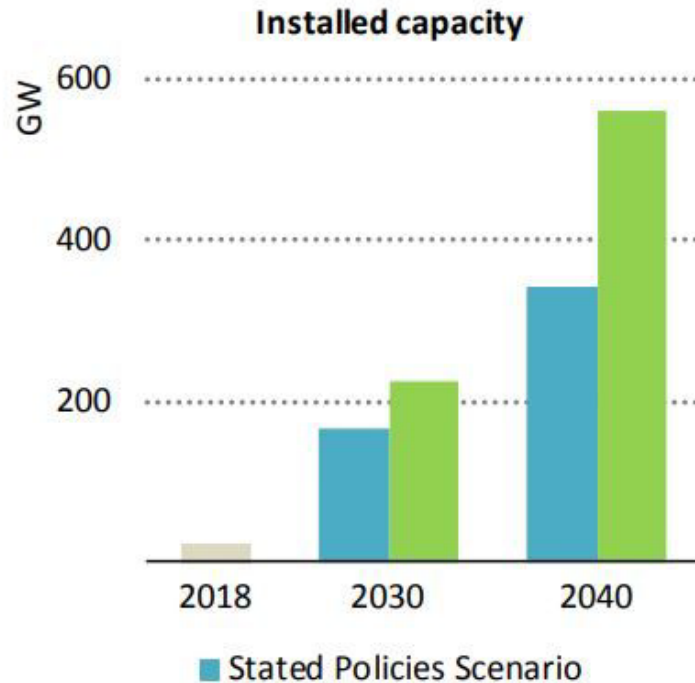




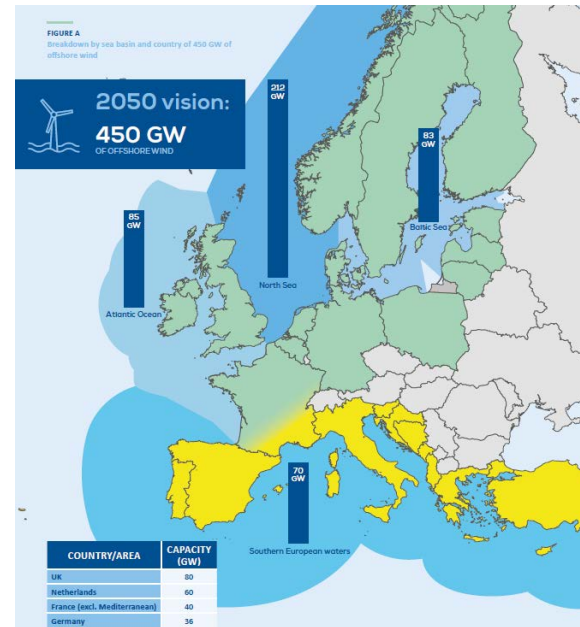
*Floating wind – an
opportunity for Norway*

Jon Barratt Nysæther, Leading engineer
Waves of Cleantech
Solstrand, November 29, 2019

