ARUP

Developing an offshore wind turbine factory

Key considerations for locating, designing and building manufacturing facilities

Offshore wind is a vital source of renewable energy for the global transition to net zero.

But where and how will the rising number of turbines and other elements be manufactured?

ARUP

This five-minute guide explores what manufacturers need to consider when setting up new offshore wind factories. It examines:

Why and where offshore wind is growing

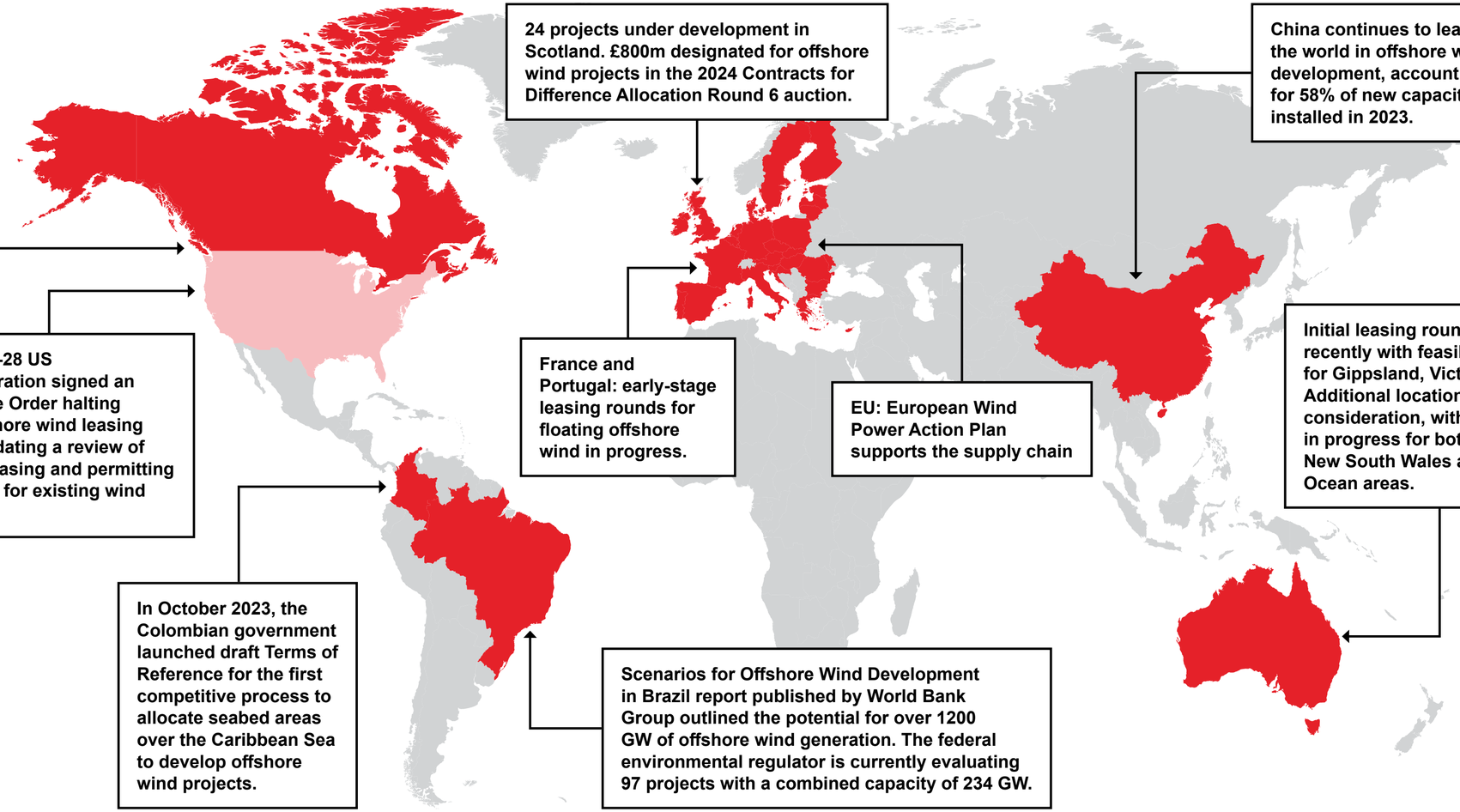
Choosing a location for offshore wind manufacturing

Securing consents for the factory

Designing and developing a factory

The guide was written by Arup's experts in operations, manufacturing, development consenting, facilities design, port engineering and offshore renewables – with input from our specialists in designing buildings for advanced manufacturing.

