WHEN TRUST MATTERS

Technology driving floating wind forward

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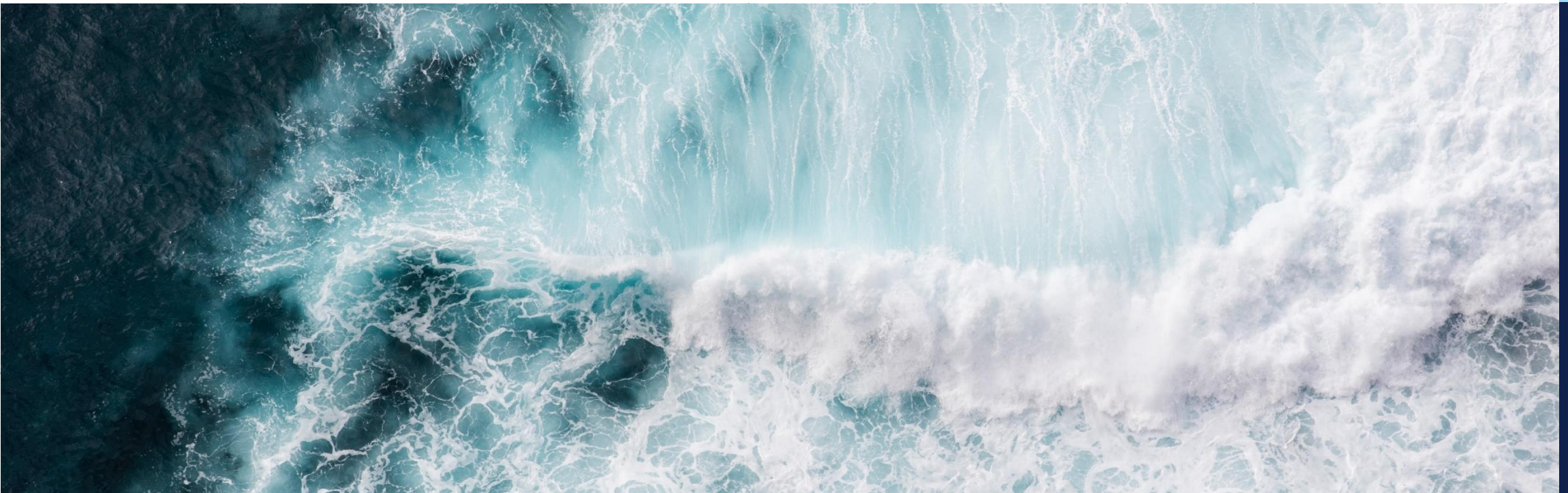
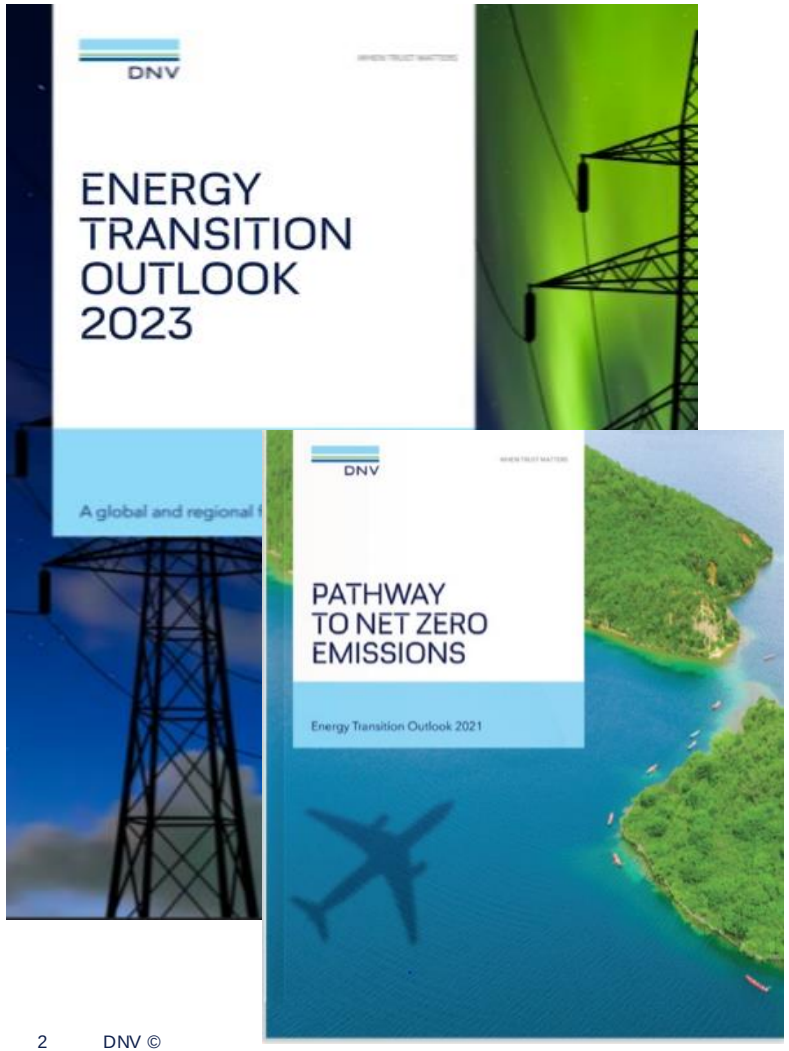
19 June 2024



DNV has been forecasting the energy transition since 2017

Main publication

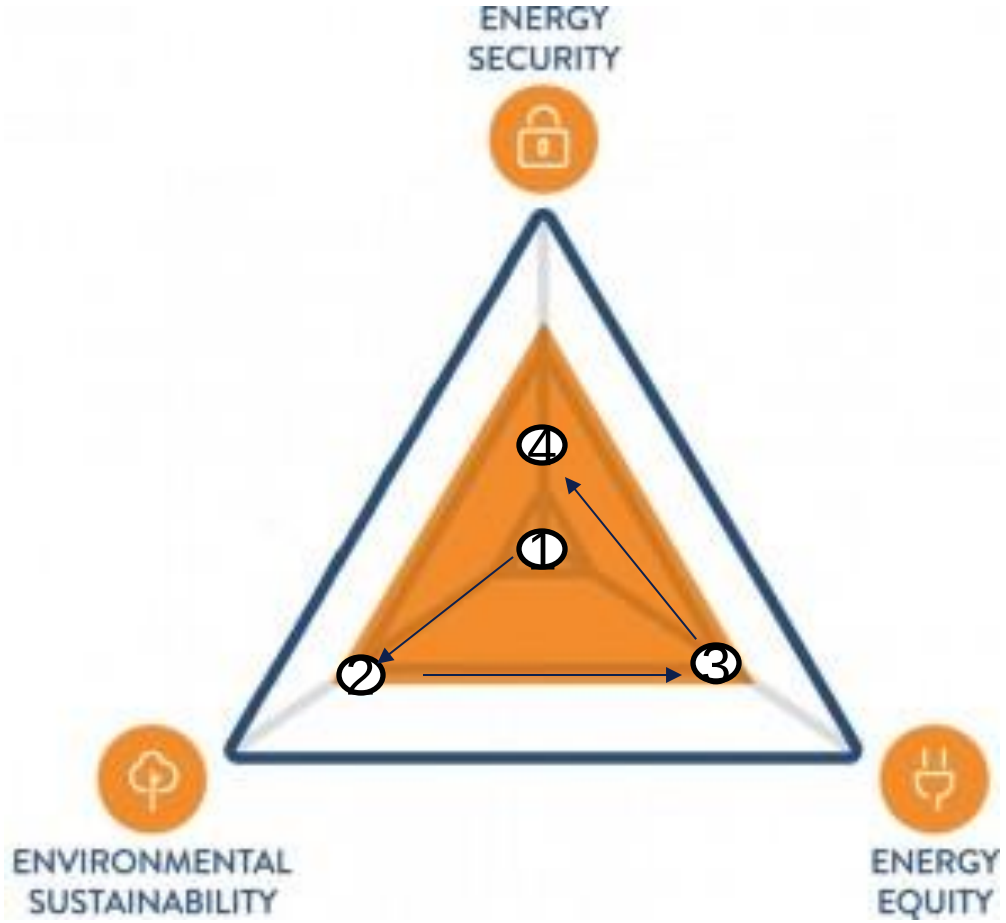


Regional reports

Sector reports

The Energy Trilemma

The Energy system Should be



1. Where we should be
2. Focus since 2015
3. Energy crunch 2021
4. Conflict between Ukraine and Russia 2022

World Energy Council's Energy Trilemma can be a good way of conceptualising the three energy policy concerns, which are often difficult to reconcile and in conflict to each other. The Energy Trilemma consists of:

