ROADMAP OFFSHORE WIND AND MARINE ENERGY IN SPAIN

Financiado por la Unión Europea
NextGenerationEU

GOBIERNO DE ESPAÑA
VICEPRESIDENCIA TERCERA DEL GOBIERNO
MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

Plan de Recuperación, Transformación y Resiliencia

STRATEGIC ENERGY AND CLIMATE FRAMEWORK

The "Roadmap for the development of offshore wind and marine energy in Spain" is in line with the "EU Strategy on Offshore Renewable Energy", having been the result of the participation of various economic players, administrations and citizens who have made their contributions. The Roadmap sets the fourfold objective of *(1) making Spain a European reference hub for technological development and environmental innovation associated with renewable energy in the marine environment, (2) making Spain an international benchmark in industrial capacities and in the sector's value chain as a whole, (3) boosting a sustainable development of offshore renewables, consistent with an environmental and social approach, and (4) establishing a sound state-level framework for the orderly deployment of offshore renewables*. This deployment is part of the set of key strategic elements in the decarbonisation path of the Spanish economy, as well as in other challenges of a more cross-cutting nature, such as the economic reactivation after the COVID-19 health crisis, the Just Transition, the Demographic Challenge and the Circular Economy.

Madrid, September 2022
NIPO: 665-22-024-5
Third Vice-Presidency of the Spanish Government
Ministry for Ecological Transition and the Demographic Challenge
Author: Ministry for Ecological Transition and the Demographic Challenge
Edited by: Ministry for Ecological Transition and the Demographic Challenge
Editing review: IDAE
Design and layout: IBERSAF

CONTENTS

EXECUTIVE SUMMARY

Marine-based energy, the so-called **"Blue Energy"**, is one of the levers for energy transformation in the medium and long term at a national, European and global level, as well as an industrial, economic and social opportunity for our country, in a coherent and consistent way with the protection of environmental values and the other uses and activities in the marine environment.

Offshore wind is accelerating its technological and industrial development, making its implementation in Spain viable thanks to the concepts associated with floating offshore wind, allowing its deployment in deep waters. Due to its high capacity factors, offshore wind can generate electricity in a stable and predictable way, increasing its production in the autumn and winter seasons, when solar radiation is lower and consumption is higher. It is therefore highly complementary to other renewable energies, contributing to security of supply, adding value to the needs of the energy system and allowing greater harnessing of available endogenous resources.

Marine Energy is on the path towards the achievement of a leap from the pre-commercial stage to the commercial phase by increasing the technological and market scale, presenting an enormous strategic potential in horizons beyond 2030, with its own differential values compared to other renewable energies. Marine energy not only has a high resource regularity and predictability, but also versatility - for both onshore and offshore deployment -, modularity, and scalability to provide electricity to a variety of end-use sectors such as ports and desalination plants, among others.

In addition to their energy potential, these energy sources stand out for their high industrial and technological potential.

On the one hand, Spain's key role as a global onshore wind development hub places the country in a privileged position for the development of offshore wind power. More specifically, Spain is the second European country and the fifth country in the world in terms of installed wind power, after China, the United States, Germany and India, and is one of the three European countries with the greatest wind power industrial capacity and R&D&I investment in the sector. On the other hand, Spain has a shipbuilding industry (shipyards), a maritime-port sector, civil engineering capabilities, and an industrial ecosystem of materials and equipment that can serve the development of offshore renewables.

In fact, the Spanish wind energy, steel and shipbuilding industries, as well as Spanish developers and suppliers of goods and services, have already played a leading role in the commissioning and operation of numerous offshore wind farms around the world. Through this activity, the Spanish industry already has a global position as one of the main European hubs of knowledge and supply for international markets within the value chain associated with offshore wind power installations.

The development of offshore renewable energies in Spain will not only contribute to expanding the market for this supply chain in Spain, but will also strengthen it in order to continue competing and providing services at a global level. The existence of a local market in Spain will maintain the competitive positioning of the Spanish offshore industry, increasing its contribution to Gross Domestic Product (GDP) and the generation of skilled employment. In addition, offshore wind is already contributing to business diversification strategies and to stabilisation of workloads in associated industrial sectors.

The coming years are expected to see a significant increase in the deployment of offshore renewable energy at global level.

According to IRENA's projections[1] to meet the Paris Agreement Climate Goals, the global cumulative installed capacity for **offshore wind power** would increase to 228 GW by 2030 and nearing 1,000 GW by 2050. According to the International Energy Agency (IEA)[2], offshore wind would account for half of Europe's wind power generation by 2040.

The European Commission's "Strategy on Offshore Renewable Energy"[3] estimates a deployment starting from 12 GW of offshore wind and 13 MW of marine energy currently installed, to at least 60 GW of offshore wind and 1 GW of ocean energy by 2030, with a view to reach 300 GW and 40 GW, respectively, by 2050.

[1] Future of Wind (IRENA 2019).

[2] Offshore Wind Outlook 2019 (International Energy Agency- IEA).

[3] COM(2020) 741 final, 19.11.2020 "An EU strategy to harness the potential of offshore renewable energy for a climate-neutral future".

In terms of the energy contribution in Spain, the Integrated National Energy and Climate Plan (PNIEC, by its Spanish acronym) 2021-2030 foresees an installed wind power capacity of 50 GW by 2030, taking into account both onshore and offshore wind. This figure represents almost double the current 25.7 GW of wind power, for which it will be necessary to mobilise estimated investments of over 30 billion euros in the period 2021-2030, in addition to those associated with the repowering of existing wind farms.

In relation to **Marine energy**, according to the vision of Marine energy Systems of the International Energy Agency (OES-IEA) , the world has the potential to develop 300 GW of wave and tidal energy by 2050. For its part, the European Union has set an ambitious target of 40 GW[4] of installed capacity in wave and tidal energy by 2050. To achieve this, the necessary evolution of cumulative installed capacity should be 1 GW by 2025 and 10 GW by 2030 in order to reach 40 GW in Europe by 2050. The target set in the PNIEC for other renewable technologies, including marine energy, is 80 MW by 2030, although this range may vary depending on technological development as mentioned above.

In relation to the environmental protection of the marine environment, the Government has established as a priority to reach the **target of 30% of marine protected areas by 2030** in line with the European Union Biodiversity Strategy. Spain currently has just over 12% of its marine area protected, so it is essential to continue strengthening this protection framework, continuing to develop and apply the management plans corresponding to the protected areas, and ensuring that all activities and uses of the marine environment are carried out in a way that is consistent with this objective.

In Spain, any energy development in territorial waters requires, in addition to the mandatory substantive authorisations, the corresponding occupation titles for a highly strategic spatial area such as the maritime-terrestrial public domain. The Administration has the obligation to ensure the integrity and adequate conservation of this space, as well as its orderly and rational use, and therefore, **the development of renewable energy in the maritime environment must be carried out in accordance with the planning and management of marine spaces**, taking into account the compatibility of the different uses, as well as the objectives and commitments regarding the protection of the sea and biodiversity.

Consequently, in compliance with the PNIEC, this Roadmap defines the objectives, as well as the lines of action and the most appropriate and efficient paths to achieve them. Likewise, its main motivation and purpose is to identify the challenges and opportunities to decisively promote the full development of offshore wind and marine energy in Spain in the short, medium and long term. Thus, the Offshore Wind and Marine Energy Roadmap has a four-fold objective:

- ***Establish Spain as a European reference hub for technological development and R&D&I*** *for the design, upscaling and demonstration of new technologies, taking advantage of the country's unique geographical features and maritime regimes, reinforcing the network of test platforms,* ***deploying a "plug & play" enabling framework that aims to become the most agile in the European environment*** *for the testing of new prototypes, and activating at least 200 million euros in public support for technological innovation in the period 2021-2023;*
- ***To be an international and European benchmark in industrial capacities*** *and in the whole value chain of these energies, contributing to European industrial leadership in this field, developing capacities to take advantage of employment opportunities, and* ***generating value chains throughout the life cycle with a Circular Economy perspective;***

[4] 'An International Vision for Marine energy 2017' (Marine energy Systems-OES-IEA).

- ***Sustainability as a central pillar.*** *Beyond achieving development consistent with the natural values of the marine environment and commitments to biodiversity protection, the Roadmap proposes to* ***embed sustainability into technological development and deployment of offshore renewable energy****, incorporating the monitoring, analysis and use of data on the marine and coastal environment in terms of meteorological conditions and climate evolution, passive monitoring of biodiversity and continuous assessment of the interactions and effects of the different uses and activities. The aim is to create a technical and data base that will improve the knowledge available and serve as a tool for decision-making on energy and the environment.*
- *An orderly deployment of offshore wind in particular, and marine renewables in general, to underpin industrial and technological development,* ***with targets of 1-3GW of offshore wind and 40-60 MW of marine energy by 2030.***

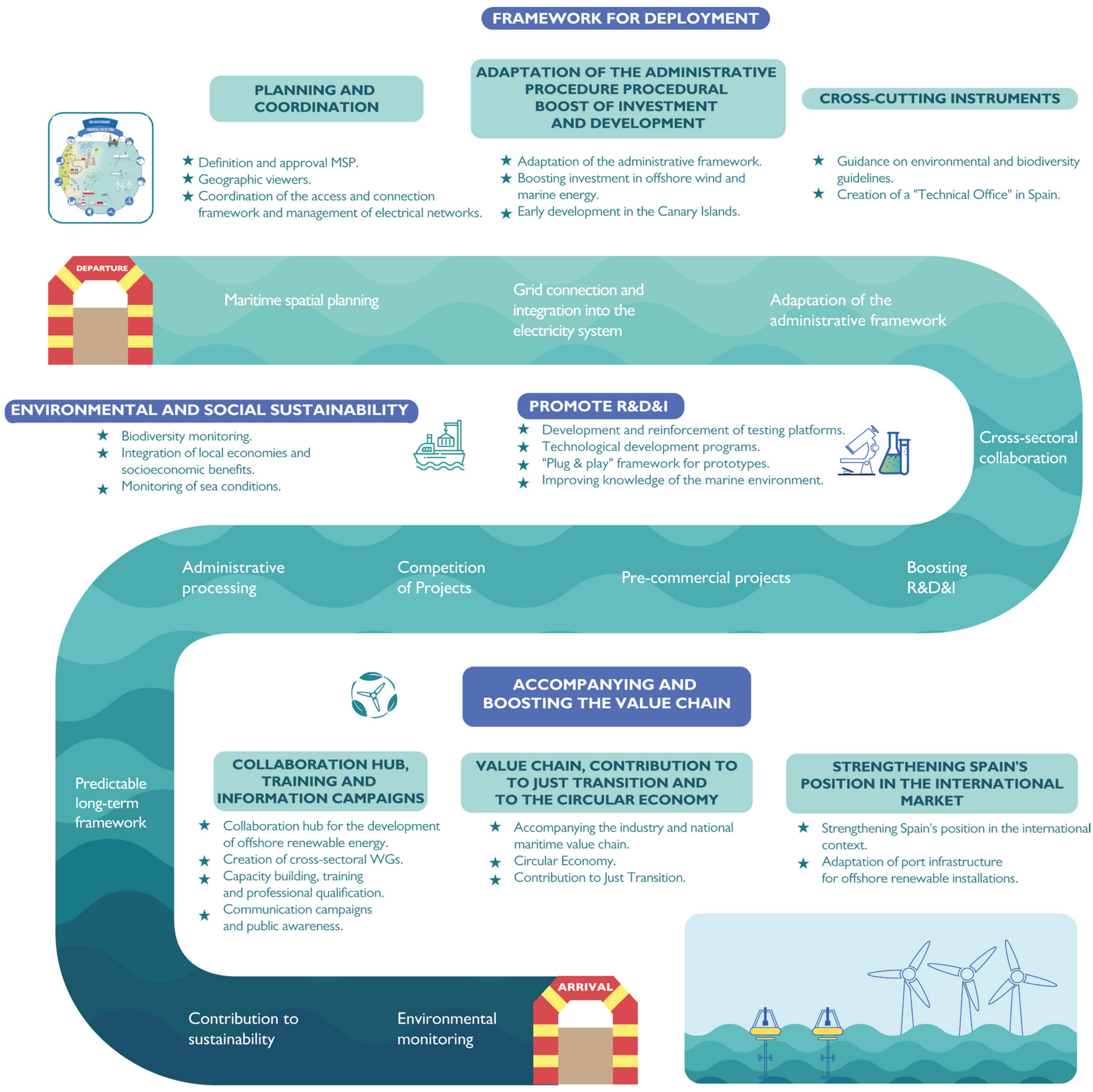
In order to achieve these objectives, the Roadmap establishes robust foundations and a suitable framework to generate the necessary interest in developers and investors, promoting key aspects to guide and favour coordination between all the stakeholders involved, as well as the approach and guidelines for the adaptation of the sector's regulatory framework. Finally, it aims to provide the necessary continuity and visibility to attract investment and to consolidate and boost industrial capacities and the value chain as a whole, as well as foster the generation of infrastructures and R&D&I projects around the activity generated.

Based on the development of the framework proposed by the measures in this Roadmap, while also taking into account the current state of the art in floating offshore wind and other marine energy, the following ranges are established as targets for the development of offshore renewables in Spain by 2030: [between 1 GW and 3 GW] for offshore wind and [between 40 MW and 60 MW] for marine energy.

The approaches contained in this Roadmap pursue a progressive and orderly implementation, coordinated and compatible with the different uses of the maritime space and prioritising the protection of the natural maritime heritage and the coast. The implementation of this Roadmap thus will not only contribute to achieving Spain's and the EU's energy and climate objectives for 2030, but also to meeting the major challenge of climate neutrality of the economy by 2050.

Finally, the development of this Roadmap has benefited from the participation of the most representative organisations in the sector, the opinion of interested groups and entities, various economic players, administrations and citizens who have made their contributions during the prior public consultation process.

Figure 1. Itinerary of the Roadmap for the development of offshore wind and marine energy in Spain. Period 2021-2030. Source: MITECO-IDAE

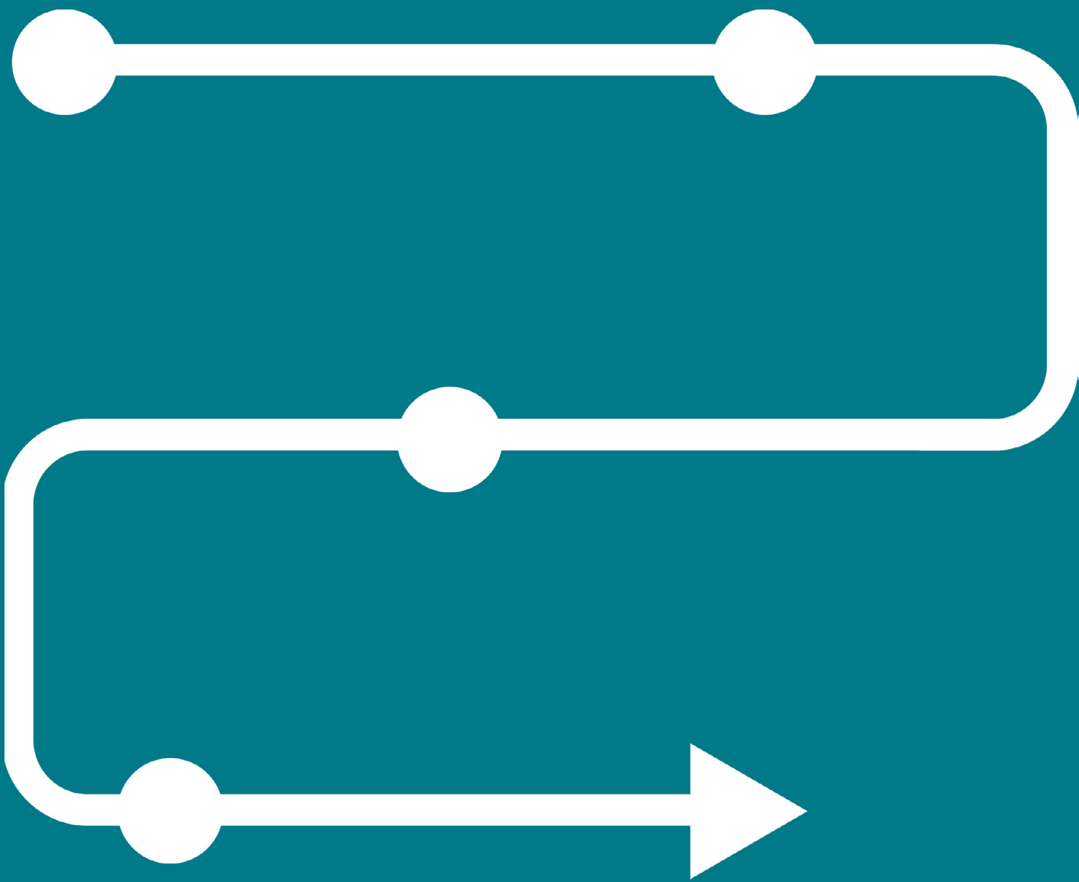


Inclusion in the Recovery, Transformation and Resilience Plan.

This Roadmap is included in the C7R4 Reform "Framework for innovation and technological development of renewable energy" of Component 7 "Deployment and integration of renewable energy" of the Recovery, Transformation and Resilience Plan in the Policy Lever 3. "Just and inclusive energy transition" corresponding to the Ministry for Ecological Transition and the Demographic Challenge. It is framed as part of the objectives and milestones of the Plan.

In compliance with the provisions of the Recovery, Transformation and Resilience Plan, Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021, establishing the Resilience and Recovery Mechanism and its implementing legislation, in particular the Commission Communication Technical Guidance (2021/C 58/01) on the application of the principle of "Do No Significant Harm", as well as the requirements of the Council Implementing Decision on the approval of the evaluation of the Spanish Recovery, Transformation and Resilience Plan (CID) and its Annex document; all actions carried out within the implementation of this Roadmap must respect the principle of "Do No Significant Harm" (DNSH). This includes compliance with the specific conditions assigned in Component 7, as well as in reform 4 and investment 1 in which these actions are framed, both with regard to the DNSH principle and to climate and digital labelling, and especially those included in sections 3, 6 and 8 of the Plan's Component document and in the Annex to the CID.

I



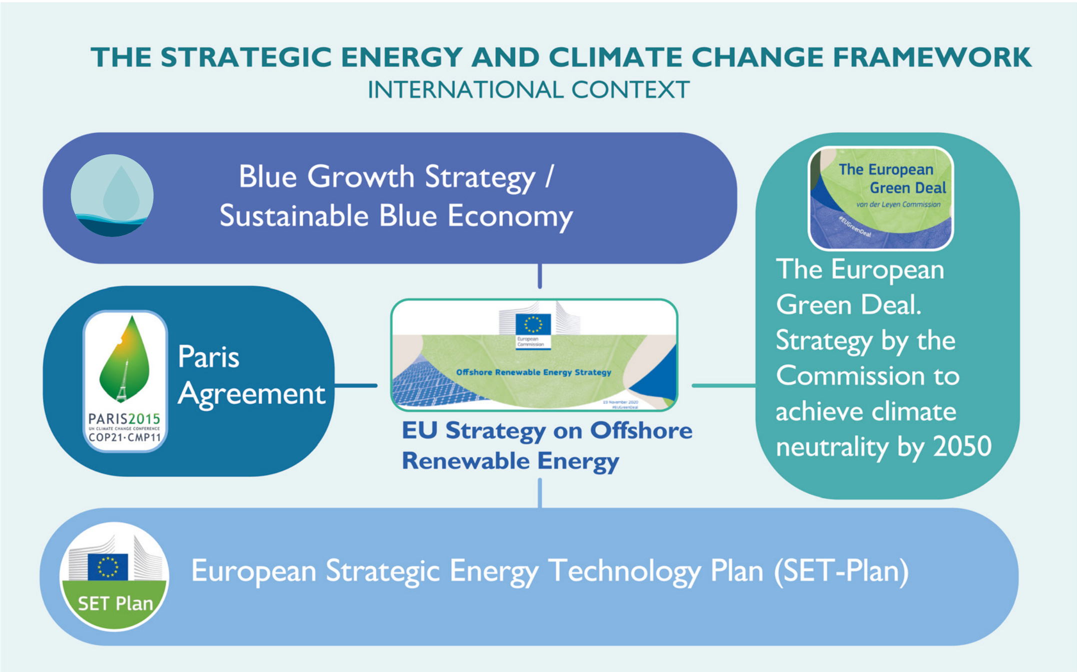
ROADMAP FRAMEWORK

1.1 THE EUROPEAN UNION CONTEXT

Already in 2012, the European Commission adopted the **Blue Growth Strategy**, which encompassed all economic activities that depend on the sea and recognised the importance of the seas and oceans as drivers of the European economy, due to their great potential for innovation, growth, and the sustainable use of marine resources. This strategy considered marine-based energy (so-called "Blue Energy") as one of the priority areas for delivering sustainable growth, noting that by 2030 offshore wind energy could supply 14% of electricity demand in the European Union, surpassing onshore wind in annual installation capacity and estimating a potential of 300,000 associated jobs in the EU by 2030.

The **European Green Deal**[5] contains Europe's long-term strategic vision for a competitive, inclusive and climate-neutral economy by 2050 and recognises that *"a sustainable 'blue economy' will have to play a central role"* in achieving this goal. It includes in its development forecasts that *"increasing offshore wind production will be essential"*, and that measures should be developed to *"manage maritime space more sustainably, notably to help tap into the growing potential of offshore renewable energy"*.

Figure 2. EU international context of offshore renewable energy. Source: MITECO-IDAE



In this context, **on 19 November 2020, the European Commission adopted the "EU Strategy on Offshore Renewable Energy"**[6], which sets the objective of **increasing offshore wind energy production capacity in the European Union starting from 12 GW to at least 60 GW by 2030, with a view to reach 300 GW by 2050**. This development would be complemented by **40 GW of Marine energy and other emerging technologies by 2050.**

Among the main elements of the European strategy is the fostering of regional cooperation mechanisms, including the promotion of a **pan-European supply chain** and the improvement of **maritime spatial planning** for large-scale deployment of offshore renewable energy and for the sustainable use of Europe's marine space and resources. Furthermore, the strategy envisages and "encourage Member States to integrate objectives of offshore renewable energy development in

[5] *European Green Deal, COM(2019) 640 final of 11.12.2019*

[6] COM(2020) 741 final of 19.11.2020 "An EU Strategy to harness the potential of offshore renewable Energy for a climate neutral future". https://ec.europa.eu/energy/sites/ener/files/offshore_renewable_energy_strategy.pdf

their national maritime spatial plans", adding that the Commission will also propose a framework under the revised Regulation (EU) No 347/2013 on trans-European energy infrastructures (TEN-E Regulation) for long-term offshore grid planning[7].

In this strategy, the Commission estimates that an investment of almost €800 billion will be required between now and 2050 to achieve the proposed objectives. In order to help generate and release such investments, it sets out the need to provide a **clear legal and support framework** at European level, as well as to mobilise all necessary funds to foster the development of the sector. The strategy also encourages Member States to take advantage of the various funding lines available to maintain and develop European leadership in technology and innovation, as well as to ensure a strengthened supply chain, underlining the need to improve manufacturing capacity and port infrastructures.

The European strategy provides continuity and concretises the scenarios contained in the long-term strategic vision set out by the European Commission in its November 2018 Communication "A clean planet for all"[8], which foresaw an increase in European offshore wind power capacity in service from 22 GW at the end of 2018 to around 240-440 GW by 2050. This Communication also identified that the remaining offshore renewables could also play a relevant role, depending on their technological evolution path.

In order to harness this potential, the European framework contains a number of essential instruments:

Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 'on the promotion of the use of energy from renewable sources' establishes the common framework for the **increased share of renewables in energy consumption**, providing a enabling regulatory framework and a series of good practices to be deployed by Member States, which are considered very positive for the evolution of the sector.

Furthermore, Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 'establishing a framework for maritime spatial planning', aimed at promoting the sustainable growth of maritime economies, the sustainable development of marine areas and the sustainable use of marine resources, including offshore wind and marine energy, in a way consistent with the protection of the environmental values of the marine environment. The Roadmap for the development of offshore wind and marine energy is part of the 2030 Agenda and is framed within the SDG 7 goal of ensuring access to affordable, secure, sustainable and modern energy.

With regard to the mechanisms to promote innovation and technological development, which are key in a sector such as this, the current **European Strategic Energy Technology Plan** (SET-Plan) stands out, which includes the objective of consolidating the EU's global leadership in offshore wind energy, identifying the development of floating wind power as one of the priority actions to achieve this strategic objective. Annex I of this Roadmap details other additional relevant instruments for boosting innovation within the European framework.

1.2 NATIONAL CONTEXT

In Spain, the Strategic Framework for Energy and Climate contains various strategic and legislative elements that aim to set out the main lines of action on the path towards climate neutrality in our country. This Framework is made up of various documents, including:

- Integrated National Energy and Climate Plan (PNIEC) 2021-2030.
- Long Term Decarbonisation Strategy 2050.
- Climate Change and Energy Transition Law.
- Just Transition Strategy.
- Strategy against Energy Poverty.

[7] Press Release 19.11.2020: https://ec.europa.eu/commission/presscorner/detail/es/ip_20_2096

[8] COM(2018) 773 final of 28.11.2018 "A clean planet for all. A European strategic long-term vision for a prosperous, modern, competitive and climate-neutral economy". https://eur-lex.europa.eu/legal-content/ES/TXT/PDF/?uri=CELEX:52018DC0773&from=EN

The **Integrated National Energy and Climate Plan (INECP, PNIEC by its Spanish acronym) 2021-2030** foresees a penetration of renewables of at least 42% in terms of final energy consumption, reaching 74% in the case of the electricity sector. To this end, it establishes energy efficiency targets and a deployment path of around 59 GW of additional renewable electricity generation during the decade, of which an increase of 25.7 GW of wind power capacity and 80 MW of other technologies, including marine energy, are foreseen. Depending on the technological development and cost evolution of the different technologies, as well as their viability and flexibility of implementation, the relative weight of these technologies in the Spanish mix could be even greater. In addition, the PNIEC considers the energy transition in general -and the deployment of renewables in particular- as an **opportunity to strengthen the industrial value chain and national technological development.**

Likewise, in the case of offshore wind power, it should be noted that the reduction of its generation costs already shows a high potential in Spain with floating technology in the 2030 horizon, so that the mechanisms to promote it should be adapted to its growing levels of competitiveness, with special attention to its contribution to the consolidation and competitiveness of the industrial fabric and its synergies with other strategic sectors (shipbuilding, shipyards, civil engineering and electro-intensive industries, among others).

To this end, the PNIEC envisages the development of a "Spanish Strategy for the development of offshore wind and marine energy", coordinated and aligned with the Maritime Spatial Planning, the conclusions and objectives of which may be incorporated into the periodic reviews of this Plan.

The **Long-Term Decarbonisation Strategy 2050** outlines the energy system transformation trajectory for the years 2030 to 2050, charting the country's evolution towards climate neutrality by mid-century. To achieve this, electrification, energy efficiency and the deployment of renewable energy will reduce greenhouse gas emissions by at least 90%. To get to this point, profound changes in the structure of the energy system will be necessary, with **offshore wind and marine energy** presenting themselves as a complementary alternative to the development of onshore renewable energy.

Law 7/2021 of 20 May on Climate Change and Energy Transition establishes the institutional framework, as well as the regulatory and economic signals that provide stability and set the direction towards climate neutrality in Spain. This law gives a decisive boost to the development of renewable energy in Spain, introducing renewable penetration targets into the legislative framework, while establishing a predictable framework for their deployment through auctions, in which the variable on which bids are made is the remuneration price of the energy generated and, in turn, admitting the distinction between technologies, criteria of location and technological maturity or others in accordance with EU regulations.

The first example of this type of auctions successfully took place in January 2021. These auctions have anticipated the approval of the Law on Climate Change and, given their urgency, have been enabled by Royal Decree-Law 23/2020, of 23 June, which approves measures in the field of energy and other areas for economic reactivation.

The Just Transition Strategy has as its primary objective the optimisation of the ecological transition for the generation of employment and to ensure that the people and regions involved can take advantage of and benefit from the opportunities arisen from the transition, making a special effort to ensure that no one is left behind. The strategy sets out measures and instruments to achieve this objective in the short term, such as the Just Transition Agreements whose priority objective is to maintain employment and the creation of activity in the territories concerned by supporting sectors and groups at risk, fixing the population, and promoting diversification and specialisation consistent with the socio-economic context.

Offshore wind energy and other offshore renewable energies are an important asset for achieving the objectives of this strategy, given their potential for the generation of quality employment, the revitalisation of traditional industries in maritime regions (shipbuilding industry, metal production and processing industry, raw materials extraction and production industry and energy industry) and for the use of infrastructure and knowledge developed over years of experience in these fields.

The **National Strategy against Energy Poverty 2019-2024** is an instrument, divided into four lines of action and 19 measures, which offers for the first time an official definition of energy poverty, establishes indicators for its monitoring that determine that, at present, there are between 8.1 and 3.5 million people who meet some of the criteria, and targets for its reduction by 2025: a target of 50% and, at least, a reduction of 25%. To this end, among other measures, the lines of the future social energy bonus are set out, which should be automatic and cover all sources of supply, while short, medium and long-term actions are proposed.

The strategic energy and climate framework foresees the fulfilment of energy and climate objectives in full alignment with the other environmental priorities. In relation to the **environmental protection of the marine environment**, the Government has established as a priority in the Declaration of Climate and Environmental Emergency[9], to reach the **target of 30% of marine area protected by 2030** through the planning, declaration and effective management of marine protected areas, in line with the EU Biodiversity Strategy, which also incorporates the target of protecting 30% of the marine area by 2030.

Spain has just over 12% of its marine protected area, making it one of the countries that has exceeded the coverage threshold committed to for 2020 under the Convention on Biological Diversity (CBD), set at 10%. Globally, the current average coverage is 7.4% and shows significant gaps in representativeness. It is essential to continue strengthening this protection framework to reach 30% by 2030, continuing with the development and implementation of management plans for protected areas.

Spain is one of the **richest** countries in the EU **in terms of marine biodiversity** and one of those that has made most progress in its knowledge, with more than 11,000 species and a large representation of marine habitats of Community interest. In this context, Spain wants to be at the forefront of countries that promote the protection and conservation of the ocean, which is why it is a member of the **High Ambition Coalition** and the **Global Ocean Alliance**, which advocate and defend the protection of 30% of the world's marine surface.

With the aim of making **uses and activities in the maritime space compatible with each other and with the environmental values of this environment**, Royal Decree 363/2017 of 8 April, which establishes a framework for maritime spatial planning, involved the transposition of Directive 2014/89/EU into national regulations. This Decree provides for the drafting of five **Maritime Spatial Planning** (**POEM**, according to the Spanish acronym of "Planes de Ordenación del Espacio Marítimo"), one for each of the five marine subdivisions[10] (Figure 3), currently under preparation and subject to public consultation as of 7 June 2021[11] (a summary of the POEM is included in Annex IV).

In accordance with their implementing regulations, these POEM will contain an inventory of the distribution of existing human uses and activities in the marine environment and, as far as possible, also of future ones, including areas for the production of energy from renewable sources. Therefore, for each of the 5 marine subdivisions in Spain (Figure 3), the POEM will contain **the identification and analysis of the areas where the implementation of offshore wind and marine energy installations could lead to a greater potential energy contribution, while maximising the compatibility of energy uses with the protection of environmental values in the marine and coastal environment, as well as present and foreseen future occupations. To this end, in the process of drafting the POEM, a series of criteria have been defined to ensure that the identification of priority and/or high potential areas for the implementation of offshore wind power facilities is compatible with the protection of marine biodiversity, also taking into account the commitment to increase the protected marine area to 30% by 2030, as well as with other present or future uses and activities in the marine environment and navigation routes, due to their importance in the strategic and logistical field**. The alignment of the deployment of offshore renewable generation with the MSP (POEM), as well as a zonal definition that protects the most environmentally sensitive areas, is precisely one of the measures identified in the Strategic Environmental Assessment of the PNIEC to ensure the compatibility of this deployment with the protection of the marine environment.

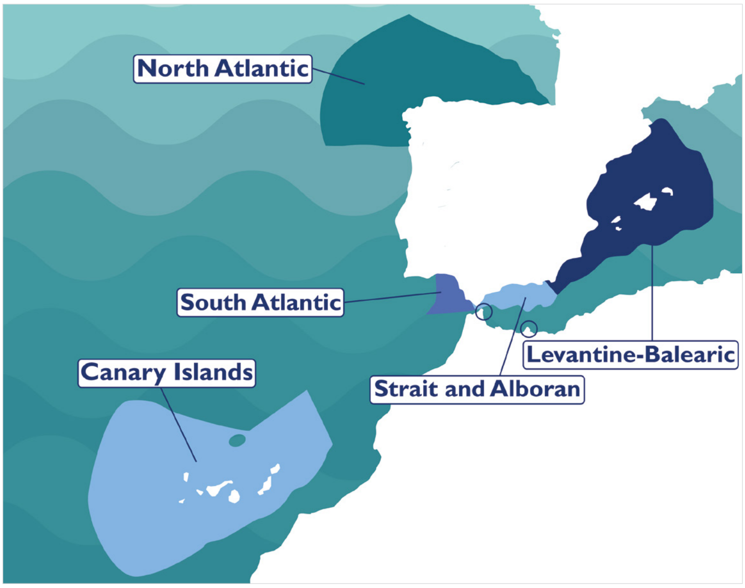
---

[9] Agreement of the Council of Ministers approving the Declaration of the Government in the face of the climate and environmental emergency (21 January 2020).