What's powering the offshore wind market?



Canada has joined the Global Offshore Wind Alliance reaffirming its commitment to offshore wind. This move follows the passage of Bill C-49 in 2024, which amends key agreements to facilitate offshore wind development. Nova Scotia is committed to a target of 5GW in seabed licenses by 2030.

The 2024-28 US Administration signed an Executive Order halting new offshore wind leasing and mandating a review of federal leasing and permitting practices for existing wind projects.

In October 2023, the Colombian government launched draft Terms of Reference for the first competitive process to allocate seabed areas over the Caribbean Sea to develop offshore wind projects.

24 projects under development in Scotland. £800m designated for offshore wind projects in the 2024 Contracts for Difference Allocation Round 6 auction.

France and Portugal: early-stage leasing rounds for floating offshore wind in progress.

EU: European Wind Power Action Plan supports the supply chain

Scenarios for Offshore Wind Development in Brazil report published by World Bank Group outlined the potential for over 1200 GW of offshore wind generation. The federal environmental regulator is currently evaluating 97 projects with a combined capacity of 234 GW.

China continues to lead the world in offshore wind development, accounting for 58% of new capacity installed in 2023.

Initial leasing rounds took place recently with feasibility licences for Gippsland, Victoria issued. Additional locations are under consideration, with applications in progress for both the Hunter, New South Wales and Southern Ocean areas.

What is happening where?

At COP28, global leaders pledged to triple the world's renewable energy capacity by 2030.

The Global Wind Energy Council estimates the total global offshore wind capacity at 75 GW as of the end of 2023, so there is a huge opportunity here to improve energy security and cut carbon emissions.

What's powering the offshore wind market?

As of 2023, there are 30 offshore wind nacelle (the enclosure housing the gearbox, shafts, generator, and brake for the turbine) assembly facilities globally, two-thirds of which are in China. Unless capacity increases, Europe, America and Asia are likely to experience bottlenecks in supply towards the end of the decade. To maximise offshore wind's potential, the industry must step up manufacturing – something that many governments are supporting by incentivising development.

Long lead times mean suppliers must make substantial investments before offshore wind farm developers can commit to orders. Building a resilient supply chain has been key to our work advising on Scotland's Strategic Investment Model, and applying this approach elsewhere would keep costs down and help meet renewables targets.

Governments and developers are also seeking to improve the sustainability of offshore wind projects and the social value they bring. We expect to see this trend continue.

" To support the increasing demand for offshore wind incentive schemes such as enterprise agency funding, innovation subsidies and tax incentives are becoming available to developers. As well as guiding clients through applications, we've also worked for governments, assessing the viability of incentive schemes, so we're familiar with the differing requirements and criteria."

Rachael Mell
Offshore Wind Innovation & Advisory Lead

Choosing the right location

Local regulations and incentives may determine where you manufacture, particularly for very large-scale projects. But if you have a range of potential locations to choose from, what are the other factors that will guide your decision?

Having a large area of land is important, due to the vast size of elements such as monopile foundations. And with huge numbers of different components – including blades, nacelles and towers – continually arriving at and leaving offshore wind manufacturing facilities to specific deadlines, virtually everything needs to be moved by sea. So a port location is essential.

The question is: which port?

