Jacobs

Challenging today.
Reinventing tomorrow.

Harboring Change: 8 Global Lessons in Wind Port Development

The success of offshore wind increasingly depends on port infrastructure that wasn't designed for today's turbines. Insights from seven global industry leaders examine how ports around the world are responding and what it will take to fund, plan and build long-term, flexible capacity.

Ports sit at the center of the offshore wind supply chain. Turbine components are received, stored, assembled and transferred onto installation vessels at ports, and their physical limits increasingly shape how quickly projects can move from planning to construction. As turbines become larger and heavier, port capability is becoming one of the defining constraints of offshore wind delivery.

Global offshore wind ambition is rising rapidly. Analysis shows there's 83 gigawatts (GW) of wind power capacity, but aligning with pathways to limit long-term global warming to 1.5°C would require more than 20 times that amount. Achieving this scale goes beyond generation targets and policy support. It depends on whether sufficient port capacity exists — and whether that capacity is configured to handle larger components, expanded staging areas, wet storage and increasingly complex logistics.

Port infrastructure has long lead times, high capital costs and limited flexibility once built. If investment decisions are deferred until project pipelines are fully secured, capacity gaps will persist and delivery risk will increase when offshore wind growth accelerates again.

These eight insights show how port operators are adapting to offshore wind's growing scale — and why ports are becoming strategic assets. Using examples from the U.S., Europe and Australia, the article explores how different business models, technologies and planning approaches can reduce risk, improve flexibility and strengthen long-term value. Together, they offer practical lessons on how ports can be designed to serve multiple projects, markets and cycles of offshore wind growth.

Making the business case stack up: Dual models for U.S. wind ports

South Brooklyn Marine Terminal, New York & New Jersey Wind Port, U.S.

On the East Coast of the U.S., two states have already tested out different funding models.

New York's South Brooklyn Marine Terminal (SBMT) shows one route through this challenge. Equinor, as developer, is funding most of the port's redevelopment under a long-term lease, supported by partial state subsidies. They will use SBMT to construct their own offshore wind farm and retain a smaller footprint for operations and maintenance. The remainder of the site is being future-proofed so it can later be leased to other developers, creating a secondary revenue stream and spreading capital costs over multiple projects.

Across the Hudson, New Jersey has taken the approach of investing directly in the New Jersey Wind Port and then offering long-term leases to project developers. This state-led model mirrors European practice: public capital unlocks heavy-load infrastructure that private enterprises alone struggle to justify. New Jersey now holds a high-capacity asset it can reposition for other tenants and commodities.

Together, these contrasting models show there is no single "right" business case for wind ports. The lesson for policymakers and investors: design ports as multi-cycle assets, not one-project bets.

Developer-led and state-led approaches can both work if they build in flexibility, future tenants and alternative uses from the outset.
- Maki Onodera

Politics, regulations and economics: Stress-testing the wind port business case

Port of Hastings & Port Kembla, Australia

Frequently, the wind port challenge is less about engineering and more about aligning commercial, political and environmental needs. In Australia's federal system where states control the coast and the Commonwealth offshore zone, every project faces a double approval gauntlet. Local electoral dynamics can matter as much as biodiversity, as seen when a Hastings port proposal was initially rejected, stalling the lead option for Victorian offshore wind.

Commercially, building a strong business case is difficult. The assets required — heavy-lift quays, rock beds and 30-per-square-meter hardstands — may last 40–50 years, but the main installation campaign might run for only a decade. This puts pressure on finding ways to keep earning off the capital investment. Private or long-leased ports like Geelong, Portland and Melbourne won't fund assets without guaranteed long-term use unless governments or developers underwrite demand. Meanwhile, the power offtake deals and power purchase agreements, which are basically long-term buying contracts for electricity, are delayed. Additionally, turbines are scaling up to 20 to 25 megawatts (MW), installation vessels are scarce and costs keep rising, all while new transmission lines and storage solutions remain contentious.

The way forward requires an integrated, systematic approach that is fit for purpose — regionally, politically and environmentally. For example, securing a site like Hastings for fixed-bottom turbines and progressing Port Kembla as a specialist floating hub. The three enablers needed for both sites are: environmental approvals, offtake frameworks and port financing. There is no universal funding model: in some regions, the state must lead; elsewhere, developers and port owners co-invest.