[10] Established in Law 41/2010 of 29 December 2010 on the protection of the marine environment.

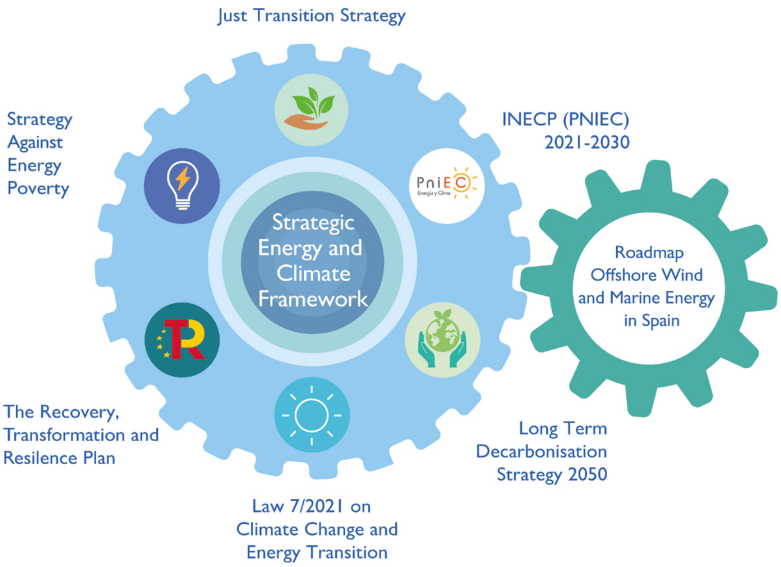
[11] Hearing and public information on the Draft Royal Decree ... / 2021 approving the maritime spatial planning of the five Spanish marine subdivisions. https://www.miteco.gob.es/es/costas/participacion-publica/00-rd-planes-oem.aspx

Figure 3. Marine Subdivisions in Spain. Source: MITECO-IDAE



In this context and in line with the Strategic Framework for Energy and Climate, the objective of the Roadmap for the Development of Offshore Wind and Marine Energy is to ensure the effective deployment of Offshore Renewables in Spain, so that it contributes to meeting the country's energy, climate, environmental and industrial objectives, in a way that is compatible with other uses and activities in the marine environment. To this end, the actions and main challenges in the development of these energies in the sea and the possible measures to overcome them must also be identified. Annex III contains the synergies between this Roadmap and the Strategic Energy and Climate Framework, as well as the 'EU Strategy on Offshore Renewable Energy'.

Figure 4. National context for offshore renewable energy. Source: MITECO-IDAE



In parallel to this Roadmap, other complementary Roadmaps and Strategies are being developed to outline the opportunities and measures to be deployed to achieve the energy and climate objectives for 2030 and 2050, such as the Storage Strategy, the Renewable Hydrogen Roadmap, the Self-consumption Roadmap and the Biogas Roadmap.

This Roadmap for the development of offshore wind and marine energy is included in **Reform C7R4 of Component 7 "Deployment and integration of renewable energy sources" of the Recovery, Transformation and Resilience**

Plan in Policy Lever 3 "A just and inclusive energy transition" corresponding to the Ministry for Ecological Transition and the Demographic Challenge. The objective of the C7R4 reform is to establish a strategic and enabling framework that allows for the continued technological development of renewable energies, sends clear signals for their orderly and coherent deployment, contains measures that enable maximum harnessing of industrial, social, environmental and economic opportunities, and ultimately contributes to progress towards 100% renewables in energy demand. Section 1.3 on the "Opportunity of the Recovery, Transformation and Resilience Plan" summarises how Spain can take advantage of this new mechanism with an approach aligned with the objectives of this Roadmap.

- **Administrative procedure currently in force**

  The current regulatory framework for the processing of offshore wind and marine energy facilities is Royal Decree 1028/2007, of 20 July, which establishes the administrative procedure for the processing of applications for authorisation of electricity generation facilities in the territorial sea.

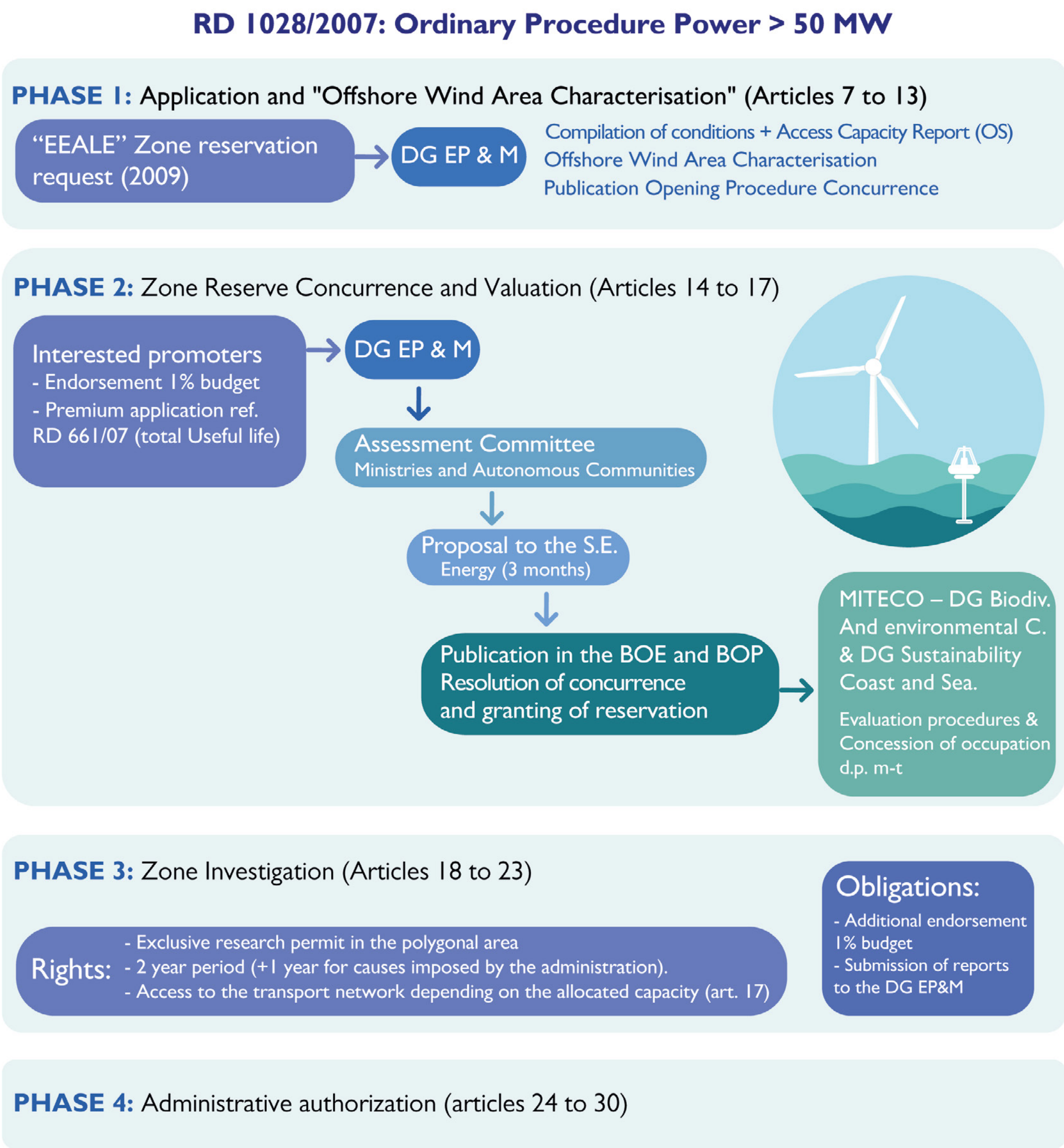
  Commercial offshore wind projects, with fixed foundation technologies, were located in very specific areas due to the characteristics of the Spanish continental shelf, establishing a competition procedure based on the prior reservation for research, which would later lead to the operating concession.

  The lack of a European and national regulatory framework for maritime spatial planning in 2007 resulted in the definition of a grid of 73 offshore wind areas - squares between two parallels and two meridians separated by one degree - for which a Strategic Environmental Study of the Spanish Coastline (EEALE) was carried out, which established a classification into suitable zones and exclusion zones for requests for zone reservation by developers of offshore wind farms of more than 50 MW.

  The zone reservation request could initiate the characterisation procedure for the affected offshore wind area or areas. This characterisation compiled in a single document all the reports issued, as well as the estimate - by the system operator and transmission grid manager - of the maximum generation that could be evacuated to the transmission grids and the impact of the offshore wind project on the surrounding elements. Once the characterisation of the area has been published in the Official State Gazette (BOE), the competition procedure would be opened, in which interested parties would present the corresponding guarantees and a premium offer, which would be resolved by an assessment committee set up for this purpose.

  The resolution of the competition procedure would grant the right of access to the transmission grid for the power assigned in said resolution and the reservation of the area which, after obtaining the corresponding title of occupation of the maritime-terrestrial public domain, would entitle the successful bidder to carry out, exclusively, wind resource research operations in the corresponding polygon for 2 years - extendable for an additional year for reasons attributable to the administration - and, subsequently, the construction and operation of the installation once the mandatory authorisations have been obtained.

Figure 5. Diagram of the current Ordinary Procedure for the Processing of Offshore renewable Installations with a capacity of over 50 MW. Source: MITECO-IDAE



Over the last decade, the offshore wind sector has advanced in knowledge and experience in international markets, with the European market being particularly prominent. In addition, since then, the technology has reduced its generation costs and has implemented innovative construction techniques that have expanded the potential geographical scope, thanks to the concepts associated with floating offshore wind. This context, together with the new European and national framework described in this section, make it necessary to adapt the current administrative procedure, in line with the other measures set out in this Roadmap.

1.3 THE TIMELINESS OF THE RECOVERY, TRANSFORMATION AND RESILIENCE PLAN

On 14 April 2021, the Council of Ministers approved the Recovery, Transformation and Resilience Plan for the Spanish Economy, which is the fundamental instrument for the implementation of the **European Next Generation EU recovery funds** and represents the most important boost in Spain's recent economic history. The Plan enables the implementation of an aid package to tackle the economic crisis resulting from COVID-19, thanks to which Spain will receive €140 billion between 2021 and 2026, €70 billion in transfers[12].

The 212 measures to which these funds will be allocated make up the Recovery, Transformation and Resilience Plan, which proposes 110 investments and 102 reforms and four axes of transformation: ecological transition, digital transformation, social and territorial cohesion and gender equality. Its objectives include modernising the productive fabric and the administration, increasing the economy's growth potential, boosting quality employment, moving towards a greener and more sustainable economy and reducing social gaps.

Likewise, Spain's 2021-2030 Integrated National Energy and Climate Plan (PNIEC, by its Spanish acronym) foresees a significant growth in the penetration of renewable energy in Spain, reaching 74% in electricity and 42% in end use by 2030. In this context, the objective of Component 7 of the Spanish Recovery, Transformation and Resilience Plan (PRTR, by its Spanish acronym) is to increase the use of renewable energy through the following elements:

- the development of a clear and predictable regulatory framework to promote investment in renewable energy;
- the establishment and consolidation of the industrial value chain in the field of renewables;
- support for innovative sources of renewable generation technologies, including their integration into end-uses; and
- the development of ecological competences.

Furthermore, if we talk about offshore renewable energy, **component 7 of the Transformation and Resilience Recovery Plan specifically aims to promote research and innovation, as well as the deployment of offshore wind and marine energy in Spain, through the updating of the main regulatory measures to establish optimal framework conditions for the correct evolution of blue economy.**

Within the PRTR, Spain has made a commitment to Europe to meet the following milestones related to the deployment of offshore wind and marine energy in Spain, for the period 2021-2023, which are to be understood as maximum time limits for their fulfilment:

Number	Measure	Milestone	Name	Timeline		Description of each Milestone and Objective
				Quarter	Year	
112	C7.R4	Milestone	Offshore Wind and other Marine Energy Roadmap	T4	2021	Publication of the Offshore Wind and other Marine Energy Roadmap.
113	C7.R4	Milestone	Entry into force of regulatory measures identified in the Roadmap for offshore wind and other marine energy	T2	2023	Entry into force of key regulatory measures identified in the Offshore Wind and other Marine energy Roadmap to promote research and innovation and support the deployment of floating technologies. Key measures: • Final approval of maritime spatial planning, • Improving coordination of network planning and marine strategy, and updating the regulatory framework.

[12] Government of Spain - Recovery, Transformation and Resilience Plan: https://planderecuperacion.gob.es/plan-de-recuperacion-para-europa

Number	Measure	Milestone	Name	Timeline		Description of each Milestone and Objective
				Quarter	Year	
116	C7.I1	Milestone	New projects, technologies or installations of marine renewable energy infrastructure.	T3	2023	At least six awarded breakthroughs promoting new projects, technologies or installations of marine renewable energy infrastructure. The six developments should contribute to the implementation of offshore renewable energy projects in Spain. The developments may include SMEs with offshore renewable energy activity which receive grants, loans or equity investments, take part in pre-commercial public procurement, as well as grants awarded directly to offshore renewable energy projects or to a prototype of a new production technology or an offshore renewable energy deployment.

Listed below are the measures of this Roadmap, the implementation of which would imply the fulfilment of the specific PRTR milestones mentioned above:

Transformation and Resilience Recovery Plan Milestones and Targets	Measures in the Roadmap for the development of offshore wind and marine energy in Spain
113 (C7.R4): Entry into force of key regulatory measures identified in the Offshore Wind and other Marine energy Roadmap.	• Measure 3.1. Definition and approval of zoning for the development of offshore wind farms in the MSP (POEM by its Spanish acronym). • Measure 3.2. Preparation and publication of geographic viewers with information on offshore wind resources and marine energy in Spain and the areas established in the MSP (POEM). • Measure 3.3. Coordination of the access and connection framework and new management models for electricity networks. • Measure 3.4. Adaptation of the administrative framework for the authorisation of offshore renewable installations.
116 (C7.I1): New offshore renewable energy infrastructure projects, technologies or installations.	The measures listed here will facilitate the implementation of the milestone, but are not a precondition for meeting the milestone. • Measure 1.1. Development and strengthening of testing platforms. • Measure 1.2. Technological development programmes.

2

STATE OF THE ART

Offshore wind power is advancing rapidly towards full technological maturity, with a high potential to add value to the national energy system in terms of diversification of renewable energy sources, consolidation of the industry, associated value chain and greater diversity in the use of available endogenous resources.

The main vectors of development are the increase in the dimensions and unit power of wind turbines, as well as tower support solutions. Specifically, the new technological concepts associated with floating offshore wind turbines have made it possible to expand the geographical limits of exploitable marine areas beyond the depths of around 50 m that fixed foundation technology allowed, reaching depths of up to 1,000 m, multiplying the areas of potential development on the Spanish coasts.

Meanwhile, marine energy is in an earlier technological phase, also full of opportunities in time horizons beyond 2030. To take advantage of this potential, during this decade the different technologies will need to gain market volume and improve their generation costs in order to enter the commercial phase in competitive conditions compared to other renewable technologies. Due to the sea conditions on our coasts, the most appropriate technologies for Spain will be tidal current and, with the greatest available geographical extension and potential, wave power.

On the other hand, in recent years, Floating Photovoltaic Solar has emerged as a model for the complementary use of renewable energy in the marine environment. The projects that are being developed at international level are detailed in section 2.3.

This section summarises the state of the art and perspectives up to 2030 and 2050 for Offshore Wind, Marine Energy - in the different technologies available - and Floating Photovoltaic Solar.

2.1 OFFSHORE WIND

Offshore wind power refers to the energy and technology area that makes it possible to harness the power of the wind in locations in the marine environment. Spain has 6,000 kilometres of coastline where there is a stable and abundant wind resource, which recent technological developments make it possible to take advantage of, as will be seen in this section.

- **Potential associated with the marine environment**

  The offshore wind resource is higher in terms of average speed, energy density and regularity than onshore:

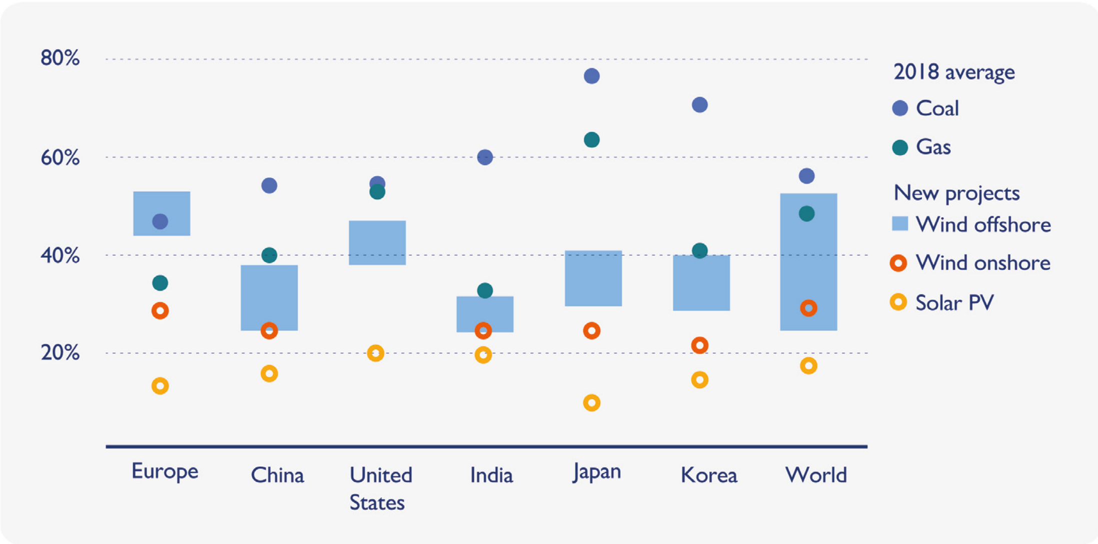
  The offshore wind power density ratio per area depends on the configuration of the wind farm, the diameter of the wind turbines, the energy losses that occur when reducing the distance between machines and also on the sea depths at the site, due to the need for clearances between the perimeter anchoring systems. A typical range for the average density ratio is generally considered to be between 4 MW/km^2 and 6 MW/km^2.

  The wind regime at sea is more laminar than on land. The lower turbulence means less surface roughness and implies a low vertical shear factor, which allows for a lower tower height than would be necessary on land for the same power and blade dimensions, resulting in savings in material costs.

  On the other hand, the lack of barriers in the marine environment leads to a more constant wind speed, which is a better resource and implies a better harnessing of it. It is also less intermittent, allowing the turbines to generate energy for longer periods of time. Therefore, offshore wind energy provides higher capacity factors than other renewable energy. In 2018, the average global capacity factor for offshore wind turbines was 33%[13] compared to 25% for onshore wind turbines and 14% for solar PV. **Looking ahead, new offshore wind projects are expected to have capacity factors of over 40% in moderate wind conditions and over 50% in areas with high quality wind resource**, reaching capacity factors comparable to other forms of fossil generation that do not depend on the availability of a variable resource, as shown in the figure below.

[13] IEA Offshore Wind Outlook 2019.

Figure 6. Comparison of annual capacity factors by technology and region in the world.
Source: International Energy Agency-IEA



Offshore wind's capacity factors and lower hourly variability represent a potential advantage over other renewables: even in the absence of storage systems, offshore wind can generate electricity during all hours of the day, provides greater firmness and tends to produce more energy during the winter, contributing to security of supply and providing high availability in line with seasons of high demand. A high capacity factor also means better and more consistent harnessing of the infrastructure, thus optimising the use of materials, the investment made and the electrical connection capacity.

In addition, the sea presents fewer spatial and transport limitations than on land. The lower density of human activity compared to onshore environments facilitates, with proper planning, the compatibility and complementarity of the expansion of activities of high social value in the marine environment that offshore wind energy represents with existing activities in the environment. In addition, transport can be easier at sea than on land, since the different components or wind turbines can be assembled as a whole from the ports.

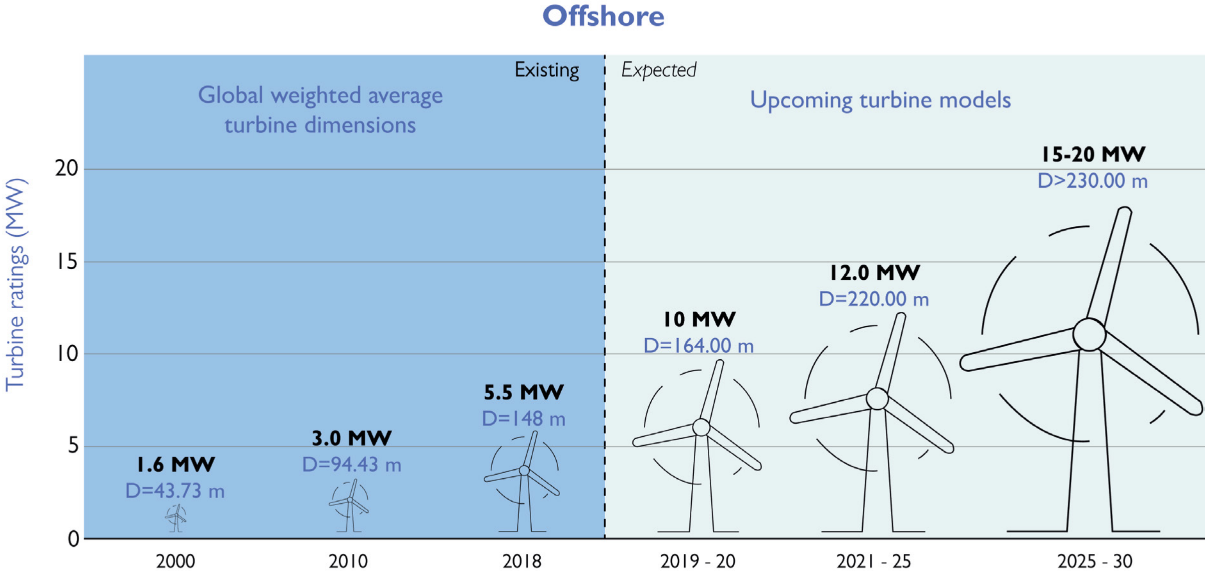
▸ Technological implications

On a technological level, the singularities of offshore wind power compared to onshore installations are due to the very nature of the marine environment.

As for the **wind turbines**, they operate on the same principle as the onshore models, although their technical design has been gradually adapted to the marine environment. The main difference lies in the robustness of these turbines to **withstand corrosion**, as they are subjected to an aggressive environment in terms of salinity, humidity and more adverse weather conditions. Corrosion affects not only the outside of the tower, but also the inside of the tower and the supporting structure. Therefore, the platform and tower are equipped with humidity and temperature control regulation systems to mitigate the risk of internal corrosion.

In addition, technological innovation, the search for a better use of the resource and the reduced spatial restrictions of the environment have led to an **increase in the size of the turbine in terms of height and swept area**, and this has increased its maximum performance.

Figure 7. Evolution of the average size of wind turbines. Source: GE Renewable Energy 2018; IRENA 2019c; 2016b; MHI Vestas 2018.



The average size of turbines used in offshore wind farms increased from 3 MW in 2010 to 5.5 MW for projects completed in 2018 (IRENA, 2019). New turbines of 10-12 MW will be able to achieve capacity factors well above 50% and prototypes under development will have an output of between 15-20 MW for offshore installation projects in 2025-2030.

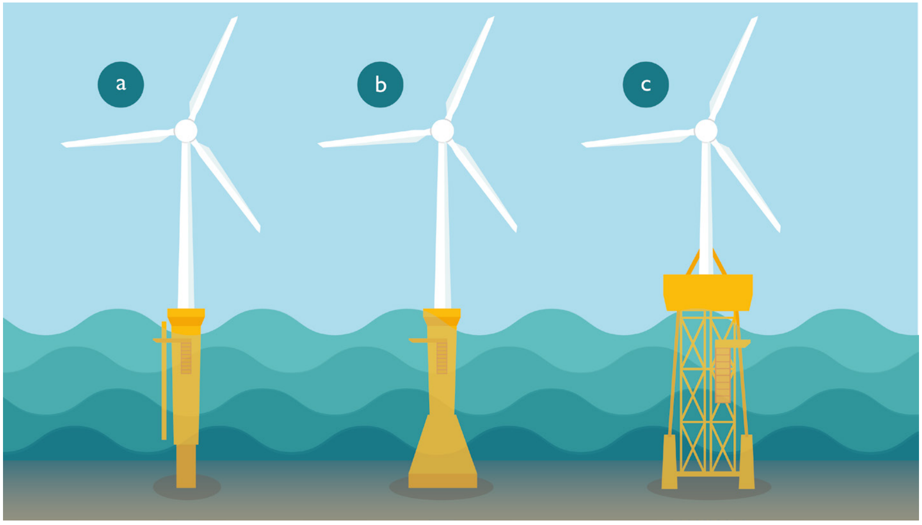
Besides the issues mentioned above, the main difference between onshore and offshore wind is the nature of the **support structure** that raises the wind turbines above sea level, depending on the depth. **Two main types of offshore wind technologies** are currently distinguished, those based on structures mounted on fixed foundations and those based on floating structures anchored to the seabed by cables or chains. The main difference lies in the way the wind turbine is fixed to the seabed, but also in the installation and assembly techniques and in the availability of suitable areas for one or the other typology depending on the depth.

- **Offshore wind turbines with bottom-fixed foundations**

Bottom fixed support structures are structures mounted on the seabed and are classified according to the depth at which they are to be installed:

- **"Monopile"**, a solution applied for shallow depths, located at depths of less than 15 metres. These are simple structures composed of a steel cylinder buried in the seabed that supports the wind turbine tower.
- **"Gravity-based"**, used at depths ranging from 15 to 60 metres for solutions under technological development, consisting of a concrete or steel platform requiring prior preparation of the seabed.
- **"Jackets"** or **"tripods"**, more complex support and support structures are required at depths of 30 metres and above, where the foundations incorporate 3 or 4 anchor points to the seabed.

Figure 8. Different fixed foundation technologies (a). Monopile. (b). Gravity-based. (c) Jackets. Source: MITECO-IDAE

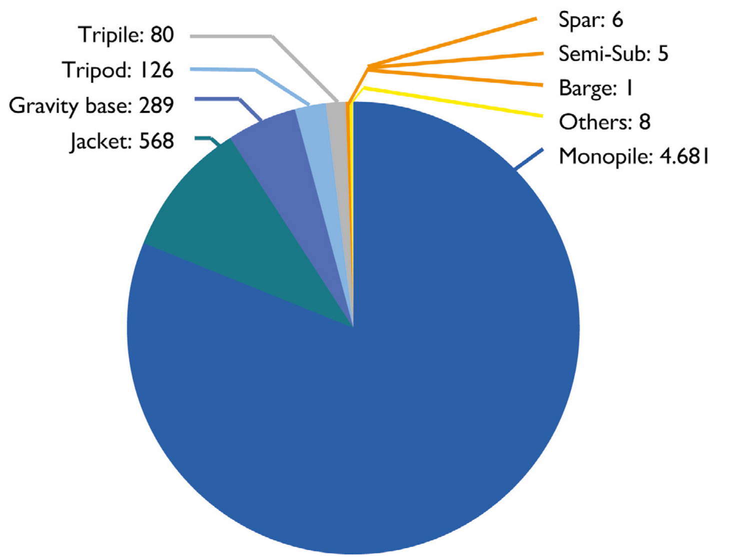


To date, all commercial offshore wind farms in service have been based on these fixed foundation typologies, having reached a cumulative figure of 29 GW[14] of offshore wind power in operation by the end of 2019. These fixed structures have been concentrated in water depths of less than 60 metres and close to shore, due to their lower cost. In Europe, the "monopile" typology accounted for 80.5% of the foundations used for offshore wind turbines in 2020[15].

The figure below shows the proportion of the type of foundations installed in offshore wind farms commissioned in Europe until the end of 2020.

Fixed foundation offshore wind technology has undergone significant progress since the installation of the first wind farms. R&D&I efforts have focused on cost efficiency neither losing performance nor affecting the safety of the installations, using larger wind turbines with better harnessing of the wind. In addition, the optimisation of the technologies involved and their production processes have enabled a radical reduction in their LCOE[16], achieving a 70% reduction in less than 10 years.

Figure 9. Cumulative number of foundations in Europe at the end of 2020, by different typologies. Source: WindEurope. 'Offshore Wind in Europe. Key Trends and Statistics 2020'.

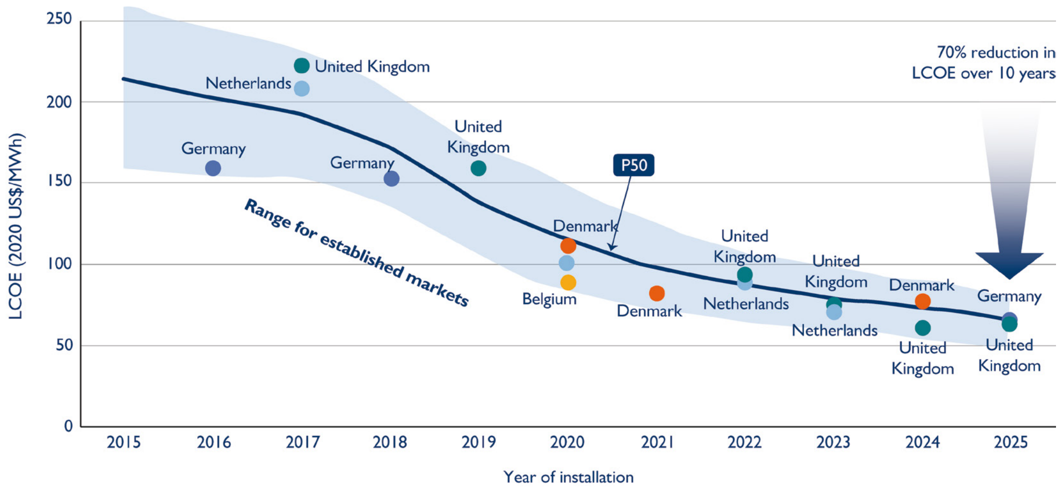


[14] IEA. "Offshore Wind Outlook 2019" (https://www.iea.org/reports/offshore-wind-outlook-2019).

[15] WindEurope. 'Offshore Wind in Europe. Key Trends and Statistics 2020' (https://windeurope.org/data-and-analysis/product/offshore-wind-in-europe-key-trends-and-statistics-2020/).

[16] LCOE - 'Levelised Cost of Energy', understood as the total investment and operating costs of a commissioned facility per unit of net electricity generation over its lifetime.

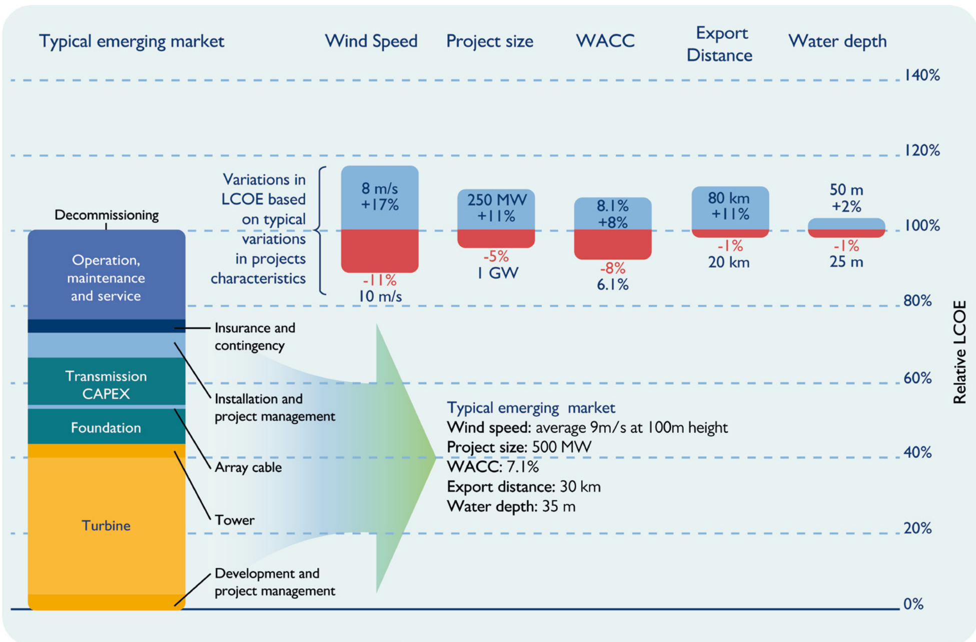
Figure 10. Evolution of offshore wind LCOE up to 2020 together with European forward auction award prices. Source: BVG Associates & ESMAP - World Bank Group 2021[17]



New projects developed in Europe with 10 MW turbines have led to even greater savings in investment and maintenance costs and capacity factors of more than 50% at many sites. As illustrated in Figure 10, **the latest European auctions have achieved very significant price reductions, even to tariffs below 50 €/MWh**[18].

