


# Offshore renewables paving the way for a competitive and climate-neutral Europe by 2050

A joint report from:

ETIP Wind
EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON WIND ENERGY

ETIP OCEAN
European Technology & Innovation Platform for Ocean Energy

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This report has been jointly issued by the European Technology and Innovation Platforms on wind energy and ocean energy (ETIPWind and ETIP Ocean).

In this report, "the EU" refers to the EU-27, while "Europe" designates all European countries – unless stated otherwise.

## About ETIPWind

ETIPWind, the European Technology and Innovation Platform on wind energy, brings Europe's wind energy community together. Key stakeholders involved in the platform include the wind energy industry, political stakeholders and research institutions.

ETIPWind was established in 2016 to inform research and innovation (R&I) policy at a European and national level. ETIPWind provides a public platform for wind energy stakeholders to identify common research and innovation priorities and to foster breakthrough innovations in the sector.

Its recommendations highlight the pivotal role of wind energy in the clean energy transition. They inform policymakers on how to maintain Europe's global leadership in wind energy technology so that wind can help deliver the EU's climate and energy objectives. As such, the platform is key in helping to implement the SET Plan (Strategic Energy Technology Plan). ETIPWind is supported by the Horizon Europe project SETIPWind.

## About ETIP Ocean

ETIP Ocean brings ocean energy experts together to share knowledge and define priorities to boost the sector's development.

ETIP Ocean maximises knowledge-exchange across the ocean energy sector through webinars and workshops. It puts forward recommendations for policymakers and industry in our high-quality publications. Together with the SET Plan Implementation Working Group for Ocean Energy, ETIP Ocean launched the Forum for Sectoral Dialogue for Ocean Energy bringing public and private leaders in ocean energy together.

ETIP Ocean is a recognised advisory body to the European Commission, as part of the SET Plan – the EU's main research and innovation policy instrument. The platform's activities and publications are free and publicly available.

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# Executive summary

## Offshore renewable energy will help deliver a competitive, secure and climate-neutral Europe

A resilient and decarbonised Europe can only be achieved through a significant roll-out of renewable energy. With an abundant resource in European seas, offshore renewables – bottom-fixed and floating wind energy, tidal stream and wave energy – provide solutions that are sustainable, tapping into local resources, and pioneered and developed by European companies.

The European Commission have recognised this potential and published an EU Offshore Renewable Energy Strategy in 2020.[1] In it the European Commission set a target of at least 60 GW of wind and 1 GW of ocean energy by 2030. And at least 300 GW of offshore wind and 40 GW of ocean energy by 2050

In October 2023, the European Commission issued a communication on its ambitions for offshore energy under the European Wind Power Package. It noted that Member States have raised their targets to almost double the initial 2030 ambition. The new but non-binding ambitions amounted to 111 GW of offshore renewable energy.[2] Meeting these targets will only require using a small fraction of the total potential of offshore renewables in Europe.

**This joint study shows that Europe's offshore renewable energy potential is 4,673 GW for bottom-fixed and floating offshore wind, and 130 GW for wave and tidal energy**.

By unlocking this potential, Europe can boost its competitiveness, reinforce energy security, and create high-skilled local jobs.

## Supportive policies are needed to scale up offshore renewables

Fully harnessing Europe's offshore renewables potential will require a supportive policy framework at both the EU and national level. Such a framework should include measures to provide market visibility, to streamline permitting, to design fit-for-purpose financing mechanisms, and to support grid development.

Together, these will help to de-risk projects, cut costs, accelerate build-out, provide long-term investment certainty, and safeguard Europe's leadership in offshore renewables.

## Targeted Research & Innovation (R&I) actions will bring the greatest cost savings

Alongside supportive policies, EU and national authorities need to optimise R&I funding by prioritising projects which accelerate the deployment of offshore renewables. Since the different offshore renewable technologies are at varying levels of technological readiness, they come with different technological and deployment challenges.

For bottom-fixed offshore wind, this means optimising the efficiency of existing technologies to safeguard competitiveness. For floating offshore wind, the focus should be on scale-up. And for wave and tidal, R&I investments should focus on large-scale demonstration projects.

Despite these differences, offshore renewable technologies have challenges in common. And these are prime targets for public R&I funding. The key topics for joint research include, for example, system integration of co-located projects, quick connect/disconnect systems for mooring lines and inter-array cables, and the optimisation of port logistics.

1 https://eur-lex.europa.eu/legal-content/EN TXT/?uri=COM:2020:741:FIN&qid=1605792629666.
2 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0668.

# 1
# Introduction

A massive roll-out of renewable energy is the chief catalyst that will deliver energy security and climate neutrality to the EU. Offshore renewables – namely bottom-fixed and floating wind energy, tidal stream and wave energy, as cited in this report – will be key to powering Europe with homegrown and sustainable energy, if the vast potential in our seas is exploited.

The European Commission recognises this opportunity in its EU Offshore Renewable Energy Strategy[3]. It states that offshore renewable energy is among the renewable technologies with the greatest potential to scale-up. From the EU's existing offshore wind capacity of 20 GW, the Commission estimates that the goal of reaching 300 GW of offshore wind and 40 GW of ocean energy by 2050 is realistic and achievable.

Unlocking the potential of offshore renewables will boost the EU's competitiveness, strengthening energy security, and delivering high-skilled jobs to EU citizens.

## Offshore renewables help decarbonise the EU

Offshore renewables can deliver a large amount of the capacity needed to decarbonise our energy system. **Meeting the EU targets for offshore wind and ocean energy would only tap into 6% of Europe's total offshore wind potential and 30% of its ocean energy potential**. Much more offshore renewable energy could still be unlocked (see Chapter 3).

## Offshore renewables enhance the EU's competitiveness

European companies are world leaders in offshore renewable energy technologies. The most advanced ocean energy technologies are European. Devices are also manufactured in Europe, with 100% European-sourced content in many cases.

Europe has also pioneered offshore wind energy technology. There are more than 6,400 turbines installed in European waters with a total capacity of 35 GW (including the EU + the UK and Norway). 99.9% of the turbines installed have been made in Europe. And each offshore wind turbine contributes €27m to Europe's economy.[4]

### EU's competitiveness

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in offshore renewable energy technologies

**The most advanced**
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3 An EU Offshore Renewable Energy Strategy (COM(2020) 741 final).
4 ETIPWind European Competitiveness Report 2024: https://etipwind.eu/wp-content/uploads/files/publications/european-wind-energy-competitiveness-report-2024.pdf.

## Offshore renewables strengthen the EU's energy security

Offshore renewable energy is a locally available resource for many European countries. Harvesting this potential will reduce the dependency on fossil fuels that need to be imported from outside of Europe. Ocean energy and wind energy have complementary production cycles, ensuring a stable flow of electricity to mainland Europe.

## Offshore renewables create European jobs

The offshore wind industry provides 98,000 jobs in Europe[5] - more than 25% of the total wind energy workforce. The total number of people employed in the European wind energy sector is expected to grow to 600,000 by 2030, of which 560,000 will be based in the EU.

Ocean energy is still an emerging sector, but it has the potential to create 500,000 jobs by 2050[6]. Many will be in coastal areas which have suffered from the decline of fisheries and shipbuilding.

## Offshore renewables grow in harmony with the environment

Scientific research on ocean energy to date shows no significant adverse impacts on local environments. The principles of the circular economy are being integrated into ocean energy designs before commercial roll-out. As the sector grows, monitoring must continue to ensure minimal impact. Wind turbines are 90% recyclable and thanks to environmental impact assessments, offshore wind developers can prevent or mitigate any impacts through adequate planning, siting, and designs.

Many innovative solutions have also been deployed to minimise impacts during installation, to safeguard marine biodiversity or to ensure new installations have a positive impact on the environment (e.g. artificial reefs).

Photo: © HydroQuest

Photo: © Equinor

**5** Source: WindEurope.

**6** [A study into the potential social value offered to Europe from the development and deployment of wave and tidal energy to 2050, ETIP Ocean, 2022](#).

# 2
# Political ambitions

## 2.1 State of play

Europe is already the global leader in **offshore renewables**. 99.9% of all the offshore wind turbines installed in European waters are made by European companies. And in 2022 and 2023 100% of offshore wind turbines orders for European projects went to European companies.

The success of offshore wind in Europe shows what is possible when market policy and industrial innovation are aligned. The domestic success of the European wind sector also strengthens its competitiveness in the global market. In 2023 European wind turbine manufacturers accounted for 75% of the global market for both onshore and offshore wind excluding the Chinese market[7] which is mostly exclusively supplied by domestic companies.

Floating wind, wave and tidal energy have the potential to replicate the success of bottom-fixed offshore wind. The first and largest floating wind farms, tidal pilot farms and full-scale wave devices have all been deployed in European waters. European companies have developed 34 out of the 50 most promising floating wind designs. Many of these have been supported by European R&I funding. As these technologies progress to full industrial-scale roll-out, European companies have the opportunity to take the lead in this new global market[8].

Photo: © RWE

Europe has pioneered **offshore wind** development. As early as 1991, the first commercial offshore wind farm known as Vindeby was installed in Danish waters. The wind farm contained 11 wind turbines with a nameplate capacity of 0.45 MW.

