Creating the Future

Case study on megatrends in the Offshore Wind Industry

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Inn2Power midterm conference

Key tasks of a TSO

Our three key tasks

1 Transmission services

Constructing and maintaining a robust high-voltage grid.

2 System services

Maintaining the balance between electricity supply and demand 24/7.

3 Market facilitation

Facilitating a smooth functioning, liquid and stable electricity market.

Transmission

Production on new locations

- Nuclear & Coal phase out
- Sun, photo voltaic (decentral)
- Wind onshore
- Wind offshore

Longer distances

- Supply → demand
- Demand ⟷ demand

New social requirements

- Landscape
- EMF
- Cabling (joints)
- HVDC

→ wintrack

Transmission

Development TenneT 2002-2017

	2002	2017
Balance sheet (€ bn)	1	20.2
Staff (internal)	276	3,040
Connections (km)	2,686	22,500
Offshore cable systems (km)	0	4,700
Offshore platforms	0	12

Investments to 2028: € >25 billion

- Expansion AC grid
- Offshore connections
- Interconnetcors: COBRA, NordLink, Doetinchem-Wesel, Meeden-Diele, BritNed2?
- HVDC (SuedLink, SüdOstLink, NL?)
- Underground cabling
- Important issues: financing, stranded assets?

System services

Balancing / congestion management

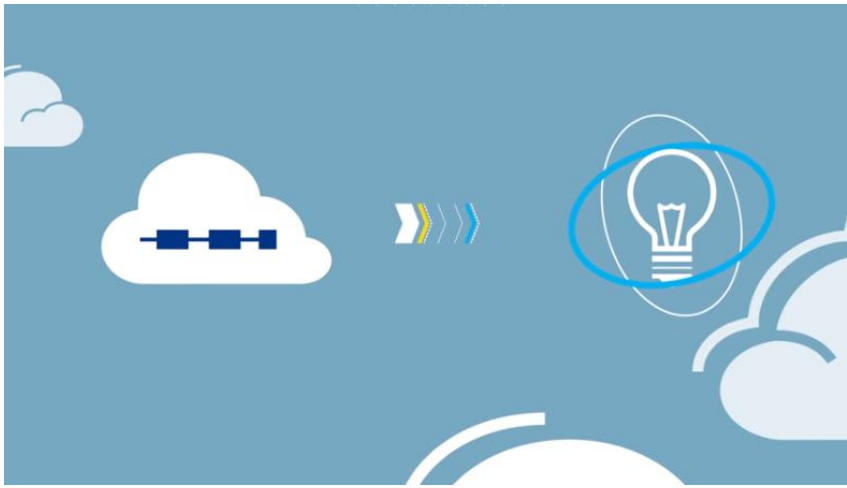
From 20 to 41.000.000 participants

Block chain technology

Pilot in the Netherlands: Vandebron
Pilot in Germany: Sonnen

Based on blockchain technology, consumers can actively participate in the (imbalance) market

“Elfstedentocht scenario”?



Connecting offshore wind energy

Green electricity from the North Sea for 19 million households

10,400 MW in 2025 (GER)