Under certain circumstances and power generation technologies, the LCOE of offshore wind has been reduced to values that make it competitive and therefore an affordable solution for many EU countries to meet decarbonisation targets.

Figure 11. Typical LCOE breakdown of a representative offshore wind project in an emerging market, including the impact of "key physical parameters". Source: ESMAP - World Bank Group 2021[17]



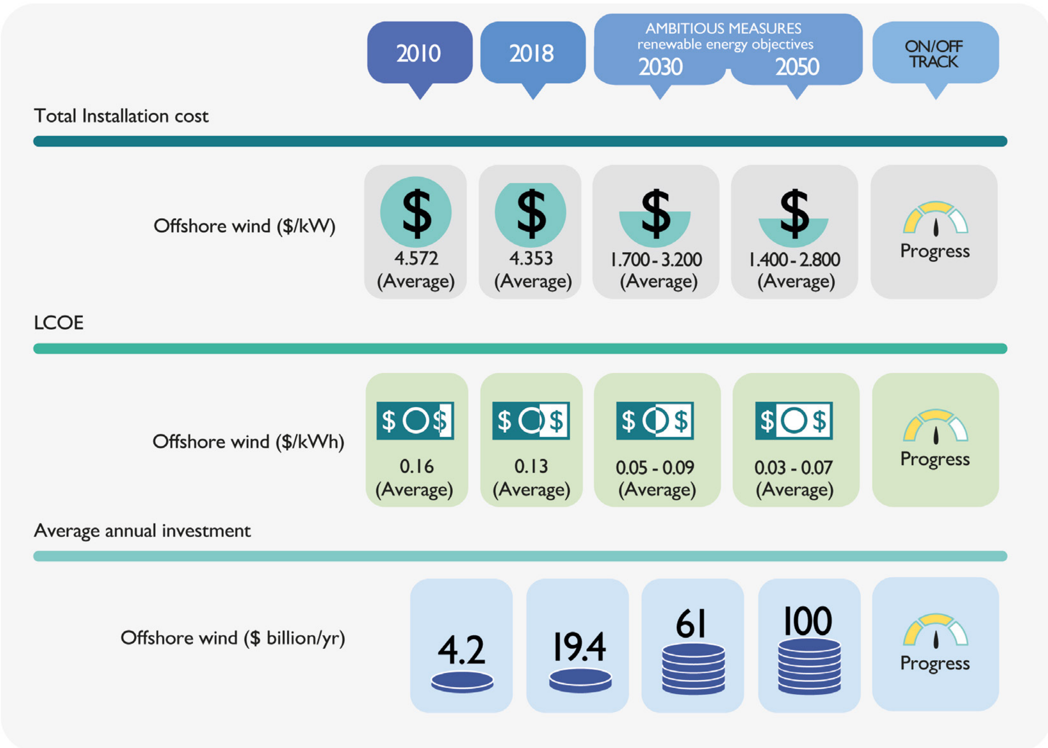
[17] ESMAP – World Bank Group 2021. Key Factors for Successful Development of Offshore Wind in Emerging Markets' (https://esmap.org/key-factors-for-successful-development-of-offshore-wind-in-).

[18] Bloomberg New Energy Finance 2019 (BNEF).

Achieving the optimal LCOE (*Levelized Cost of Energy*) for offshore wind projects in Spain will occur the more of the following "key physical parameters" are present in such projects:

- High wind resource at the site, as it spreads investment and operating costs over more electricity generation. This factor has the greatest impact on reducing generation costs.
- Larger size of the offshore wind farm and of the unit power of the turbines, due to economies of scale.
- Minimisation of financial costs through effective frameworks and appropriate management of project risks and operating, leasing and permitting costs.
- Shorter distance to the coast and to the nodes connecting to the transport network.
- Shallower depth of the marine site. This factor would have the least impact on reducing generation costs, thanks to technological advances with floating solutions.

Figure 12. Present value and future forecast of total cost, LCOE and average annual investment of offshore wind projects. Source: Future of Wind. Deployment, investment, technology, grid integration and socio-economic aspects. IRENA 2019



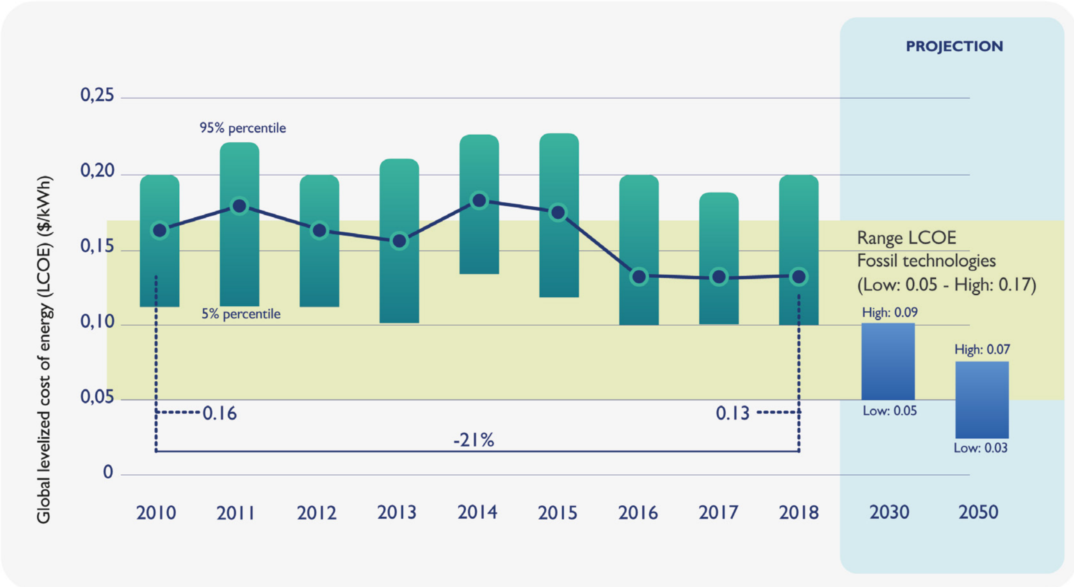
According to analyses by the International Energy Agency[19], the development of the technology will enable reductions of an additional 40% of the LCOE by 2030, to values between 30-40 €/MWh, and 60% by 2040.

IRENA's analysis published in October 2019[20] reaches similar conclusions that offshore wind will reach competitive values in other markets by 2030 and values between $0.03 to $0.07/kWh by 2050 (see Figure 12).

[19] Source: IEA Offshore Wind Outlook 2019.

[20] Future of Wind. Deployment, investment, Technology, grid integration and socio-economic aspects. IRENA 2019.

Figure 13. Evolution of offshore wind LCOE 2030-2050. Source: EA Offshore Wind Outlook. IRENA 2019



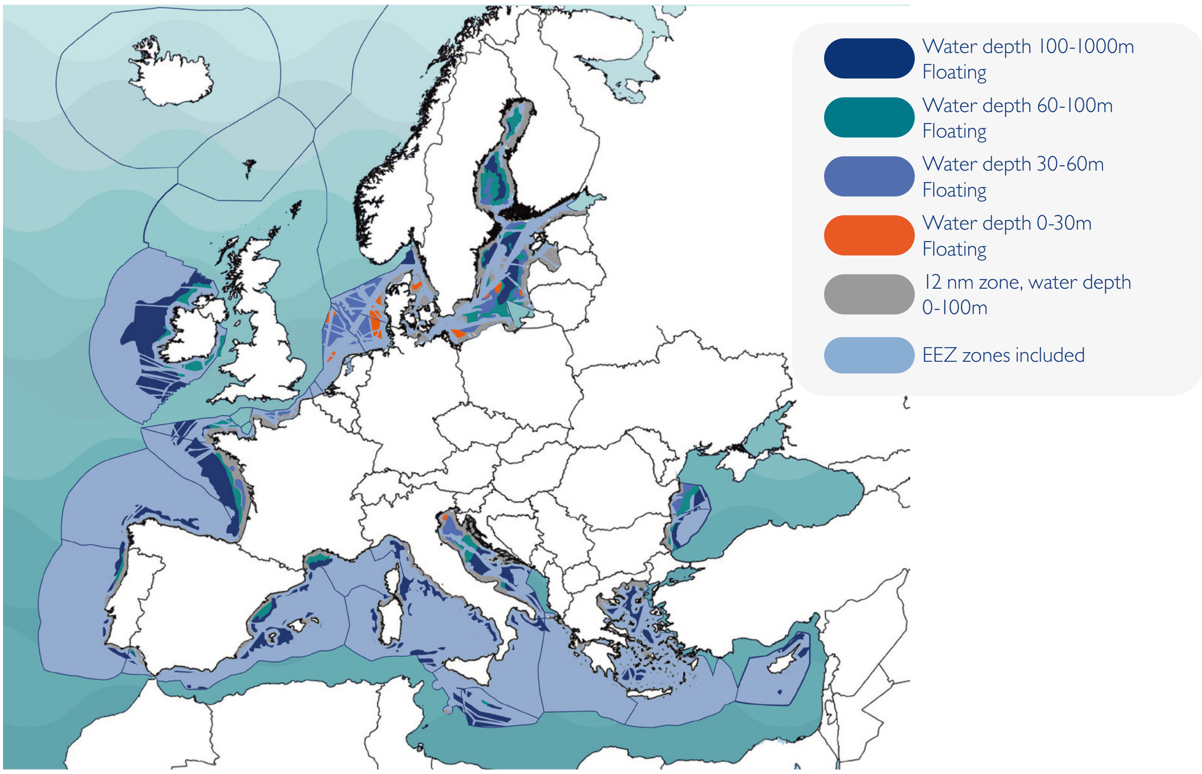
However, despite technological and logistical improvements, **fixed foundation structures become unfeasible in locations deeper than 50-60 metres**, due to higher economic costs and practical difficulties of installation and operation. All this entails a constraint of the use of fixed foundation solutions in a significant proportion of the European and global marine environment, especially in environments with higher wind potentials. In this context, floating platform solutions become relevant.

- **Offshore wind turbines on floating platform**

Floating structures offer decisive opportunities for the offshore wind industry and open the door to new locations further offshore that were technically and economically inaccessible with fixed foundation technology concepts. For this new technology, the depth restriction comes from the laying of underwater power infrastructures, which **can reach hundreds of metres deep**.

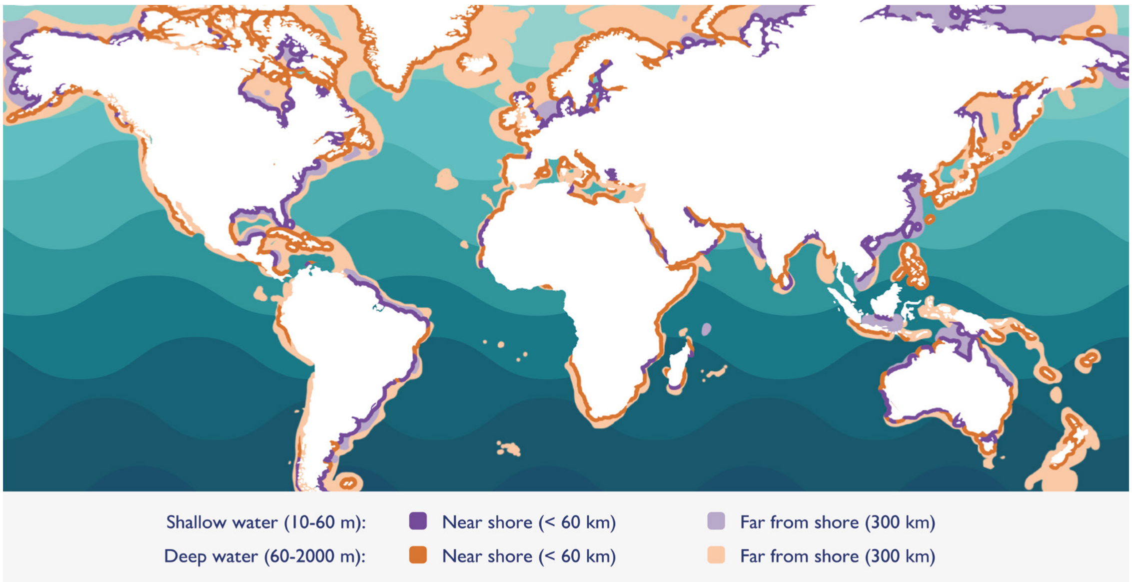
Thus, while the North Sea is so far the leading region in terms of installed offshore wind power capacity, floating concepts allow wind turbines to be deployed in large deep sea areas with higher wind potential. At the European level, Figure 14 illustrates the potential for offshore wind deployment of floating solutions compared to fixed foundation solutions. This difference is notable around the Iberian Peninsula, but also along much of the Atlantic and Mediterranean coasts with depths in excess of 50m close to shore.

Figure 14. Offshore wind energy potential in the EU-27 accessible sea basins. Source: JRC



This principle can be extrapolated globally: As an international reference, it is estimated that between 60%-80% of the offshore wind resource would be located in areas where the only technological option would be floating[21], as can be seen in Figure 15.

Figure 15. Global map of offshore wind potential. Source: IEA OffShore Wind Outlook 2019



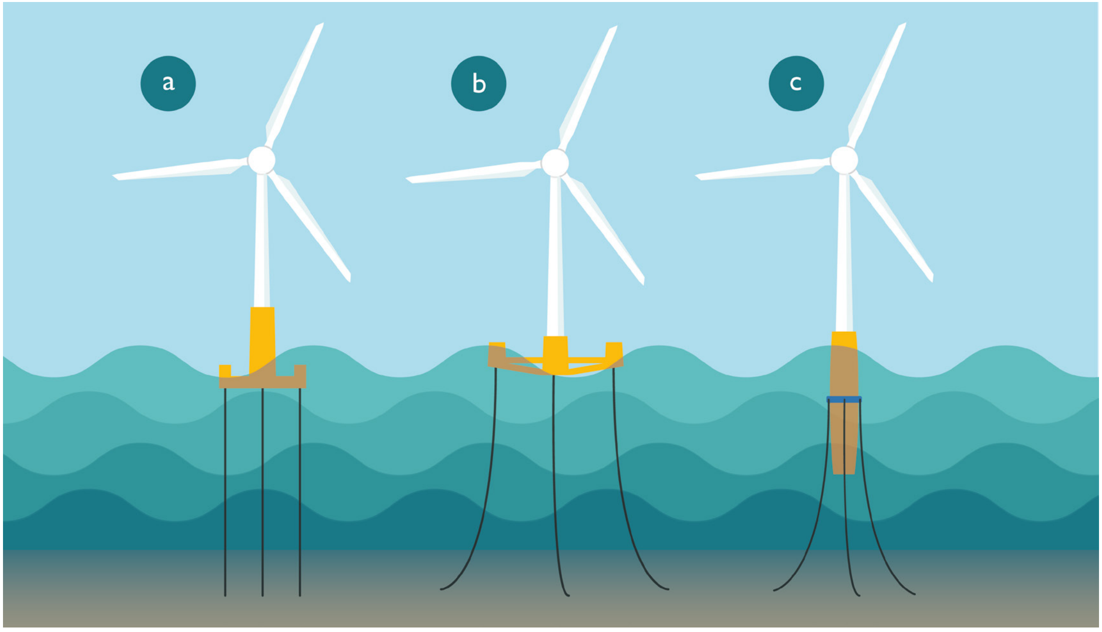
[21] Future of Wind, October 2019 - IRENA

The development of floating technologies therefore represents an enormous potential for the deployment of offshore wind energy and an essential factor for its appropriate deployment at Spanish, European and global level.

There are currently at least three floating solutions that have already gone beyond the installation of pre-commercial projects and that demonstrate the technological maturity necessary to compete in the market. These are classified, depending on the anchoring system to the seabed, as follows:

- ▹ **Floating monopile or "spar"**, cylindrical floating buoy moored by cables or chains to the seabed.
- ▹ **Semi-submersible platform**, anchored to the seabed based on experience from the oil and gas industry.
- ▹ **Tension-Leg Platform (TLP):** a floating structure vertically moored by tensioned cables to install wind turbines in deep-water environments.

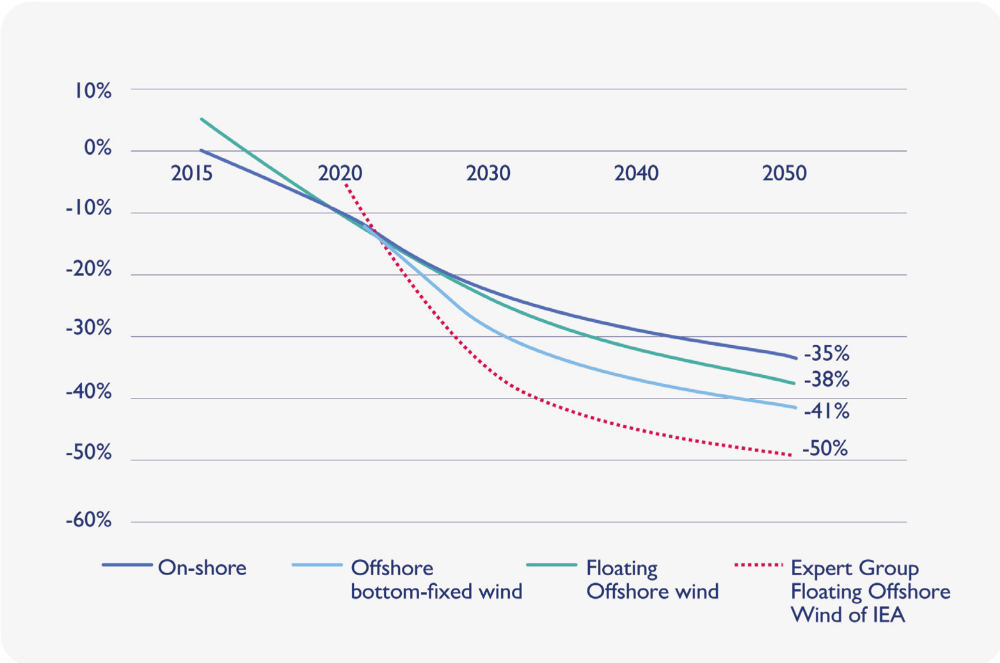
Figure 16. Floating wind technologies: (a) tension-leg platform (TLP), (b) semi-submersible platform and (c) floating monopile or spar. Source: MITECO-IDAE



The successful completion of the demonstration phases achieved by different floating technologies to date allows the installation of commercial wind farms to be considered in deep water locations, precisely those that best suit the characteristics of the Spanish coastline. A rapid evolution and maturity of floating offshore wind energy in Europe is expected by 2030, with a significant reduction in costs that will enable floating offshore wind solutions to be fully competitive.

As shown in the figure below, floating offshore wind is expected to follow a steeper declining equivalent cost of energy trajectory than onshore wind, in part due to access to areas of greater resource and therefore better capacity factor. The costs of this technology are expected to decrease between 38% and 50% by 2050.

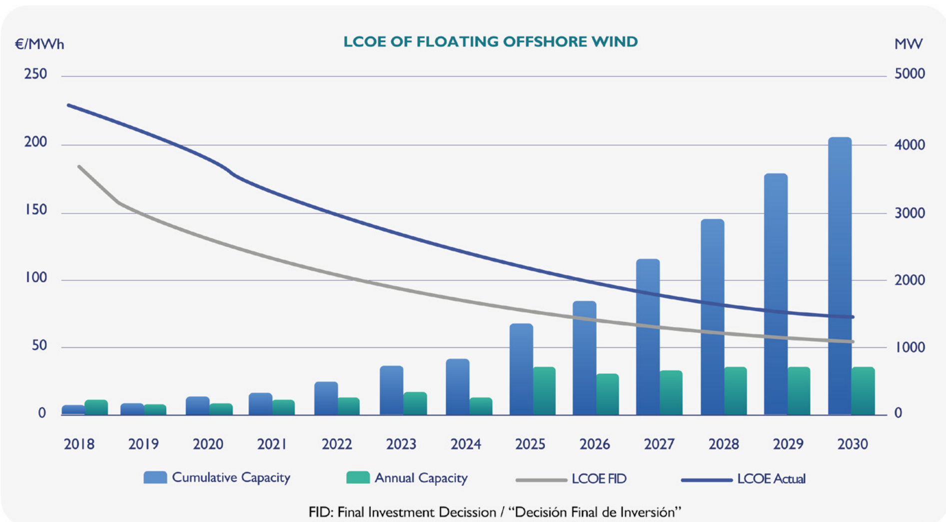
Figure 17. Comparison of LCOE reduction of floating offshore wind, fixed foundation offshore wind and onshore wind. Source: International Energy Agency - IEA



So far, this technology has already experienced a larger cost reduction than fixed-foundation offshore wind, and is expected to follow the same path from the current 180-200 €/MWh for small-scale pre-commercial projects, to 80-100 €/MWh in 2025 for the first commercial-scale projects using existing proven technologies. It is expected to reach 40-60 €/MWh by 2030 at commercial scale.

As has been the case in recent years with other renewable technologies, it is necessary to reach a critical mass in the deployment of projects, which will also allow technological consolidation around the most competitive solutions, in line with the objectives of this Roadmap. Consequently, the real evolution of cost reduction over the next decade for floating offshore wind will depend on the speed of deployment of commercial installations (see Figures 18 and 19).

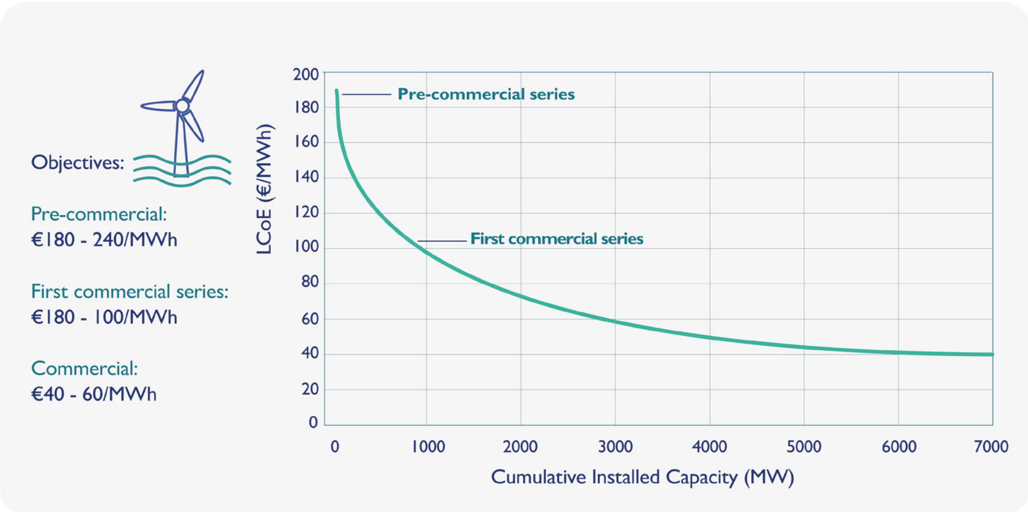
Figure 18. LCOE reduction of floating wind until 2030. Source: Floating Offshore Wind Energy - WindEurope



By December 2020, **compared to the aforementioned 29 GW of fixed-foundation offshore wind**, some 88 MW[22] of floating wind were installed globally, all pre-commercial, ranging in size from 2 MW to 30 MW, consisting of 1 to 5 machines of up to 8.4 MW unit power. Taking into account the planned projects, a **global cumulative floating wind capacity of approximately 350 MW would be reached by 2022.**

We are therefore at a turning point that will determine the potential take-off of floating offshore wind in the coming decades. According to IRENA[23], it is estimated that by 2030 there could be between 5 and 30 GW of floating technology installed globally. As a complementary reference, in the "EU Strategy on Offshore Renewable Energy", the European Commission establishes a target of 60 GW for offshore wind energy as a whole by 2030, without breaking it down into fixed and floating foundations.

Figure 19. LCOE reduction of floating offshore wind as a function of cumulative installed capacity.
Source: WindEurope 2019



Finally, it is interesting to note that the development of floating offshore wind will **reduce the costs and risks currently associated with the construction, installation, operation and decommissioning** of traditional fixed offshore wind installations. As they are located on floating structures, they will require fewer operations below sea level, and most installation and maintenance activities will be carried out on land, thus reducing costs and risks.

Technological advances in floating offshore wind energy also allow the use of new techniques that minimise potential environmental impacts compared to the techniques associated with the projects presented more than a decade ago.

▸ Other elements of offshore wind farms

The unique opportunities and challenges posed by the marine environment have led to a high diversity of elements and technological solutions in the wind turbines themselves and in their support structures, as seen above. In addition, the following activities stand out due to their logistical complexities:

- ▹ **The cabling for the internal connection** of the various wind turbines that make up the wind farm and the energy evacuation line to land is one of the largest cost items in offshore wind projects. The cable laying depends on the type of seabed and can be above or below the seabed.

[22] WindEurope. 'Offshore Wind in Europe. Key Trends and Statistics 2020' (https://windeurope.org/data-and-analysis/product/offshore-wind-in-europe-key-trends-and-statistics-2020/).
[23] IRENA. 'Future of Wind'. October 2019 (https://www.irena.org/publications/2019/Oct/Future-of-wind).

- ▷ **The electrical substation** is the key element for the transmission of underwater electrical power which, due to environmental conditions, is built in an interior structure on platforms anchored to the seabed.
- ▷ Offshore wind power generation facilities, due to their large dimensions and their particularities of operation and maintenance, require specialisation in some specific sectors:
  - In particular **naval transport** and port infrastructures are specialising, not only for transport and structural solutions, and not only for **initial assembly**, but also for possible corrective processes and for dealing with breakdowns and emergencies, as well as their impact on maritime safety or the marine environment.
  - Due to the large dimensions of offshore wind turbines, the installation of offshore wind farms requires **highly specialised vessels** incorporating large cranes, of which there is little supply on the market. In addition, the complexity of moving and assembling a wind turbine in an offshore environment is multiplied by the cost, technical challenges and company specialisation. Innovative technological solutions are currently being tested to mitigate the dependence on the use of large marine auxiliary equipment.
- ▷ The level of survivability at sea must be higher than the equivalent on land because of the higher costs of corrective maintenance, making **sensor, command and control systems** much more demanding for optimised preventive maintenance. This requires advanced and robust monitoring and control technology solutions.

In terms of **interactions with their environment**, there are many potential synergies between wind energy and the fisheries sector and there are already examples of the two industries working together, drawing on the knowledge, experience and skills related to the marine environment that the fisheries sector already possesses.

However, the fisheries sector in Spain still identifies risks and potential adverse effects on its activity due to the development of offshore renewable technologies. Their concerns and proposals include:

- ▷ Ensure that historical and traditional fishing grounds specific to local fishermen are not affected.
- ▷ That it does not have a negative environmental, ecological, socio-economic and cultural impact, neither on fishermen and aquaculture producers, nor on food security - due to the status of fisheries, recognised in the 2030 Agenda as a key sector, an economic driver and an activity that provides the backbone of the territory[24].
- ▷ According to the fishing industry, fishermen might avoid areas with offshore wind farms even if access is allowed, because of the risk of accidental damage, snagging and loss of fishing gear.
- ▷ Location, where possible, of offshore wind farms in areas where fishing is permanently prohibited.
- ▷ That infrastructure remnants from the development of underlying offshore renewable installations do not pose a risk to the safety of fishing vessels.

Consequently, it will be essential in Spain to establish forums for meeting and dialogue between the developers of offshore renewable projects, the fishermen's organisations in the areas where such projects interact and the maritime administration and the maritime transport sector in general. It is worth highlighting the previous cooperation initiatives for the preparation of the MSP (POEM by its Spanish acronym), the prior public consultation of the Roadmap for offshore renewable energy, among others.

An **integrative approach** is envisaged, **considering the deployment of offshore renewable installations in harmony with fishing activities and encouraging their involvement during the development of projects** (e.g. by

---

[24] Government of Spain. Ministry of Social Rights and Agenda 2030. Progress Report 2021 and Sustainable Development Strategy 2030. Page 213. (https://www.mdsocialesa2030.gob.es/agenda2030/documentos/informeprog21eds30r.pdf).

establishing prior stakeholder consultations in order to identify potential difficulties in their preliminary phase and recognise the importance of all players, the involvement of independent third parties and/or socio-economic benefits to fishermen and local communities, especially in fisheries-dependent regions), as well as **providing guidance on best practices for maritime spatial planning and cooperation between sea users.**

Fishing on wind farms is allowed in some European markets, maximising compatibility between activities also for zoning purposes. In this regard, the 'EU Strategy on Offshore Renewable Energy' identifies the fisheries and aquaculture sectors as key elements to assessing compatibility between activities. In it, the Commission proposes to organise a European High Level Conference on Offshore renewable Energy, with the presence of these sectors together with Member States and civil society to promote the exchange of best practices and discuss common challenges. Positive experiences have been noted in Northern European countries that have been investigating for years the possible synergies between fishing activity and the presence of wind farms. Thus, the study 'Impact of the use of offshore wind and other marine renewables on European fisheries'[25], commissioned by the European Parliament's Committee on Fisheries, includes good practices of coexistence, co-location and cooperation between the wind and fisheries sectors in countries such as the United Kingdom, Denmark, Belgium, the Netherlands and Germany. The report includes examples of good practice for the co-existence of fisheries and offshore wind farms, such as in Denmark, where the Fisheries Act provides for a consultancy process, where developers present and discuss their development plan directly with the fisheries sector. Negotiations include possible mitigation measures as well as financial compensation. Mitigation measures are, for example, the inclusion of fishermen in the construction and operation of the wind farm or the authorisation of passive fishing within the wind farm. Negotiations on compensation are conducted by the Danish Fishermen's Association (verified by an independent consultant).

Furthermore, in the UK, a group called 'Fishing Liaison with Offshore Wind and Wet Renewables' (FLOWW) has been facilitating consultancies and discussion between the fishing and wind energy sectors since 2002. The FLOWW also developed 'Best Practice Guidelines for the Fishing of Offshore Energy Developers' that address mitigation and coexistence planning, such as compensation for disturbance and loss of earnings for fisheries. Passive fishing techniques or navigation are still allowed in offshore wind farms, fishermen are only excluded when a project is under construction or closed for maintenance. In addition, a market has emerged for tourism and recreational fishing with charter boats within the wind farms. The effects of artificial reefs enhance the opportunities for angling at sea.

At the environmental level, the deployment of renewable energy in marine environments must be compatible with the protection of biodiversity. The Strategic Environmental Assessment of the PNIEC establishes the guidelines that the deployment of offshore wind and associated electrical evacuation infrastructures must comply with. Benthic habitats are relevant, requiring that anchoring and cabling elements be designed and located in such a way as to minimise their interference. In this context, floating technologies could reduce the intensity of impacts on the shallower seabed during both the construction and operation phases. Seabird communities are also relevant, as is the case with land-based infrastructures, so the zoning contained in the MSP (POEM) takes into account as a priority the areas classified as SPAs (Special Protection Areas for Birds), as well as the areas identified as being of interest and value for seabirds and critical areas for some cetacean species, while also taking into account the presence of marine habitats of Community interest. Thus, the identification of favourable locations for the development of offshore wind energy is based on the analysis of the known distribution of the elements most sensitive to this type of activity. In any case, as with onshore projects, the processing of projects will be subject to the environmental impact assessment procedure, which must analyse the potential impacts in each specific case. In addition, projects must have the corresponding title of occupation of the maritime-terrestrial public domain, and the report on compatibility with marine strategies.

In particular, the zoning contained in the (Spanish) Maritime Spatial Planning (Draft POEM in the public consultation phase as of December 2021, see Annex IV) takes into account the following marine areas as a priority for the preservation of the marine environment:

[25] Study Impact of the use of offshore wind and other marine renewables on European fisheries (https://www.europarl.europa.eu/RegData/etudes/STUD/2020/652212/IPOL_STU(2020)652212_EN.pdf).

- Those areas catalogued as ZEPA (Spanish acronym which translates into "Special Protection Area for Birds") declared in the sea.
- Two areas under study in the framework of the INTEMARES project to be declared SPAs in the near future (the coastal marine area north of Barcelona and the Strait of Gibraltar).
- Those areas identified as valuable and of interest for seabirds in the framework of the INTEMARES project's marine Natura 2000 gap analysis.
- In SACs/SCIs, those areas where Habitats of Community Interest (1110, 1120, 1170, 1180, 8330) are present.
- In the areas identified as valuable or of interest for habitats in the framework of the INTEMARES project - including the six areas under study in the framework of this project to be declared as SCIs in the near future, specifically, the underwater mountains of Mallorca, Cap Bretón and Seco de Palos -, those areas where Habitats of Community Interest are present.
- Critical areas of species (especially killer whales, beaked whales, sperm whales, porpoises and pilot whales).

However, positive examples of the interaction between offshore wind installations and marine biodiversity have also been reported, although they require further research.

