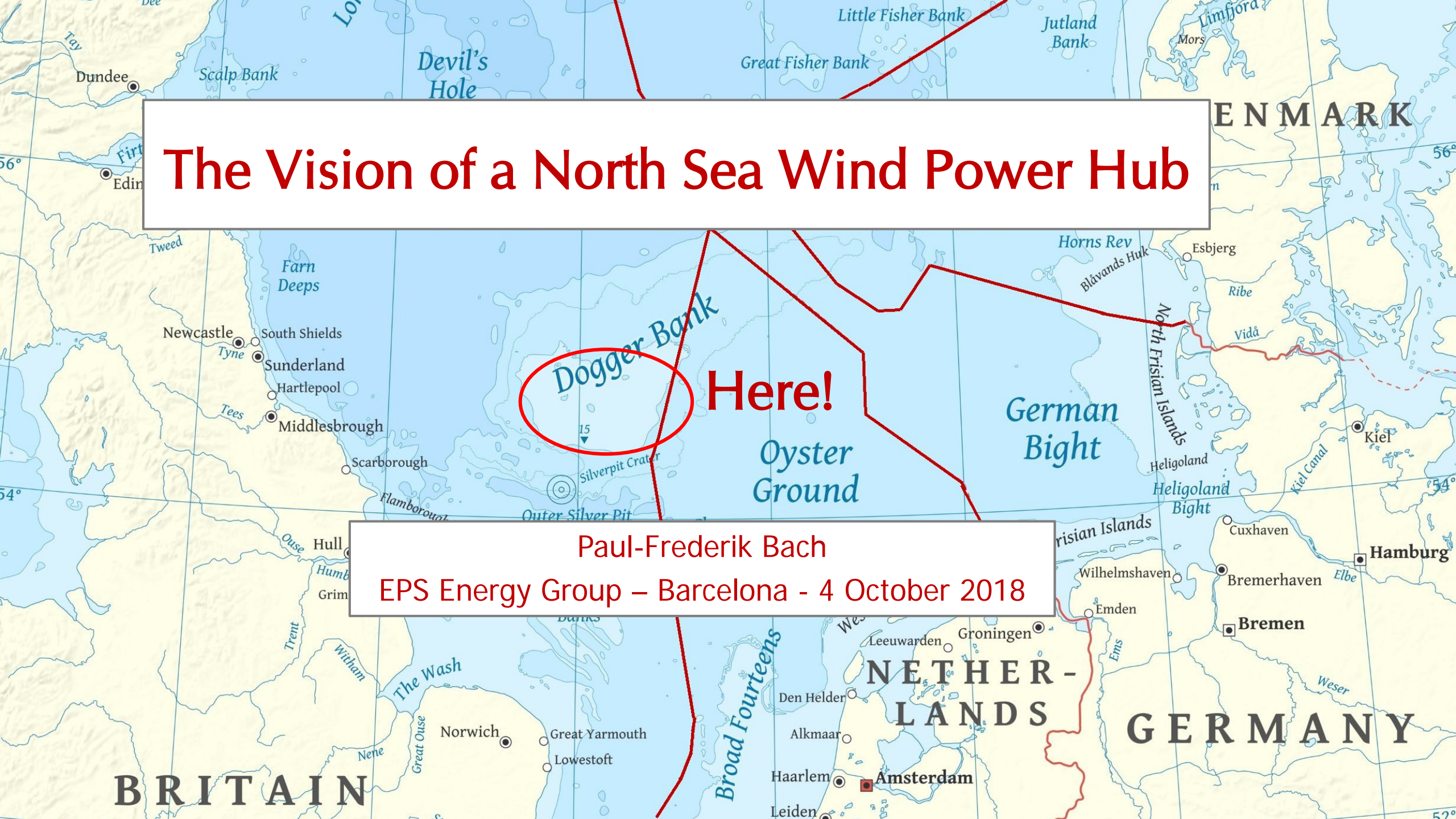


The Vision of a North Sea Wind Power Hub

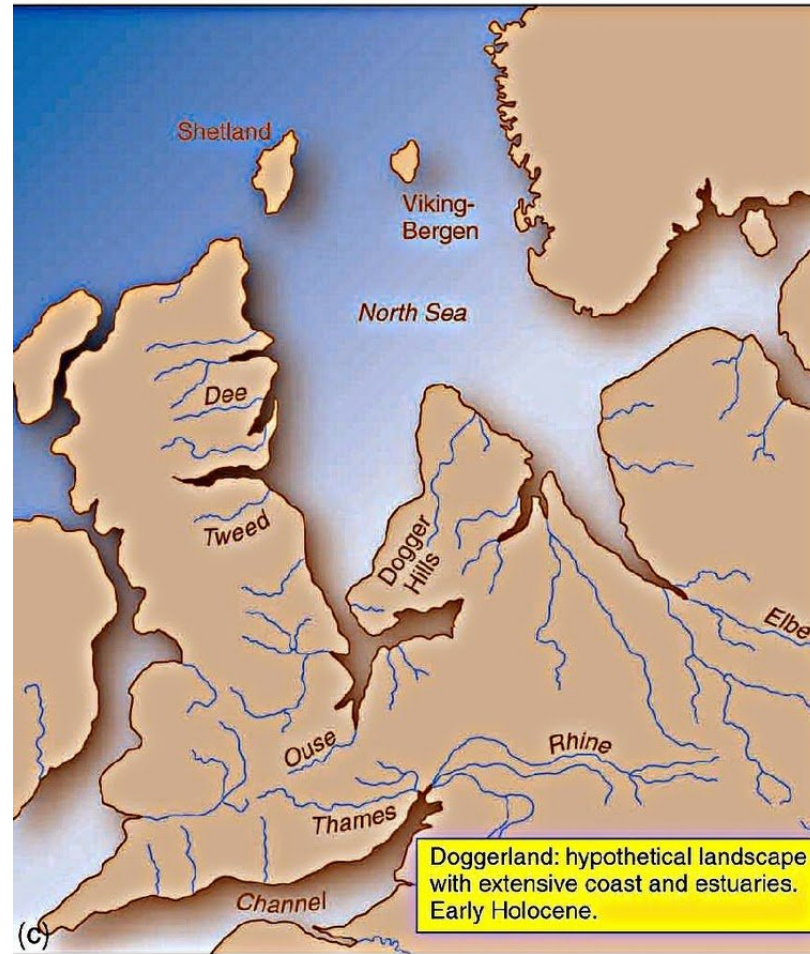
Here!

