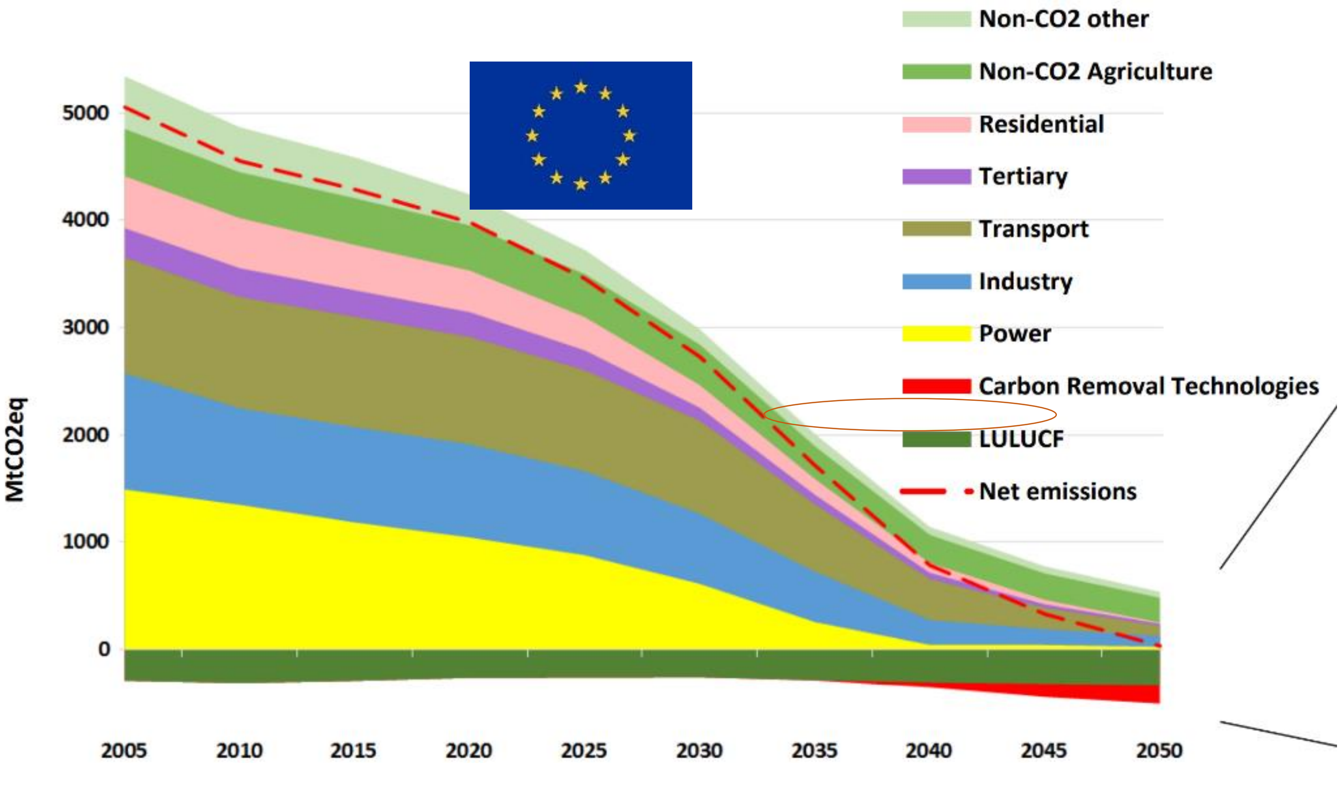
The European energy transition and the North Sea

Prof. Asgeir Tomasgard
Director FME NTRANS – Norwegian Centre for Energy Transition Strategies
Director NTNU Energy Transition Inititative

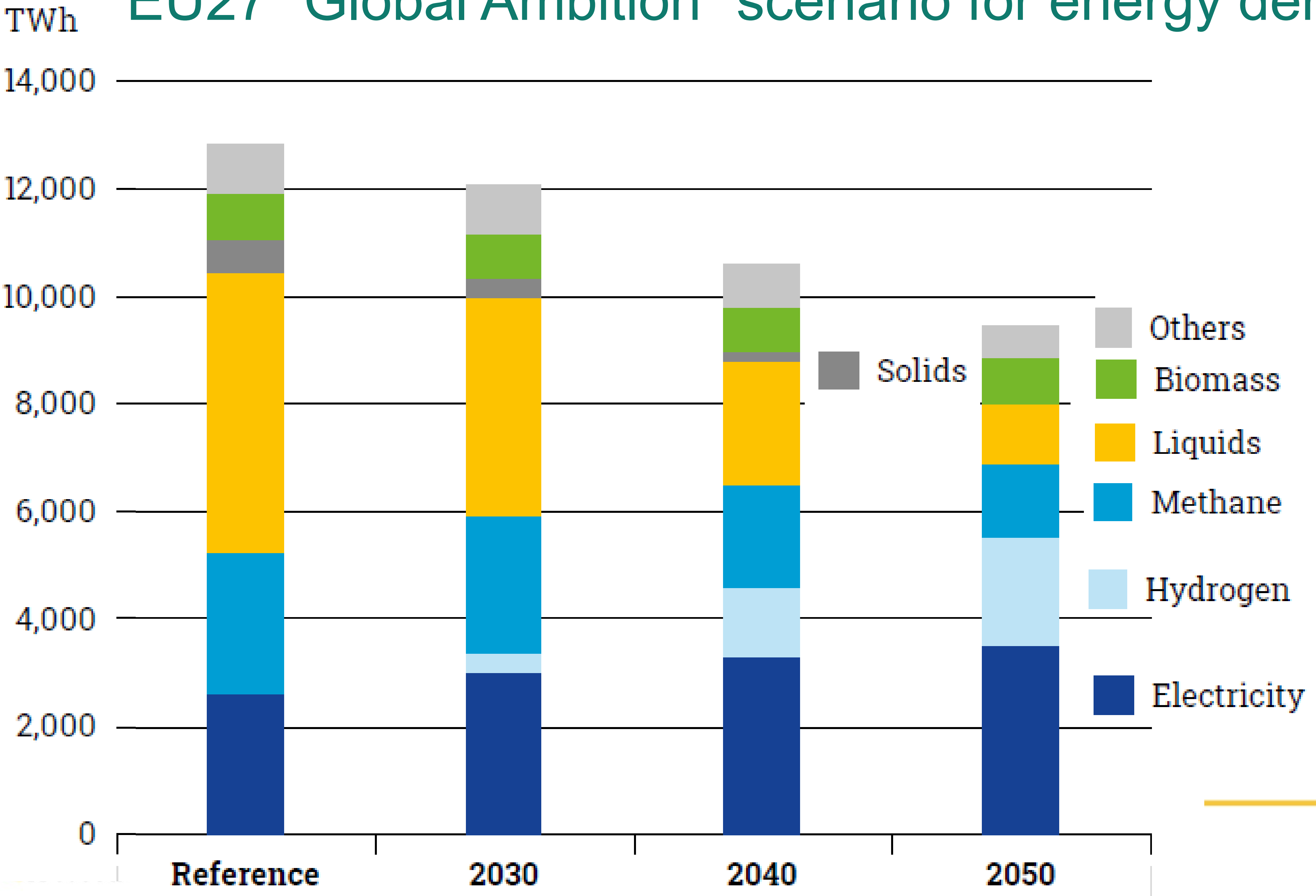
NTNU

Europe 2050



European Commission (2018), A Clean Planet for all A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy

EU27 “Global Ambition” scenario for energy demand



Source: ENTSO-E Draft scenario report 2022

EU27 scenarios for power generation

Source: ENTSO-E Draft scenario report 2022

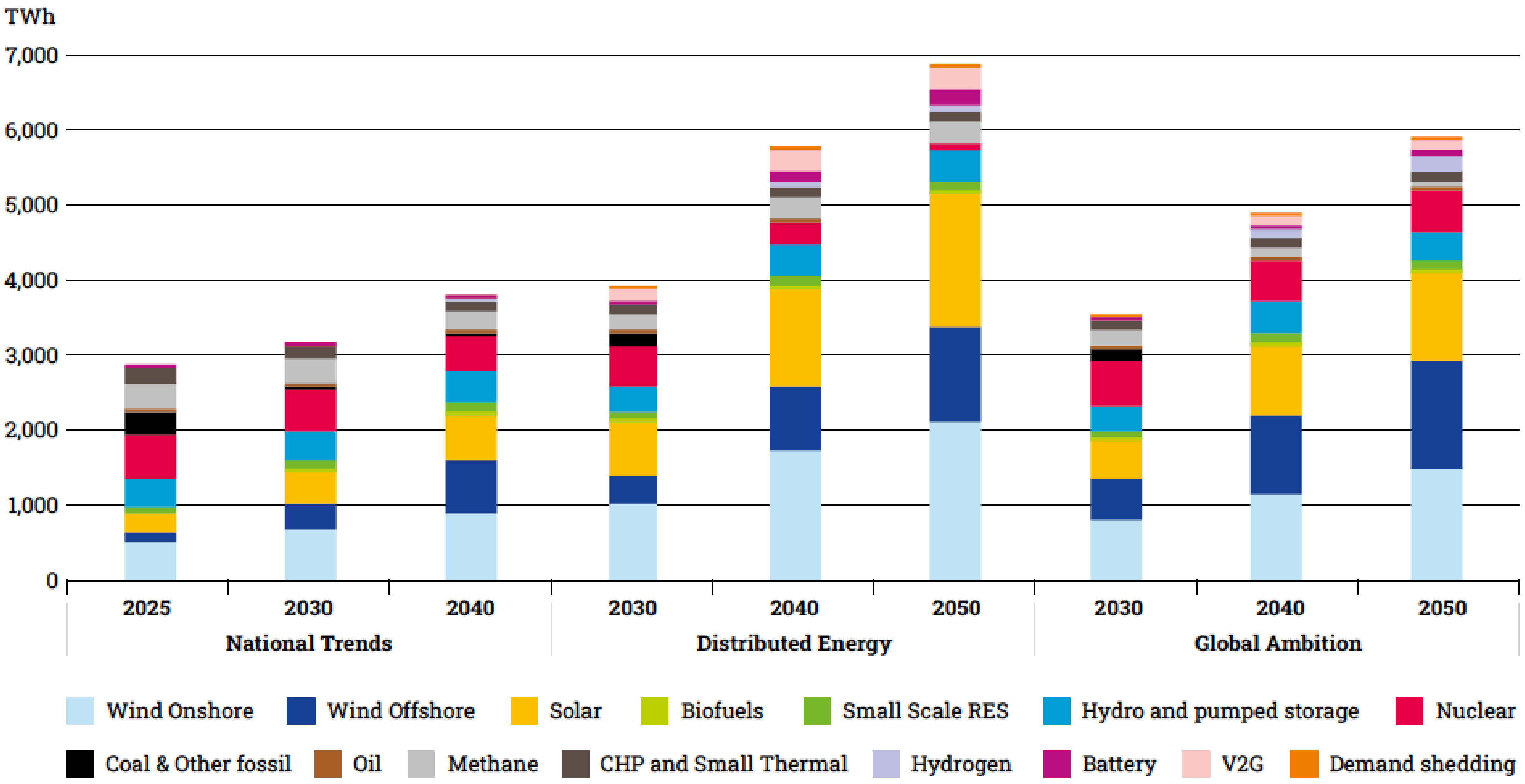
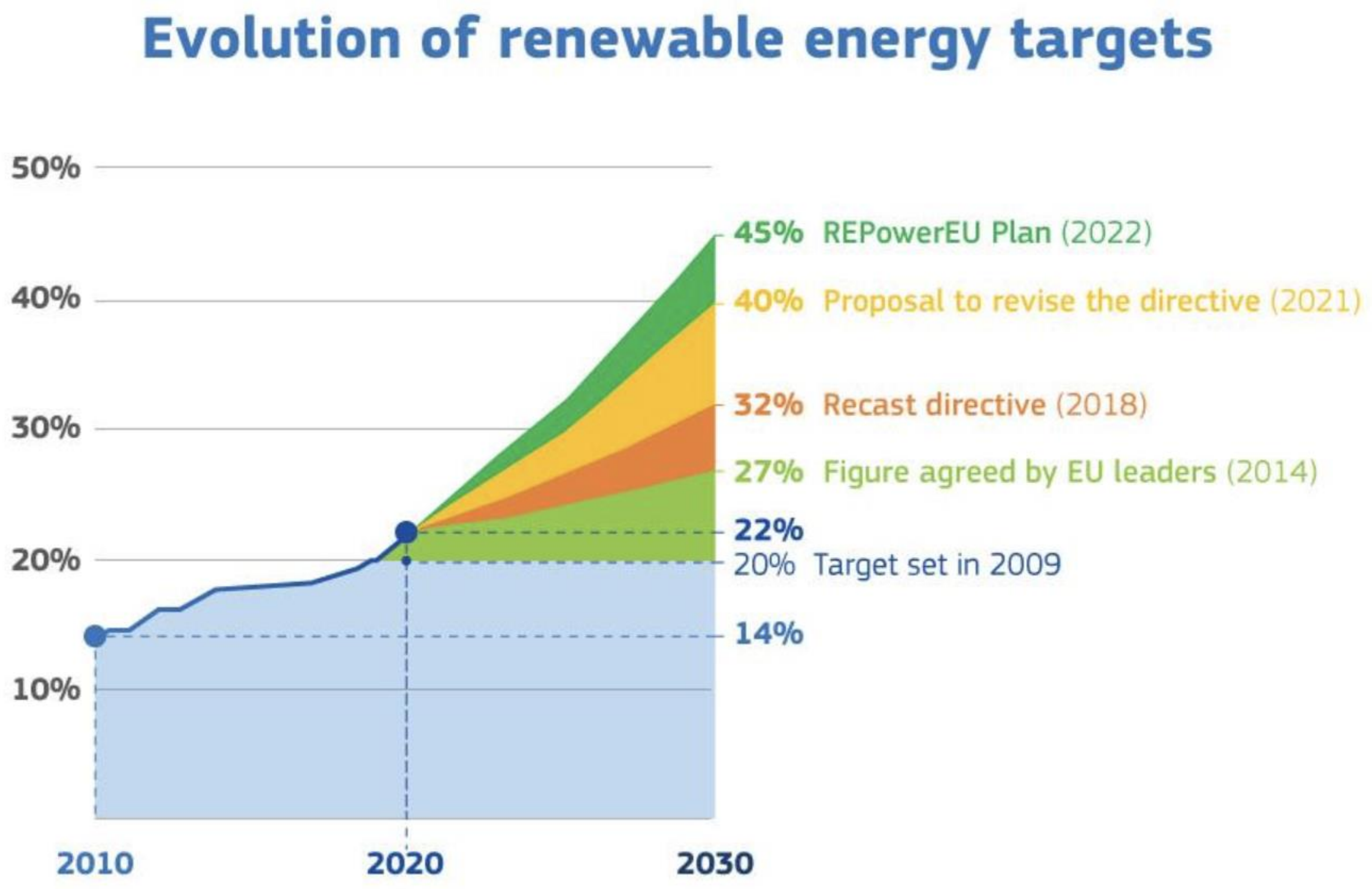