1. Energy Equity, which aims to make energy affordable for consumers,
2. Energy Security, which seeks to ensure the reliability of energy sources, including price and geopolitics
3. Energy Sustainability, which seeks to minimise environmental harm, such as climate change emissions.

FOW technology – where are we now?

235 MW in operation

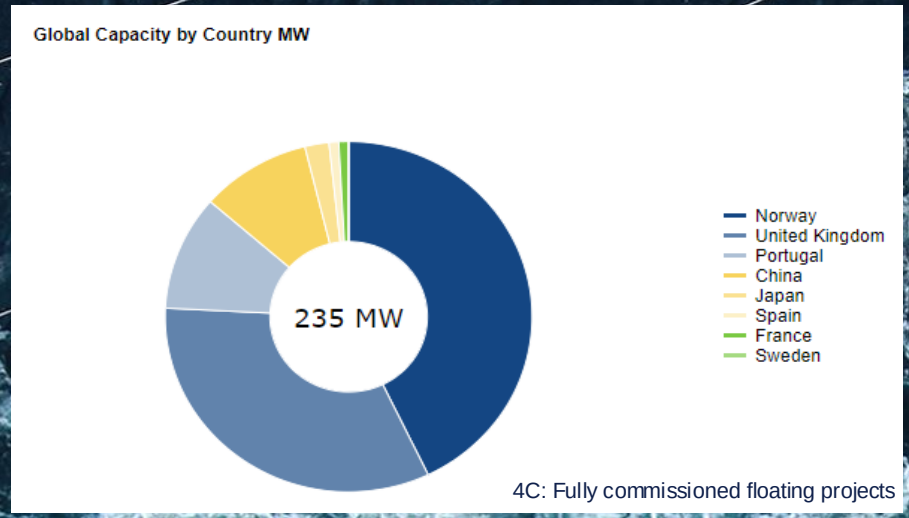
Pilots and demonstrators

Fundamental concept of FOW proven

High capacity factor

High costs

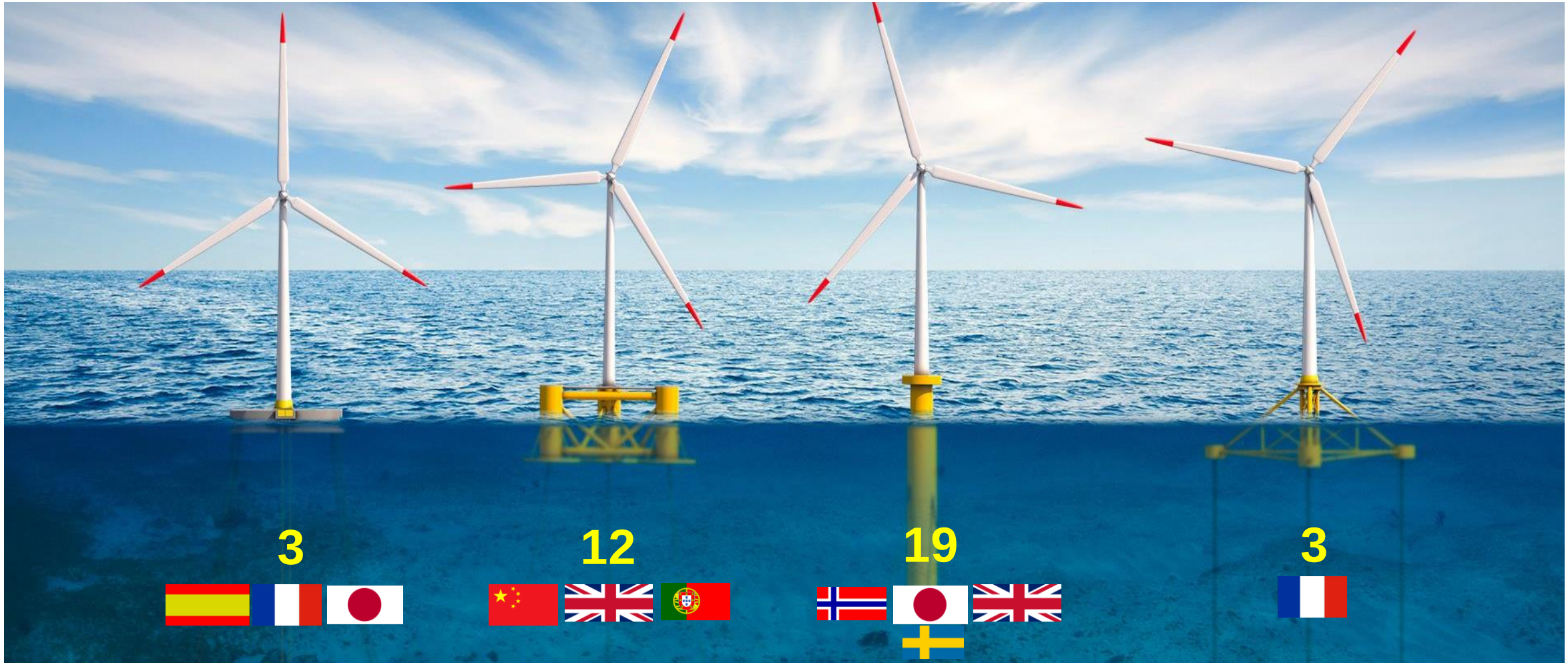
Remaining technical and financial risks to be managed