Paul-Frederik Bach
EPS Energy Group – Barcelona - 4 October 2018

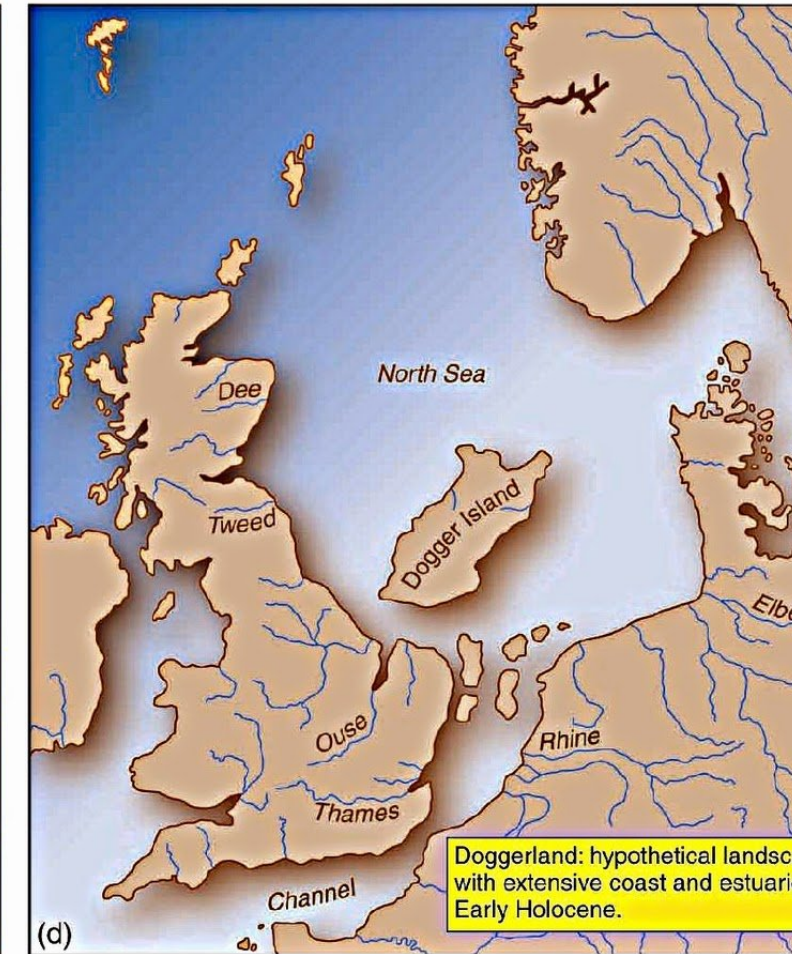


There have been people living in Doggerland (later Dogger Island)

- British and Dutch archaeologists have found remains at the sea bed.
- The Doggerlanders were hunter-gatherers
- Melting ice flooded the people out of their hunting grounds.
- The water level has changed at least 50 m at the Dogger Bank.
- Next time we could be the climate refugees.



About 9,000 years ago



About 7,500 years ago

Maps from Geographical News

Why Offshore Wind Turbines?

■ Advantage

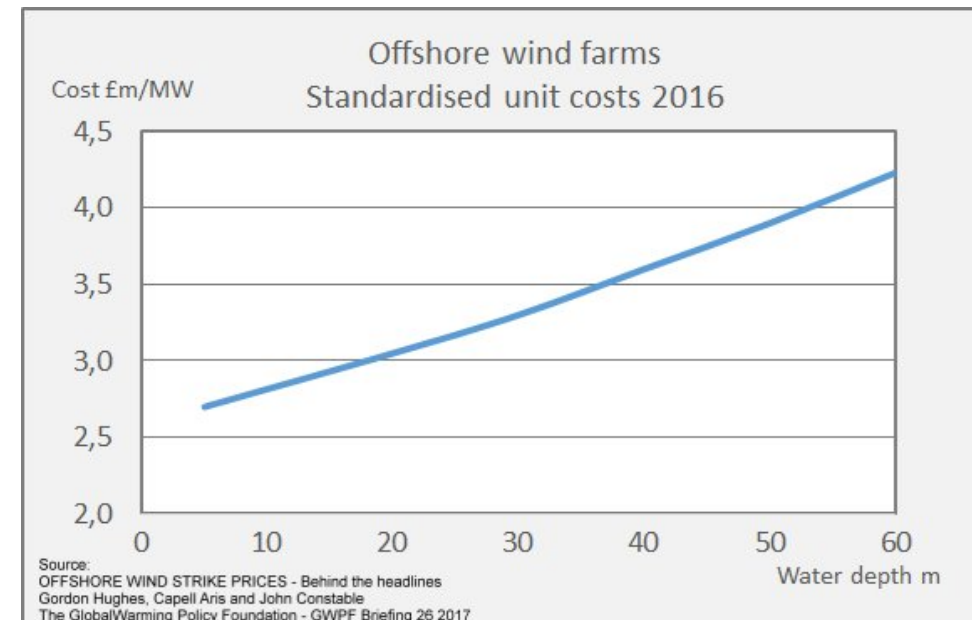
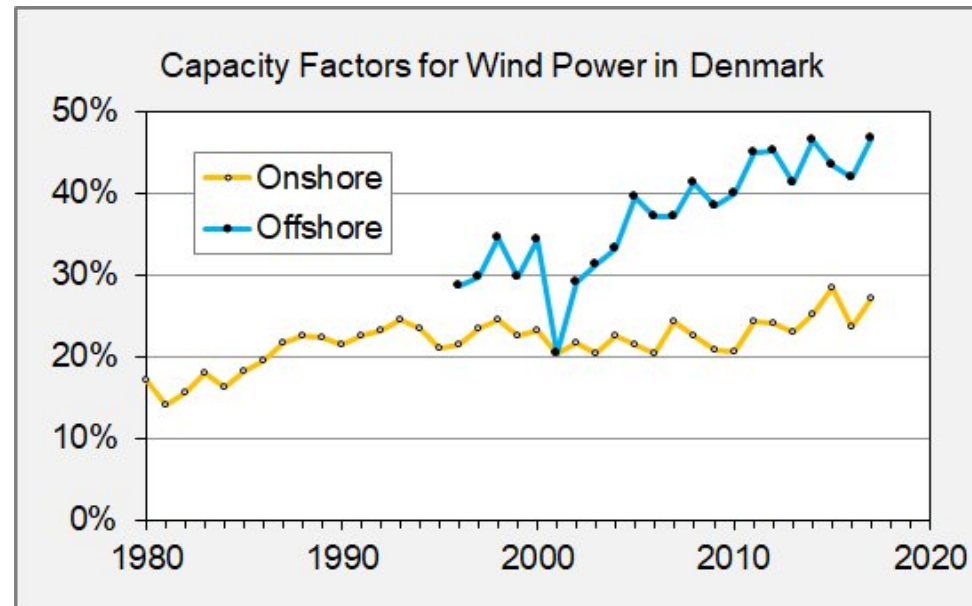
- More energy
- The North Sea has more wind than other Danish waters