alpha ventus
AC
66 km · 62 MW
Hagermarsch

BorWin1
DC
200 km · 400 MW
Diele

BorWin2
DC
200 km · 800 MW
Diele

BorWin3
DC
160 km · 900 MW
Emden/Ost

DolWin1
DC
165 km · 800 MW
Dörpen/West

DolWin2
DC
135 km · 916 MW
Dörpen/West

DolWin3
DC
160 km · 900 MW
Dörpen/West

DolWin6
DC
90 km · 900 MW
Emden/Ost

SylWin1
DC
205 km · 864 MW
Büttel

HelWin1
DC
130 km · 576 MW
Büttel

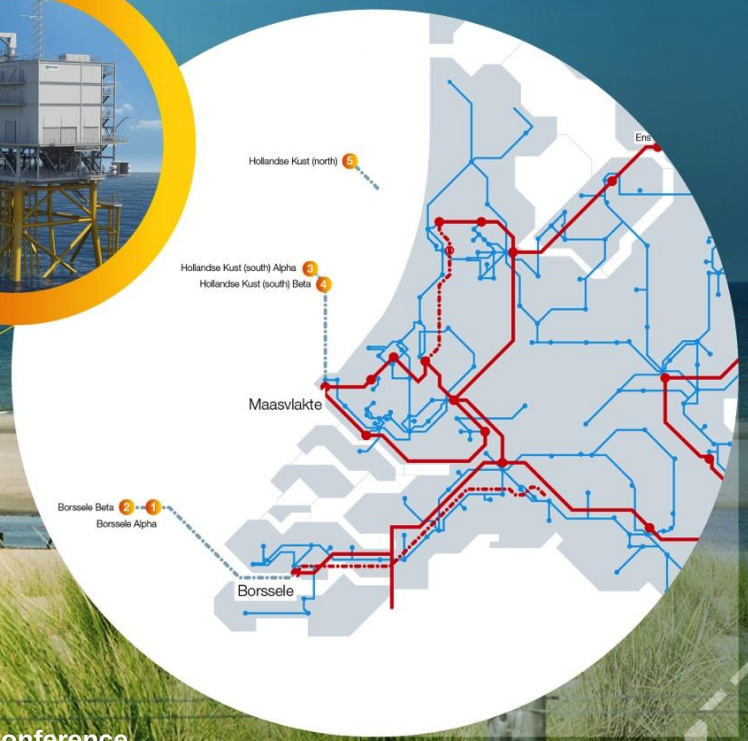
HelWin2
DC
130 km · 690 MW
Büttel

Riffgat
AC
80 km · 113 MW
Emden/Borssum

Nordergründe
AC
32 km · 111 MW
Inhausen

3,500 MW in 2023 (NL)

1. **Borssele Alpha**
   AC – 62 km – 700 MW – Borssele
   Commissioning in 2019
2. **Borssele Beta**
   AC – 69 km – 700 MW – Borssele
   Commissioning in 2020
3. **Hollandse Kust (south) Alpha**
   AC – 43 km – 700 MW – Maasvlakte
   Commissioning in 2021
4. **Hollandse Kust (south) Beta**
   AC – 34 km – 700 MW – Maasvlakte
   Commissioning in 2022
5. **Hollandse Kust (north)**
   AC –700 MW – cable route and landing location being investigated. *Commissioning in 2023*



Just to be continued?

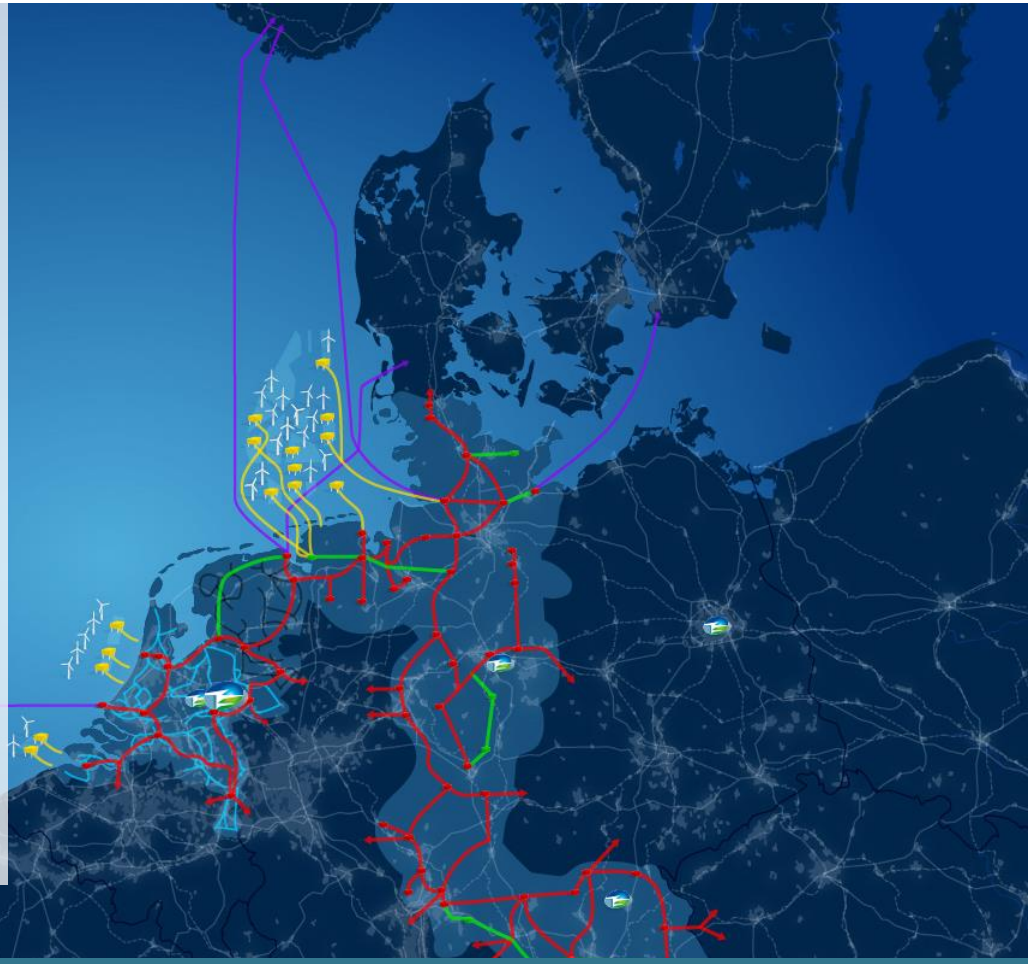
Paris (COP21) agreement:

- Limit global avg. temperature to well below 2ºC above pre-industrial levels.
- Pursuing efforts to limit the temperature increase even further to 1.5ºC.

