
Photo of the WindFloat Atlantic project courtesy of Principle Power/Ocean Winds

WFO

FLOATING OFFSHORE WIND COMMITTEE

# Context for defining Floating Offshore Wind Turbines

Louise Efthimiou
WFO Floating Offshore Wind Manager

Comité Maritime International Colloquium 2024, Gothenburg

# WFO and the FOWC

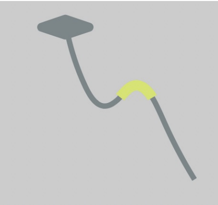
**WFO (World Forum Offshore Wind)** is the world's leading business platform for the offshore wind industry. By connecting and supporting our members, WFO is helping to make offshore wind one of the world's leading sources of renewable energy.


**120+ members**

Events & Network, Committees, Research & Insights, Visibility

# FOWC Subcommittees

FLOATING OFFSHORE WIND COMMITTEE



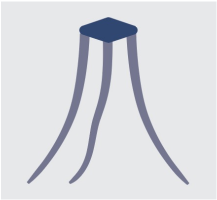
## Cables & FOSS

Hayden Marcollo, Moorsure/AMOG

White Paper = Status quo of dynamic cable development for floating offshore wind

Workshop to be planned in June to answer insurer questions

New topic under investigation



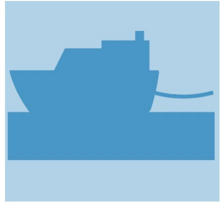
## Moorings

David Timmington, Griffin-Woodhouse Ltd.

Continued exploration of technologies and research in FOW moorings

Drafting second White Paper further defining mooring system reliability, bringing together other research projects in this area

Strong community of experts in FOW moorings



## O&M

Ilmas Bayati, PEAK Wind

February 2023 publication of second White Paper on offsite major maintenance

New topic: defining digitalisation of the operational phase for FOW

## Risk & Insurance

Ralf Skowronnek, Skowronnek & Bechnak

Liaising relationship with JNRC

2024 onwards: Extending focus areas, next one being a study of the cost vs. risk allocation across the entire FOW system (not only moorings, cables, O&M but also floater and turbine)

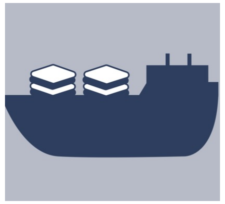
# FOWC Subcommittees

### Environment, Cohabitation & Biodiversity

Roland Teixeira, H2Air / Jean-Philippe Pagot, EDF Renouvelables / Tania Moreira, Masdar / Brian McGrellis, Renantis / Roeland De Rycker (DEME)

Focus on environmental impacts: life cycle assessment, link with fisheries, marine habitats…

Demonstrate that floating offshore wind can coexist harmoniously with marine ecosystems & other economic activities



### Serial Fabrication

Darren McQuillan, BARDEX

Full name: Serial Production and Fabrication of Steel and Concrete Platforms Subcommittee

Promote lean manufacturing principles, standardization and automation concepts to reduce costs and reach net-zero goals

Platform agnostic approach

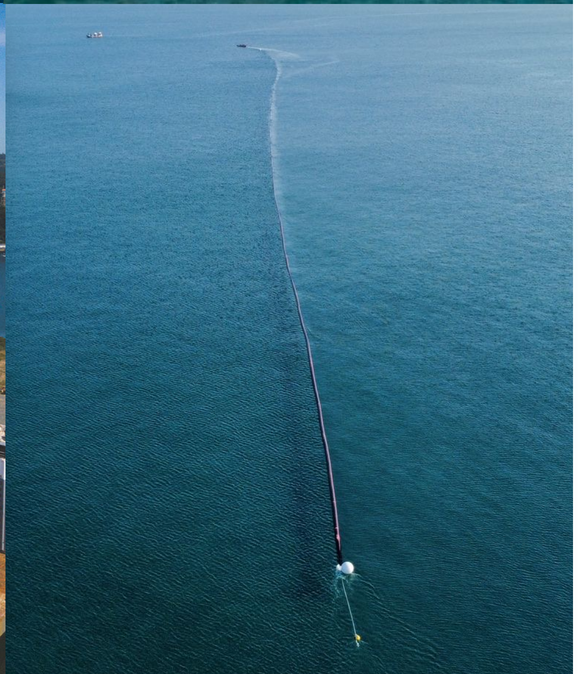
### Contract Interface

Azadeh Nassiri, Slaughter & May / Sophie Fellah, BW Ideol / TBD

Provide guidance to minimise interface risk in multi-contract procurement structures and at various project phases (FEED, installation…)

Identify opportunities for risk sharing and other solutions to favor insurability & bankability



