# EUROPEAN EXPERIENCE WITH INTERCONNECTION OF OFFSHORE PLANTS

## ESIG - 2019 Fall Technical Workshop
## October 28-30, Charlotte

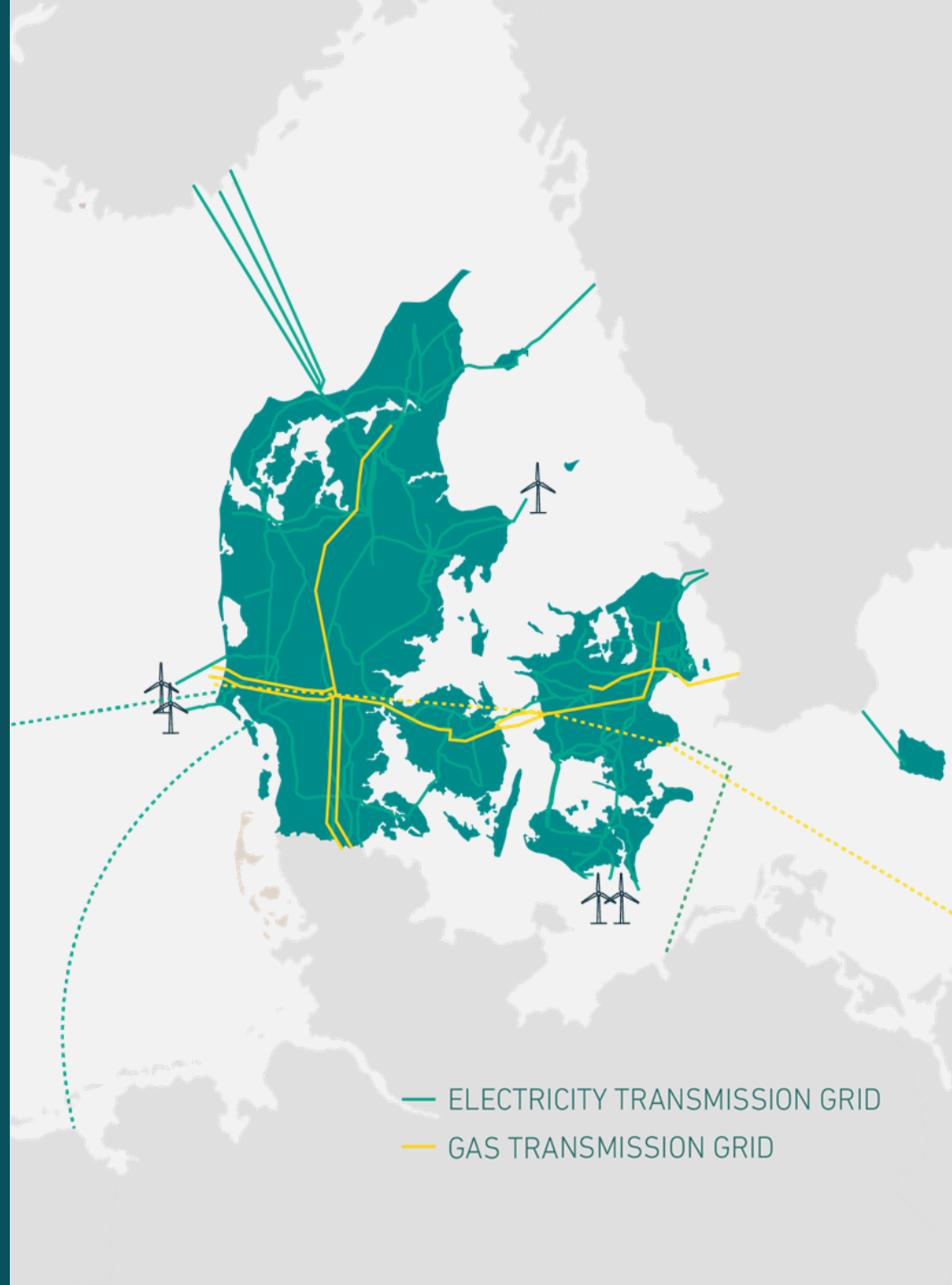
*Peter Jørgensen, VP Energinet Associated Activities, Denmark*

# ENERGINET

Transmission System Operator for electricity and gas in Denmark

- Day-to-day and long-term responsibility for transmission systems in Denmark
- Development of energy markets in Denmark and the EU
- Own, operate and develop the transmissions systems
- Contribute with long-term planning and analysis of coherent energy systems