■ Challenges

- Construction in deep waters is expensive
- The feeder lines get longer

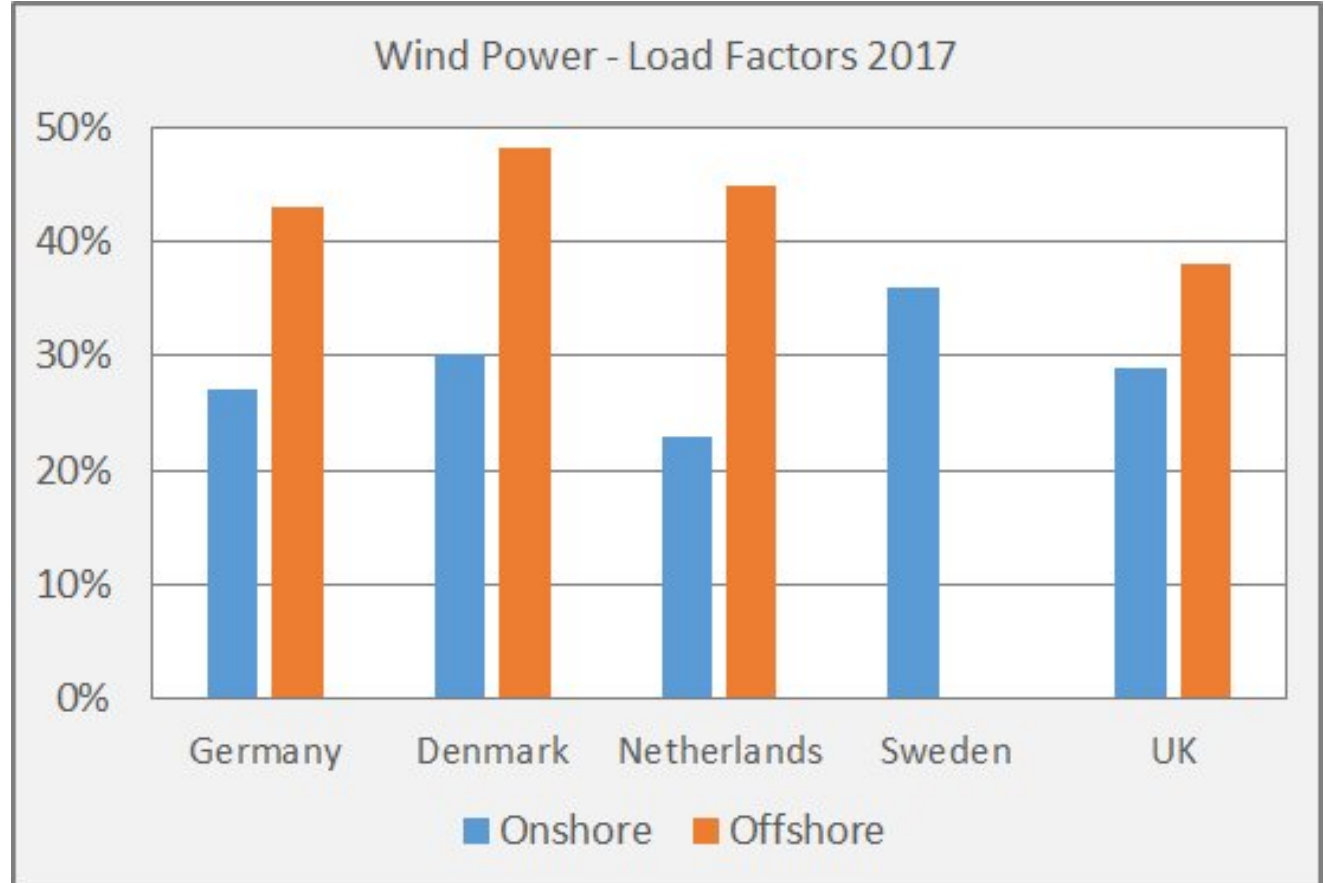
■ Wanted

- Shallow waters
- Short feeder lines



Neighbouring countries

- Load factors depend on type of wind turbine, location and surroundings
- On Dogger Bank, load factors will be the best possible
- The electricity consumption has an even larger load factor, e.g.
 - 71% in Germany
 - 65% in Denmark
- High load factors mean not only more energy, but also
 - less backup energy (not necessarily less backup capacity)
 - less energy overflow



