

TenneT offshore

PROMOTioN Workshop

A photograph of an offshore wind farm construction site. In the foreground, a large, dark, coiled cable or hose is visible. In the middle ground, a worker in a red suit and white helmet stands on a blue metal platform. To the right, a large, yellow, cylindrical structure is being lifted or moved by a crane. The background shows a clear blue sky with a few clouds.

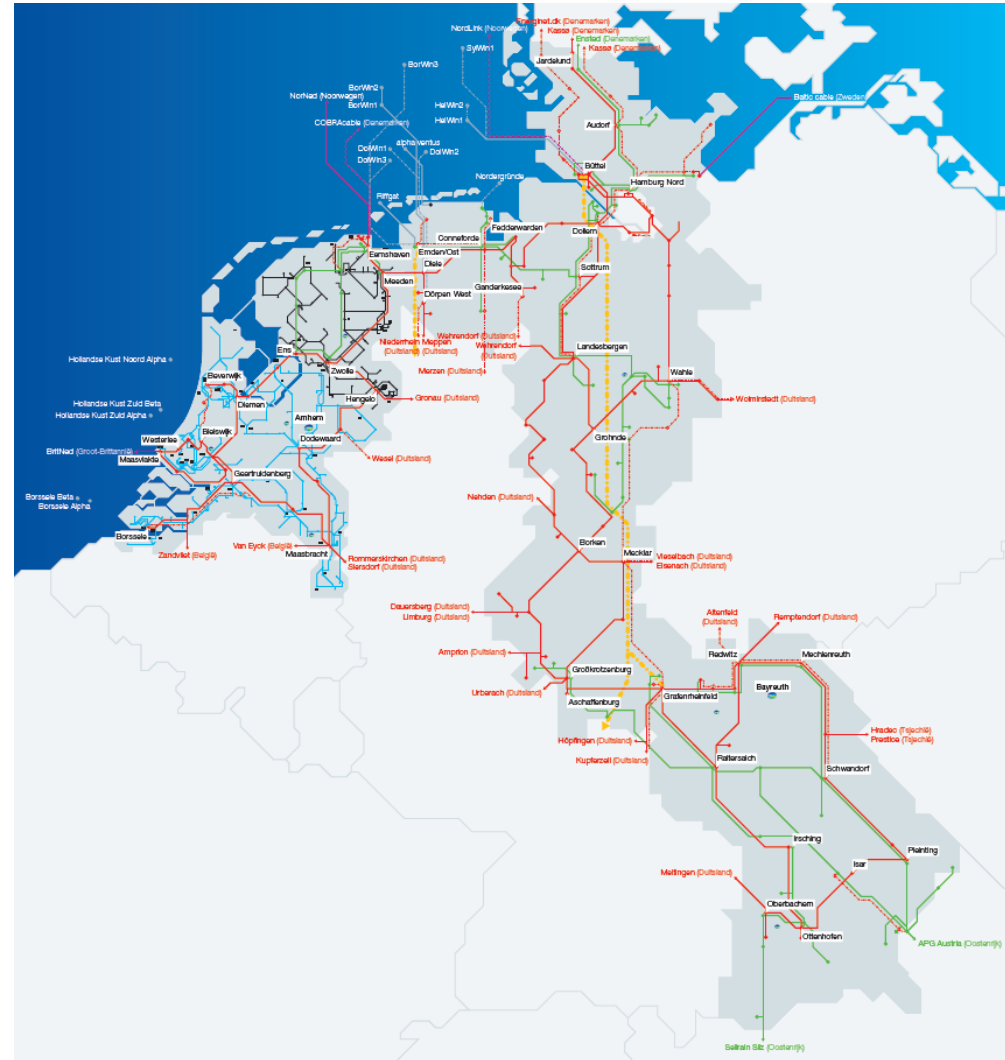
Thomas Donders
Edinburgh

05.10.2016

TenneT at a glance



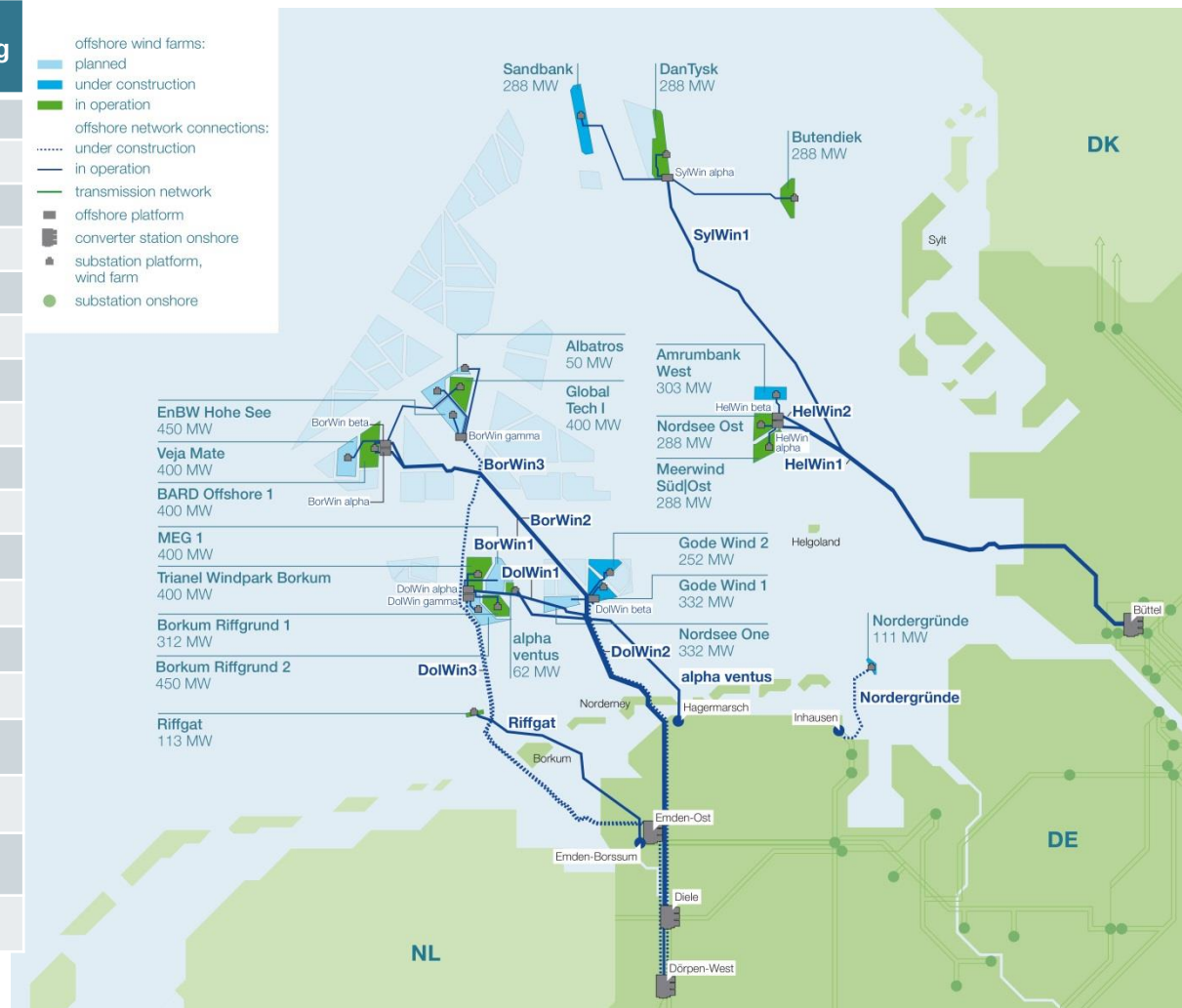
- Europe's first cross-border grid operator for electricity
- Top five grid operator in Europe
- International offshore division
- 21,000 km high-voltage lines
- 41 million end-users
- ~3000 employees
- 2015: Revenues EUR 3.3 bn
EBIT EUR 1,1 bn
Assets EUR 15,4 bn
- 99,99% security of supply
- Owned by Dutch State



Offshore experience Germany



Project	Capacity (MW)	Commissioning
Operational		
alpha ventus	62	2009
BorWin1	400	2010
BorWin2	800	2015
DolWin1	800	2015
HelWin1	576	2015
HelWin2	690	2015
Riffgat	113	2014
SylWin1	864	2015
Under construction / awarded		
BorWin3	900	2019
DolWin2	916	2016
DolWin3	900	2017
Nordergründe	111	2016
Σ	7.132	
To be built by 2025 in accordance with O-NEP		
One HVDC connection	900	
As of November 2015		



Offshore experience Germany



HelWin 2



690 MW, 2015

DoWin 2



900 MW, 2015

DoWin 3



900 MW, 2017

Experiences in Germany



- 6,5 GW by 2020
- Realistic planning
- Masterplan
- Coordination with onshore
- Standardisation
- Synergies in O&M
- Clarity liabilities and risks
- Bundling infrastructure