EU Goals:

- 2030: 40% CO_2 compared to 1990 levels.
- 2050: 80-95% CO_2 reduction.
- Power sector decarbonized.

Regional cooperation is essential



Challenges: Support schemes | renewables goals | national focus

Huge amounts of offshore wind

COP21 agreements implies a radical change in electricity generation mix for the North Seas countries

- **230** GW offshore wind capacity
- **180** GW deployed in the North Sea

Source: Translate COP21: 2045 outlook and implications for offshore wind in the North Seas (Ecofys 2017 by order of TenneT and Energinet). Countries: FR, BE, NL, UK, IE, LU, DE, DK, SE and NO)

New concepts needed

Further offshore: large potential development offshore wind

- Scale and distance:
  DC connections
- Hub-function: platforms/island?
- WindConnector
- Storage/conversion; hydrogen

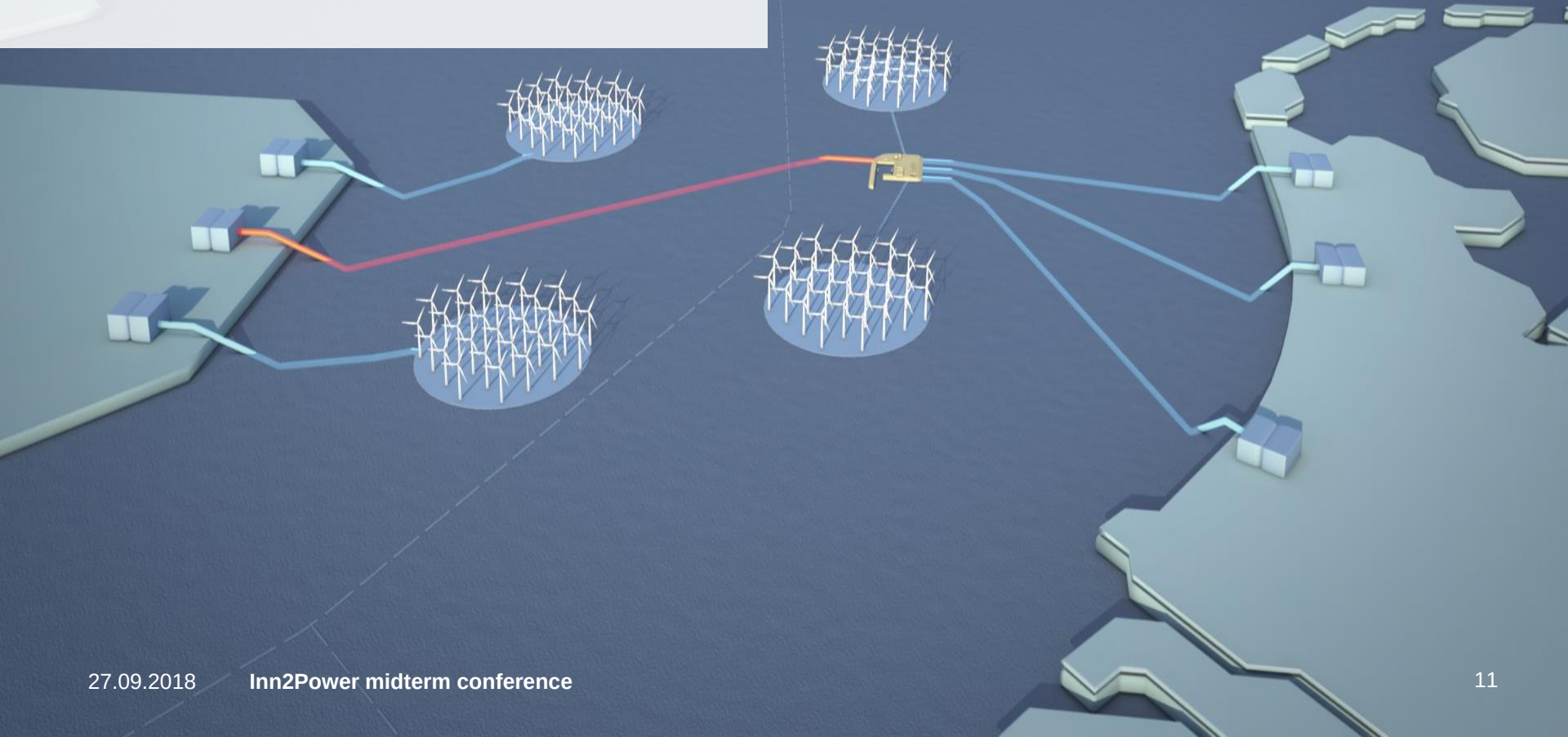
Island solution

- no limitation for converter
  ➔ increase of power
- storage of spare parts
- basis for offshore staff
- improved logistic concepts