- State-owned and non-profit




## GREEN TRANSITION

STATUS:

63% green electricity

34% green energy

2030 TARGET:

100% green electricity

55% green energy

70% reduction in emission of GHG compared to 1990

2050 TARGET:

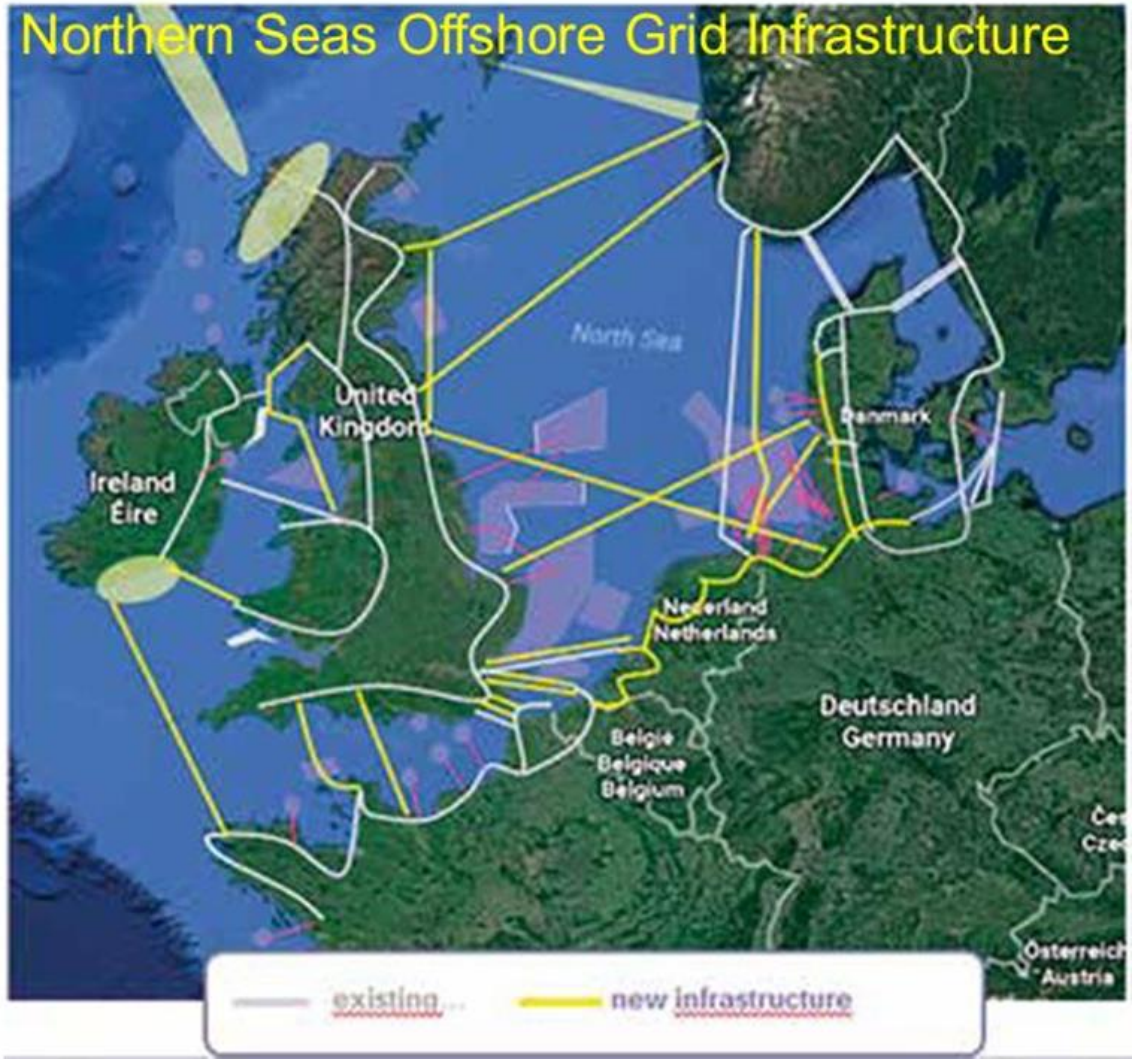
100% green energy

# INTEGRATION OF WIND POWER IMPLIES MORE THAN GRID CONNECTION

## ENTSO-E Ten Year Network Development Plan 2018

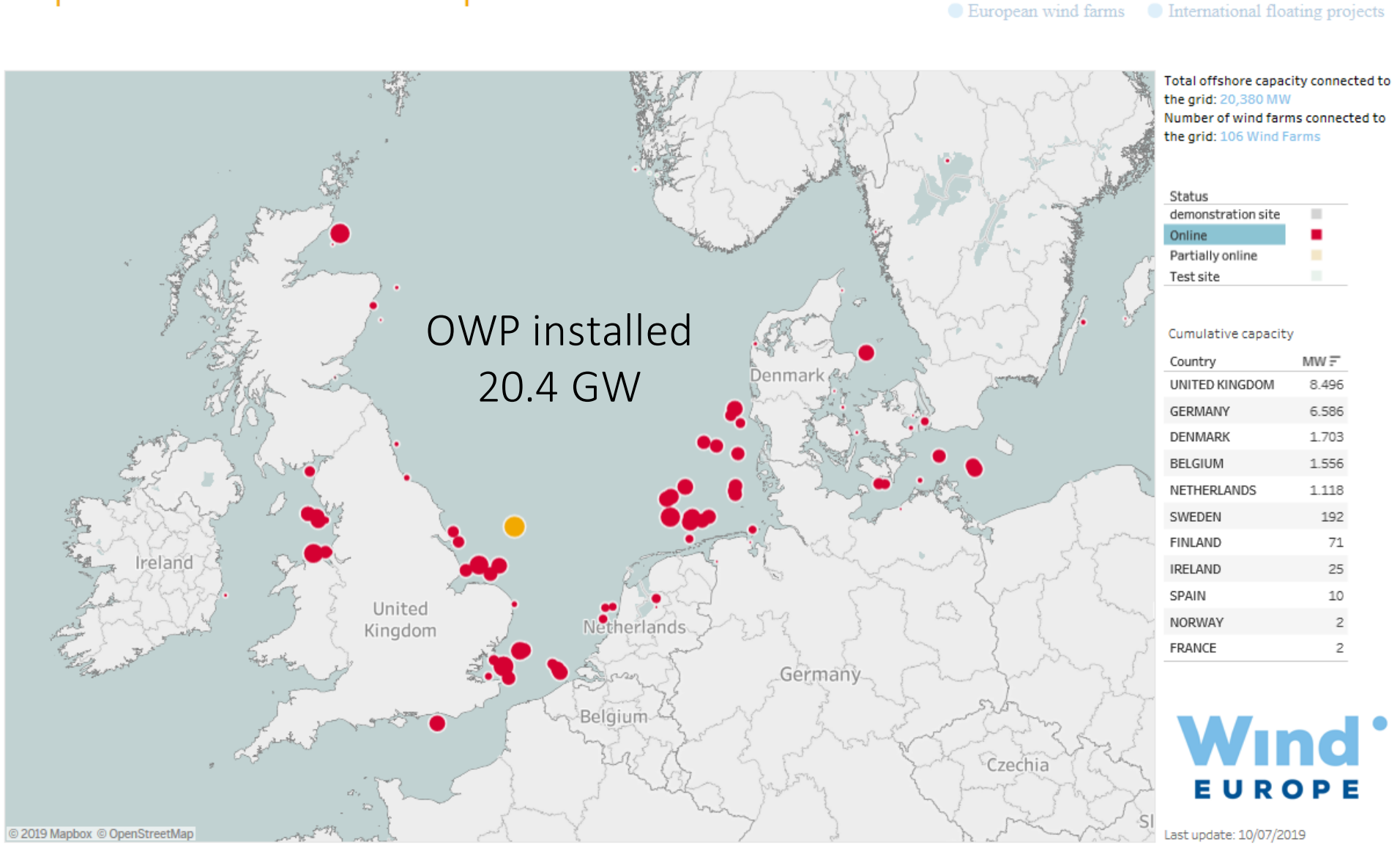
- Installed offshore wind power in Europe:
  - Today: 20,4 GW
- ENTSO-E scenarios for the NSOG region:
  - 2030: 40 - 60 GW
  - 2050: 85 - 125 GW

- Northern Seas Offshore Grid Infrastructure in TYNDP 2018:
  - 20 individual projects into common scheme
  - Investment costs €14-27 bn
  - Socio-economic benefits €1.3-2.4 bn/year
  - Facilitates extra RES generation 14-19 TWh/year