Since then, offshore wind technology and the accompanying industry have grown tremendously. Today most developers are ordering turbines of 14-15 MW from European manufacturers. That is several times greater than the capacity of the entire Vindeby wind farm.

The reason is that when it comes to offshore wind technology, the mantra of "bigger is better" has driven development in the last decades. If we compare the statistics of modern-day offshore turbines to those of the very first offshore wind farm we can see that blades are six times longer (18 m compared to 115.5 m), the swept area 40 times larger (1,075m² compared to 43,742m²) and the nameplate capacity is 33 times higher (0.45 MW compared to 15 MW). The energy production of individual turbines is 92 times higher (0.87 GWh/year compared to 80 GWh/year).

The meteoric rise of the bottom-fixed offshore wind sector makes it Europe's flagship renewable energy industry. Today we have 35 GW of offshore wind installed in Europe, of which 20 GW is in the EU. But the annual build-out of offshore wind needs to ramp up significantly. In 2023 Europe installed 3.7 GW of new capacity. By 2030 we expect annual offshore wind installations to reach 15 GW, a fourfold of today's rates.

While the North Seas are home to 98% of Europe's installed capacity today, offshore wind development has also extended to the Mediterranean and Europe's South-Eastern basins. The rise of floating offshore wind has led to major business opportunities for European players in the North Seas, Atlantic and along the Mediterranean coast.

**Ocean energy** is currently at the demonstration and pre-commercial stage with a pipeline of 167 MW of projects publicly supported by EU programmes or national schemes.

When it comes to tidal, the first pilot farms were put in the water in 2016, and developers are now seeking finance for their upcoming pre-commercial farms. As for wave, several

7 Woodmackenzie 2024.

8 WindEurope report "Ports: a key enabler for the floating offshore wind sector" https://windeurope.org/intelligence-platform/product/ports-a-key-enabler-for-the-floating-offshore-wind-sector/.

scaled and full-scale prototypes are being tested in real sea conditions, and the first pilot farms are seeking finance.

The deployment of **tidal energy** in Europe has led to a gradual increase in recent years. Since 2010, Europe has installed a total of 30.5 MW of tidal stream capacity, with 11.75 MW currently operational. The remaining 18.75 MW has been decommissioned after successfully completing their testing phases. The next major capacity additions are anticipated to occur in 2026, driven by pilot and pre-commercial farms. The cumulative electricity production from current tidal energy projects and pilot farms in Europe reached 93 GWh at the end of 2023.

The UK and France continue to lead in the development and demonstration of tidal stream technologies, leveraging their abundant natural resources and historical industrial expertise. Both nations have implemented revenue support systems to facilitate the scaling up of pilot farm projects. EU grant funding is playing a pivotal role, unlocking 14 MW of new tidal farms via Horizon Europe. This enhanced funding landscape has attracted private investors, unlocking several new tidal pilot farm projects.

Tidal energy is set to experience major growth in the next five years, with 155 MW of pilot farms currently under development. This marks a crucial phase in the transition from pilot projects to commercial-scale operations. The current pipeline is set to grow and could reach 700 MW by 2028 depending on the maintenance of existing market mechanisms and the implementation of ambitious new policies.

The **wave energy** sector in Europe has witnessed significant technological advancements, with several full-scale devices deployed in recent years. These deployments are the result of targeted R&I investments over the past decade. This trend is expected to continue, with several additional deployments planned in the coming years.

Since 2010, Europe has installed a total of 13.3 MW of wave energy capacity. Currently, 1 MW remains operational, while 12.3 MW has been decommissioned following the completion of testing and demonstration programs.

Until 2023, most wave energy deployments consisted of individual small-scale or full-scale prototypes. The wave energy sector in Europe is now transitioning to the pilot farm stage. The launch of the first calls for European wave pilot farms at the end of 2023, along with support for two wave projects from the Innovation Fund, marks a significant shift.

This new funding has bolstered national political support and has attracted private investments. Wave energy is expected to achieve significant capacity additions over the next five years. This acceleration underscores the growing technological maturity and market opportunities for wave energy, particularly along the Atlantic coastline.

## 2.2 Political context

The European Union is committed to become the first climate neutral continent by 2050. Offshore renewable energy will be key to delivering the **European Green Deal** and reaching the EU's ambitious energy and climate targets for 2030 and 2050. In recognition of its importance, a comprehensive regulatory framework has emerged around the offshore renewable energy sector.

In 2020 the European Commission published a dedicated **EU strategy on offshore renewable energy** that will shape the sector for the next 30 years. It set ambitious targets of at least 60 GW of offshore wind and 1 GW of ocean energy by 2030, and 300 GW of offshore wind and 40 GW of ocean energy by 2050.

Based on the revised TEN-E regulation and non-binding agreements with Member States, the European Commission's Communication **Delivering on the EU offshore energy**

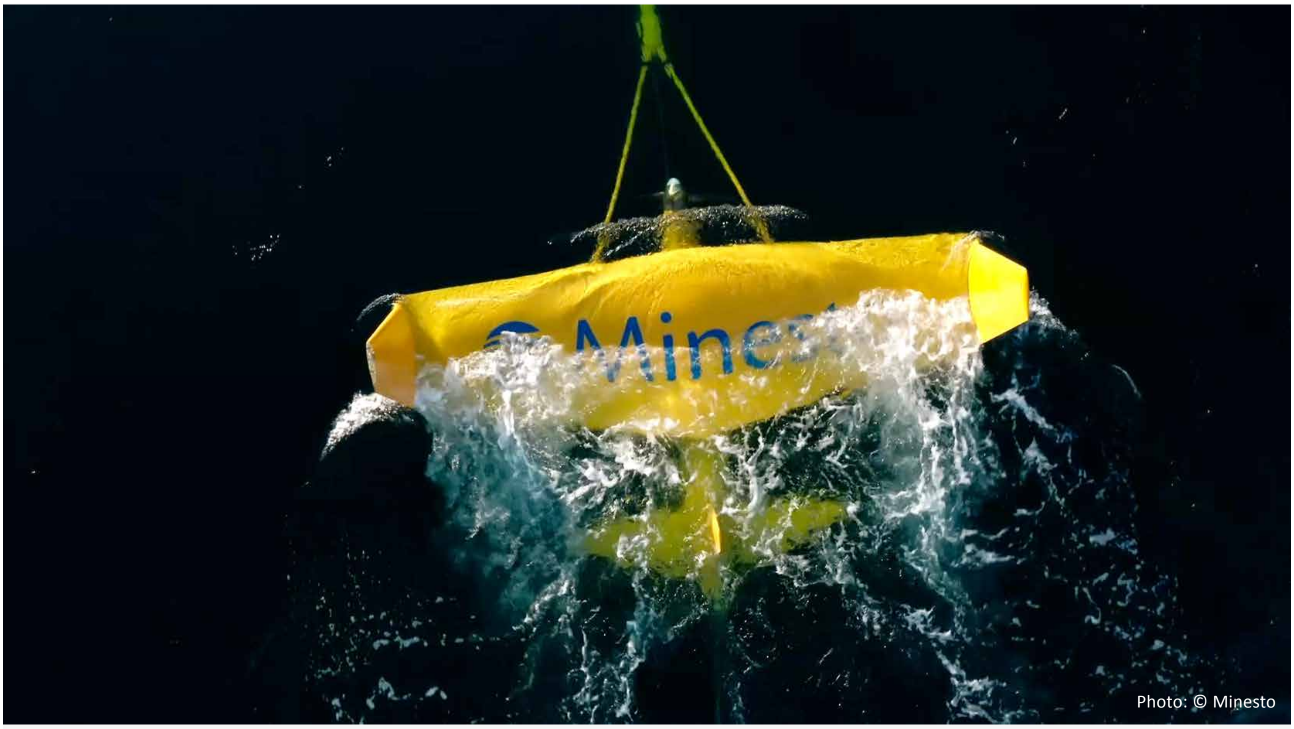


Photo: © Minesto

**ambitions** of October 2023. It shows how Member States have set ambitions to install 111 GW of offshore renewable generation capacity by 2030. This is nearly as much as the initial objective of at least 61 GW set in 2020, whilst long term ambition levels remain in line with the strategy on offshore renewable energy.

The revised **Renewable Energy Directive** includes a 2030 EU-wide renewable energy target of 42.5%. It also sets an indicative 5% target of newly installed capacity from innovative renewables –including floating wind, tidal and wave energy – in each EU Member State by 2030. Member States must implement these targets through their National Energy and Climate Plans (NECPs).

The geopolitical context after Russia's invasion of Ukraine called on policymakers to fast-track their energy transitions with renewables, reduce their dependency on imported fossil fuels and boost Europe's energy security by 2030. The new energy strategy **REPowerEU** makes important provisions for auction design and permitting to accelerate the deployment of offshore renewable energy.

After the COVID-19 pandemic it was difficult for the European wind energy supply chain to bounce back. Material and logistical cost inflation, ongoing permitting delays, and auctions with negative bidding meant that many companies struggled financially. In response to this, EU institutions and Member States have taken new initiatives to support the growth and competitiveness of the European wind energy sector.