WindConnector

Combining infrastructure for wind areas further offshore with interconnection

- Cooperation with Vattenfall
- Doubling the return on investment
- Doubling use rate infrastructure

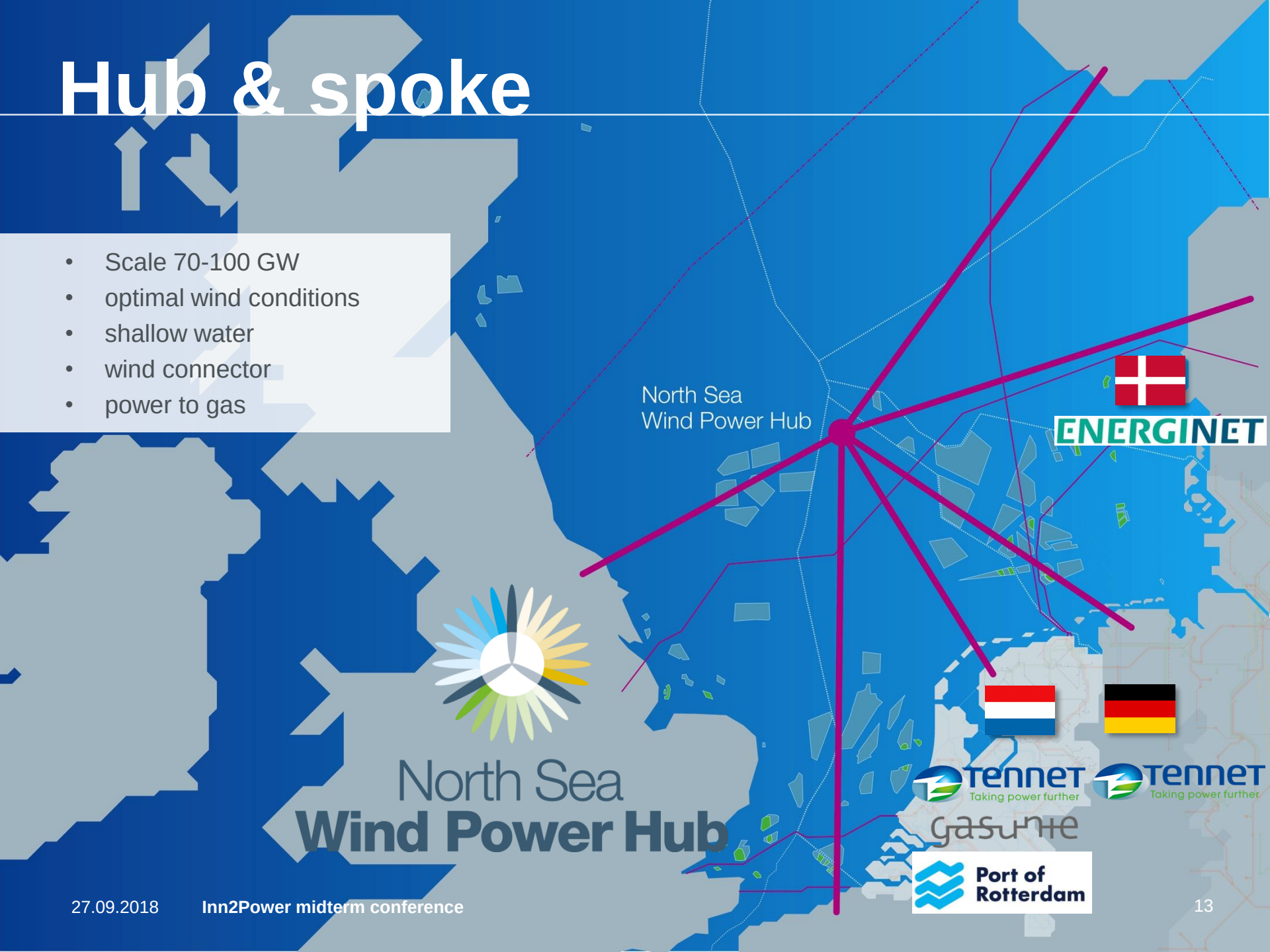


Electrification O&G platforms

- Remaining exploitation lifetime offshore assets
- Distance from electricity grid (max. 60 km)
- Power consumption platform
- Emission reduction potential:
  - 135,000 ton CO2
  - 190 ton NOx
  - per 28 MWe platform

Hub & spoke

- Scale 70-100 GW
- optimal wind conditions
- shallow water
- wind connector
- power to gas



Thank you for your attention!
Any questions?

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