ENTSO-E: European Network Transmission System Operators - Electricity

# European Offshore Wind Farms Map




Total offshore capacity connected to the grid: 20,380 MW
Number of wind farms connected to the grid: 106 Wind Farms

| Status |
|---|
| demonstration site |
| Online |
| Partially online |
| Test site |

Cumulative capacity

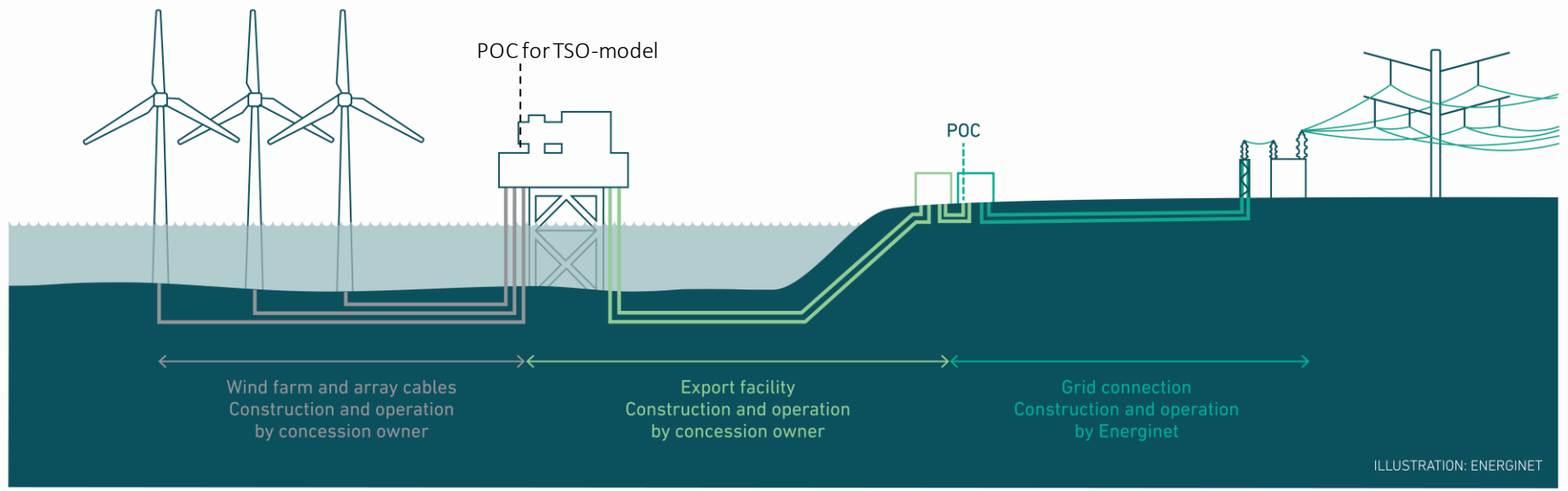
| Country | MW |
|---|---|
| UNITED KINGDOM | 8.496 |
| GERMANY | 6.586 |
| DENMARK | 1.703 |
| BELGIUM | 1.556 |
| NETHERLANDS | 1.118 |
| SWEDEN | 192 |
| FINLAND | 71 |
| IRELAND | 25 |
| SPAIN | 10 |
| NORWAY | 2 |
| FRANCE | 2 |