Offshore wind on the rise – great potential for floating



Source: IEA Offshore Wind Outlook 2019



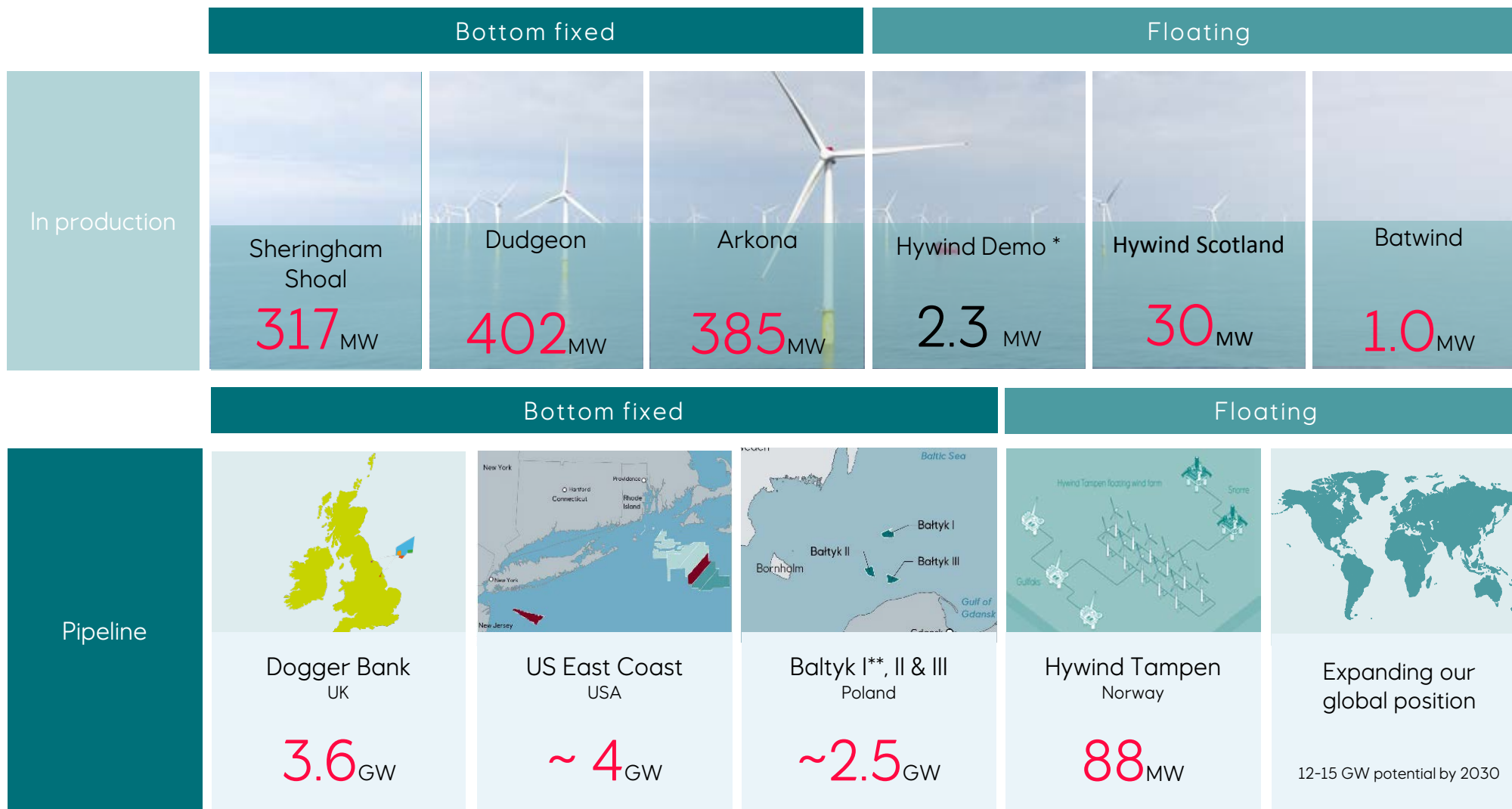
Source: Wind Europe 2019

Global market for floating wind

Year	Capacity
2030	12 GW
2040	40 GW
2050	100 GW

Source: Menon Economics 2019

Expanding our offshore wind position



Stepping up floating wind to become a competitive source of energy

Equinor ambition: Remain the world leading developer and operator of floating wind