4C: Fully commissioned floating projects


Equinor: Hywind Tampen

235 MW in operation



3 examples out of the 50-150 concepts and fabrication strategies

Spar concrete floaters

Aker Stord, Norway

Semi sub steel floaters

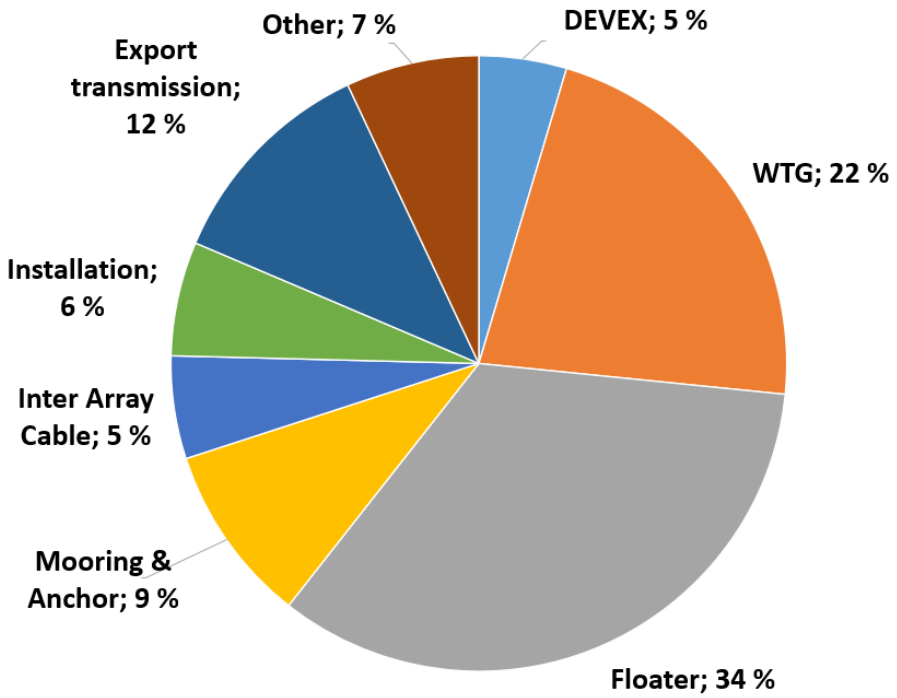
Navantia, Spain

TLP steel floaters

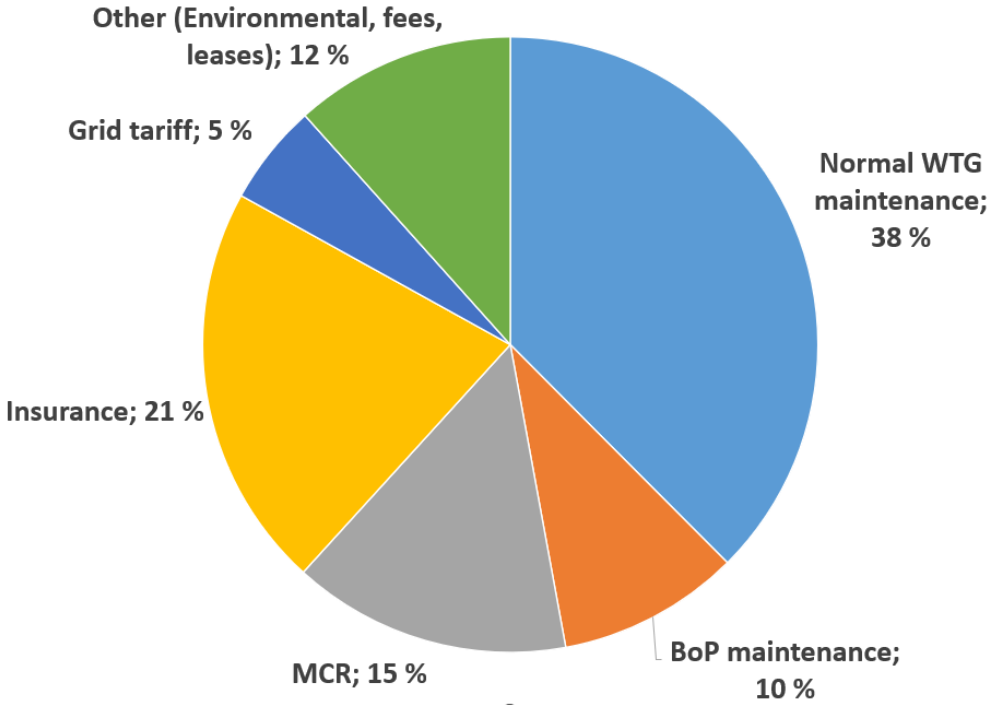
Eiffage, France

Technology driving floating wind forward by reducing LCOE

CAPEX

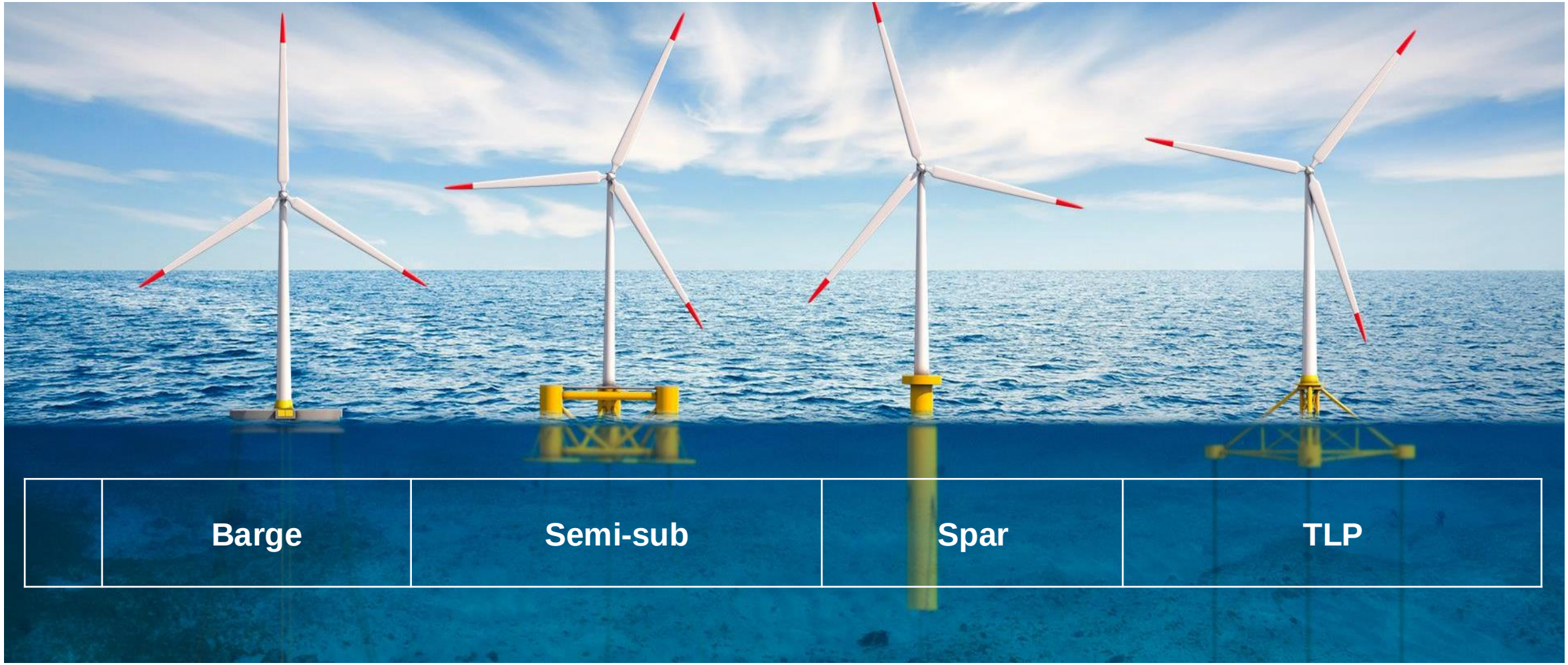


OPEX



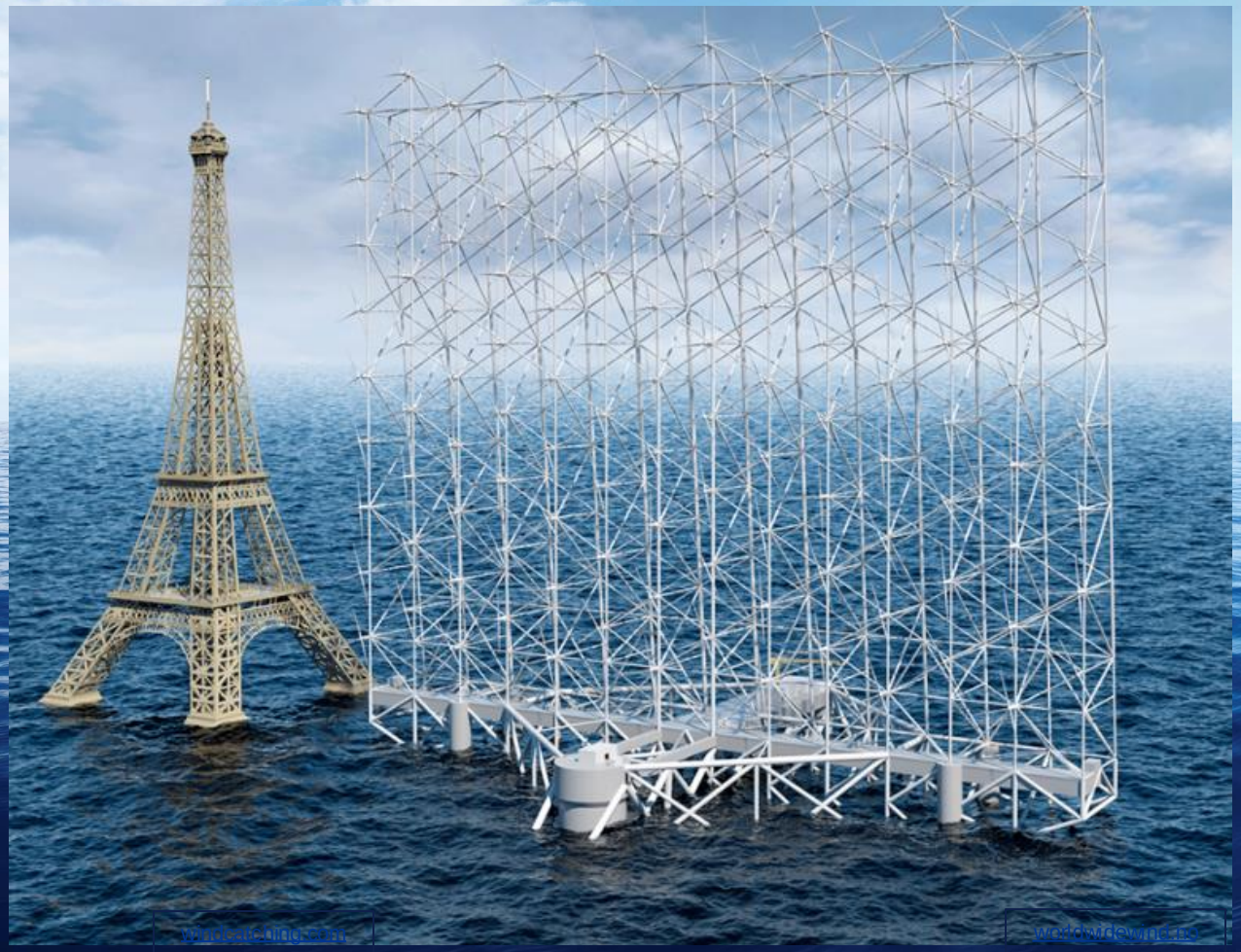
Energy production: Reliability, availability, wind farm layout