Dutch offshore grid strategy



Offshore grid development

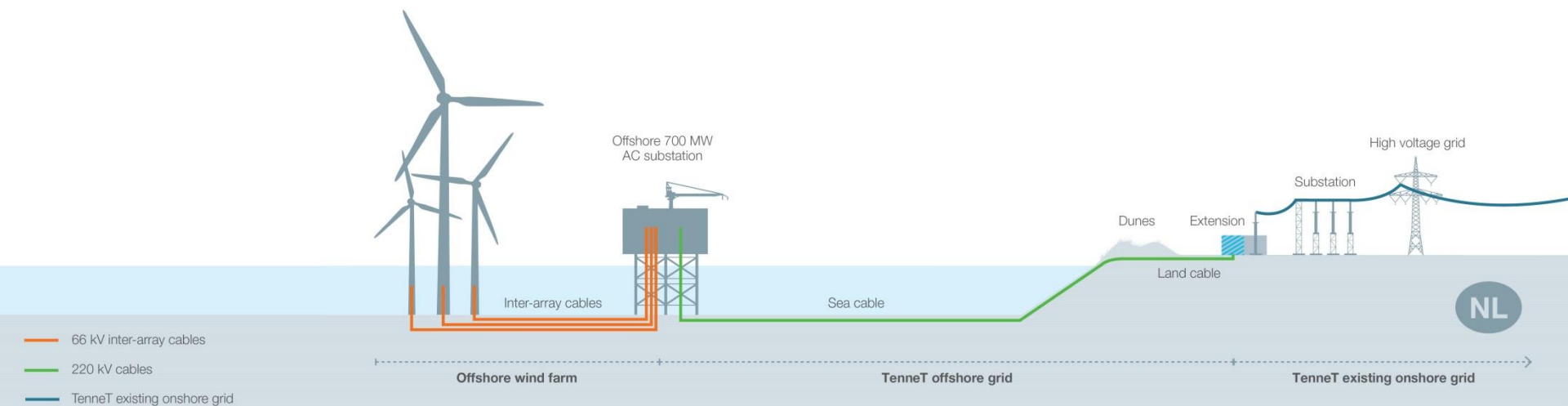
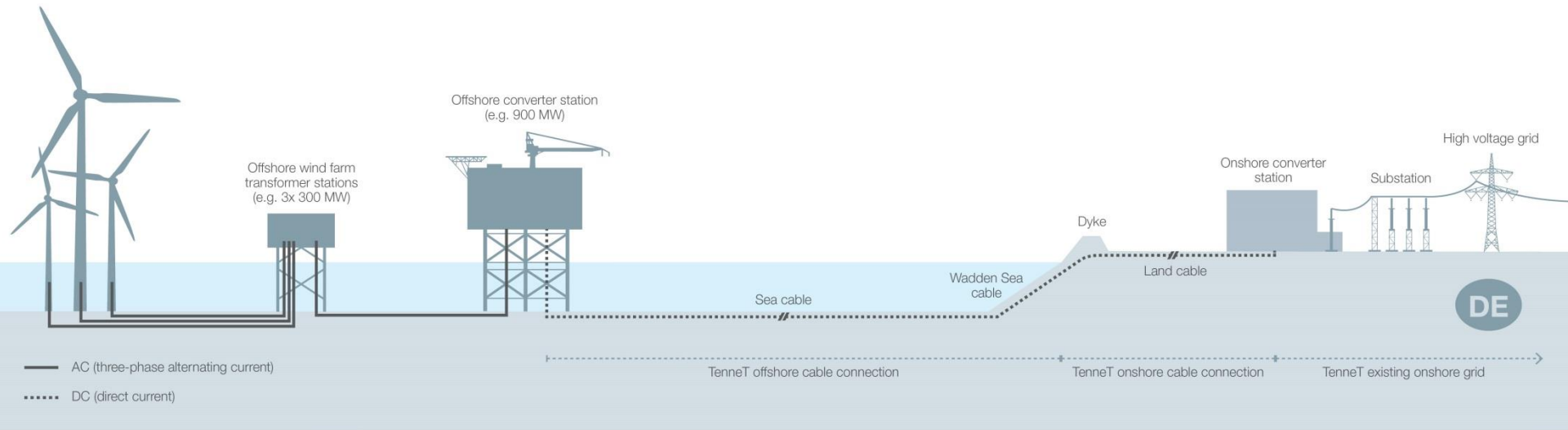


- Five wind areas of 700 MW
- Lowest possible LCOE
- Planning of the 'Energy Agreement'
- Future proof
- Minimal habitat disturbance
- Innovative

Year	Subsidy	Area
2016	700 MW	Borssele
2016	700 MW	Borssele
2017	700 MW	Hollandse Kust: Zuid Holland
2018	700 MW	Hollandse Kust: Zuid Holland
2019	700 MW	Hollandse Kust: Noord Holland



Schematic comparison DE - NL



Tonstad

NO

DK

Flensburg

DE

Hagermarsch

Inhausen

Wilster

NordLink

- TenneT (25%), KfW (25%), Statnett (50%)
- First direct connection between German and Norwegian electricity markets
- 623-km-long HVDC cable link, capacity of 1,400 MW, ready by 2020
- Connecting Norwegian hydropower to German wind and solar energy; natural storage of wind energy



COBRAcable

- TenneT (50%), Energinet.dk (50%)
- First direct connection between the Dutch and Danish electricity markets
- 325-km-long HVDC cable link, capacity of 700 MW, operational ready by 2019
- Multi terminal ready: prepared to connect wind farms
- Connecting Danish wind power to Dutch/European wind and solar energy
- Security of supply

TenneT offshore by 2023



Germany

- Fifteen grid connections for offshore wind farms
- Twelve DC connections, three AC connections
- 4,300 MW at present
- 9,832 MW by 2023 (7,132 MW by 2019)
- NordLink: 1,400 MW (2020)