Figure 25: Power generation mix for EU27 (including prosumer PV, hybrid and dedicated RES for electrolysis)

REPowerEU: Joint European Action for more affordable, secure and sustainable energy

- “The case for a rapid clean energy transition has never been stronger and clearer”
  - Renewables, heat pumps, reduced energy use,
  - Wind: 430 GW (FF55 2030) + 20% (REPOWEREU)
  - Interconnectors, power and gas
- Hydrogen – a new hope..
  - FF55 Ambition before 2030: 5.6 mt renwable H_2
  - REPOWEREU20 mt before 2030 (10 mt import)
  - : Global renewable H_2 in 2020 was below 0.5 mt

REPowerEU



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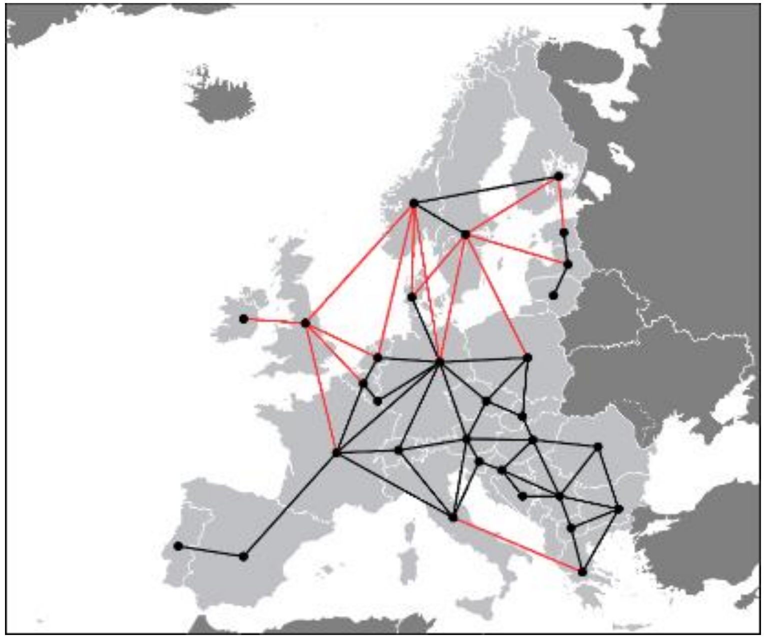
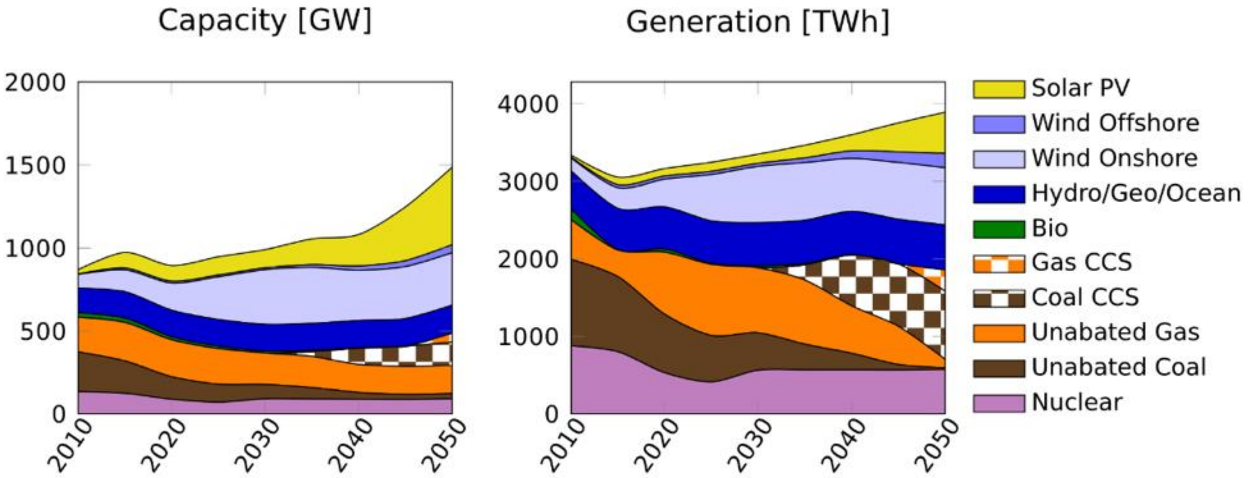
EUROPEAN POWER MARKET ANALYSIS - EMPIRE