‘Standard’ floating wind concepts

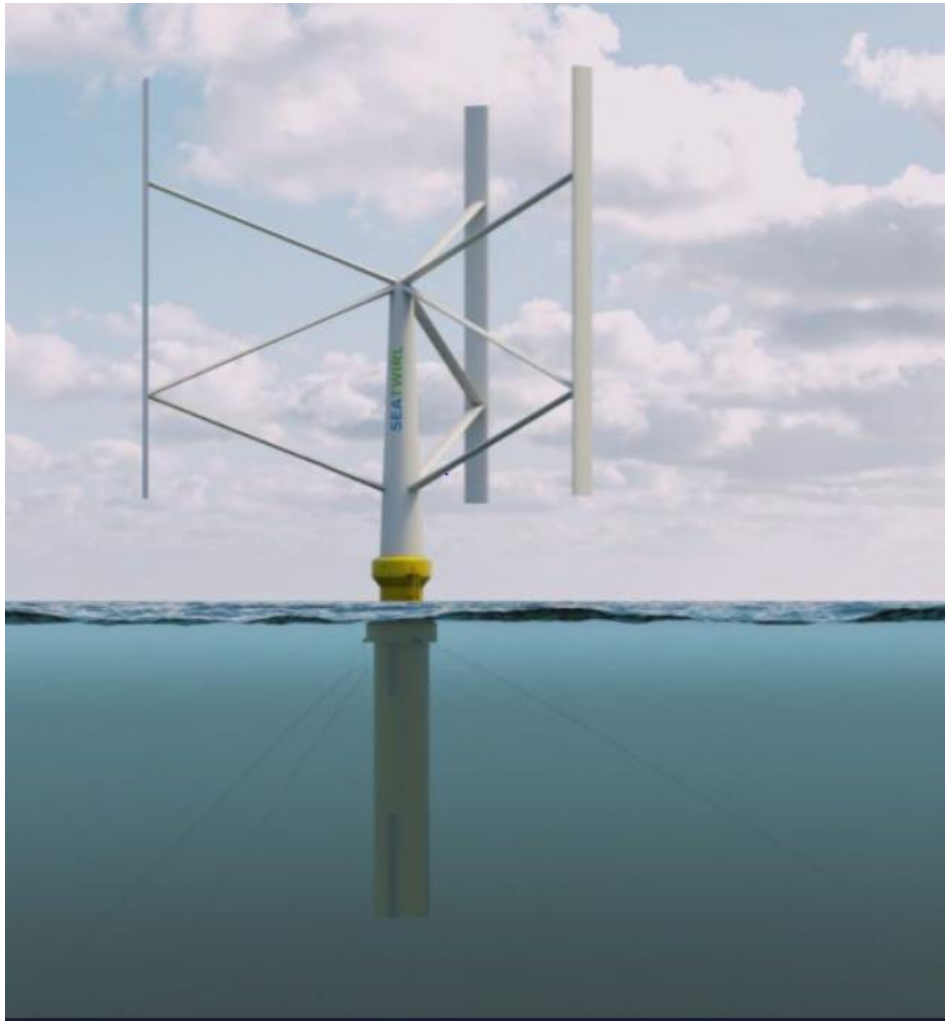


DNV

Innovative concepts



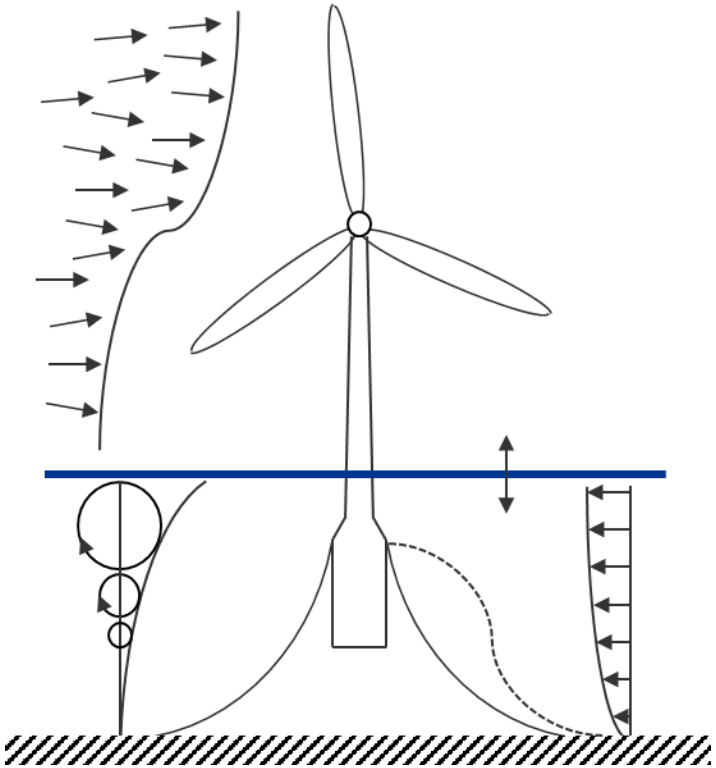
Disruptive Concepts



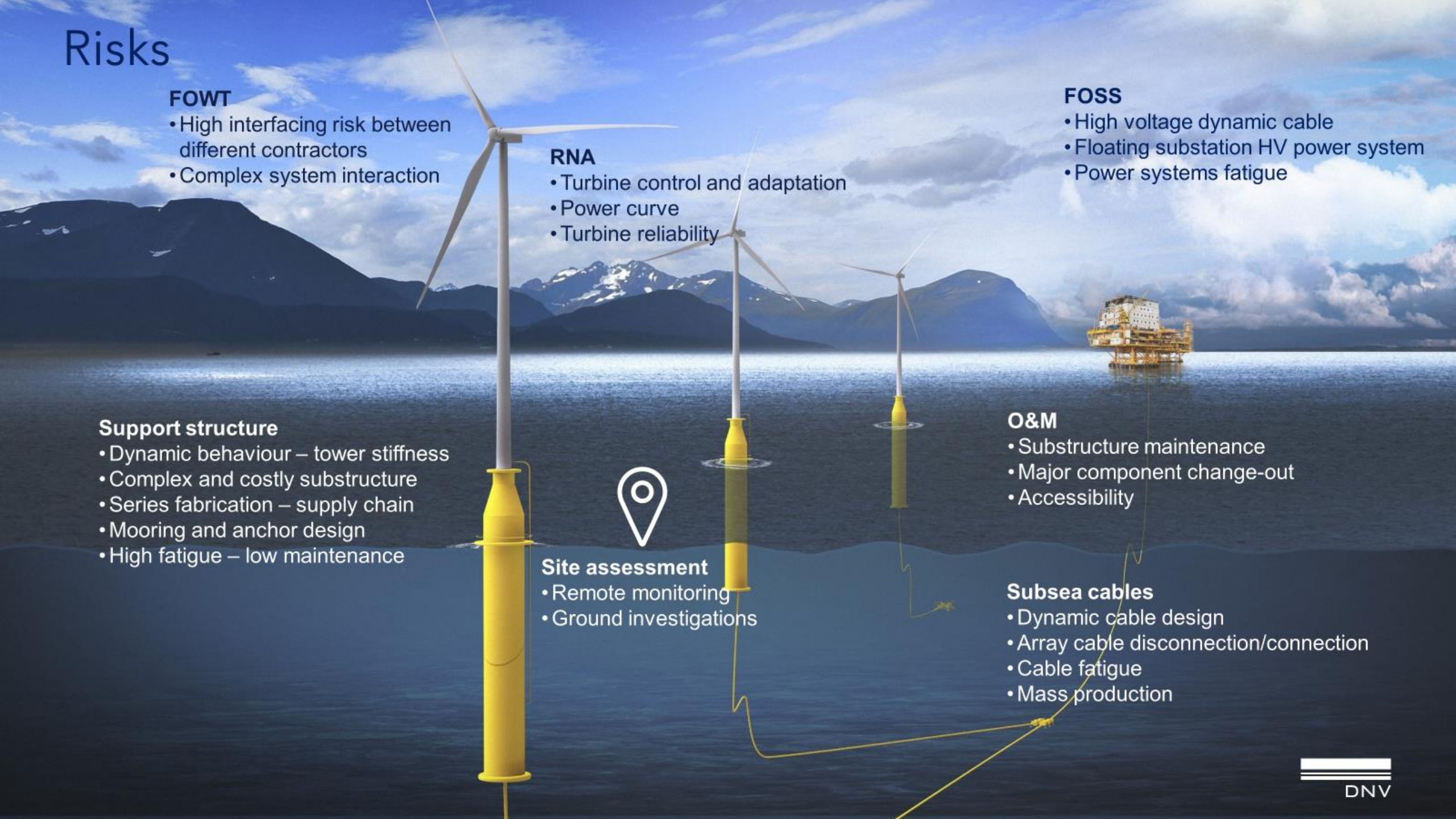
- Vertical turbine
- Specifically designed for floating application
- Turbine and floater integrated
- Generator at or below sea level (easy access and COG)
- Enabling offshore maintenance and repair/component replacement

Floating wind is complex – both technically and commercially

- The technical complexity involved should not be underestimated:
  - The added complexity of going from bottom-fixed to floating (fatigue, mooring)
  - To couple the dynamic thrust from the turbine with a dynamically moving foundation