Sources: RWE, BW Ideol, Principle Power, RTE

# Floating Offshore Wind Turbine (FOWT) key characteristics

**Floater design**

**Moorings**

**Cables**

**Fabrication & installation**

**Operations & Maintenance (O&M)**

**Environmental impact**

Sources: Josh Bauer/NREL

Provence Grand Large – SBM/IFPEN

Tension-Leg Platform

Hywind Tampen – Equinor

Spar

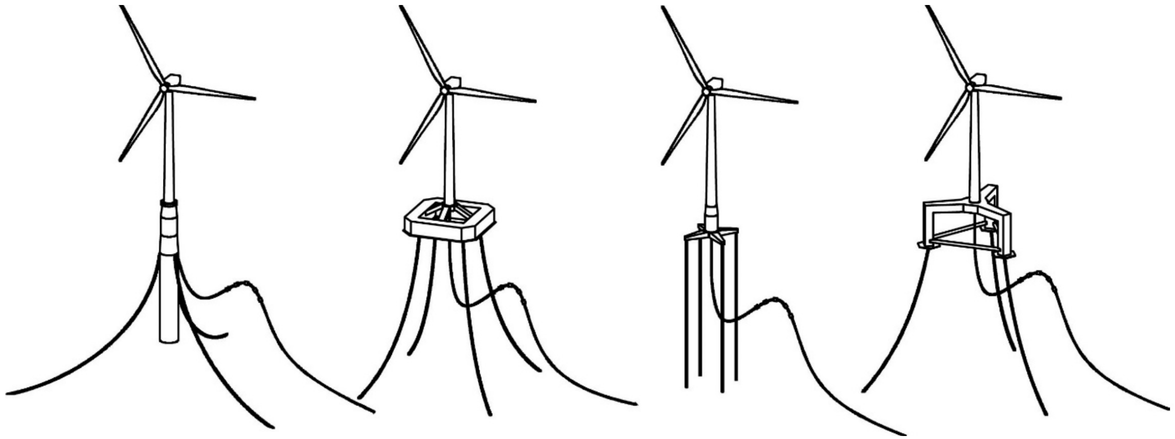
Floatgen – BW Ideol

Barge

Kincardine – Principle Power

Semi-submersible

# Moorings configuration



Spar, Barge, TLP, Semi-Sub (from left to right). Source: Scheu et al. 2018

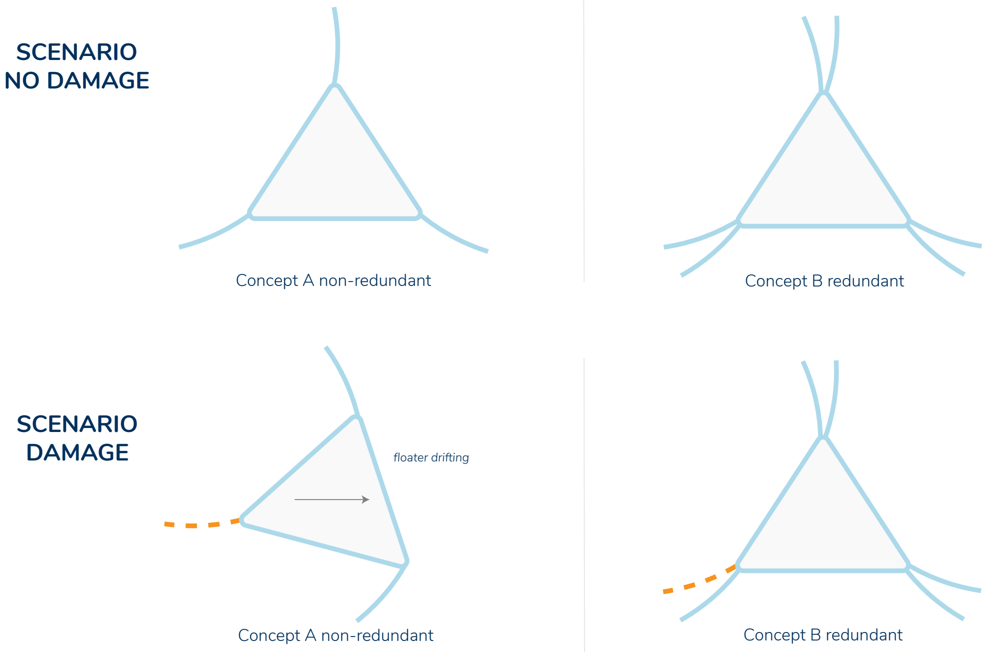
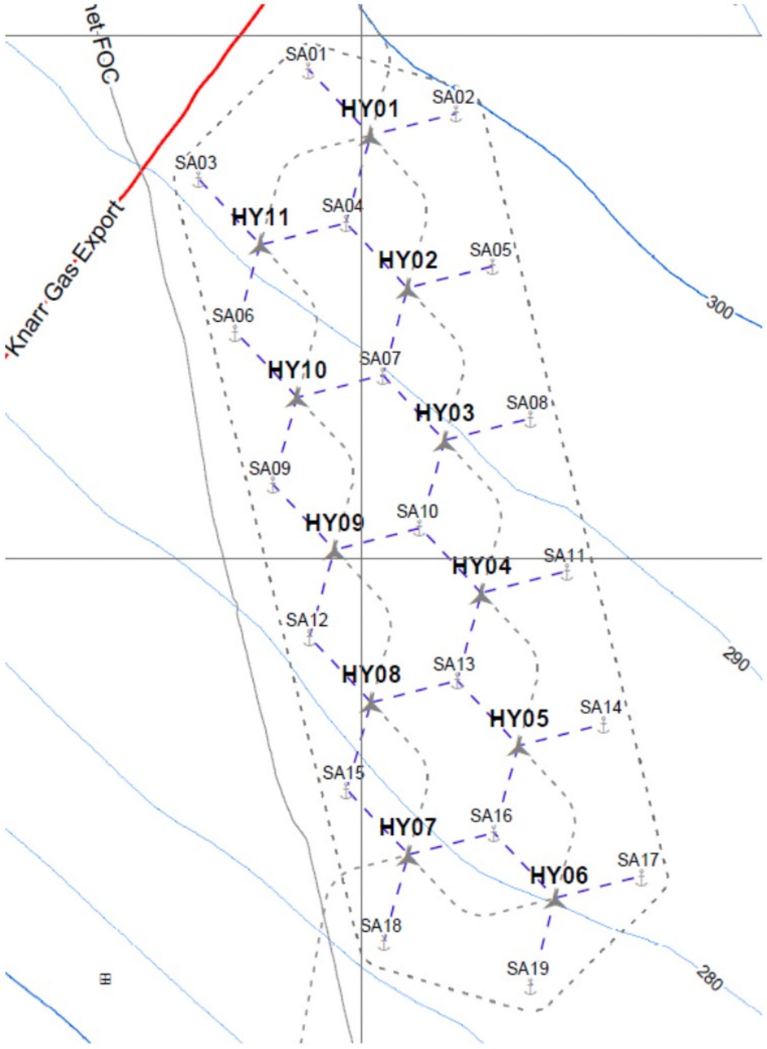



Illustration of moorings redundancy concept. Source: WFO




Hywind Tampen mooring configuration (19 shared anchors, 1.7 per turbine). Source: DOF

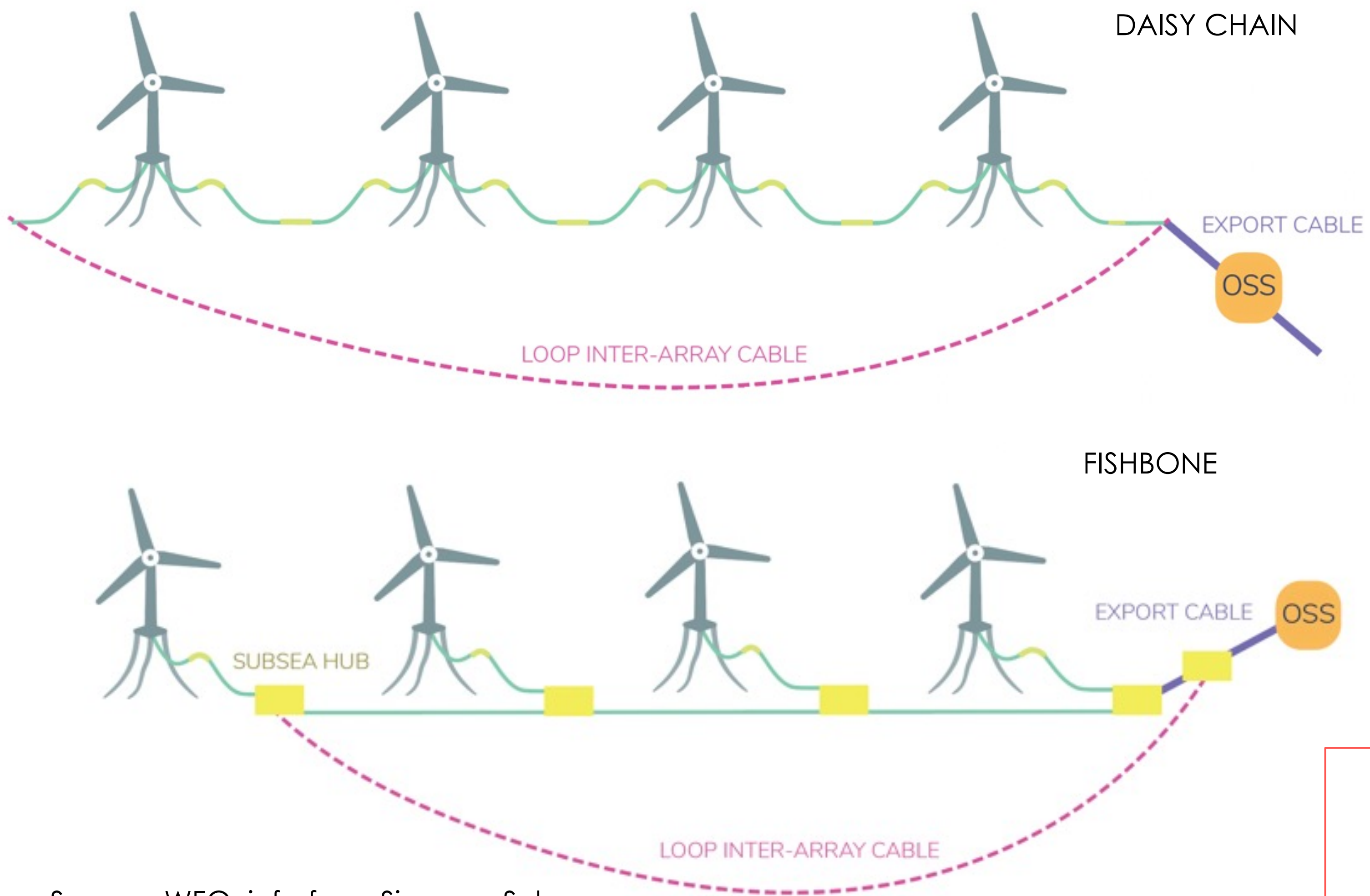
WFO 2021 – Mooring Systems for Floating Offshore Wind: Integrity Management Concepts, Risks and Mitigation

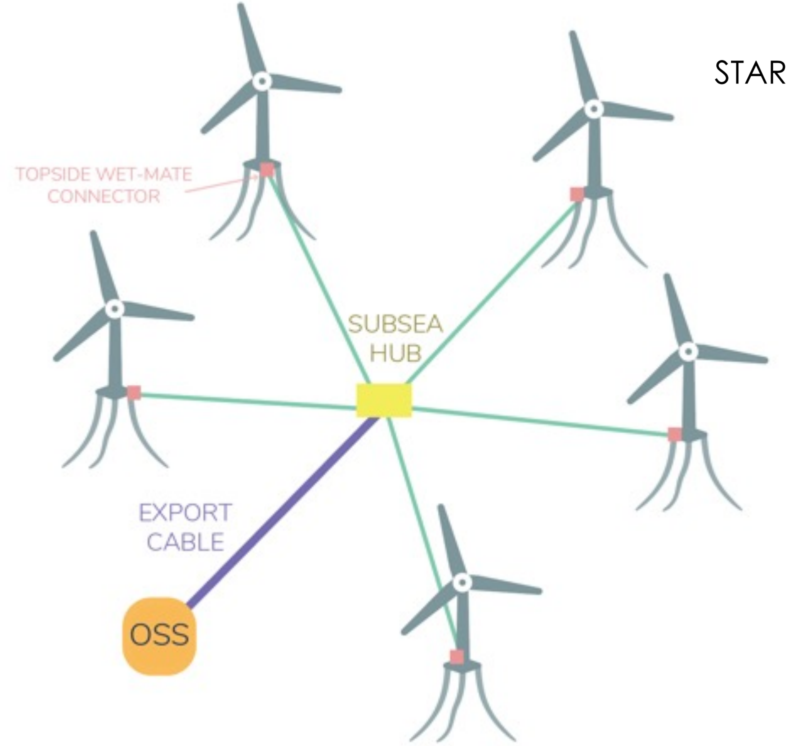
Competition to solve the challenge of regaining control of a floating offshore wind turbine that has come loose from its anchors. Norwegian Offshore Wind March 2024