Netherlands

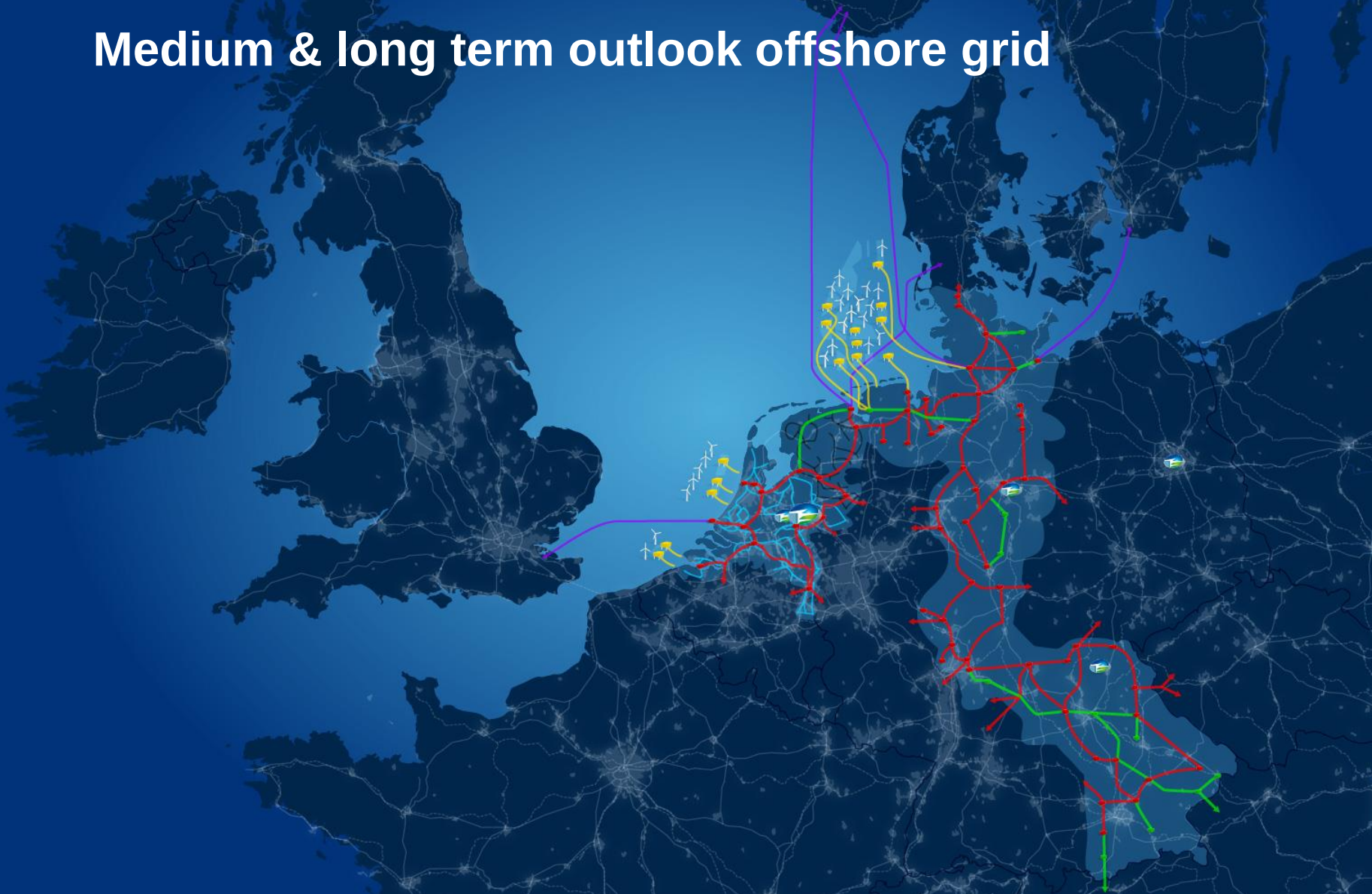
- Five grid connections for offshore wind farms
- Only AC connections
- 3,500 MW by 2023
- NorNed (2008): 700 MW
- BritNed (2010): 1,000 MW
- COBRA cable (2019): 700 MW



By 2023 TenneT will have realized 17.1 GW of offshore connection capacity (13.3 GW for offshore wind energy, 3.8 GW for interconnection): 13,000 km cable.

Electrifying the North Sea

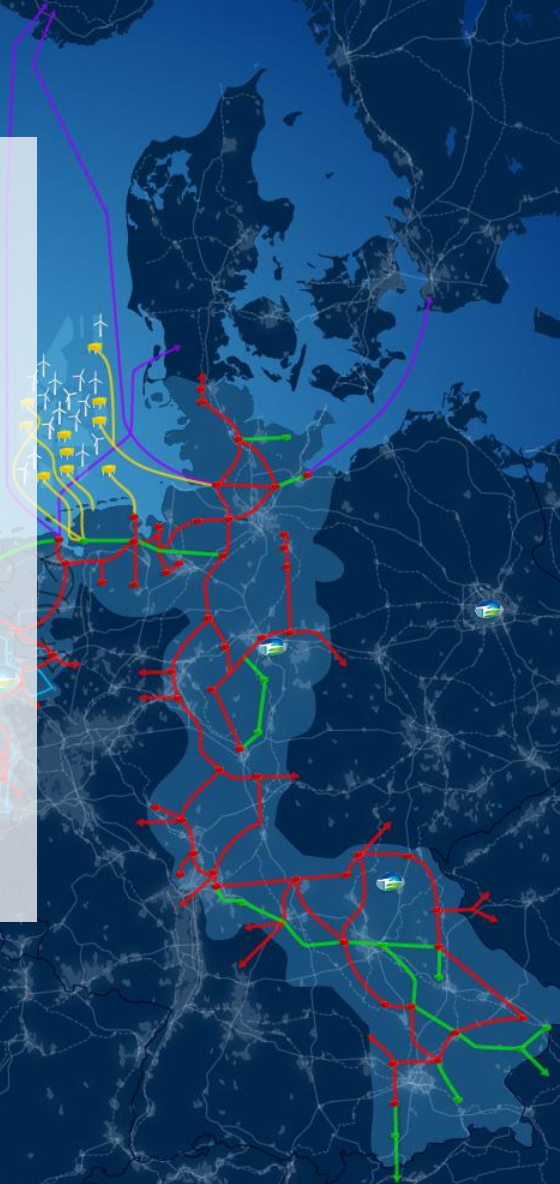
Medium & long term outlook offshore grid