  - Optimized power production (LCOE)
  - Uninterrupted power production (energy security)
  - Turbine availability
  - 20+ years' service life



Risks



FOWT
- High interfacing risk between different contractors
- Complex system interaction

RNA
- Turbine control and adaptation
- Power curve
- Turbine reliability

FOSS
- High voltage dynamic cable
- Floating substation HV power system
- Power systems fatigue

Support structure
- Dynamic behaviour – tower stiffness
- Complex and costly substructure
- Series fabrication – supply chain
- Mooring and anchor design
- High fatigue – low maintenance

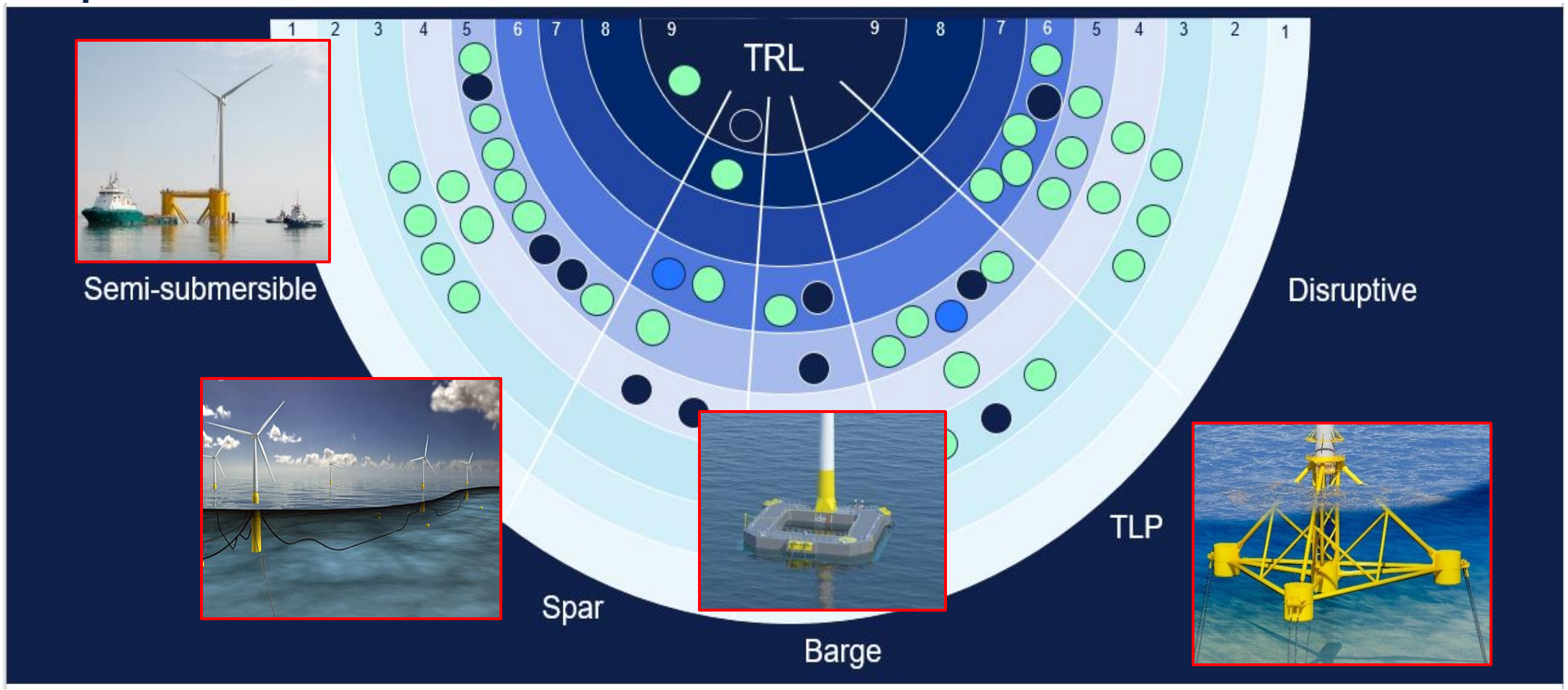
Site assessment
- Remote monitoring
- Ground investigations