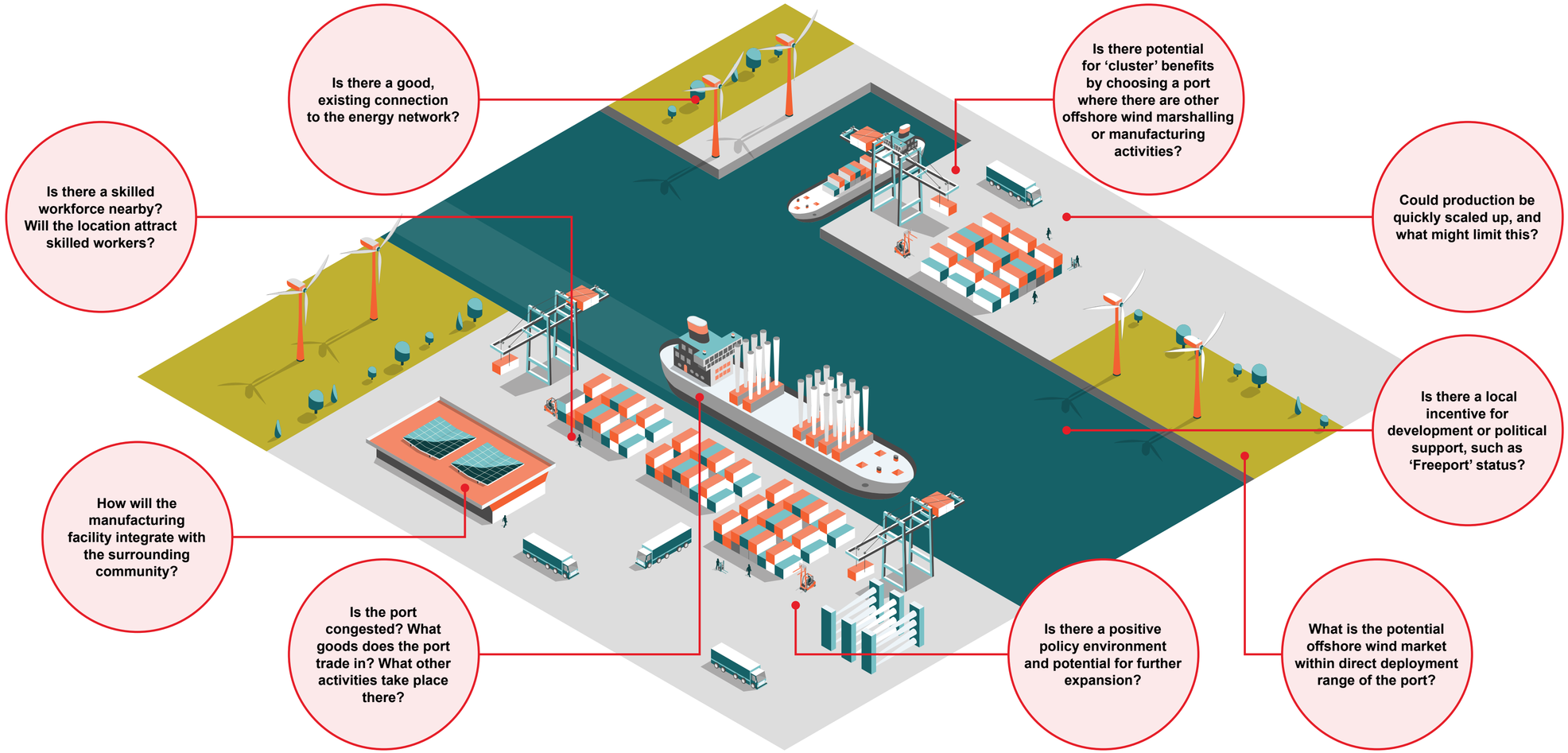
“ What you’re manufacturing determines where you make it: ports must have very large areas of developable land, while quays must have the load capacity and depth for vessels that carry parts like jacket foundations. For floating offshore wind, components are even bigger and even heavier – a critical consideration.”

Chris Bolton
Ports for Offshore Wind Lead

ARUP

Choosing the right location

Easy, quick access by sea to local installation sites is critical, particularly when manufacturing the largest components such as foundations. The port should also have a reliable link to major roads for moving smaller components and for staff to reach the factory.

