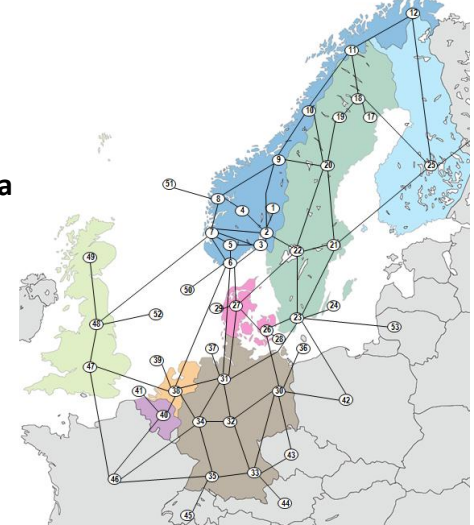
Detailed simulation

Water values

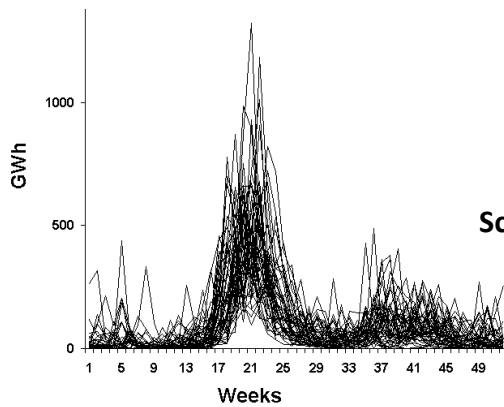
Market data

Allocation

Market description



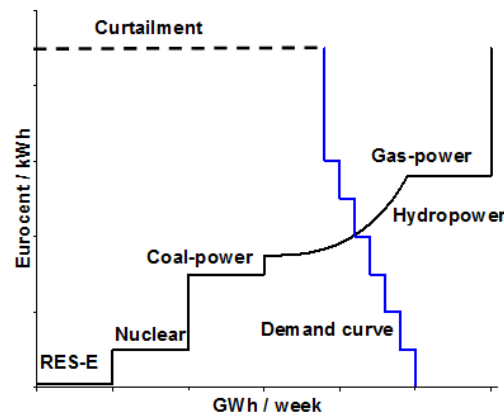
Stochastic weather



Probabilities

Scenarios

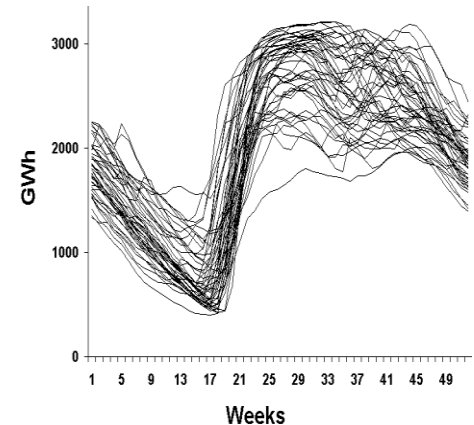
Market simulation (LP)



Market data

Solutions

Results



Case study

Study object

Analysis of outages for the Nord.Link HVDC cable

- Connecting Norway and Germany
- Planned to be commenced in 2020
- 1.4 GW installed transmission capacity
- Assumed to have same characteristics as the existing NorNed HVDC cable