O&M
- Substructure maintenance
- Major component change-out
- Accessibility

Subsea cables
- Dynamic cable design
- Array cable disconnection/connection
- Cable fatigue
- Mass production

DNV

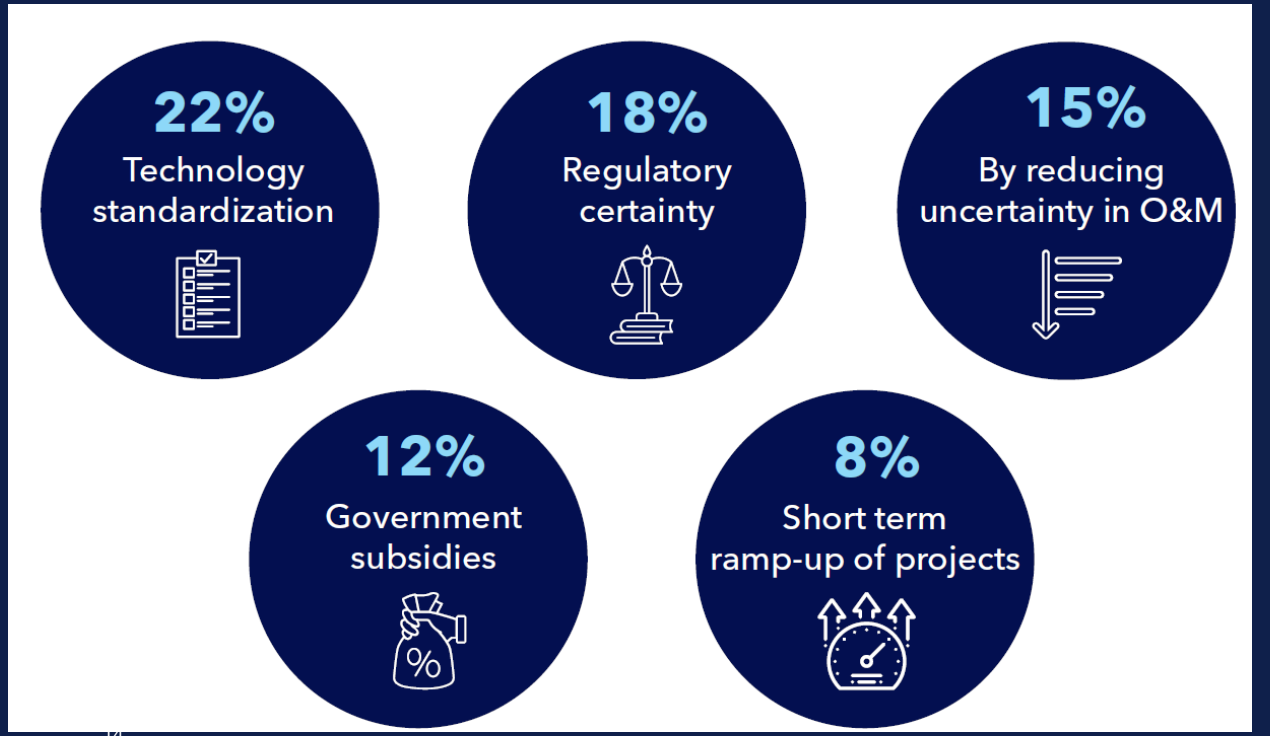
A huge variety of concepts – searching for the best compromise