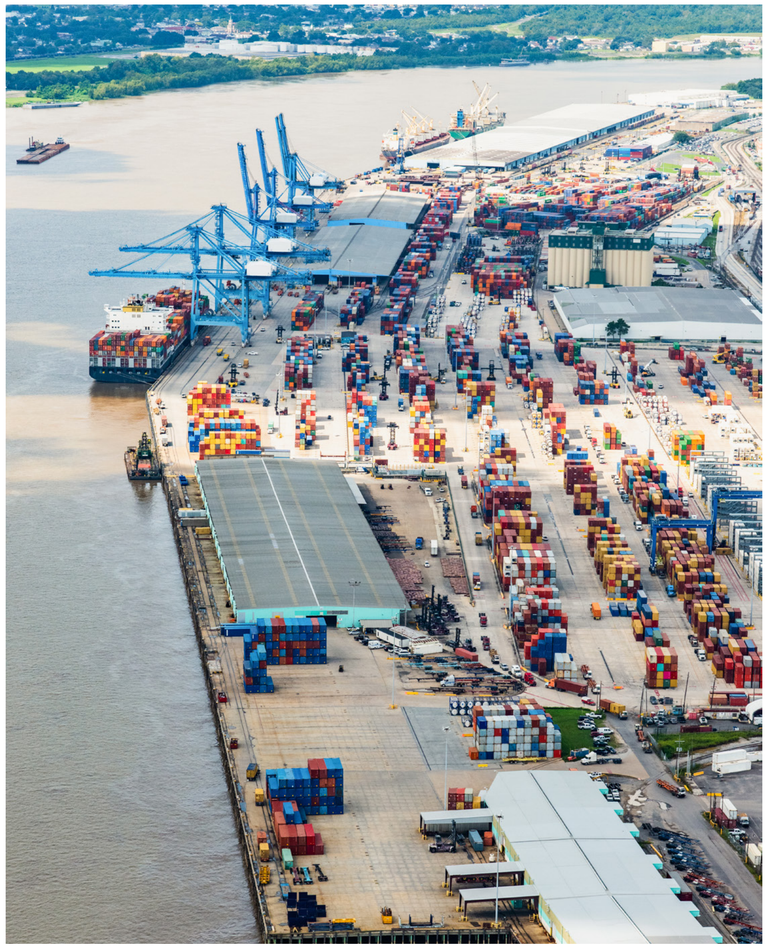


Securing consent

An existing, operational port is normally considered as an industrial land use. For this reason, development policy (which is created and approved by government and local authorities) generally supports development in appropriate locations in and around an operational port.

But what consents are needed, what supporting information is needed and how can you speed up and simplify the process?

Policies, guidance and requirements vary between, and even within, countries. Some requirements may be mandated, while other guidance may be advisory, or in draft form.



“ Consenting is often a two-way process and it’s changing rapidly. By virtue of their coastal locations, ports are often very sensitive environmental habitats, so it’s important to balance maximising economic benefits with protecting sensitive species and habitats. Following due process, completing full and proper consultation and making pragmatic assessments ensures robust decisions.”

