Joint study between

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RENEWABLE ENERGY INSTITUTE

Aegir

New study:

The cost of fixed-bottom offshore wind in Japan

Offshore Wind at a New Stage: Policy and Institutional Design for Scalable Deployment

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Tokyo, Japan

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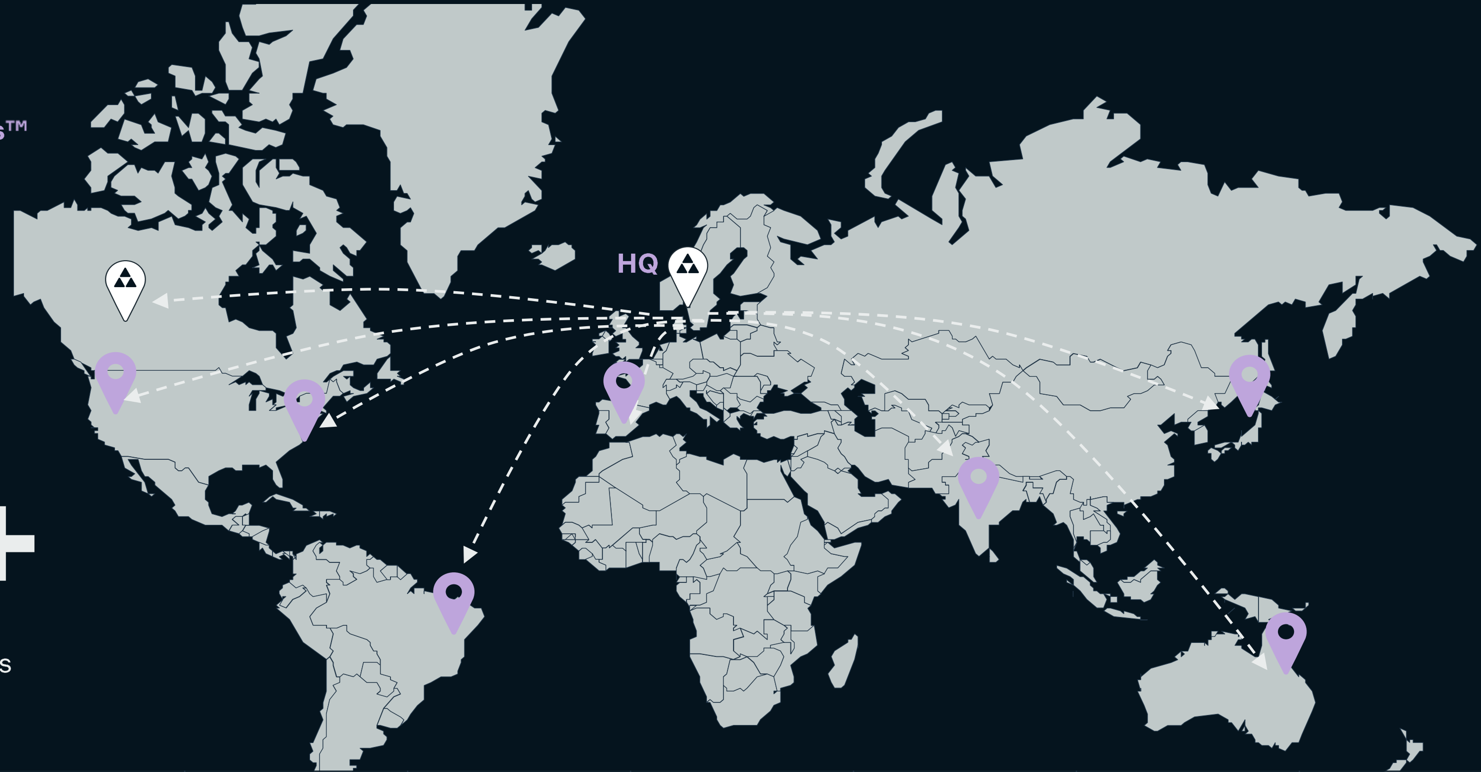