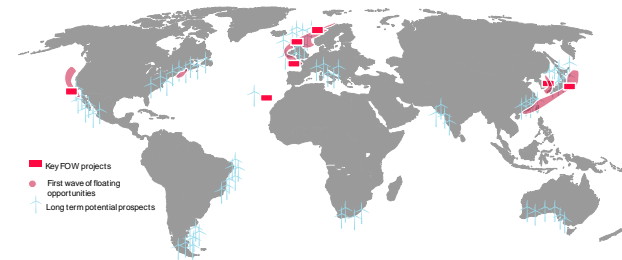
Hywind demo
2.3 MW



Hywind
Scotland
30 MW



Hywind
Tampen
88 MW



Next floating
project(s)
> 200 MW

Utility scale
project
500 - 1000
GW

Key markets:
Korea, Japan, US, Scotland, France, Spain
(Canary Islands), Norway



Fully
commercial
technology
40-60
EUR/MWh

Technology development

Cost reduction

Industrialization

Hywind Scotland – world's first floating wind farm



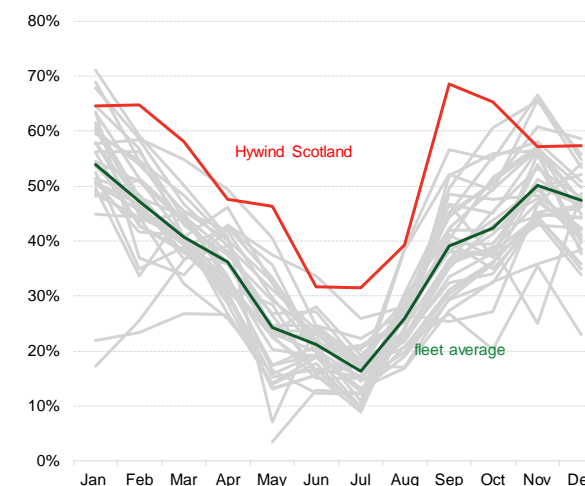
- Aim of Hywind Scotland project:
 - Demonstrate commercial scale floating wind
 - Upscaling from demo to larger turbine
 - Verify and further develop Hywind technology

- Project details
 - 30 MW (5 x 6 MW turbines)
 - Water depth 95 – 120 m
 - Draft of substructure: 78 m
 - Export cable length: 30 km
 - First power: Q4 2017
 - Project delivered on time and without serious incidents

- Harsh conditions = high production
 - Average wind 10.1 m/s
 - Average wave height 1.8 m
 - Highest wind/waves experienced
 - 45 m/s wind (gust), > 8 m waves during storm Caroline
 - Production and performance significantly exceeding expectations



Load factor of UK offshore wind farms

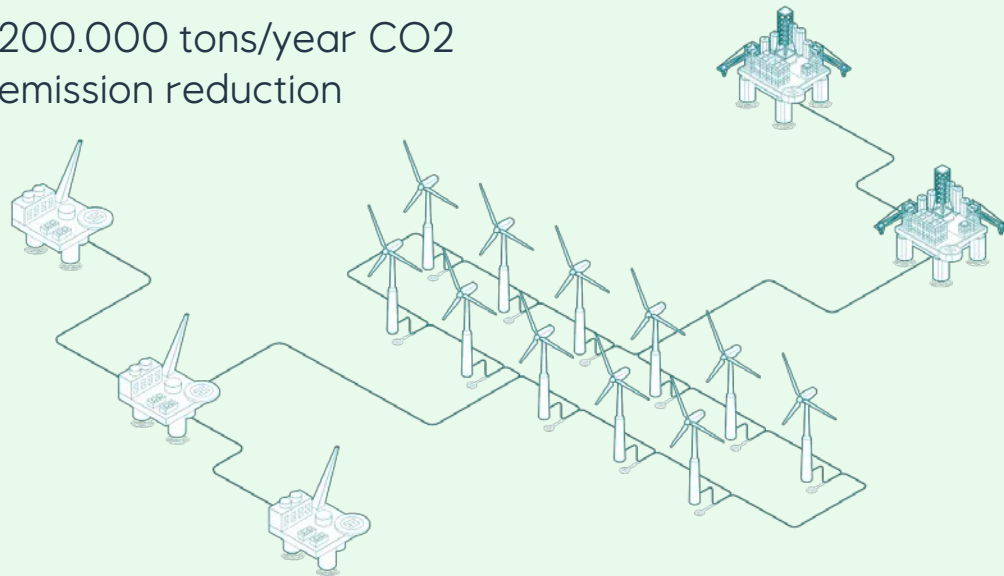


First year of operation:
 Average availability: **95%**
 Average capacity factor: **56%**

Hywind Tampen

The world's first floating offshore wind farm to supply renewable power to offshore oil and gas installations.

- 11 wind turbines
- Combined capacity of 88MW
- Concrete substructures and shared anchors
- 200.000 tons/year CO2 emission reduction