Debbie Harper
Director, Energy Consenting

Securing consent

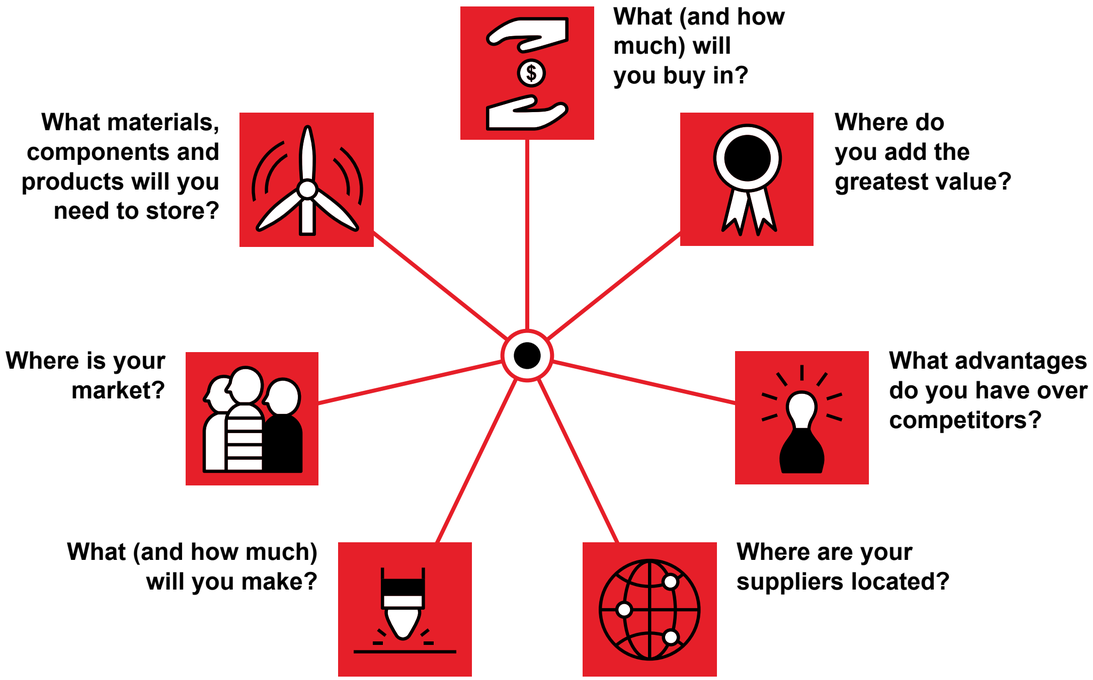
Local teams and technical experts are invaluable. They can help you navigate the consenting system in that location and, crucially, shorten the process by:

- Guiding you through the process
- Developing strategies for formal consultation
- Helping you engage early with stakeholders and decision-makers to ensure full and proper communication
- Working with local communities to understand what matters to them
- Listening to and resolving concerns about issues such as transport and construction timescales
- Ensuring compliance with environmental and wildlife protection requirements

ARUP

Developing a factory

At the outset, it's fundamental to identify the factory's operational requirements.



" By building up a rich picture of operational requirements we can create a development roadmap to take clients from initial concept to the start of production. Getting this planning stage right and holding regular go/no-go 'gateway' reviews, makes it easier to control costs, programme and risk."