The load factors may be inaccurate if the installed capacity has changed during the year

Shortage of nearshore sites with shallow waters

Anger over new nearshore wind farms

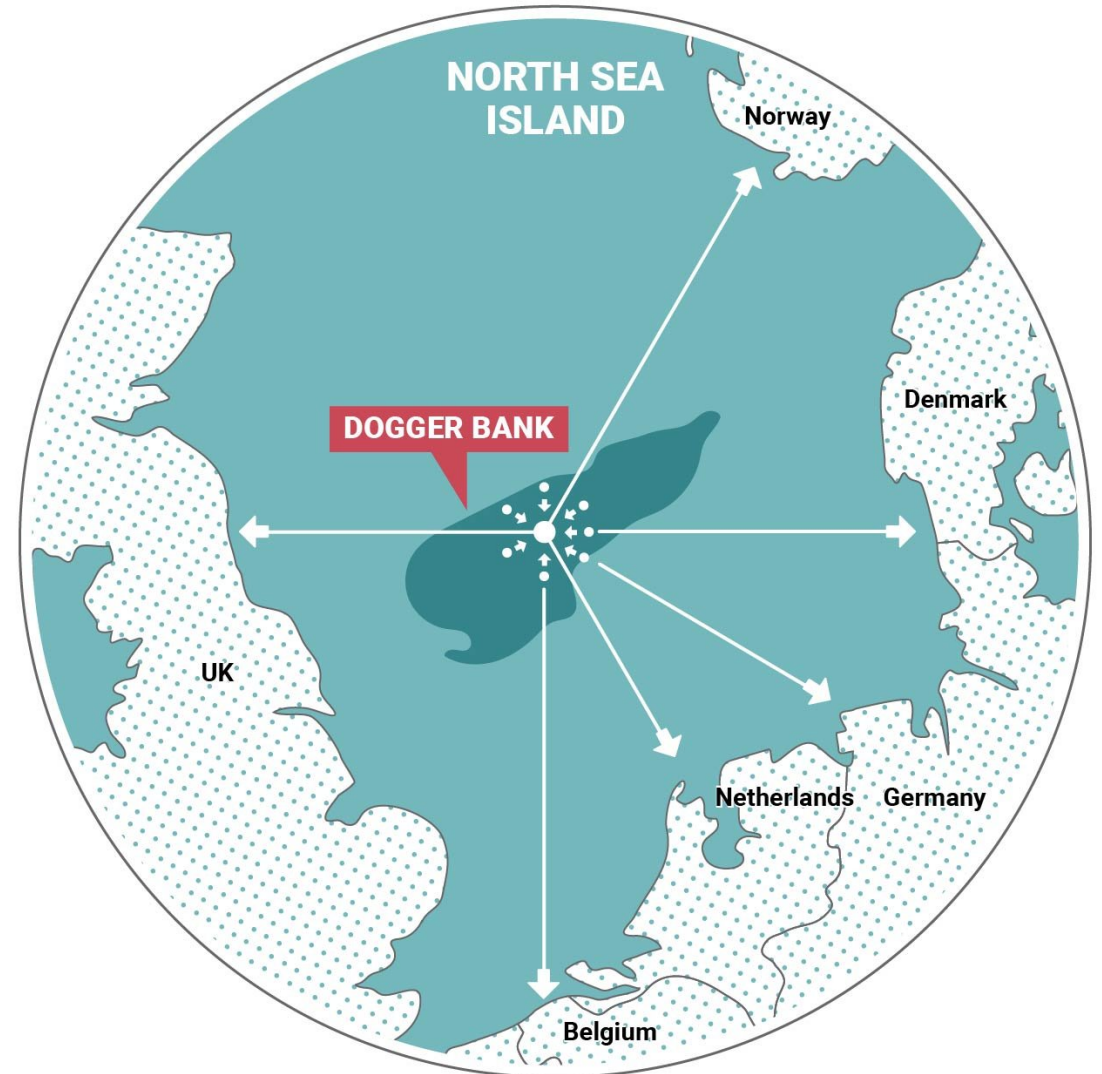
Horns Rev 1+2+3

A new ressource?



The idea

- New wind farms on the Dogger Bank
- An artificial island for collection of production at short distances
- Transmission cables from the hub to Denmark, Germany, the Netherlands, the UK and Norway also form an interconnection grid
- An international group is examining possible solutions
- The project partners:
 - Tennet, DE and NL
 - Energinet, DK
 - Gasunie, NL and DE
 - Port of Rotterdam, NL
- Project web site:
 - <https://northseawindpowerhub.eu/>

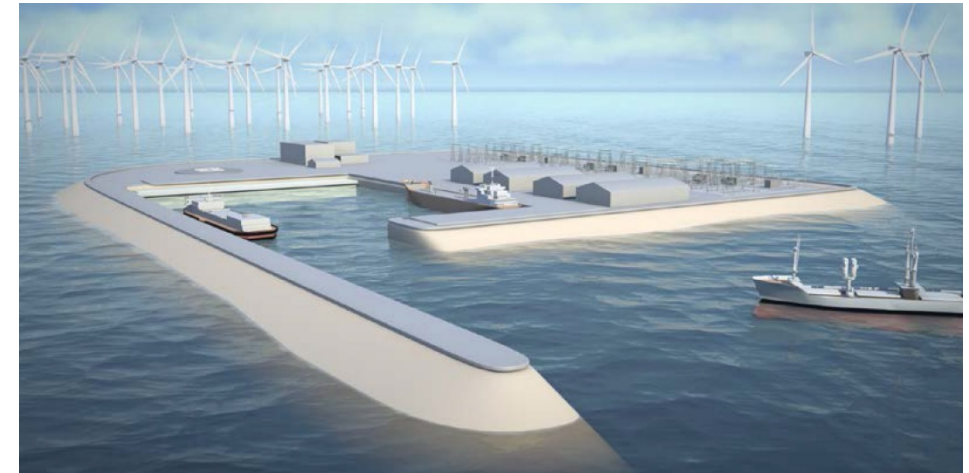


Source: TenneT

The artificial island

- 500 ha, including
 - Harbour
 - Air strip
 - Power conversion and energy storage
 - Maintenance facilities
 - Living quarters
 - Nature