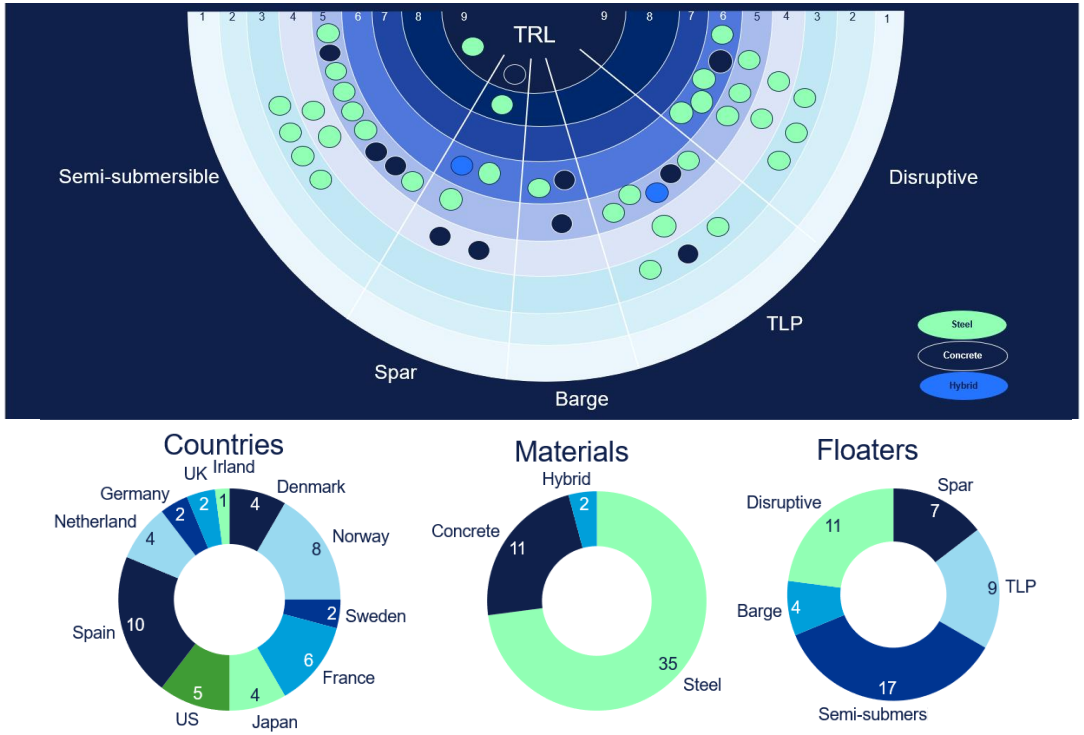
TRL: Technology Readiness Level

Call for standardization

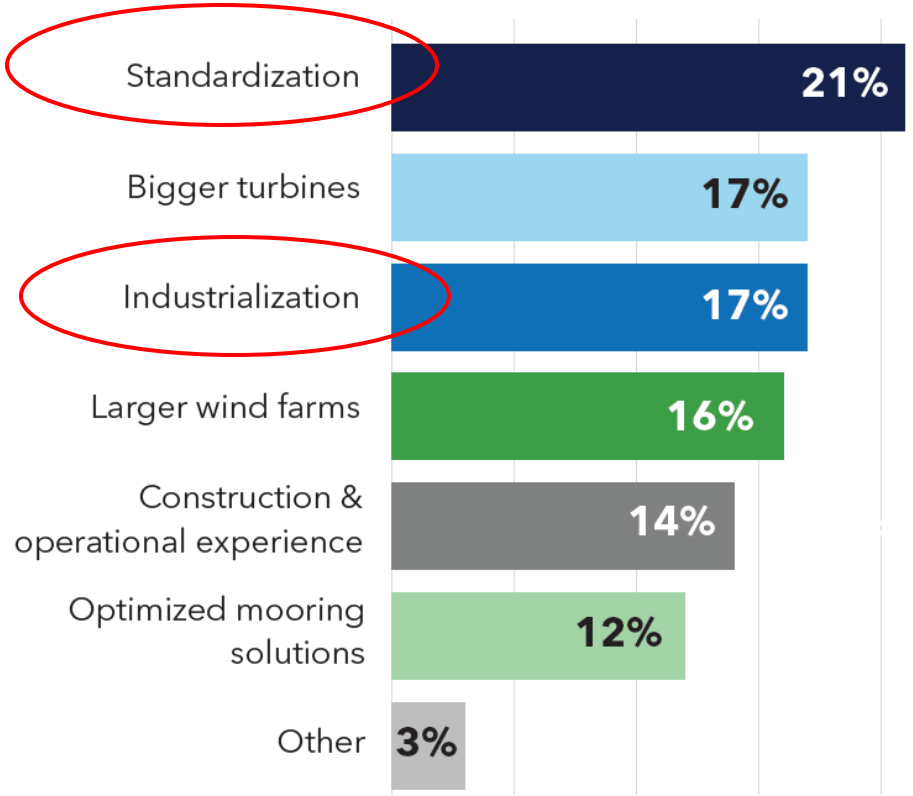
Industry view: How can investors mitigate their risks in such a fast growing industry?

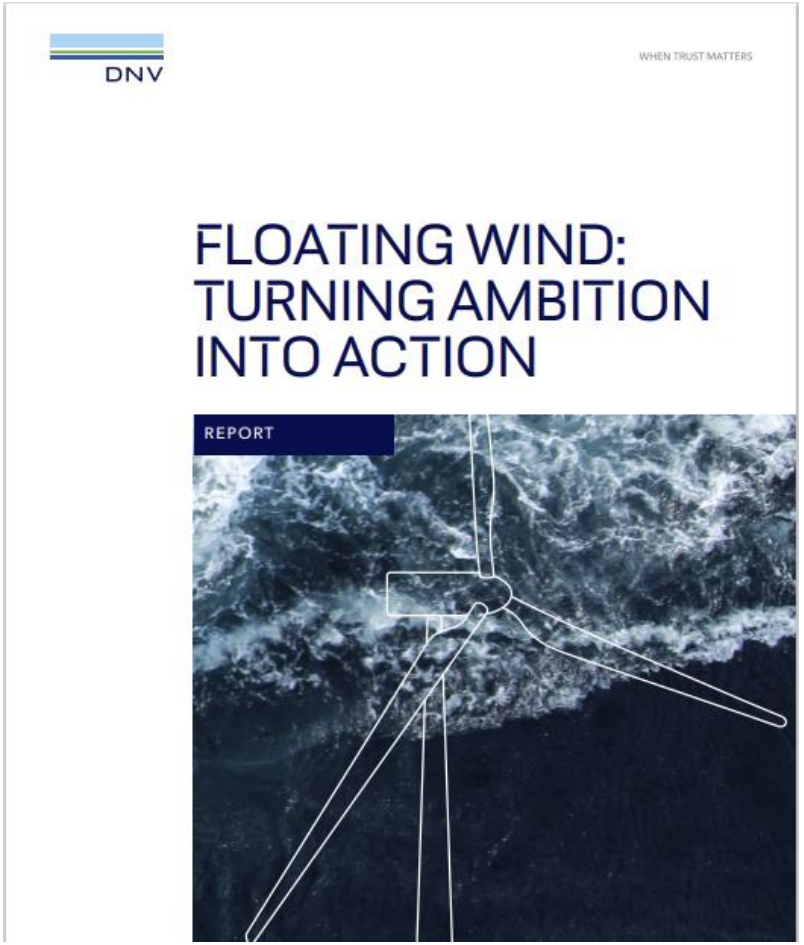


DNV view: Technology readiness of 50 selected concepts (out of 150 out there..?)



Where will the LCOE reduction come from?

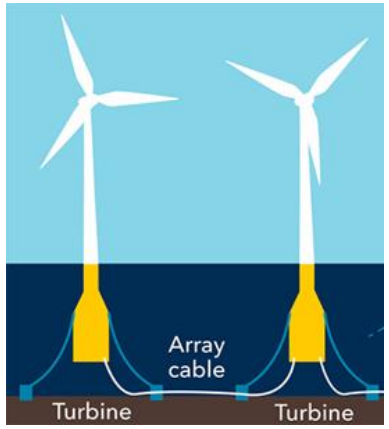




[Floating Wind: Turning Ambition into Action (dnv.com)]
Feedback from 240+ global floating wind experts

Supply chain is not yet ready – invest and develop!

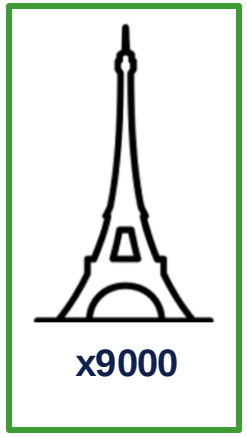
18 000 floating turbines



42 000 km array cables

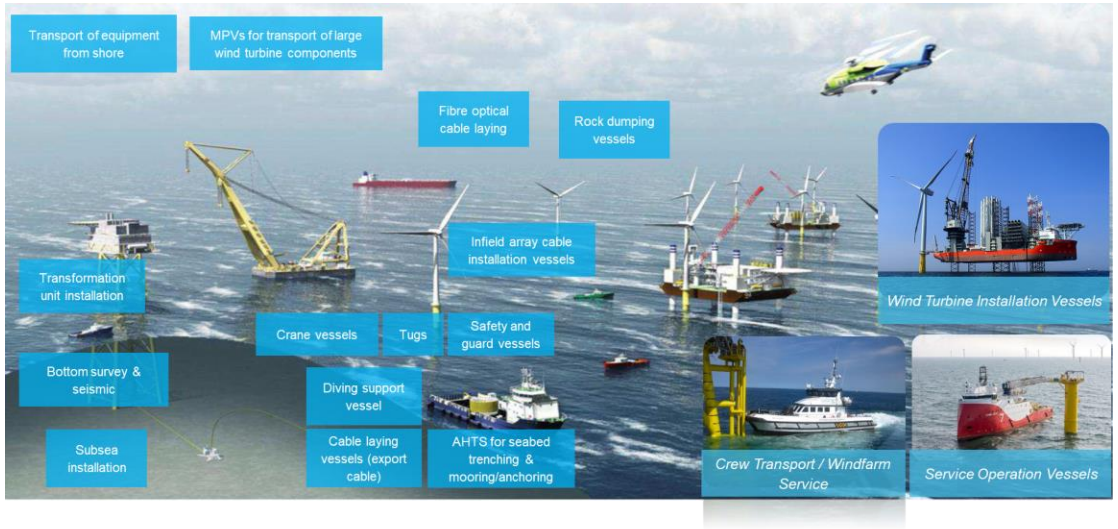
60 000 km mooring line

90 million tons of steel



Material need to meet DNV's prognosis[1] of 270 GW installed capacity by 2050. This equals > 800 floaters per year!