> *The goal is a bespoke, locally anchored business case that recognizes short revenue windows, storage and transmission constraints and the outsized reality of today's non-containerized turbine hardware.*
> *- Eoin Richardson*

The rise of transformer ports: A three-phase programmatic model with port screening

Port of Virginia, U.S.

Globally, most port terminals are built for single functions — container, offshore, bulk, or roll-on/roll-off (RoRo). In some cases, these can be adapted for new uses during a 10–15-year window, which aligns with offshore wind port timelines. The Port of Virginia's Portsmouth Marine Terminal, once a container hub, was modernized to handle massive offshore wind turbine components. This redevelopment positions the port as a logistics center for the Mid-Atlantic's offshore wind industry, supporting the 2.6 GW Coastal Virginia Offshore Wind (CVOW) project, the largest in the U.S., with 176 turbines powering 660,000 homes.

> *Three phases — location feasibility, suitability and preferability — guide port screening, considering draft, berth space, bearing capacity, labor and manufacturing systems.*
> *- Michael Wilks*

Successful transformations hinge on a programmatic phased approach, focusing on long-term energy generation and investment returns for stakeholders. Ports evolve with trade demands; the energy transition is the latest chapter. Because individual customer demand is often short-lived, phased planning is especially effective. The approach's success relies on rigorous screening, informing developers, owners and governments for smart infrastructure and investment decisions.

Adapting brownfield ports for 15 years or more can lower costs, speed up production and offer greater sustainability than building new offshore wind ports. This strategy positions ports to remain dynamic and resilient, supporting the energy transition while maximizing existing assets and infrastructure.

Spreading the investment bet: Enter the energy hub port

Port of Newcastle, Australia

Creating energy hubs by pairing traditional and renewable power in phased, hybrid models reduces risk, supports a gradual transition from fossil fuel, and offers investors more reliable returns in an uncertain global energy landscape.

The Port of Newcastle, the world's largest coal export port, is a prime example. Its Clean Energy Precinct is driving the transition to renewables, focusing on hydrogen production, storage and export, with ammonia and gas also in development. The port itself now runs entirely on renewable energy due to a power-purchase agreement and onsite solar panels.

> *This approach uses existing infrastructure rather than abandoning it, recognizing that the energy transition is an evolving process, not a sudden switch.*
> *- Medha Rahman*

With no clear winner yet between hydrogen and electricity as the dominant renewable, and battery technology still uncertain, the Port of Newcastle is pursuing multiple small-scale projects in phases to hedge its bets and reduce risk. Legacy fossil fuel ports, with their vast storage and infrastructure, can be repurposed for energy hubs, remediating former coal stockpiles for hydrogen, ammonia or solar power. While land is being remediated, it can also be used for solar generation.

This phased approach revitalizes ports in regions with declining heavy industry, creating new jobs, community investment and a broader value chain. It makes these hubs catalysts for net zero ambitions.

Digital twins and masterplanning: Tripling growth with technology

Port of Esbjerg, Denmark

Offshore wind ports are facing mounting pressure to expand berth depth and space as turbine components grow ever larger, making land transport less feasible and operations more complex. Fluctuating demand for wind port services means ports must have adaptable marshaling areas and flexible infrastructure. This, combined with a weak business case, creates significant economic headwinds for the industry.

The 2022 Esbjerg Declaration — signed by the leaders of Germany, Belgium, Denmark and the Netherlands — sets out to transform the North Sea into a green power hub for Europe, with targets of 65 GW of offshore energy by 2030 and 150 GW by 2050.

Technology is proving essential: the Port of Esbjerg has pioneered the use of a digital twin and a comprehensive database to simulate port operations in real time. This innovation optimizes space, streamlines processes, and reduces the need for costly physical expansion as workloads shift. According to the Port, the digital twin has tripled the annual offshore wind shipping capacity, from 1.5 GW to 4.5 GW in just three years. It also identifies ideal storage, recommends deeper basins and improves access routes, all while ensuring other port activities are not sidelined. Enhanced by machine learning and AI, the system draws on decades of data, promising even greater efficiencies as global suppliers are integrated.