# Cable configuration

WFO

[WFO 2024 - Floating Offshore Wind Dynamic Cables: Overview of Design and Risks]



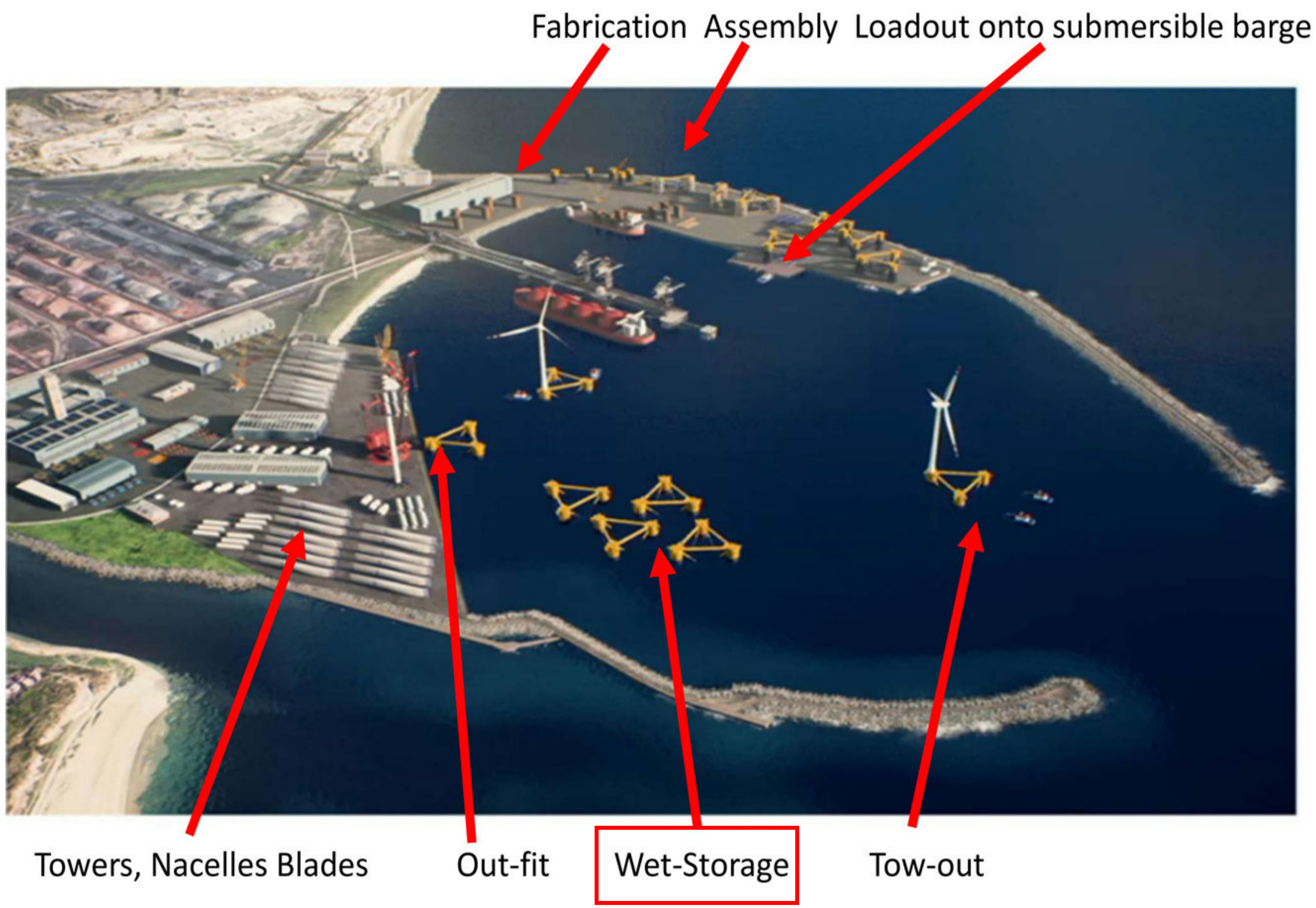




Source: WFO, info from Siemens Subsea

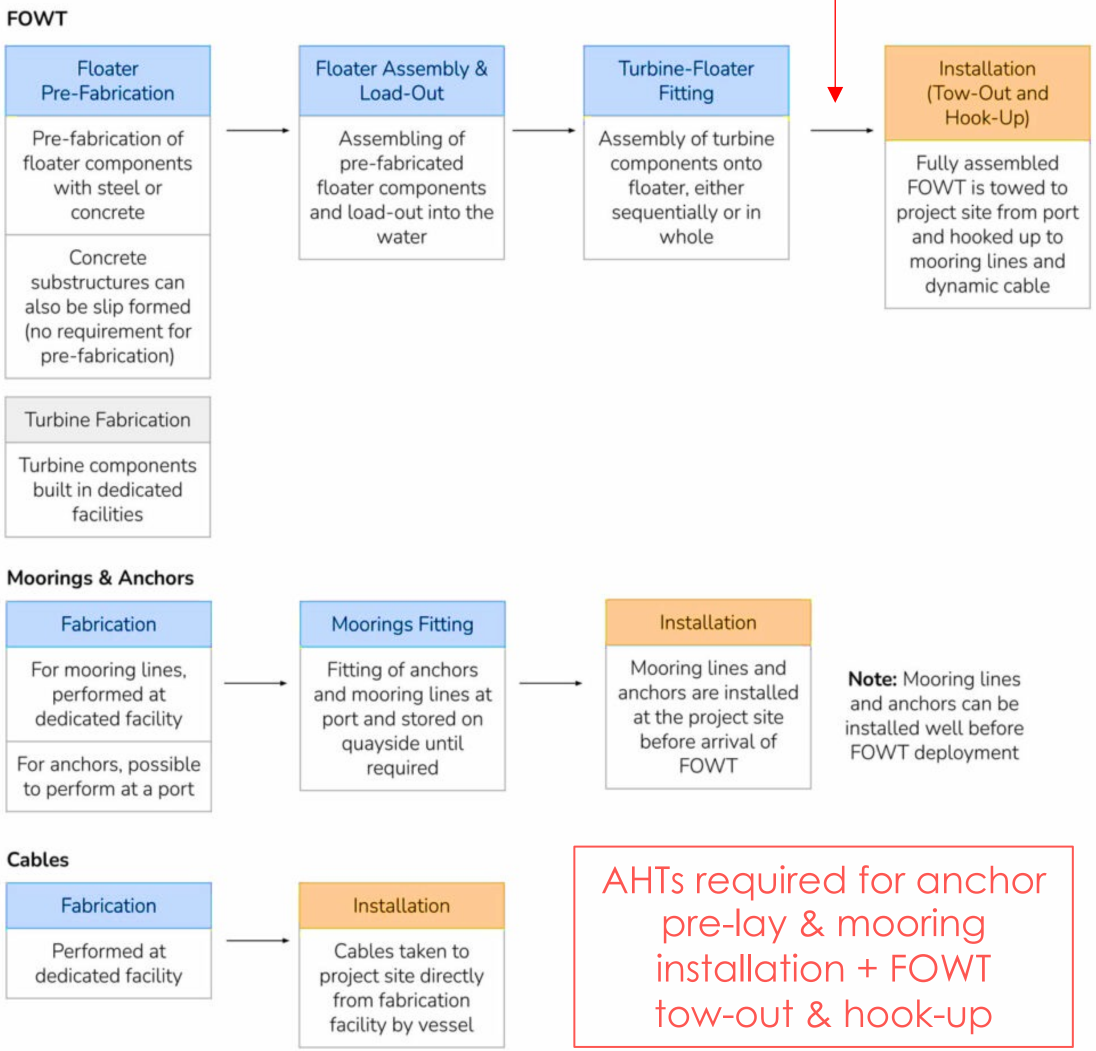
Disconnection of mooring lines and cables a complex operation. Question on where to place after disconnection: at seabed, on buoy?

# Fabrication & installation

Floater guide port design or port capability guides floater? (🐣)




volume, time?