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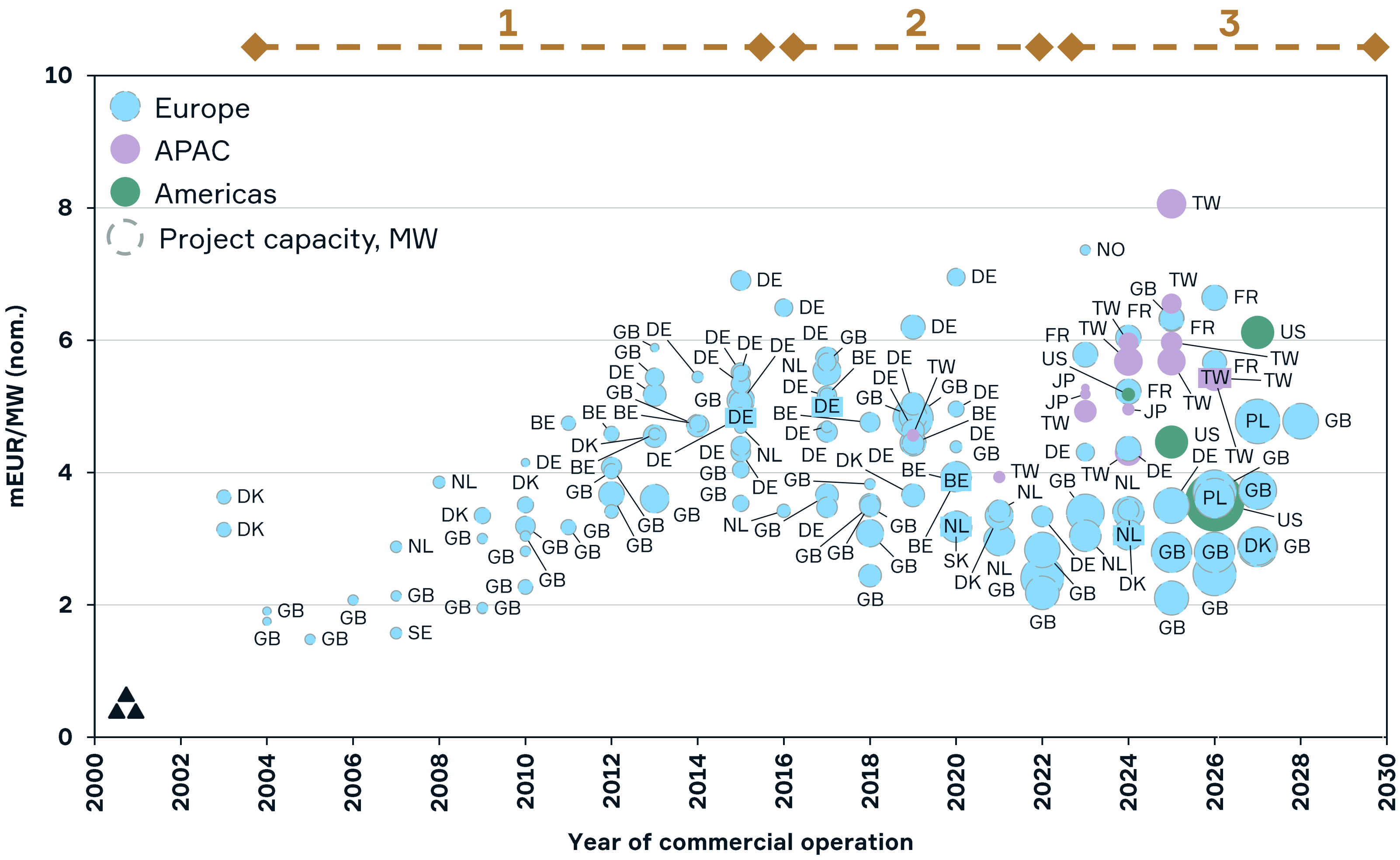
Historical CAPEX on a global scale can be split into three phases: 1) Early learnings, 2) Cost-out, and 3) New markets with new challenges

After a 10-year decline in offshore wind costs, new markets are creating new challenges



Based on a comprehensive overview of CAPEX numbers, the historical cost development can be split into three phases:

1. **Early Learnings:** Early projects benefited from being close to shore and frequently utilizing onshore wind technologies. There was a period of costs rising with implementation of learnings.
2. **The Big Cost-Out:** With interest rates near zero and intense supply chain competition, mature markets achieved record-low costs, making OSW competitive with conventional generation.
3. **New markets, new challenges:** As new markets emerged, localization requirements and early-stage challenges drove costs higher. This was compounded by an inflation shock through the supply chain.

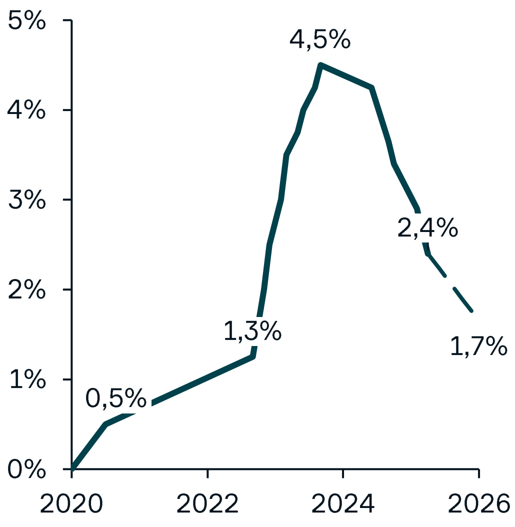
Sources: Aegir Insights CAPEX Intelligence; Aegir Quant 2025.2; CAPEX sources include project company financial statements , regulatory disclosures and announcements
Notes: Chart shows projects >50MW. In cases where transmission scope is excluded from project, additional transmission CAPEX is added based on market specific transmission estimate.

Outset of the study: Offshore wind is at a crossroads – both in Japan and globally

Three key data trends to explain offshore wind recovery...