The European energy transition

Ambitious goals

- EU ambition: 80-95% CO₂ reduction in 2050 compared with 1990 levels
- Large volumes of RES needed:
 - 2000 GW of sun PV required to cover 50% of the electricity demand (TU Delft)
 - 600 GW offshore & onshore wind power required to cover 50% of the electricity demand (WindEurope)
- Cooperation Member States is essential to reach the European energy goals
- Member States should agree upon targets/goals



The challenge

Sun has a huge potential, still vast amounts of wind are needed:

- Wind energy on land
- Wind energy near shore
- Wind energy far shore
 - Construction (expensive)
 - Maintenance (expensive)
 - Infrastructure (expensive)

Challenge

- How to get cost level down? Below or comparable to near shore
- How to integrate in the environment?
- How to cooperate internationally?



Solution: hub and spoke concept

Hub and spoke delivers

Scale: A large scale European roll-out for offshore wind delivers a significant contribution to cost reduction

Location: When far shore becomes necessary, shallow waters with better wind conditions contribute to cost reduction

Wind connector: The wind connector combines large scale wind farms with powerful interconnectors for more efficient use of the electrical infrastructure and further European Market integration

Hub function/ island: By building an island, a hub function can be created with virtual near-shore environment



Solution: location



When far shore becomes necessary to realize the required scale

Shallow waters

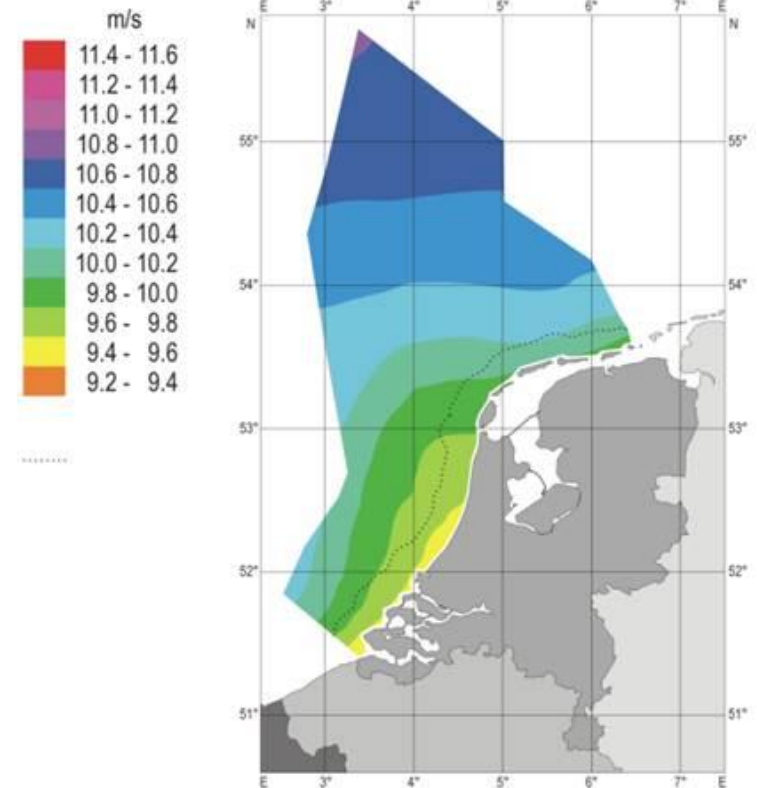
Water depth has a significant impact on the development for offshore wind. A development in shallow waters contributes significantly to cost reduction.

Wind conditions

Wind conditions get better further at sea, which has a substantial impact on the LCOE of offshore wind