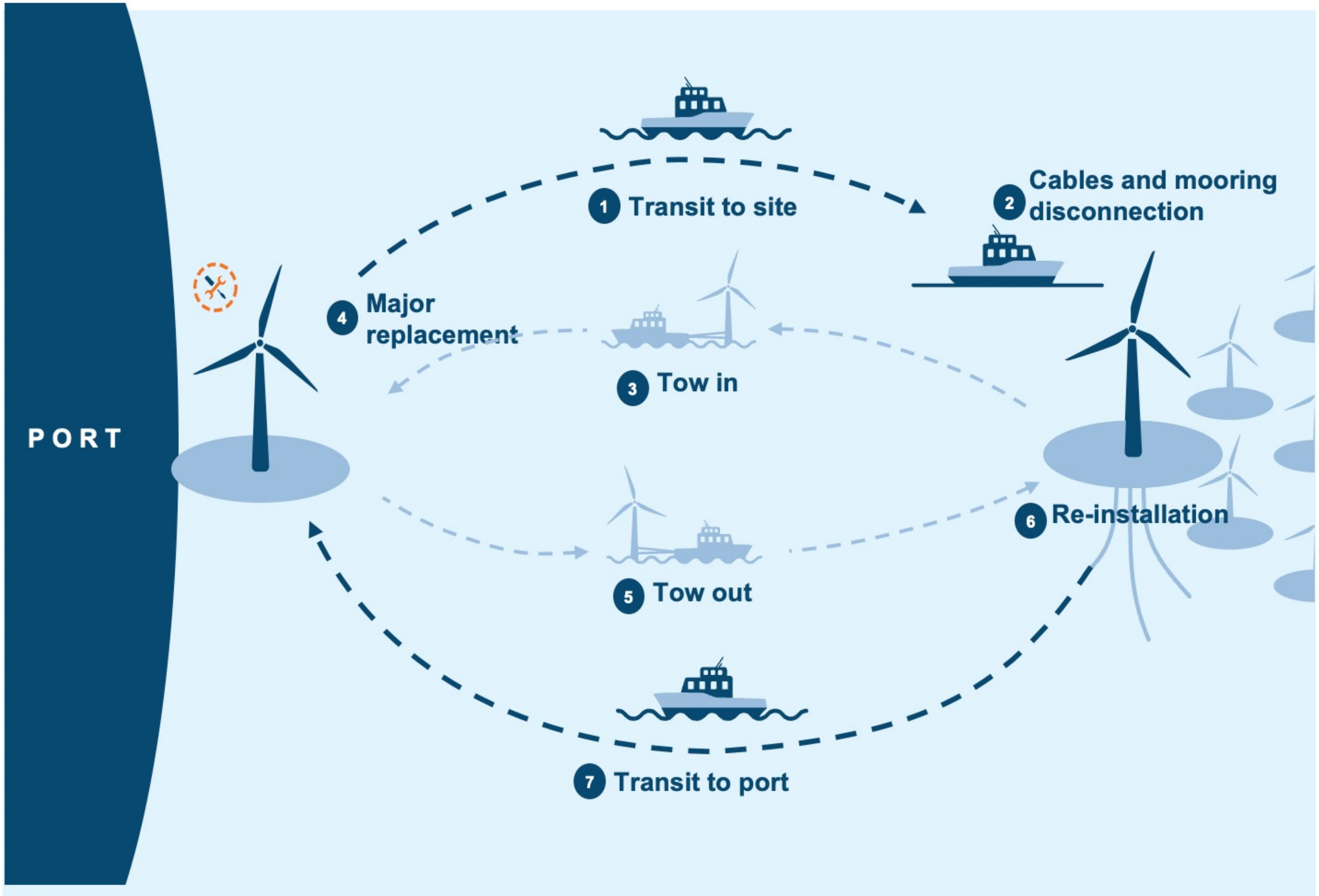



AHTs required for anchor pre-lay & mooring installation + FOWT tow-out & hook-up

Source: left image ABP, Crowle and Thies (2021) ; right image WFO

[WFO 2022 blog article]

# O&M: today we do tow-to-port



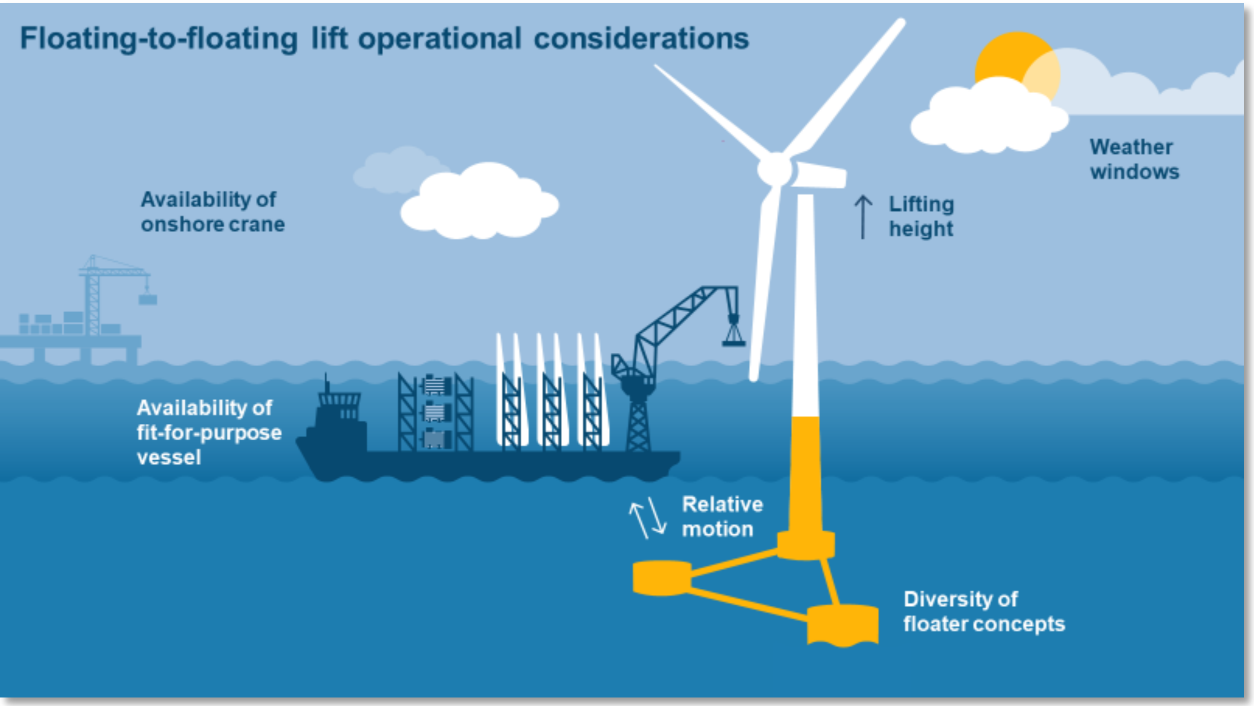

Source: PEAK Wind

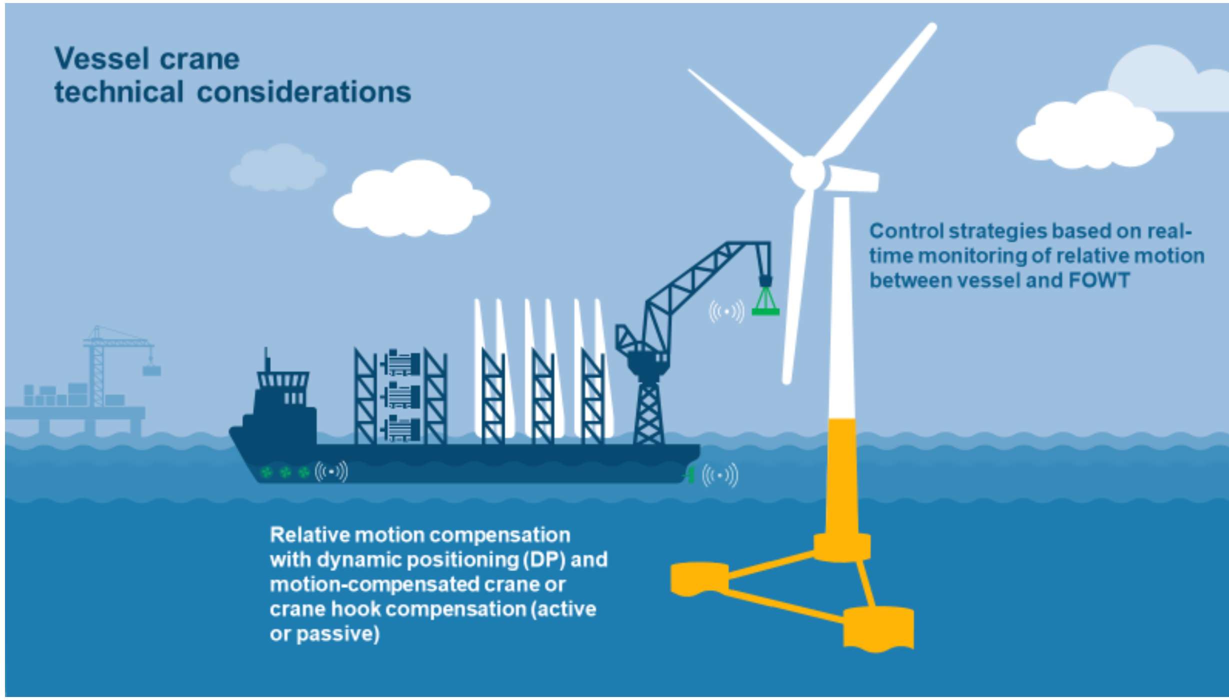
- ✓ Relatively straightforward process
- ✓ Connection / reconnection
- ✓ Not involving major technology developments
- ✓ Reverse installation