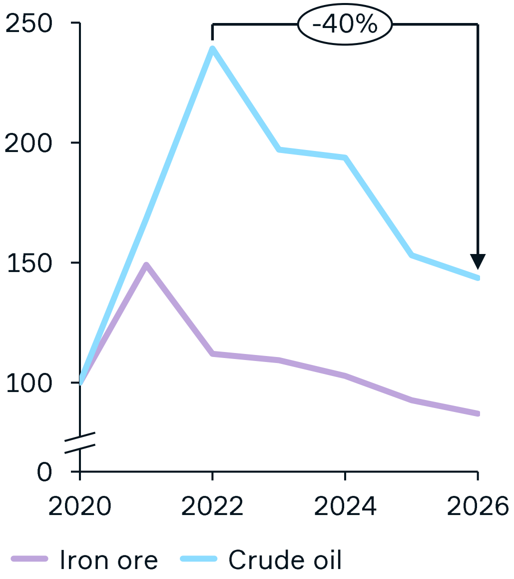
Declining interest rates

ECB lending rate (MRO), 2020-2025



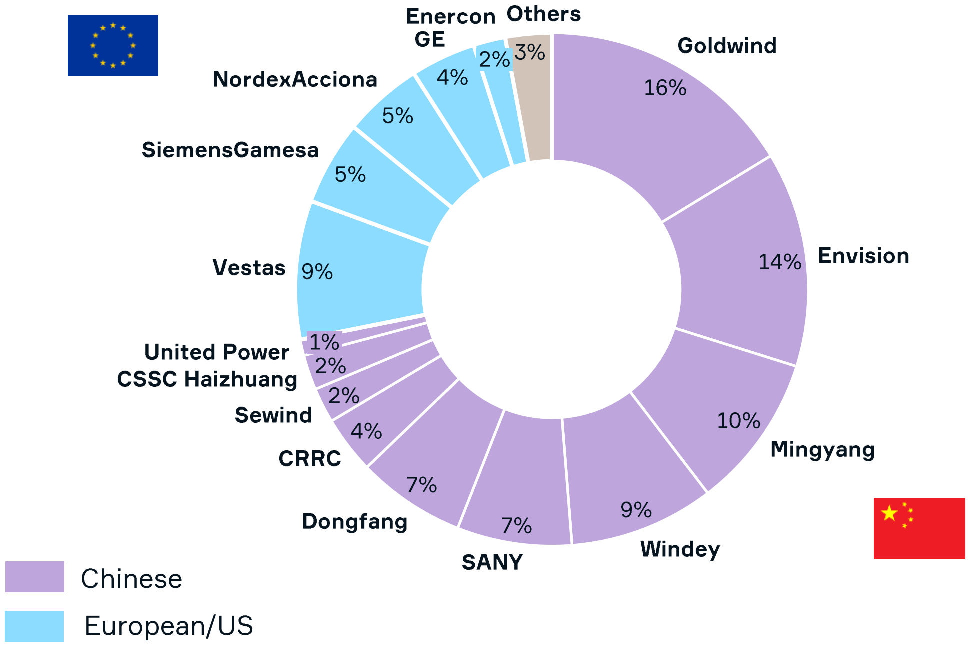
Declining commodity prices

World Bank, commodity prices (index, 2020 = 100)



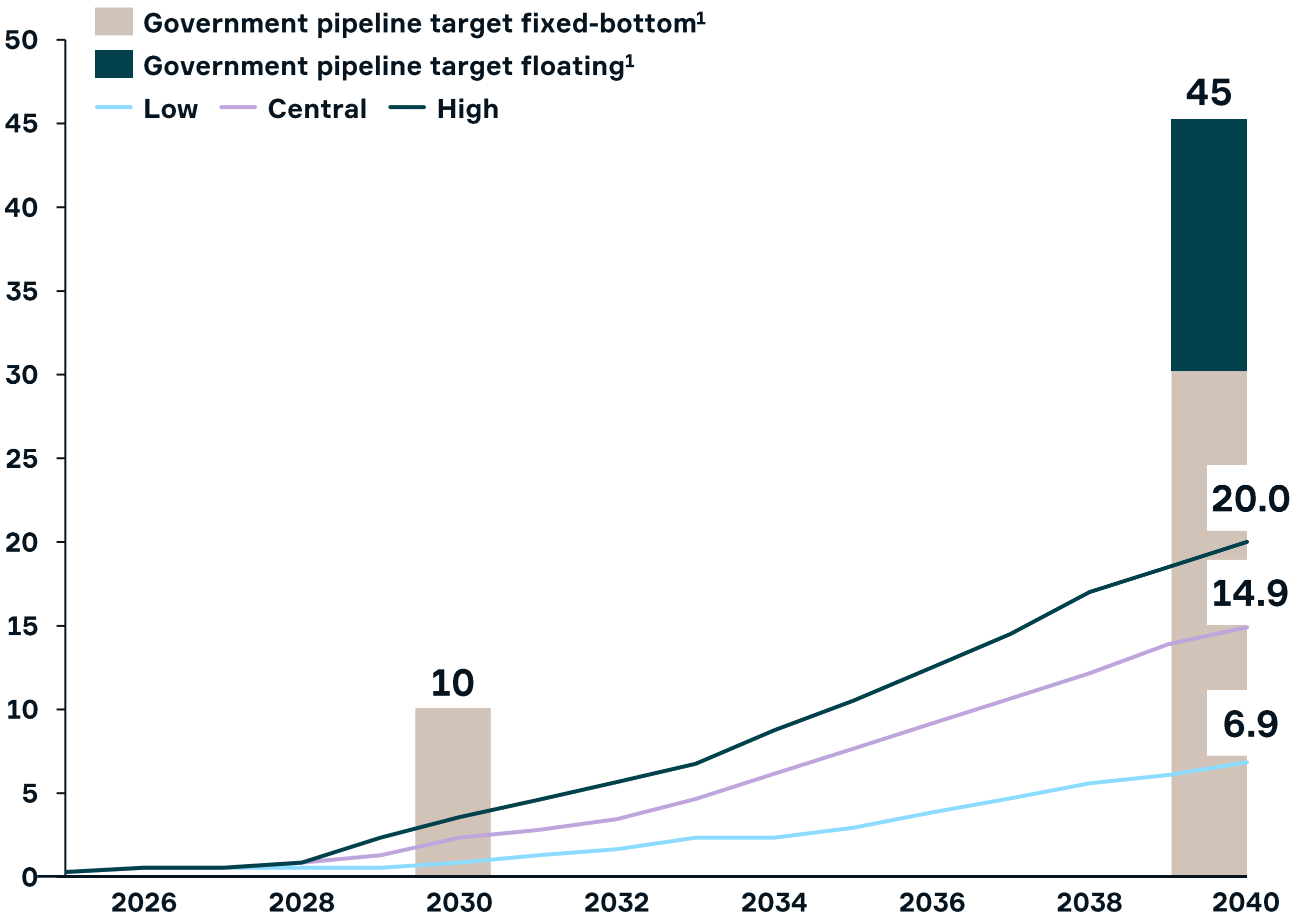
Increasing supply chain competition

Wind turbine OEM share of global installed capacity % 2024 offshore and onshore



Offshore wind in Japan is expected to be built out continuously after 2030, going from 2.4 GW to 14.9 GW in the central scenario