> *To achieve these visionary goals and overcome the economic headwinds, we need to dial up the deployment speed and drastically improve operating efficiencies.*
> *- Alan Roper*

Floating ports, moving hubs: Overcoming ROI with relocation

California, U.S. & North Sea, Europe

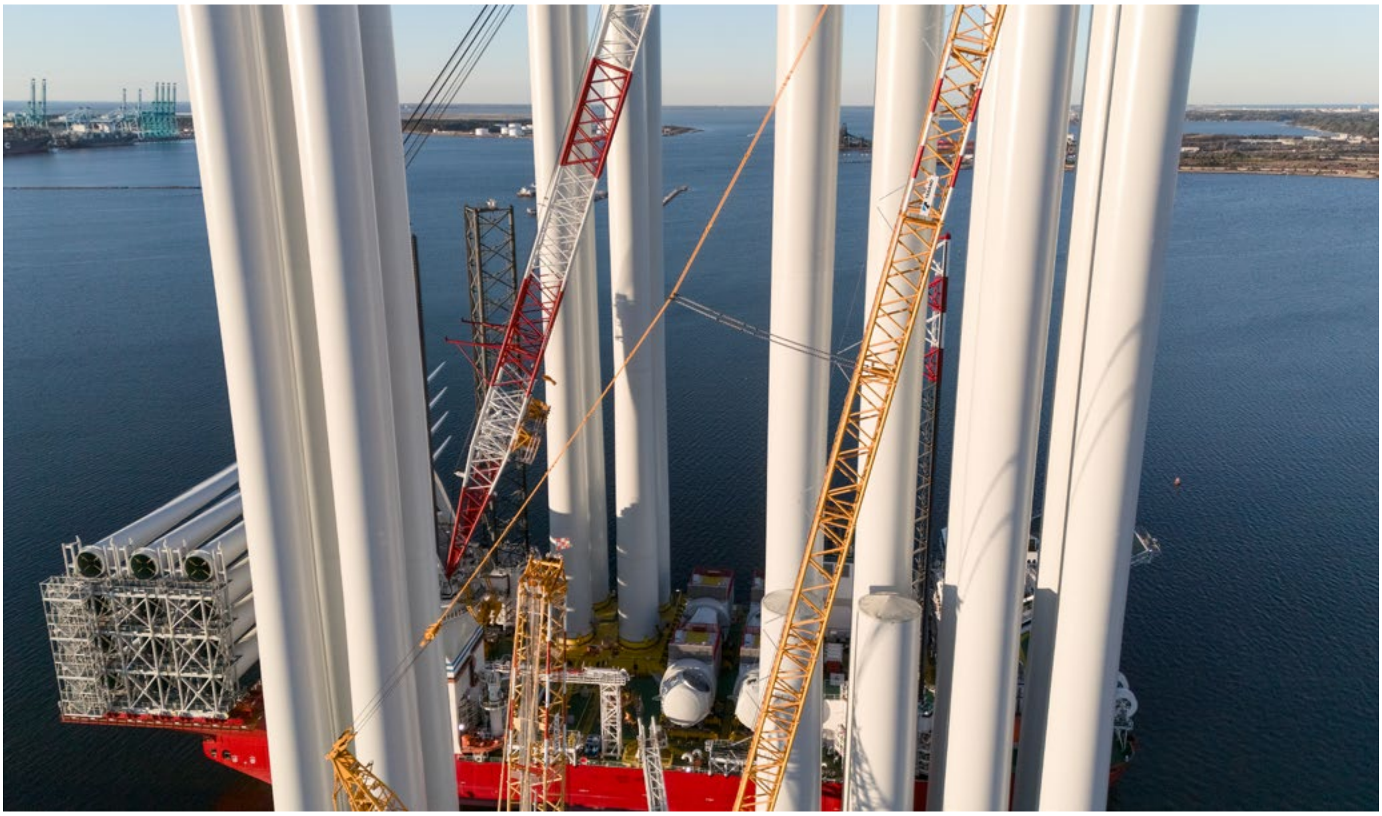
As components and loads become greater in scale, the question arises: do we need to do the final assembly at the shore?

This has sparked a new idea: ports that float. Concepts shown at U.S. offshore wind forums show modular platforms built from flat-top barges, floating docks and rafted pontoons, with jack-up cranes and wet storage moorings creating a temporary marshaling hub. This can then be towed into place, used intensively for a build-out then relocated to the next project cluster. Unlike a fixed terminal, a floating port doesn't need decades of local follow-on demand to justify its capital expenditure. Its business case rests on serving multiple regions over time.