Wind EUROPE

Last update: 10/07/2019

# GRID CONNECTION MODELS

## Developer- and TSO-models in Europe




Developer-model: Developer | TSO

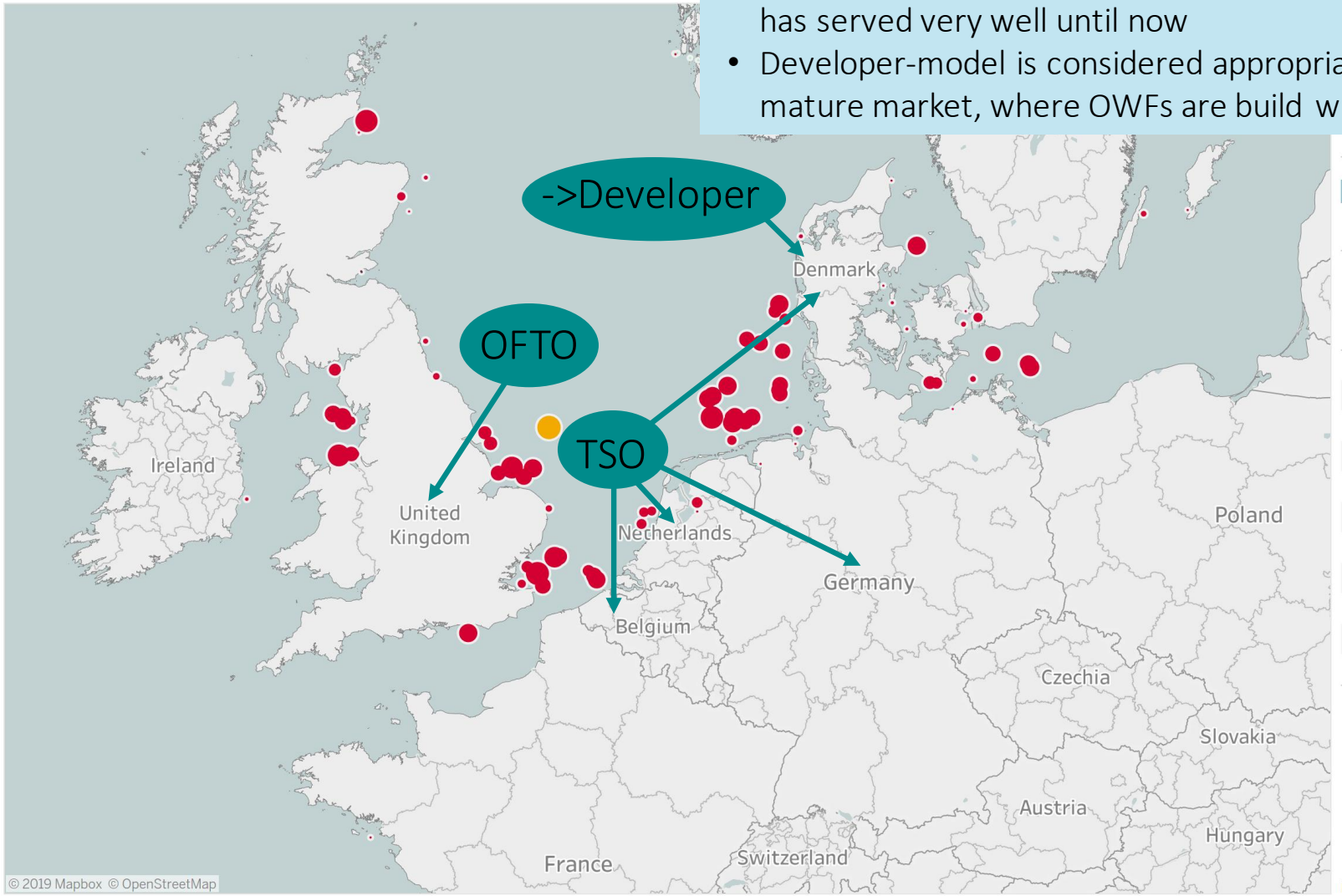
TSO-model: Developer | TSO

# GRID CONNECTION MODELS

## European Offshore Wind Farms Map

**Denmark:**

- TSO-model including IEA and seabed survey for wind farm has served very well until now
- Developer-model is considered appropriate in today's mature market, where OWFs are build without subsidies