- Snorre
- Hywind Tampen
- Gullfaks

Mongstad
Sture
Kollsnes
Bergen
Florø



Hywind Tampen Contractors

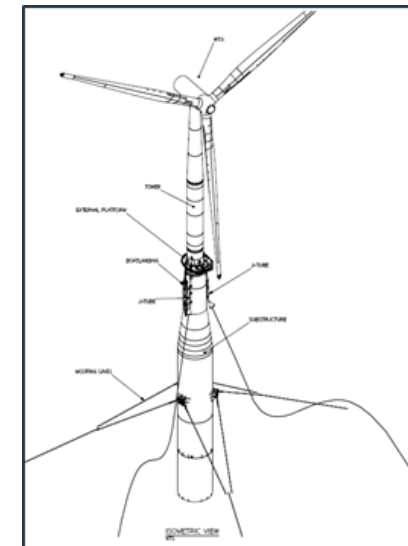
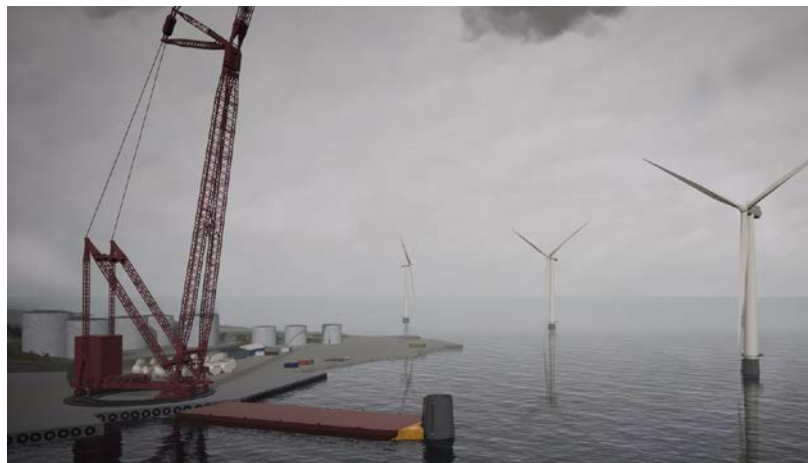
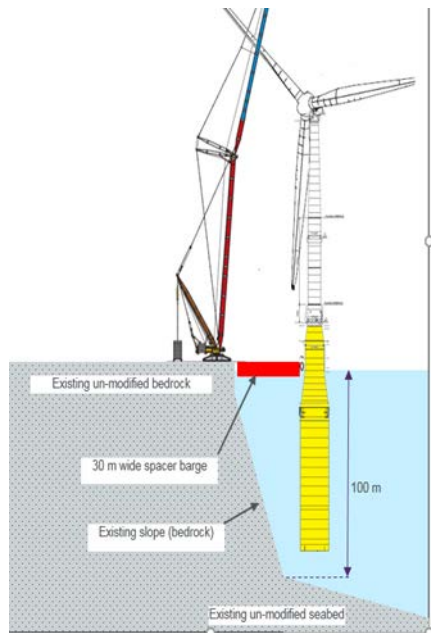


Main contractors

- Wind Turbine generators:
- Concrete substructures:
- Inter-array and export cables:
- Marine operations:
- Topside modifications:
- Assembly site Sløvåg:
- Onshore crane:

Siemens Gamesa
 Kvaerner AS
 JDR Cable Systems
 Subsea 7 / Seaway 7
 Wood
 Wergeland Base
 Mammoet Norway

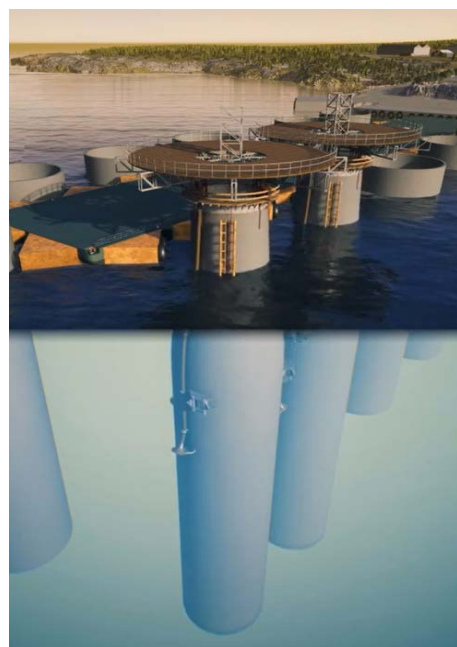
Norwegian content for Hywind Tampen is around 50%