Real-world projects are already pointing in this direction. California' Pier Wind at the Port of Long Beach and the heavy-lift terminal at Humboldt Bay aare being designed as staging and integration hubs for floating turbines assembled quayside, then towed 20–30 miles (32-48 kilometers) offshore. Lessons can also be learned from the barges and floating platforms of the oil and gas sector. Jacobs has already delivered floating infrastructure on a smaller scale, such as floating solar photovoltaic panels in Singapore, floating cofferdams and floating barge gates in the U.S., and tested floating piers for naval use. So, building a relocatable wind hub is more an engineering challenge than science fiction.

Designing towable, reusable floating hubs could turn today's site bottlenecks into a flexible, regional network for tomorrow's offshore wind.

> *The lesson for policymakers and developers: in deep-water markets with fragmented coastlines and challenging politics, the "port" may not be a place at all, but an asset you move.*
> *- Tzvetomir Kotzev*



Harnessing a cluster approach:
Bringing together capabilities to drive a better return

Port of Cuxhaven, Germany

A cluster approach can significantly reduce costs and carbon by integrating multiple functions into a single, heavy-duty port, creating a stable pipeline of work and a central hub for transport and commerce. While the upfront capital investment is substantial, this model offers safer returns and the potential to scale offshore wind production. By bundling existing workstreams and investments, the cluster approach delivers greater value and operational efficiency: driving productivity, innovation and new business formation that are hard to replicate remotely. In offshore wind, these advantages translate to fewer touchpoints, faster cycles, and lower installed costs per MW.

Located in the Elbe estuary, Cuxport operates two multimodal deep-water terminals, Europakai and Lübbertkai, with six berths enabling parallel operations and reducing bottlenecks. The port's strategic connections to Hamburg, the Baltic Sea and international routes enhance its role as a logistics hub. For offshore wind, Cuxhaven offers a three-way process: on-site component manufacturing, integration and shipping, all supported by the German Offshore Industry Centre, a purpose-built complex with heavy-duty quays, roads and logistics areas

Beyond wind components, the port handles RoRo, break bulk, paper, steel and oversized goods. Its comprehensive infrastructure and diverse operations ensure a stable workflow, helping to mitigate the cyclical nature of wind farm development.

> *Crucially, several public bodies invested in this center, demonstrating the effectiveness of public-private partnership within the cluster model.*
> *- Alan Roper*

Relying on a stronger sum of the parts: Pairing renewables for better results

Humber Ports, England

In the renewables race toward net zero, there is competition between new technologies in some sectors. However, pitting the different renewables against each other can drive up risk and costs, while pairing them could unlock greater opportunities.