- “Lean island”, including
 - Harbour
 - Power conversion
 - Maintenance facilities





COMPARISON MAASVLAKTE 2 & NSWPH

	MV2	NSWPH
Context >	National	International
Purpose >	Container, distribution & industry	Power Hub, conversion & wind farm services
Area >	2000 / 1000 ha	500 ha (incl. 100 ha nature)
Max wave height >	8,5 m	12 m
Revetments >	3,5 km	ca 7 km
Sand coast >	7,5 km	Ca 1,5 km
Amount of Sand >	240 million m3	200 million m3
Construction period >	3 years	7 years



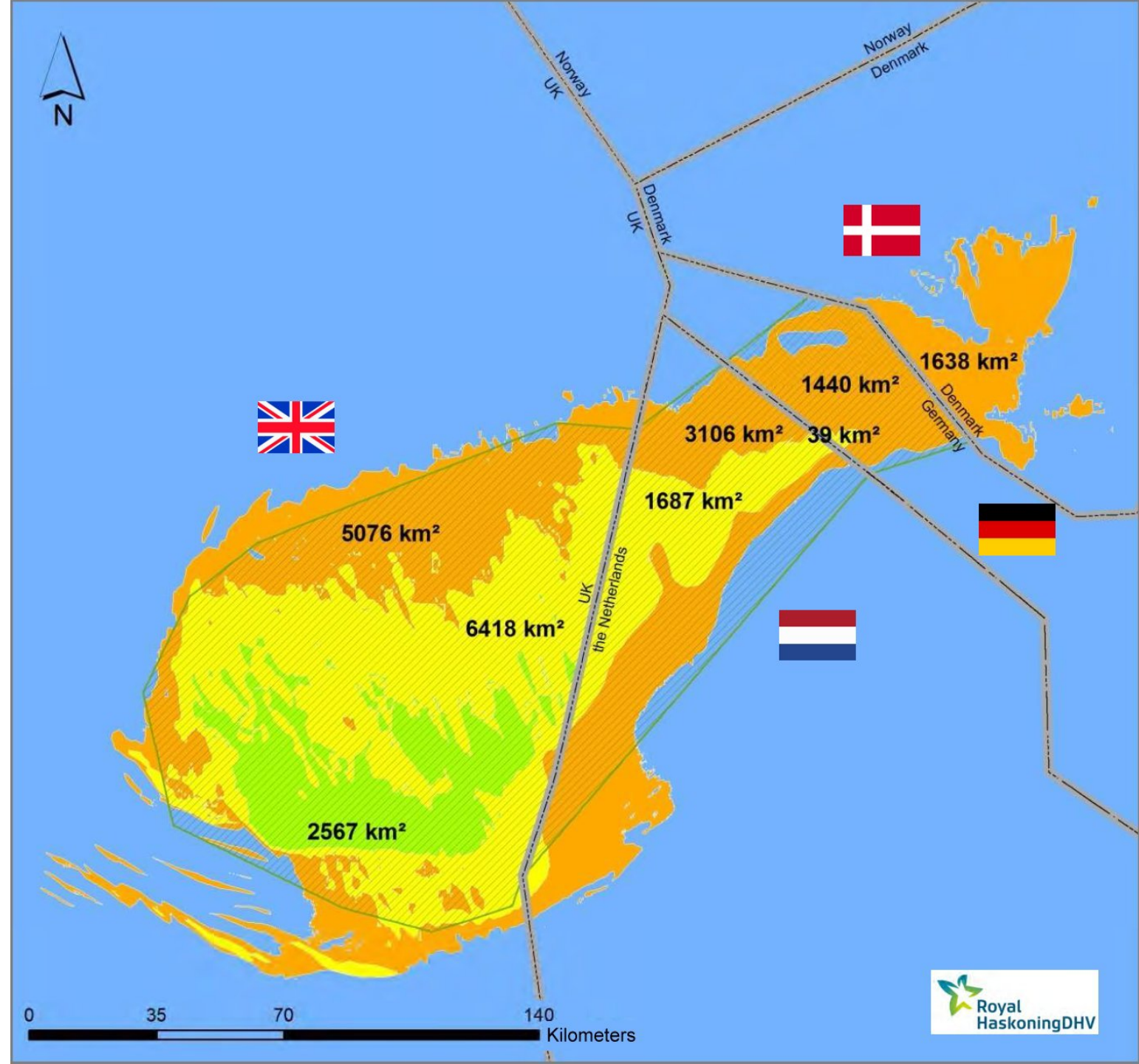
Legal issues

■ Territories

- Most of the Dogger Bank is British

■ Nature

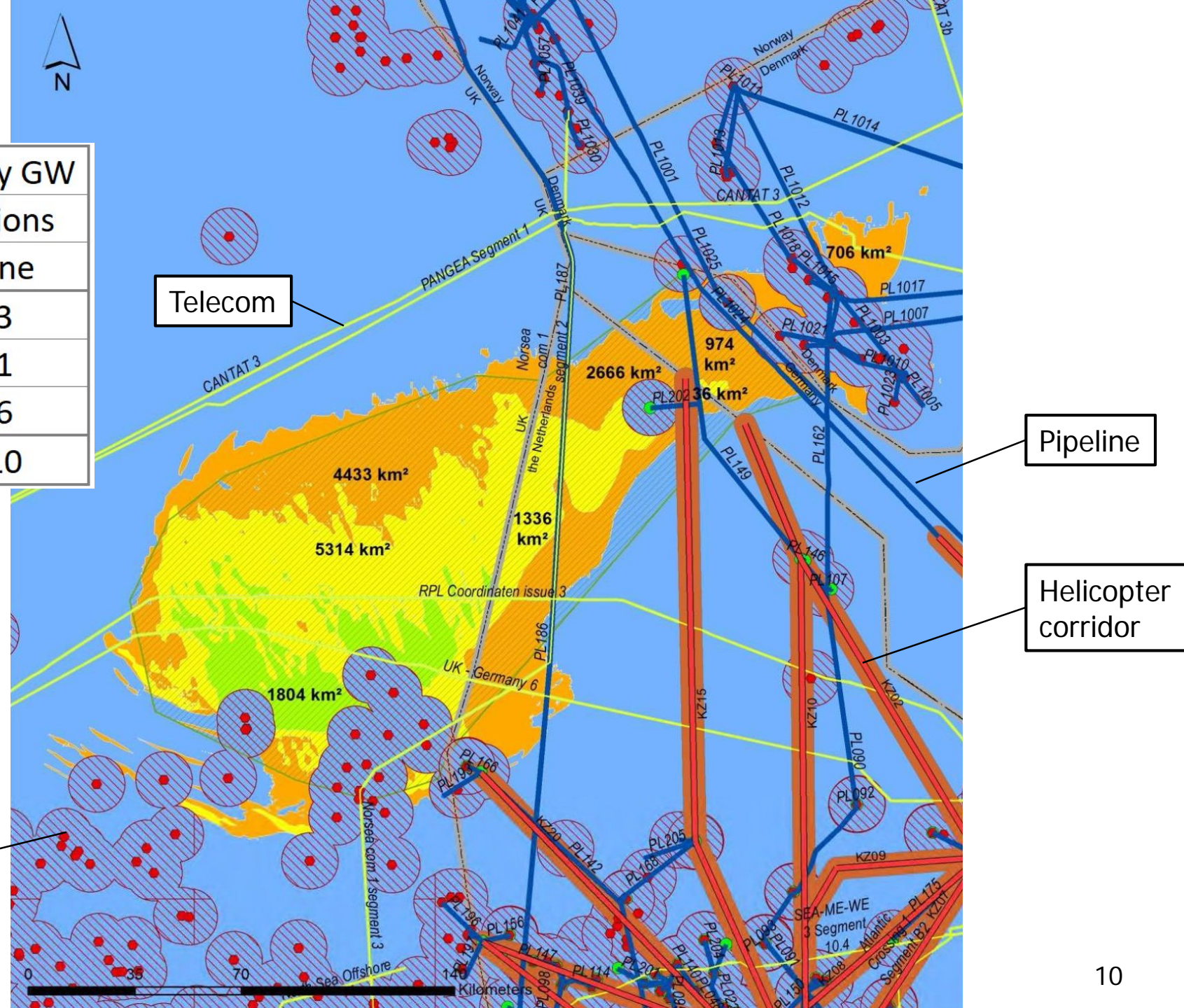
- Natura 2000 (includes the British, Dutch and German territories)



Other activities

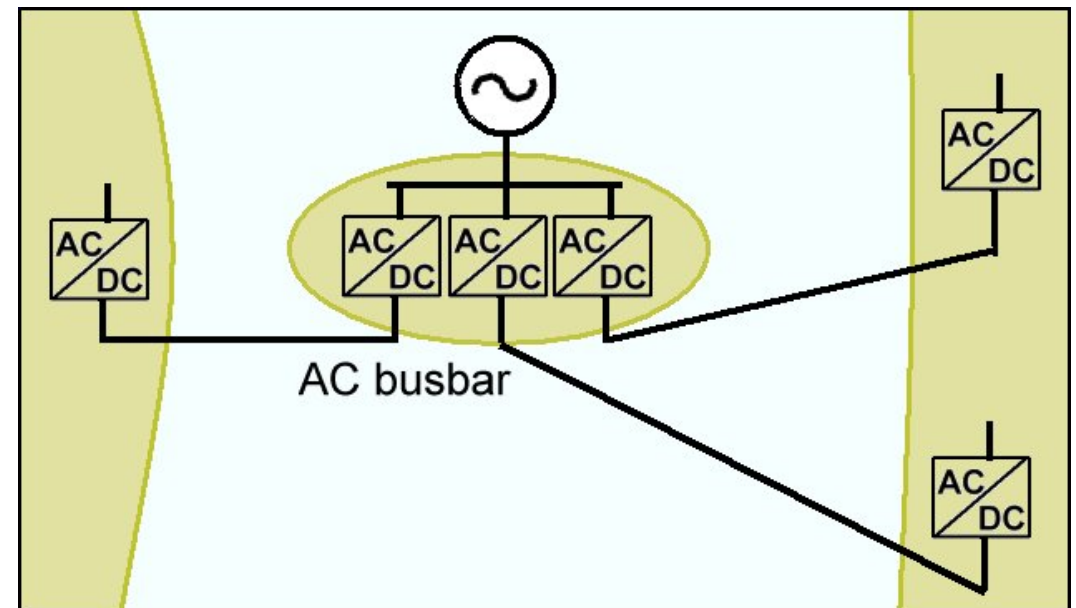
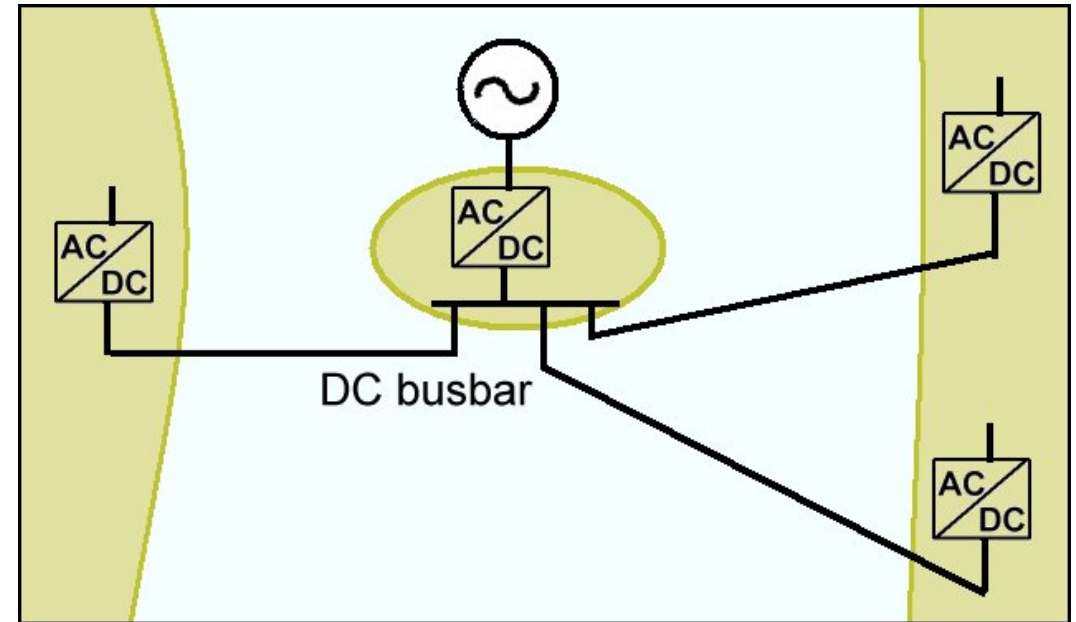
Estimated wind power capacity GW		
	Oil and gas functions	
Depth m	Present	None
0-20	9	13
20-30	33	41
30-40	44	56
Total	86	110