Matt Cooper
Operations Consultant, Manufacturing

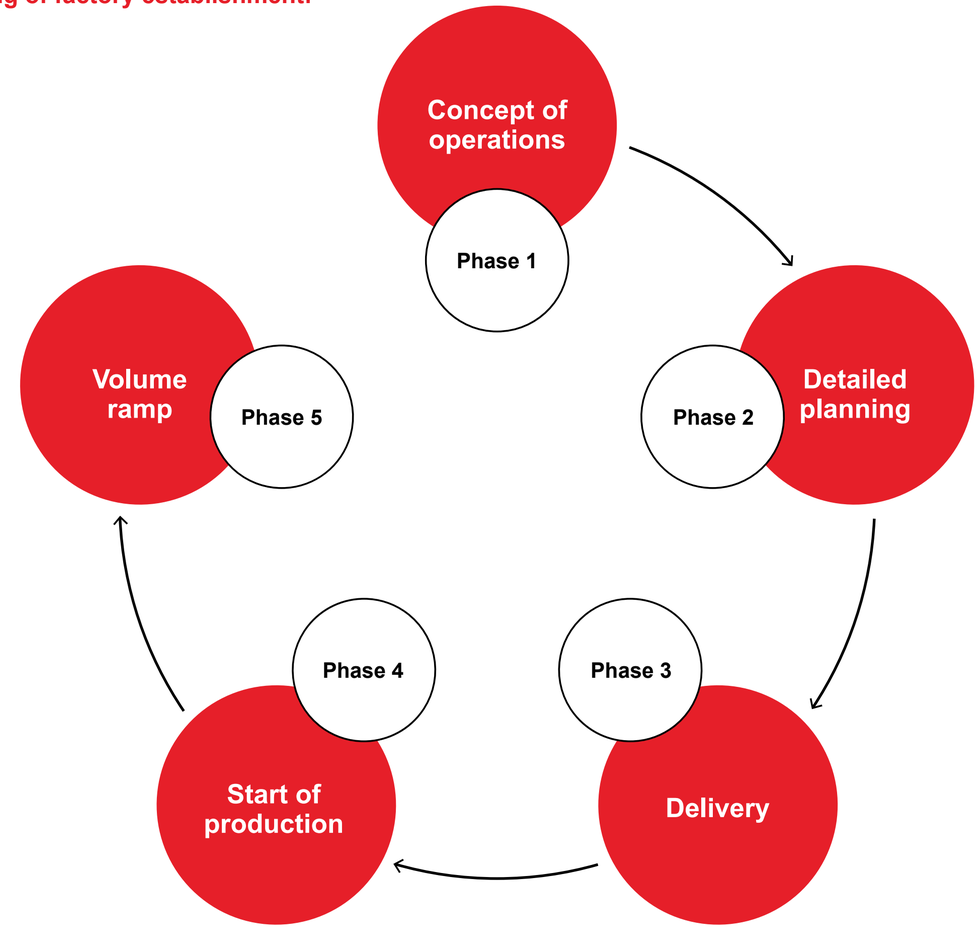
ARUP

Developing a factory

Offshore wind components are large and unwieldy so minimising movements – in terms of numbers, route and distances – is key. Whether you plan to build new or re-purpose an existing building, it's important to consider laydown areas, quayside draft, length, bearing capacity, navigational channel dimensions and wet storage facilities.

When designing large or complex manufacturing facilities, the design team needs to understand the manufacturing process well so that their architectural and engineering solutions are suitable, flexible and cost-effective.

Example gateway phasing of factory establishment:



ARUP

Developing a factory

- Have you considered workers' wellbeing by providing daylighting, views, good air quality, low noise levels, and amenities?
- Can you create a great place to work?
- Is the factory well laid out and easy to work in, and do different parts of the business interact?
- Can the design and its 'look and feel' contribute to your brand identity, a positive work culture and demonstrate your competitive edge to potential customers?

Developing a factory

What about day-to-day maintenance and repairs? Is everything accessible to maintenance workers and machinery? Are operations compartmentalised so they can be upgraded without a complete shut-down? This is much harder to retrofit than to design in. Thorough design and planning will also cut carbon emissions and create a more sustainable ‘green factory’.

Finally, there is what we call ‘the human factor(y)’. It’s easy to overlook the vital role that people play in manufacturing. Where will the factory source its skilled workers from? If the company will bring in their own experienced workers, will those people want to re-locate? What services and support will the workers and their families need, including housing, education and healthcare?

By investing in planning all this from the outset, you can streamline every stage of the process – from initial concept to the start of production and beyond.

ARUP

Authors

Rachael Mell
Offshore Wind Innovation & Advisory Lead
rachael.mell@arup.com

Debbie Harper
Director Energy Consenting
debbie.harper@arup.com

Discover more about our expertise in offshore wind and manufacturing

Offshore wind

Our markets

Chris Bolton
Ports for Offshore Wind Lead
chris.bolton@arup.com

Matt Cooper
Operations Consultant Manufacturing
matt.cooper@arup.com

Cossel Chang
Ports for Offshore Wind Co-Lead
cossel.chang@arup.com

Photo credits
Cover: Sjo/Getty Images
p5: shaunl/Getty Images
p8: Art Wager/Getty Images
p13: industryview/Getty Images

ARUP

Key contacts: Industry and manufacturing

Jennifer DiMambro
Global and Americas
Industry and Manufacturing Leader

Elida Karaivanova
Europe
Industry and Manufacturing Leader

Mark Bartlett
Australasia
Industry and Manufacturing Leader

Daniel Birch
UKIMEA
Industry and Manufacturing Leader

William Chan
East Asia
Industry and Manufacturing Leader

ARUP

Key contacts: Offshore Wind

James Theobalds
Global
Offshore Wind Leader

Peter Thompson
East Asia
Energy Leader

Francisco Ciruela-Ochoa
Americas
Offshore Wind Leader

Graeme McCann
UKIMEA
Offshore Wind Leader

Damon Sunderland
Australasia
Offshore Wind Leader

ARUP