Aegir Insights' forecast for operational capacity in Japan by scenario, GW

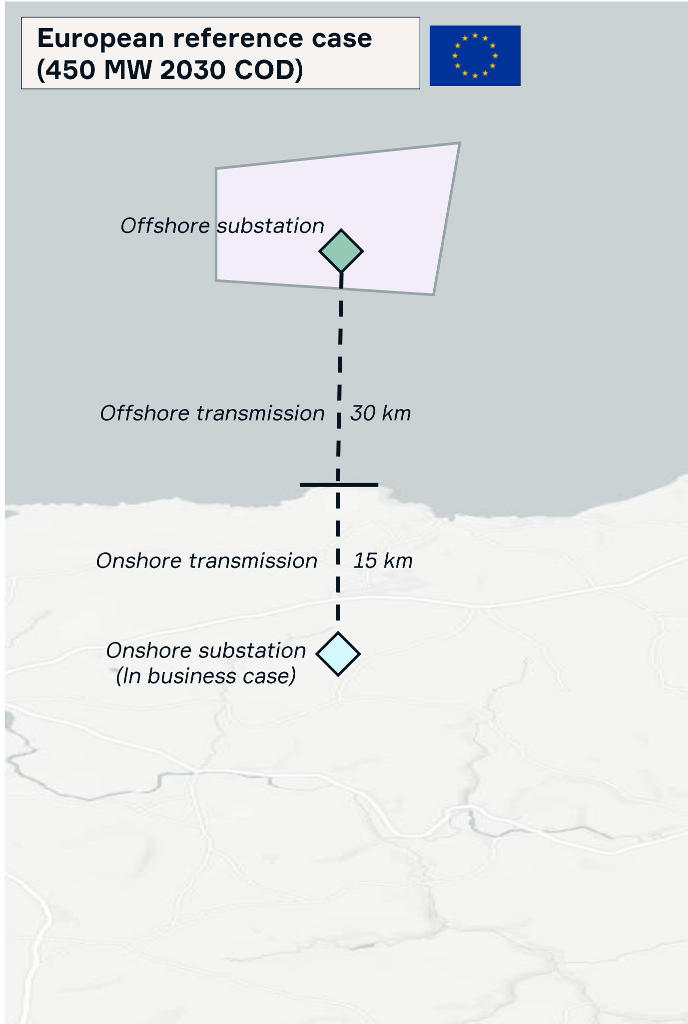


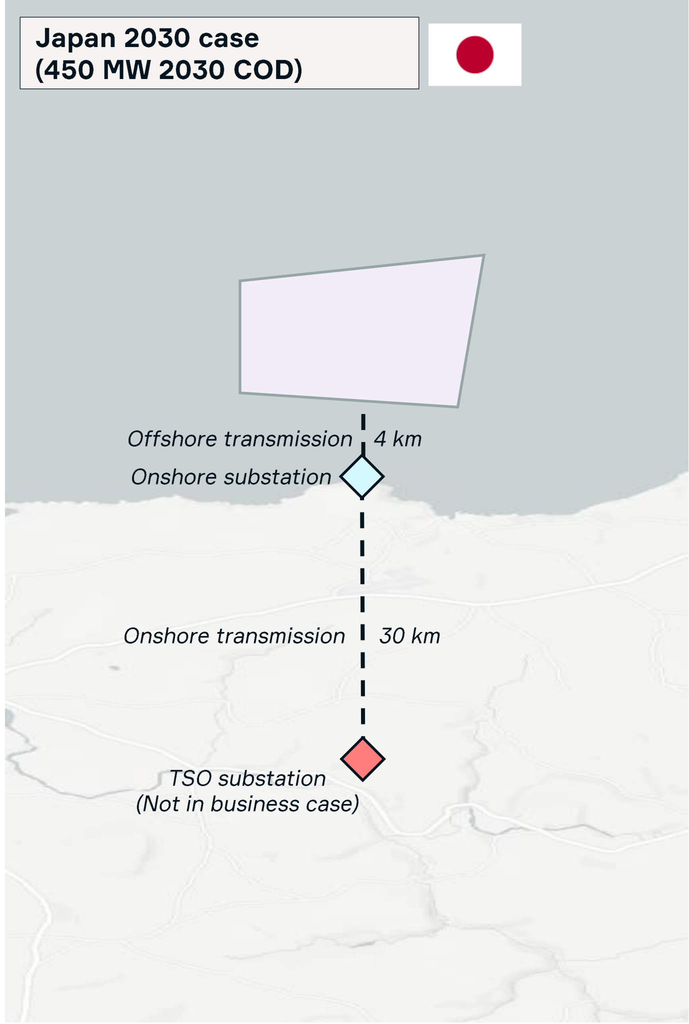
- In the **Central Case**, Japan's operational offshore wind capacity is projected to reach 2.4 GW by 2030, 7.7 GW by 2035, and 14.9 GW by 2040. By 2040, Japan would hold the second-largest installed capacity in Asia-Pacific, following South Korea.
- A slower build-out is expected through the 2020s, mainly due to Mitsubishi cancellations. However, growth is forecast to accelerate sharply from the early 2030 onward.
- In the **Low Case**, capacity reaches only 0.9 GW in 2030, 2.4 GW in 2035, and 6.9 GW in 2040. This reflects ongoing permitting challenges and massive project delays, and assumes delivery is largely limited to smaller-scale projects.
- In the **High Case**, Japan could achieve 3.6 GW in 2030, 10.5 GW in 2035, and 20 GW in 2040. This assume full project implementation without delays for awarded projects and quick turn-around on the next auction rounds.
- **NB:** The forecast capacity is based on project COD, while government targets are allocation-based.