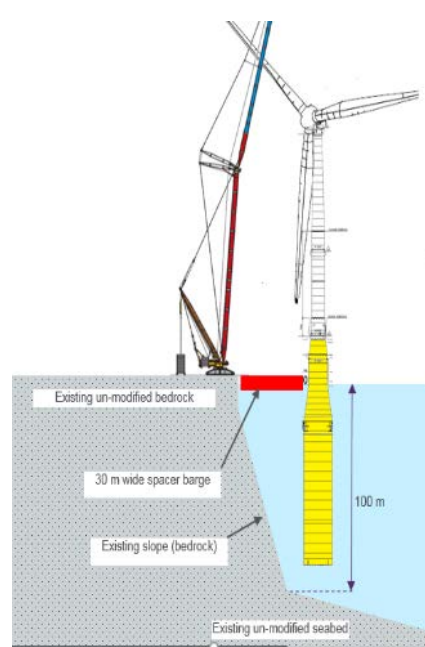
Technology development in Hywind Tampen



Larger turbines



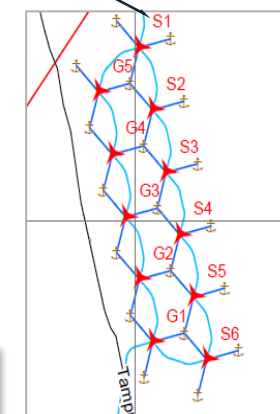
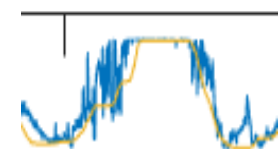
Concrete substructure