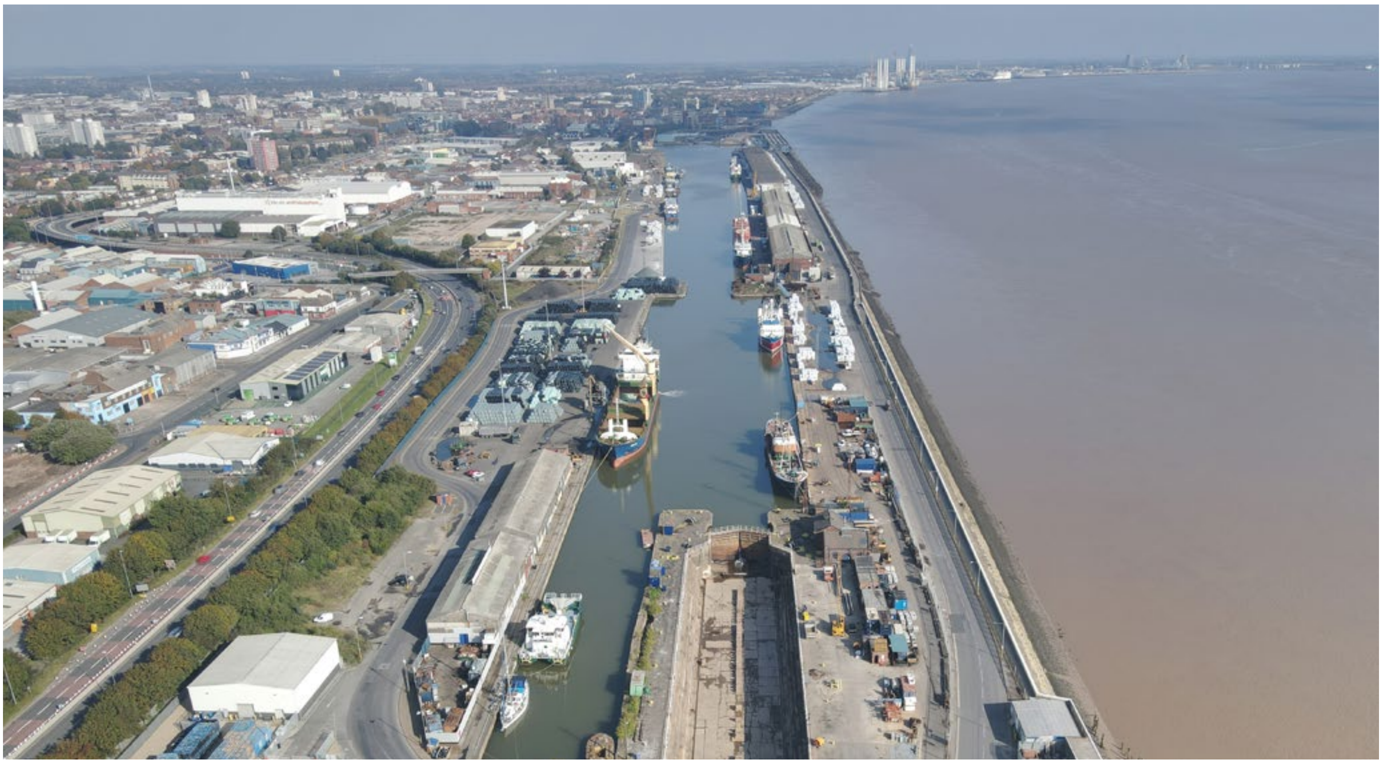
The Humber has always supported diverse energy-related industries. Hull was the U.K.'s largest whaling port in the 19th century and has since progressed from whale oil to fossil fuels to renewables, including wind and green hydrogen. Now it's part of an 'Energy Estuary' which provides nearly 20% of the country's electricity, a third of its refined fuel and 20% of natural gas imports. The offshore wind industry is supported by Green Port Hull Wind Port which opened in 2016 and has served for nearly 10 years as a center for wind power manufacturing and logistics.

Now there are plans for undersea hydrogen storage at Westermost Rough, roughly five miles north-east of Withernsea off the Holderness coast in the North Sea. In most cases, offshore power is fed into the grid immediately.

Now, these port partnerships can bring together energy generation, storage and transmission opportunities. In the process, the region becomes more self-reliant, which makes it more attractive for similar future investments.

The lessons for the industry: success is not reliant on one source of renewable energy. Every renewable energy solution has pros and cons. Ports which leverage the complementary strengths of the different solutions can lower risk, improve efficiencies, and more effectively harness the context of a specific location, such as the physical properties of the Humber Estuary, the five rivers and existing infrastructure.

> *The existing storage is currently being used for natural gas, but the offshore wind energy can be used to create hydrogen and then stored.*
> *- Laurence Banyard*



The Future Forecast

WHAT DO YOU WANT TO HAPPEN IN OFFSHORE WIND PORT DEVELOPMENT?	FIVE-YEAR TIMELINE	TEN YEARS AND BEYOND
Laurence Banyard	Renewed confidence in the offshore wind industry globally by a combination of (re) established grant funding and successful auctions.	Integration of green technologies becomes commonplace: Offshore wind energy generation with hydrogen production to enable green energy storage, combined with global market in green ammonia shipping.
Maki Onodera	A programmatic approach in the U.S. which crosses state lines and provides benefits through multi-phased development. Fewer ports will be built, but there will be a more secure pipeline and shared services.	Clarity and long-term commitment from governments globally to support developer investment.
Eoin Richardson	Approval of licenses and environmental assessments for several wind farm investments, including the Victorian Renewable Energy Terminal at the Port of Hastings.	A much greater reliance on wind and solar in the Australian energy mix to achieve the nationwide goals of reducing emissions by at least 62% by 2035 and net zero by 2050.
Michael Wilks	Regional co-ordination and memorandums of understanding across U.S. state lines along with a stress-tested business model which includes complementary port uses for fallow periods.	A much greater system of battery energy storage and transmission globally to provide a better balance of renewable and intermittent resources.
Medha Rahman	A few years of policy stability to develop competitive tension and interest by developers in the wind port market.	A technology race toward the net zero challenge and fully fledged operations and maintenance capabilities to service wind farms globally.
Alan Roper	Confidence to investors through demonstrator projects that the Levelized Cost of Energy remains competitive against fixed-bottom alternatives.	Industrialized clusters to service new and existing Floating Offshore Wind (FLOW) with globalization of the various manufactured products.
Tzvetomir Kotzev	A common framework or programmatic approach on a country or regional level for offshore wind power development.	Floating ports which can be moved, upgradeable foundations (to account for turbine growth) and low-fi, sustainable energy storage.