Case study

Assumptions

Outages with different duration: 1 week to 13 weeks

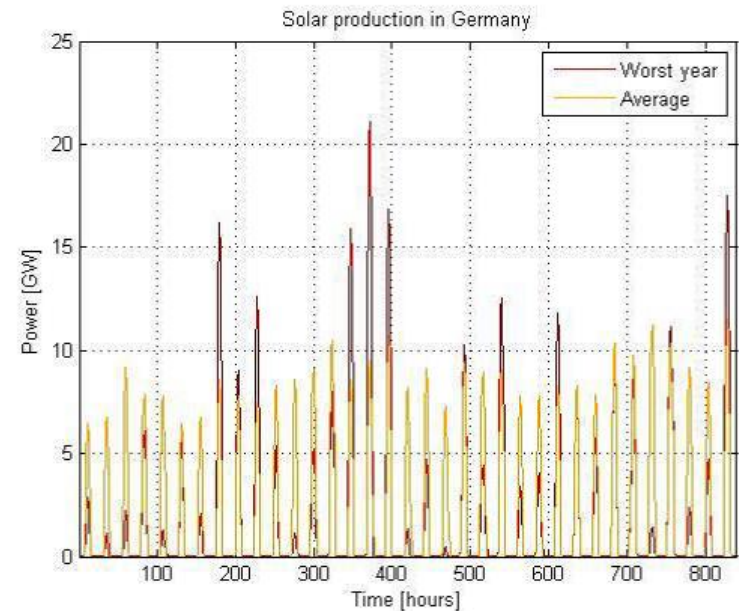
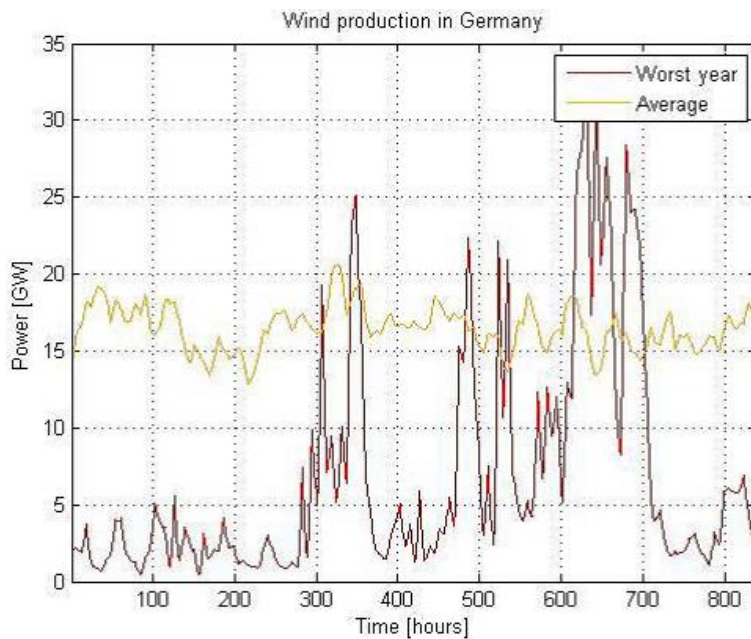
Always assumed to occur at the begin of the year (highest probability of generation capacity shortage)

Only one outage assumed during the year

Comparison of transmission outage with equivalent outage of thermal production capacity