- × Risks of damage during connection / reconnections
- × Lengthy process weather windows, availability
- × Number and type of vessels involved
- × Uncertainties on storage of cables and moorings
- × Harbor-specific (dimensions, draft)

WFO 2021 – Challenge and Opportunities of Major Maintenance for Floating Offshore Wind

# Future? Onsite repair: floating-to-floating




[WFO 2023 – Onsite Major Replacement Technologies for Floating Offshore Wind]

**Source:** WFO/PEAK Wind

# Future? Onsite repair: add-on crane

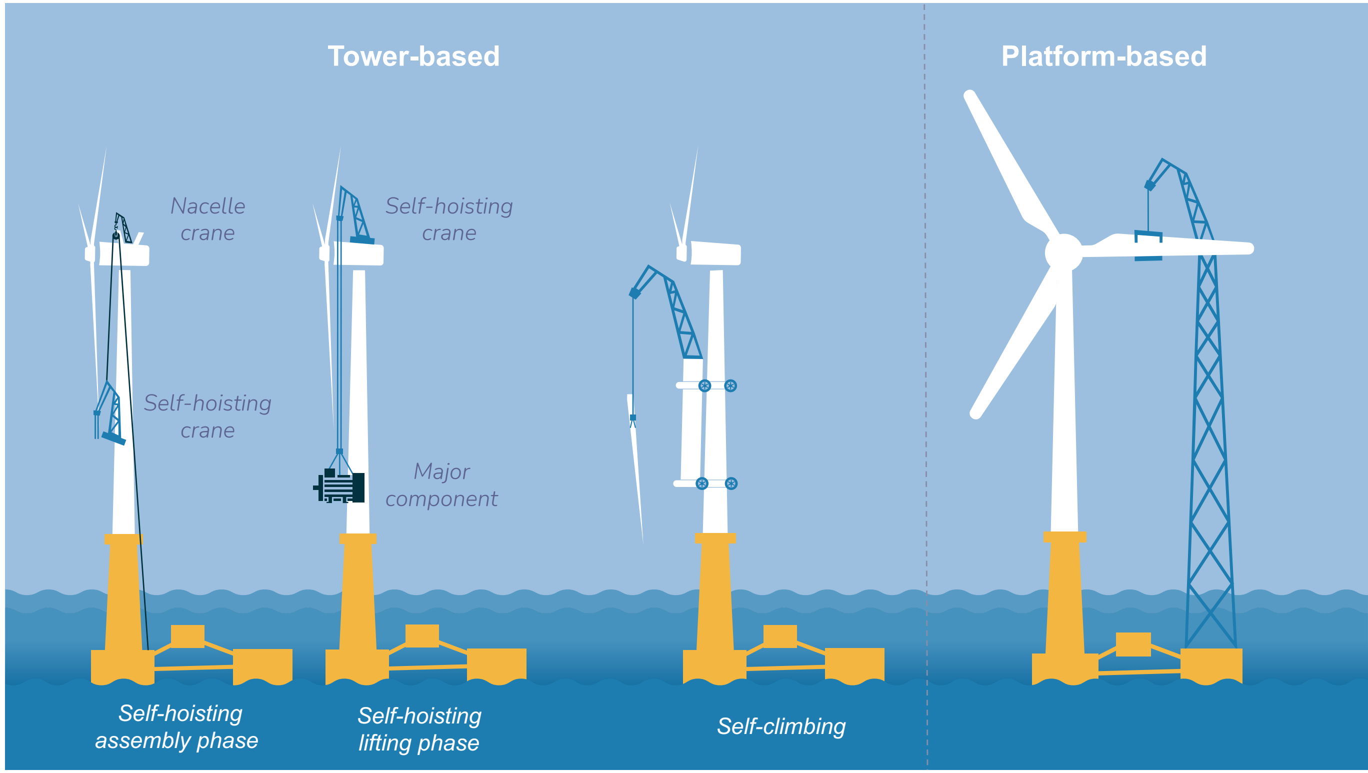
**1) Tower-based**

**1a) Self-hoisting**: Self-hoisting cranes are installed by using wires attached to the nacelle. They can crawl via those wires.

**1b) Self-climbing:** Self-climbing cranes are adapted to the tubular steel tower and can climb up to the nacelle. The lifting mechanism can be a brace that secures itself around the tower, or a system that attaches itself directly to the tower using pins.

**2) Platform-based**

A platform-based add-on crane is secured on an area of the floater. An area of the floater could mean the column or between two columns for a semi-sub (Figure 3), or somewhere on the barge.




**Source:** WFO/PEAK Wind

# Insurance perspective

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WFO 2021 – Insurability of Floating Offshore Wind

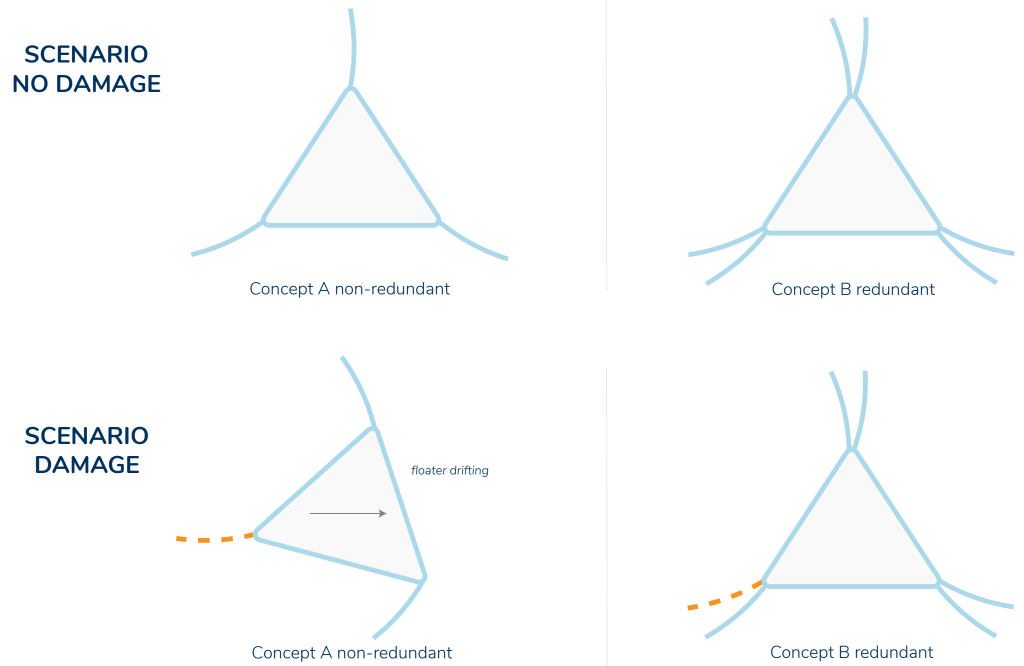
**RISK MITIGATION**: lower the probability of failure in dynamic cables

- redundancy : loop for array, dual export cable (like b-f), substation, mooring system

**LOSS MITIGATION:** reduction of repair cost and downtime

- replaceability : accessories designed for cost-efficient and fast repair/replacement
- replaceability cont'd: spare parts plan & procurement, clear repair terms

Cable failure = loss of energy production i.e. loss of FOWT / wind farm function. Managing risks therefore key to achieving insurer confidence.




**How the CAR/DSU and OAR/BI insurances responds in case of LOSS OR DAMAGE DUE TO DEFECT:**

| | | |
|---|---|---|
| Floating Offshore Wind: | LEG 1 -> LEG 2 | floater, mooring leg, dynamic cable |
| Bottom Fixed: | LEG 2 -> LEG 3 | foundation and static cable |
| Wind Turbine (Floating/Bottom F.): | LEG 2 | |

| LEG 1 | | LEG 2 | | LEG 3 | |
|---|---|---|---|---|---|
| Repair Costs | Loss of Revenue | Repair Costs | Loss of Revenue | Repair Costs | Loss of Revenue |
| ❌ | ❌ | ❌ ✅ | ✅ | ✅ | ✅ |