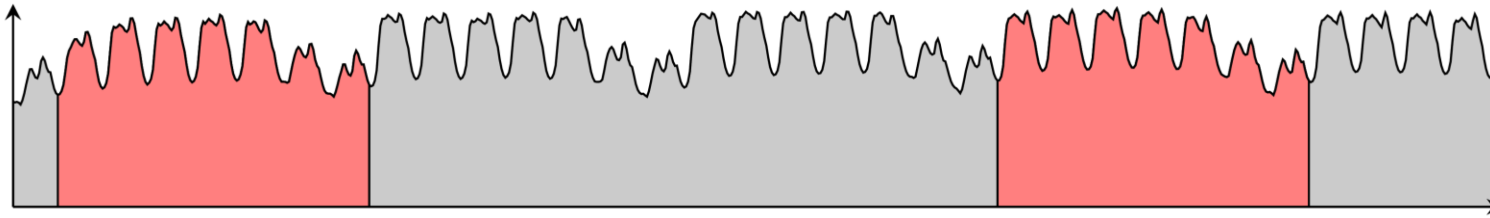


Optimal investment strategy 2010-2015



Coupled optimization problem to minimize total system costs

Optimal dispatch for representative 168-hour blocks



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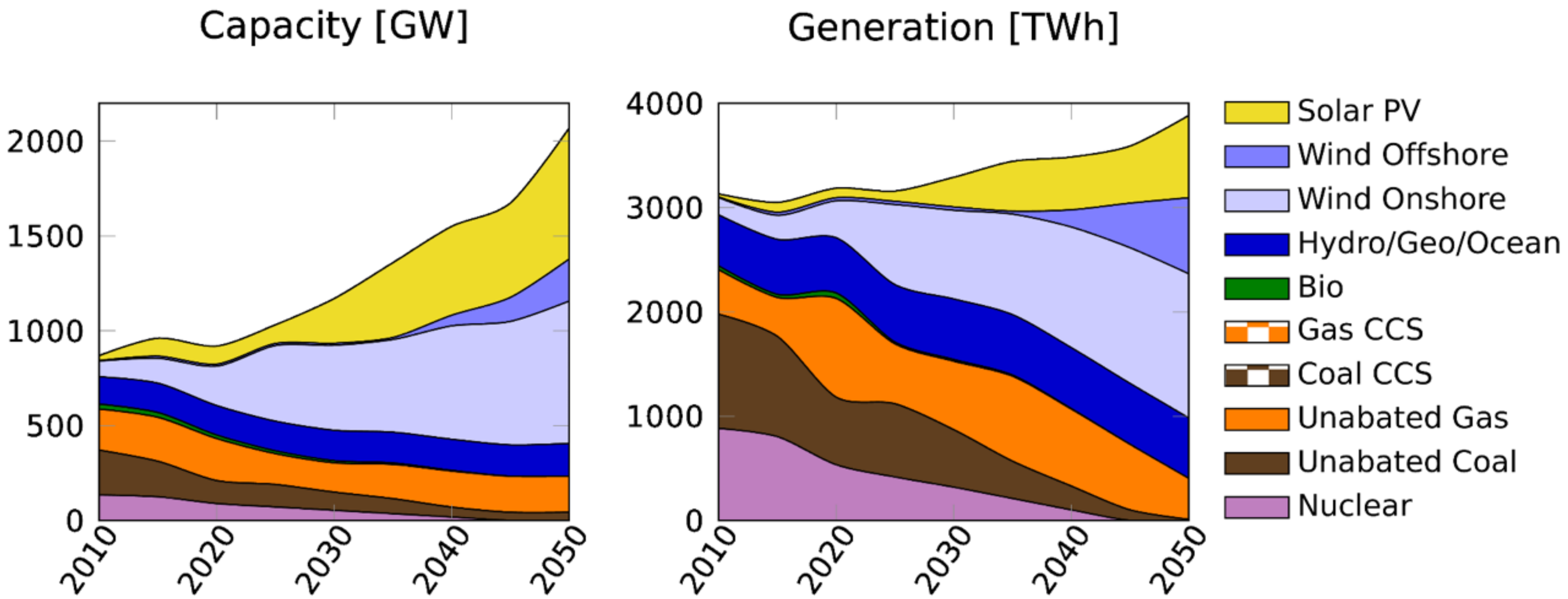
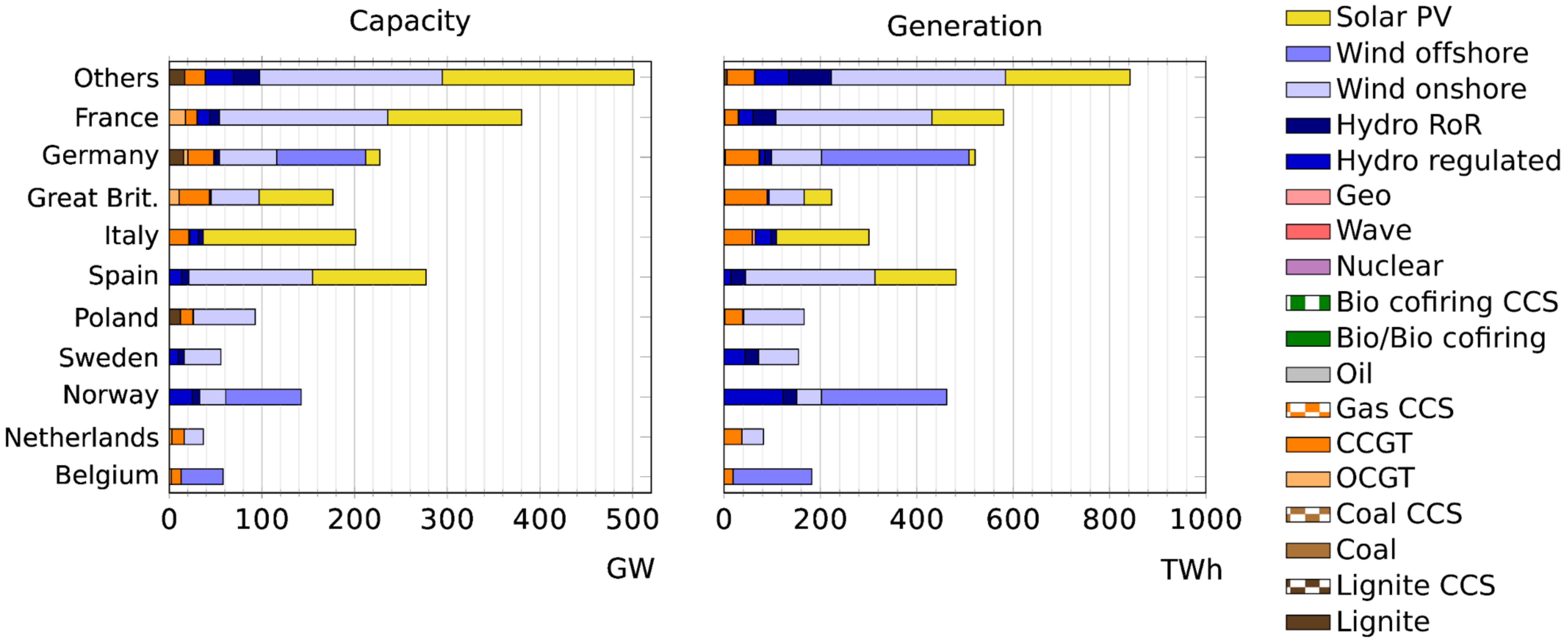
NoCCS scenario: 90 % emission reduction

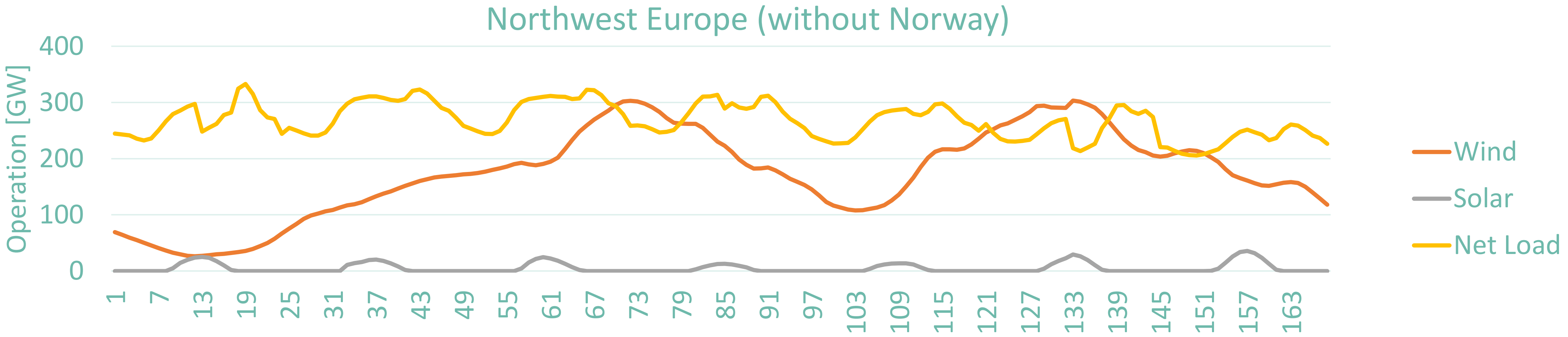


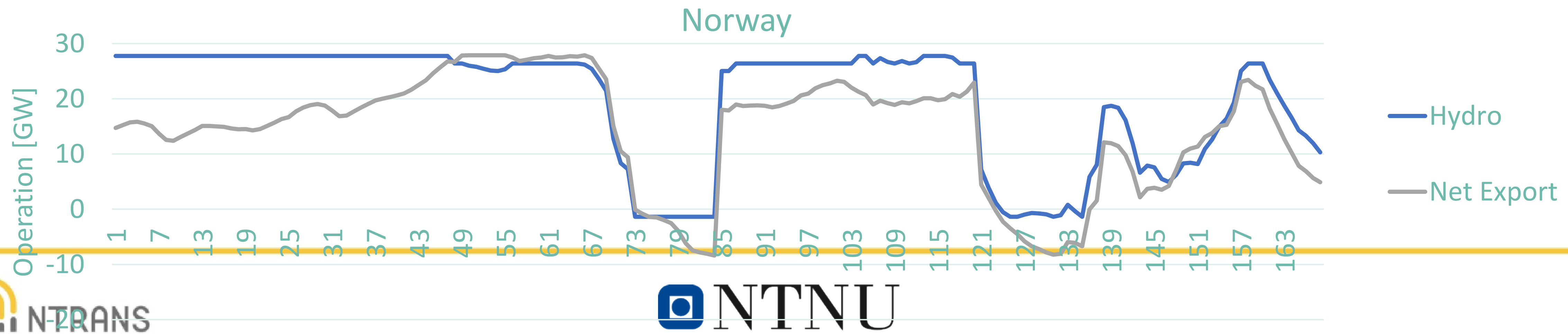
Technology/fuel (2050)	Capacity [GW] (% share)		Generation [TWh] (% share)	
Solar	690	(33%)	788	(20%)
Wind onshore	751	(36%)	1381	(36%)
Wind offshore	222	(11%)	730	(19%)
Coal (unabated)	43	(2%)	11	(0%)
Natural gas (unabated)	190	(9%)	393	(10%)
Others	173	(8%)	580	(15%)

NoCCS country results 2050



Northwest Europe winter week 2050 (Baseline)





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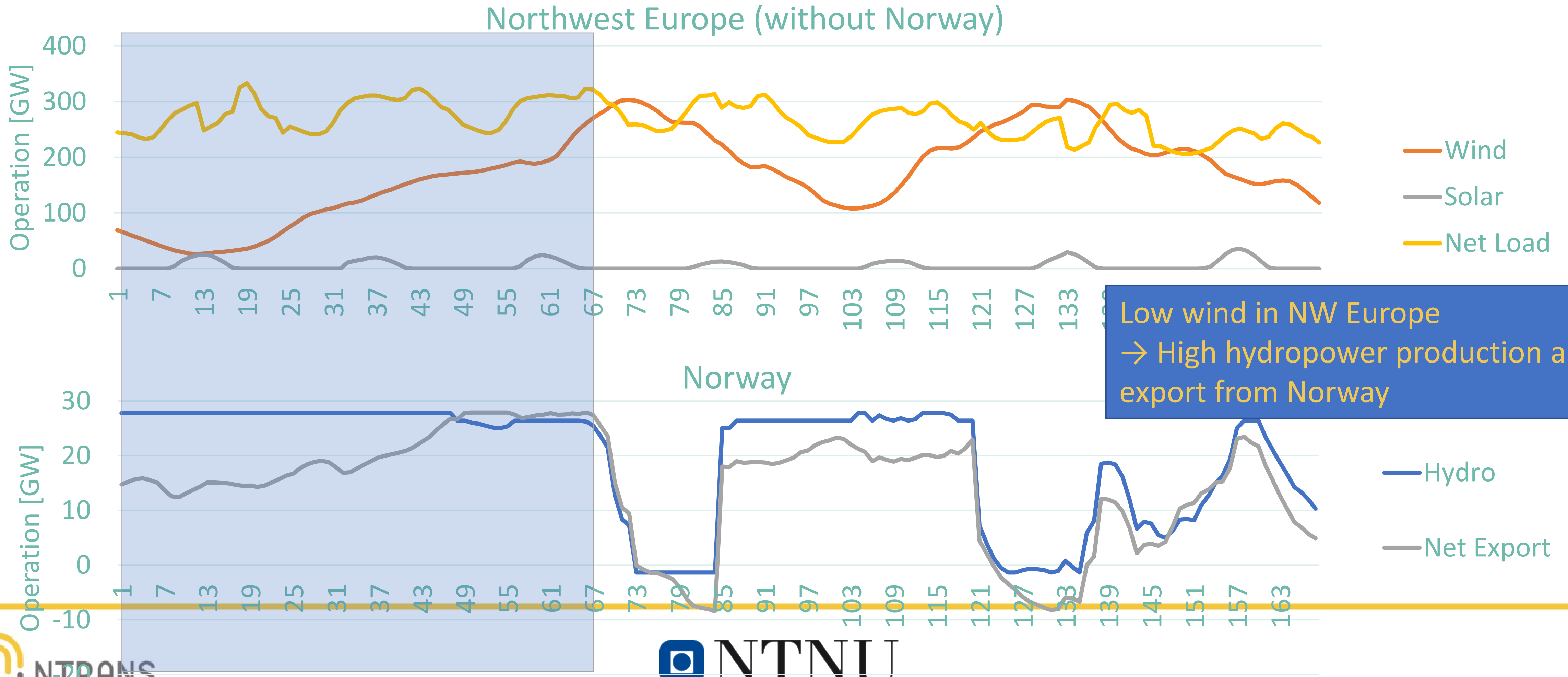
Northwest Europe winter week 2050 (Baseline)