In 2023 the European Commission launched the **Wind Power Action Plan**, a set of 15 immediate actions to be taken by the Commission, Member States, and industry. 26 Member States signed the European Wind Energy Charter committing to implement the action plan and to accelerate the roll-out of wind energy.

Member State pledges on offshore wind have continued to grow and surpassed those of the Offshore Renewable Energy Strategy. In the 2023 draft of the **National Energy and Climate Plans** we find a combined ambition of 87 GW of offshore wind by 2030. And in the Ostend Declaration on the North Seas as Europe's Green Power Plant, seven EU Member States, Norway and the UK committed to develop at least 120 GW of offshore wind by 2030 and at least 300 GW by 2050.

## 2.3 Key enablers

Delivering the EU's offshore renewable energy targets will require more than just ambitions and regulatory initiatives. It will require robust, speedy, and well-coordinated actions taken within a wider political context marked by geopolitical tensions, economic growth, and climate change.

Implementing the EU's **comprehensive policy framework** at the national level is essential for expanding offshore renewable energy. This includes Member States setting clear deployment targets with a clear timetable of auctions, setting the right auction criteria, and streamlining permitting processes.

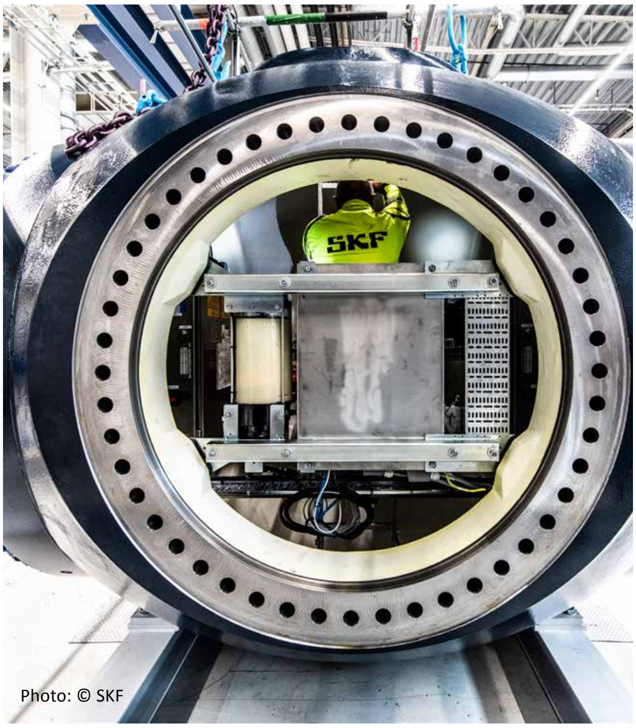


Photo: © SKF

The expansion of wind energy and ocean energy technologies heavily depends on the **capacity and flexibility of the power grid**. Investments in both onshore and offshore grids and grid technologies need to double to collect and deliver the expected amounts of offshore electricity. Delays in grid investments and grid access permits are significant bottlenecks that ultimately also delay investments in offshore energy projects.

Strengthening the resilience of the European offshore supply chains is crucial. We will need to see a **strong industrial strategy** to boost Europe's manufacturing capacity for offshore renewable energy components. This would bring additional socio-economic benefits such as new jobs and taxes that will tie offshore renewable energy industries more closely to their local communities. In this perspective, the priority shall be for the EU Member States to implement the Net Zero Industry Act which sets up targets to expand the manufacturing of clean technologies in the EU.

**Retaining and building on Europe's innovation excellence** is key to maintaining leadership in innovative offshore renewables globally. European universities and research centres are world class in developing innovative solutions and technologies. But bringing those innovations to market and crossing the "valley of death" is still a formidable challenge. Governments should support Europe's emerging sectors and ease market access for innovative technologies. We would need to see specific financial mechanisms to help scale up and deploy innovative energy solutions.

# 3

# The untapped potential

The EU Offshore Renewable Energy Strategy sets targets of at least 300 GW for offshore wind and 40 GW for ocean energy by 2050. While these figures are a step up from the current deployed capacity, the true resource potential for offshore renewables in Europe would be much higher than this[9].

**Europe's potential for offshore wind energy is 4,673 GW**, spread across various sea basins. This means the EU's ambition to deliver at least 300 GW of installed capacity would mean using just 6% of this total potential.

Of this 4,673 GW figure, two thirds or 3,131 GW lies in waters deeper than 75 m and will mean deploying floating offshore wind technologies. Another 1,542 GW lies in waters that can be accessed with bottom-fixed offshore wind technologies. 1,800 GW can be harnessed within territorial waters, defined as the 12 nautical mile zone. Depending on the country this will require either bottom-fixed technology (e.g. in the Netherlands) or floating wind technologies (e.g. in Portugal).

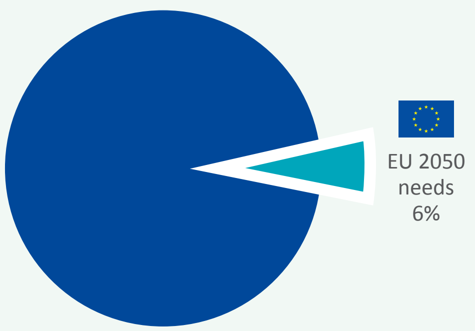
Whereas the largest untapped potential is to be found in the Atlantic Ocean and Mediterranean Sea we expect more potential from the northern seas (the North Sea and Baltic Sea) to be exploited in the years ahead. This is because of the clearer political ambitions of Governments around the northern sea basins and the higher maturity of the bottom-fixed offshore wind industry.

For ocean energy, **the figure for practical resource potential in Europe is 130 GW with current ocean energy technologies**, of which at least 80 GW is in EU waters[10]. This means that the EU's ambition to deploy 40 GW of installed capacity would mean harnessing less than one third (30.7%) of this potential. Moreover, future technology improvements can unlock lower-resource areas where waves are smaller, and tides are slower. These can expand the practical deployment area of ocean energy devices exponentially.

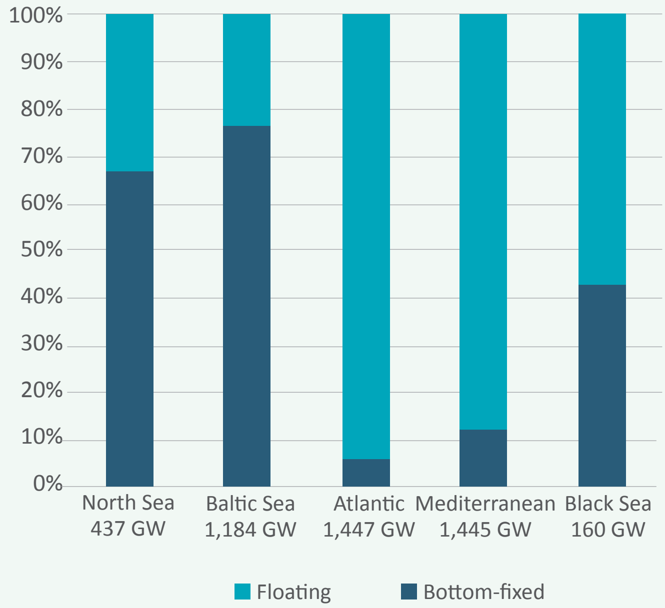
Most of the tidal potential in Europe is in France and the UK. Atlantic waters coming from the west to the UK and French coasts create some of the strongest tidal currents on Earth. Those water masses must force their way through the narrow channels of the British Isles, as well as the English Channel, creating a bottleneck and speeding up the water flows considerably.

The biggest wave energy potentials in Europe are found in Ireland, Portugal, France, and Spain. These countries share a common exposure to the wind that travels long distances across the Atlantic which causes powerful waves to crash onto their western seaboard.

**Offshore wind technical potential and its distribution per sea basin and water technology**




*"There is plenty of potential, space allocation and auctions must be planned in line with the long-term targets"*




**Source: WindEurope**

**9** See Annex for the resource potential methodology.
**10** Ocean Energy Resource Potential, Ocean Energy Europe. In preparation.

# 4

# Research & Innovation priorities

Continued technological improvement is key to cutting costs and maximising power output. R&I funding must focus on the topics with the greatest impact on technological progress. This chapter looks at how EU and national funding can best support offshore renewables and outlines the common and sector-specific R&I priorities for offshore wind and ocean energy.