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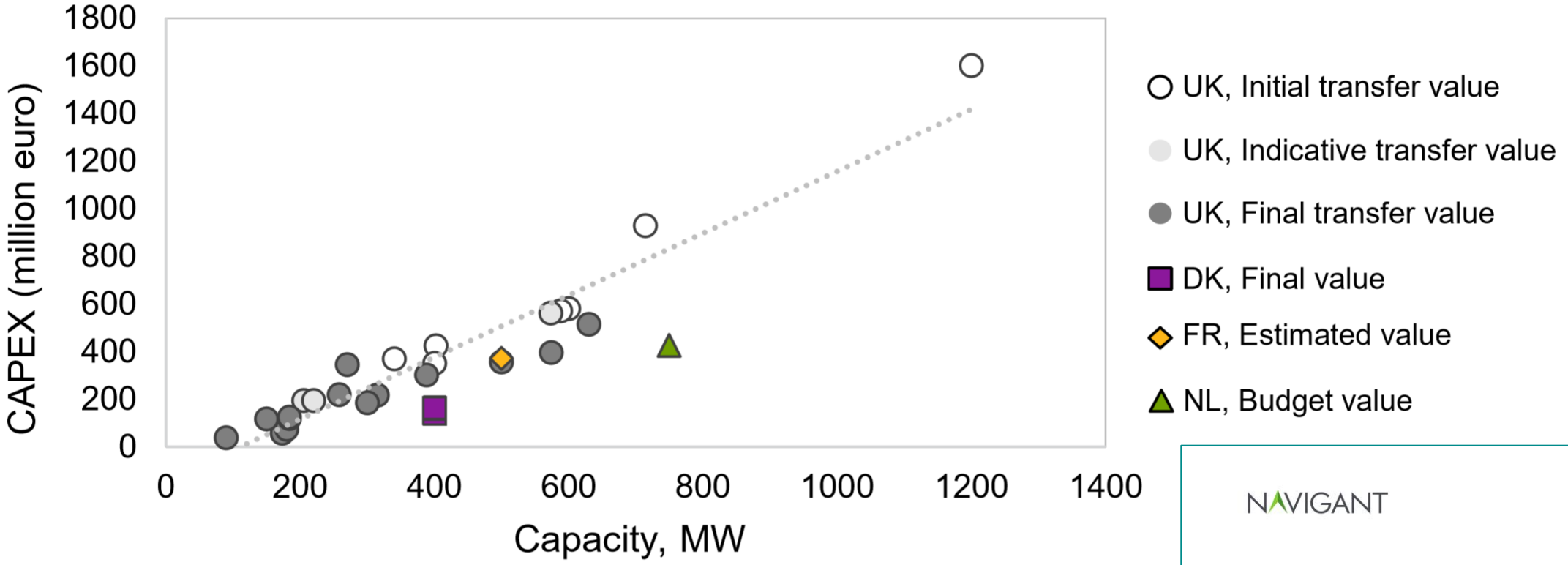
## Figure 11. Offshore HVAC transmission system CAPEX comparison.