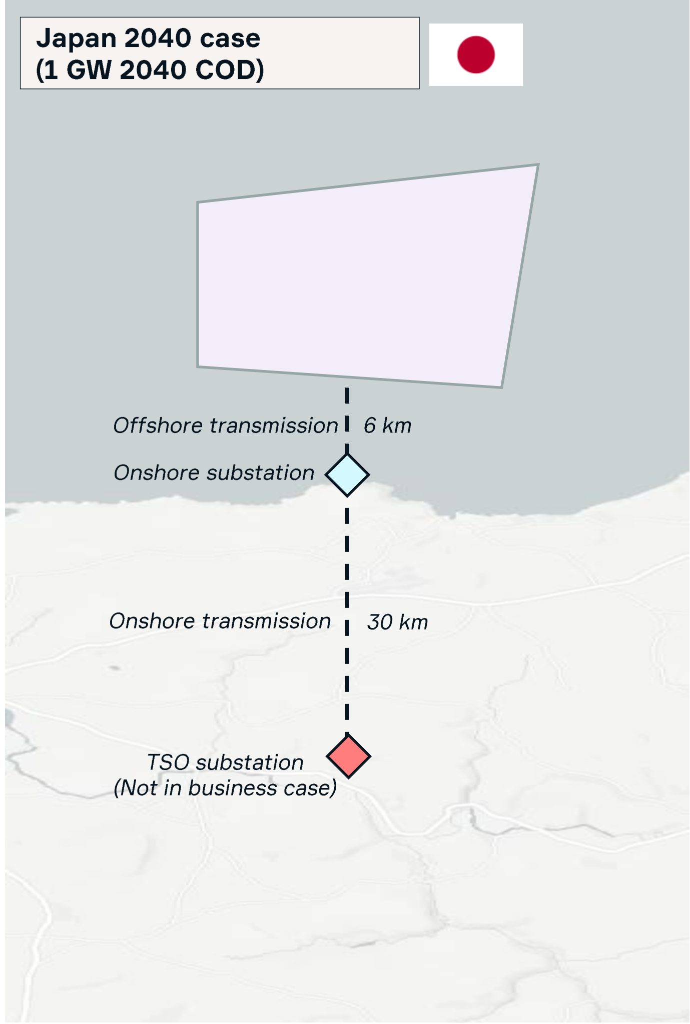
Sources: Aegir Insights Market Forecast Q1 2026
Notes: 1) The governmental targets is based on allocation: Japan aims to allocate 10 GW offshore wind by 2030 and 30-45 GW by 2040, including 15 GW of floating wind.

Study methodology: A European reference project in the North Sea is used as a benchmark for understanding the cost difference to Japanese projects

Project scope is fundamentally different in the European and Japanese reference cases



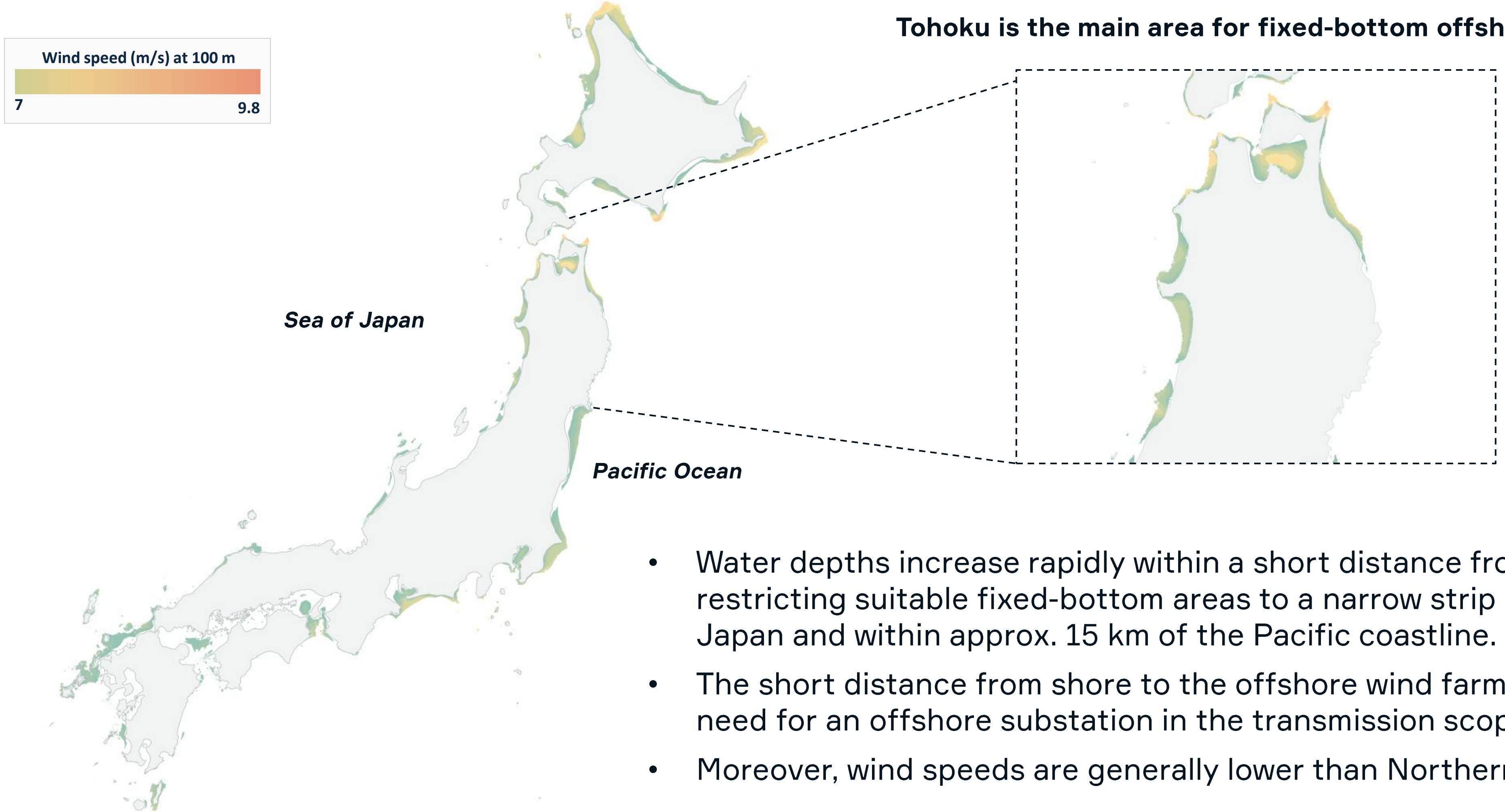




Physical conditions: Japan's bathymetry limits the areas suited for fixed-bottom offshore wind – and wind speed are generally around 7-9 m/s