## 4.1 Public funding for offshore renewables

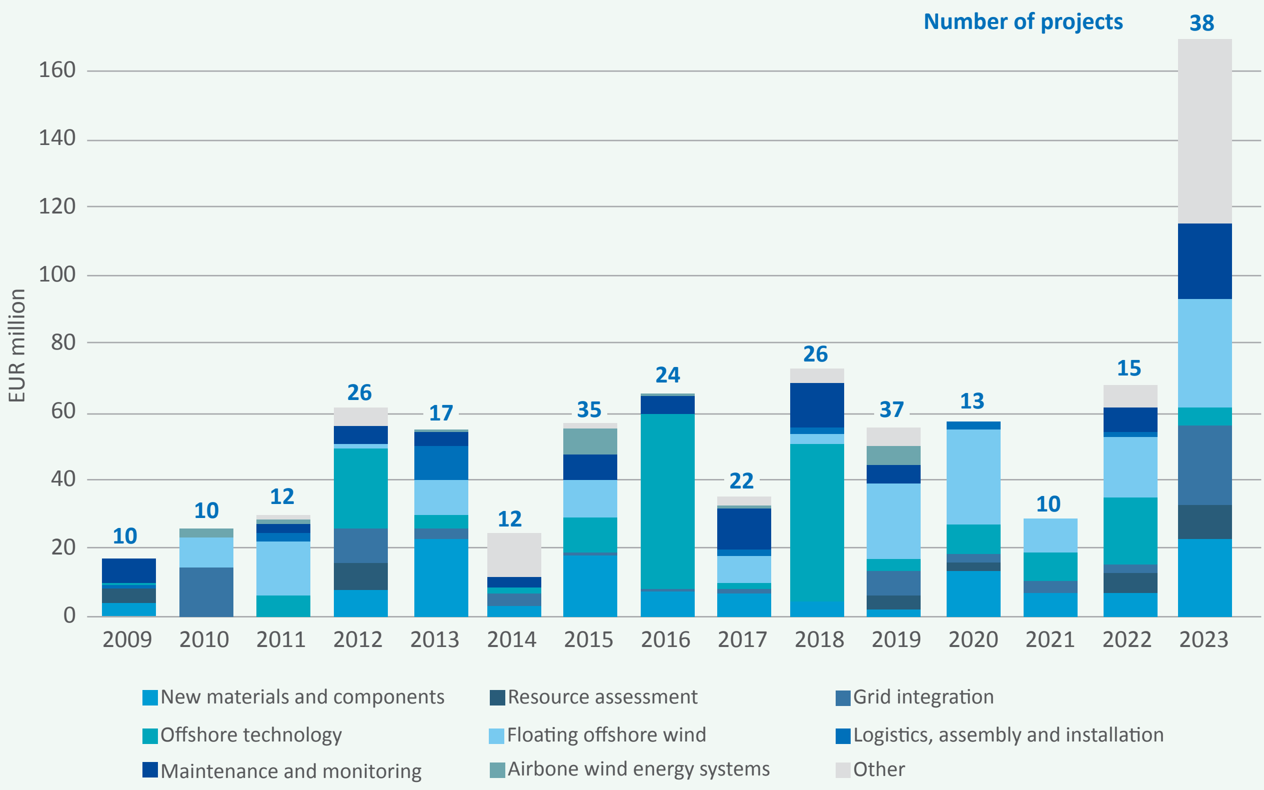
### 4.1.1 EU funding for offshore renewables

The EU is a long-standing and important source of R&I funding for offshore renewables.

Since 2009 EU framework programmes have allocated substantial funding across wind research R&I priorities. According to the latest JRC figures[11], projects on general offshore wind technology (€191m), floating offshore wind (€165m) and new materials & components (€128m) received most of the funds.

In 2023, 14 wind research projects worth €63.9m in EU funding came to an end. 55% of this funding addressed offshore wind technology (bottom-fixed and floating). However, the total EU funding for wind energy is just recovering from a low level of funding support in the previous years (e.g. less than €40m in 2017).

**EU funding for wind energy under FP7, H2020 and Horizon Europe**



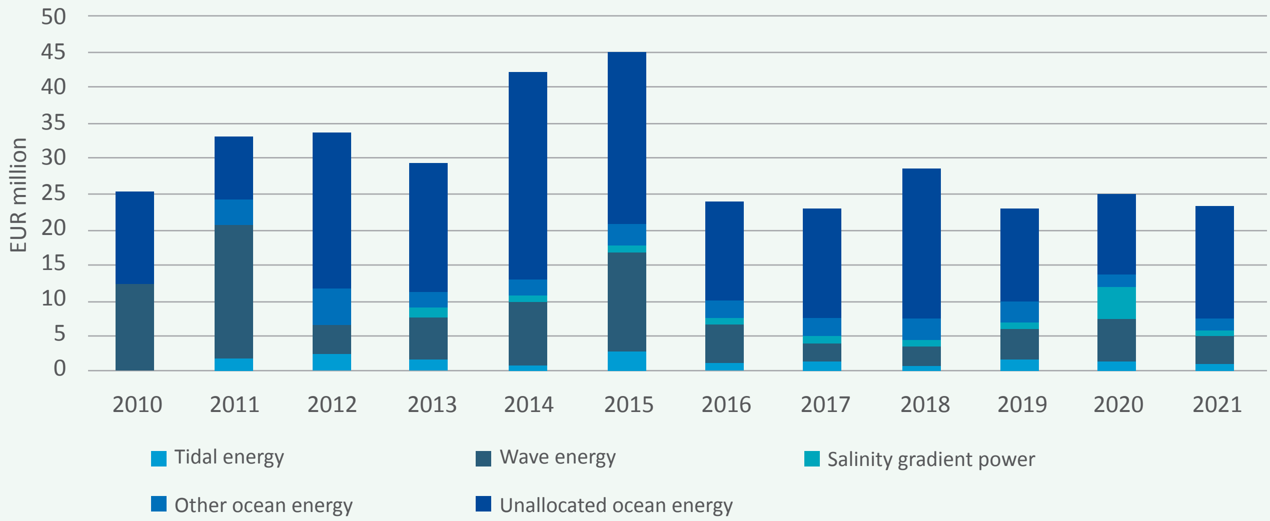

Source: Joint Research Centre

11 Source: JRC based in CORDIS, 2024.

Over the past 10 years, the European Commission has also invested over €460m in ocean energy research, development and innovation (RD&I), through a range of funding programmes[12]. The funding had a significant impact–EU-funded projects have lifted technologies up from labs to full-scale devices and first pilot farms generating electricity and powering European homes.

The following graph shows public investments in ocean energy R&D by year and by technology in the EU since 2010.

**Public investment in ocean energy R&D in the EU**




**Source: Ocean energy in the European Union. JRC. 2023.**

### 4.1.2 Enhanced, increased and targeted public R&I funding

R&I has been instrumental in developing offshore renewable energy technology in Europe. But to reach its full potential, private and public investment in R&I are still needed. Not just to commercialise floating wind and ocean energy, but to safeguard Europe's leadership in all offshore renewable energy technologies.

**Bottom-fixed offshore wind technologies have reached full commercial application** for development, commissioning and operation. As with any mature industry, **maintaining technology leadership and competitiveness depends on sustaining innovation to adapt to the changing circumstances of growth**. Continuous public R&I support plays an important role in de-risking R&I activities and safeguarding the competitiveness of offshore wind.

For bottom-fixed offshore wind most R&I efforts in the past have focused on cost-reduction, allowing offshore wind technology to compete with other energy technologies. Now the focus will be on reliability, optimising the efficiency of the existing technologies thanks to digital tools or O&M, and industrialisation.

**R&I investments in floating wind should focus on scaling-up the technology**. In the past few years several floating wind concepts have been demonstrated at scale in Europe. But now the sector is moving to pre-commercial and commercial deployment. In 2024, France tendered a 250 MW floating wind farm off the coast of Brittany. And large-scale floating wind auctions are expected to take place this year in Spain, Portugal and Norway.

R&I funding priorities in floating wind include the optimisation of floating substructures, their risk mitigation, and developing large-scale manufacturing, assembly and transport of the floating wind components. High-TRL research will also be needed to optimise the cable and mooring line systems of floating wind turbines and to facilitate manufacturing and assembly at ports.

**R&I funding to support and accelerate industrialisation will be needed for all wind energy technologies**. There is a focus on providing the solutions that will help accelerate the production and installation of offshore turbines (including foundations). But end-of-life solutions also need to scale up. This would call for R&I investments in small and large-scale prototypes but also high-TRL technologies closer to commercialisation that can be implemented quickly by the industry.

For wave and tidal stream, R&I investments should primarily focus on demonstration of full-scale devices and pilot farms. In the past few years several tidal and wave concepts have been tested and demonstrated in Europe. But the main drivers for cost reduction are industrialisation and investor confidence, which brings down costs. This will mean R&I investments for large-scale demonstration projects that are the only way to reach a sufficient volume and trigger those two drivers.

12 Source: Ocean Energy Europe.

**In tidal energy, public sector financial support for the deployment of pilot and pre-commercial farms will be key to cutting costs and attracting private investment**. These projects will allow the demonstration and optimisation of key components and enabling technologies, such as drivetrains, intra-array cabling or condition monitoring. **For wave energy, demonstration of full-scale prototypes and deployment of the first pilot farms will be the major focus** over the coming years and this should continue for a significant amount of time.

The rapid deployment of offshore renewables is essential to delivering the EU's climate and energy targets. Europe must make critical choices to sustain the technology leadership it has built up in offshore renewable energy. Public R&I funding for offshore renewable energy must therefore be ramped up. EU funding programmes should prioritise offshore renewable energy as a key and strategic sector, as is mentioned in the EU's Green Deal Industrial Plan. A "technology-neutral" approach will no longer help the EU to meet its targets on time.