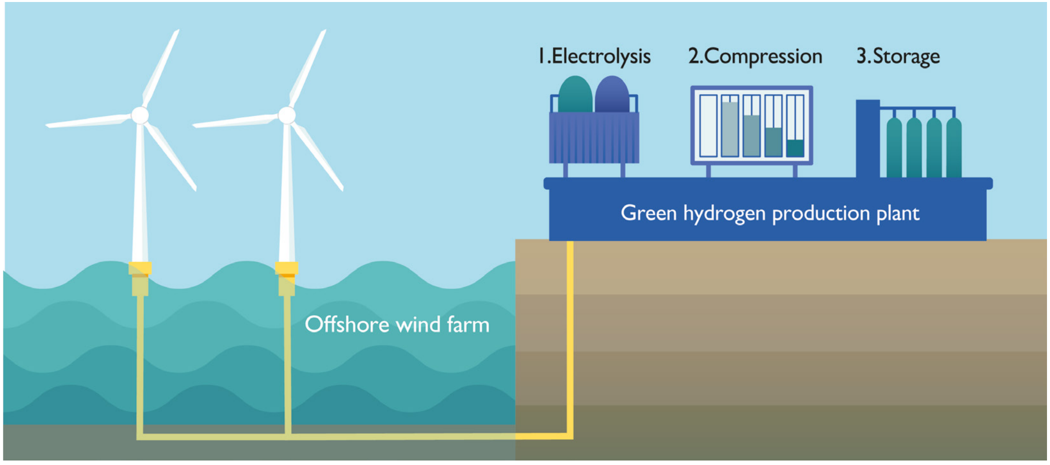
In any case, in order to be able to carry out this coexistence, it is essential to undertake an adequate environmental characterisation of the area prior to deployment (baseline), as well as to establish environmental monitoring systems that allow surveillance and security work to be carried out, and the observation of birds and mammals for environmental monitoring.

Moreover, the deployment of renewable energy in the marine environment must be compatible with previous uses of space, such as maritime navigation. To this end, the impact on safety of navigation, communications systems and navigation aids, search and rescue activities and marine pollution prevention and control activities must be assessed for each project.

Likewise, offshore wind and other marine energies have enormous potential for **interaction with other relevant advances in the energy field**. Among others, the potential for hybridisation of offshore wind with other renewable generation technologies and with storage systems stands out, which would increase the efficiency of installations for optimal use of renewable resources and provide the electricity system with the flexibility to integrate large amounts of renewable generation, ensuring safe and economically efficient operation, in line with the provisions of the *Energy Storage Strategy*.

On the other hand, the generation of renewable hydrogen from offshore wind energy is an alternative that contributes to the coupling of sectors, with the potential to optimise the use, where applicable, of surplus generation from the offshore installation at times of surplus renewable generation or in cases of limited grid connection capacity. Although, in the case of Spain, the high photovoltaic and onshore wind resource is one of the bases for the development of renewable hydrogen under highly competitive conditions, prioritising local uses and coupling supply and demand in line with the *Hydrogen Roadmap*, there are synergies to be explored in technological, industrial and energy development.

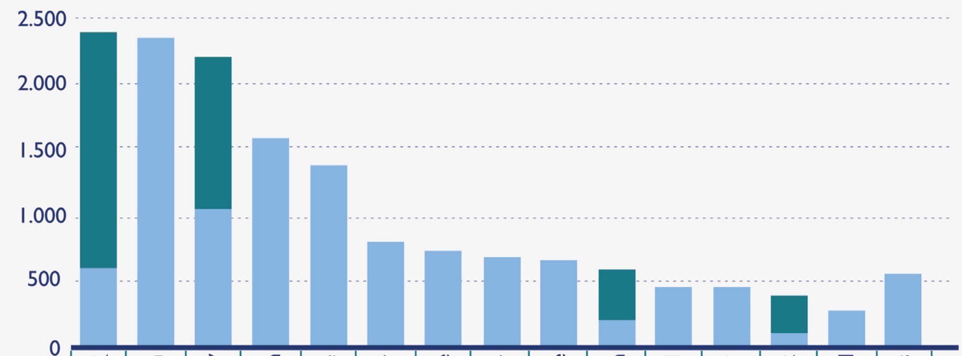
Figure 20. Schematic of offshore wind farm for renewable hydrogen production.
Source: MITECO-IDAE



▸ Situation of offshore wind power in Spain

The geographical characteristics of Spain and the existence of sites with great potential for the development of onshore wind power have meant that the development of wind energy has focused mainly on the onshore sector.

Figure 21. New onshore and offshore wind power capacity installed in Europe in 2019. Source: AEE - WindEurope 2019

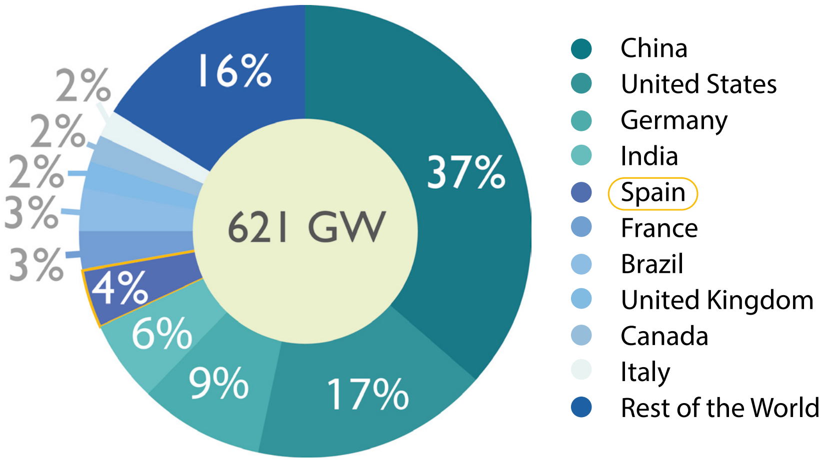


	UK	Spain	Germany	Sweden	France	Norway	Greece	Turkey	Ukraine	Belgium	Ireland	Italy	Denmark	Finland	Others
OFFSHORE WIND	1764	0	1111	0	0	0	0	0	0	370	0	0	374	0	8
ONSHORE WIND	629	2319	1078	1588	1336	780	727	686	637	207	463	456	28	243	563
Total	2393	2319	2189	1588	1336	780	727	686	637	577	463	456	402	243	571

The narrowness of the Spanish continental shelf, where water depths are very deep at very short distances, has made it difficult to deploy fixed-foundation offshore wind projects, the consolidated technological solution to date.

Meanwhile, more than 25 GW of onshore wind power capacity has been installed in Spain, making it the leader in wind power generation (see Figure 22) and the country that has installed the most capacity in 2019 in the EU (see Figure 21), maintaining its 5th position in the world ranking of installed capacity and being one of the main exporters of the technology.

Figure 22. Ranking of countries by cumulative onshore wind power in 2019. Source: GWEC



The experience gained during more than 20 years of onshore wind implementation, and the significant capabilities of Spanish industry, have already enabled both the wind and naval sectors to successfully participate in offshore wind projects around the world, exporting components and services throughout the value chain.

The evolution towards technological maturity of floating solutions, however, will allow offshore wind deployment to be carried out in Spanish waters as well. In this context, several Spanish companies are developing floating technologies that are at different stages of advancement, between TRL-4 to TRL-6[26], and which aspire to reach pre-commercial status in the coming years. Specifically, of the 27 floating solutions currently identified worldwide, 7 are Spanish patents[27]. This shows the great potential of Spanish companies in the development of innovative and disruptive designs for floating platforms.

- **Offshore wind resource in Spain**

Certain marine areas of Spain have the wind resource for offshore wind development with sufficient local implementation potential to develop technological learning curves and foster new economic activities.

The following figures identify the marine areas which, according to the "Wind Atlas of Spain" developed by the IDAE in 2008, have an average speed of more than 6.5 m/s at a height of 100 metres above sea level. In general terms, it is estimated that they may represent a minimum technical potential for the implementation of offshore wind installations in Spain up to 2030, including those intended for R&D&I, with the current technological state of the art.

This technical potential is **one of the elements that, together with the identification of other uses and activities and the compatibility between them, as well as the environmental protection values and figures, have been analysed in the preparation of the MSP (POEM by its Spanish acronym) to determine the most suitable areas for the deployment of offshore wind power in our country**, taking into account that those areas with higher wind speeds would be the most suitable for the implementation of offshore wind farms, as they would imply a greater energy contribution and lower generation costs.

[26] TRLs: 'Technology Readiness Levels'. 9 levels are considered, ranging from the basic principles of the new technology to its successful testing in a real environment: TRL 1: Basic principles observed and reported / TRL 2: Concept and/or technology application formulated / TRL 3: Critical analytical and experimental function and/or proof of concept characteristic / TRL 4: Validation of component and/or component arrangement in a laboratory environment / TRL 5: Validation of component and/or component arrangement in a relevant environment / TRL 6: System or sub-system model or prototype demonstration in relevant environment / TRL 7: System or prototype demonstration in real environment / TRL 8: System completed and certified through testing and demonstration / TRL 9: System successfully tested in real environment. (Source: MINCOTUR).

[27] Source: Asociación Empresarial Eólica (AEE) / "Spanish Wind Energy Association".

Figure 23. Offshore Wind Potential in the North Atlantic Subdivision.

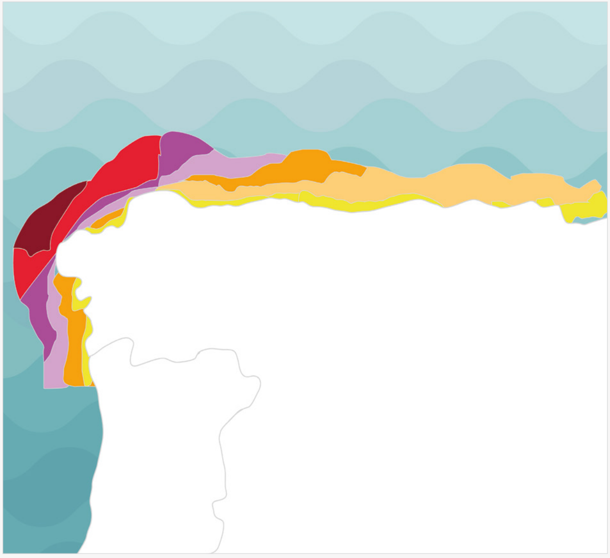


Figure 24. Offshore Wind Potential in the Levantine-Balearic Subdivision.

Figure 25. Offshore Wind Potential in the South Atlantic Subdivision.

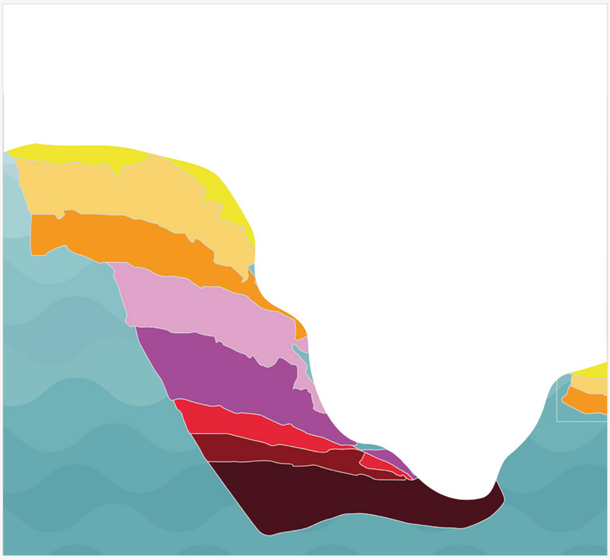
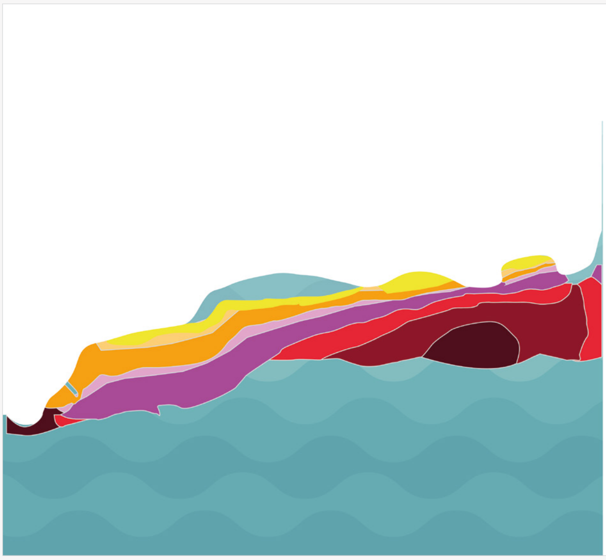


Figure 26. Offshore Wind Potential in the Strait and Alboran Subdivision.



Speed (m/s)

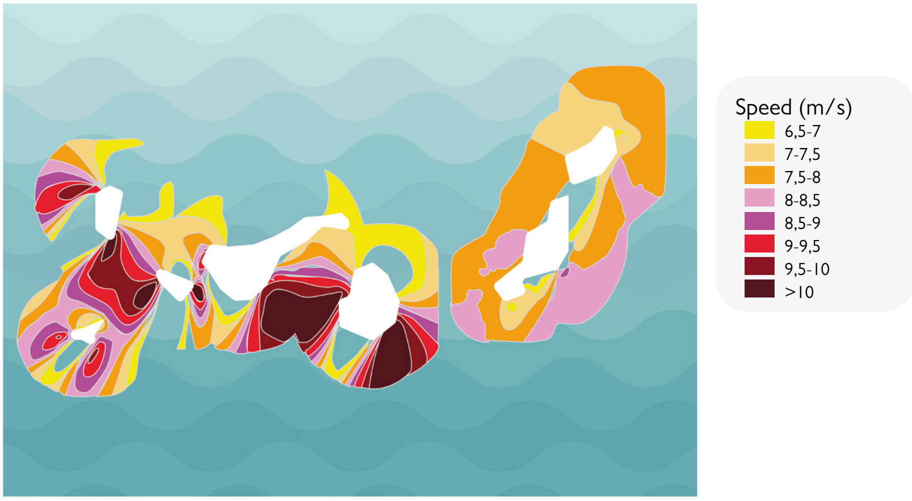
6,5-7 | 7-7,5 | 7,5-8 | 8-8,5 | 8,5-9 | 9-9,5 | 9,5-10 | >10

Source: MITECO-Draft POEM based on information from the IDAE Offshore Wind Atlas

Average wind speed and bathymetry are the two most relevant technological elements taken into account in the development of the MSP (POEM by its Spanish acronym) which, together with the analysis of the other uses and activities in the marine environment, the environmental values and protection figures, as well as the compatibility between the different elements, allow the definition of the most suitable areas for the deployment of offshore wind power in our country.

The Canary Islands, through renewable energy, can play a key role in the energy transition, particularly in offshore wind energy, bearing in mind that it is a territory highly limited by spatial restrictions related to the protection of the terrestrial and marine environments.

Figure 27. Offshore Wind Potential in the Canary Islands Subdivision. Source: MITECO-Draft POEM, based on the IDAE Offshore Wind Atlas

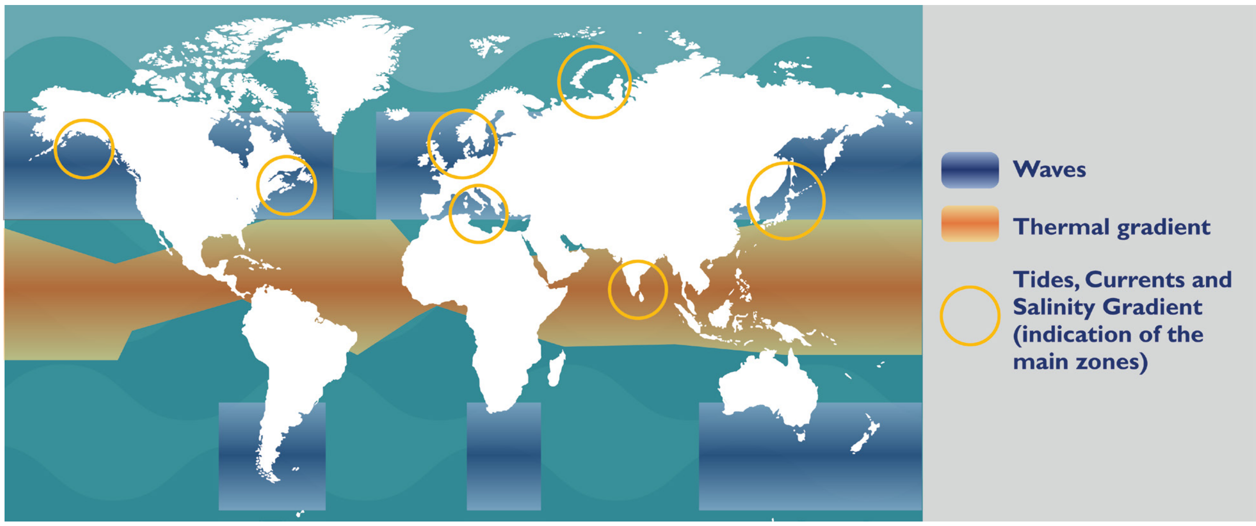


2.2 MARINE ENERGY

The oceans are an immense source of resources, available over a large area of the planet, which can be used to generate large amounts of energy. Marine or ocean energy refer to the harnessing, use or application of the energy resource that is mainly manifested in waves, tides, ocean (tidal) currents/streams, in the difference in temperature between the surface and the seabed and in the difference in salinity between freshwater and saltwater in the contact zones of both.

The following figure shows the global distribution of the main marine-derived energy sources:

Figure 28. Global distribution of marine energy sources. Source: Tecnalia



In addition to the enormous potential, the other great quality offered by the sea is its regularity and predictability, which means that the available resource and, therefore, energy production can be estimated with high precision, giving it an important differential value compared to other renewable energy sources. Additional advantages are its applicability and availability for both onshore and offshore deployment and its modularity and scalability to provide electricity to different end-use sectors (e.g. ports or desalination).

From an environmental point of view, recent studies[28] carried out by the Marine energy System (OES) Programme of technological collaboration between different countries of the International Energy Agency for marine energy concluded that marine energy devices have a minimal impact on marine life and visual impact, as they are located submerged or at a low elevation above sea level, at a distance from the coast, except for those located in dikes or coastal infrastructures.

However, it should be noted that, at present, these energies are in an incipient state of pre-commercial technological development, marked by great opportunities with first deployments of small-scale prototypes, but also with a long way to go to achieve the maturity that will allow them to face their commercial exploitation in competition with other sources.

Depending on the different marine energy resources, the technologies can be classified into the categories shown in Figure 29. Globally, the installed capacity of marine energy is 578 MW, distributed in the different typologies as follows:

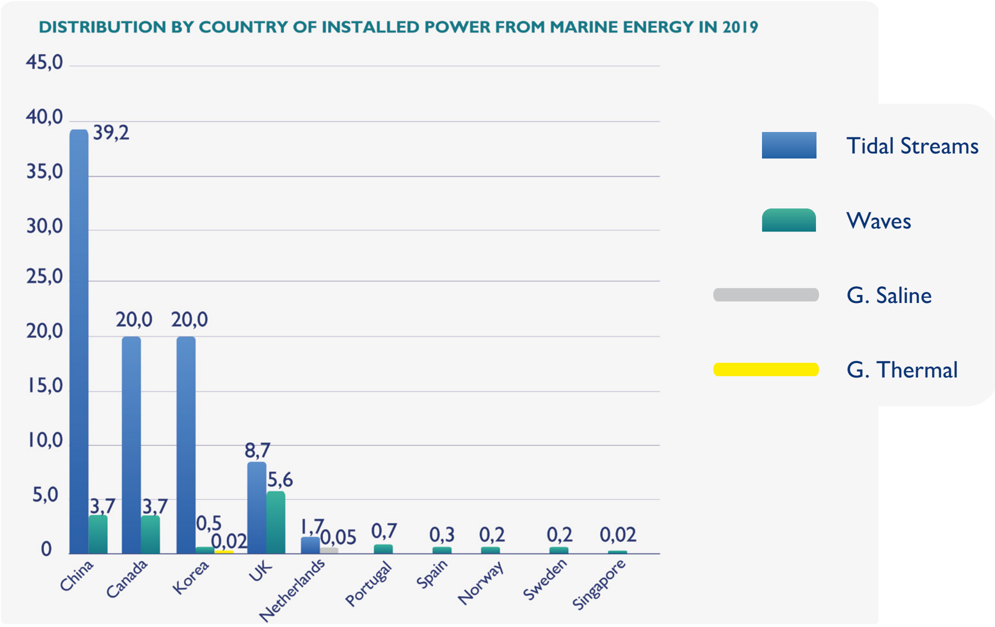
Figure 29. Global installed capacity of marine energy sources. Source: JRC Ocean Energy Status Report 2018 OES - IRENA 2020

TECHNOLOGY	POWER (MW)
Tidal range	485
Tidal streams	89,65
Waves	11,61
Salt gradient	0,05
Thermal gradient	0,02

The following figure shows the distribution of installed power by country, among which Korea, China, Canada and the United Kingdom stand out in the use of marine energy. According to the different resources, China leads in the installation of current technologies, although the United Kingdom, France and Canada are the main countries that are investing in the development of marine energy. The UK is the leader in wave energy devices. In thermal gradient there is only one 23 MW pilot plant in Korea and in saline gradient there is only one 50 kW plant in the Netherlands.

[28] OES. 'Environmental 2020 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World'. September 2020 (https://www.ocean-energy-systems.org/news/oes-environmental-2020-state-of-the-science-report/).

Figure 30. Distribution by country of installed power from marine energy (except tidal range) in 2019.
Source: MITECO-IDAE



The following is a description of each of the five marine energy technologies, as well as their potential development capacity in Spain:

- **Wave energy**

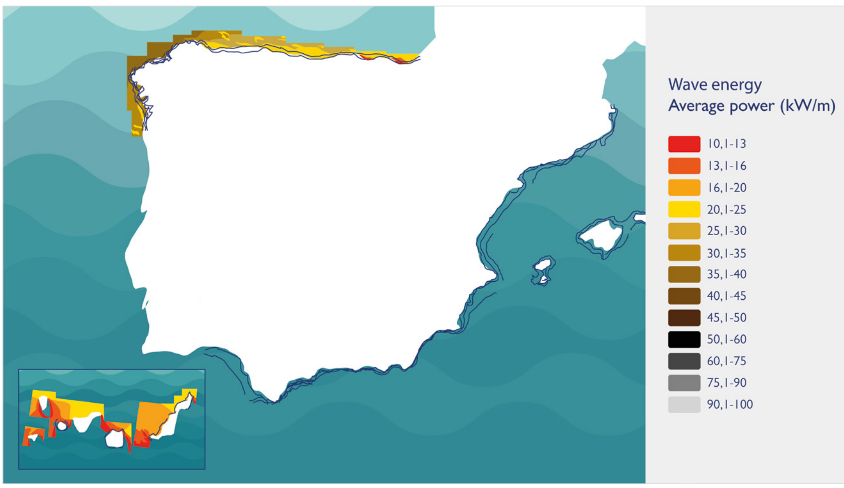
In Spain, wave energy has a high quality resource for its viability and development. In terms of potential, Galicia has the highest potential energy values, with average power between 40-45 kW/m. The Cantabrian Sea is, in second place, the next coastal area in terms of resource (around 30 kW/m, decreasing from west to east) and, in third place, the northern coasts of the Canary Islands (with 20 kW/m).

The theoretical global potential of wave energy is estimated at 29,500 TWh/year.

Planning should take into account the possible impact on maritime traffic and safety of navigation.

Wave energy technologies present a wide range of devices tested to date, but without yet converging to a common, small-scale design. **Of the total number of existing grid-connected devices, more than 75% of them have relatively low outputs of 20 kW per unit and of the remainder, seven of them have maximum outputs of 350 kW and only one installation has a capacity significantly higher than 1.25 MW**.

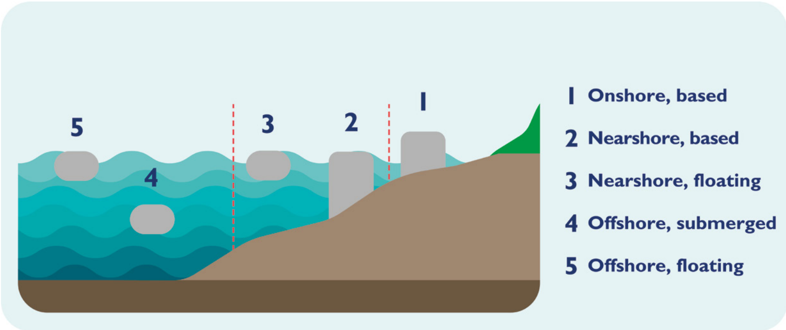
Figure 31. Wave energy potential in Spain. Source: MITECO and Draft POEM based on the "Estudio Técnico de Evaluación del Potencial de la Energía de las Olas" (Wave Energy Potential Assessment Technical Study) of the IDAE.



There are different types depending on their location, size and orientation and the principle of capturing wave energy. Depending on their location, they can be distinguished as follows:

- Onshore shore-based devices, located at a depth of 0 to 10 metres, usually integrated into a breakwater or seawall, fixed to a cliff or resting on the seabed. They are characterised by their ease of operation and maintenance activities.
- Devices in shallow nearshore waters, located between 10 and 40 m depth. Their deployment and maintenance costs are low as they are usually supported on the seabed and do not require anchoring systems. They can be supported or floating.
- Devices in deep water "offshore" from 40 m depth, far from the shore. They are capable of capturing energy from the most resource-rich locations, but installation and maintenance costs are higher. They can be floating or submerged.

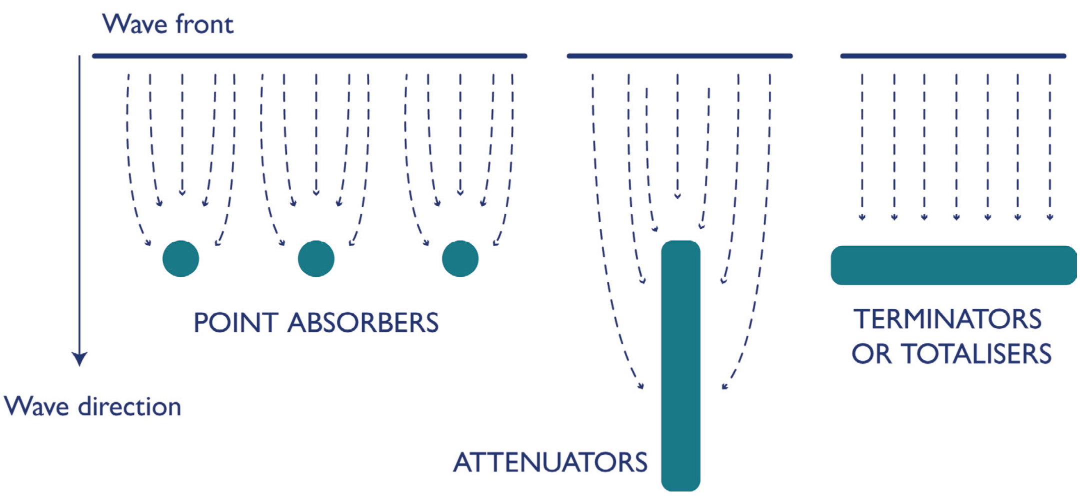
Figure 32. Wave devices according to their location. Source: MITECO-IDAE



Depending on the size and orientation of the devices with respect to the swell, they can be classified as follows:

- Point absorbers, buoy type: axially symmetric devices capable of capturing waves from any direction. Dimensions one order of magnitude smaller than the wavelength.
- Attenuators: devices oriented parallel to the incident wave, the length of the device being of the same order of magnitude or greater than the wavelength.
- Terminators or totalisers: Similar in dimensions to the attenuators, but placed perpendicular to the incident wave.

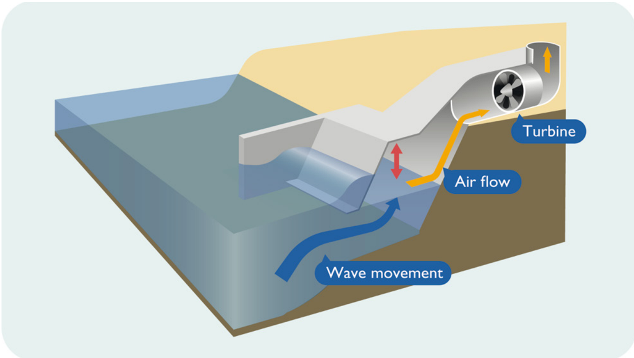
Figure 33. Typology of wave energy devices according to size and wave orientation.
Source: MITECO-IDAE



According to the wave-capture principle, which is the most commonly used classification of wave energy devices, they are classified as follows:

- **Oscillating Water Column (OWC)**. In these devices it is not the waves that move the turbines directly, but a mass of compressed air that is pushed by the waves. They are installed on the coastline on breakwaters or jetties, on harbour breakwaters or on floating platforms.

Figure 34. Schematic diagram of operation of the oscillating water column catchment principle. Source: MITECO-IDAE



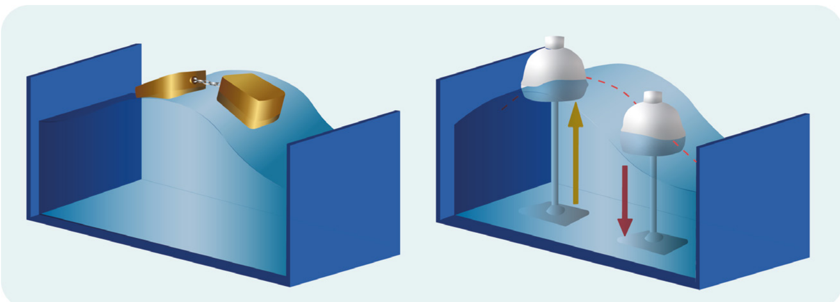
One of the distinguishing features of these converters is the significant cost savings that their construction and installation entails if it is carried out simultaneously with the execution of the coastal defence. As they are integrated into the infrastructure, the devices are not visible and do not pose any obstacle to coastal protection or affect the coastal landscape.

As a pioneering project, the 296 kW Mutriku wave power plant, located in the outer dock of the port of Mutriku in the Basque Country, stands out as the first commercial installation in the world to operate by injecting wave-generated electricity into the grid.

Since its commissioning in 2011, the wave power plant has operated uninterruptedly, making it the longest-lived plant in the world, the one that has generated and sold the most energy to the grid, and the one that has accumulated the most hours of operation and availability.

- **Floating devices (offshore):** This is based on one or several floating bodies that move following the waves vertically, horizontally, pitching or any combination of the three. The relative movement between the different parts of the device allows the mechanical energy of the wave to be converted into electricity. The most common configuration is vertical oscillation (buoy type).

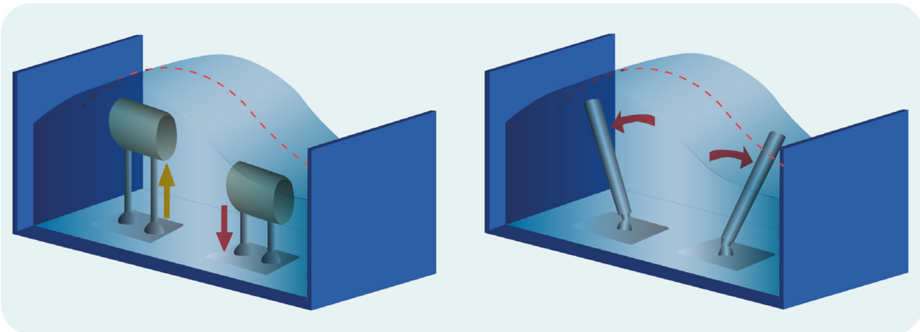
Figure 35. Most commonly used configurations for floating devices. Source: MITECO-IDAE



In 2016, the first floating wave energy device was installed on the BIMEP test platform, a 30 kW point absorber or buoy, making it the first device that has lasted 3 consecutive years in the water, in real sea conditions.

- **Submerged devices (vertical oscillation and articulation with respect to the bottom or impact).**

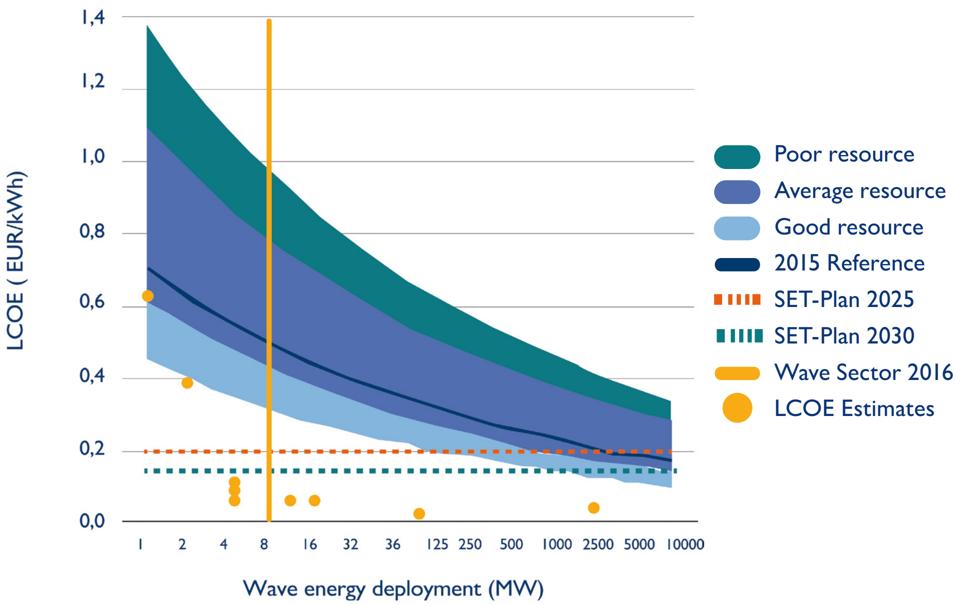
Figure 36. Most commonly used configurations of submerged oscillating devices.
Source: MITECO-IDAE



Wave Energy technologies present a large variability in costs due to the great diversity of existing prototypes, as well as of anchoring/fixing systems and systems to transport the energy. However, significant cost reductions are expected in the areas of installation, grid connection and project development due to economies of scale and improvements in these processes as a result of learning by doing.