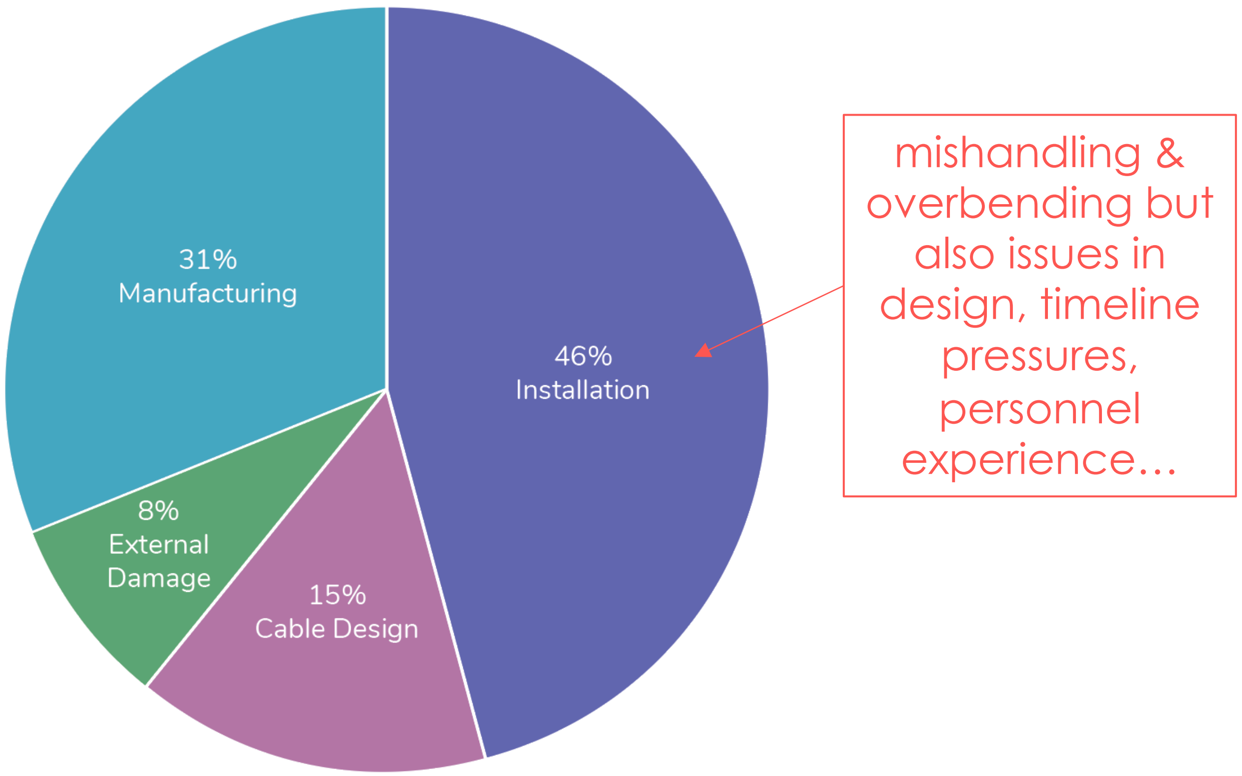
Source: Ralf Skowronnek, Chairman WFO Floating Wind Insurance Subcommittee

# Bottom-fixed experience

The Carbon Trust estimates the average failure rate envelope of static offshore wind subsea cables to be between $1.9 \times 10^{-3}$ failures/km/year and $2.13 \times 10^{-2}$ failures/km/year. (Phase V FWJIP 2023)

Mitigation measures needed across development, manufacturing and installation phases:

→ quality site survey, subsea cable expert expert in manufacturing and installation
→ public communication of cable issues as done in the past

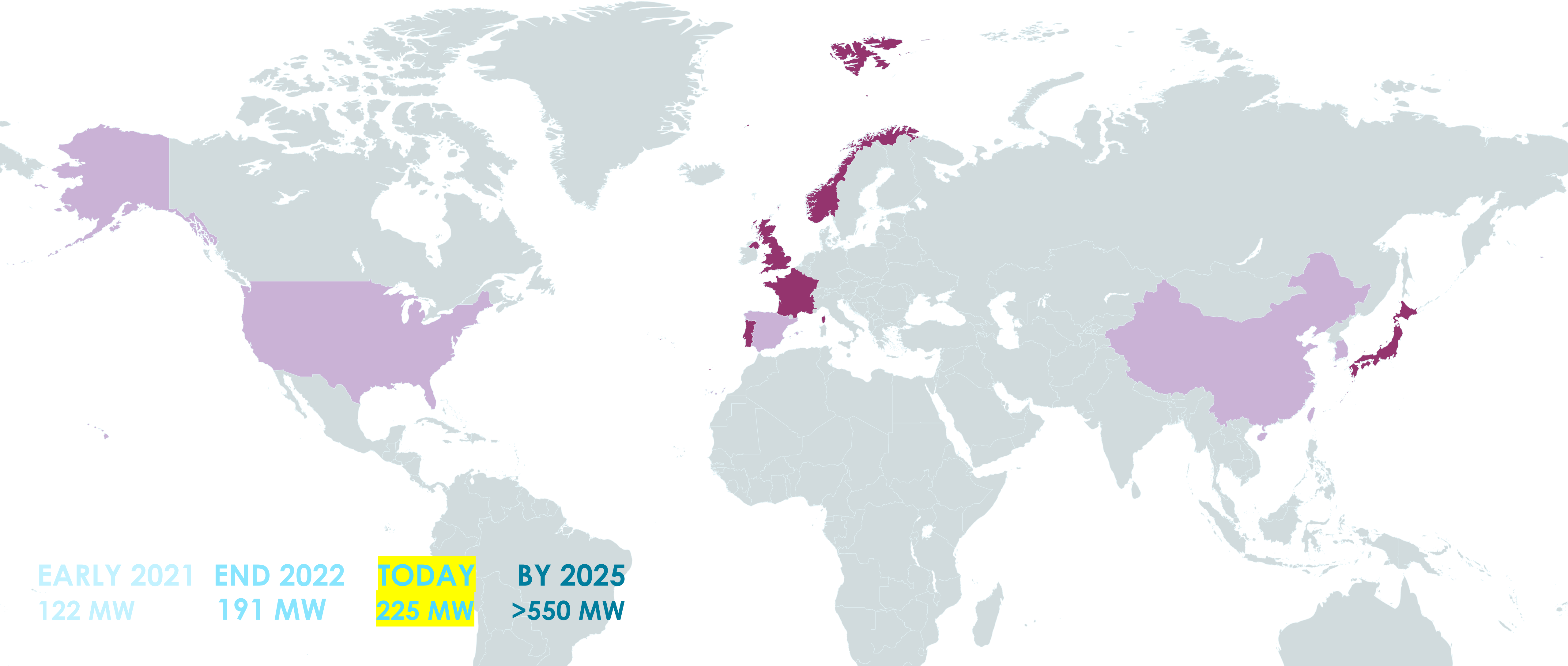



**Recorded failure modes for bottom-fixed wind export and inter-array cables in the UK that were discovered during operation.**
Source: ORE Catapult 2021

# Market outlook 2021-2025

**Commissioned in 2023:** Hywind Tampen (88 MW), CNOOC Deep Sea Floating Qingdao/Haiyou Guanlan (7,25 MW), X1 Wind PivotBuoy (0.22 MW, Mar-May 2023), WP2Power (0.2 MW, Nov 2022-Jan 2023), DemoSATH – BIMEP (2 MW), T-Omega Wind 1/16 Prototype (0,3 MW)

**To be commissioned in 2024-2025:** Nezzy^2 (16.6 MW), Provence Grand Large (25 MW, all turbines installed), EFGL (30 MW), EOLINK (5 MW), Eolmed (30 MW)