Low wind in NW Europe
→ High hydropower production and export from Norway

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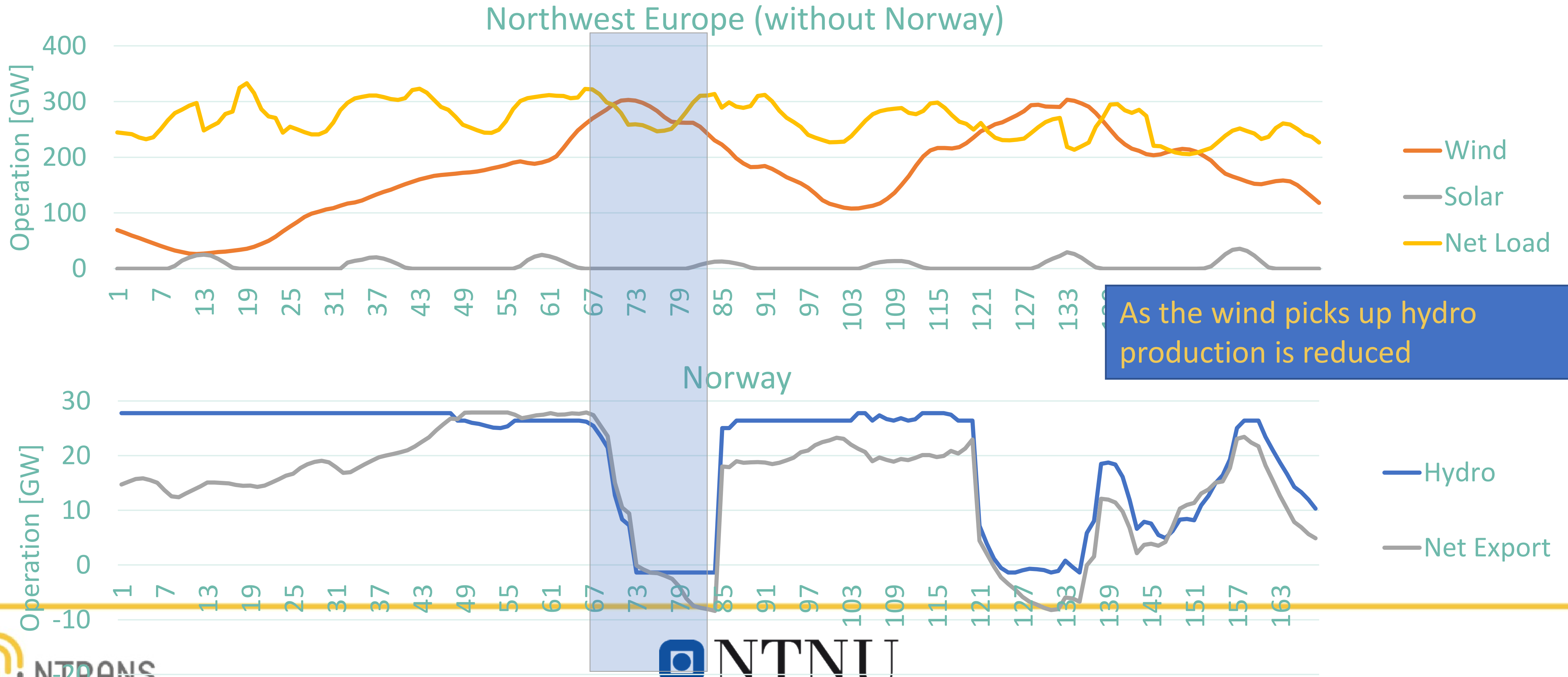
Northwest Europe winter week 2050 (Baseline)



As the wind picks up hydro production is reduced

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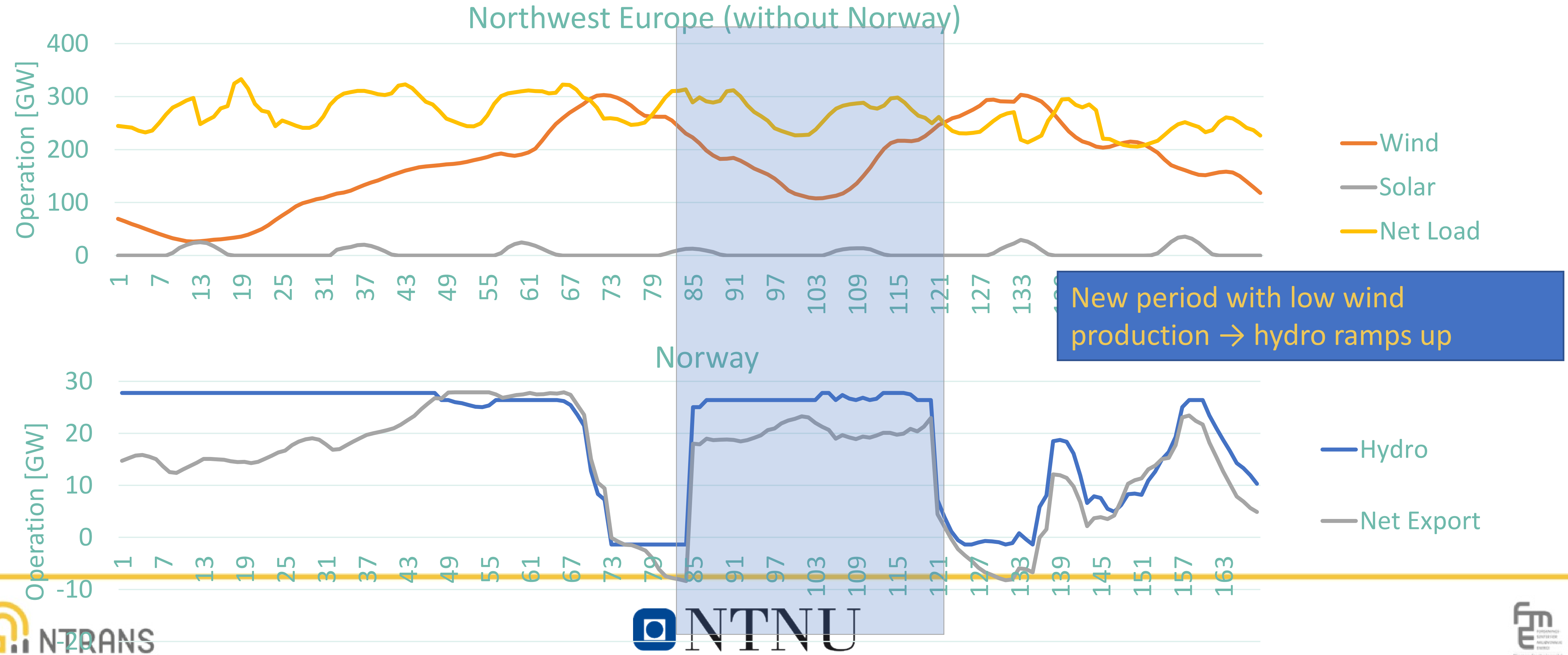
Northwest Europe winter week 2050 (Baseline)



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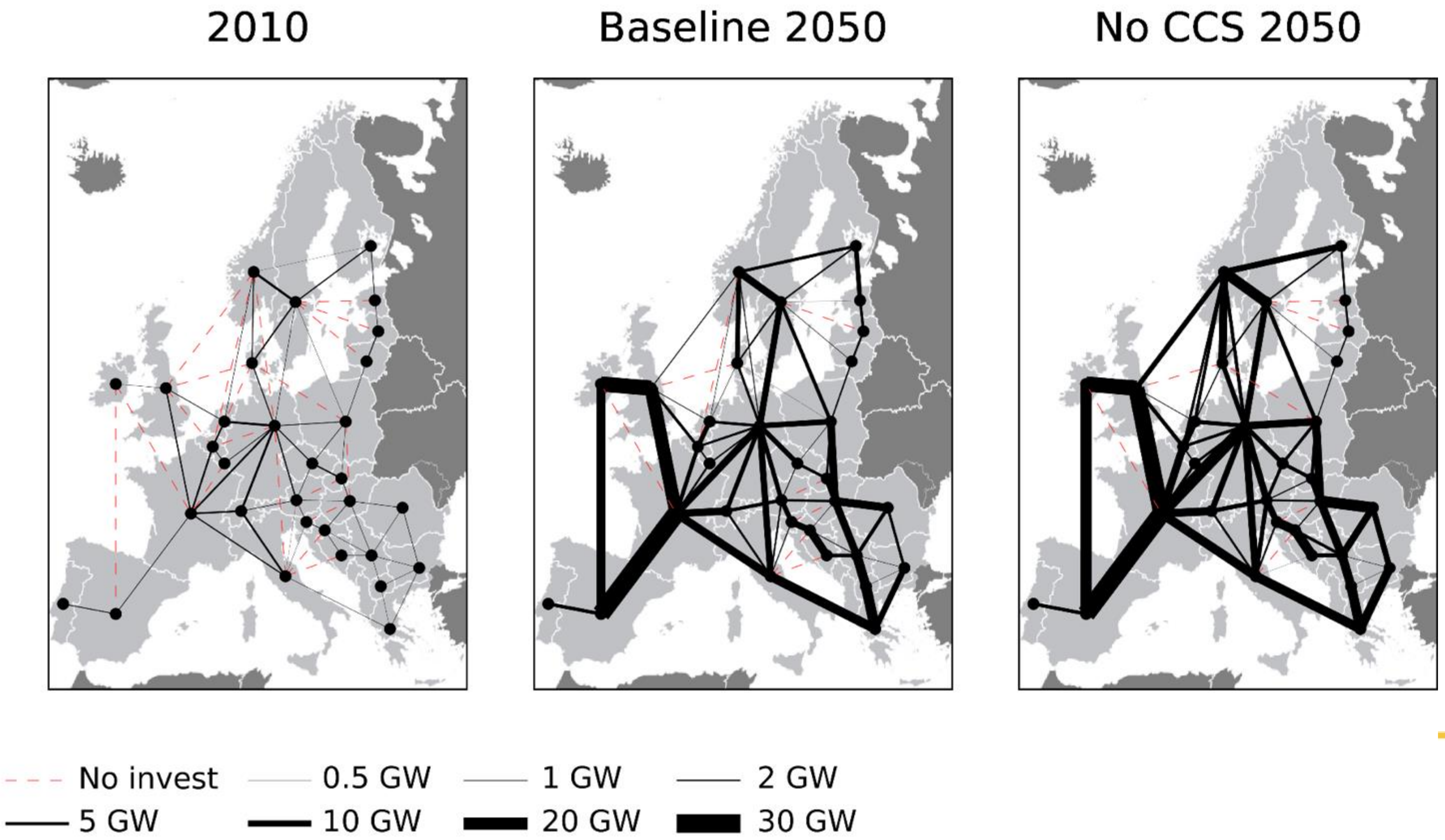
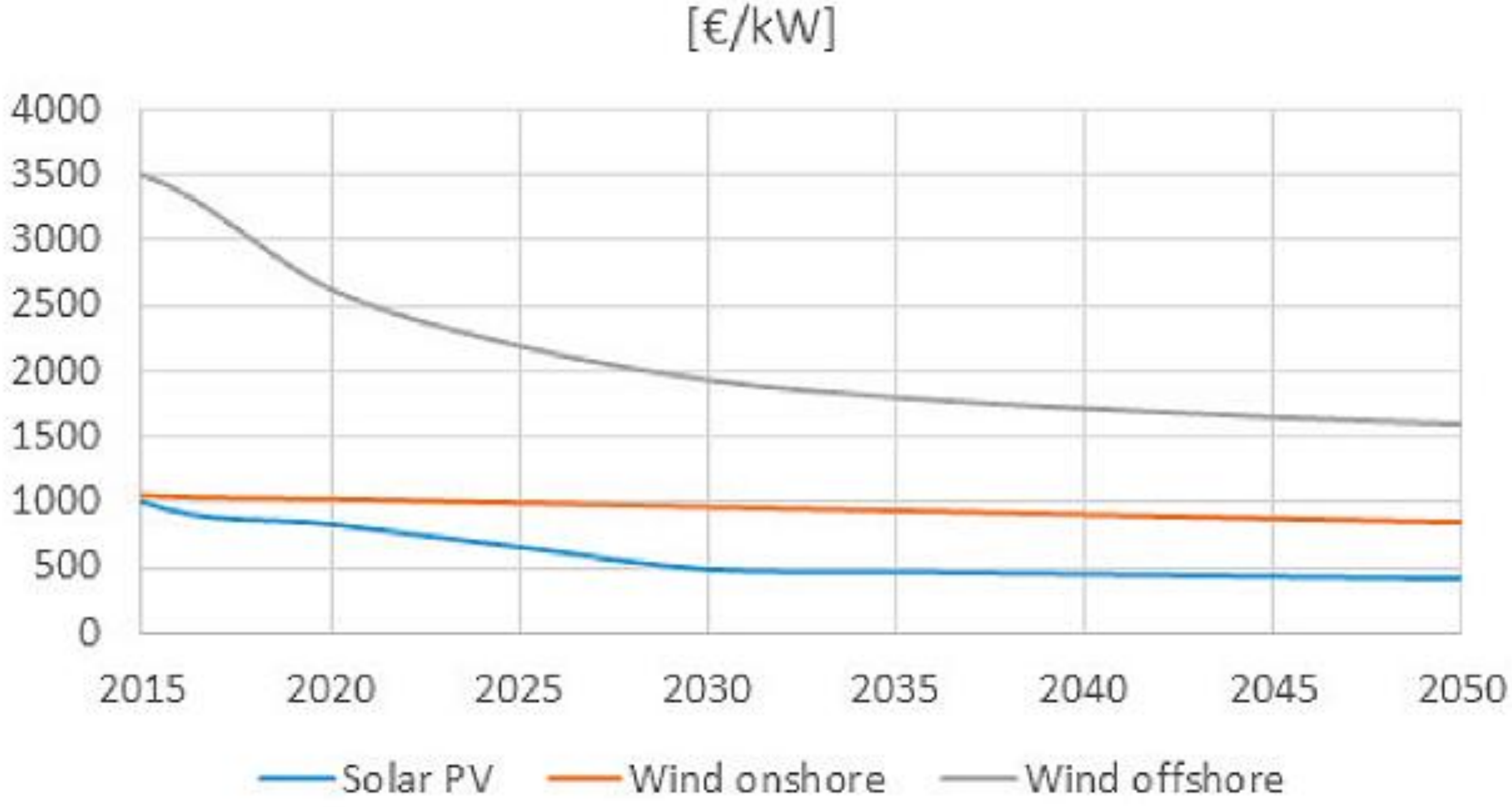
Transmission