In 2015, the LCOE of wave energy ranged from €470/MWh to €1,400/MWh, having reduced to €560/MWh in 2018 with the development of the first demonstration ones. With the cost reduction curve shown in the figure below, wave energy technologies are expected to reach an LCOE of 200 €/MWh by 2025 and 150 €/MWh by 2030.

Figure 37. LCOE reduction of wave energy technology as a function of cumulative installed capacity.
Source: JRC 2020 - ETRI 2014 (Tsiropoulos et al 2018)



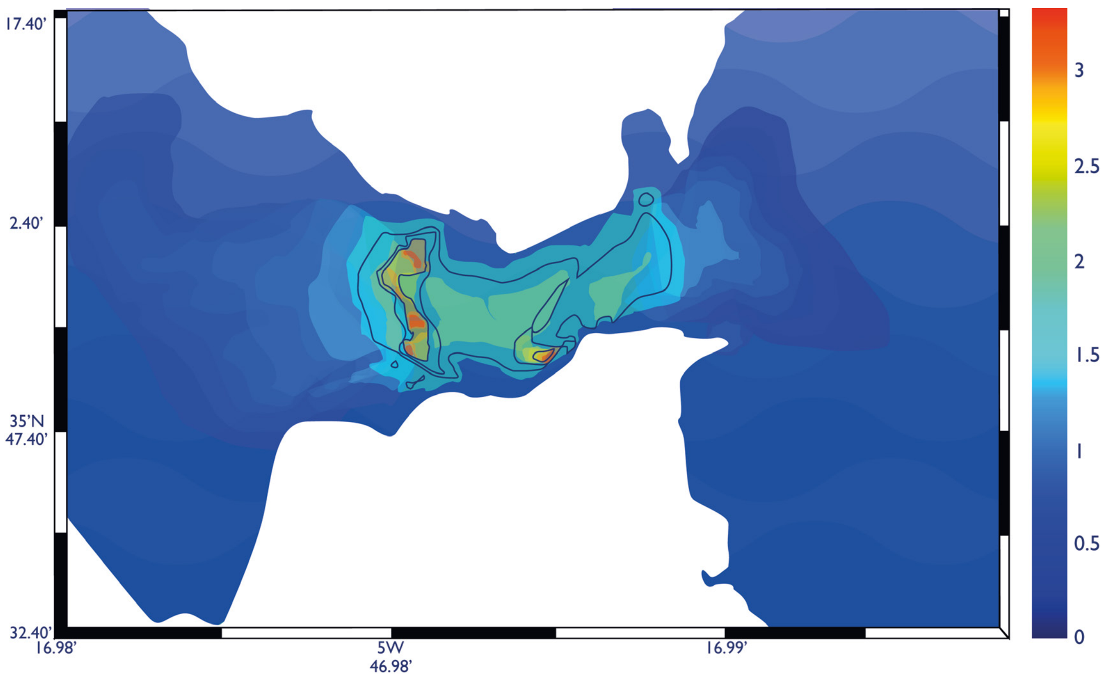
▸ **Energy of (tidal) currents/streams**

Another important source of energy from the sea is the harnessing of the kinetic energy of ocean currents. These are produced by the confluence of several factors: the rise and fall of the tides, which have been produced by the gravitational interaction of the Earth with the Sun and the Moon, the temperature differences produced by the unequal level of absorption of solar radiation in the seas and oceans, the planetary winds and the topography of the seabed near the coast.

Generally, stronger currents exist in areas that are relatively shallow, where there is a certain tidal range, and the topography of the seabed and coastline produce a funnel effect. Typical areas where these characteristics occur are the entrances to estuaries, bays, channels, straits and some large harbours. This means that in most areas the current velocity is not high enough to make exploitation of the resource profitable.

The areas with the greatest potential for marine current energy in Spain are confined to the areas of the Strait of Gibraltar and the Galician currents, which is where the speeds necessary for the operation of these devices are reached. The following figure identifies the area of Spain with the greatest potential for current energy:

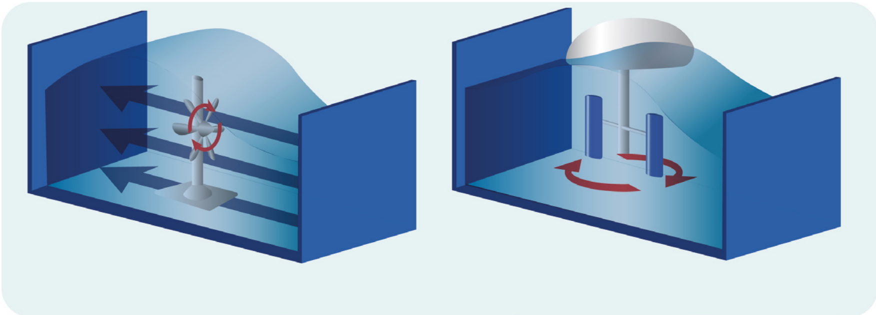
Figure 38. Maximum current speeds in the Strait area.
Source: University of Cadiz and Andalusian Energy Agency



Energy of (tidal) stream harnessing systems can be classified into two main groups: those that use a turbine to extract kinetic energy and those that use other types of systems (Venturi effect and hydrodynamic profiles).

Due to the similarity of the operating principle and the possibility to adapt some aspects and solutions of the design, most of the current devices under development employ a turbine, which depending on the direction of the current can be horizontal, vertical or cross-flow.

Figure 39. Most commonly used configurations of current energy devices.
Source: MITECO-IDAE



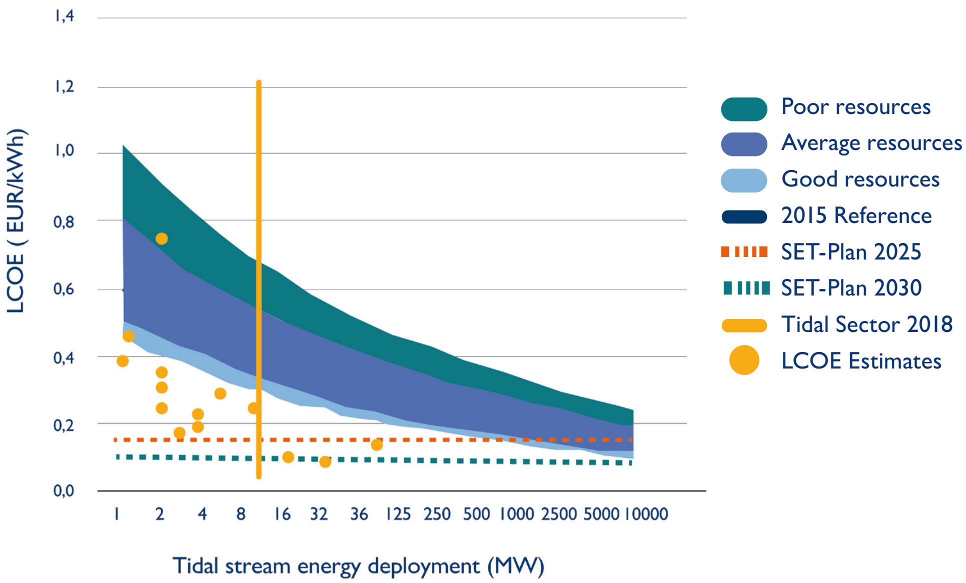
Developing tidal stream technologies have begun to converge on a common design (horizontal axis turbines) and are reaching a certain degree of maturity and implementation.

The technology associated with the exploitation of tidal currents presents construction processes with a high local content in shipyards and indirect and induced value chains, in which the industrial areas of Cadiz and Galicia, close to the areas of potential identified in Spain, are well positioned and highly competitive. As a result, the development of these projects could serve as a stimulus at local level.

On the other hand, the need for marine space for the use of tidal currents is reduced in terms of MW/km^2, compared to offshore wind farms - due to the necessary separations between wind turbines; with the additional advantage of not having a visual impact as they are submerged in the sea, but the impact they may have on maritime traffic and navigation safety must be taken into account, bearing in mind that the areas with the greatest potential for energy from marine currents in Spain are limited to the Strait of Gibraltar and areas of Galicia where there are very high densities of maritime traffic and where there are also traffic separation devices.

In terms of cost evolution, in 2015, the LCOE ranged between 470 and 1,020 €/MWh, reducing its value to around 400 €/MWh in 2018. With the cost reduction curve shown in the figure below, it is expected that the current energy technologies will reach a LCOE of 150 €/MWh by 2025 and 100 €/MWh by 2030.

Figure 40. LCOE reduction of tidal stream technology as a function of cumulative installed power. Source: JRC 2020 - ETRI 2014 (Tsiropoulos et al 2018)



- **Tidal amplitude energy**

They consist of taking advantage of the rise and fall of seawater produced by the gravitational action of the sun and the moon, based on the storage of water in a reservoir formed by building a dam that allows the entry of water or flow to be turbined in a bay, cove, river or estuary for electricity generation, although they can only occur at those points on the coast where the high tide and low tide differ by more than five metres in height. This condition, together with the application of different socio-environmental criteria in Europe, hinders the further expansion of this technology.

The technology used has a high degree of maturity due to its similarity to hydroelectric power plants in large-scale projects. The largest installation of this type is the La Rance power plant in France which started operating in 1967 with an installed capacity of 240 MW and more recently new projects are being developed in countries such as Korea and China.

In the case of Spain, there is no coastal area in which the minimum required differences in tidal range between high and low tide are achieved to allow the viability of this type of installation. This modality is therefore excluded from the scope of this Roadmap.

- **Thermal gradient energy or tidal energy**

The use of thermal energy from the sea is based on the difference in temperature between the sea surface and the deepest waters of the ocean. In places where this thermal gradient is at least 20° C, electricity can be produced by means of Rankine-type thermodynamic cycles. This minimum temperature difference limits the possible areas of exploitation to the waters between the tropics and near the equator.

The global potential of this type of resource is 44,000 TWh/year, the largest of all marine energy sources.

These technologies, known by their acronym OTEC "Ocean Thermal Energy Conversion", are still in the research and development phase, although the first demonstration plants in Hawaii and Japan, with a nominal power of 100 kW, have been successful. The Republic of Korea is currently installing a 1 MW plant in Kiribati in the Pacific Ocean. This will be the largest of its kind and is expected to demonstrate the high potential of OTEC in island applications, as these locations allow water flows to be used for purposes other than power generation, such as desalination, aquaculture and cooling.

In Spain there is no possibility of developing these technologies due to the climatic conditions of our coastal waters. Therefore, this modality is excluded from the scope of this Roadmap.

- **Salt gradient energy**

This is the energy obtained from the difference in salinity between seawater and river water through osmosis processes. Due to geographical limitations, this energy has the lowest potential of all marine energy sources with only 1,650 TWh/year worldwide.

The theoretical potential derived from mixing river water with seawater is 0.75 kWh/m^3, which can be increased when the salinity difference between the waters is higher; for mixing river water with Dead Sea water up to 14 kWh/m^3 could be reached.

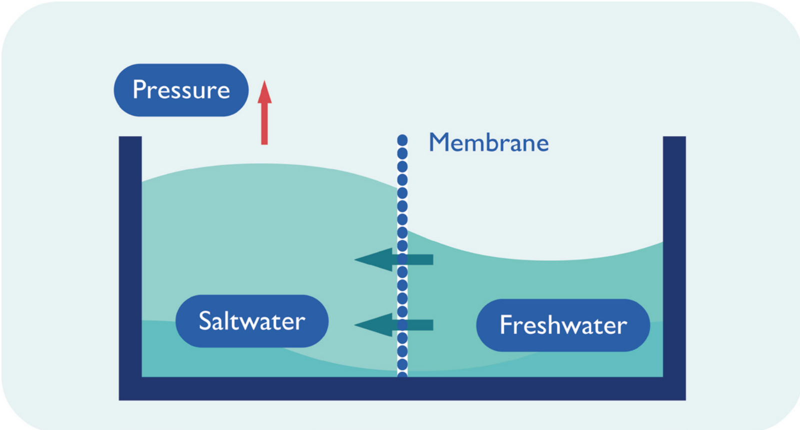
The most developed technologies or processes for harnessing the energy of the salt gradient are: pressure retarded osmosis and reverse electrodialysis.

  - Pressure Retarded Osmosis (PRO)

    The process is carried out in a tank consisting of two compartments separated by a semi-permeable osmotic membrane. Seawater is pumped into one of the compartments, while the other contains fresh water. As a result of the difference in salinity between the waters, osmosis occurs, which causes a natural flow of fresh water through the membrane to the seawater side, resulting in a pressure increase sufficient to drive a turbine and generate electricity.

    In this technology, the membrane is the main and most expensive element, so research on this technology is aimed at increasing its performance and lifetime.

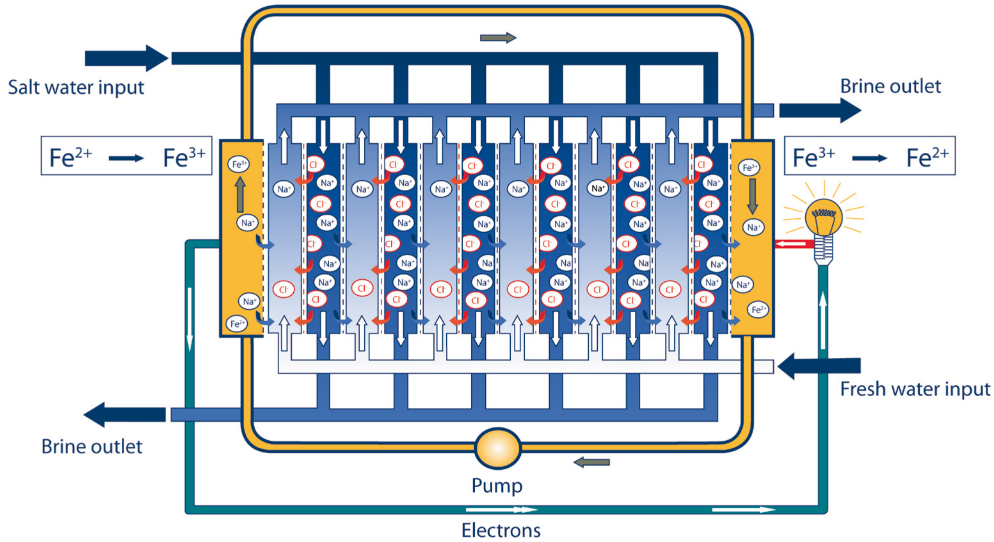
Figure 41. Diagram of the PRO process. Source: MITECO-IDAE



▹ Reverse electrodialysis

The process of electricity generation by reverse electrodialysis also uses membranes, but of a different nature. As a result of the difference in salinity of two electrolyte solutions on either side of the membrane, an electrical voltage is induced in the membrane. The total potential results from the electrical coupling of the membranes in the installation. The main challenge is to increase the scale of the membranes and, consequently, the power generated in the membranes.

Figure 42. Diagram of the reverse electrodialysis process. Source: MITECO-IDAE



Currently, these technologies have not advanced from R&D&I prototypes, but many countries are intensively researching these technologies. To date, there is only one 50 kW demonstration plant in operation using RED technology in the Netherlands and a Danish company plans to install its first commercial unit (80-100 kW) in 2021 in PRO technology.

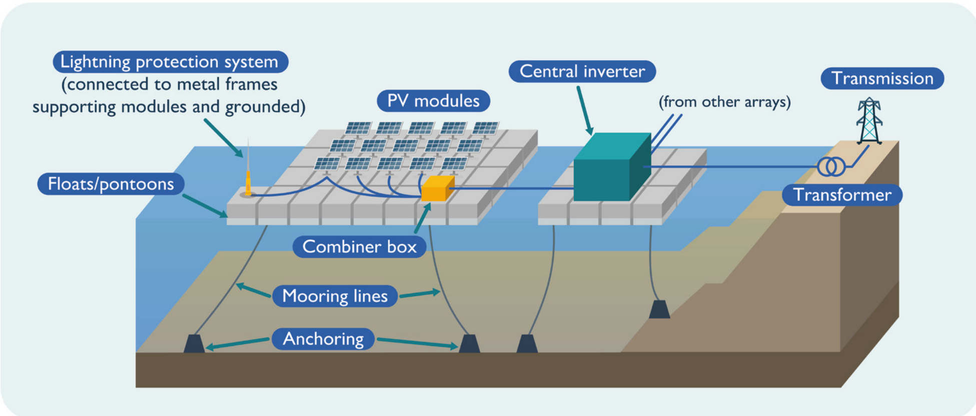
2.3 FLOATING PHOTOVOLTAIC SOLAR ENERGY

The term "*Floating Photovoltaic*" (FPV) is used to refer to any type of photovoltaic system installed on water bodies such as lakes, reservoirs, hydroelectric dams, mining or industrial and irrigation ponds, water treatment ponds and coastal lagoons and in experimental cases on the open sea.

In most cases, PV modules are usually mounted on a floating structure that is anchored and fastened to a fixed point, either on the bottom or on the shore.

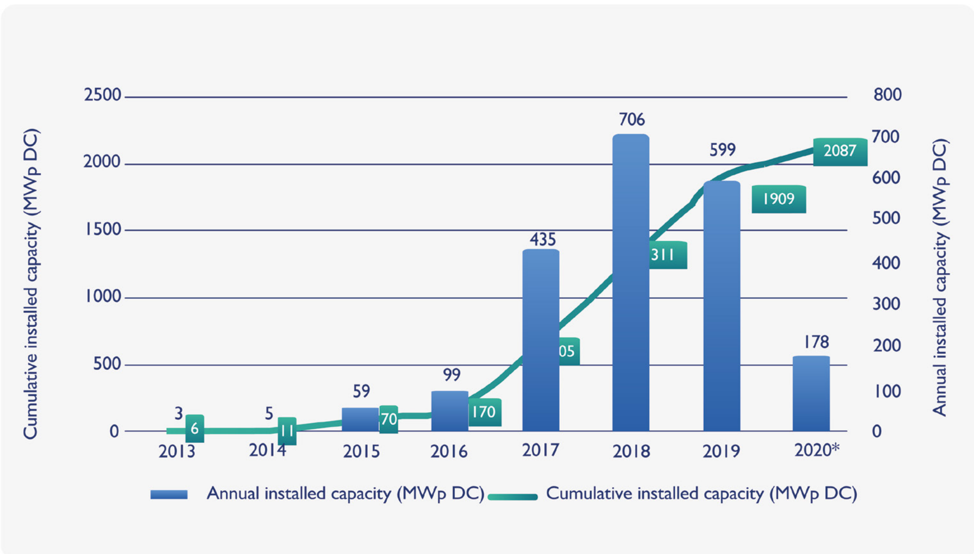
The installations are similar to land-based plants, whereby a distinction is made between a PV module part (PV modules) and a power electronics or conversion part (inverters). For smaller plants the inverter equipment can be located on the shore, for larger plants equivalent floating platform systems are designed which place the inverter equipment next to the PV field.

Figure 43. Schematics of FPV systems and key components. Source: Solar Energy Research Institute of Singapore



Floating Photovoltaics has been growing rapidly in recent years, mainly in countries with limited land space, such as Japan, or densely populated countries, such as China.

Figure 44. Global installed FPV capacity. Source: SERIS 2020



Floating solar PV, whether in freshwater or seawater, can be considered the third pillar of the global PV market, together with ground- and roof-mounted PV (including canopies and agrovoltaic installations), due to the growing demand for this technology, especially in countries with low land availability, such as densely populated countries and islands (IRENA, 2020)[29].

Comparing FPV systems with traditional solar photovoltaic systems, in ground and rooftop plants, we can find the following characteristics:

- ▹ Increased generation efficiency due to lower module temperature and lower surface dust.
- ▹ Reduced evaporation in water reservoirs and increased water quality by reducing algae blooms.
- ▹ Reduction or elimination of shadows.
- ▹ No land disturbance is required and assembly is simple and modular.
- ▹ Proximity to hydroelectric power plant locations, thereby optimising the use of existing lines.

▸ Technologies

Most large-scale plants are based on floating systems on which the PV modules are placed on a support structure with a fixed tilt angle.

The floating system may consist of isolated floats (called pure floats), floats with metal anchors, or membrane floats. In all cases an anchoring or mooring system is provided, the design of which depends on the location of the plant, depending on wind conditions, depth and water level variation:

▹ Pure floats

It consists of a system of two floats, where the main float holds the photovoltaic module with a certain inclination (between 15° and 22°), and the secondary floats ensure the correct fastening of the main floats, establishing the necessary distance to avoid shadows and allowing the platform to be walked on for O&M work. They incorporate standard size photovoltaic modules.

▹ Pontoon structures and metal frames

These are metal platforms that support the photovoltaic modules on floating pontoons, without the need for specially designed floats.

▹ Membrane structures

These are hydro-elastic floating membranes on which modules are placed without inclination through fastening rails. These membranes are usually made from polymers with high corrosion and mechanical fatigue resistance. They are usually designed to delimit a specific space, so they are not normally scalable.

▸ Current situation and future of the FPV

Although floating solar PV technology remains a "niche" technology, it is attracting increasing interest and the rate of implementation of unique projects has been increasing since 2013[30]. Based on observed trends, annual growth of more than 20% is expected until 2024 (Bhambhani, 2019)[31]. Energy Market Research estimates that the cumulative global installed capacity of FPV will be around 4.2 GW in 2024 (Energy Market Research, 2019)[30].

---

[29] IRENA (2020a), Fostering a blue economy: Offshore renewable energy, International Renewable Energy Agency,AbuDhabi https://www.irena.org/publications/2020/Dec/Fostering-a-blue-economy-Offshore-renewable-energy.

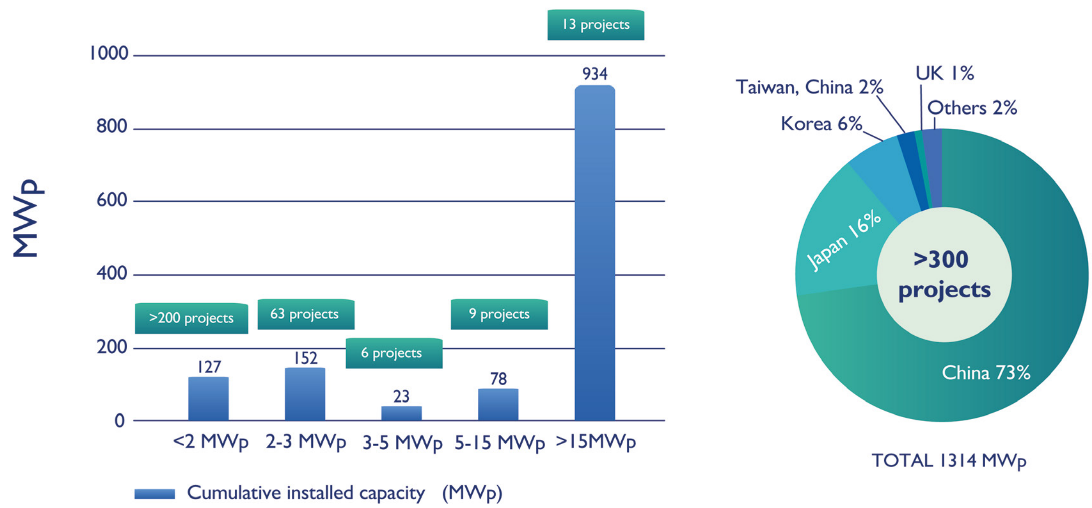
[30] Energy Market Research (2019), Global floating solar energy market – research and markets, Dehradun, www.researchandmarkets.com/reports/4855363/global-floating-solar-energy-market.

[31] Bhambhani, A. (2019), "2.4 GW cumulative floating solar installed by 2019-end", TaiyangNews, http://taiyangnews.info/business/2-4-gw-cumulative-floating-solar-installed-by-2019-end (accessed 9 February 2021).

At the end of August 2020, cumulative installed floating solar PV capacity was over 2 GW across 338 active projects in 35 countries worldwide mainly on artificial freshwater reservoirs. Installed capacity has doubled from 1.1 GW in 2018.

The country with the largest installed capacity of FPV is China, with 70% of the total. China is also home to the largest operating plants, some of which have installed capacities of up to 150 MWp.

Figure 45. Distribution of FPV plants by size as of December 2018.
Source: Solar Energy Research Institute of Singapore, 2019



In Africa, Ghana installed its first 5 MW floating solar power plant in 2020[32]. On this continent, the potential of floating photovoltaic technology is immense, estimated at around 2.92 GW on the 146 existing reservoirs. In Africa, the advantages of this technology are even more striking as it would drastically reduce evaporation losses in reservoirs and reduce the use of hydroelectric power plants in times of drought while conserving water resources.

In Europe, France, Italy, the United Kingdom and the Netherlands have large plants. For example, the Netherlands hosts a 27.4 MW plant[33]; in the UK, a 6.3 MW plant is located in the urban environment of London on one of the Thames reservoirs supplying drinking water to the city.

In Spain, there are several plants of varying power installed on irrigation water reservoirs. Of particular note is the plant connected to the grid on the Sierra Brava reservoir (Cáceres). With a power of 1.125 MW, it is made up of five adjacent floating systems and has been conceived as a technological demonstrator aimed at analysing the most suitable solutions for optimising energy production in this type of facility.

In Spain, there are also future innovative developments, such as the Plataforma Oceánica de Canarias (PLOCAN) project, which will test a floating photovoltaic power plant in the waters off the Canary Islands as part of the European BOOST project (Bringing Offshore Ocean Sun to the global market).

The project will pilot in unsheltered marine waters, a floating PV plant system inspired in part by the float and mooring technology that has been used for 20 years in Norwegian waters by the fish farming industry. This floating and mooring technology is combined with a disruptive and patented floating hydroelastic membrane (<1 mm thick) that is attached to an outer perimeter of floating pipe so that the float is not swept away by the mooring, even in strong currents, winds and waves.

[32] JRC, 2021. Assessment of floating solar photovoltaics potential in existing hydropower reservoirs in Africa

[33] IRENA_G20 https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Jul/IRENA_G20_Offshore_renewables_2021.pdf

The development of floating solar PV has led to a decrease in the technology's LCOE, which is currently estimated to average USD 0.354/kWh (Bellini, 2020). However, in some countries, floating solar PV has reached record levels of LCOE competitive with ground- and roof-mounted solar PV. For example, a 13 MW floating PV array in Selangor, Malaysia, achieved an LCOE of USD 0.051/kWh (Bellini, 2020). These records indicate that floating solar PV could reach competitive prices of USD 0.05/kWh by 2030 and USD 0.04/kWh by 2050 (Bellini, 2020)[34], with plants that can reach sizes and power outputs comparable to ground-mounted PV plants.

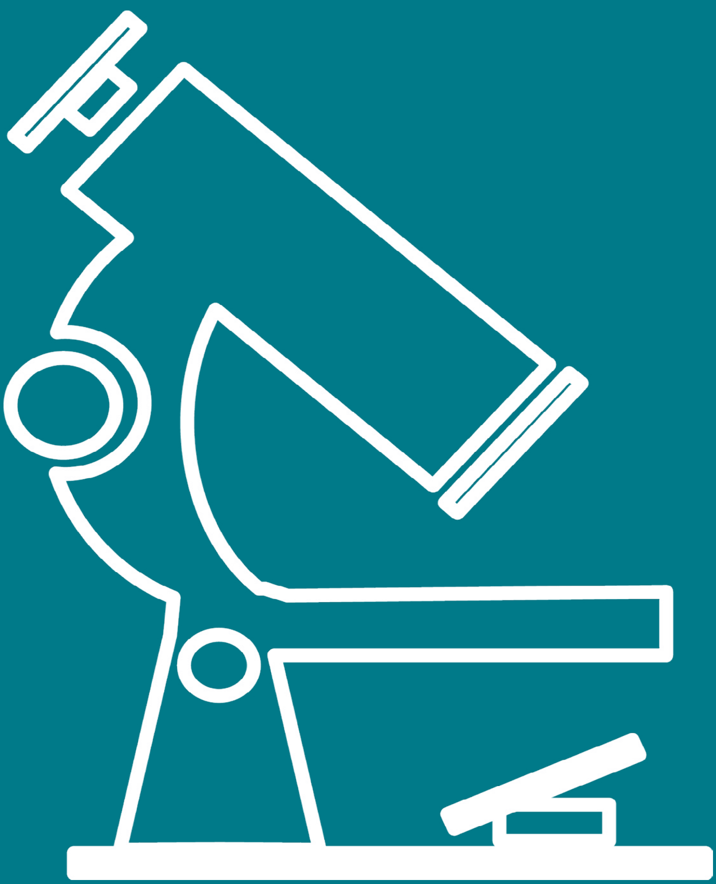
▸ Trends for floating photovoltaic solar energy

The main emerging trends for floating solar PV technology from a site-specific deployment point of view and from a coupling perspective are as follows:

- Increased deployment over water reservoirs and dams.
- Deployment at sea. Due to the pressing challenge of land availability, as well as the large potential of PV for islands, the technology is focusing on open water at sea, in contrast to conventional deployment in artificial water reservoirs and lakes. Of particular relevance could be locations of floating PV plants in port areas for self-supply and coverage of port electricity demand. For the study of possible locations at sea, their possible impact on maritime traffic and safety of navigation will have to be taken into account.
- Creation of combined technology power plants, sharing infrastructures with other marine and/or offshore wind energy technologies to reduce current investment and operating costs.
- Increase in installations associated with the direct and indirect electrification of sectors and activities linked to blue economy.

[34] Bellini, E. (2020), "Offshore floating PV may reach maturity in 2030", PV magazine, www.pv-magazine.com/2020/12/10/offshore-floating-pv-mayreach-maturity-in-2030 (accessed 25 April 2021).

3



ANALYSIS AND STRENGTHS OF THE SECTOR, INDUSTRIAL VALUE CHAIN AND R&D&I IN SPAIN

Offshore wind is an opportunity for Spain to take advantage of its potential for industrial development and innovation. The European Wind Energy Association, WindEurope, estimates that investment in the offshore sector will reach €16.5 billion in 2030 at European level, while the 'EU Strategy on Offshore Renewable Energy' recognises that to meet targets and maximise the benefits for the European economy, the offshore renewable energy value chain must be able to **increase its production capacities** and achieve higher rates of installation.

Spain is in a position to play a leading technological and industrial role in this context, to provide innovative and cost-effective solutions for fixed and floating offshore wind and marine energy in response to this investment potential.

In line with the framework for boosting the energy transition and its associated value chain envisaged in the Strategic Energy and Climate Framework, the Sectoral Agenda for the Wind Industry[35] identifies **offshore wind as one of the main levers for strengthening the Spanish wind industry**. This document, which forms part of Spain's Industrial Policy Strategy 2030[36], proposes a series of lines of action necessary for the development of the national offshore wind industry.

Offshore wind in Spain also has very important synergies with other strategic sectors, such as the shipbuilding industry (shipyards), the maritime-port sector and civil engineering, for which offshore wind has become a very important potential market in their business diversification and workload stabilisation strategies.

Many of the national companies have been heavily involved in the development of offshore wind farms in Europe and are already playing a leading role in the supply chain of the first floating wind turbine arrays on the continent, with Spain being the main supplier of floating foundations.

In addition, its geographical position, the extension of its coasts and the diversity of maritime regimes to which they are exposed, as well as the technological and research ecosystem, place Spain in an ideal position for the development, testing and demonstration of new prototypes and technological solutions linked to offshore wind, especially floating.

In this context, measures are necessary so that the Spanish industrial and naval ecosystem can maintain and strengthen the competitive positioning of the offshore industry, increasing its contribution to Gross Domestic Product and the generation of qualified employment in our country. In addition to the measures aimed at strengthening capacities, the development of offshore wind in Spain envisaged in this Roadmap also contributes to expanding the national supply chain market, as well as to continuing to develop innovative solutions that allow the sector to continue to compete and provide services at a global level.

3.1 OPPORTUNITIES AND INDUSTRIAL VALUE CHAIN

The industrial opportunity has been identified for Spain to reinforce the transfer of certain knowledge of the supply chain of onshore wind technology already existing and strongly implemented in the national territory to the marine field. In addition, Spain also has strong industrial capacities and talent in other important sectors for the development of marine energy, such as the shipbuilding sector, auxiliary industries and electrical systems.

In this sense, the development of marine energy will not only benefit directly related sectors, such as the manufacture of components for offshore operation -turbines, foundations, floating platforms and other auxiliary services- and service companies -potentially extended to operation and maintenance, vessels and other offshore services-, but also other relevant sectors of the Spanish economy could benefit from the development of offshore wind energy:

- The possible **use or reconversion of port infrastructures**, both for the **manufacture and assembly** of components and for use as **operating ports**. According to the 'EU Strategy on Offshore Renewable Energy',

[35] Ministry of Industry, Trade and Tourism and Asociación Empresarial Eólica, September 2019. Link: https://aeeolica.org/agenda-sectorial-de-la-industria-eolica/.