| EARLY 2021 | END 2022 | TODAY | BY 2025 |
| --- | --- | --- | --- |
| 122 MW | 191 MW | 225 MW | >550 MW |

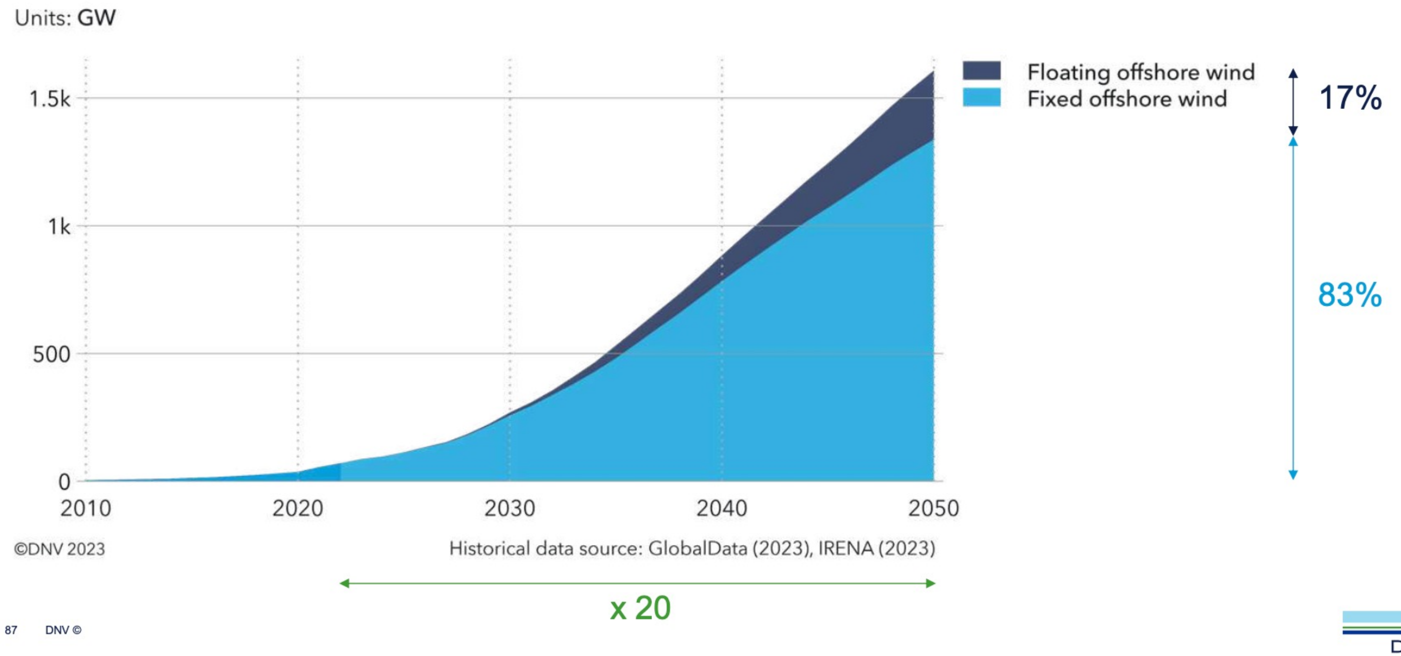
# Contextualising figures

WFO 2023 – Global Offshore Wind Report

**2023:** largest offshore wind farm commissioned is 1.5 GW. For floating wind it's 88 MW. Less than 10% size.

**As of 2023:** There is 67 GW of offshore wind capacity in operation. 225 MW of it is floating wind. **Less than 1% of offshore wind capacity in operation.**

**Reminder estimation by DNV for 2050:** Floating wind reaches a global installed capacity of 289 GW equivalent to **17% of offshore wind capacity in operation** (=1700 GW).



# Auctions & tenders 2022-2025

**Already announced**

- **UK** January 2022: 15 GW ScotWind. March 2023: INTOG awarded to 13 winners, including 2 major floating developers.
- **UK** recent AR5 strike price was too low (44 pounds/MWh) and no offer was made by developers. UK government increased the strike price to 73 pounds/MWh for the next AR6 set to open by March 2024. AR6 also ups the cap for floating wind projects to £176/MWh, 52% higher than AR5's £116/MWh.
- **USA** December 2022: 4.6 GW lease sale in California December 2023-May 2024: Proposed Sale Notice in Central Atlantic, Gulf of Mexico (second time), Gulf of Maine, Oregon.
- **Portugal** launched the initial stage of offshore wind tender with three areas totalling 3.5 GW

**To be announced later (this year or early next):**

- **UK** Celtic Sea Floating Offshore Wind Leasing Round 5 upsizes capacity to 4.5 GW
- **Norway** Utsira Nord zone is postponed indefinitely for now, waiting for future updates
- **France** Brittany A05 250 MW winner chosen but not yet announced, Mediterranean A06 2 x 250 MW winner announced by end 2024
- **Taiwan** demo project of max 540 MW winner announced by end 2024

# Industry priorities

Centred on **design** for reliability and serial production

→ Standardisation of floater parts
→ Innovation for moorings & cable systems : size, materials, accessories
→ Validation of design tools
→ Turbine control methods

(ETIPWind Roadmap 2020, still relevant today)

…**What can CMI do in the meantime?**

# Thank you!

louise.efthimiou@wfo-global.org

https://wfo-global.org/


Photo of the WindFloat Atlantic project courtesy of Principle Power/Ocean Winds

# Floater technology

As you may have seen from the market overview, there are not many projects currently in the water. The main operating projects are :

→Floatgen using BW Ideol concrete barge with moonpool (Hibiki steel version in Japan). Both operating since 2018. Performance facts: Floatgen cumulated capacity > 30 GWh, lifetime extension announced; Hibiki weathered 8 super typhoons (2022 report)

→WindFloat Atlantic (COD 2020) & Kincardine (COD 2021) using Principle Power WindFloat floater). Performance facts: WindFloat $H_s$ 20m, end 2023, Kincardine major component replacement

→ Hywind Scotland (2017), Hywind Tampen (2023) with Equinor spar floater (working on semi-sub concept too). Performance facts: Scotland 54% capacity factor over 5 years but now need for tow-to-port, environmental impact studies at Scotland, Tampen has first-ever shared moorings system

**BUT ALSO**: TetraSpar (Stiesdal, spar configuration) DEMOSath (Saitec, barge).

Some of their next activities:

- Ideol Eolmed (30 MW) project; involved in South Brittany and Mediterranean floating tenders
- Principle Power on EFGL (30 MW)
- Principle Power and Equinor involved in California lease. RWE too (behind TetraSpar and DemoSATH)
- But also Korea, Japan, UK, Norway

# Onsite repair: add-on crane

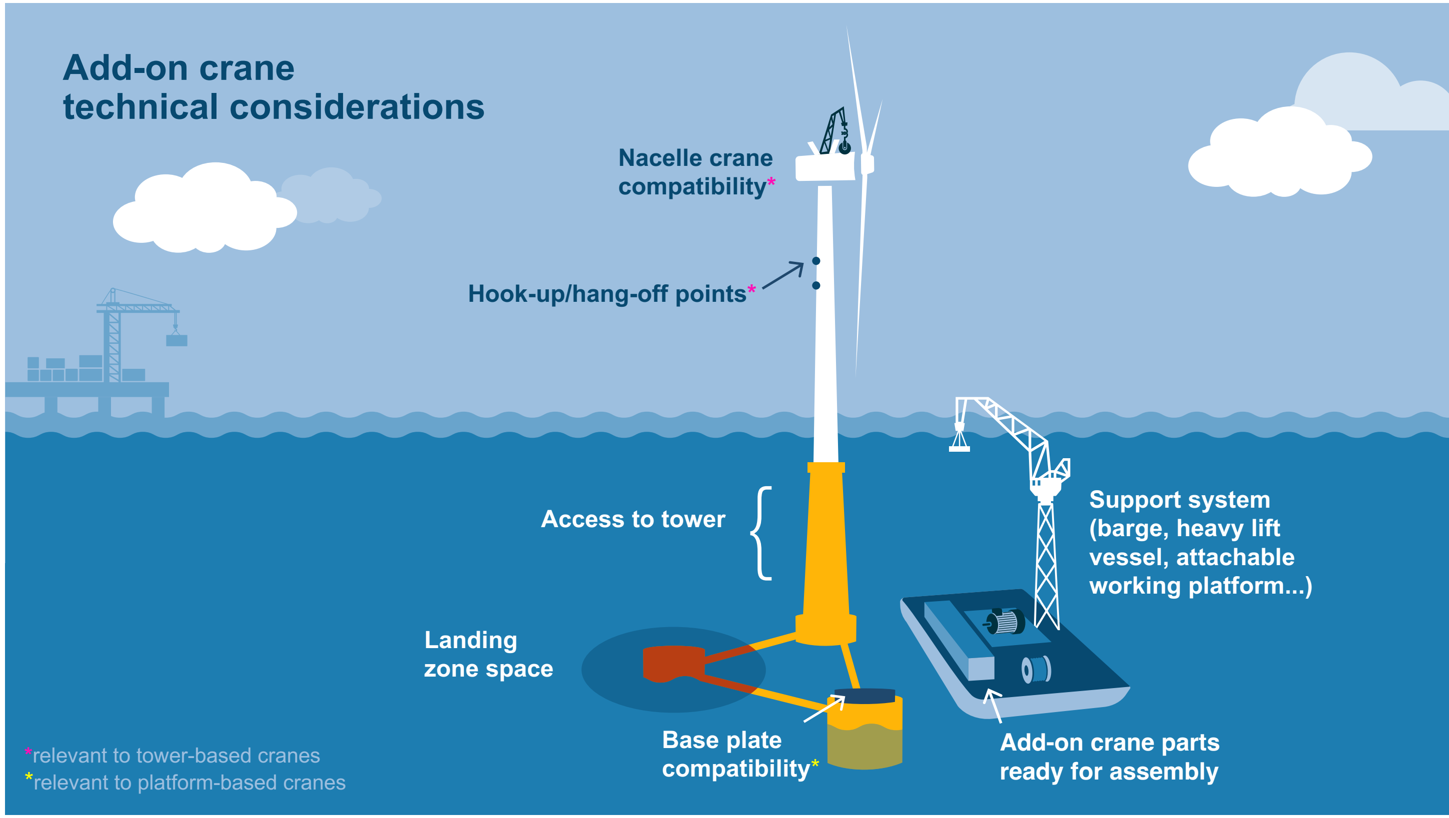
**Number of technical considerations:**

- Hook-up/hang-off points
- Nacelle crane compatibility
- Base plate compatibility
- Access to the tower
- Landing zone space
- Ballasting
- Support vessel
- Motion compensation
- Control system