- Oil and gas installations are supposed to become decommissioned
- First stage assumed to include 30 GW



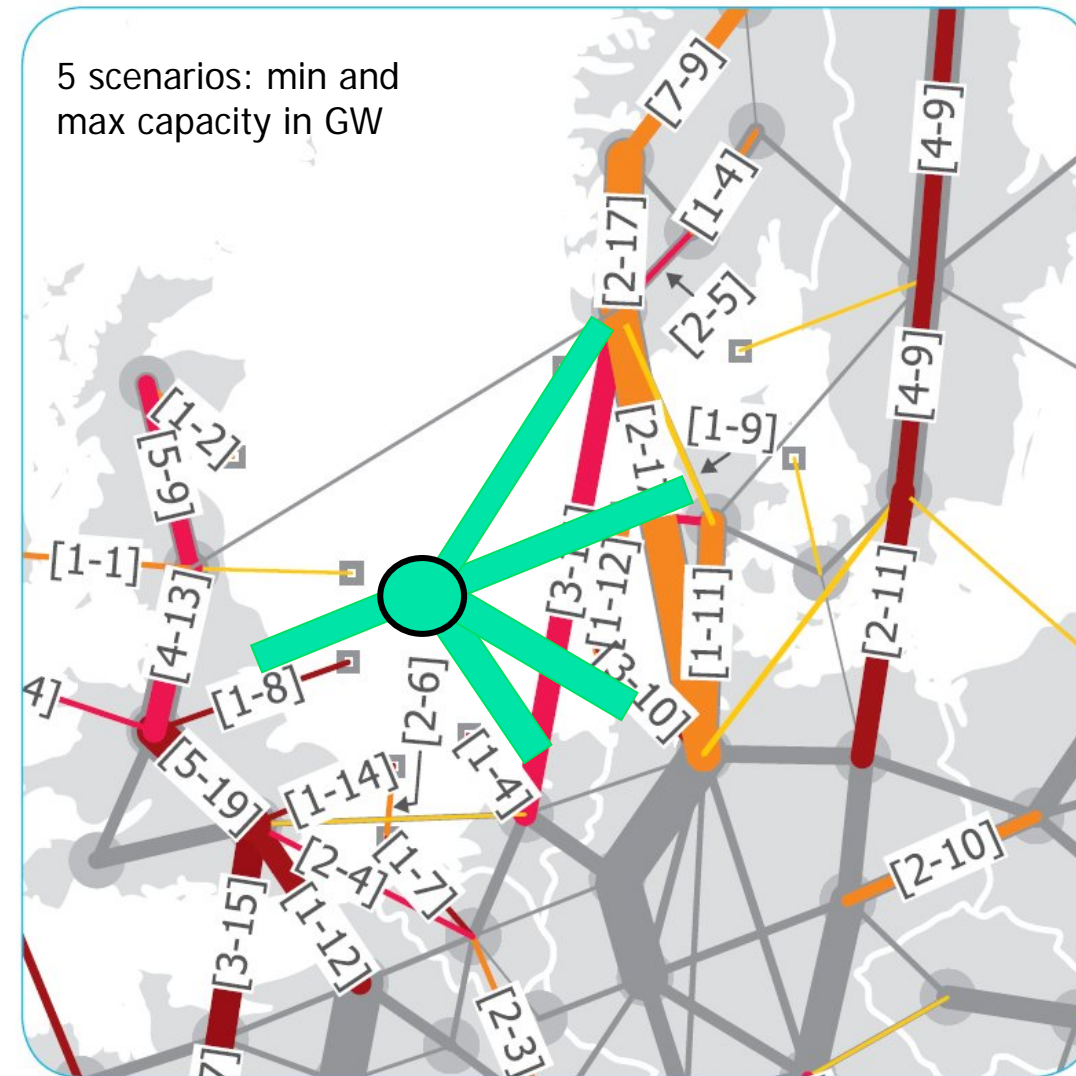
Transmission options

- Multi-terminal HVDC grid
 - The technology is not yet mature
- Point-to point HVDC connections
 - The secure operation of an isolated AC grid will be a real challenge
 - The AC busbar will be a vulnerable element
 - The inertia from rotating engines is important for the stability of normal AC grids.
 - Zero-inertia or low-inertia AC busbar?
 - Frequency: 50 Hz or something else?
 - The sudden loss of e.g. 30 GW must be avoided
 - The European grids would not survive it
 - Typical sudden losses ("N-1 events") can be 1 to 3 GW depending on largest component
 - E.g. the loss of 1.4 GW caused blackout in parts of Arizona, California and Mexico in 2011



Future Transmission Corridors

- The EU-supported project, *E-highway 2050*, did not predict a North Sea grid
 - but between 15 and 115 GW wind power in the North Sea with direct links to the coast were assumed