[36] Ministry of Industry, Trade and Tourism: https://www.mincotur.gob.es/es-es/gabineteprensa/notasprensa/2019/documents/docu%20directrices%20generales%20de%20la%20pol%C3%ADtica%20industrial%20espa%C3%B1ola.pdf.

only a few European ports are currently suitable for the assembly, manufacturing and maintenance of marine energy infrastructure, and it is estimated that an investment of between 500 and 1 billion euros may be needed to upgrade port infrastructure and capacities.

- The development and future operation of offshore wind farms in Spain would also give rise to a new **repair and maintenance** market, very interesting for the Spanish shipbuilding industry. Shipbuilding, both for the manufacture or assembly of components, as well as for the manufacture of specific vessels for installation activities and marine operations.
- Many of the national **engineering companies** already have some involvement in the implementation of offshore wind projects at international level. Therefore, their technological development capacity will allow them to take on offshore renewable projects and strengthen their penetration in the global market, taking into account their participation and recognised international prestige in projects in other renewable or traditional sectors (such as the construction, naval, transport, etc.).

Measures to boost offshore wind will therefore generate direct benefits for these strategic sectors, which are traditionally subject to strong market fluctuations. In addition, specific opportunities are identified in the context of two key sectors: the wind energy sector itself, and the shipbuilding and port industry sector.

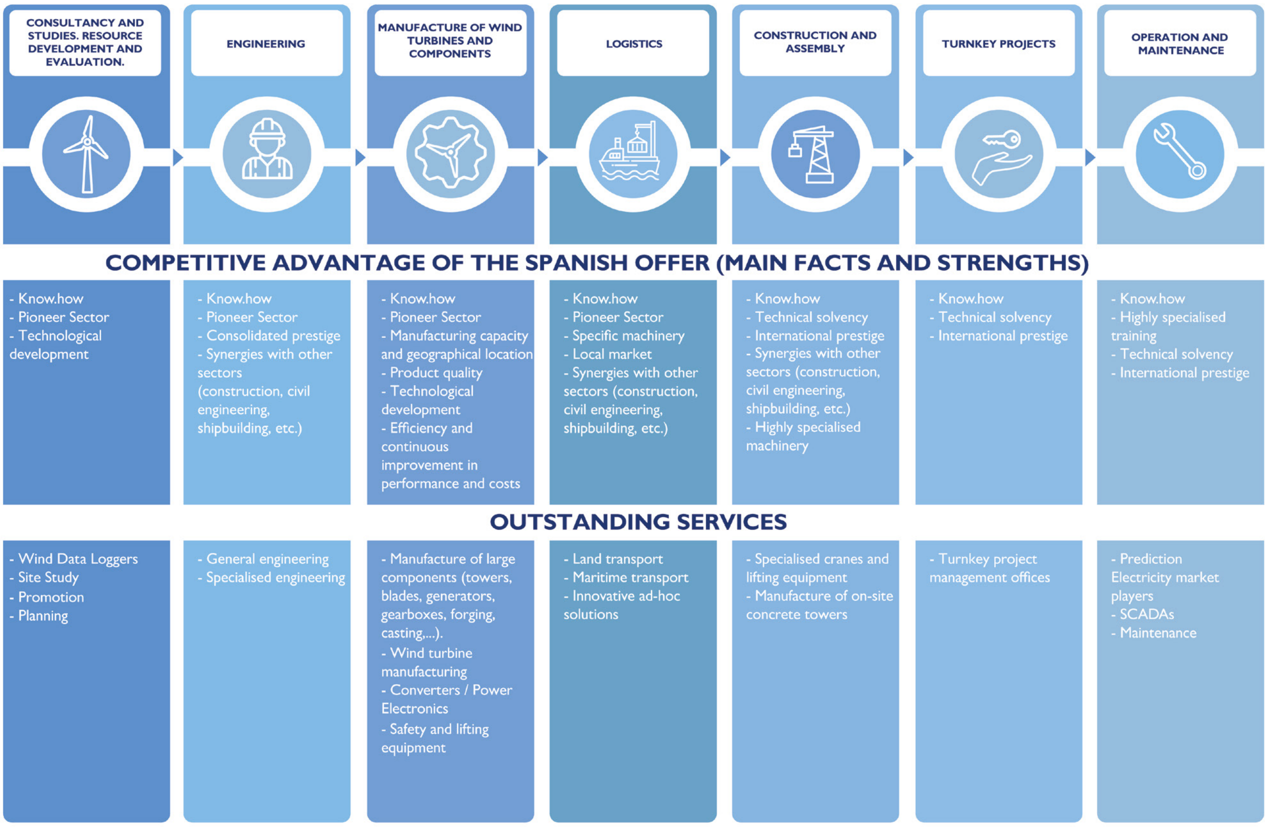
- **Industrial and innovation potential of the wind energy sector**

In relation to the industrial potential of wind turbines and the wind energy sector itself, it is a sector that invests particularly heavily in R&D&I. Spain is one of the three European countries, together with Germany and Denmark, in which the bulk of public and private investment in R&D&I in the field of wind energy is concentrated[37]. Specifically, Spain has more than 800 patents in wind energy since 2006, making it the sixth country in the world and the third in the European Union in this indicator[38].

Furthermore, the Spanish industrial sector is capable of providing the entire value chain associated with the design, development, construction and operation of an onshore wind farm, as shown in the following figure.

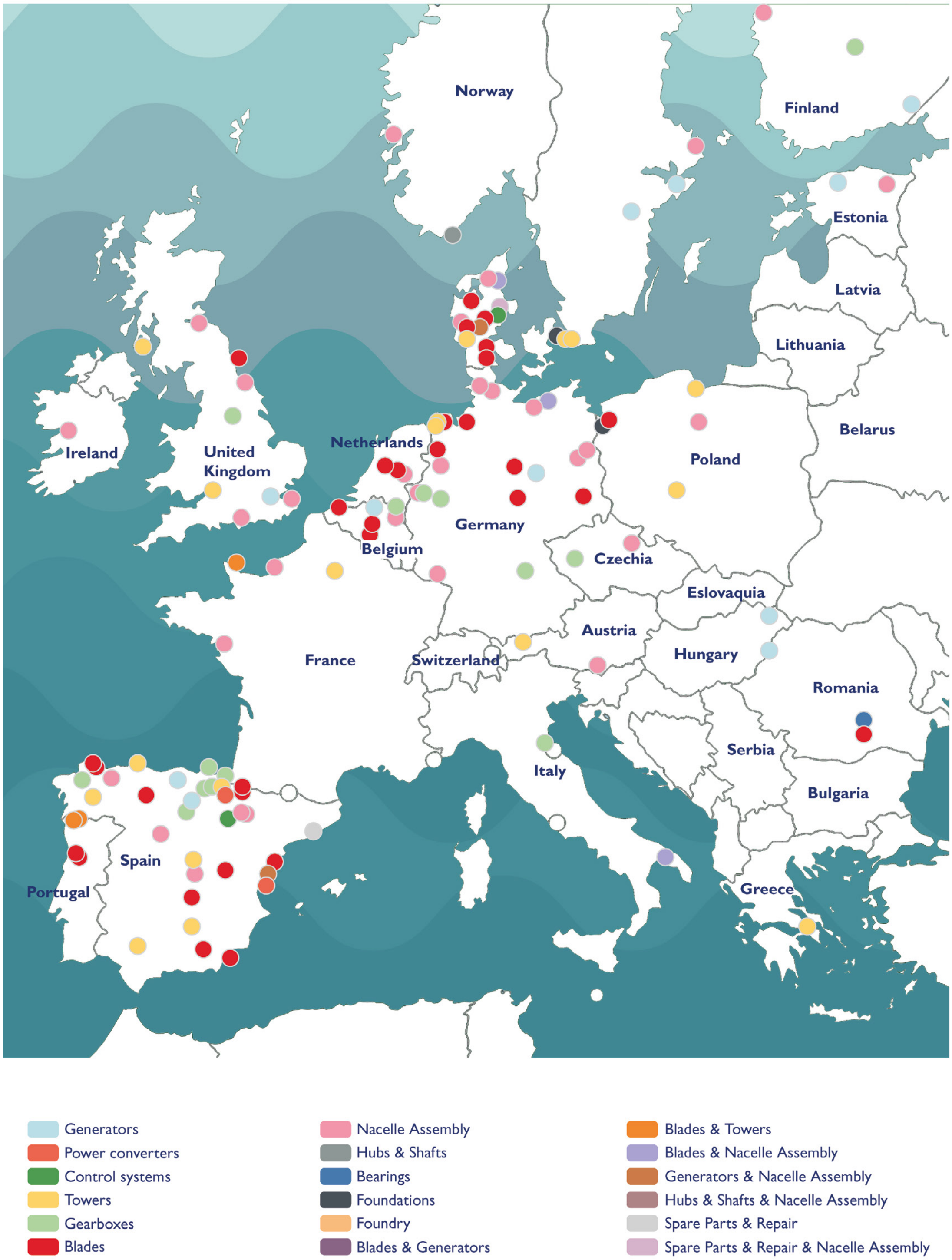
[37] Wind Energy Technology Market Report – JRC (EUR 29922 EN).
[38] Wind Yearbook 2020 (AEE).

Figure 46. Value chain of the wind industry. Source: Wind Industry Sectoral Agenda



In addition to representing the entire value chain, this sector in Spain has a relatively distributed presence, generating industrial opportunities in different areas of the peninsular territory, as illustrated in the following figure.

Figure 47. Wind energy component manufacturing facilities in Europe. Source: JRC



- **Shipbuilding, shipyards and port industry sector**

The marine energy market is positioned as an important source of demand for **vessels to support the construction**, commissioning and maintenance of offshore wind farms. The Spanish naval industry and engineering are capable of meeting the future demands of other industrial sectors and thus opening up new market segments. In this sense, the Spanish naval sector's experience in the construction of support vessels for offshore operations in the field of *oil & gas* can be used for the construction of special vessels associated with the deployment of offshore renewable energy.

As for its innovative contribution in the naval field, it is particularly relevant in the manufacture of marine drones, **innovative products** for offshore wind farms, marine energy devices, engine components, propellers or complex naval fittings for ships.

From a qualitative point of view, within the demanding global market of highly complex and unitary value prototype ships and specialised marine artefacts in which the Spanish sector competes, the Spanish shipbuilding industry enjoys great international prestige that makes it a world reference, thus determining its clearly export-oriented character.

On the other hand, the **manufacture of large structures** (fixed, floating or even complete offshore substations) and various wind power components in Spanish shipyards, located in areas close to ports and which also have extensive experience in the manufacturing processes of metal products, is providing a great opportunity for the diversification of the shipbuilding industry's business. The shipyards and the ancillary naval industry have already experienced the increase in activity derived from the wind power segment, combining their own activity of building service vessels for offshore wind farms with the construction of wind turbine components, also acting as a logistics hub for pre-assembly and loading onto the ships that transport them.

Spanish shipyards and ports have the human resources, industrial facilities and technological excellence to deal with the specific complexity of marine energy projects, which represents an important opportunity that also has a driving force on industry and local employment in the regions where the projects are developed.

In relation to **ports**, the size and weight of offshore wind turbine components make the ports supporting these projects relatively unique compared to conventional port typology. Port facilities have different specific requirements depending on whether they are used for manufacturing, operations and maintenance or storage activities: access for large capacity vessels, indoor and outdoor storage capacity, lifting capacity, ability to accommodate specialised vessels (nacelle transport, crane vessels, cable laying vessels, service vessels) and crew transfer among others. Therefore, being able to carry out the necessary adaptations in Spanish ports will allow them to gain competitiveness in the framework of the offshore renewable energy value chain.

Finally, it will be necessary to ensure that regulatory or procedural developments cover all aspects related to safety in a broad sense and the prevention of contamination of the different structures and elements that make up the wind farm.

- **Strengths and capacities**

In more specific terms related to Spain's strengths and capabilities for the development of technological concepts specific to offshore wind, the following aspects stand out:

  - Attractive geographical location for accessing European markets and the East Coast of America.
  - Engineering studies, siting and assessment of marine resource and maritime climate conditions.
  - Geophysical surveys, bathymetric and geotechnical studies.
  - Floating systems with Lidar technology for offshore wind resource measurement.
  - Offshore blades and towers, where Spain already has infrastructure and players dedicated to the construction of offshore blades and towers. Existing manufacturing facilities can easily be adapted to accommodate larger elements required for offshore wind applications.

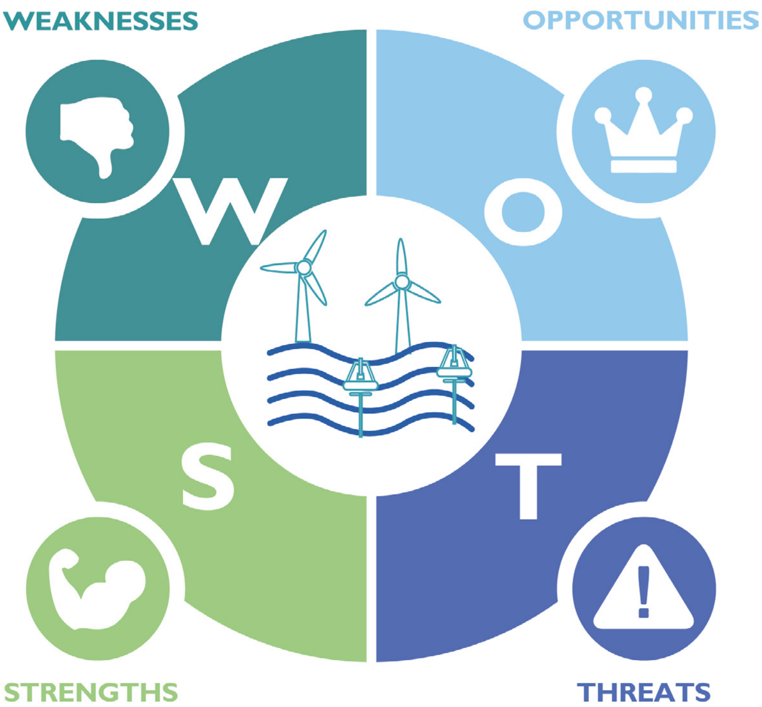
- Chains for anchoring systems for underwater structures: Spain has a great capacity in both the design and manufacture of chains and is a world leader. The momentum and demand for floating wind turbines will have a major impact on this industry.
- Anchoring system: Jack-up structures for wind turbine installation.
- Marine electrical substations in direct or alternating current: Spain has a great deal of capacity in power electronics, experience in the construction of substations for fixed foundations and the capacity to build floating structures. When local and European demand arises, Spain could position itself as a leader in substations.
- Manufacture and installation of submarine cables.
- Wind turbine support structures, fixed or floating, which can be made of steel, concrete or mixed. Spain has industrial capacity in the technological development of floats and has concepts under development such as steel and concrete floats.
- Installation vessels and support vessels for offshore wind farms, for the installation of the support structures and/or the wind turbines themselves, as well as for their maintenance and decommissioning.
- Vessels and platforms for the installation of support structures and/or wind turbines, as well as for their maintenance and decommissioning.
- Port infrastructure, shipyards and manufacturing capacity.
- Service/O&M vessels for offshore wind farms of SOV (Service Operation Vessel) or catamaran type.

The following figure summarises the SWOT analysis of Strengths, Weaknesses, Threats and Opportunities of the Offshore Floating Wind Sector in Spain, carried out by EIT-Innoenergy.

Figure 48. SWOT analysis of the Offshore Floating Wind Sector in Spain. Source: EIT-Innoenergy

1. Although several developers have expressed their interest in implementing this technology in the Iberia, this has not yet materialized into a particular pipeline of projects.
2. Currently, INECPs of Spain and Portugal include very low or no specific targets for offshore energy to 2030.
3. Investments in the development of new projects, and even more so regarding the supply chain, require a long-term political perspective.
4. Existing regulations requires updating in both countries regarding MSP, streamlining of administrative procedures and the establishment of an appropiate remuneration framework.
5. Public Investment is needed to promote the development of an internal demand of projects (e.g., supporting mechanisms).

1. Significant cost reductions are expected in the coming years wich will bring down the LCOE by a 66% on average.
2. The EC estimates 450 GW of offshore wind by 2050; of which 100 and 150 GW are anticipated to be floating.
3. WindEurope estimates that Iberia could install up to 22 GW of offshore wind by 2050 and this is expected to be mostly floating given water depths.
4. An internal demand of projects will activate strengthen the industrial network and value chain, allowing to move to the outside market.
5. FOW could have a significant impact for the Iberian economy.
6. Annual GDP contribution could reach a value between EUR 4,681 and 7,752 millions.
7. The consequent job creation would range between 43,669 and 77,825 jobs.



1. Iberia has a significant offshore wind resource and given its water depth conditions, FOW is expected to be the appropriate technology for it
2. The Iberian region has strong capabilities across almost the entire FOW value chain, resulting in a relatively advantageous positioning against other competing regions
3. Additionally, the Iberian region is very strong in some cross-cutting capabilities which have a low replicability (geogrphical positioning, supply chain, port infrastructure, manufacturing cost competitiveness, etc.)
4. First mover advantage:
   - There are several FOW technologies being developed in the region, with a precommercial project in operation in Portugal (WindFloat).
   - Spanish shipyards have constructed the floating structures for some of the most relevant FOW projects and the region has leading players in offshore moorings

1. Competition with other renewable energy sources.
2. Current LCOE levels for FOW are yet not competitive against other generation tecnologies.
3. Competition with other potential technology and industry hubs.
4. There are other countries/regions wich are well positioned for FOW development and might threaten Iberia's positioning (e.g., France, Poland, UK, etc.).

In summary, the Spanish and Iberian value chain presents high capacities and a favourable positioning to establish itself as a hub of reference at international level, although this should be accompanied by measures to mitigate the weaknesses detected, such as the need to generate a sufficient internal market, adapt regulation and promote the development of projects of high technological value on the coasts of the Iberian Peninsula.

3.2 SPAIN AS A BENCHMARK IN OFFSHORE WIND AND MARINE ENERGY INNOVATION INFRASTRUCTURES

Spain has a great capacity for R&D&I in offshore wind in general and floating wind in particular, with important marine-maritime research centres, unique offshore wind projects, wave and current energy prototypes and cutting-edge research groups, as well as several top-level testing platforms for marine energy generation technologies supported by the Administration.

Spain also represents one of the countries where the largest number of innovative offshore floating platform designs are being developed. As previously indicated, of the 27 floating solutions currently identified as active worldwide, 7 are Spanish patents and are mostly innovative prototypes that seek to reduce the cost of floating wind technology.

It should also be noted that Spain offers **infrastructures of international reference** for the technological development of marine energy and in particular **floating technology**. Most of these infrastructures are grouped together by the Ministry of Science and Innovation through the "Singular Scientific-Technical Infrastructures (ICTS) Programme", called Maritime Aggregated Research Hydraulic Infrastructures (MARHIS) programme. According to the recently published report "An overview of Marine energy Activities in 2020" by the IEA, Spain is the **European Union country with the most R&D&I facilities for marine energy** and has up to **three (3) open sea test centres** (BIMEP, PLOCAN, Punta Langosteira), perfectly enclosed and fully equipped to house offshore wind and marine energy devices and prototypes in its waters. Offshore test centres are a common step in the development of marine energy in countries around the world and are a key milestone for the innovation and development of the marine energy industry.

Figure 49. Map of R&D&I infrastructures in Spain related to offshore renewable energy.
Source: MITECO-IDAE

This set of reference facilities consists of the following:

- **The Great Maritime Engineering Tank of Cantabria / *Cantabria Coastal and Ocean Basin* (GTIM-CCOB)** located in the Science and Technology Park of Cantabria (PCTCAN, Santander) and managed by the Environmental Hydraulics Institute Foundation. The tank has a **global conceptual design that is unique in the world in the field of maritime engineering**, which can be used to simulate any process, design or any type of infrastructure. The large tank is 44 metres wide and 30 metres long, can hold 5.5 million litres of water and simulate waves of up to 20 metres and winds of 150 kilometres per hour. In this installation it is possible to recreate conditions that occur in a real atmospheric phenomenon, simulating waves in all directions.
- ***Integrated Coastal Infrastructures for Experimentation and Modelling* (iCIEM)**, managed by the Maritime Engineering Laboratory, a specific research centre of the Polytechnic University of Catalonia, BarcelonaTech (LIM/UPC) and distributed in different locations in the coastal area of Barcelona. It allows research and engineering activities in the maritime field (coastal, port and environmental applications), consisting of a combination of laboratories of various scales, field monitoring stations, and advanced numerical modelling platforms. The main facilities are:
  - The CIEM **large-scale wave flume** and the CIEMito **small-scale flume**, both capable of generating waves and currents. The former, a large-scale 2D test flume channel with almost no distortion (100 m long, 3 m wide and up to 7 m deep), is a relevant tool for carrying out experiments in the field of coastal, port and oceanographic engineering, as well as in other fields such as aquaculture or the energetic exploitation of marine resources. The CIEMito is a transparent channel with a total length of 18m, with a useful section of approximately 0.40m wide and 0.56m high. It allows small-scale experiments and optimisation and complementarity, especially for optical measurements of transparent water, with the CIEM.
  - The Maritime Field Observation Laboratory has the XIOM Shelf Observatory for the **collection of meteorological and oceanographic variables** along the Catalan coast, from the Gulf of Roses to the Ebro Delta, with the capacity to measure waves, currents, meteorology, long period oscillations (tide and other long waves) and a group of maritime-terrestrial meteorological stations specially adapted for the coastal area.
  - The Pont del Petroli Coastal Observatory is a jetty extending 250 m out to sea, from very shallow waters to intermediate depths (12 m). It is **the first installation in micromareal conditions in the European Union**, and complements the network of instrumented pontoons of which HORS in Japan and Duck in the USA are part. Both laboratories are complemented by a high-resolution Numerical Modelling Laboratory, which provides services ranging from the **replication of hydraulic models to prediction systems for meteo-oceanographic parameters**; as well as a "Remote Laboratory" (rWLaB), a platform for **education, research and dissemination** of knowledge that allows remote access to the laboratory facilities and to the different field data acquisition stations (XIOM and Pont del Petroli).
- **Centro de Experiencias Hidrodinámicas de El Pardo (CEHIPAR)**, which depends on the Instituto Nacional de Técnica Aeroespacial (INTA) and is located in El Pardo (Madrid). It is a public centre for research, technological development and high-level technical assistance, **internationally recognised as a leading centre for hydrodynamic research**, which carries out projects, experimentation and research work requested by organisations, shipyards, shipping companies, engineering offices, manufacturers and private individuals. It has the following unique facilities:
  - Still water channel (320 metres long, 12.5 metres wide and 6.5 metres deep, allows wind speeds of up to 10m/s).
  - Laboratory for ship behaviour at sea and manoeuvrability (150 m long, 30 m wide and 5 m deep pool capable of generating 90 cm high waves. It has modern wave generation technology and instrumentation for testing the movements of ships, off-shore platforms and floating artefacts in waves and wind. This laboratory has a 150 m long, 30 m wide and 5 m deep channel which at one end has a 10 m square with an additional 5 m deep (total depth 10 m) and a wave generator.

  - ▷ Cavitation Tunnel: The cavitation tunnel allows optimisation of propeller design by testing and studying cavitation generation, erosion risk, pressure fluctuations and noise production inherent to cavitation.

- **Biscay Marine Energy Platform (BiMEP)**, a public company of the Basque Energy Agency (EVE) and the Institute for Energy Diversification and Saving (IDAE) for the development, construction, operation and maintenance and management of the open sea test platform. This is an infrastructure for **testing both marine energy collector prototypes and offshore wind systems and auxiliary equipment** in real sea conditions, located off the coast of Armintza (Lemoniz, Vizcaya).

  BIMEP, in operation since June 2015, offers technology developers an area with a wave and wind resource suitable for demonstrating the technical and economic feasibility of different concepts, as well as their safety before moving to full-scale commercial status. It consists of an **open sea test area, with a 5.3 km^2 restricted sailing area, with grid connection for the demonstration and validation of wave energy converters and floating wind platforms**, at depths between 50-90 metres. It has a total capacity of 20 MW distributed over four (4) submarine cables of 5 MW each equipped with optical fibres.

  Since 2019, the Mutriku wave power plant, **the first commercial facility in the world to operate by injecting wave-generated electricity into the grid**, is integrated into BiMEP. It consists of a wave power generation and testing plant with Oscillating Water Column technology that offers a unique opportunity for the testing of new concepts of air turbines and control systems and auxiliary equipment prior to their testing in the open sea, at BiMEP's facilities in Armintza.

- **Oceanic Platform of the Canary Islands** managed by the PLOCAN Consortium (co-financed in equal parts by the General State Administration, through the MICINN, and the Government of the Autonomous Community of the Canary Islands).

  PLOCAN is part of the Map of Singular Scientific-Technical Infrastructures (ICTS) and its mission is to promote scientific, technological development and innovation of excellence in the marine and maritime field, accelerating the arrival to the market of its results and products, in particular those, such as offshore renewable energy, whose development requires test beds located in the marine environment, favouring economic growth and employment, through efficient access to the ocean at increasing depths and in an environmentally sustainable manner.

  PLOCAN provides **access and transdisciplinary logistical support through its onshore facilities and marine test beds**. The offshore infrastructure consists of a fixed marine platform located 1.5 km offshore and at a depth of 30 metres in the open sea in the Northeast of the island of Gran Canaria, in an area of 23 km^2 reserved for such scientific-technical experimentation and validation of prototypes.

  The onshore infrastructure integrates 400 m^2 of **workshops equipped for electronics and mechanical integration, repair, storage and logistics, including a wet laboratory with a salt water tank**. In addition, a control room for the piloting of marine vehicles and related topics is also available.

  It has two (2) submarine power cables in service and two (2) more in the pipeline, with a maximum evacuation power of 15 MW. One of the main 5MW modules is intended for wave energy converters with 5 positions of 1 MW each and the other module for offshore wind technologies.

- **Unique CEDEX facilities used for offshore wind experimentation**

  The Ministry of Transport, Mobility and Urban Agenda has, through the CEDEX Centre for Ports and Coasts Studies, a set of **unique facilities - a multi-directional wave tank, a large-scale wave and wind channel and a ship manoeuvring simulator** - with the capacity to carry out simulation and experimentation studies on physical models of structures and facilities that may be located in the marine environment.

  These infrastructures allow tests to be carried out on fixed and floating platforms to support offshore wind energy generators, as well as devices for wave energy generation, and have already been used by the private sector for testing and testing in different R&D&I projects in the field of offshore renewable energy.

- **Experimental area for the use of marine energies in Punta Langosteira, Galicia**

The outer harbour of A Coruña Punta Langosteira, in the municipality of Arteixo, is home to the experimental wave energy plant, part of the EnergyMare project. It is considered to be the **second experimental area in the world with the highest concentration of wave energy**, after the south coast of Wales.

The Instituto Enerxético de Galicia (INEGA) coordinates the consortium formed by eleven (11) partners from Spain, Portugal, France, United Kingdom and Ireland, which aims to develop the 2.6 km^2 maritime-terrestrial public domain in the vicinity of the outer harbour of A Coruña, at a distance of between 20 and 60 metres from the coast and at a depth of 500m.

Since mid-2015, the waters of Punta Langosteira have been the maritime laboratory where different companies and research entities have been carrying out tests aimed at obtaining energy from waves.

This is an **ocean infrastructure for research, demonstration and operation of marine energy converters** in real open water conditions, mainly wave energy converters. The test area allows developers and technologists to test their devices and validate designs, components and materials, as well as to verify the technical and economic feasibility of the devices.

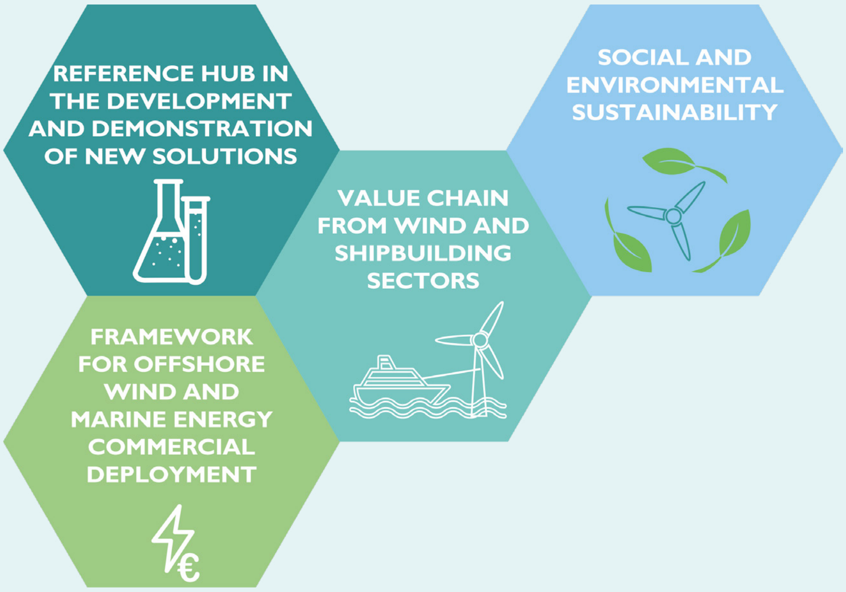
A modification of the concession is currently being considered so that it can also host offshore wind tests.

4

OBJECTIVES TO 2030 AND VISION OF THE FRAMEWORK FOR THE DEPLOYMENT OF OFFSHORE RENEWABLE ENERGY IN SPAIN

With this Roadmap for offshore wind and marine energy, Spain has set itself a four-fold objective:

Figure 50. Key objectives of the Roadmap for the development of Offshore renewable Energies in Spain. Source: MITECO-IDAE



Establish Spain as **the European pole of reference for technological development and R&D&I for the design, upscaling and demonstration of new technologies and environmental innovation**, taking advantage of the country's unique geographical features and maritime regimes, reinforcing the network of test platforms and deploying a "plug & play" enabling framework to streamline the testing of new prototypes;

Take advantage of the Spanish industry's leadership in wind energy, in the shipbuilding and maritime industry, as well as in the manufacture of capital goods, to extend it to offshore wind energy and marine energy, making the country **an international and European benchmark in industrial capacities and the entire value chain of these energies**. This approach seeks to contribute to European industrial leadership and its strategic autonomy in this field, the consolidation and generation of employment in the value chain associated with offshore renewables and the promotion of aligned industrial investment decisions.

Promote the development of offshore renewables that not only ensures their **environmental compatibility**, but also contributes to a **better understanding of the marine environment, its state of conservation and the possible interactions and effects of the different uses and activities with synergistic approaches and the search for socio-economic benefits for local communities**, as facilitating and consensus-building elements to make commercial offshore wind projects viable. This deployment will enable the application of best practices, with successful international references, to achieve positive environmental impacts that guarantee the conservation of marine biodiversity.

Define targets for the **deployment of offshore wind in particular and offshore renewable energy harnessing** with long-term goals to provide the continuity and visibility needed to achieve climate objectives, also underpinning industrial and technological development.

4.1 SPAIN AS A REFERENCE HUB FOR THE DEVELOPMENT AND TESTING OF NEW OFFSHORE SOLUTIONS

In order for the development of floating wind and other marine energy solutions to meet the most ambitious cost reduction targets and achieve full competitiveness, continuous investment in research, development and innovation is essential, as well as the promotion of new solutions that make the necessary technological leap forward effective.

Reducing the *time to market* for new technological concepts means being able to test experimental projects, prototypes or pre-commercial facilities quickly and in real conditions. Spain has not only leading test platforms equipped with the necessary infrastructures and services, but also diverse climatic conditions and geographical and maritime regimes that allow testing solutions for different environments and markets.

Therefore, this Roadmap proposes to make Spain **the European benchmark for the testing of new prototypes and solutions, establishing a flexible and agile 'plug&play' framework** by strengthening existing test platforms, developing an attractive processing framework for new test platforms and, especially, the exchange of prototypes within the boundary conditions of the platforms, all accompanied by the R&D&I ecosystem of which the country's technology centres form part.

- **In particular, the framework to be developed aims to be a European leader in terms of authorisation timing for the testing of new prototypes.**
- **In addition, it is accompanied by a support framework that seeks to significantly increase the budget for public investment in R&D&I in the field of offshore wind energy and marine energy, devoting at least 200 million public euros in the period 2021-2023 for technological innovation in this field, depending on the maturity of the projects and the proposals presented by the different players.**

In addition to the above, it is proposed to consolidate the R&D&I infrastructures and technology centres in Spain related to offshore renewable energy, mentioned in section 3.2, as forums for the development of projects that test and demonstrate the commercial viability of innovative solutions for the generation of offshore renewable energy with an environmental focus.

4.2 CONSOLIDATION AND STRENGTHENING OF THE VALUE CHAIN

The relevant positioning of the Spanish industry in the wind and naval fields has allowed the country's companies to play a role in the deployment of offshore wind at European and global level.