Central location

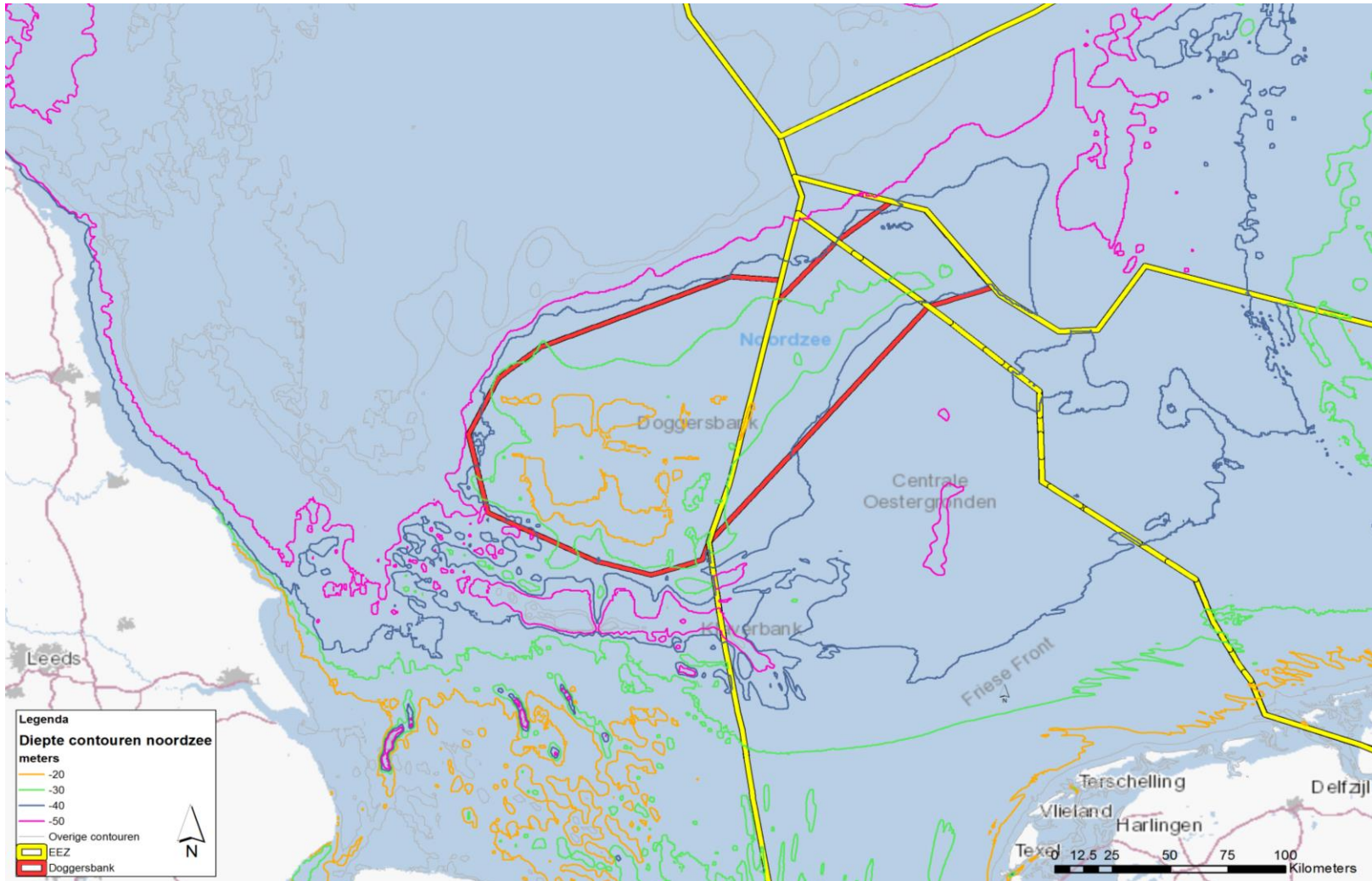
For a European coordinated roll-out, a central location is important.