- Based on 5 scenarios for 2050 a *least-regret grid 2040* was designed
- A North Sea grid with a 30 GW hub would completely change the topology of the power grid in northern Europe.
- If the results of the current study confirms the expectations of the consortium, the work should be extended to at European forum
- A redesign of the *least-regret grid 2040* would be a natural next step



Europe's future secure and sustainable electricity infrastructure e-Highway2050 project results, November 2015

Electricity Markets

- European power trading arrangements are different and complex
- There are several power exchanges in Europe
- Output from the North Sea Power Hub could be sold via
 - Nordpool Spot
 - EEX
 - APX
 - N2EX
- It is not known which trading arrangements the consortium envisages for the North Sea hub
- Future trading opportunities are as important for the project profitability as the technical solutions

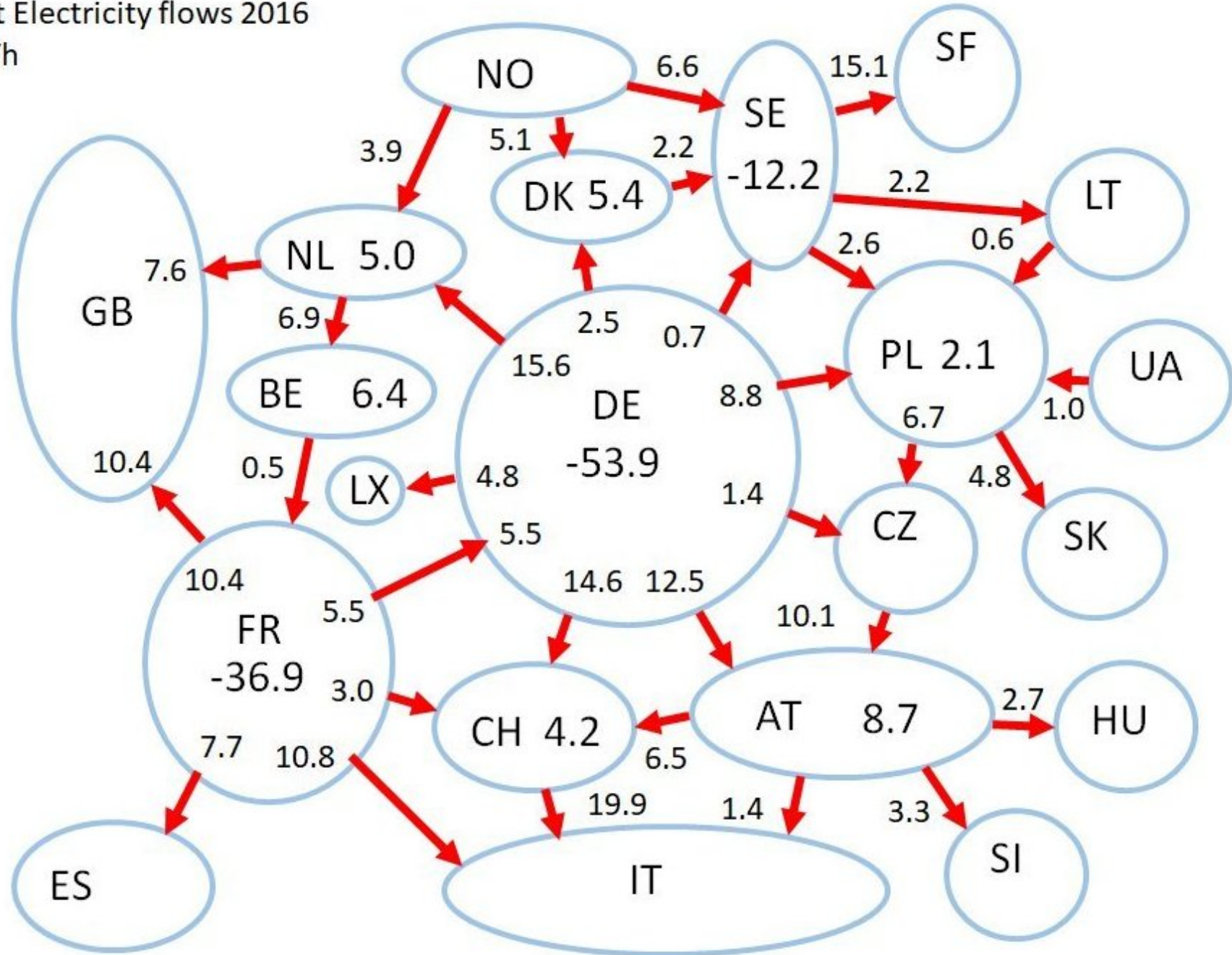
Electricity Power Exchanges in Europe





Thank you!

Net Electricity flows 2016
TWh



2017

Net electricity flows 2017
TWh