*Right now:*

Technology suppliers making strategic decisions to serve the floating wind turbines of 2030 and beyond, considering the priorities of:

- Project developers
- Floater designers (🐣)
- Turbine OEMs




**Source:** WFO/PEAK Wind

# Government targets 2030-2040 (fixed & floating)

**Installed capacity projections (fixed-bottom & floating wind)**

180 GW by 2030 (low scenario)

500 GW by 2030 (high scenario)

Westwood

**Floating wind installed capacity projection = 6.8-11 GW by 2030**

**Installed offshore wind capacity targets by countries (fixed and floating)**

**United Kingdom:** 50 GW by 2030**, 5 of which is floating**

**Ireland:** 5 GW by 2030

**France:** 2,4 GW by 2024; 5-6.2 GW by 2028; 40 GW by 2050

**Portugal:** 2-3.5 GW by 2030 for first auction, aiming to reach 10 GW

**Spain:** 3 GW by 2030

**Norway:** 30 GW by 2040, ports able to facilitate 5 GW by 2030

**Greece:** 4.9 GW by 2032 **mainly floating**

**Turkey:** 5 GW by 2035

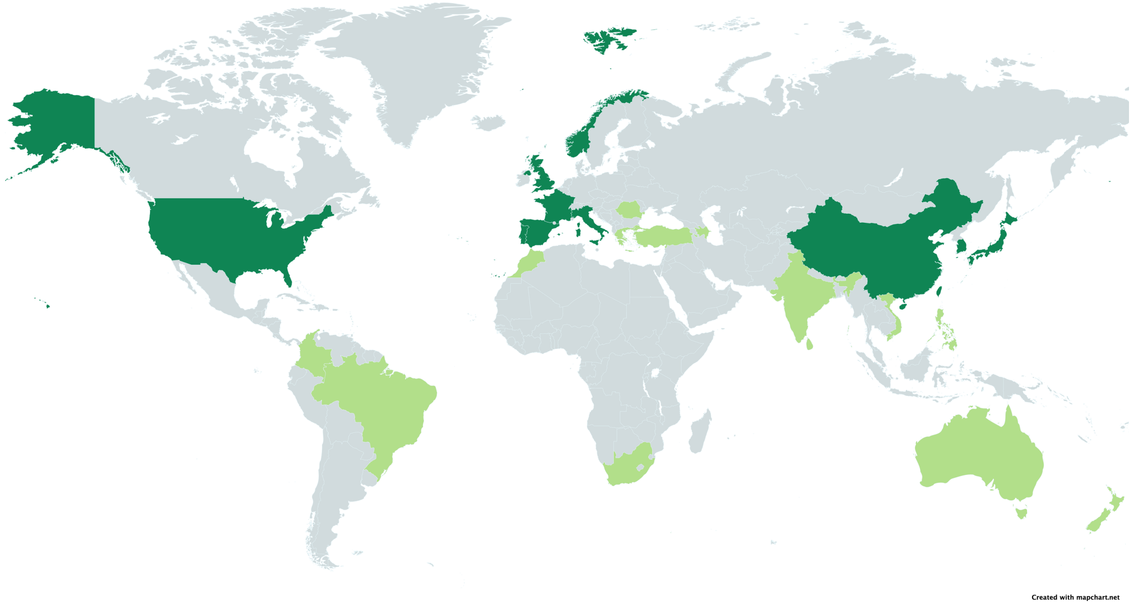
**South Korea:** 14.3 GW by 2030, **half of which is floating**

**Japan:** 10 GW by 2030, 30-45 GW by 2045; 4 sea areas identified for next auction of FOW demos; Goto project delay because of defect in the spar

**Taiwan:** 5.7 GW by 2025; 13 GW by 2030; 55 GW by 2050

**Victoria State (Australia):** 2 GW by 2032, 4 GW by 2035, 9 GW by 2040

**United States:** 30 GW bottom-fixed by 2030 + **15 GW of floating by 2035. By state:** *Oregon*: 3 GW by 2030, *Louisiana*: 5 GW by 2035, *California*: 5 GW by 2030



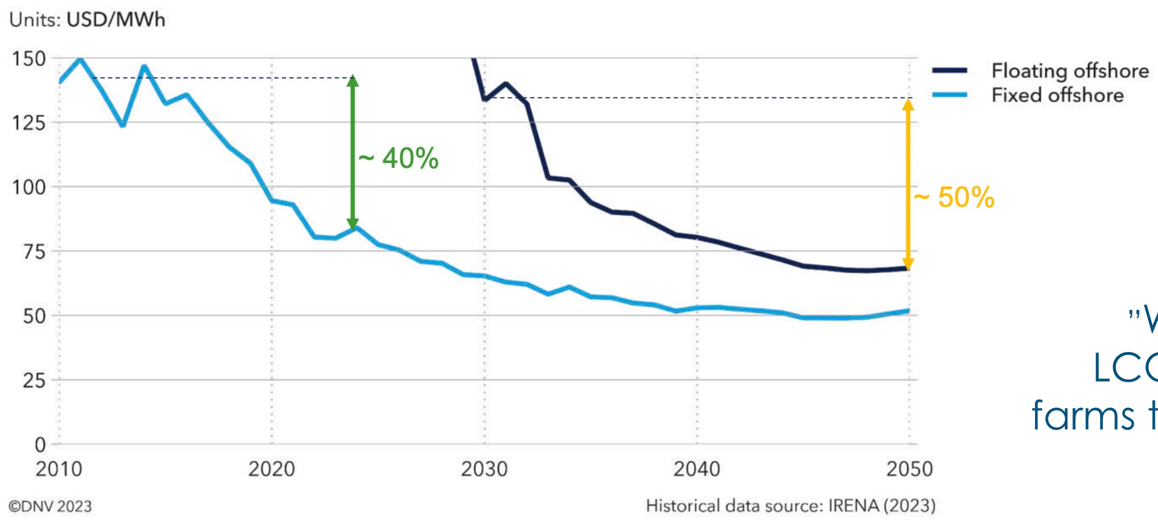

**More markets:** Large projects announced in **Italy**; more demonstrations in **China**; 2 GW of projects announced in **New Zealand;** 3 offshore wind zones announced in **Australia**

**Emerging markets:** World Bank/ESMAP published offshore wind roadmaps for **Vietnam, The Philippines, Sri Lanka**; **Colombia** is preparing offshore wind tender; **Romania** published draft law for offshore wind framework; **India** introduced 37 GW of bids between 2024-2030**; Brazil** proceeds to environmental licensing agency

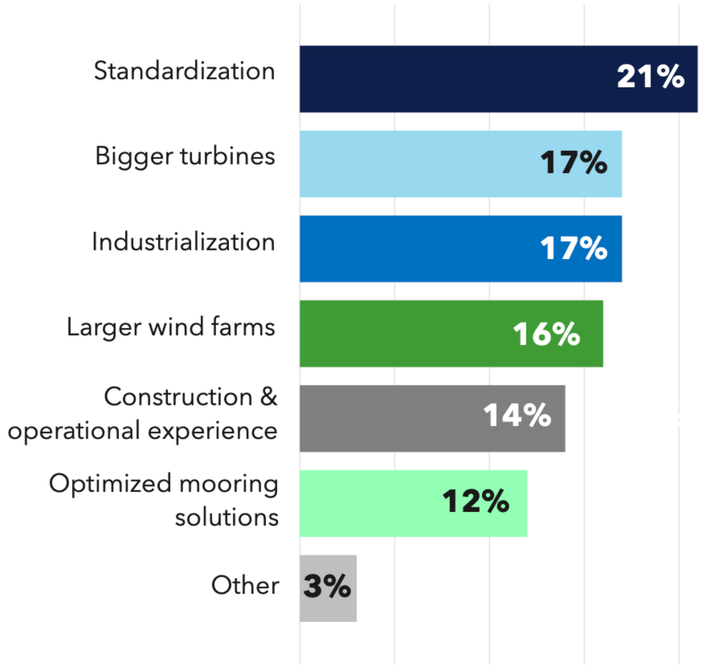
# Market outlook 2050

**DNV 2024**: Floating wind reaches a global installed capacity of 289 GW by 2050 equivalent to 17% of offshore wind capacity out of almost 1700 GW in total.

**IRENA 2021**: The world needs 2000 GW offshore wind by 2050 to achieve carbon neutrality and a 1.5°-compliant pathway.




**Where will the LCOE reduction come from?**




"Wind farm and turbine size increase to be the biggest driver of LCOE reduction as we move from pilot to commercial sized wind farms this decade, with standardization becoming a key enabler for industrialization, which will drive cost reduction post 2030."

**DNV - Floating Wind: Turning Ambition Into Action (2023)**