Site conditions is significantly different than in Europe

Wind resource map of Japan at water depths below 60 m



- Water depths increase rapidly within a short distance from shore, restricting suitable fixed-bottom areas to a narrow strip along the Sea of Japan and within approx. 15 km of the Pacific coastline.
- The short distance from shore to the offshore wind farms eliminates the need for an offshore substation in the transmission scope.
- Moreover, wind speeds are generally lower than Northern Europe.

Physical conditions: Japan is highly exposed to natural hazards with frequent typhoons as well as earthquakes with potential for tsunamis

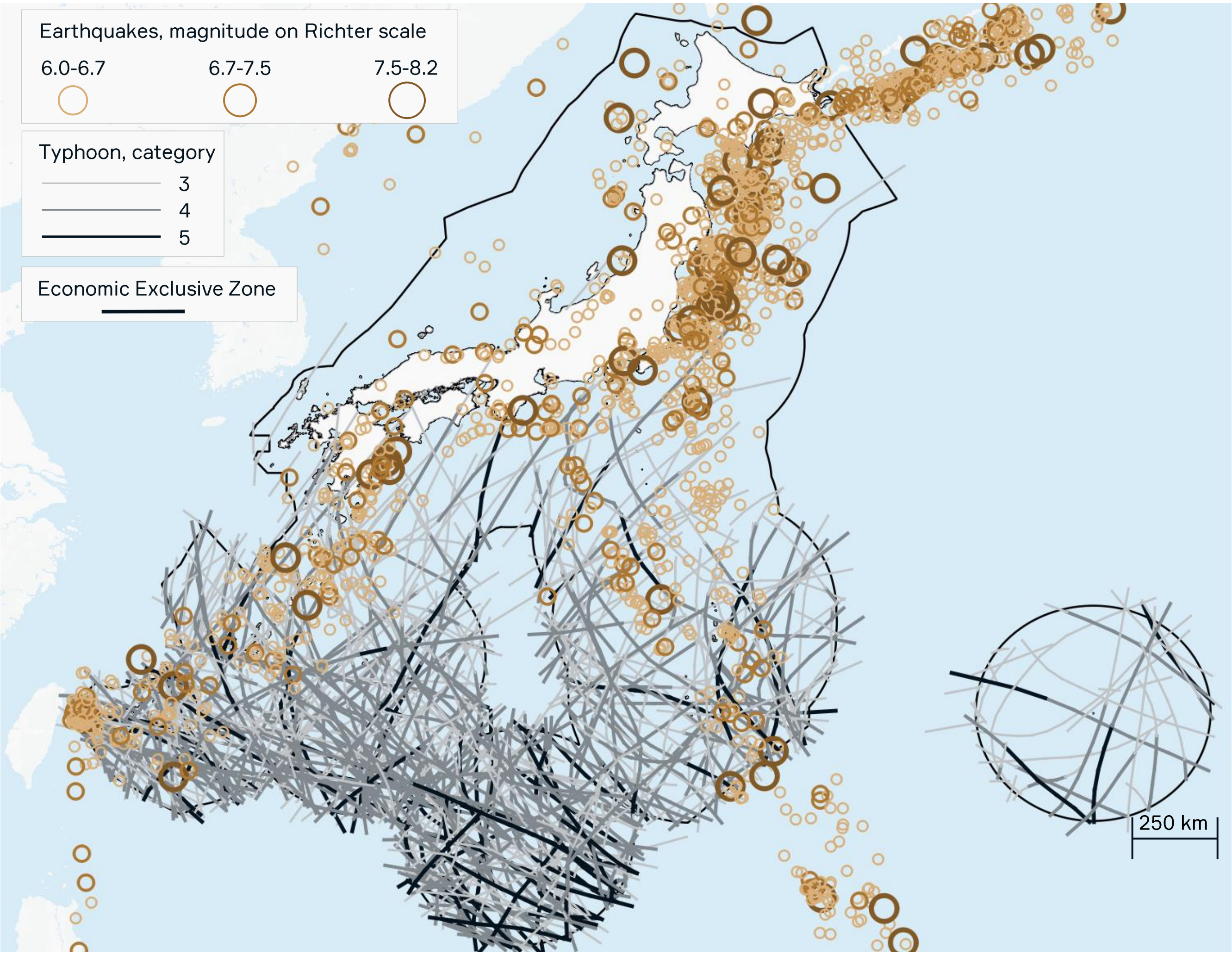
Earthquakes and typhoons in Japan effect component design, vessel utilization and surveys

Earthquakes

- Japan is very prone to earthquakes as it is located on tectonic plate boundaries with frequent seismic activity. This led to frequent earthquakes followed by tsunamis.
- The consequence is a materially more complex and costly design process for Japanese projects due to earthquake certification requirements.
- Moreover, detailed seismic hazard assessments, adds to the surveys at the front end of a project.