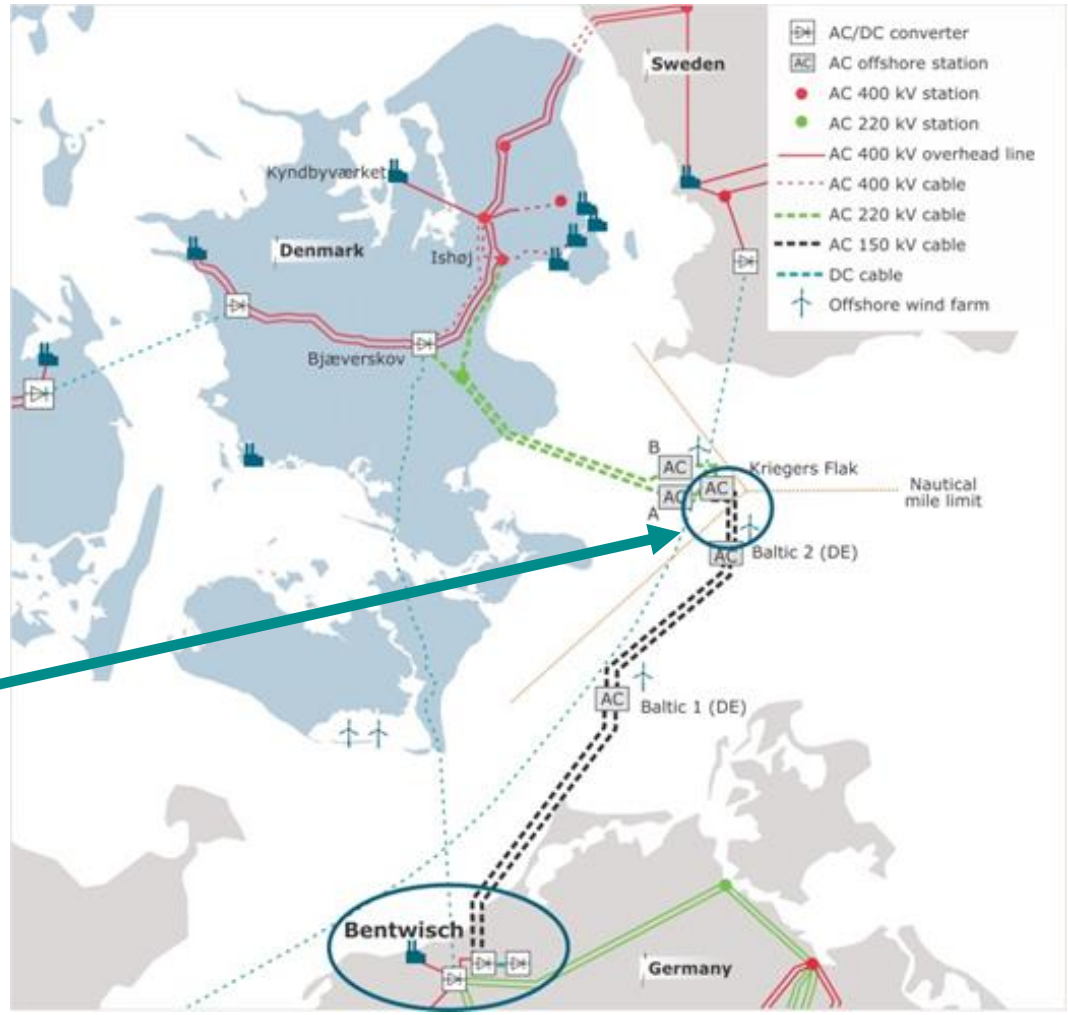



*Source: Navigant analysis based on DNV-GL, 2019, with input from RTE*
Note: Trend line only represents UK connection systems

# KRIEGERS FLAK COMBINED GRID SOLUTION

## First combined grid connection and interconnection

- Wind farms:
  - Danish: 400 MW & 200 MW
  - German: 48 MW & 288 MW
- Grid connections
  - Danish: 45 km+26 km, 2x220 kV
  - German: 60 km + 60 km, 2x150 kV
- Interconnection: 25 km, 2x150 kV, 400 MW
- Offshore platforms: AC-transformers
- Onshore: HVDC back-to-back converter in DE




Available capacity allocated for trade

# NORTH SEA WIND POWER HUB

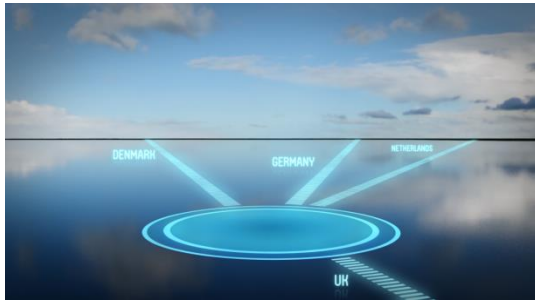
ENERGINET TenneT gasunie

- Regional perspective on grid connection and system integration of offshore wind in the North Sea
- Coordinated and coherent development
- “Hub and spoke” concept – modular
- Based on existing technology
- Integration of flexible solutions and increased electricity consumption - for instance PtX