The EU should also encourage Member States to align their national R&I agendas more closely with EU priorities. This must be done through the Strategic Energy Technology Plan (SET Plan) and with Member State involvement in the SET Plan entities (ETIPs, IWGs). As within EU funding programmes, dedicated R&I funding should be allocated to offshore renewable technologies through national programmes. These investments will help bring emerging offshore renewables to market and create competitive supply chains for mature offshore renewables.

### 4.1.3 The ripple effect of R&I in offshore renewables

Europe's offshore renewable technologies have different levels of technology readiness. And for that reason they face different challenges when it comes to technology development and deployment. But several challenges are common to them all, and as one technology matures, the others can benefit from the lessons learnt.

For example, innovative solutions developed for commercial technologies (e.g. automated repair methods for bottom-fixed turbines) will also accelerate the development of other technologies (e.g. floating wind or tidal) as they will benefit from advanced components, tools or methods. This "ripple effect" of R&I will enable emerging technologies to move faster to the next level of maturity.

The figure below depicts the main R&I needs of each technology (wave, tidal, floating and bottom-fixed offshore wind) according to its stage of development (technology development, market uptake and commercialisation).

It shows that even at the commercial stage, R&I is required. Bottom-fixed offshore wind for example, does not need R&I in disruptive devices anymore as commercial solutions already exist on the market. But R&I needs for this technology have shifted to other areas such as accelerating the manufacturing processes, optimising operations & maintenance (O&M) activities, or innovative life extension / decommissioning methods.

Photo: © EDF

## The ripple effect of R&I investments in offshore wind and ocean technologies

Bottom-fixed

Floating wind

Tidal energy

Wave energy

### COMMERCIAL

- Automation of components manufacturing
- Innovation on the supply-chain and production line methodologies (inc. optimised ports logistics)
- Improved construction, transport and installation methods
- Digital tools for operational efficiency
- Autonomous O&M including advanced repair methods for foundation and cables
- Innovative decommissioning tools and methods
- Optimised design for more reliable and lasting products
- Biodiversity solutions

### MARKET UPTAKE

- Industrialisation of floating wind substructures
- Replacement and transport of large components

- Optimisation of ports logistics enabling faster load-out, efficient use of port space

- Demonstration of single ocean energy devices and pilot farms
- Accessing and upgrading testing facilities
- Array interaction analysis and planning tools
- Modelling and simulation of array construction/operation
- Innovative materials and manufacturing processes
- Application of ocean energy in off-grid markets
- Demonstration grid-scale benefits of ocean energy

### TECHNOLOGY DEVELOPMENT

- Quick connect/disconnect systems for cables and mooring lines
- Development of innovative health monitoring systems for structural and functional relevant components
- Analysis of system integration needs (technical, economic, regulatory) to support the development of offshore energy co-located projects with other technology

- Disruptive wave energy devices
- Innovative PTO and control systems
- Advanced simulation of ocean energy sub-systems and devices
- Design optimisation of other ocean energy technologies

Offshore wind | Ocean energy | Joint R&I topics

## 4.2 Research & Innovation priorities

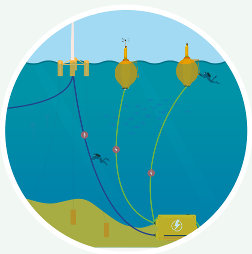
### 4.2.1 Common R&I priorities

Although offshore wind and ocean energy technologies are not at the same level of maturity, they have several R&I challenges in common. These are ideally suited for public R&I funding.

In February 2024 experts from the offshore wind and ocean energy R&I communities identified four common R&I priorities for consideration as potential collaboration topics:

#### Analysis of system integration needs (technical, economic, regulatory) to support the development of co-located projects (offshore wind and wave)

- **Shared use of space for generation projects** (offshore wind, wave) could lead to (1) increased energy production from a particular area, (2) more efficient use of shared infrastructure assets (intra-array cables, collection hubs, export cables, etc.), (3) more efficient offshore operations and maintenance, and (4) a more stable and reliable energy supply. However co-location projects should be carefully assessed as they still bring extra risks and costs for the projects. Further R&I is needed to derisk these projects.



#### Quick connect/disconnect systems for mooring lines & for inter-array cables

- **Rapid mechanical or electrical connection systems** that simplify and speed up the operation of connecting/disconnecting mooring lines, dynamic umbilical and intra-array cables should be developed to minimise OPEX and ensure they are reliable and robust.

#### Optimisation of logistics (including ports)

- **The optimisation of logistics and installation** of offshore renewables will enable faster load-out and efficient use of port space, boosting efficiency while ensuring safety and reducing environmental impact.
- **The design of waterways,** integration of technologies for automation and digitalisation in ports should be addressed as well.

#### Development of innovative health monitoring systems for structural and functional relevant components

- **New methods for condition/health monitorin**g need to be developed for critical components and assemblies where reliability cannot be fully demonstrated during design. With that in mind, these components and assemblies need to be carefully tracked during operation to ensure the structural integrity or operational safety of the asset.
- **Reduction in costs of instrumentation** and their connectivity brings opportunities to better characterise load, response, and power performance.

### 4.2.2 Technology specific R&I priorities

#### OFFSHORE WIND ENERGY

The ETIPWind's latest Strategic R&I Agenda 2025-2027 defines 23 short-term R&I priorities and estimates that €1.8bn of public investment is needed to correctly address those topics. Priorities that are particularly relevant for offshore wind are summarised below.

##### 1 Industrialisation, scale-up and competitiveness

Automation, robotisation, optimisation of manufacturing processes, optimisation of logistics, and installation methods are many areas where innovation is needed to scale-up and improve the reliability and efficiency of the offshore renewables' supply chain. For bottom-fixed offshore wind, automated or semi-automated processes for components and foundation fabrication will enable mass-production in Europe. For floating offshore wind, innovative ways of manufacturing components, cost-efficient installation methods and transport of large components including optimised port logistics must be developed to accelerate deployment.

##### 2 Optimisation and further digitalisation of Operations & Maintenance (O&M)

There are major opportunities for R&I to improve digital tools that facilitate and optimise offshore wind farm O&M. New technologies to train and assist technicians at sea, AI tools for predictive maintenance, advanced forecasting methods for wind resources. R&I investments in autonomous tools and vehicles for O&M are also needed to improve robotic blade service or to automatise inspection methods. For floating wind, developing safe and reliable servicing is one of the keys that will help derisk the technology as well as solutions for replacing large components.

##### 3 Wind energy system integration

The rapid integration of large amounts of offshore renewable electricity into the energy system will require a new class of technologies and solutions for system planners and operators. We will need to see demonstrations of system integration using co-located renewables, offshore hybrids or energy islands via new or repurposed (e.g. oil and gas platforms) infrastructure. Innovative solutions such as meshed HVDC, multi-terminal DC solutions, and cross-border interconnectors should also be optimised and deployed to bring large volumes of offshore renewable energy to the onshore grid.

##### 4 Sustainability and circularity

R&I can always help to make offshore wind even more resource efficient and circular. We will need to develop innovative decommissioning solutions to extract or cut the monopiles on the seabed and to use cable extraction tools. These should be designed so that they ease the reuse and recycling of materials. Continuous monitoring of environmental effects and biodiversity is vital for the success of offshore wind farms. But there are still knowledge gaps on the cumulative impacts from wind power installations on biodiversity. New nature positive strategies and technologies should also be developed for example to reduce underwater noise or to build new habitats in offshore wind farms with artificial reefs.

##### 5 Skills and coexistence

R&I will be needed to look for new models to address societal concerns about offshore wind and to enhance societal awareness about its benefits. Understanding the effects of wind energy's coexistence with other activities (e.g. marine ecosystems, aquaculture, fisheries, etc) will mean harmonised data-collection and models to simulate interactions between these activities. Offshore wind development will call for even greater numbers of skilled workers in the coming years (550,000 people by 2030). Skilling, re-skilling, and upskilling activities are therefore central to futureproofing offshore wind energy.

## OCEAN ENERGY

### 1 Design and validation of ocean energy devices

Ocean energy devices must be deployed and operated at sea for significant periods to improve design and performance, and to validate business models for investors. This includes demonstrating single devices and pilot farms, the first open-sea testing of new devices and the pre-commercial deployment of more advanced ones.

### 2 Next generation technologies and subsystems

New ideas and concepts for capturing ocean energy are constantly emerging and evolving, and they coexist with the step-by-step development of more mature alternatives. The aim is to develop technologies, subsystems and components that demonstrate high potential for significant reduction in cost, risk and maintenance; and where possible can be used by a wide range of developers.

### 3 Ocean energy analysis and modelling tools

The accuracy and affordability of analysis and modelling tools has a direct impact on the innovation and development process of ocean energy. Device developers need them to assess performance, optimise design, and evaluate new solutions in the early stages. Advanced projects need tools to predict array performance, to optimise farm design, and to plan and manage construction and operation.