To ensure the resilience of the Spanish and European position in the face of the expected turning point in the deployment of floating wind and other offshore energy, as identified in the 'EU Strategy on Offshore Renewable Energy', it is necessary to develop supply-side policies. In this sense, it is essential to **systematise industrial policy in the field of offshore renewable energy, identify existing and foreseeable needs in the new context, and take advantage of synergies with the rest of the national and European industrial ecosystem**, especially in a context of necessary economic recovery. The approach to this objective would be to boost the capacities of the national value chain in this strategic sector, both nationally and in international showcases[39].

[39] Example of action in collaboration between ICEX and the Spanish Wind Energy Association (AEE): Spanish Wind Energy Industry Catalogue. 2019 (https://www.aeeolica.org/images/Publicaciones/Catalogo-de-la-Industria-Eolica-Espaola.pdf).

- **This Roadmap aims to back, support and strengthen the value chain associated with the deployment of offshore renewable energy, trying to create the logistical conditions, accompanying companies and identifying the appropriate conditions to take advantage of opportunities for the stakeholders involved.**

In this sense, the sectoral measures proposed contemplate not only the offshore renewable projects themselves, but also the logistical, infrastructural, industrial and value chain approach to generate economic and social activity and quality employment during the manufacture of components and the generation of associated goods and services. In addition, cross-cutting measures are proposed with other strategies and roadmaps currently under development.

4.3 ENVIRONMENTAL AND SOCIAL SUSTAINABILITY

As indicated above, Spain has just over 12% of its marine area protected, exceeding the 10% coverage threshold committed to by 2020 under the Convention on Biological Diversity. Furthermore, in line with the High Ambition Coalition and the Global Oceans Alliance to which Spain belongs, the country has set itself the **objective of strengthening the protection framework to reach the target of protecting 30% of the marine area by 2030**, which should comprise a representative and well-connected sample of marine habitats and species from the different biogeographic regions present in Spanish seas.

For its part, the coastal strip of our country is home to a third of the Spanish population, although it only makes up 6.7% of the territory. During the first years of the 21st century, the resident population in coastal municipalities has grown at a higher rate than the national average (1.9%, compared to 1.6% overall). The coasts are also a key attraction for one of the country's main economic activities: tourism.

Both the sea and the coastal zone are subject to risks arising from Climate Change and pressures from different activities and uses of the maritime-terrestrial environment. Amongst others, increased water temperature, increased acidity, decreased oxygen levels and more violent storms at sea constitute physical and chemical impacts that will in turn cause changes in species distribution, an increase in invasive species and losses in fisheries productivity. Meanwhile, coastal hazards from Climate Change include increased frequency and intensity of coastal storms, permanent inundation from sea level rise, increased erosion and loss of key ecosystems as a result of warming seawater.

According to the Global Ocean Observing System (GOOS), by 2025, the projected rapid increase in coastal populations could expose 75% of the world's population to ocean-related hazards. These hazards will be exacerbated by climate-related sea level rise as well as storms intensified by ocean heat. Risks that may affect coastal dwellers, but also shipping because of their dependence on weather forecasts for their activities.

Human beings also depend on the ocean for food, pharmaceuticals, minerals, navigation, transport and recreation. Other valuable ocean resources are linked to our energy needs. We depend on the ocean and coastal areas for habitat and economy, so human vulnerability is linked to the ocean not only for coastal hazards, but also for the health of ocean ecosystems.

It is therefore essential not only to **ensure the compatibility of uses and activities in the marine area with each other and with the conservation of the marine environment**, within the framework of the Maritime Spatial Planning (POEM, by its acronym in Spanish), but also to take **into account the growing pressure on these environments and the activities carried out in them as a result of Climate Change and other processes of local and global change and, furthermore, criteria should be established to protect maritime safety**, both in terms of the protection of human life at sea and the avoidance of accidents. In this sense, a facilitating tool to be considered in the development of projects would be the creation of meeting forums, with the proactive participation of the developers involved, local social agents and the maritime administration, to explore solutions with a long-term environmental and socio-economic vision.

To this end, it is essential to have reliable data on the state of conservation of the marine environment and its evolution, and to be able to measure the possible interactions between the different factors. In this sense, and in compliance with the obligations of the Marine Strategy Framework Directive (Dir 2008/56/EC), Spain has set up marine strategy monitoring programmes, the ultimate objective of which is to assess the environmental status of the marine environment in the five Spanish marine subdivisions. This assessment is based on 11 descriptors of good environmental status, and also includes an analysis of the pressures and impacts to which the marine environment is subjected. The assessment is repeated every six years, and is the basis on which the environmental objectives and programmes of measures of the marine strategies are defined. The second assessment took place in 2018[40], and its conclusions have been the reference on which maritime spatial plans have been designed.

Additionally, the latest Global Ocean Observing System (GOOS) Report has identified the impact that the COVID-19 pandemic has had on ocean observations, and the need to strengthen and fill the geographic and resource gaps in the global ocean observing system to meet the growing need for ocean information services.

Another relevant factor to consider in the case-by-case analysis would be the use of Best Available Techniques/Technologies (BAT) and Best Environmental Practices (BEP) for the reduction of underwater noise in the construction, foundations, anchoring, etc. of fixed and floating offshore wind farms. The application of BAT and BEP is a requirement adopted by various international agreements and conventions, whereby other countries[41] have already established acoustic limit standards potentially replicable in Spain.

For all of the above reasons, this Roadmap establishes the objective not only of establishing sustainability as a prior criterion for the definition of areas of lesser impact, and therefore of greater suitability, for the deployment of offshore renewable energy, but also **of converting the development of these technologies into a tool for improving knowledge of the marine environment, of the evolution of its state, and of the impact on it both of the development of offshore renewables and of other uses and activities,** while also taking into account respect for previous traditional uses. In particular, the objectives are established as follows:

- **Installation in new offshore renewable energy infrastructures of sensors to monitor the main marine meteorological variables, ocean heat content and sea level, to enable Climate Change monitoring, implement real-time services through early warning of ocean hazards, and weather and maritime forecasts.**
- **Inclusion of "passive monitoring" elements (e.g. passive acoustic hydrophones) for the monitoring of marine biodiversity and birdlife.**
- **The use of these elements also for the implementation of environmental monitoring plans associated with the authorisation of offshore renewable infrastructures, providing information to improve knowledge of the marine environment, as well as the potential impacts of other activities and uses on the marine environment and on navigation, with a view to the development of regulatory and technological improvements and the identification of best practices.**
- **Use of this knowledge for a deployment of offshore renewables more consistent with the environmental values of the marine environment in Spain, as well as the enhancement of capacities and knowledge that position the national value chain as a leader at European and global level in the environmental compatibility of offshore renewable developments. It is considered relevant to provide a guide for offshore wind farm developers on this issue.**

[40] https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/estrategias-marinas/eemm_2dociclo.aspx.

[41] In 2013, the German Federal Agency for Nature Conservation (FANC) published its 'Sound Protection Concept. Ascobans 2020 report by the FANC on 'Noise mitigation for the construction of increasingly large offshore wind turbines' (https://www.ascobans.org/sites/default/files/document/ascobans_mop9_inf6.2.6c_noise-mitigation-construction-offshore-wind-turbines.pdf).

4.4 FRAMEWORK FOR THE DEPLOYMENT OF FLOATING OFFSHORE WIND AND OCEAN ENERGY

The deployment of offshore wind and other marine energy is essential both to meet energy and climate objectives and to underpin industrial and R&D potential. In this regard, the 'EU Strategy on Offshore Renewable Energy' identifies as a priority the need for a clearer regulatory framework that provides the necessary predictability and certainty to address these investments, which are often highly complex in technical and administrative terms.

In particular, the singularities of the offshore environment require this framework to address three key elements in a coordinated and simultaneous manner: spatial planning, grid connection and business model. Although these three conditions must also be met in the development of any onshore generation facility, in the case of offshore wind farms they take on special relevance due to the location in the public domain, the great weight of the initial investment in the decision making process, as well as the high level of electricity generation that offshore wind developments entail.

Maritime Spatial Planning (MSP)

The framework for granting, where appropriate, the rights to occupy the maritime-terrestrial public domain required for offshore wind development in Spanish marine waters must follow the provisions of the Maritime Spatial Planning, in terms of zoning, organisation of uses and activities, criteria for coexistence between the different uses and activities - as the case may be, including in port service areas - as well as the maintenance of the good environmental status of the marine environment and navigation, maritime safety, rescue and protection of the marine environment.

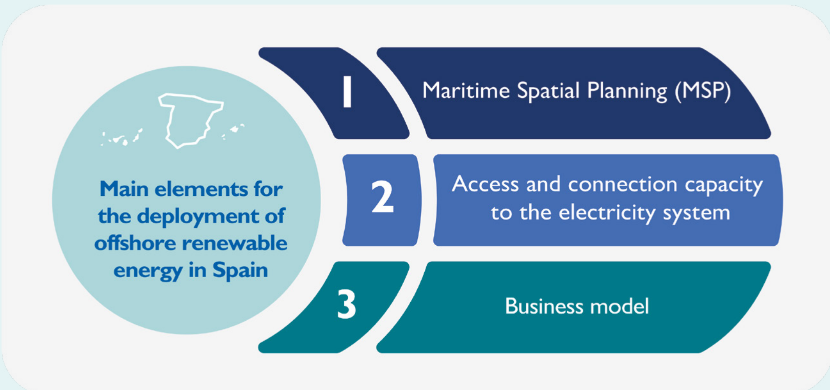
Access and connection capacity to the electricity system

In turn, the spatial location of projects must be aligned with the necessary certainty about the ability of the electricity system to connect and integrate the power generated. This requires coordination between spatial planning and the **ability to access and connect to grid nodes,** as well as technical and environmental requirements for the interconnection infrastructure of offshore wind projects' land-sea links.

Business model

The investments needed to promote offshore renewables require a clear and transparent framework to enable the viability of the business model for the most competitive projects. This framework must, in turn, be coordinated with the frameworks relating to the occupation of the maritime-terrestrial public domain and access and connection to electricity grids indicated in the previous two points.

Figure 51. Main elements for the deployment of offshore renewable energy in Spain. Source: MITECO-IDAE



As developed in the measures section of this Roadmap, the procedure based on these three elements could include pre-qualification stages and the establishment of a competitive mechanism to identify the most appropriate projects in each case. These processes would be established at the earliest possible stage, allowing both the promoters and the administrations and bodies that have to pronounce to focus their efforts and resources appropriately.

Based on the development of the framework proposed by the measures in this Roadmap, and taking into account the current state of the art in floating offshore wind and marine energy, the **following ranges are established as targets for the development of Offshore Renewable energy in Spain by 2030**:

Figure 52. Targets by 2030 of the Roadmap for Offshore Wind and Marine energy in Spain

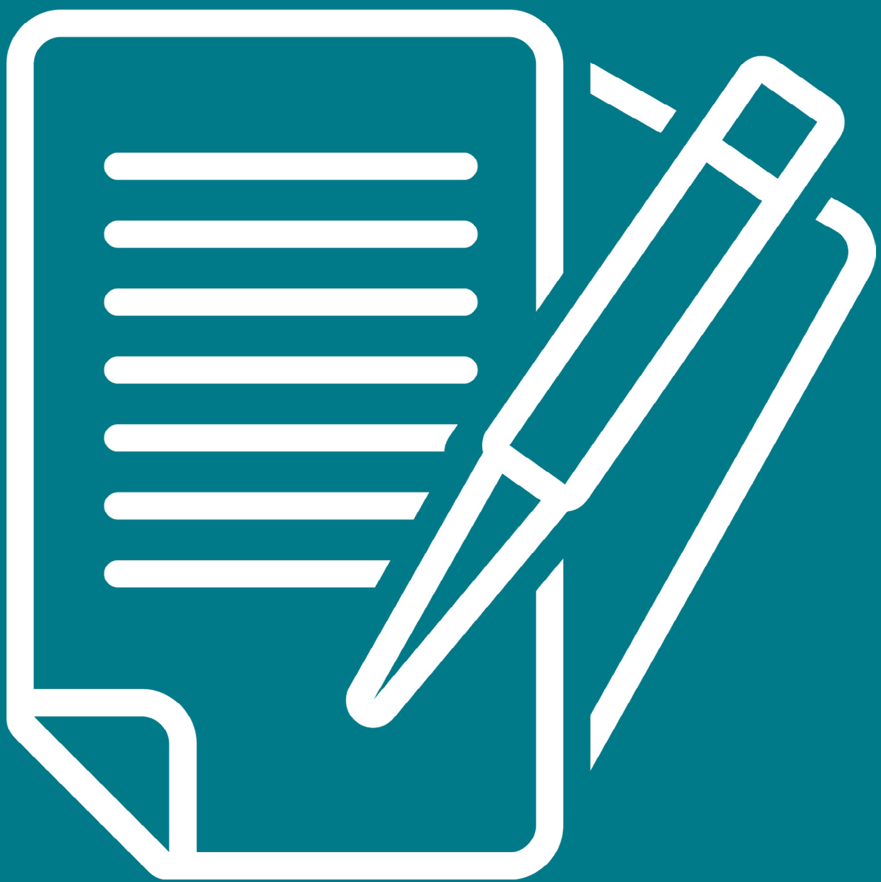
	2030 Targets	References 2030
Offshore wind energy	**1 – 3 GW**	5 – 30 GW floating globally.[42] 7 GW floating at European level.[43] 60 GW (fixed and floating) at European level.[44]
Marine energy	**40 – 60 MW**	10 GW at global level.[45] 1 GW at European level.[46]

As can be seen in the references included in the table above, the commitment to floating offshore wind energy in this Roadmap represents a significant contribution to a technology that is culminating its process towards technological maturity and is at a turning point in its deployment, as illustrated by the wide ranges in the forecasts of the different institutions at European and global level.

In particular, this implies a contribution of up to 5% of the European targets for offshore wind by 2030, with a possible contribution of up to 40% in relation to the specific European target for floating offshore wind.

[42] IRENA. 'Future of Wind'. October 2019.
[43] WindEurope. 'Offshore Wind in Europe'. February/2021.
[44] European Commission. https://ec.europa.eu/commission/presscorner/detail/es/ip_20_2096.
[45] IRENA. Analysis for Upcoming Report. May/2020.
[46] European Commission. https://ec.europa.eu/commission/presscorner/detail/es/ip_20_2096.

5

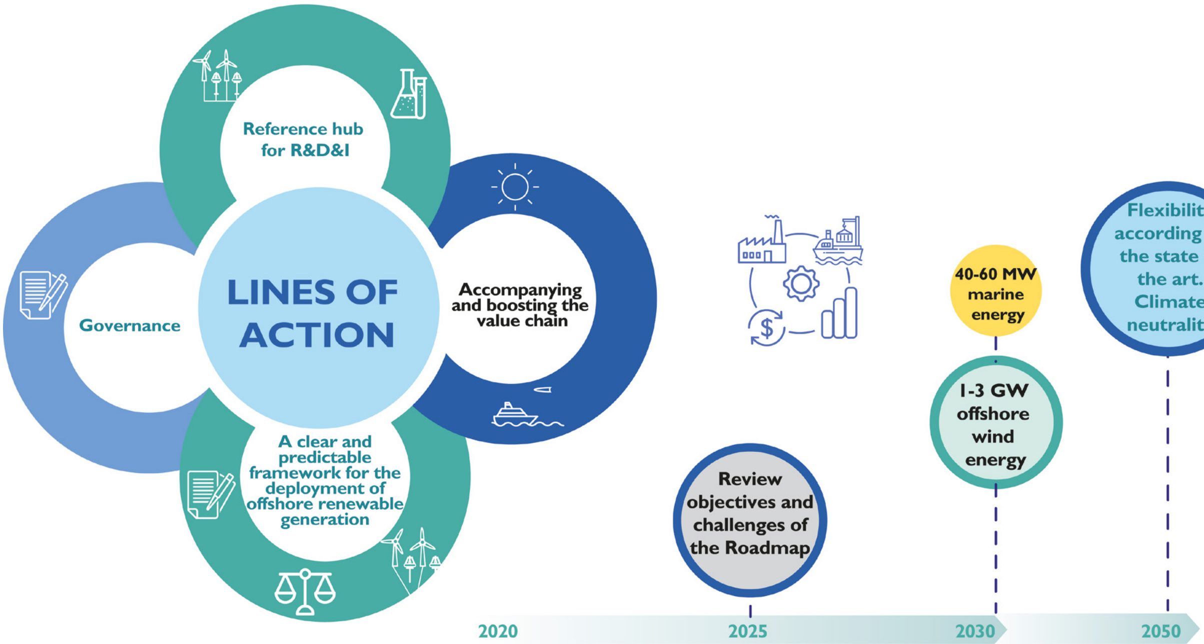


LINES OF ACTION AND MEASURES

The following is a summary of the proposed lines of action, which are generic measures, the detailed development of which will be moved to the implementation of the measure itself.

Lines of action	
1. Spain as a benchmark for R&D&I in offshore renewable technologies	
MEASURE 1.1.	Development and strengthening of testing platforms.
MEASURE 1.2.	Technology development programmes.
MEASURE 1.3.	'Plug & play' framework for the replacement of experimental prototypes on offshore renewable energy test platforms.
MEASURE 1.4.	Improving knowledge of the marine environment.
2. Accompanying and boosting the value chain	
MEASURE 2.1.	Assessment of port infrastructure for the construction, assembly or export of components associated with offshore renewable installations.
MEASURE 2.2.	Monitoring and accompanying the national maritime industry and value chain for the development of offshore wind and marine energy projects.
MEASURE 2.3.	Public-private and private-private partnership *hub* for the development of offshore renewable energy.
MEASURE 2.4.	Strengthening Spain's position in the international context.
MEASURE 2.5.	Capacity-building, training and professional qualification in the offshore renewable energy sector.
MEASURE 2.6.	Contribution to Just Transition.
MEASURE 2.7.	Circular Economy: boosting eco-design and end-of-life value chain.
MEASURE 2.8.	Coordination with the sector for communication and public awareness campaigns.
MEASURE 2.9.	Creation of cross-sectoral working groups for the development of offshore renewable energy.
3. A clear and predictable framework for the deployment of offshore renewable power generation	
MEASURE 3.1.	Definition and approval of zoning for the development of offshore wind farms in the MSP (POEM by its Spanish acronym).
MEASURE 3.2.	Preparation and publication of geographic viewers with information on offshore wind resources and marine energy in Spain and the areas established in the MSP (POEM).
MEASURE 3.3.	Coordination of the access and connection framework and new management models for electricity networks.
MEASURE 3.4.	Adaptation of the administrative framework for the authorisation of offshore renewable installations.
MEASURE 3.5.	Framework for the promotion of investment in offshore wind and marine energy.
MEASURE 3.6.	Early development of offshore wind deployment in the Canary Islands.
MEASURE 3.7.	Guidance on environmental and biodiversity guidelines on the implementation of renewable energy in the marine environment.
MEASURE 3.8.	Creation of a "Technical Office for the deployment of Offshore Renewable Energy" in Spain.
4. Governance	
MEASURE 4.1	Monitoring, cross-sectoral cooperation and assessment.
MEASURE 4.2	Updating and Renewal of the Roadmap in 2025.

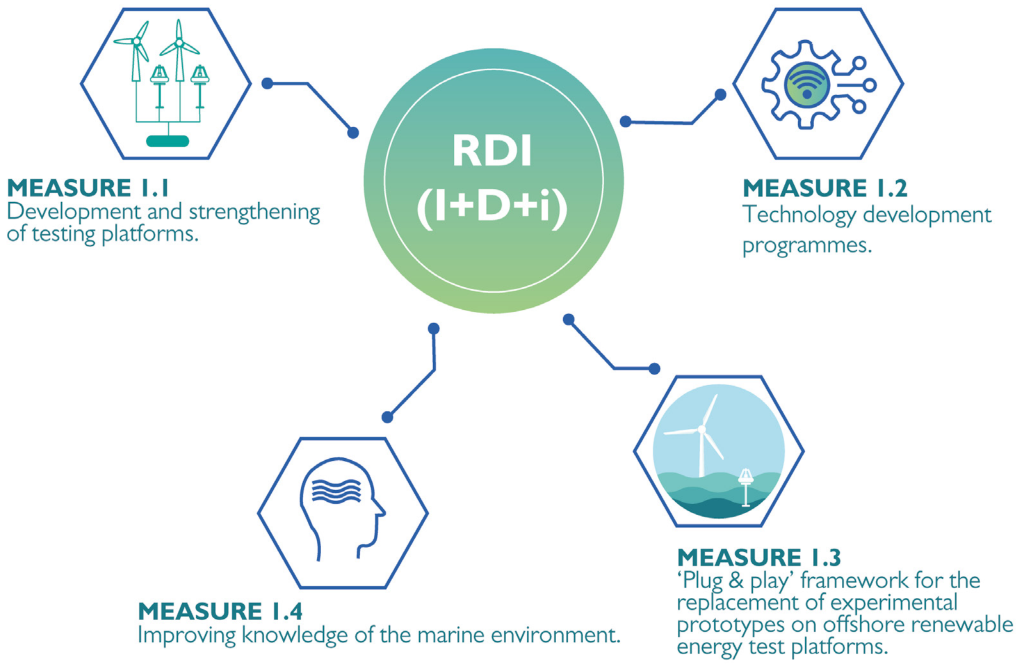
Figure 53. Overview of the Lines of Action and objectives of the Offshore Wind and Marine energy Roadmap in Spain. Source: MITECO-IDAE



5.1 SPAIN AS A REFERENCE HUB FOR R&D&I IN OFFSHORE RENEWABLE TECHNOLOGIES

This section includes measures to support technological development in the specific field of offshore renewable energy, including the provision of new additional sites, with better resources and without technical restrictions, to allow the testing of wind turbines with unit power adapted to future commercial models.

Figure 54. Measures to position Spain as a reference hub for R&D&I in offshore renewable technologies. Source: MITECO-IDAE



MEASURE 1.1: **Development and strengthening of testing platforms.**

Objectives:

Consolidate and enhance Spain's leading position in terms of capacities and infrastructures for R&D&I and demonstration of innovative technological solutions related to offshore renewable energy, including 'offshore renewable hybrid installations'.

Description:

Reinforcement of the testing capacities of existing R&D&I infrastructures in Spain related to offshore wind and marine energy, including those identified in section 3.2.

Implementation of new test platforms for prototypes and pre-commercial offshore wind and marine energy projects, also building on existing port infrastructure and including locations in deep water offshore sites.

The new test platforms will contain the corresponding electrical connection infrastructure (using offshore umbilical cables), anchoring positions, grid connection point at an onshore electrical substation, equipment for measuring and recording offshore wind and marine energy resources, control infrastructure, information and communications systems, monitoring and auxiliary equipment, including infrastructure for environmental monitoring. It will be considered that the new test platforms have the capacity to connect prototypes of higher unit power than those currently available, in order to increase the testing and validation capacities of prototypes in stages closer to their commercial launch.

Measure 1.2 of the technological development programmes mentions the lines of aid to be launched during 2022 to support and encourage the creation of new test platforms and/or the reinforcement and adaptation of existing ones for offshore renewable energy, including the adaptation of port facilities.

MEASURE 1.2: **Technology development programmes.**

Objectives:
Technological development of pre-commercial installations and offshore wind prototypes for both floating and fixed foundation technologies, floating substructures and marine energy devices, attraction of actual testing of these technologies to offshore test platforms in Spain and market development for new technologies.

Description:
Mechanisms and instruments to promote and support technological development projects, focused on attracting pilot, R&D&I and pre-commercial projects with new technological concepts in the field of offshore renewable energy, for their implementation on the Spanish coasts.

Within the framework of the Recovery, Transformation and Resilience Plan, it is planned to mobilise at least 200 million euros of public budget to support the technological development of offshore renewable technologies in the period 2021-2023, depending on the participation of the different players, the maturity of the projects and the R&D&I initiatives that could benefit from this action line. This amount will be earmarked at least for the following lines of aid in this initial period until 2023:

- Offshore renewables pilot projects.
- Creation of new testing platforms and/or reinforcement and adaptation of existing ones for offshore renewable energy. [See Measure 1.1.]
- Aid programme for the adaptation of port facilities as test and development sites for offshore renewable projects. [See Measure 1.1.]

It is foreseen that the first lines of aid will be published during 2022. The preferential funding mechanism for these first lines would be an investment grant on the basis of competitive mechanisms.

Among other issues, technology development will seek to maximise the environmental compatibility of offshore renewable technologies.

In addition, direct investments in companies and initiatives and the potential use of innovative financing mechanisms to facilitate the early development of new technological concepts will be valued.

MEASURE 1.3: **'Plug & play' framework for the replacement of experimental prototypes on offshore renewable energy test platforms.**

Objectives:

Spain aims to become the most agile European location for the authorisation and installation of new prototypes and pre-commercial facilities on test platforms.

Description:

Adaptation of the administrative processing framework for offshore wind prototype test platforms and devices for harnessing energy from the sea to **facilitate and streamline the procedures for the rotation and replacement of R&D&I prototypes**, provided that they comply with the boundary conditions and basic characteristics that gave rise to the prior administrative authorisation of the 'umbrella project' and that the period of occupation of the domain by the new prototypes is of limited duration.

These facilities may include robust systems for monitoring impacts on biodiversity, accidental spills and the control of other potential risks to the environment. It should also include the availability of contingency plans with adequate means of response and consideration of potential risks to the safety of navigation.

MEASURE 1.4: **Improving knowledge of the marine environment.**

Objectives:

Take advantage of the new R&D&I infrastructures that are generated, associated with offshore renewable technology field trials, to characterise and/or monitor the marine environment and its biodiversity.

In addition, it will be possible to analyse the interaction between the set of operations related to the use of offshore wind and marine energy, with other activities in the marine environment, maritime safety and navigation, drawing conclusions that may help to establish criteria for the management of marine space and coexistence between sectors, with the integrated vision of compatibility of uses of marine space.

Description:

Characterisation and/or monitoring would be aimed at obtaining more information to be able to assess the environmental impact of floating technologies on the environment and on other uses of maritime space. In this way, progress will be made in the knowledge of the impacts on these activities and in the appropriate definition of priority areas and areas of preferential use in the subdivisions in future revisions of the MSP (POEM by its Spanish acronym), as well as in the establishment of criteria or potential mechanisms for compatibility between multisectoral activities.

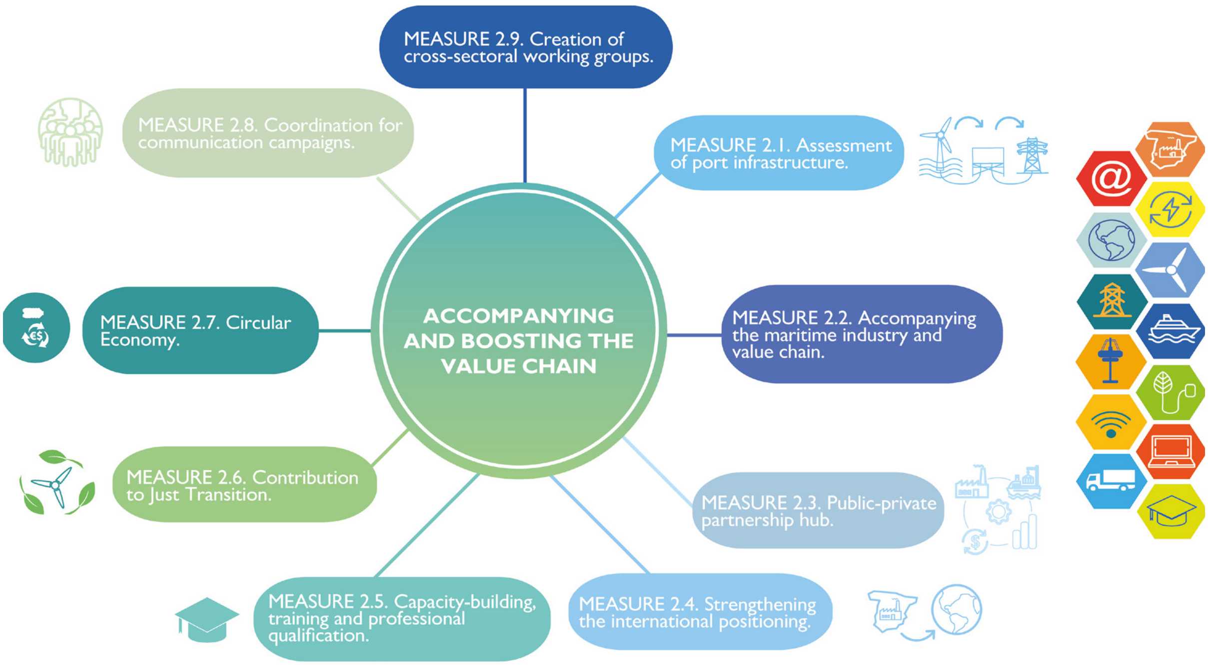
The analyses would further study the life cycles of birds, marine mammals, turtles and other species that may inhabit the testing area and may be affected by the installation of offshore renewable facilities.

The activities and equipment associated with the implementation of this measure in new offshore renewable facilities could be considered eligible costs in the aid programmes established for their development.

5.2 ACCOMPANYING AND BOOSTING THE VALUE CHAIN

These measures focus on maximising the boost to the national value chain that will come from the development of the offshore renewable energy sector in general, and floating offshore wind in particular.

Figure 55. Measures to accompany and boost the value chain of the offshore renewable energy sector.
Source: MITECO-IDAE



MEASURE 2.1: Assessment of port infrastructure for the construction, assembly or export of components associated with offshore renewable installations.

Objectives:

Strengthen the country's logistical and port infrastructure capabilities for the manufacture and assembly of offshore wind farms and marine energy devices.

Description:

The needs and potential alternatives will be analysed in order to achieve an adequate logistical framework for the promotion of the value chain associated with marine technology components.

Ports have great potential as large assembly areas for the components of large offshore wind turbines with high unit capacity, both for the development of offshore renewable projects in Spain and for international markets, as well as for containing logistics related to the operation and maintenance for this type of installation, making use of port services for the stevedoring of components and spare parts, supply of vessels, mobile cranes, transport equipment, etc.

To facilitate the implementation of this measure, related to measure 1.1 regarding the use of ports as sites for testing and demonstration facilities, an aid programme will be designed to promote and adapt port facilities to the development of innovative and unique offshore renewable technology projects.

MEASURE 2.2: **Monitoring and accompanying the national maritime industry and value chain for the development of offshore wind and marine energy projects.**

Objectives:
Support the national industrial fabric related to the development of offshore wind and marine energy projects, in line with the promotion of innovation and technological development.

Description:
For the deployment of offshore renewables, it is a key element to have national and European manufacturers throughout the value chain for the different technologies, in order to create economies of scale that are able to gradually reduce manufacturing costs, while bringing added value and strategic autonomy to the EU as a whole. The aim is to build on the current availability of the value chain in the onshore wind and shipbuilding sectors and to extend it to the offshore wind and marine energy sectors.

A diagnosis will be made and mechanisms for coordination, monitoring and accompaniment of the industrial and maritime sectors involved in the offshore wind and marine energy value chain will be evaluated, taking into consideration the identification of weaknesses that may exist in the national industrial chain, with the aim of implementing potential additional measures in order to cover them with national industry.

Adaptation needs of key assets, such as manufacturing, steel, shipbuilding, construction and services, as well as the digital transformation of companies, will be analysed in order to achieve a competitive, versatile, fast-response industry with sustainable techniques that encompass and interact with the aforementioned value chain associated with offshore renewable installations.

MEASURE 2.3: **Public-private and private-private partnership hub for the development of offshore renewable energy.**

Objectives:
Creation of an agile and versatile knowledge hub or forum at the disposal of stakeholders and public administrations to catalyse strategies and promotion programmes, seeking to turn Spain into a global industrial leader in Floating Offshore Wind, focused on continuous improvement, on taking advantage of synergies and on competitive positioning.

Description:
Together with the sector and the industrial and R&D&I ecosystems, the creation of an industrial, innovation and public-private knowledge nexus (offshore renewable energy *hub*) will be studied, which will serve as a forum to identify and monitor the state of the situation of the entire value chain, promote synergic actions between public and private stakeholders and synergies between the energy and industrial sectors themselves, as well as to increase the degree of knowledge of the technological concepts and potential of offshore wind and marine energy and the options they present. The creation of knowledge hubs or forums by marine subdivision will be assessed, with the participation of public players and administrations, which will enable strategies and promotion programmes to be channelled in a more flexible and versatile manner, adapted to the specific characteristics of each subdivision. Marine subdivisions with similar solutions, representatives and stakeholders could be grouped together.

Furthermore, due to the geographical synergies and interactions between actors in South West Europe, a broad regional cooperation alliance is proposed to work in synergy with neighbouring Member States.

An example of this is the Supercluster Atlantic Wind (SAW) strategic alliance, where the main industrial clusters in the regions of northern Spain have signed a collaboration agreement. The aim of this alliance is to develop a shared strategy that positions northern Spain as an international benchmark for offshore wind energy, both in the development of demonstration projects and in the commercial promotion of this wind energy alternative, as well as in the consolidation of its own value chain with international projection.

MEASURE 2.4: **Strengthening Spain's position in the international context.**

Objectives:
Contribute to offshore renewable energy capacities at European level and play a leading role in the development of floating offshore wind at international level.

Description:
The development of offshore renewable energy gives national companies the opportunity to exercise a new leadership role at international level. One of the keys to internationalisation will be the participation of organisations and associations in the main international and European forums.