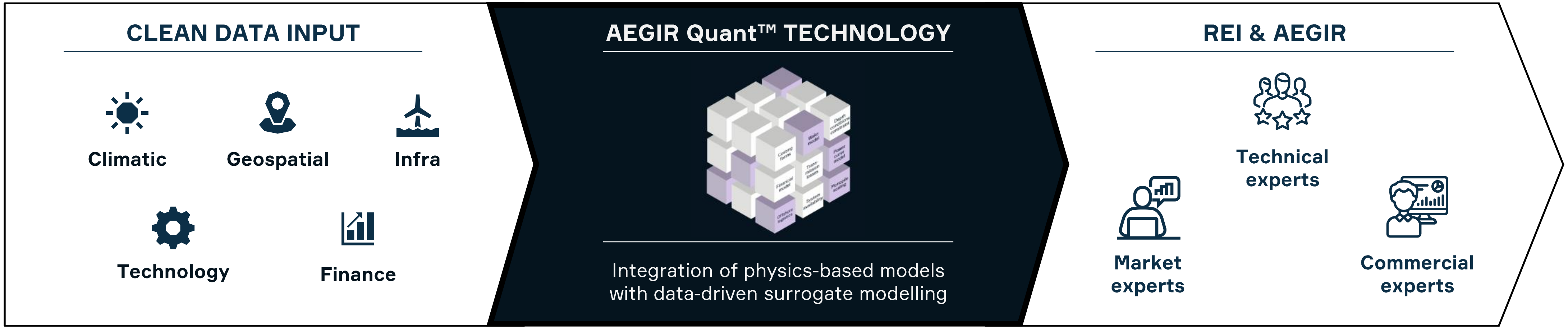
Typhoons

- Typhoons occur frequently in Japan with most historical activity around Japan's southern islands.
- Most typhoons fade before reaching land, but offshore wind are at greater risk of being hit.
- Turbines and monopiles have been utilized in other typhoon-prone areas but the design requirements adds cost to both component types.
- Moreover, Japan experiences seasonal high waves and gusts due to frequent typhoons affecting vessel utilization.



Study methodology: The Aegir Quant™ techno-economic model is used to CAPEX benchmark three reference cases

	Europe 2030	Japan 2030	Japan 2040
Foundation type	Monopile	Monopile	Monopile
Size (MW)	450	450	1000
Turbine rating (MW)	15	15	20
Water depth (m)	30	20	30
Annual mean wind speed at 100m height (m/s)	10.2	7.9	7.9
Capacity factor (%)	54	37	39
Vessel utilization factor	1.5	2.05	2.05
Positions requiring drilling (%)	0	25	25



Result: The CAPEX comparison shows that Japan's higher total cost is primarily driven by significantly higher installation costs and higher turbine supply costs

CAPEX benchmark: Europe versus Japan in 2030

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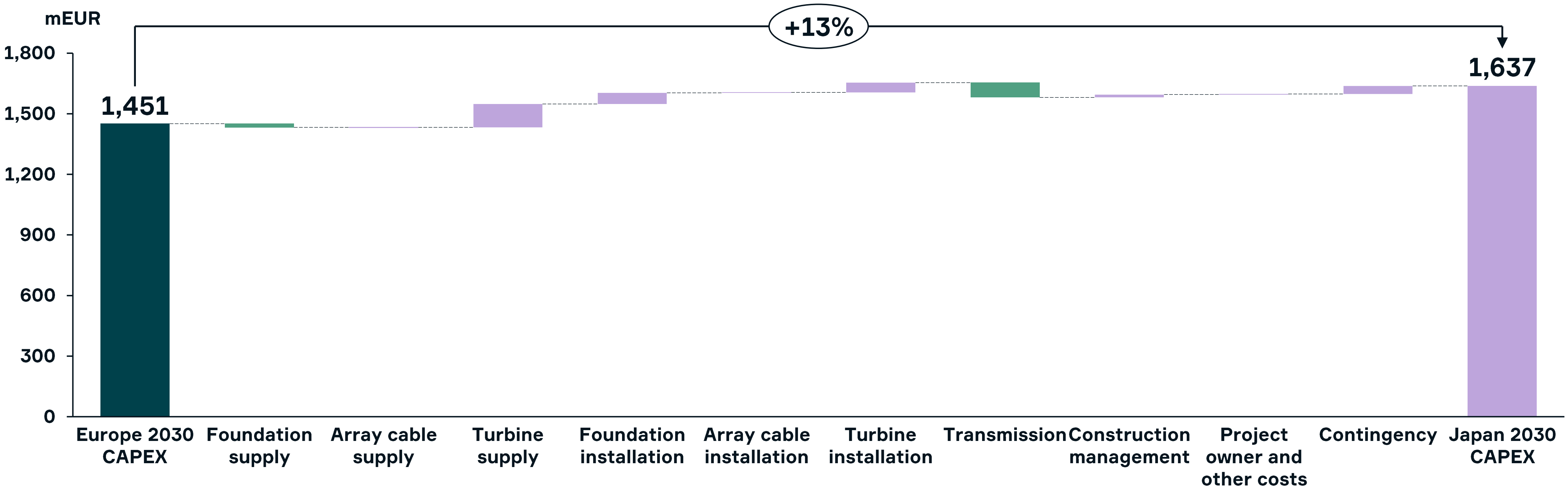

- The CAPEX benchmark show a 13% cost premium in Japan compared to Europe in 2030 resulting in CAPEX growing from 3.23 mEUR/MW (515.97 mJPY/MW) to 3.64 mEUR/MW (582.15 mJPY/MW).
- The largest cost driver is wind **turbine supply**, adding EUR 115m (JPY 18.42bn) to the European baseline, while **monopile and turbine installation** amount to a combined increase of EUR 93m (JPY 14.98bn) with a roughly 50:50 split between them.
- The transmission partially offset the premium due to projects assumed to be close to shore, eliminating the need for an offshore substation.