### 4 Integration of enabling technologies in ocean energy systems

New materials for devices and components, and new manufacturing and assembly processes can cut fabrication costs and boost durability. Smaller and lower-cost sensors and data transmission solutions have allowed for better monitoring of structural behaviour and of component operating conditions in other sectors. New computational methods such as artificial intelligence are being rapidly applied to research and engineering, enabling analysis that up until now would have been too complex or computationally expensive.

### 5 Ocean energy market development

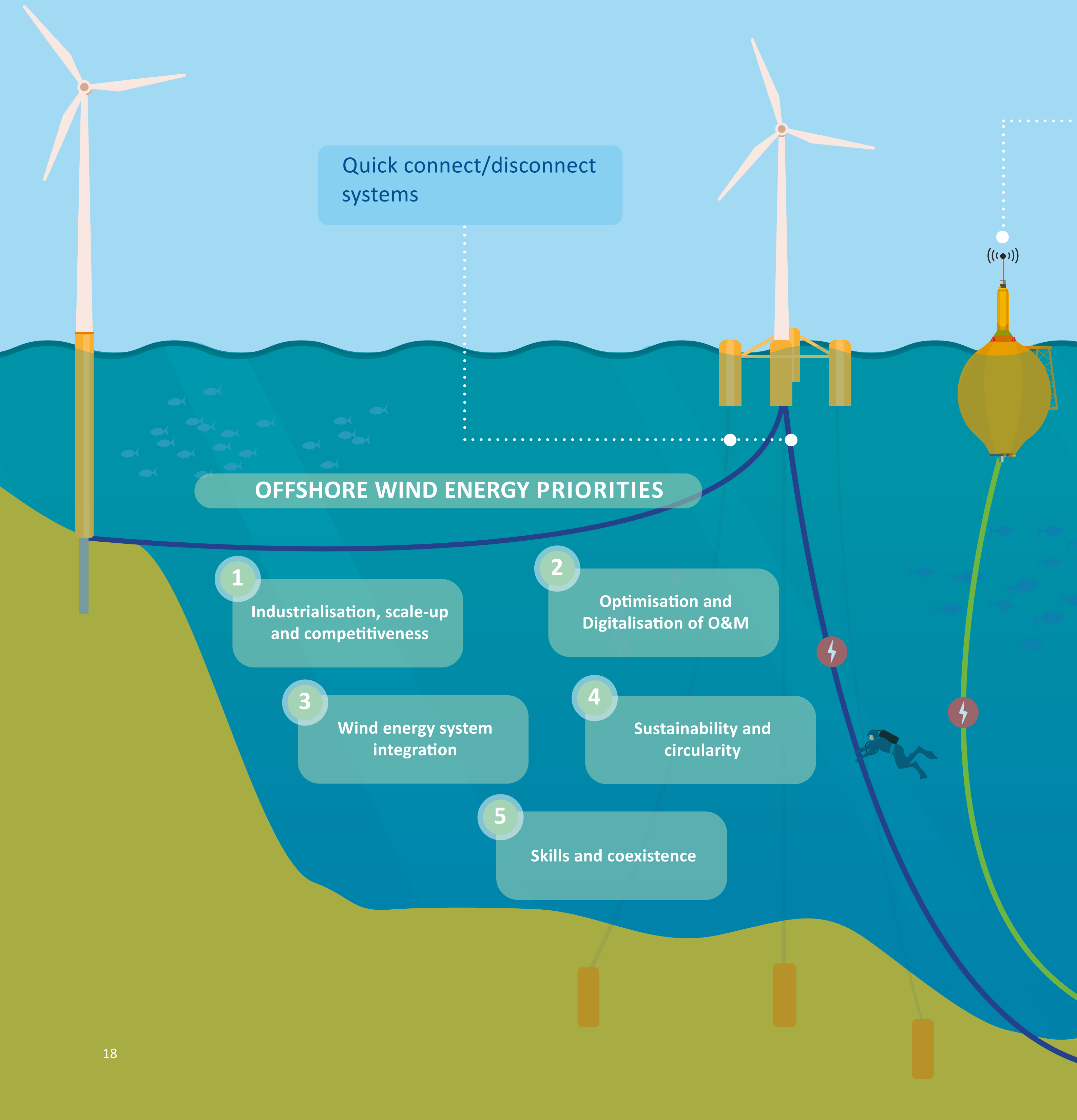
The development of an effective ocean energy market requires a combination of technological advancements, collaboration, a supportive policy framework and adequate funding. Aspects such as the benefits of ocean energy relative to other renewables, synergies with other activities in the coastal zone and marine space, and system integration must be identified and promoted.

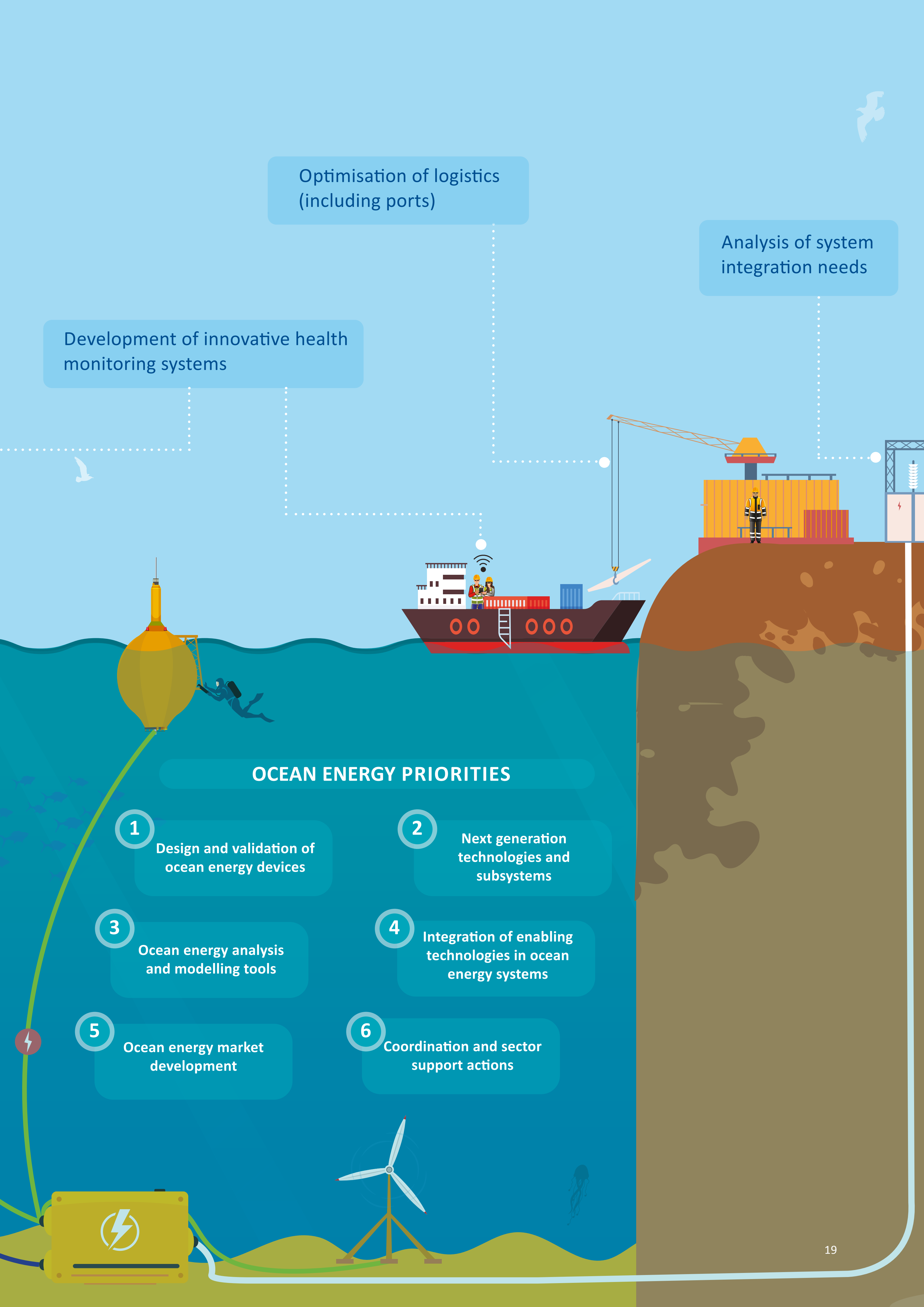
### 6 Coordination and sector support actions

The effective use of available funds requires coordination. For the sector to benefit from the limited number of at-sea campaigns that can be supported, some of the results from these tests should be shared sector-wide, while ensuring a developer's privately-led innovations benefit themselves first. Other sector-wide priorities that require coordination and support include advancing standards, upgrading testing facilities and developing the supply chain or professional training.

# Research & Innovation priorities

## JOINT PRIORITIES




Optimisation of logistics (including ports)
Analysis of system integration needs
Development of innovative health monitoring systems
OCEAN ENERGY PRIORITIES
1
Design and validation of ocean energy devices
2
Next generation technologies and subsystems
3
Ocean energy analysis and modelling tools
4
Integration of enabling technologies in ocean energy systems
5
Ocean energy market development
6
Coordination and sector support actions

# 5
# Policy recommendations

A supportive policy framework at both the EU and national level is a prerequisite to unlock the full potential of offshore renewables. Such a framework should consist of measures to provide market visibility, to streamline permitting, to design fit-for-purpose financing mechanisms and to support grid development.