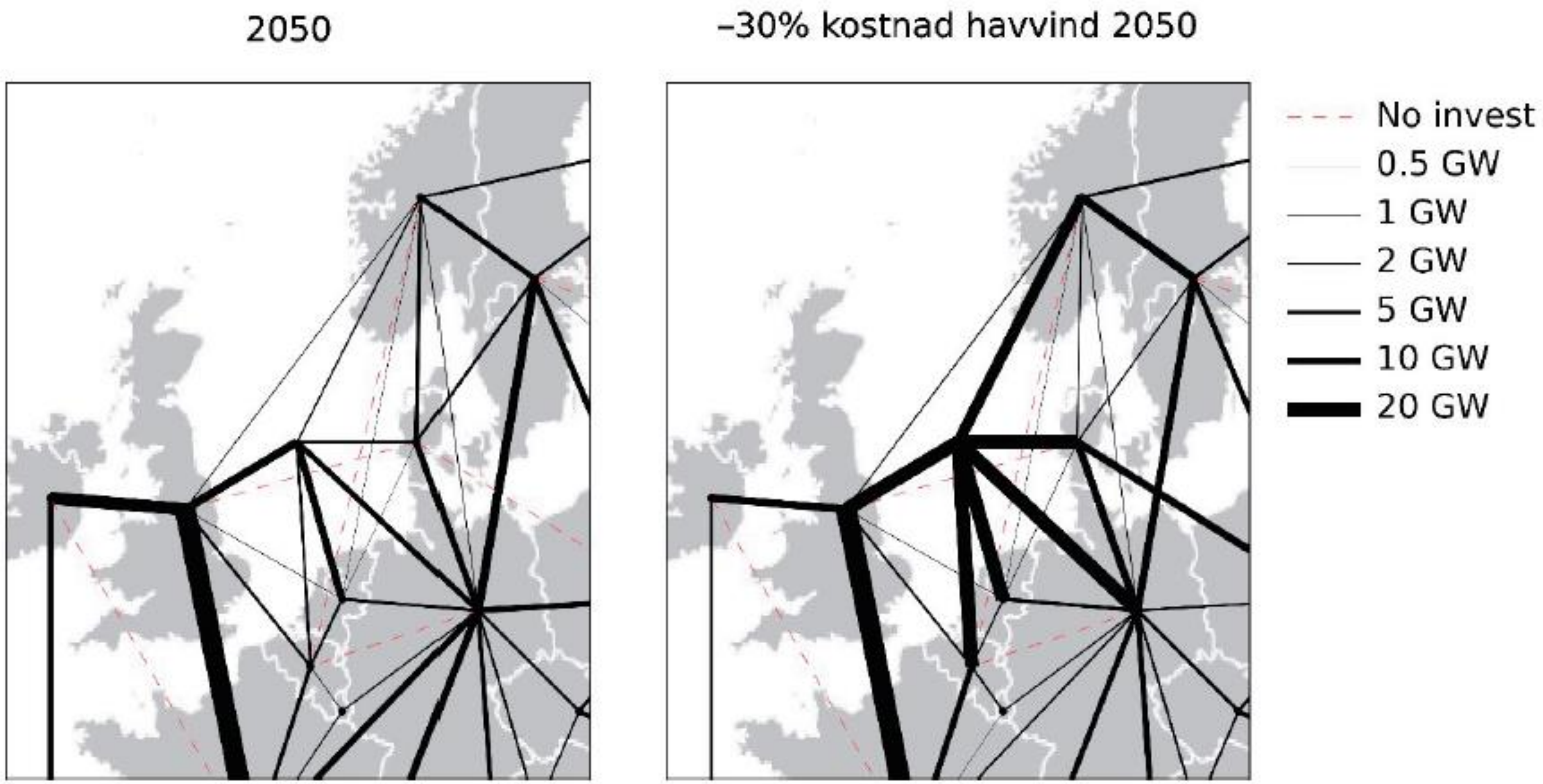
Baseline
cross-boarder expansion: increases by 701% from 2010 to 2050

NoCCS
Capacity increases by 811% from 2010 to 2050

Offshore wind study



With offshore wind region in the North-sea



Baseline 42 GW
installed wind capacity

30 cost reduction: 143 GW

Some case studies from the North Sea

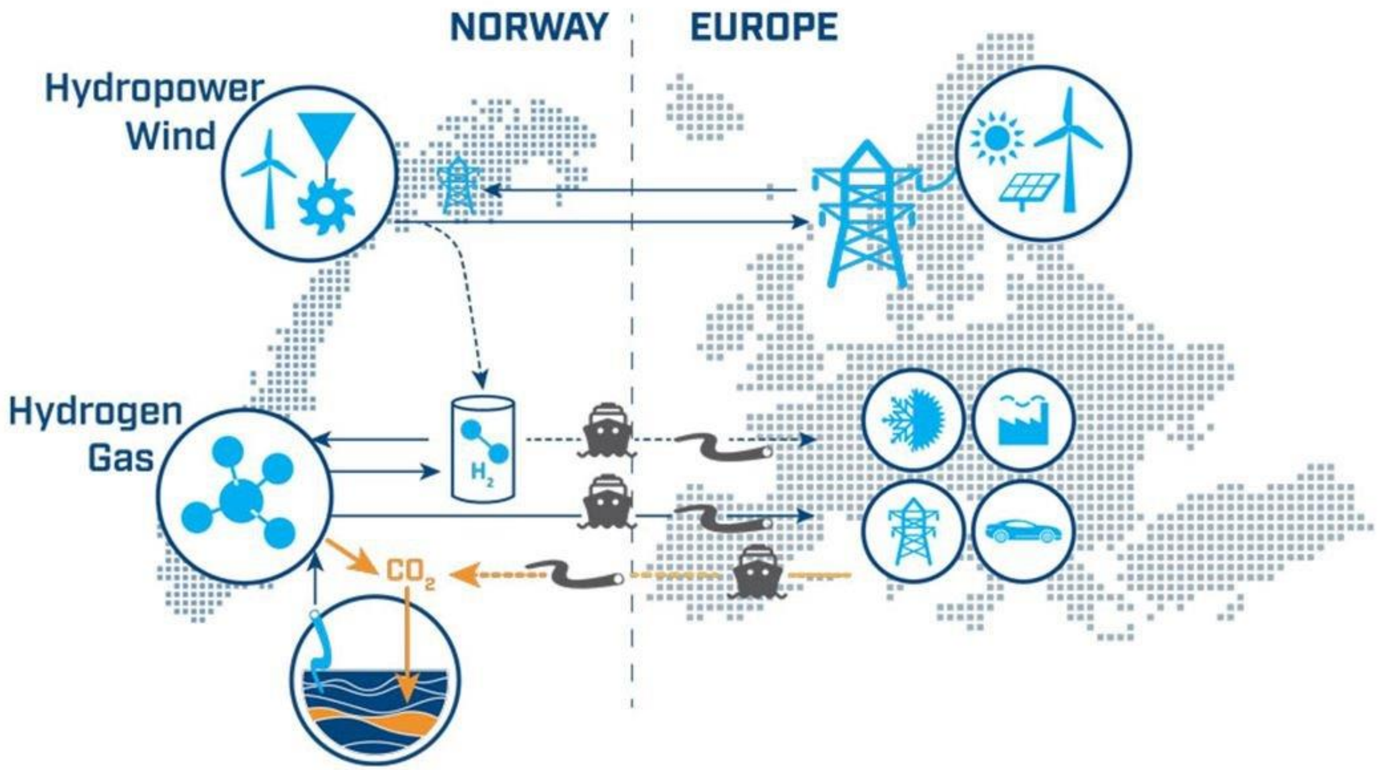
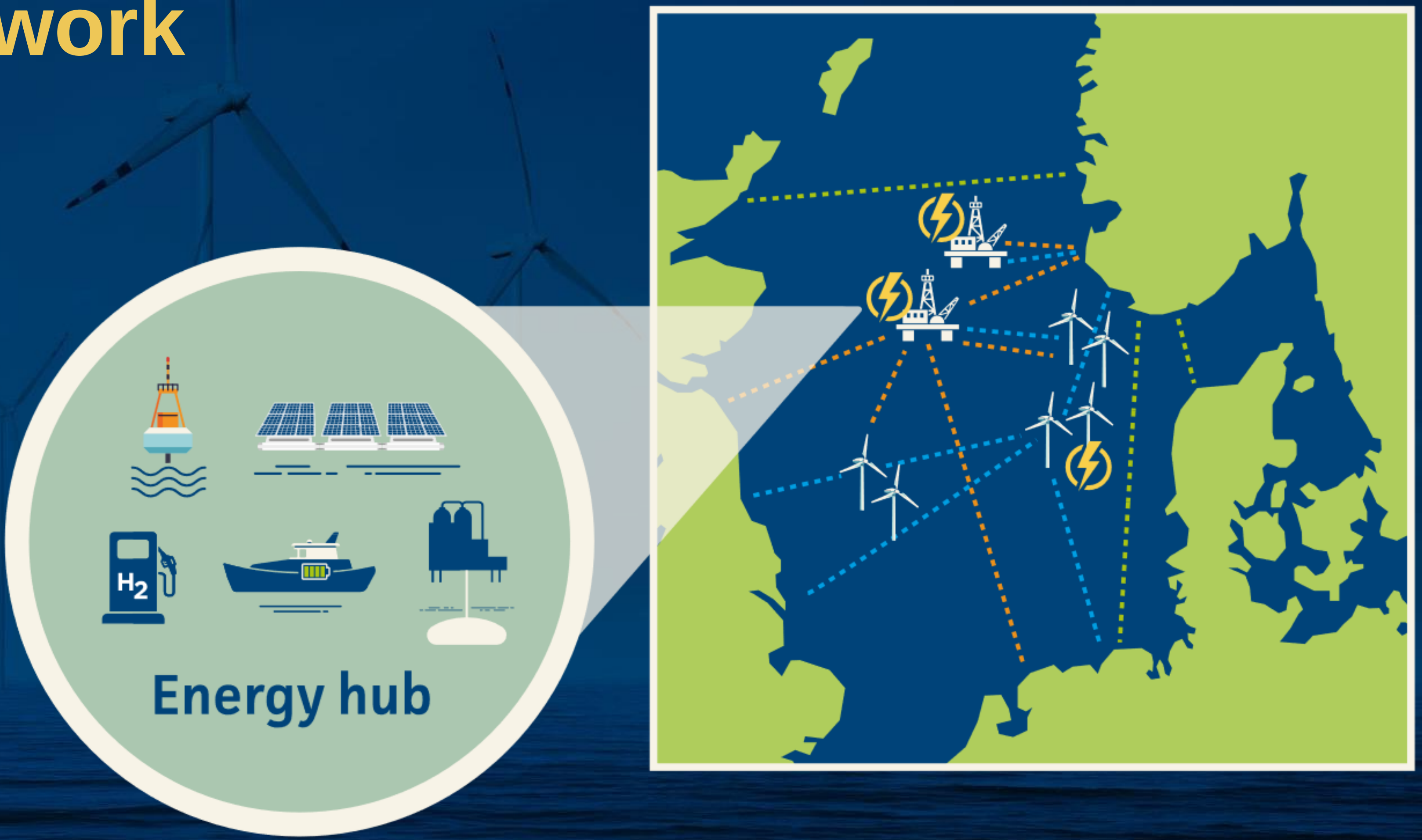