Result: A 19% cost reduction is achievable between 2030-2040 in Japan – but this is contingent on policy and market development

CAPEX benchmark: Japan in 2030 versus 2040 (1 GW project size)

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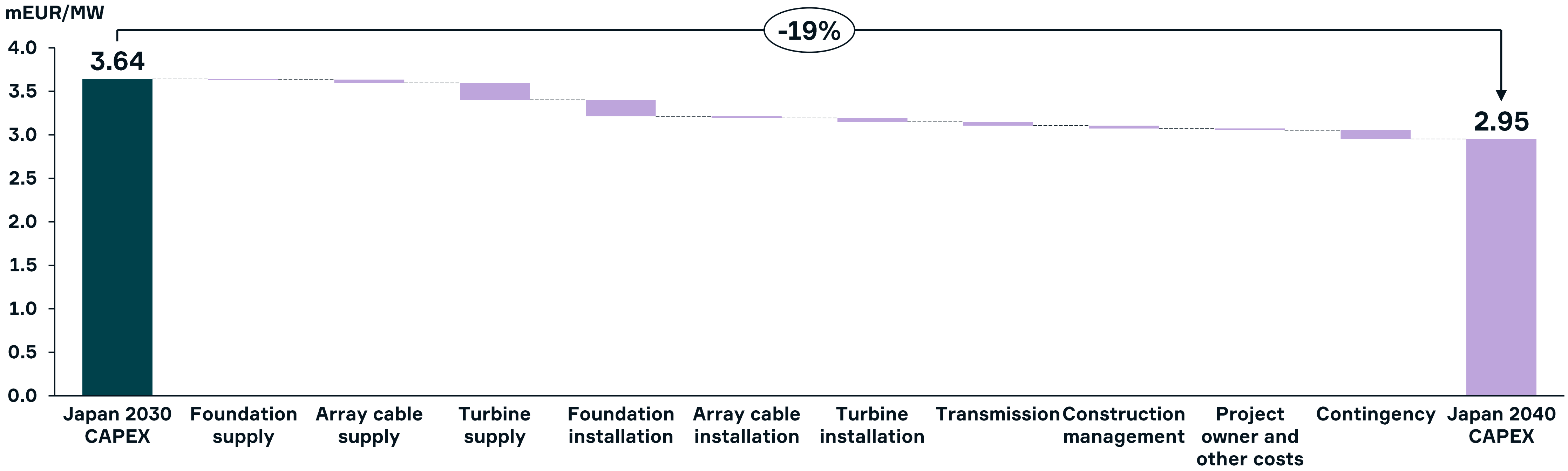

- The CAPEX benchmark for Japan in 2040 shows a possible 19% cost reduction resulting in CAPEX decreasing from 3.64 mEUR/MW (582.15 mJPY/MW) to 2.95 mEUR/MW (472.67 mJPY/MW).
- The decrease is driven by the combined effect of **technology learning, turbine scaling, supply chain maturation**, and improving **market maturit**y over the decade. **Turbine supply and foundation installation** is the most prominent factors by package.
- Turbine cost reductions reflect the global expectation that per-MW turbine prices will decline through 2040, driven by continued **upscaling of turbine ratings and maturing supply chains,** while the decline in monopile installation costs is driven by **improved vessel availability**.

Japan's cost drivers split into two distinct categories: structural constraints and addressable policy levers

Structural factors (harder to address)

Typhoon design

- Japan's typhoon classification requires enhanced structural specifications.
- Turbines and associated components need to be engineered for extreme loads, increasing manufacturing complexity and cost. This include tower reinforcement, and blade bracing.

Seismic loading and seabed conditions

- The frequency of earthquake in a Japanese context means that the reference case assume a high seismic design basis.
- This includes the requirement for heavier monopiles while hard bedrock conditions also add piling complexity.

Vessel utilization factor (WDF)

- Japan's higher vessel utilization factor reflect significant weather downtime factor from typhoon seasonality, monsoon periods, and high wave-height windows.

Addressable factors (policy-reducible)

Port lease fees

- Japan's base port scheme imposing lease costs and reforms of the tripartite agreement mechanism are central to the 2040 outlook.

Build-out of domestic turbine production

- Establishment of strong local turbine production could reduce turbine price premiums if capacity and competition increases.
- Japan is already targeting to develop typhoon-certified supply capacity through localization.

Market maturity

- As Japan's market matures and track record improves, contingency allowances converge toward European norms, which could enable decrease of 0.69 mEUR/MW.
- However, this require sustained and predictable auction pipelines with price-indexed support — like European CfDs. Without this, vessel scarcity and turbine mark-ups persist well beyond 2030.

- **Structural factors increase the cost of the 450 MW project in 2030 by EUR 139m, accounting for ≈75% of the total cost difference.**
- **Japan is likely to remain a structurally higher-cost market than Europe despite addressable factors reducing costs over time.**

Key takeaways: Japan’s fixed-bottom offshore wind cost challenge is real but tractable

1

The 13% premium is real, not a perception

Aegir Quant™ modelling confirms Japan's 2030 total installed costs at 3.64 mEUR/MW vs. 3.23 mEUR/MW in Europe. The premium is driven by hard physical constraints such as typhoon design, seismic loading, and metocean conditions — not solely by market immaturity.

2

Installation is the most stubborn cost floor

Japan’s significant weather downtime factor cannot be engineered away. It underpins EUR 93m in combined foundation and turbine installation cost premium in 2030 and is not expected to improve materially by 2040. Supply chain investment in dedicated Japan-capable vessels is the only effective lever.

3

2.95 mEUR/MW in 2040 is achievable with the right policy mix

A 19% reduction from 2030 levels could be reached under the right conditions. This requires coordinated action on port fee reform, auction continuity, and turbine localization all within government influence.

4

Japan's window to act is now

The investment decisions required to deliver most of the 20–30 GW by 2040 must be made in the current auction cycle planned. Delayed policy reform compounds supply chain under-investment and will lock in higher costs well beyond 2030.

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Reach out to hear more about the study

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