The following policy recommendations are directed both at the European Commission and the Member States. The European Commission has a key role in designing policy measures, which then must be implemented at the national level.

## 5.1 Create market visibility through a clear auctioning calendar

Market visibility is crucial to attracting investment in offshore renewable energy. Various mechanisms can be used to give political signals to investors on future markets.

The EU has set **ambitious deployment targets for offshore renewables**. This is very helpful, but they should now be adopted at the national level. In the case of offshore wind, Europe must go from installing 3 GW/year today to at least 15 GW/year by 2030. To that end, Member States and the EU must rapidly implement the measures to accelerate offshore wind deployment, including policies to scale-up the offshore wind supply chain.

Member States must enshrine their offshore goals into their **National Energy and Climate Plans (NECPs)** and outline the volume pipeline up to at least 2035. NECPs are important as they provide great certainty for investors and encourage long-term investments. Member States can take Portugal[13] as an example for their updated draft NECP. They have boosted their deployment target for wave energy from 70 MW to 200 MW in view of their excellent wave resource. Other Member States have significant ocean energy resources and should follow suit. That way the industry will engage in those countries first.

**For commercial technologies**, **Governments should tender out large volumes as soon as possible** to boost supply chain investment in production sites and infrastructural upgrades. Tenders should be more frequent and sufficiently sized to deploy the potential of offshore renewables in Europe. In the case of bottom-fixed offshore wind, new tenders should be at least 1 GW. The centralised tender approach remains the best approach for offshore renewable energy auctions.

In 2023 Germany closed its largest offshore wind auction round for a total of 7 GW spread across four sites, and Denmark committed to tender out at least 6 GW across six offshore wind projects. This helped facilitate long-term agreements between supply chain actors, which also accelerates the uptake of innovative solutions. Governments should also incentivise sectoral cooperation to optimise deployment schedules, use of existing infrastructure, and the best construction strategy across neighbouring projects.

Even if most of the auction volumes will principally focus on mature or nearly mature technologies, progressive tendering with increasing volumes (e.g. 50 MW, 250 MW, 500 MW...) and long-term visibility on auctions should be applied for floating offshore wind, tidal stream, and wave energy. It will allow technological progression up to full commercial readiness, give security to investors that those markets are here to stay, and enable investments in local manufacturing capacity.

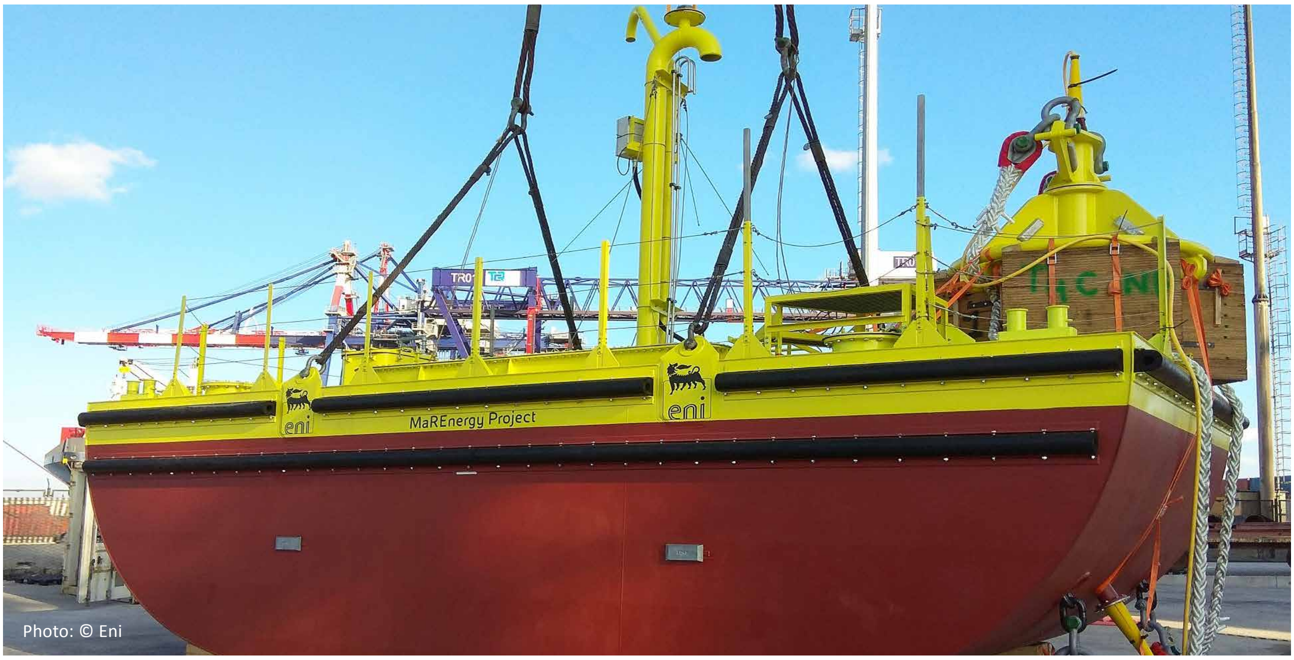


Photo: © Eni


## 5.2 Improve Maritime Spatial Planning (MSP) & streamline permitting

Permitting bottlenecks are one of the biggest barriers to the expansion of offshore renewables. Without faster and more streamlined permitting and an efficient use of the maritime space, the 42.5% renewables target will not be achievable.

To streamline permitting processes, Member States must implement the new permitting provisions under the **EU's Renewable Energy Directive (REDIII)**. This includes measures to accelerate permitting, such as creating a well-resourced **one-stop shop for the entire permitting process** and digitalising it.

Additionally, by the end of 2024, the MSP Directive (2014/89/EU) requires Member States to submit and monitor their MSP. The MSPs should confirm existing offshore renewable energy areas and start screening additional ones for the post-2030 deployment phase.

To this end we call on Governments to **improve coordination** between all public and private stakeholders, **to tailor permitting processes** to the different offshore renewables, and to **explore co-location and multi-use solutions** to avoid spatial conflicts and increase the functionality of the sea - for example by encouraging the deployment of wave energy devices in-between wind turbines.

## 5.3 Implement public financing mechanisms to attract private investors

In recent years the combined effects of geopolitics, inflation, and various interventions in the electricity market have made price negotiations and credit risk more challenging for investors and project developers. It is therefore important to implement a proper support mechanism to create an investment climate more favourable to offshore renewables.

Deployment targets and market visibility need to be complemented by financial support that will make projects bankable and ensure returns for investors. The main ways of efficiently financing offshore renewables projects are through revenue support mechanisms, investment aid, or a combination of both. A good design that combines investment aid and revenue support ensures that public funding finances technology development rather than banking profits.

**Earmarked revenue support** is also an excellent way of showing investors that there will be a long-term market for a particular technology. Over time, the amount of public support needed will reduce as deployments provide learnings and economies of scale, reducing costs.

### Revenue support mechanisms

First, different offshore technologies require different revenue support mechanisms. National Governments should hold **technology-specific auctions** that will allow them to adapt the support mechanism to the development stage of each technology.

Revenue support, whether Feed-in-Tariffs or Contracts for Difference with a fixed negotiated price, are the ideal instruments to attract investment into pilot farm projects. Volume (MW/€) for Feed-in-Tariffs should be limited, controlled and in line with the expected development for the emerging technology at stake. Revenue support should be ringfenced for a specific technology, as innovative technologies cannot compete on price with established technologies.

For offshore wind, Governments can de-risk large projects by offering **two-sided Contracts for Difference (CfD)**. These contracts ensure Governments don't just pay out for the electricity, but that they also get paid back when the electricity price is higher than the CfD price. The perspective of stable revenues allows investors to minimise their financing costs and risks. This financial de-risking gives companies more 'breathing room' to deploy and demonstrate innovative technologies.

Getting the **auction design** right is vitally important. This means setting a realistic ceiling price, offering price indexation, and avoiding any form of negative bidding. In addition **Governments should use non-price criteria** to ensure that projects which add the most value to European society get properly rewarded. Some non-price criteria such as responsible business conduct and cybersecurity should be part of the prequalification process. Others, such as environmental sustainability and innovation, should be part of the award process. Introducing these non-price criteria will also incentivise European developers to boost R&I efforts that go beyond cost reduction towards value creation.

For wave and tidal, Feed-In-Tariffs or CfDs with auctions both work, but they should be in line with the expected development of each technology. For auctions, an adequate fixed floor price must be set, to avoid a price race to the bottom. This would be counterproductive when trying to de-risk an innovative technology like ocean energy and would also incur a risk of some investors simply underbidding to exclude others from a given market.

The French France 2030 programme (previously called 'Investissements d'avenir') is an example of an innovative funding programme offering two financial instruments in one: a grant from the French energy agency ADEME, of which two-thirds is repayable if the project generates revenue (essentially, a less-risky, zero-cost loan); and a feed-in tariff from the French state. This is an excellent way of lowering costs as grants don't generate financial costs for the project, and ensure a return for private investors.