Figure credit: https://www.sintef.no/en/projects/2020/cleanexport/

North Sea network



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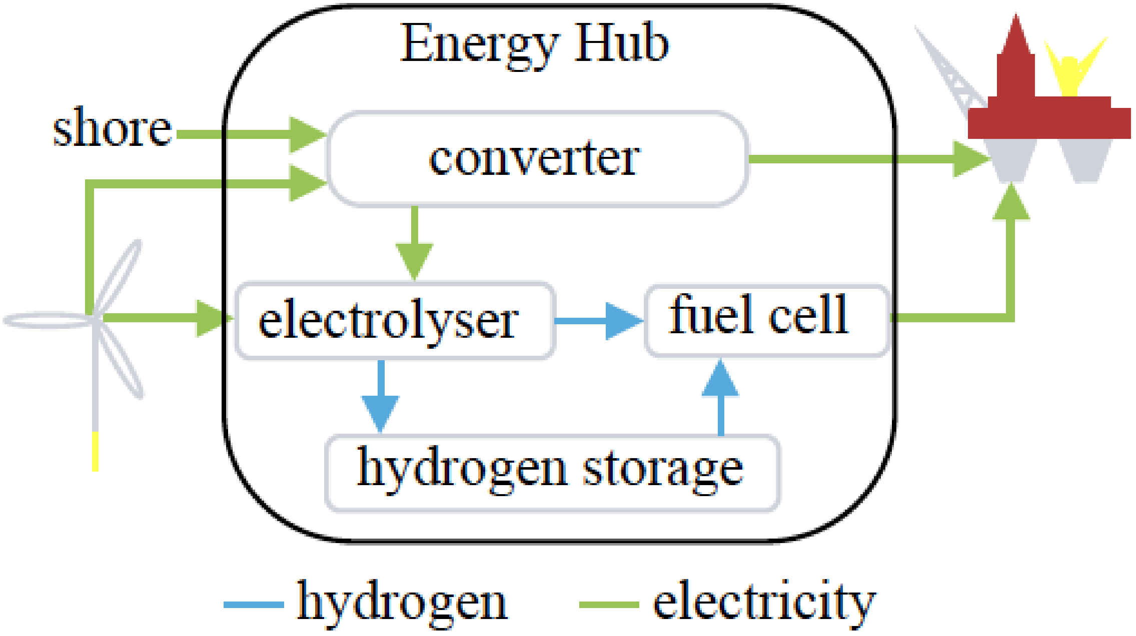
Case study 1 and 2
A view on the North Sea

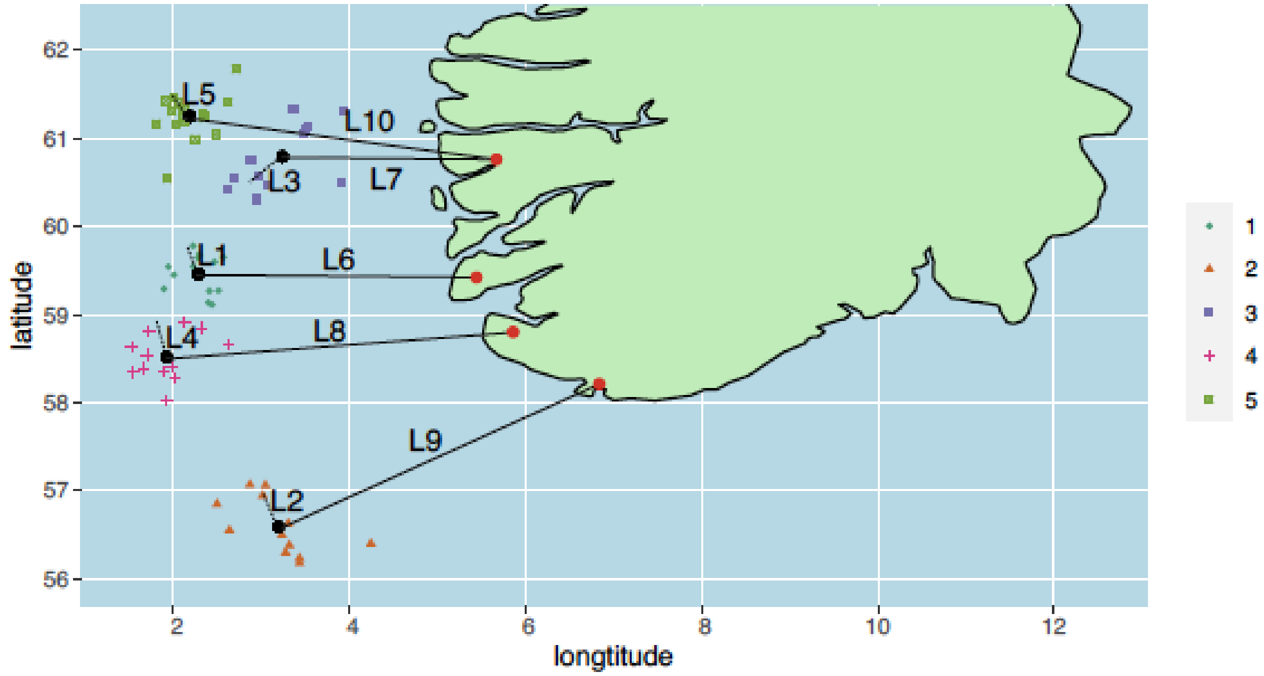
- *investment planning for a decarbonised NCS energy system*
- *considering offshore wind and solar, energy hubs, converter stations,*
- *subsea cables, electric boilers and batteries.*

Zhang, H., Tomasgard, A., Knudsen, B. R., Svendsen, H. G., Bakker, S. J., & Grossmann, I. E. (2022). Modelling and analysis of offshore energy hubs. *Energy, 261, 125219. https://doi.org/https://doi.org/10.1016/j.energy.2022.125219*

Energy hub:

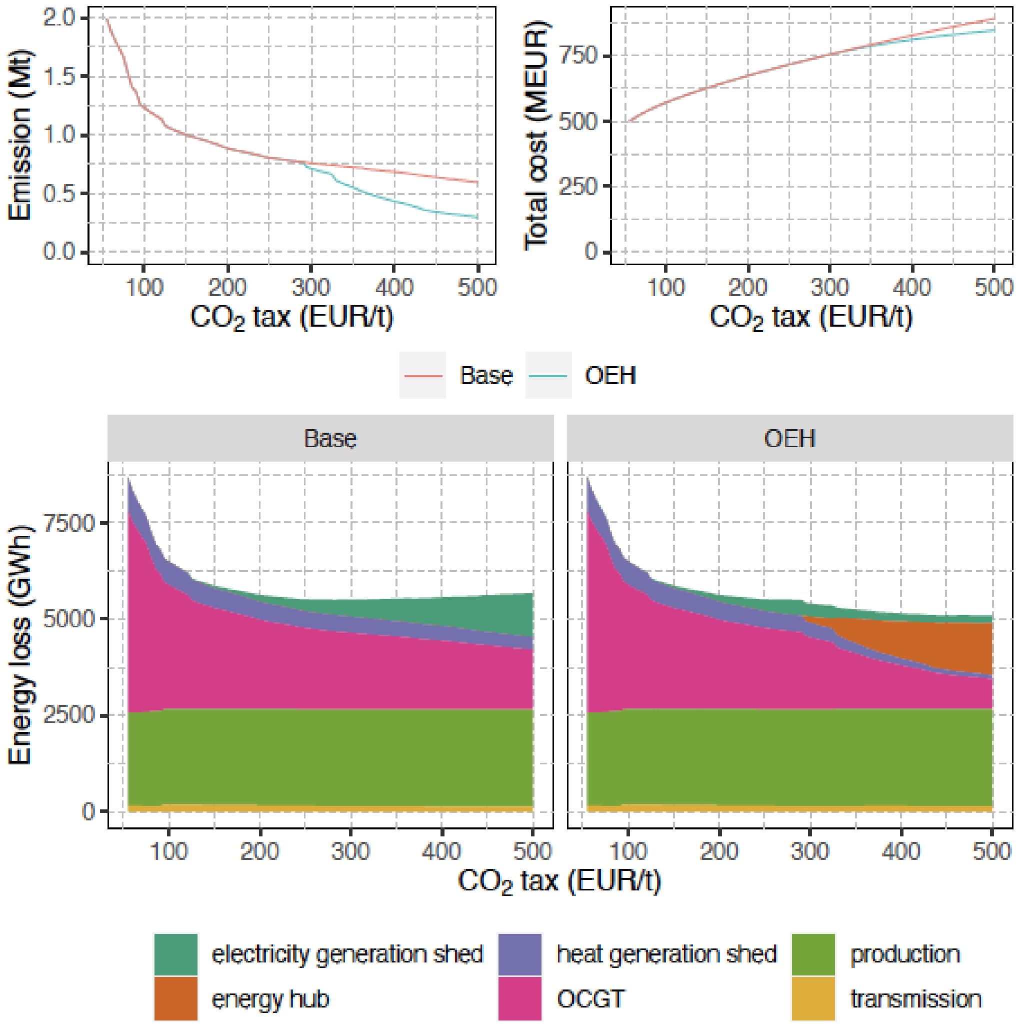


NCS energy system:



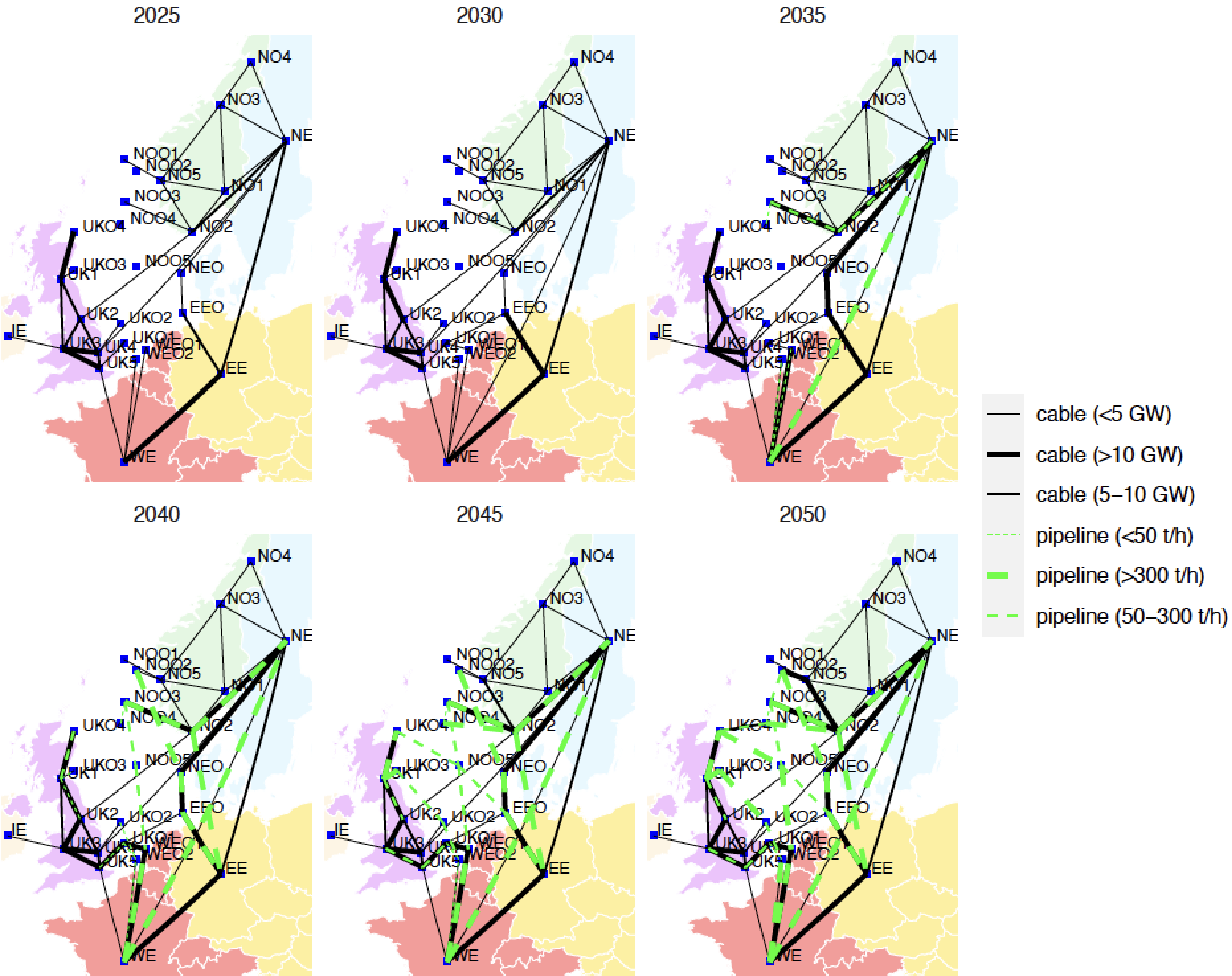
Decarbonize the continental shelf

- Increasing the carbon tax from 55 to 500 €/tonne with a step size of 5 €/tonne.
- CO_2 tax as a single instrument may not be enough to motivate a zero-emission system.
- Offshore Energy Hubs (OEHs) can potentially reduce up to around 50% more CO_2 emission and 5% total cost.
- Energy loss is up to 10% lower in the case of OEHs compared with Base.



Results-energy hubs for the European energy transition

- Extension of the work with links to Eruope: we see hydrogen pipelines emerging around 2035 in extended analyses



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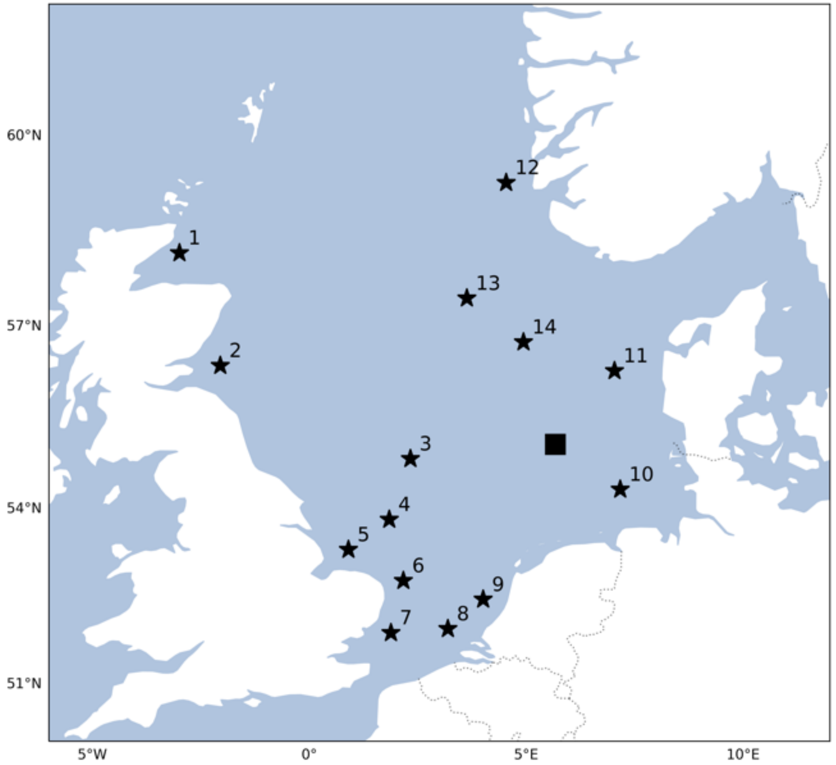
Case study 3 The NCS and Europe

- Investigate investments into power and hydrogen sectors until 2060
- Power & hydrogen operations explicitly linked
- Focus on the North Sea area



Goran Durakovic, Pedro Crespo del Granado, Asgeir Tomasgard, Powering Europe with North Sea offshore wind: The impact of hydrogen investments on grid infrastructure and power prices, Energy, Volume 263, 2023,

- https://doi.org/10.1016/j.energy.2022.125654.

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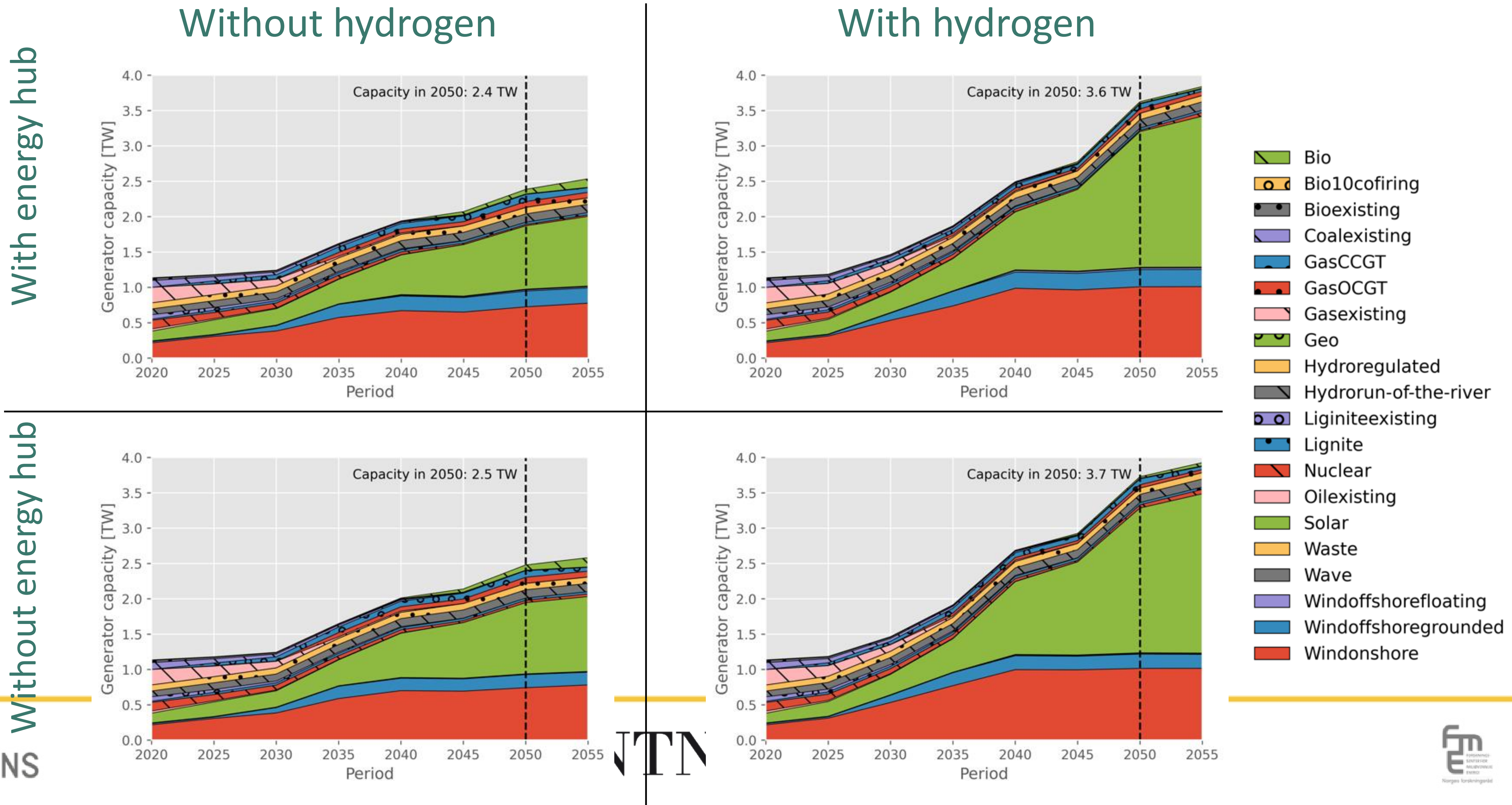
European generation capacity