Conclusion

From repurposing industrial legacies to pioneering digital twins and energy clusters, these ports are gateways for offshore wind power and catalysts for economic renewal, technological progress and sustainable growth. Business cases can be strengthened by integrating technologies and servicing several interlinked markets to drive better returns for investors. While approaches differ across regions and timelines, the core lesson is clear: by sharing global expertise and adapting strategies locally, the port industry can overcome investment challenges and help unlock offshore wind's full potential. Wind port success lies in bold partnerships, tailored strategies and tapping into global expertise and innovation.

Authors

Laurence Banyard | *Global Principal for Maritime Energy Transition*

Laurence plays a pivotal role in Jacobs' commitment to driving sustainable solutions in the maritime industry. He leads the worldwide promotion of decarbonization, resilience and the integration of cutting-edge energy technologies. His responsibilities include the development of port facilities for the shipping of lower-carbon fuels, ensuring energy efficiency and resilience of ports and overseeing maritime works for offshore renewable energy generation.

Maki Onodera | *Global Principal, Maritime Resilience and Practice Lead, Ports and Maritime, U.S. Northeast*

Maki shapes how ports and waterfronts adapt to a changing climate. In his role, he leads teams delivering resilient, high-performing maritime infrastructure — from planning through design and long-term asset management. With 24 years of experience in waterfront planning, design, inspection and rehabilitation, he specializes in coastal resilience and lifecycle management of maritime assets across local and international projects, supporting clients to strengthen critical infrastructure and the communities they serve.

Eoin Richardson | *Senior Associate Transport Economist*

Eoin offers more than 13 years of experience delivering projects for public- and private-sector clients in domestic and global markets. He advises governments and developers on infrastructure and development proposals, with a focus on wider economic benefits. His expertise includes employment and demand forecasting, development pattern analysis and economic inputs across the power, water and transport sectors.

Michael Wilks | *Lead, Renewable Generation, North America*

Michael is a leading expert in renewable energy strategy, specializing in wind, solar, wave, geothermal, and storage projects. With extensive experience across the U.S. and the U.K., he excels in infrastructure planning, regulatory roles, and project delivery for public and private sector clients in complex energy and transportation sectors.

Medha Rahman | *Director, Ports and Maritime*

Medha leads multidisciplinary initiatives advancing resilient, low-carbon port infrastructure across international markets. With experience spanning smart ports, energy transition and investment planning, he specializes in port decarbonization, hydrogen-enabled development and strategic advisory for complex stakeholders. Medha partners with clients from early visioning and business case creation through design, delivery and outcomes, enabling ports to adapt and grow sustainably and equitably.

Alan Roper | *Principal Engineer*

Alan leads multidisciplinary teams delivering complex infrastructure programs. With broad experience spanning planning, design and construction support, Alan specializes in structural engineering, asset lifecycle management and resilience for transport, water and energy clients. He champions safety, sustainability and digital delivery, coordinating stakeholders from concept through handover.

Tzvetomir Kotzev | *Engineering Manager*

With experience spanning waterfront planning, design, inspection and rehabilitation, Tzvetomir specializes in coastal resilience, port structures and lifecycle management of assets for public and private clients. He is active in outreach for the Coasts, Oceans, Ports and Rivers Institute, mentoring students and advancing engagement with the maritime community across the region's projects and initiatives.

Jacobs

Challenging today.
Reinventing tomorrow.