Installation – land based crane

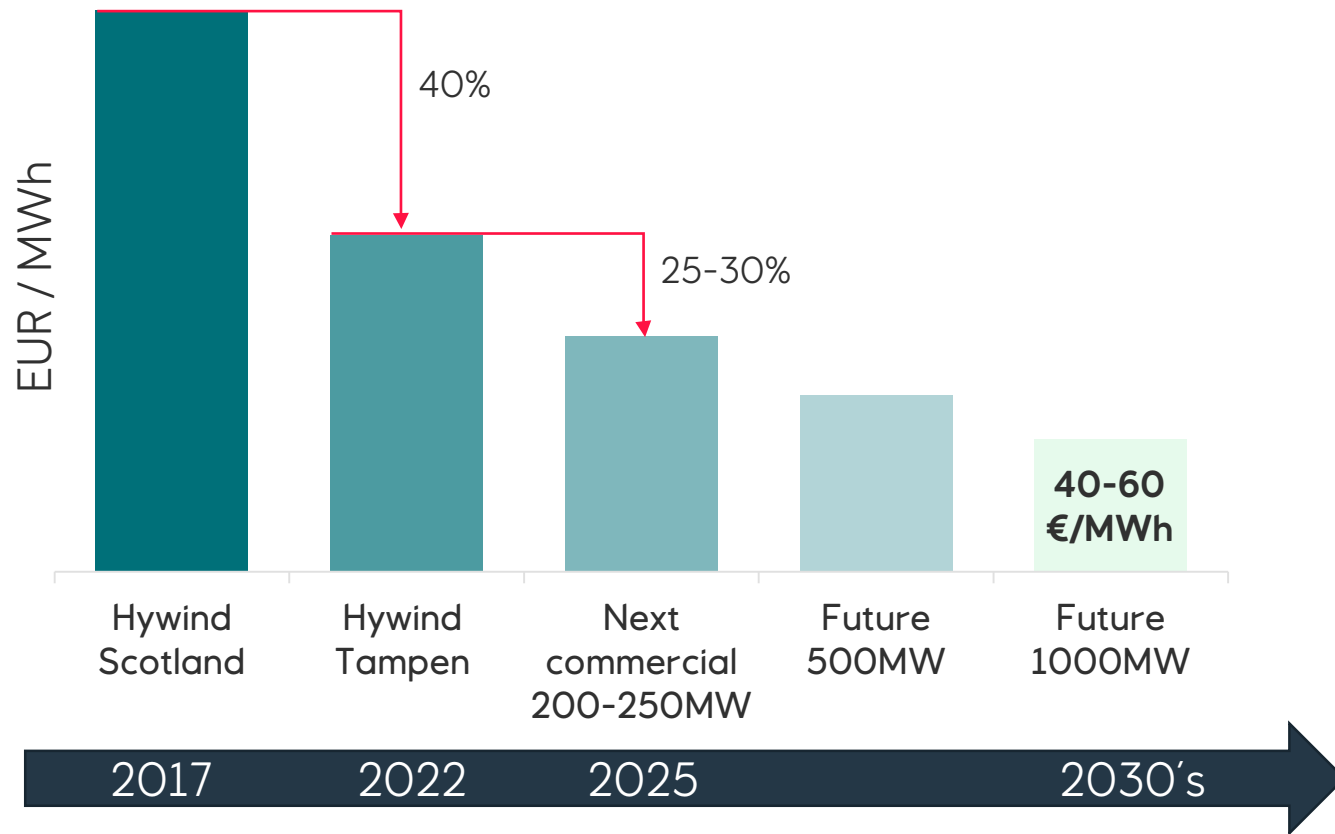


Simplified mooring



Gas and wind integration

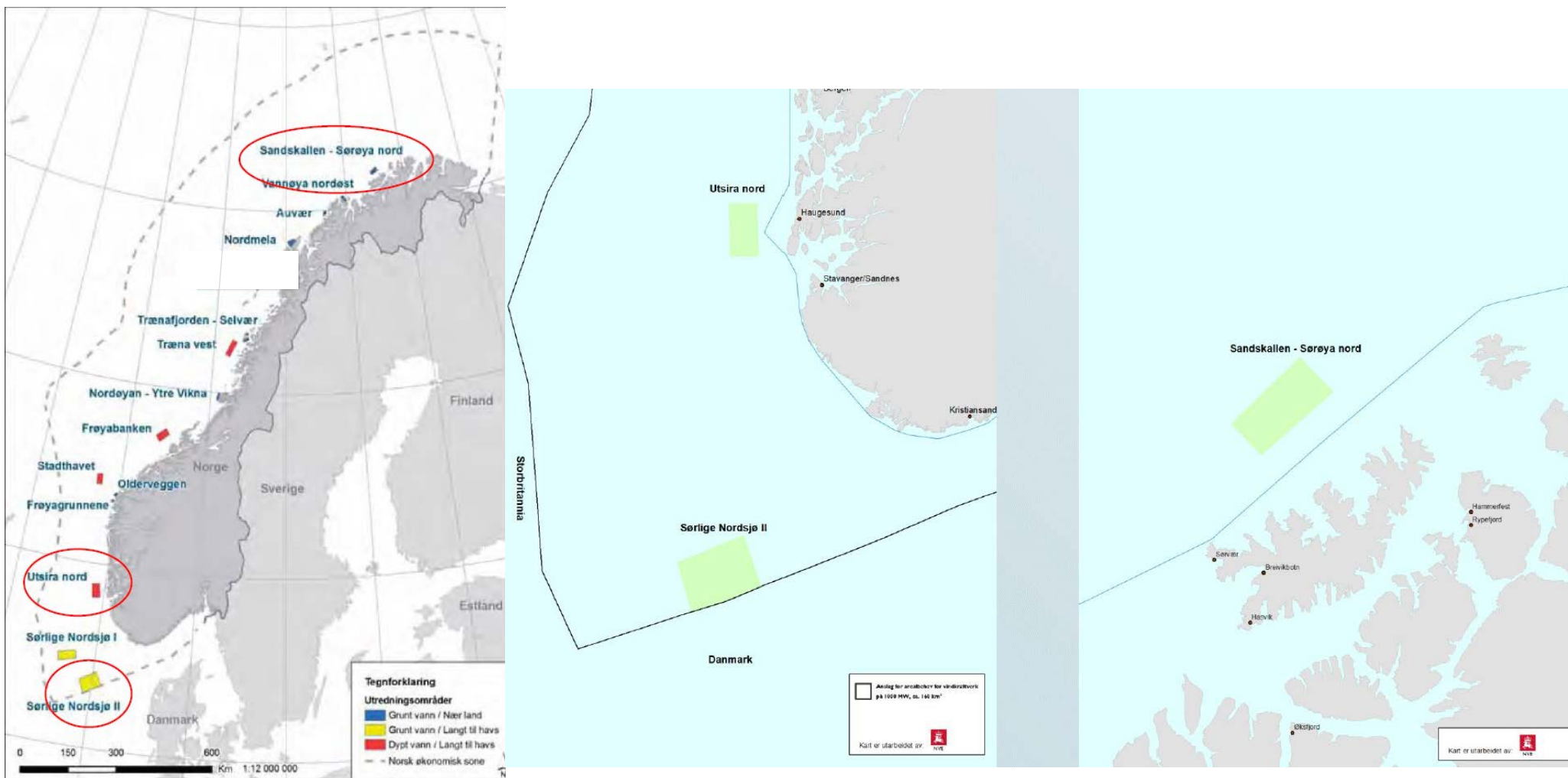
Costs of floating offshore wind is declining, and will continue to do so



Cost drivers:

- Project experience
- Scale effects
 - Larger turbines
 - Large scale windfarms
- Competitive supply chain
 - Efficient and standardised operations
 - Mass fabrication of substructures
- Incremental & disruptive innovation
 - Optimised substructures
 - Innovative mooring solutions
 - New materials
 - New floating concepts