Economic analysis of energy-only market vs. Capacity remuneration mechanism

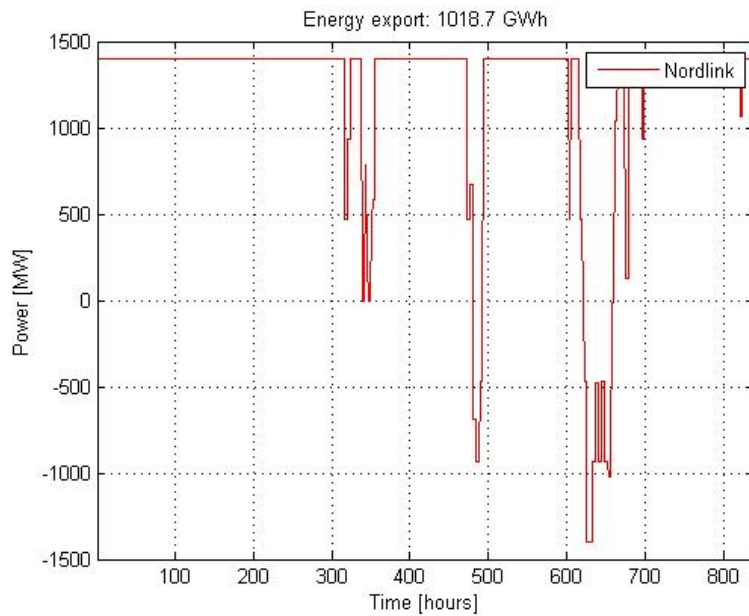
Differences in climatic years



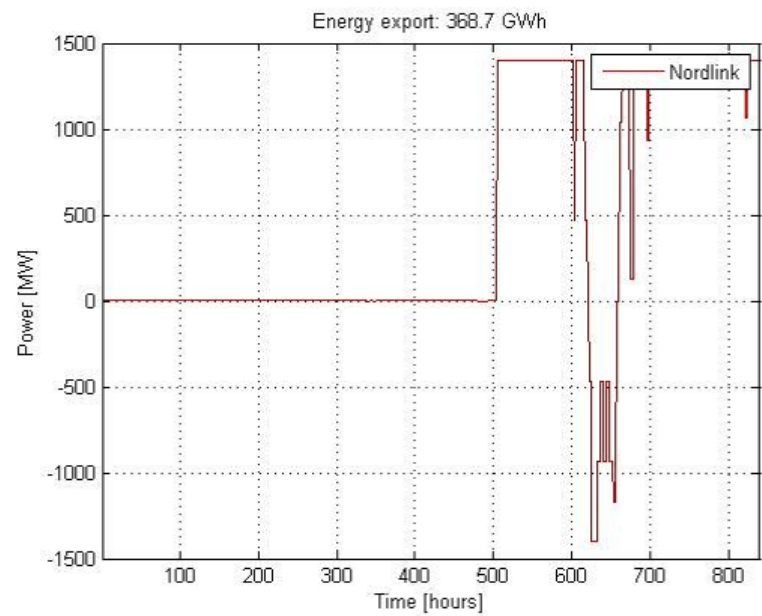
Impact on the exchange

Across Nord.Link – 3 weeks outage

NO OUTAGE

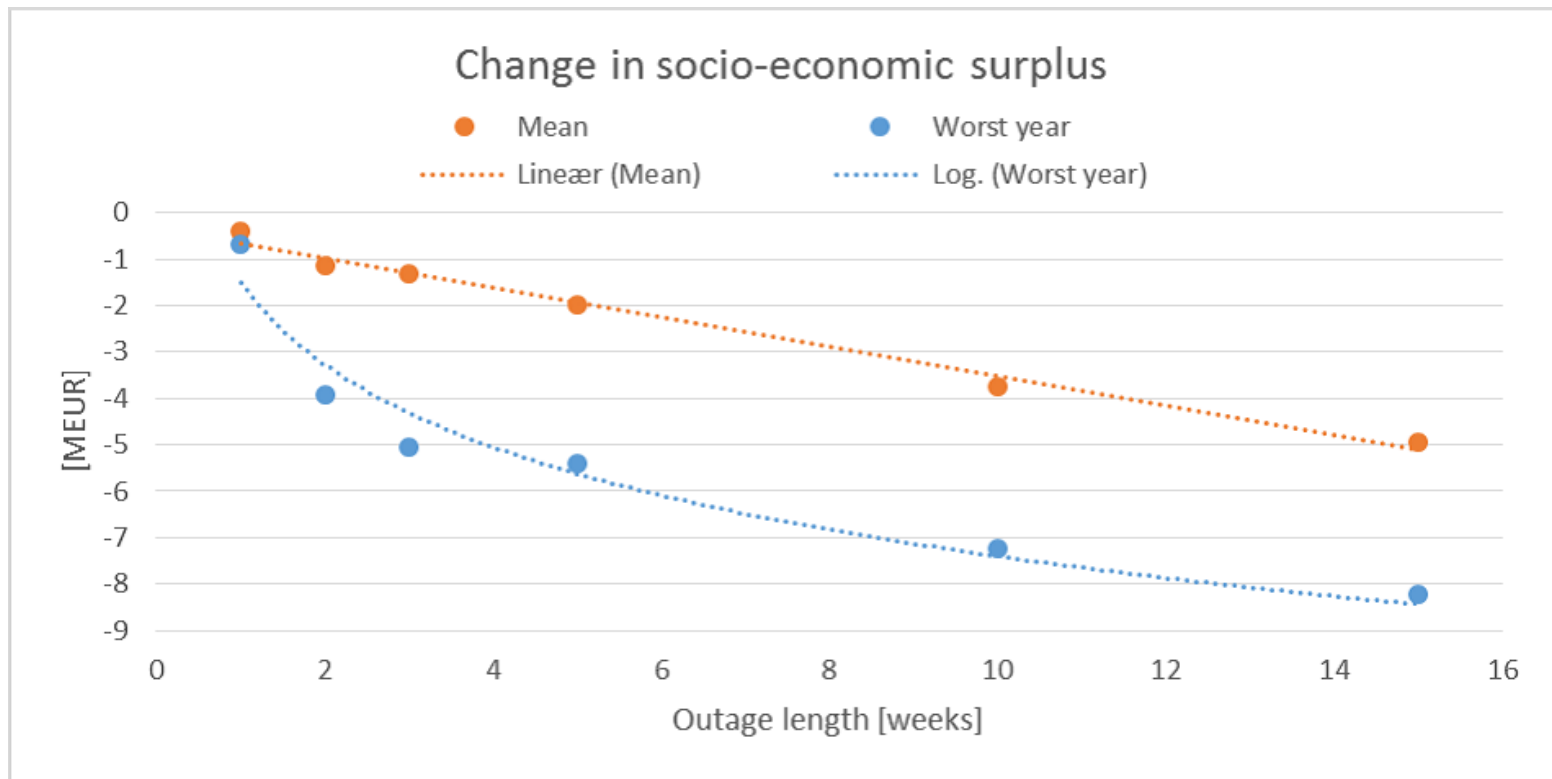


OUTAGE



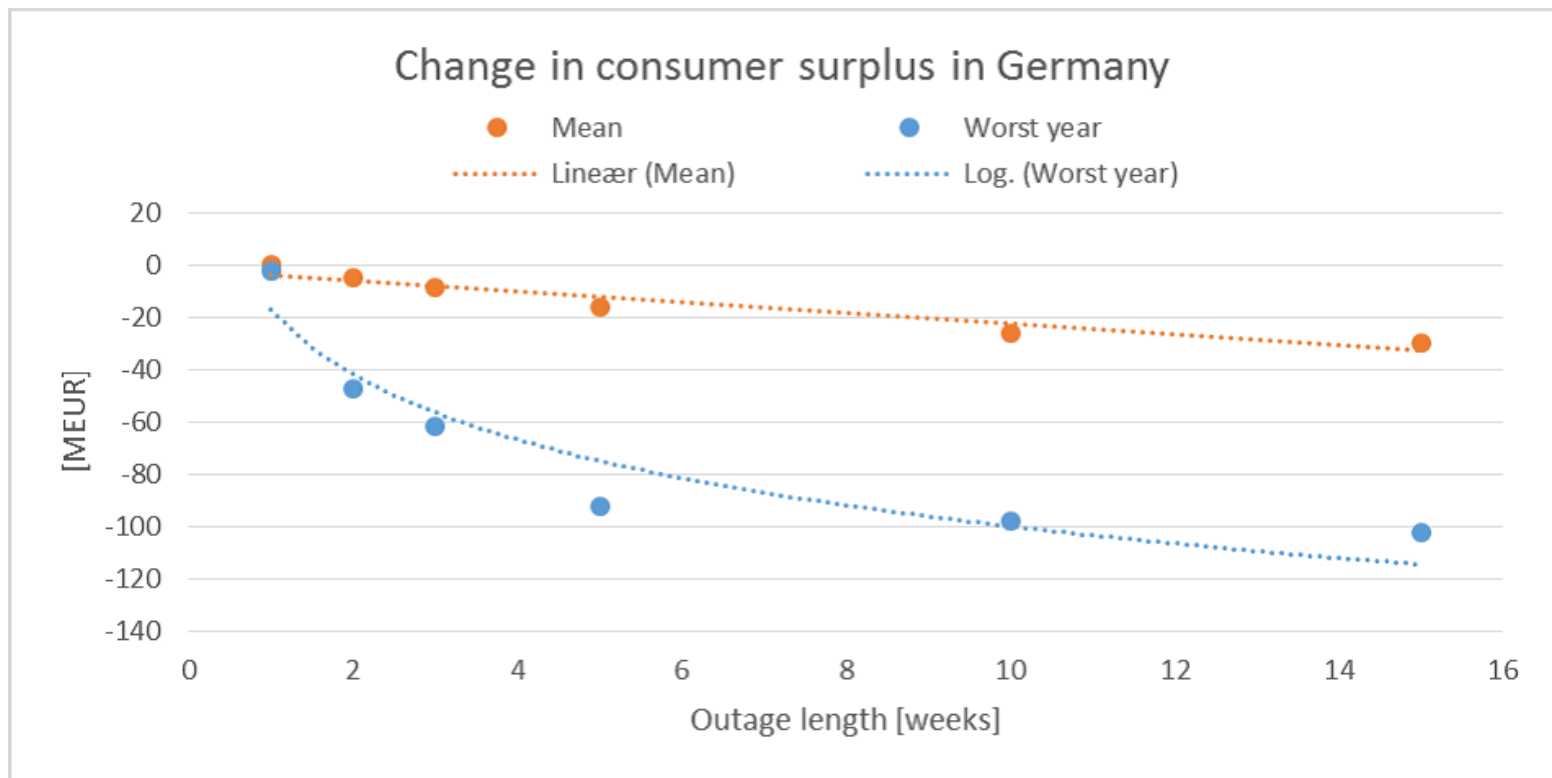
Economic impact