Finally, Governments can also share development risks and therefore de-risk large offshore renewable energy projects thanks to **Power Purchase Agreements** (PPAs). These long-term power offtake contracts can help hedge the investment risk of merchant projects and consequently drive down financing costs. As with two-sided CfDs the financial de-risking allows for more innovative solutions to be deployed at project level.

### Investment aid

In addition to revenue support, **investment aid** is key to reducing the amount that needs to be sourced on the private market, from prototype to demonstration. It lowers the overall financing costs of projects — and also lowers the level of revenue support needed.

Even early-stage ocean energy pilot farms are project-financed, as the overall investment need is generally above the budget of a single funding instrument (e.g. Horizon Europe) and requires private capital. This means that a mix of equity, debt and grants is needed to get them to financial close.

Public grants, equity and/or zero-interest loans have the double positive impact of reducing the amount that needs to be sourced on the private market. And, crucially, they reduce the overall financing costs of the project. Financing an ocean energy pilot farm purely with private capital would result in at least 50% of the kWh price bring used for financing costs.

### Tailored financing mechanisms according to each technology readiness level

| | BOTTOM-FIXED | FLOATING | WAVE | TIDAL |
|---|---|---|---|---|
| Feed-in-Tariffs | Not suitable | Not suitable | Suitable | Suitable |
| Feed-in-Premium | Could work but not ideal | Could work but not ideal | Could work but not ideal | Could work but not ideal |
| 2-sided Contract for Difference | Suitable | Suitable | Suitable | Suitable |
| Zero subsidy + Power Purchase Agreement | Could work but not ideal | Not suitable | Could work but not ideal | Could work but not ideal |
| Zero subsidy + Negative bidding | Not suitable | Not suitable | Not suitable | Not suitable |

Suitable   Not suitable   Could work but not ideal

## 5.4 Scale-up, optimise, digitalise & future-proof European grids

Electricity grids are the backbone of the digital and energy transition. They ensure a continuous and reliable electricity flow, integrate most renewable energy sources, and enable new customer services. Grid infrastructure is critical to delivering the EU's offshore renewable energy potential.

But Europe's grids must be optimised in order to connect and make use of the large volumes of offshore renewable energy that the EU will install. The current 2050 offshore targets would lead to an offshore wind capacity[14] that is comparable to 1.35 times the average load in Europe. This calls for massive infrastructure build-out, not just to bring the power to shore, but also to the load centres throughout Europe. The European Commission have addressed this and other related issues in the EU Action Plan for Grids[15].

In particular, we will need to **scale up Europe's offshore grid infrastructure manufacturing capacity**. For offshore wind, we can currently produce 9.5 GW of offshore wind capacity per year whereas we will need to produce 15 GW per year by the end of the decade, with higher installation rates afterwards. The offshore grid infrastructure will need to be significantly expanded to integrate this new capacity in the power grid. The EU also needs to expand its manufacturing capacity for transformers and substations.

Governments should support supply chain growth with dedicated funding and financing. National authorities must also enable TSOs and DSOs to make proper planning and **anticipatory investments in grid transmission capacity** as per the Market Design reform. These investments should go to the grid expansion, but also to grid reinforcement, modernisation, efficiency and flexibility.

National authorities should also incentivise network operators (TSOs/DSOs) to make investments in **grid optimisation**. Certain technologies such as flexible AC transmission systems (FACTS), dynamic line rating or modular power flow control can help to move far more electricity with existing cables.

Furthermore, Europe needs to **invest in matching digital infrastructure for the grid**. This digital infrastructure will maximise the use of the system by enabling operational efficiency gains in system flexibility and remote asset management. The latter is particularly important for future offshore systems. At the same time, this kind of digital infrastructure needs to be planned from the start with cybersecurity in mind.

The EU needs to **future-proof the regulatory framework on grids**. Whilst many grid technologies and solutions are already advanced, the regulatory framework often hinders their implementation. Thus, along with dedicated investments and R&I programmes on one side, a supportive regulatory framework for those technologies on the other is needed to roll out existing technologies, to test new applications and services in the power grid, and to accelerate offshore grid development.

Europe needs a coordinated and **holistic approach to the offshore grid** to optimise the use of resources and infrastructure. Until recently, wind farms have been connected individually to shore, via point-to-point connections, with little coordinated planning for future development. Equally, subsea interconnectors have primarily been used to only connect two separate transmission systems.

Europe needs to **deploy more multi-purpose assets such as offshore hybrid projects** that combine offshore energy generation and transmission assets into a single project. With the right coordination and planning these offshore hybrid projects can be connected to each other, forming meshed offshore grids in Europe's sea basins. Multi-GW energy islands have emerged as a next step in the development of wind infrastructure, where large offshore wind farms are integrated into a single offshore collection point.

Finally, it is vital that we **help TSOs to plan for the future grid**, which needs project visibility well beyond 2035. Ideally, a broadly coordinated (master)plan for the European power grid up to 2050 will be necessary to help deliver the additional grid infrastructure across the continent in an efficient and timely manner.

In 2024 EU Member States and TSOs published their Offshore Network Development Plans (ONDP) in January 2024. They now need to implement and combine them with the onshore grid plans. As per the TEN-E Regulation, these plans will be based on non-binding commitments. This is a major shortcoming that could lead to under/over-planning significant investments. The EU should **review the TEN-E Regulation to make these plans legally binding**.

Governments should **clarify the roles and responsibilities for grid infrastructure development**, for both radial and hybrid connections, as soon as possible. After roles have been defined, cooperation between Governments, TSOs, and other relevant stakeholders can help fast-track grid development and avoid bottlenecks in offshore wind deployment.

**14** WindEurope's position paper on power grids, September 2023 https://windeurope.org/wp-content/uploads/files/policy/position-papers/20230904-WindEurope-Power-grids.pdf.
**15** https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2023%3A757%3AFIN&qid=1701167355682.

# Annex: Resource potential methodology

## ANNEX 1: OFFSHORE WIND METHODOLOGY

The European Commission Joint Research Center (JRC) conducted an analysis of an open, EU-28 wide (prior to Brexit), transparent, and coherent database for mapping wind, solar, and biomass energy potentials, referred to as ENSPRESO – Energy, Systems Potential Renewable Energy Sources.

The database maps out the technical potential, which the JRC defines as the upper limit of power that can be produced in a certain region using a chosen technology, considering several restrictions including sea use by other sectors, technology limitations, and geographical restrictions.

For offshore wind, the JRC developed three scenarios that vary based on the range of restrictions on sea use at the surface level. Today's offshore wind farms and the regulatory framework in which they are developed most closely align with the scenario featuring low restrictions. As such the JRC's technical potential gives a good representation of what is practically possible to deploy in European waters. That is why we use this scenario as the reference.

Currently, most wind farms are in shallow waters and use bottom-fixed foundations. However, some regions, particularly the Mediterranean Sea and the Atlantic Ocean, have large areas of good wind resources located in deep waters, where floating wind foundations become economically attractive.

The transition zone from shallow to deep waters (50-75 m) could use either bottom-fixed or floating technologies, depending on site conditions and project economics. It is possible to design bottom-fixed foundations for deeper waters, but their large dimensions and cost might be offset using floating foundations. Today, we have operational bottom-fixed wind farms up to 60 m depth using jackets.

In this report, we define the foundation choice to untap the estimated potential as follows:

- **Bottom-fixed:** for water depths up to 75 m wind deployment will mostly rely on bottom-fixed foundations such as monopiles and jackets. This includes deployment in the transition zone, which could use either bottom-fixed or floating foundations.
- **Floating:** for water depths of 75 m or more, we see floating foundations such as spars and semi-submersibles as the main substructures for wind deployment. There is a wide range of designs today, and the consolidation of concepts will follow on from the first commercial projects.

The study assumes areas allocated for offshore wind have a power energy density of 5 MW/km², which is quite standard in research and industry. Wind farms usually have a higher density, between 8-11 MW/km² depending on the country – Germany and Belgium are good examples of denser wind farms. But because new, bigger projects are also spread over a larger surface area, we retain the standard assumption as valid for translating surface area into potential capacity and production.

## ANNEX 2: OCEAN ENERGY METHODOLOGY

The potential outlined is the most readily usable for decision-makers — the practical potential. It goes beyond the technical potential, which considers only what the technology can achieve at a given moment. The practical potential considers climatic, natural, engineering and technological constraints, as well as economic and legal constraints – such as environmental restrictions, and marine spatial planning. It reflects what can be practically deployed, taking into account economic and social constraints at the time of publication. This is inherently the most conservative figure. This potential can increase as costs go down and legislation improves. Thus, it can underestimate the usable potential.

The potential of ocean energy in Europe showcased in this report is based on the outcome of the global resource report authored by Ocean Energy Europe (to be published in February 2025). It is the most exhaustive literature review to date, gathering relevant analyses on the ocean energy resource, country by country. It considers the findings of independent studies across the globe, including in Europe, published by Government agencies and international organisations, as well as academic literature.

ETIP OCEAN

European Technology & Innovation Platform for Ocean Energy

ETIP Wind

EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON WIND ENERGY

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