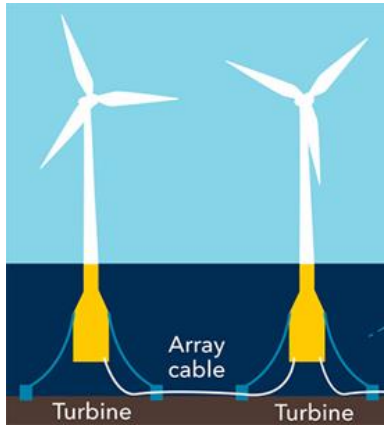
1: DNV ETO 2023



Huge competition to get access to right size and capabilities of vessels during installation, operation and service – matching the concept chosen!

Risks in construction: Supply chain capacity

18 000 floating turbines



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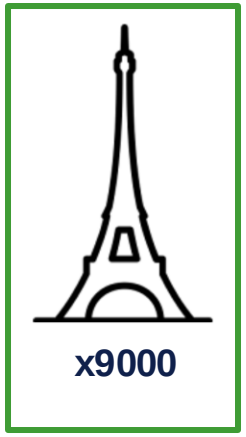

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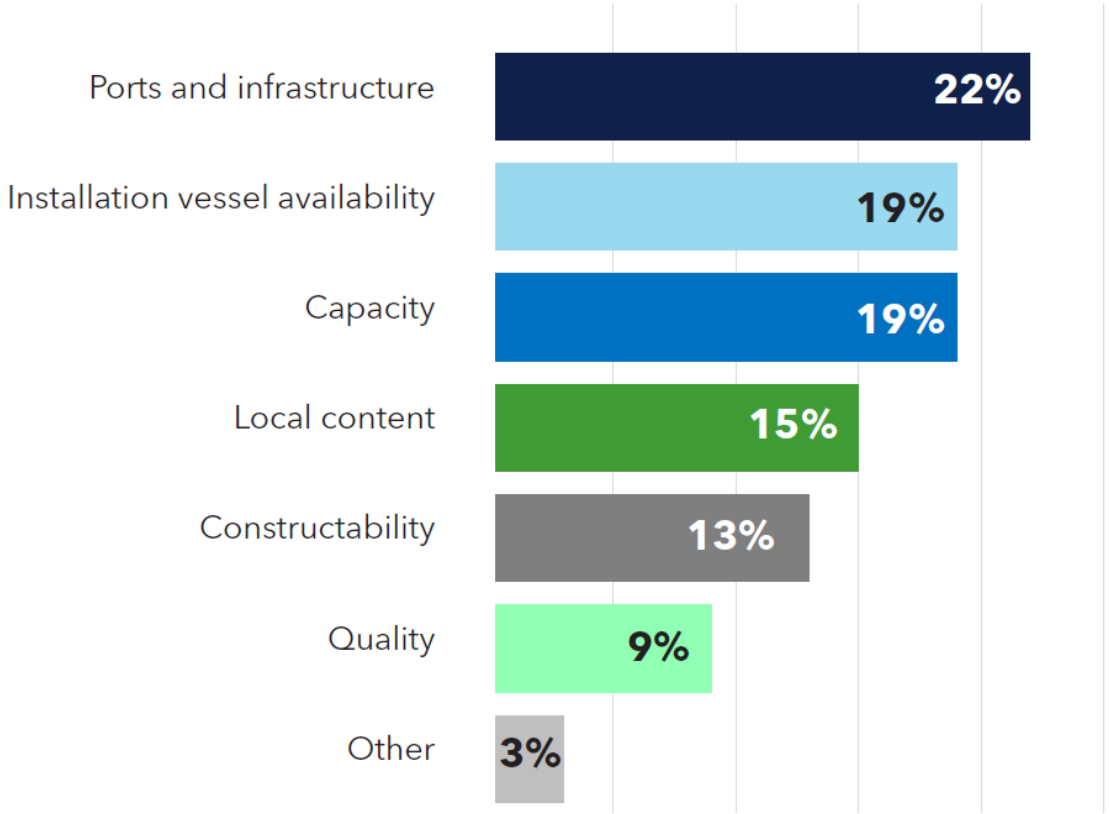
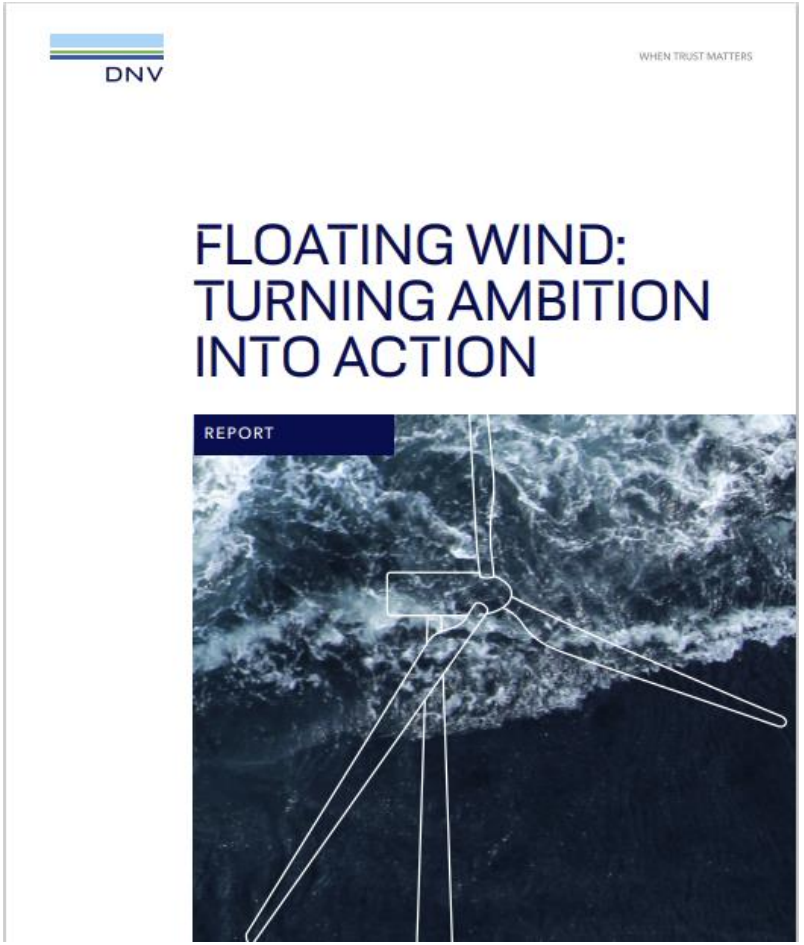
1: DNV ETO 2023

	Category	Mateirals & Suppliers	Labour and experience	Shipyard Prodcution	Total
Europe	UK	🔴	🟢	🔴	🔴
	France	🔴	🟢	🟡	🔴
	Norway	🔴	🟢	🔴	🔴
	Spain	🔴	🟢	🔴	🔴
	Portugal	🔴	🟡	🔴	🔴
	Germany	🟡	🟢	🟡	🟡
	Italy	🔴	🟢	🟡	🟡
	Turkey	🟡	🟡	🔴	🔴
Asia	China	🟢	🟢	🟢	🟢
	S. Korea	🟢	🟢	🟢	🟢
	Japan	🟢	🟡	🟢	🟢

DNV analysis of current capacity to single-source floating structures of steel for a 1 GW project in one year (67 structures per year)

Where do you see the biggest risk in supply chain?





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Industry has still a lot to figure-out & develop on O&M

Cost Effective O&M

Planned activities:
Remote operation, monitoring, inspection, repair etc.

Major component replacement:
Tow-to-port or In-situ?

oceannnews.com

Summary

- Operation philosophy to be established day 1 (feed into design)
- Size matters – bigger turbines bigger windfarms (does size have a turning point?)
- Shore based MCR to be avoided
- Final design & solution is probably not yet there

Thank you

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