Sensitivity to outage length



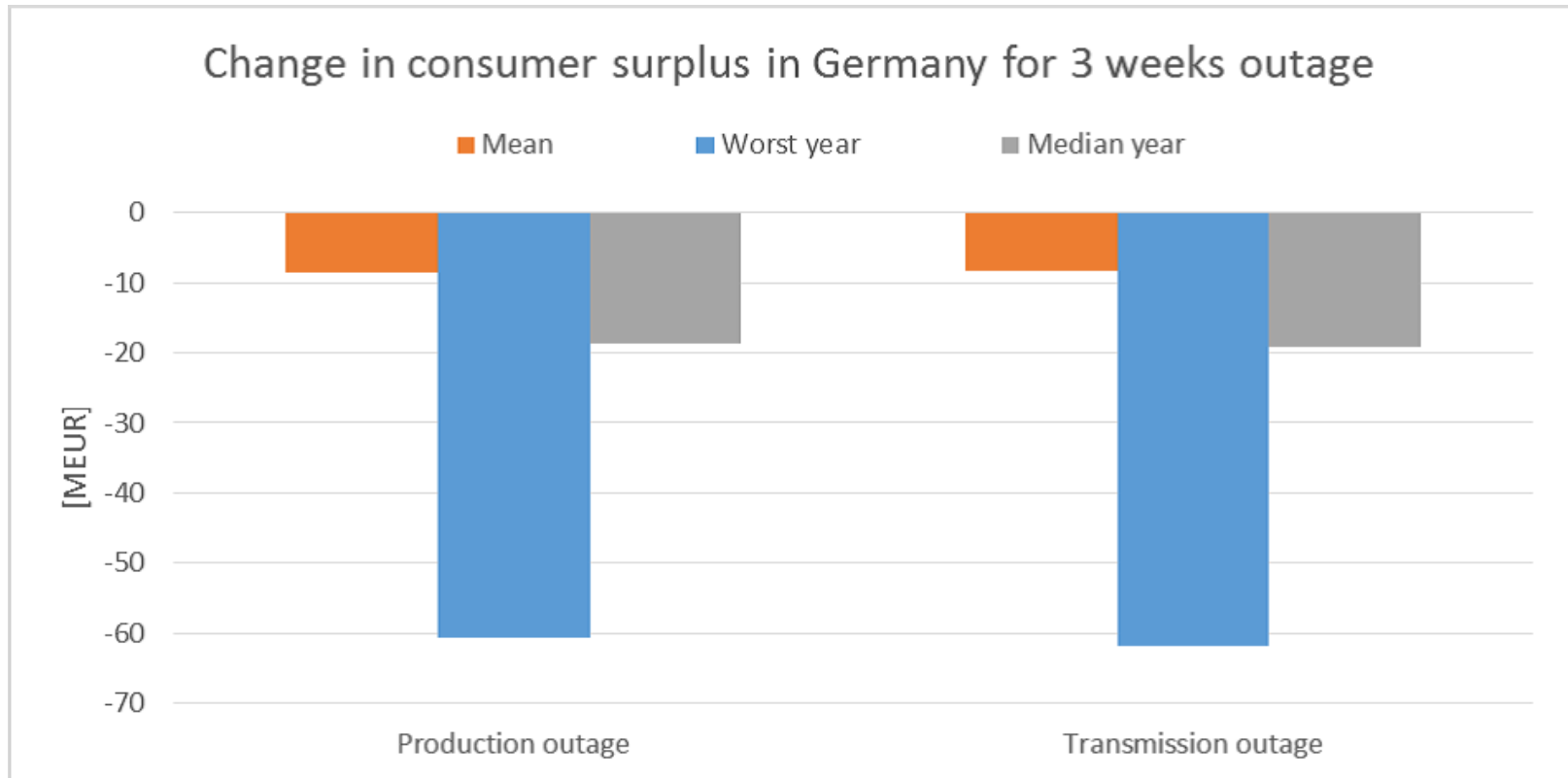
Economic impact

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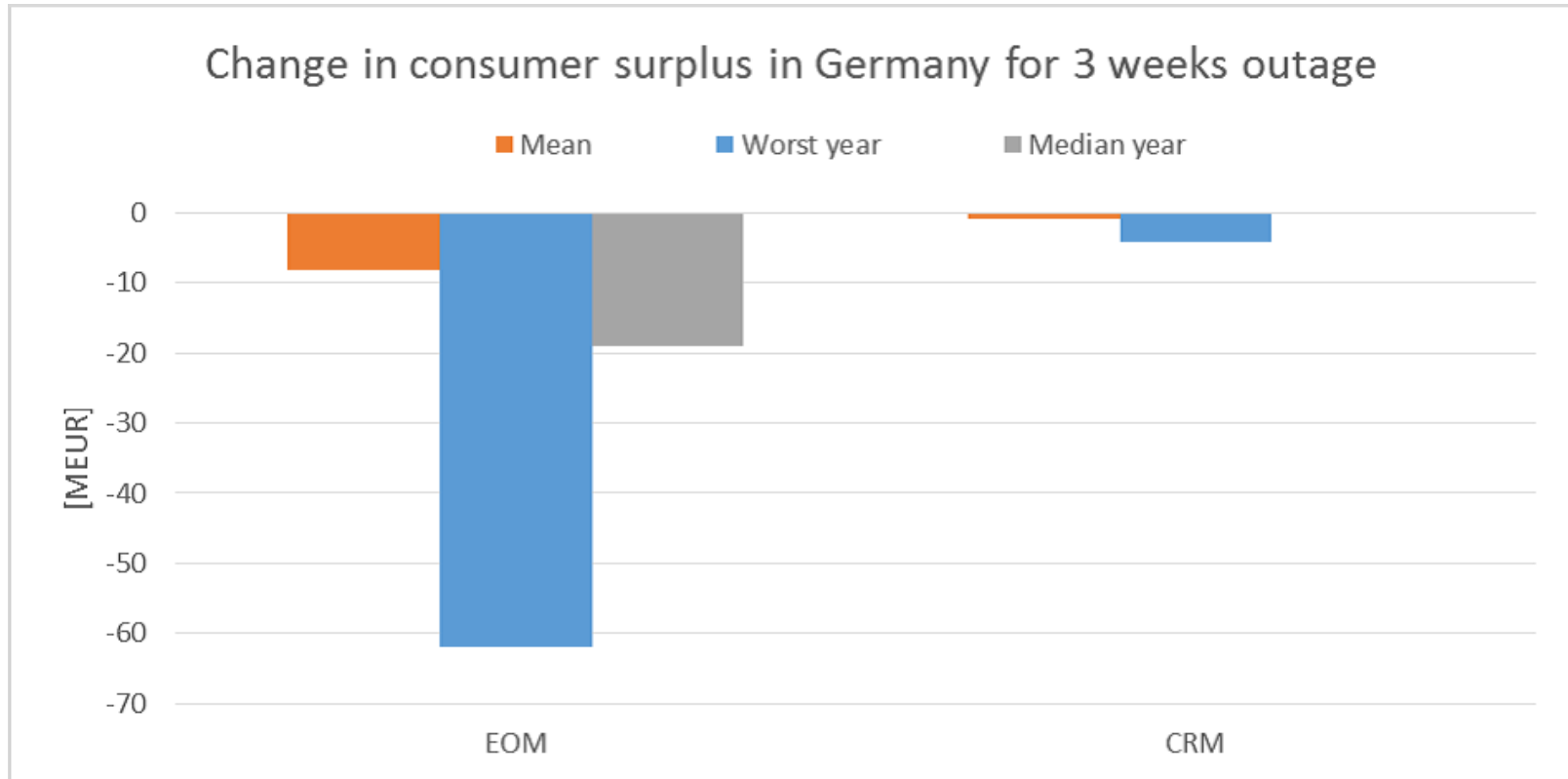
Impact on consumers

Generation outage vs HVDC outage



Impact on consumers

EOM vs CRM



Conclusions

A transmission cable outage is expensive for consumers in continental Europe if it occurs during power capacity shortage. Consequences of outage are more sensitive to the initial power situation and the market solution in the affected area than the outage length.

An outage of one link is not covered by increased power flow in other interconnections during power capacity shortage, as these cables already are fully loaded due to price difference in such circumstances.

Cable outages have identical consequences like generation capacity outage for the continent. Hence, it is suggested that cross-border capacity should be included in foreign Capacity Remuneration Mechanism (CRM).



Source: statkraft.no

Thank you for your attention

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Power systems group