



Balancing options and costs for offshore wind in the North Sea

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Simulated 2030 North Sea wind power during the storm front of «Carmen»...



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Source: Aigner (NTNU)

...but it is the Net Load that matters

- The system will see the aggregated net imbalance
 - Unforeseen variations in load, wind and solar
 - Net load = Load Wind Solar



- Flexibility of thermal power plants (ramp rates, start/ stop operation)
- With very high RE share, thermal plants can be pushed out of the market security of supply has to be fulfilled

North Sea offshore wind lead to a large increase in Net Load variations



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Source: Aigner (NTNU)

Wind pushes fossils out of the spot market...



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...and into the capacity market



What about energy storage?

GW installed capacity





The future says...





CEDREN Case study 2030

10-20 GW new pumping and generation capacity using existing reservoirs



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Norwegian pumped hydro has low electricity costs compared with other flexible plant types



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Pumped hydro also the requries lowest capacity auction price for peaking needs



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Large benefits of integrating the Northern and continental balancing markets

Total annual balancing cost savings (Mill.EURO)





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SINTEF Source: Farahmand (NTNU/SINTEF)

Balancing options for OFFSHORE WIND & Co

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Summary

- Norwegian pumped hydro is cost-effective for balancing
 - Large potential
 - Large flexibility and multiple uses
 - Requires European collaboration
- An efficient and integrated power market is an enabler for high RE penetration
 - Reduces the need for expensive storage
 - Reduces the need for expensive reserves
- Comprehensive studies of balancing markets in Northern Europe
 - Large benefits of integrated markets for balancing resources
 - Large benefits of integrated markets for intra-day trading