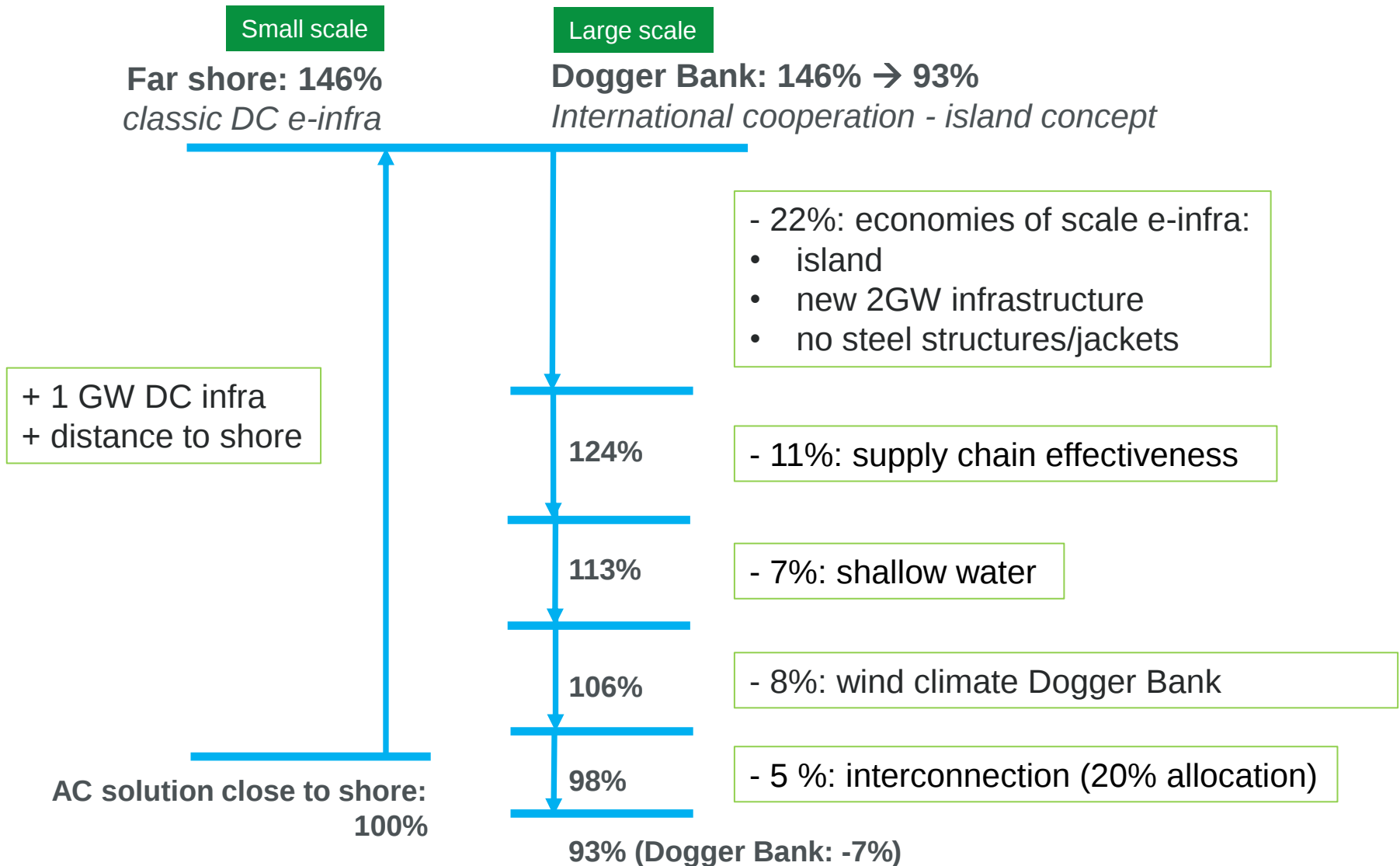
Solution: location



When far shore becomes necessary to realize the required scale

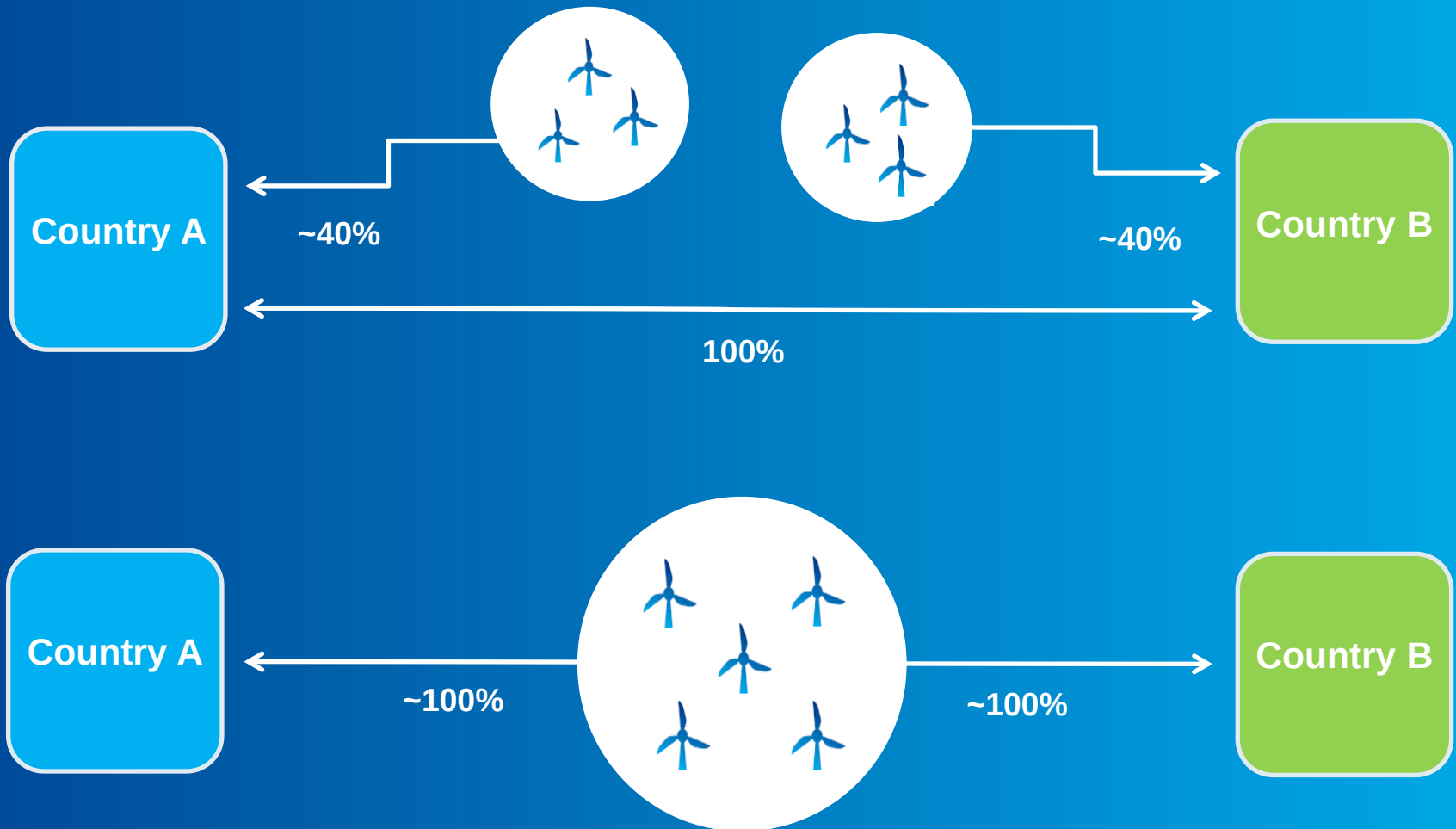


Solution: scale



Solution: the Wind Connector

The '*wind-connector*': wind infrastructure and interconnector combined in one function