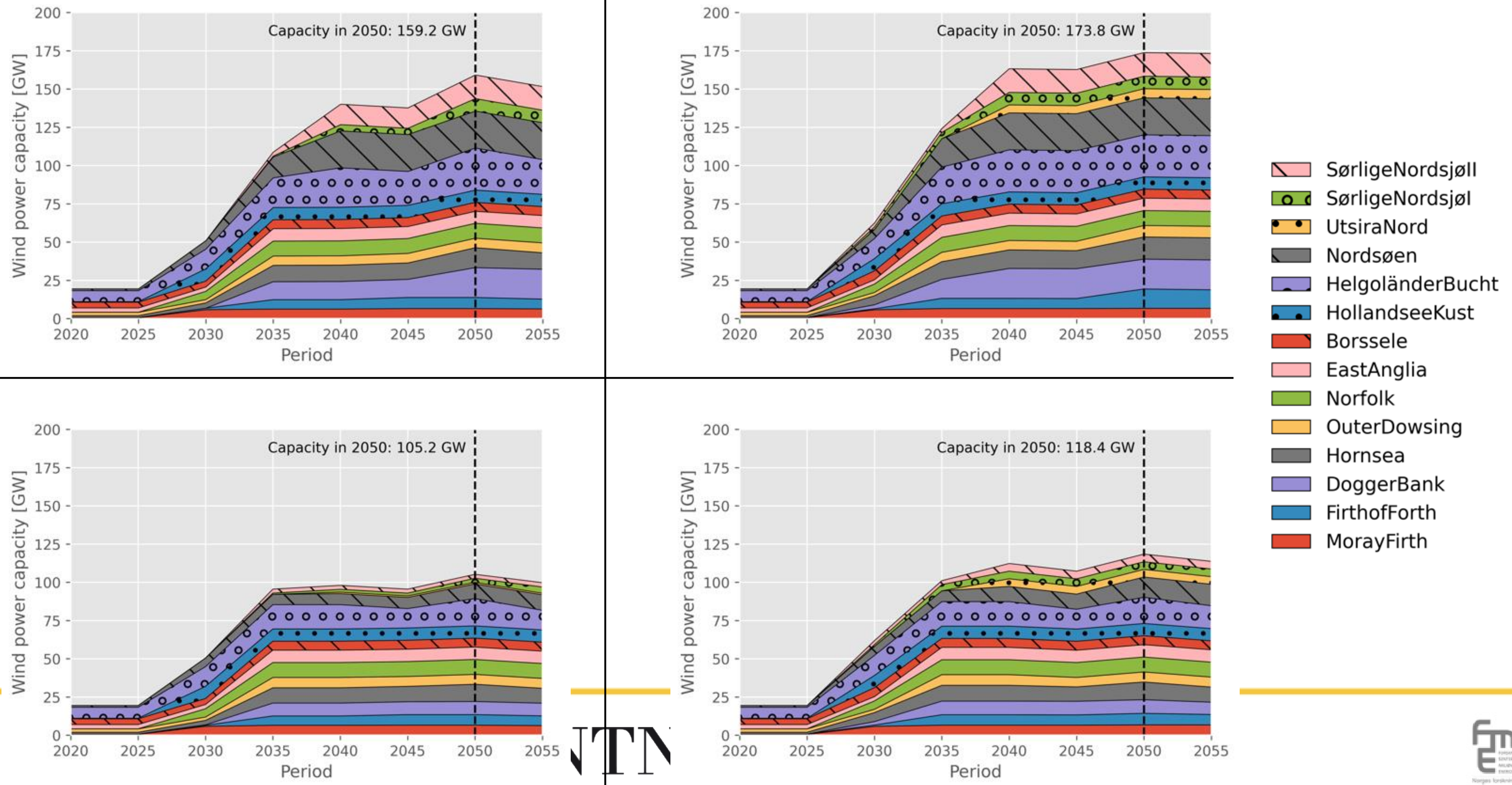
North Sea offshore wind investments

Without hydrogen

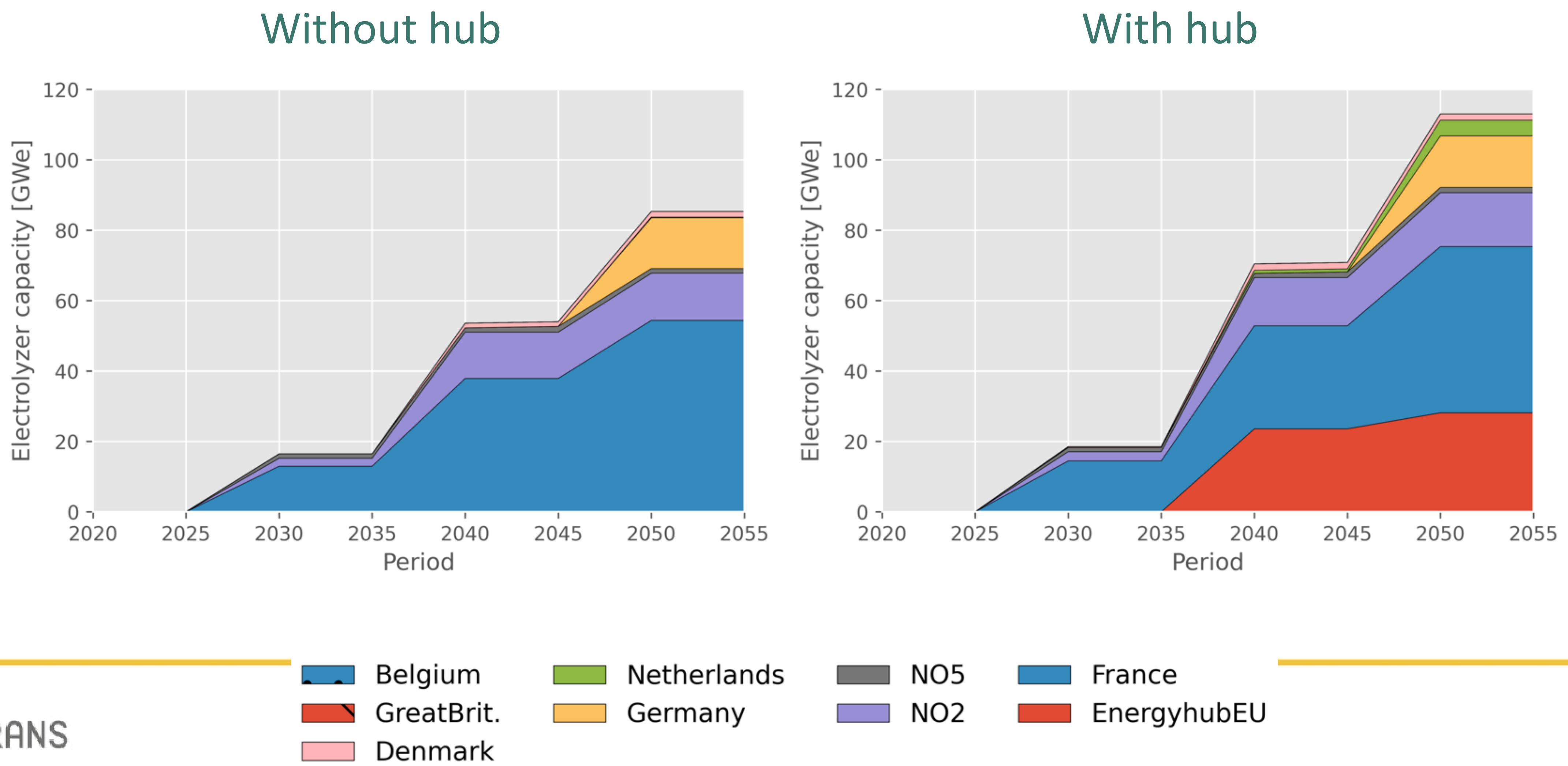
With hydrogen

With energy hub

Without energy hub



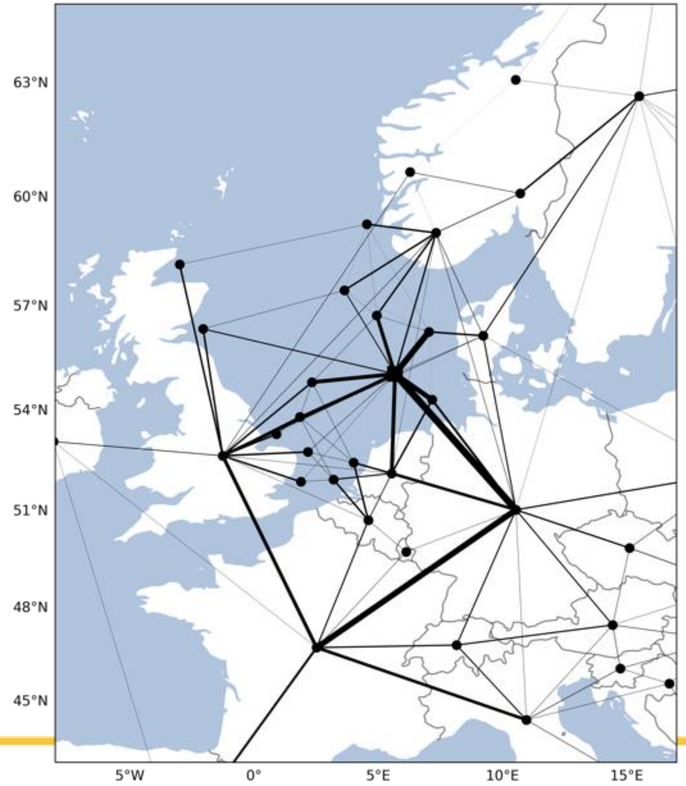
Placement of electrolyzer capacity in North Sea

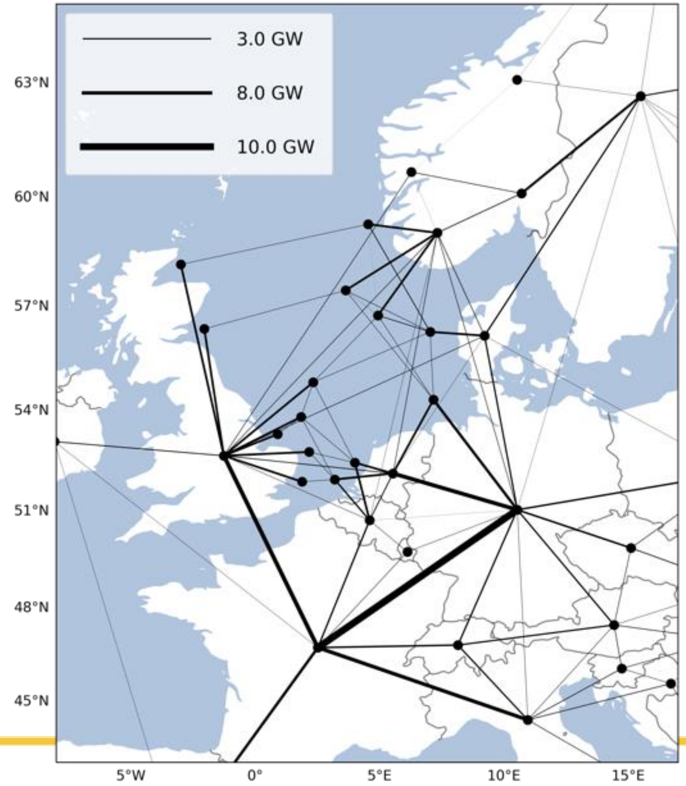


Interconnection capacity

	Without hydrogen	With hydrogen
With offshore energy hub	248.7	264.8
Without offshore energy hub	154.0	165.0

North Sea grid transmission capacity (GW)





Key findings for the power system in Europe

- **Natural gas** still remain in the mix to provide flexibility
  - But how should it be priotized
- **Onshore wind** become the most significant low carbon technology
  - 1/3 of the mix in Europe
  - more than the share of solar PV and offshore wind combined
- **Transmission** is the favored flexibility measure
- **Hydropower a unique resource**.

Policy needed

- Sector coupling essential:
  - heat, transport, industry
  - power, gas, hydrogen
- Hydrogen will have a major effect on the power and gas markets.
  - How will the energy be provided?
  - Where will it be produced
  - The North Sea seems to play a role