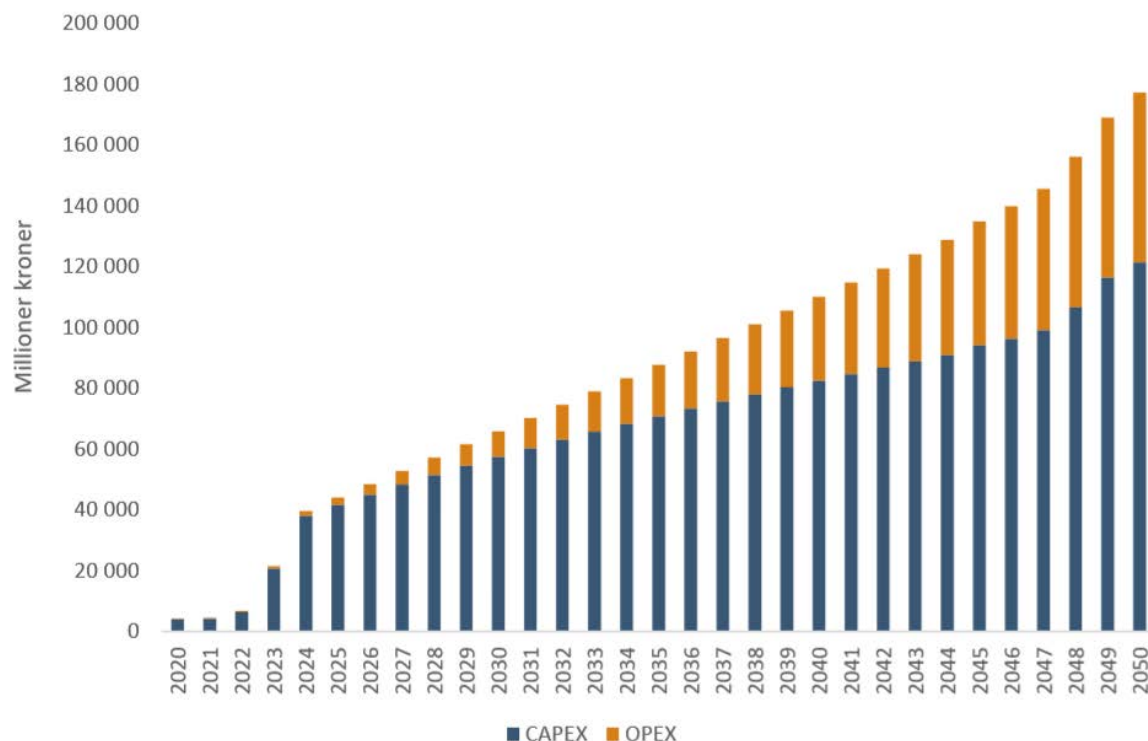
Opening of new areas for offshore wind in Norway







Norway can capture up to 20% of a growing global market

Floating offshore wind – global market outlook

Figur E: Årlig omsetning i det globale markedet for flytende havvind i basisscenariet i millioner 2019-NOK i perioden 2020 til 2050. Kilde: Menon Economics



Succes criteria for value creation for Norwegian industry (Menon Economics, 2019)

-  **Et aktivt hjemmemarked**
-  **Være tidlig ute**
-  **Tydelig visjon fra myndighetenes side**
-  **Tilpassede virkemidler**

The supplementation of **oil and gas sector know-how** further increases Norway's potential to take a significant global market share

Yet, the 'success factors' identified above point to the fact that an **active home market** will act as a crucial scaling, testing and learning arena which will strengthen the Norwegian players' international competitiveness.

..the dependence on **political decisions** involves the potential for a small country such as Norway, to play a **significant role in driving global developments**, as has been done by Denmark in the market for bottom-fixed offshore wind.

Our assessment of the range of possible value creation outcomes for a Norwegian based floating offshore wind industry shows that **up to 20 percent of the global market** can be captured.

Menon economics: VERDISKAPINGSPOTENSIALET KNYTTET TIL UTVIKLINGEN AV EN NORSKBASERT INDUSTRI INNEN FLYTENDE HAVVIND, 2019

Hywind Tampen video:

<https://www.kvaerner.com/kvaerner-contract-for-hywind-tampen-is-a-vital-strategic-break-through/>



Floating wind – an opportunity for Norway

Jon Barratt Nysæther, Leading Engineer
Olstrand November 29, 2019

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