Outlook

Integrating Offshore
Wind & Interconnectors

Medium term

Offshore grid concept for wind area
IJmuiden Ver

- Investigate:
 - Technology (AC, DC)
 - Combination of interconnector to UK (wind farm)
 - System integration with existing oil and gas infrastructure
 - Storage/conversion
 - Island solutions
 - Transport capacity onshore grid
- From approx. 2024 – 2035



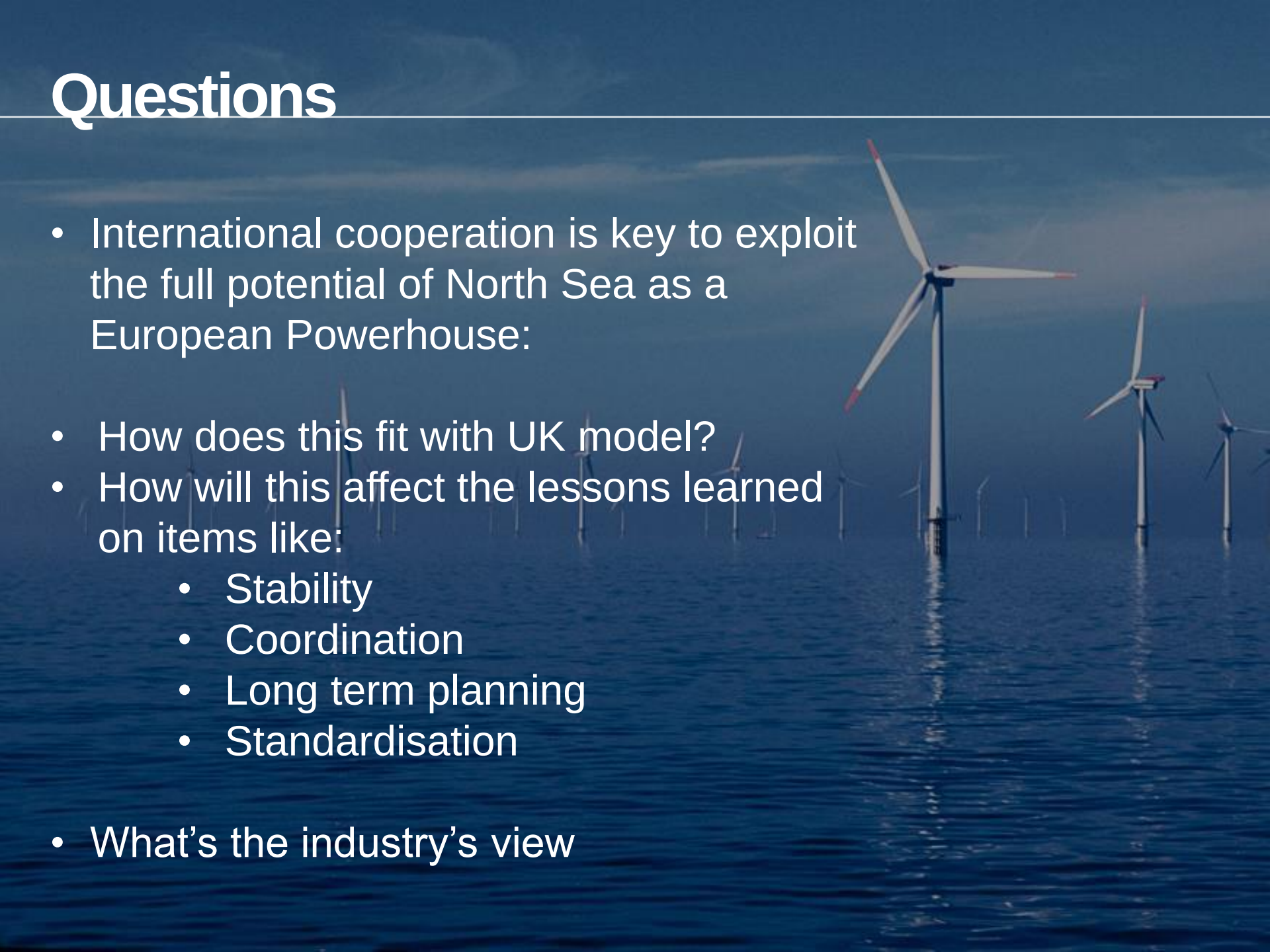
Long term

Further develop North Sea Infrastructure concept

- Start development now → in parallel with medium term developments
- Facilitate required economies of scale and cost competitiveness
- International cooperation
- Integrate in environment
- Development up to 2050



Questions

The background of the slide is a photograph of several offshore wind turbines in the North Sea. The turbines are white with three blades each, and they are mounted on tall, dark metal towers. The water is a deep blue, and the sky is a lighter blue with some wispy clouds. The turbines are arranged in a line, receding into the distance.

- International cooperation is key to exploit the full potential of North Sea as a European Powerhouse:
- How does this fit with UK model?
- How will this affect the lessons learned on items like:
 - Stability
 - Coordination
 - Long term planning
 - Standardisation
- What's the industry's view



Thank you for your attention !

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www.tennet.eu

TenneT is Europe's first cross-border grid operator for electricity. With about 21,000 kilometers of (extra) high-voltage lines and 41 million end-users in the Netherlands and Germany, we rank among the top five grid operators in Europe. Our focus is to develop a North-west European energy market and to integrate renewable energy.

Taking power further