Offshore windfarms

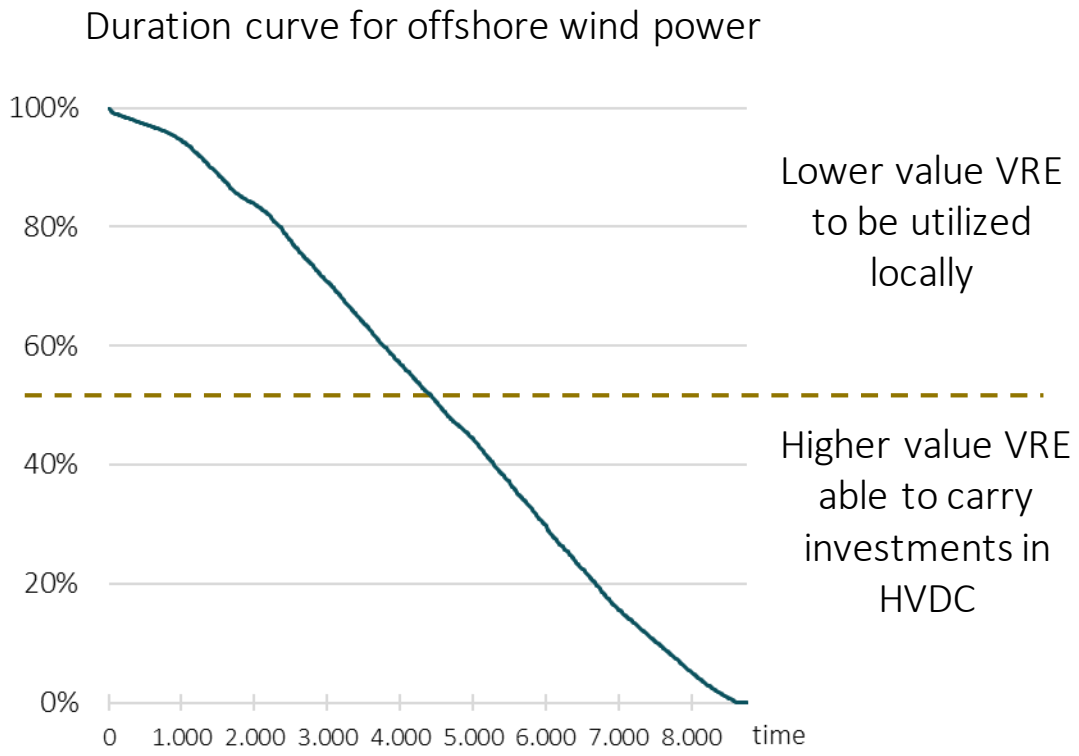
Hub

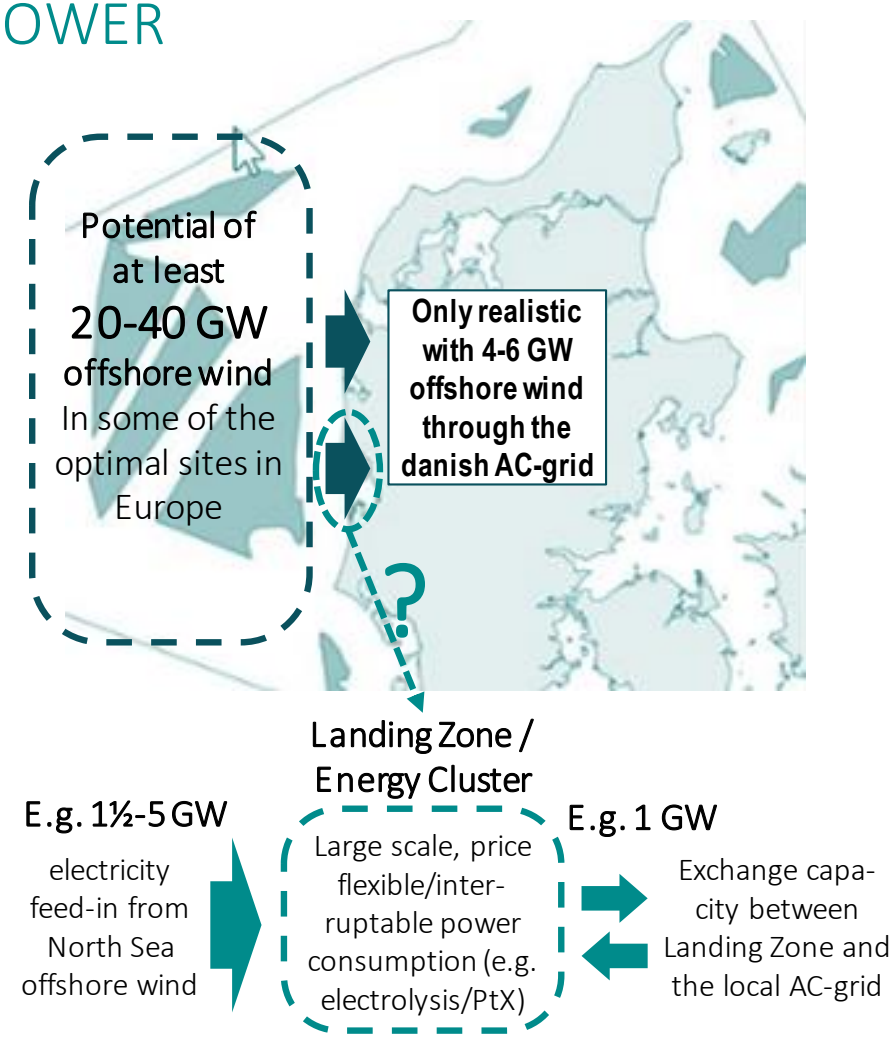
Combined grid connection and interconnections




Modular Hub

# LANDING ZONES FOR MULTI GW OFFSHORE WIND POWER




ENABLER FOR LARGE SCALE HARVESTING OF HUGE OWP-POTENTIAL TO SUBSTITUTE FOSSIL FUELS


THANK YOU FOR THE ATTENTION
WWW.ENERGINET.DK