These include the Offshore Renewable Energy Working Group dedicated to the offshore renewable energy value chain proposed in the 'EU Strategy on Offshore Renewable Energy', aimed at assessing compliance with the European strategy, as well as facilitating cooperation and knowledge exchange between offshore energy technologies and between different supply chains, consistent with competition rules.

To achieve this leading role in the offshore renewables sector, there are also measures 2.2 to monitor and support the industry and the value chain, and measure 2.3 to create an agile and versatile knowledge hub to make Spain one of the industrial leaders in offshore renewables.

MEASURE 2.5: **Capacity-building, training and professional qualification in the offshore renewable energy sector.**

Objectives:
Availability of qualified professionals for the installation, operation and maintenance of the devices and their infrastructures, with the dual objective of creating local employment and taking advantage of the opportunity for the development of offshore renewable energy.

Description:
It has been detected that in the field of Offshore Wind and Marine Energy there might currently be a lack of professionals in these sectors for the expected deployment, which require specific and qualified training. According to the 'EU Strategy on Offshore Renewable Energy', up to 30% of companies identify skills and qualified personnel shortages.

In coordination with the different competent administrations and social agents, the best way to improve the technical skills required in the labour market of the offshore renewable energy sector will be analysed. Special attention will be paid to the introduction of equality and social inclusion criteria in training and vocational training for the occupation of the professional profiles demanded by the sector. The need to reinforce the training programmes offered by existing training centres at national level will be reviewed so that they are capable of training professionals to carry out the tasks foreseen in offshore wind and renewable energy projects. The need and convenience of supporting the Vocational Training Centres closest to the sea will be assessed, for the development of specific training facilities for offshore wind energy, especially in safety and survival at sea issues in specific specialised training centres and the need to make this training compatible with international standards in the field. The coordination of these activities with Rescue and Combating Pollution Plans, as well as their own contingency plans and means to deal with them, must also be considered, as well as transport and access issues and the GWO-Offshore.

This commitment to training could be reinforced through its connection with some of the European initiatives under the European Agenda for Skills[47], which promote capacity building for the use of offshore renewable energy.

MEASURE 2.6: **Contribution to Just Transition.**

Objectives:

Promote coastal areas by developing offshore wind and marine energy projects as centres of industrial activity and renewable energy generation. Focus attention on those coastal nodes where there has been or is expected to be in the short term the closure of thermal power generation plants, the reduction of coal logistics activity in ports or any other impact on local employment resulting from the Energy Transition.

Description:

Taking into account the context of the Energy Transition in which we find ourselves, the Just Transition Agreements, whose objective is to promote economic activity and improve the employability of workers in transition to low-carbon development, are an excellent opportunity for the development of offshore wind and marine energy due to their great contribution to job creation and the reindustrialisation processes in certain areas. In this context, the potential use of the financial support mechanisms of the General State Administration (AGE) will be analysed within the Agreements established in the Just Transition Strategy, with the aim of adapting and strengthening the energy, logistics and industrial centres on the coast, based on the development of energy generation facilities using offshore wind and marine energy, which contribute to establishing industrial and service activity, to avoid rural depopulation and to achieve the objectives of the demographic challenge, with special attention to the regions of Just Transition close to the coasts.

In addition, specific actions will be undertaken to align the objectives of Just Transition and allow the development of offshore wind energy, such as the cross-referencing of the lists of Just Transition nodes established in Annex I of Royal Decree-Law 23/2020, of 23 June, with those required for the

[47] European Skills Agenda for Sustainable Competitiveness, Social Fairness and Resilience, 2020, COM(2020) 274 final.

deployment of offshore wind energy in the areas reserved for it in the MSP (POEM by its Spanish acronym) and the presence of shipyards.

The location of available grid access capacity after the closure of thermal power plants can be taken into account in the electricity planning of the transmission grids. In general, however, these access points are not particularly suitable for the development of offshore renewable energy.

MEASURE 2.7: **Circular Economy: boosting eco-design and the end-of-life value chain.**

Objectives:
Promoting the circular vision in the value chain of offshore renewable energy, from eco-design to end-of-life use, generating technical specialisation and a value chain associated with the management and recycling of components and materials for offshore and onshore wind energy.

Description:
Work will be carried out to identify measures and mechanisms that encourage the development and implementation of Circular Economy solutions and processes related to life cycle analysis in the development of offshore wind and marine energy projects, from the eco-design of new composites or wind turbine components and their manufacture to the decommissioning of critical components, the sustainable recycling of wind turbine blades or the harnessing of critical materials, including construction techniques with a Circular Economy vision.

It should be noted that the main components of wind turbines contain four materials (boron, molybdenum, niobium and rare earths) whose production does not exist in the European Union and which appear on the list of Critical Raw Materials contemplated by the European Commission on the basis of their importance in the economy (volume of end-user and contribution of added value) and supply risk (concentration of suppliers and typology of supplier countries).

During the decade 2021-2030, approximately 22 GW of installed renewable electricity capacity in Spain will have exceeded its regulatory useful life. The advanced age of part of the Spanish wind farm represents an opportunity for the development of a value chain for the decommissioning, recycling and treatment of wind turbines and associated materials, which can be scaled up and offer services also as part of the offshore wind value chain.

The regulatory design has to be in line with international standards and take due account of the need to preserve safety and the marine environment. Article 60 of the United Nations Convention on the Law of the Sea (UNCLOS) on structures in the Exclusive Economic Zone (EEZ) should be taken into account during the decommissioning of such installations at the end of their service life. In addition, any proposed installation should provide for the removal of such installations at the end of their service life or when necessary and which do not interfere with maritime traffic and the safety of navigation.

MEASURE 2.8: **Coordination with the sector for communication, participation and public awareness campaigns.**

Objectives:
Raise awareness of the social, employment, territorial, environmental and industrial opportunities of offshore renewable energy, as well as their compatibility and complementarity with other maritime and coastal uses and activities.

Description:
Participation and support to the sector's players in their events, campaigns and information actions that promote the participation of social agents in the exploration of solutions with a long-term environmental and socio-economic vision, related to the deployment of renewable energy in the marine environment. These actions will seek synergies with other sectors and elements that make other maritime activities in the marine area compatible, as far as possible.

Activities in the marine and coastal environment have defined industrial and territorial development in many areas of the country. The development of offshore renewable energy represents an opportunity as a generator of employment and economic activity in a sector of the future, taking advantage of its role as a driving force on new business models and opportunities at a local level.

MEASURE 2.9: **Creation of cross-sectoral working groups for the development of offshore renewable energy.**

Objectives:
Establishment of forums to bring together representatives of multi-sectoral economic activities associated with the uses of marine space, including maritime traffic and safety of navigation, to study interactions and encourage the shared use of space, the search for inter-sectoral synergies and the generation of proposals aiming to streamline viable developments of offshore renewable energy in the identified suitable areas, especially where they have a high renewable resource.

Description:
The main sectoral activities identified to be present in these working groups could be: Biodiversity, National Defense, Navigation, Maritime Safety and Pollution Prevention, Fisheries and Aquaculture, along with the offshore renewable energy development sector itself.

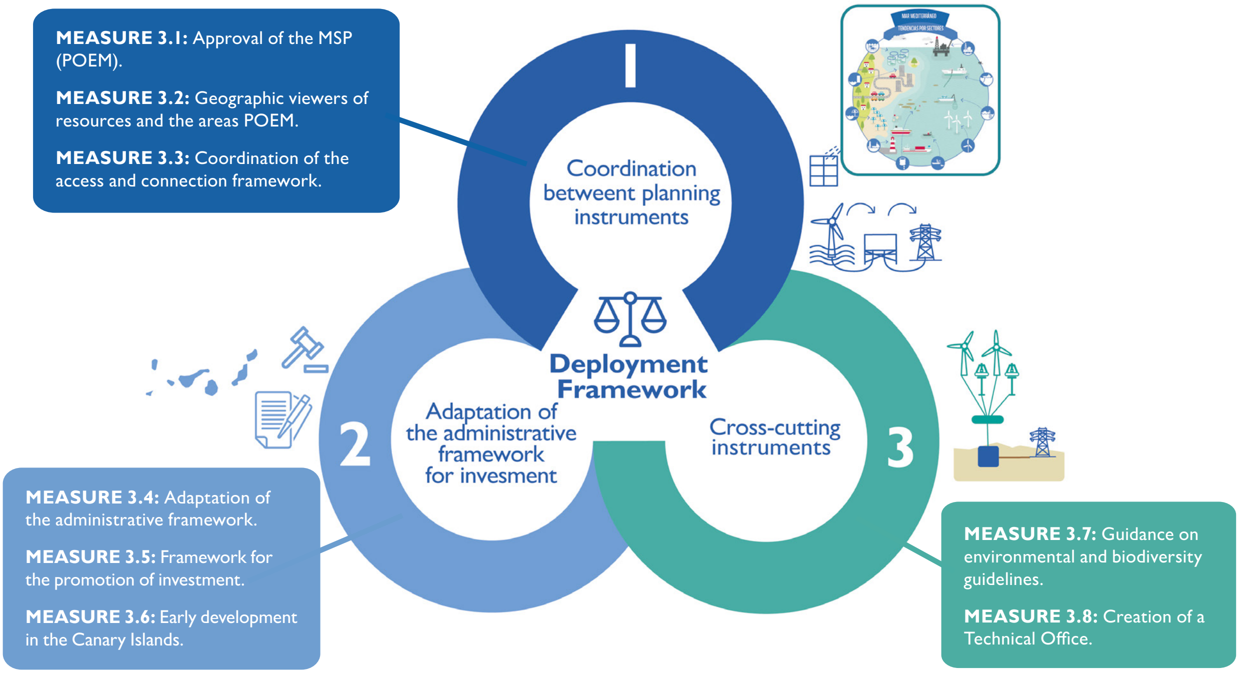
In order to develop this measure, the lessons learned from other experiences carried out in other European marine areas where offshore renewable installations, especially offshore wind farms, have been installed or are being implemented in Europe will be taken as a reference. In this regard, the study *"Impact of the use of offshore wind and other marine renewables on European fisheries"*, commissioned by the European Parliament's Committee on Fisheries, includes good practices of coexistence, co-location and cooperation between the wind and fisheries sectors in countries such as the United Kingdom, Denmark, Belgium, the Netherlands and Germany. It is advisable to promote this type of experience in Spain, in conjunction with the deployment of offshore wind farms and, as far as possible, from the outset of the proposals.

The aim would be to establish multi-area zones in which fishing, aquaculture, navigation, Defense support activities and offshore renewable installations coexist, and compensation mechanisms could be proposed, should it be necessary to displace certain economic activity in a specific location.

5.3 CLEAR AND PREDICTABLE FRAMEWORK FOR THE DEPLOYMENT OF OFFSHORE RENEWABLE POWER GENERATION

In this section, the main regulatory and administrative measures that can help boost the offshore renewable energy sector in Spain are outlined.

Figure 56. Measures towards a clear and predictable framework for the deployment of offshore renewable generation.
Source: MITECO-IDAE



MEASURE 3.1: **Definition and approval of zoning for the development of offshore wind farms in the MSP (POEM by its Spanish acronym).**

Objectives:

To bring coherence to the different spatial and energy planning instruments, providing certainty and visibility for a deployment of offshore renewable generation in line with the protection of the natural values of the marine space, maritime traffic, navigational safety and compatibility with other activities and uses in these spaces. This compatibility of offshore renewable energy with other activities is one of the key factors identified in the 'EU Strategy on Offshore Renewable Energy', which invites Member States to take into account the renewable development targets foreseen in the respective INECPs when drafting the MSP (POEM).

Description:

The MSP will consider offshore renewables as one of the future uses within the maritime space to be allocated areas of priority use and/or high potential. Maritime Spatial Planning (MSP, see Annex IV) will establish specific marine areas identified as preferred development locations for offshore wind farms, based on the availability of the resource and the preservation of natural marine values and biodiversity. The MSP (POEM) may also establish criteria and conditions of application to demonstration or small-scale projects, in addition to those contemplated by the R&D&I platforms, which will facilitate the transition from the development phase of individual devices to commercial farms, which must prioritise compatibility with other uses, as well as with the natural values of the environment in which they are located.

This identification could also take into account the necessary land-sea interface from offshore wind development areas.

MEASURE 3.2: **Preparation and publication of geographic viewers with information on offshore wind resources and marine energy in Spain, and the areas established in the MSP (POEM).**

Objectives:
Facilitate universal access to information on the environmental sensitivity and resources of Spanish areas with the capacity to take advantage of offshore wind energy opportunities, as well as marine energy.

Description:
The geographic information on the different uses and activities in the marine environment, as well as its natural values, used in the diagnostic process for the preparation of the MSP (POEM), will be accessible in the form of a geographic viewer. This information will include data relating to offshore wind and marine energy resources in Spain, the bathymetry of this environment, the presence of other uses and activities (such as aquaculture, port activity, navigation, etc.), as well as the environmental and protection values of the marine environment. It will also contain the regulatory cartography resulting from the zoning established in the MSP (POEM).

MEASURE 3.3: **Coordination of the access and connection framework and new management models for electricity networks.**

Objectives:
Provide a framework for access and connection that allows for the full integration of new marine energy generation capacity into the electricity system, providing predictability for developers and optimising investments and management modes to minimise costs for consumers.

Description:
In coordination with the MSP (POEM by its Spanish acronym), the planning of the transmission grid should take into account offshore renewable developments both in terms of interfaces for connection and effective capacity, with the aim of enabling their integration into the electricity system.

On the other hand, building on Royal Decree 1183/2020, 29 December, on access and connection to electricity transmission and distribution networks, which provides for the possibility of access capacity tenders using technological criteria, it is necessary to adapt the framework for connection to the electricity system to the offshore context. As indicated above, in this context, the framework for access and connection must be coordinated with the frameworks relating to the occupation of the maritime-terrestrial public domain and, where appropriate, with the frameworks that promote investment.

In addition, models for the management of marine networks should be developed, defining clear responsibilities and obligations among the players involved, which optimise investments in infrastructures, considering, when identified, synergies with international interconnections, with submarine links between islands or with submarine cables connected to different points of the same electricity system.

In line with the 'EU Strategy on Offshore Renewable Energy', possible synergies with the framework for electricity interconnections with other Member States should be analysed.

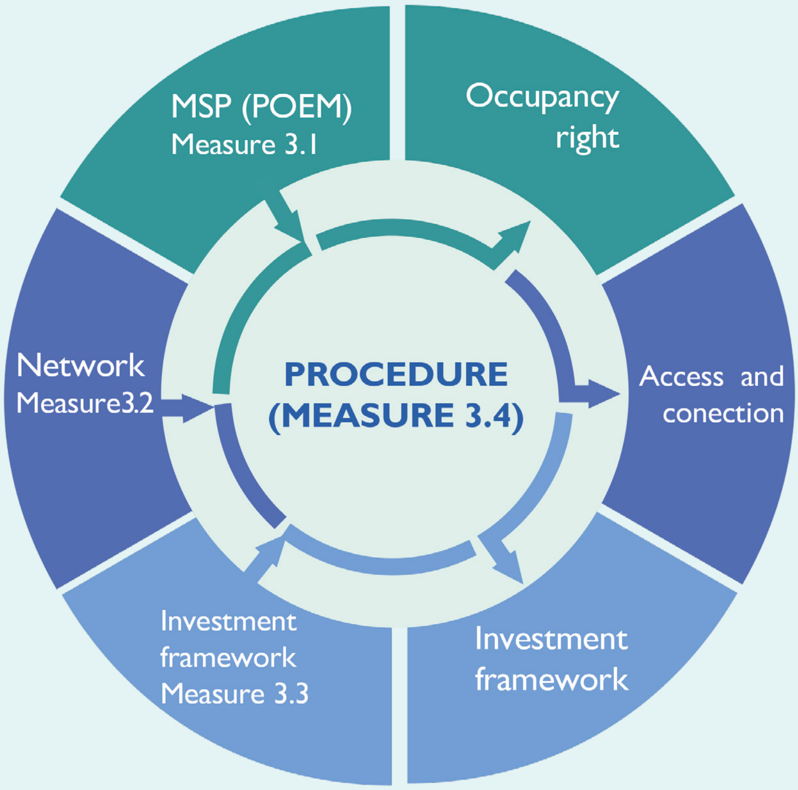
MEASURE 3.4: **Adaptation of the administrative framework for the authorisation of offshore renewable installations.**

Objectives:
Adapt the framework for the authorisation of projects for offshore renewable energy installations, in order to provide certainty and be consistent with existing regulations.

Description:
Adaptation of the administrative processing procedure for offshore renewable energy projects, and in particular offshore wind projects, updating the current Royal Decree 1028/2007, of 20 July, which establishes the administrative procedure for the processing of applications for authorisation of electricity generation facilities in the territorial sea and, where appropriate, in port service areas.

The high associated investments, spatial occupation and volumes of power and energy, together with the need to schedule actions with a significant timeframe, makes it necessary that the start of the administrative processing of offshore wind projects must be subject to the compliance with the three elements aforementioned: Based on the spatial definition set out in the MSP (POEM by its Spanish acronym) [measure 3.1] - and also, as the case may be, in port service areas - that minimises environmental impact and maximises compatibility with other uses and activities, electricity planning and regulations [measure 3.3] and the establishment of the framework to promote investment [measure 3.5]; the administrative framework must coordinate the processing and, if appropriate, the granting of rights to use the space, the reservation of access and connection to the electricity system and economic predictability of income.

Figure 57. Outline of the adequacy of the administrative procedure, linked to the planning instruments and the concurrence mechanism. Source: MITECO-IDAE



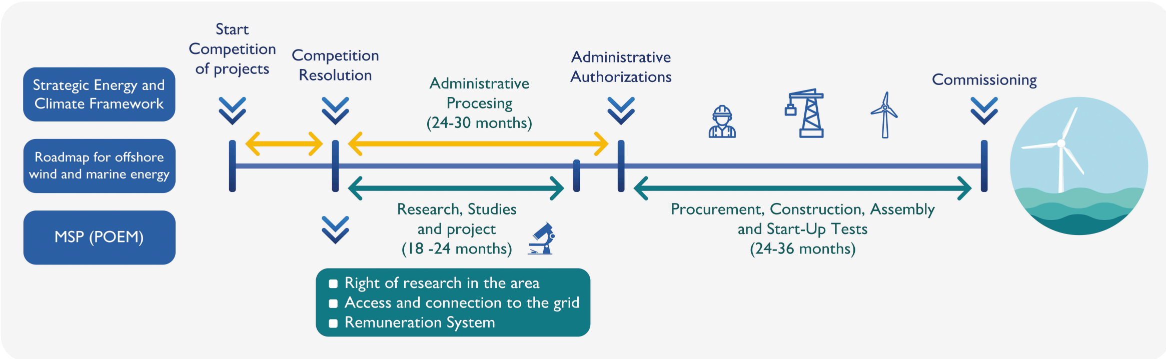
It is important to note that any potential allocation of an offshore wind development zone for research and detailed studies would not exempt the successful bidder from obtaining all the required permits and authorisations for the implementation, commissioning and operation of its project under the conditions proposed during the process of granting the zone allocation. In particular, the environmental impact statement is required to ensure that the project has a minimum impact on the good state of the marine environment.

The following is an indicative timetable based on "target deadlines" for the development of offshore wind energy projects in Spain, which correspond to periods aligned with European guidelines on administrative simplification and project streamlining. These target deadlines for the processing of offshore wind projects would be achieved through the implementation of this 'Adaptation of the administrative framework' measure, also depending, among other issues, on the prior characterisation of the marine environment on a case-by-case basis, as well as the ability to coordinate and align the entire value chain for the smooth development of projects during their execution.

In this context, the regulation that would, at least, be affected by the adequacy of the administrative framework is listed:

- Adaptation or replacement of Royal Decree 1028/2007 of 20 July 2007, which establishes the administrative procedure for processing applications for authorisation of electricity generation facilities in the territorial sea.

Figure 58. Indicative timeline for the development of Offshore Wind Farms in Spain



- Adaptation of the current regulation regarding the granting of access capacity, to bring it into line with the result of a competition procedure for the development of offshore wind projects in areas defined in the MSP (POEM) and, where appropriate, in port service areas, incorporating technical and economic criteria, thus extending the procedure established in Royal Decree 1183/2020, of 29 December, on access and connection to electricity transmission and distribution networks.
- Review and adaptation, if appropriate, of Royal Decree 876/2014, of 10 October, approving the General Coastal Regulations, in relation to the granting and authorisation of concessions for the occupation of the maritime-terrestrial public domain.
- Adjustment of the terms of validity of access and connection permits for offshore wind projects, which are more complex and take longer to develop than onshore wind farms.

Finally, the development of the administrative framework may take into account the following aspects:

- The establishment of competitive procedures called by the Administration, taking into account environmental, zoning and energy criteria. Likewise, Just Transition criteria could be considered.
- The need to process the administrative authorisation and the environmental impact assessment of the project after the competition phase.
- The need for the administrative authorisation procedure to take into account the assessment of the impact on maritime traffic and navigation safety.
- The need for the deployment of offshore renewable energy projects to contribute to the boosting of the quality and industrial value chain, as well as to the positive social impact on the environment.
- The protection and compatibility with the natural values of the marine and coastal environment, as well as the follow-up and monitoring of the environment.
- Continuous improvement in the administrative processing, moving towards simplicity, digitalisation and integrated procedures.
- The adaptation of mandatory regulatory deadlines for the administrative milestones of offshore wind projects and hybrid projects with other technologies.

Furthermore, the authorisation and deployment of offshore renewable energy generation will be compatible with the objective of contributing to sustainability and environmental monitoring included in the objectives of this Roadmap.

MEASURE 3.5: **Framework for the promotion of investment in offshore wind and marine energy.**

Objectives:
Favour the development of offshore renewable energy installation projects through mechanisms that provide visibility and certainty for investments, compatible with Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

Description:
Development of frameworks that provide visibility in the medium and long term and enable the viability of offshore wind and other marine energy projects through competition instruments that contribute to the continuous reduction of costs and the deployment of these technologies in the most competitive and beneficial way for consumers.

These frameworks should be coordinated in their design and call for proposals with those relating to the occupation of the maritime-terrestrial public domain and with the rights of access and connection to the electricity system. These frameworks could include unique pre-commercial offshore renewables farms and experimental projects in order to favour technological development and support all phases of the life cycle of innovative technologies.

In this context, for commercial offshore wind installations, a number of specific aspects of the competition framework adapted to the particularities of offshore wind are indicated:

- The definition by the Administration of the total capacity subject to the competition, as well as the spatial scope of the projects to participate in it, in accordance with the planning foreseen in the MSP (POEM by its Spanish acronym), with that of the port service areas, where appropriate, and with that of the evacuation nodes where the capacity subject to the competition is available.
- The assurance of the technical and economic capacity of the participants and their previous experience to carry out the projects in due time and form, in the event they are awarded the contract.
- The definition by the participants of the technical characteristics of the project, its suitability to the spatial scope of the competition, indicators on the area occupied, power, technology, as well as the criteria, data or studies considered for the definition of the project, as well as the conditions of safety and compatibility with other uses of the sea.
- The presentation -together with the bids- of information relating to, among others, the commitments made by the project to the territory and the estimation of its socio-economic impact and benefits on other activities in the marine environment, local employment and on the local, regional and national industrial value chain, assessed by means of an objective and quantifiable methodology.

- ▸ The consideration of the initial investment or the price of energy as a variable for the allocation of the remuneration framework.

However, it may also consider other criteria relating to the technical and environmental quality of the project and to certain socio-economic criteria of the project, whenever deemed appropiate.

- ▸ The inclusion of a dialogue phase between the Administration and the participants.
- ▸ The possibility of including mechanisms or incentives for the successful bidder in the competitive procedure for the development of commercial offshore wind farms, in the marine area covered by the concession, to consider or allocate positions for testing prototypes or pre-commercial hybrid technological or wind farms.

MEASURE 3.6: **Early development of offshore wind deployment in the Canary Islands.**

Objectives:

- ▸ Use of the Canary Islands as a testing ground for energy transition technologies or policies.
- ▸ Facilitating the exploitation of employment opportunities and improving competitiveness and social cohesion generated by the energy transition.
- ▸ Market development for new renewable energy technologies associated with strategic sectors related to the Blue Economy.

Description:

The Canary Islands have a high potential for offshore renewable energy; specifically, the estimated offshore wind resource for future offshore wind farms in the Canary Islands could exceed 4,500 equivalent hours of operation, providing higher and complementary capacity factors to the implementation of onshore renewables, which is increasingly limited due to the lack of available land.

In 2018, renewable electricity generation in the Canary Islands accounted for only 10.5% of total electricity generation. The remaining 89.5% came from conventional generation by burning oil-based fuels (fuel oil, diesel and gasoil), far short of meeting European and national energy and climate targets.

Spain's INECP 2021-2030 (PNIEC) allocates its Measure 1.1 to the "Development of new electricity generation facilities with renewables", contemplating public support mechanisms adapted to the particularities of each technology, taking into account the high energy potential of technologies in the marine environment, as well as the solid base of companies already in the value chain.

In addition, the PNIEC includes Measure 1.12 to promote singular projects and a strategy for sustainable energy in the islands, in collaboration with the autonomous and island governments, the opportunity they represent as a testing ground for energy transition technologies or policies that can then be exported to the mainland, in turn enabling the reduction of energy cost overruns, which are particularly high in the Canary Islands.

MEASURE 3.7: **Guidance on environmental and biodiversity guidelines on the implementation of renewable energy in the marine environment.**

Objectives:

To achieve the design of offshore renewable projects in the most appropriate way to avoid or minimise potential environmental effects on the marine and coastal environment, as well as to maximise compatibility with other uses and activities, in particular fishing activity and navigation and maritime traffic in general.

Description:

In line with the Strategic Environmental Assessment of the INECP (PNIEC), a guide of environmental guidelines on the implementation of renewable energy in the marine environment will be drawn up, based on the results of the environmental and monitoring indicators, as well as the lessons learned and best practices carried out in other countries with experience in the implementation of wind farms or renewable energy at sea, which establishes the criteria, guidelines and best practices for the design, location, installation and maintenance of these projects, in order to minimise the potential impacts on the marine and coastal environment. Criteria relating to maritime traffic and safety will also be taken into account.

The guide should address, among others, the aspects relating to the work necessary for the preparation of the baseline (adequate environmental characterisation of the area prior to deployment), the work necessary for the study and assessment of the potential environmental impacts on the marine and coastal environment of the projects in their different phases of execution (installation, operation and decommissioning), the specific criteria relating to the analysis of the impact on the Natura 2000 Network when applicable, and the compatibility with marine strategies and other activities specific to the environment. The preparation of the guide may involve the participation of relevant experts and administrative bodies.

MEASURE 3.8: **Creation of a "Technical Office for the deployment of Offshore Renewable Energy" in Spain.**

Objectives:

To enable, accelerate and streamline the effective deployment of renewable energy in Spain, providing the General State Administration with the logistical and human resources necessary to successfully implement the measures proposed in this Roadmap and to respond quickly to the needs for knowledge and resources required by the Ministry for Ecological Transition and the Demographic Challenge.

To carry out dissemination, awareness-raising and social participation actions related to the use of offshore wind and marine energy.

Description:

Creation of a "Technical Office for the deployment of Offshore Renewable Energy" in Spain, which will serve as a lever for the proper implementation of the measures contained in this Roadmap in different areas, which may include responsibilities and/or actions relating to the following aspects:

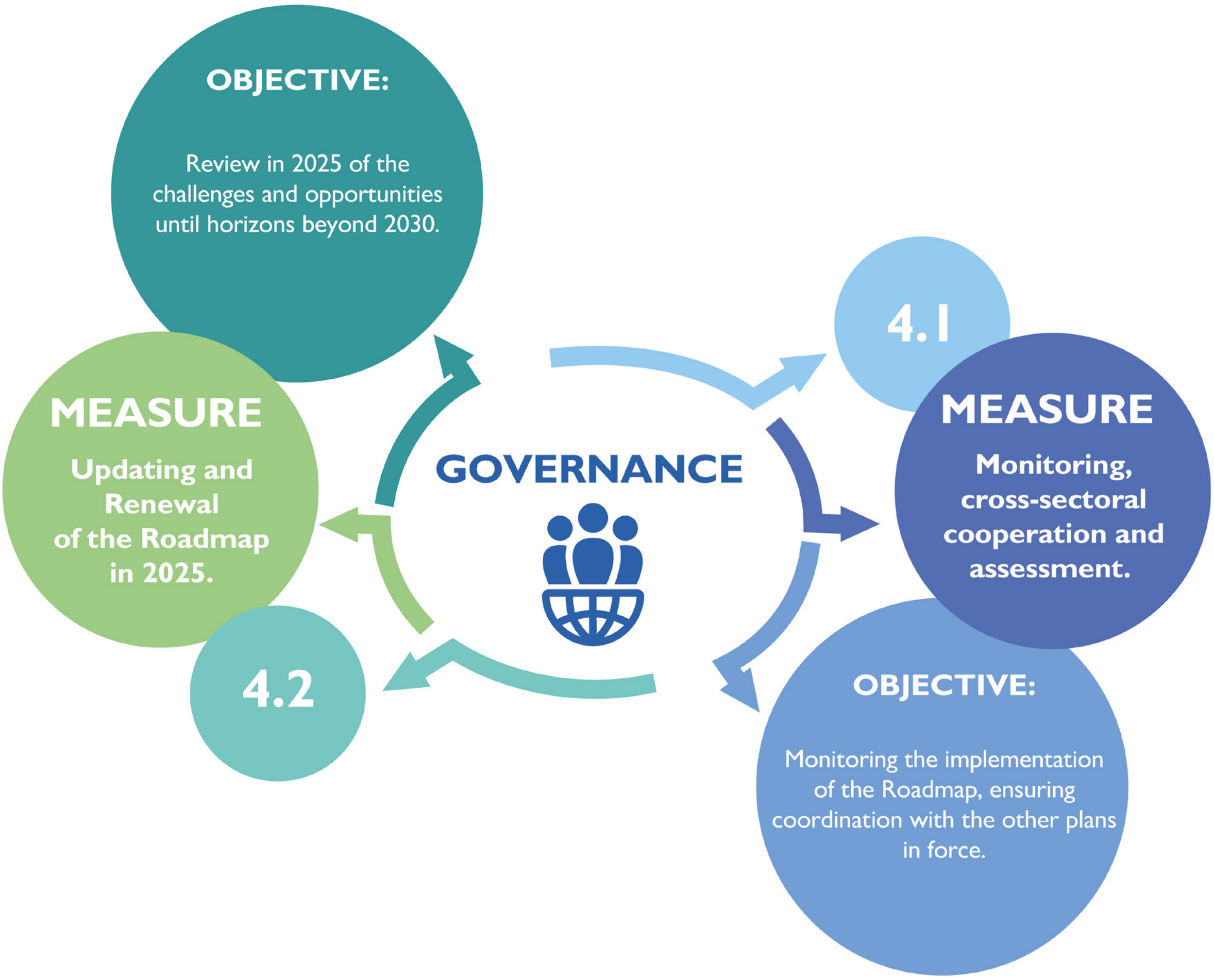
- Identification of best technological practices for minimising negative impacts and enhancing positive effects, reinforcing compatibility with other activities in the marine environment.
- Preparation of guides, studies of potential and elements for dissemination and public awareness-raising.
- Technical advice and liaison with stakeholders.
- Coordination actions related to the deployment of offshore renewable energy. Examples: Development of the Industrial Agenda; Coordination of training, capacity building and talent attraction actions for the offshore renewable energy sector; development of R&D&I strategies and identification of innovative projects.
- Monitoring of best practices in other countries and support for international cooperation actions in this area. In particular, with the countries of the Mediterranean area in strategies of common interest and with Portugal and France as geographically closer neighbours of the European Union with which infrastructures and specific projects could be shared.
- Support in the regular reviews of the planning envisaged in the Governance measures of this Roadmap.
- Maintain constant dialogue with groups of experts from different sectors related to offshore energy in order to broaden, discuss and exchange experiences and knowledge.

5.4 GOVERNANCE

The validity of this Roadmap refers to the period 2021-2030, in line with the implementation period of the Integrated National Energy and Climate Plan that frames it.

Over the next decade, regulatory developments and technological evolution, as well as potential lessons learned during the implementation of concrete measures, may update the deployment potential of offshore renewables, as well as their impact on the national and European value chain. Consequently, a monitoring and updating framework for this Roadmap is needed in line with the evolution of the sector in the coming years.

Figure 59. Governance measures. Source: MITECO-IDAE



MEASURE 4.1: **Monitoring, cross-sectoral cooperation and assessment.**

Objectives:
Monitoring the implementation of the Roadmap, ensuring coordination with the other plans in force, detecting good practices and shortcomings that serve as a basis for continuous improvement in the energy transition process and assessing the compatibility of the deployment of offshore wind and marine energy with the different uses and activities of the marine environment, as well as its good state of conservation.

Description:
A monitoring and coordination system -involving the different sectors concerned, including fisheries, aquaculture and navigation, the different public administrations- is necessary, to assess the evolution of the objectives contained in this Roadmap and to identify synergies and opportunities to strengthen cooperation between the different uses and activities of the environment, in coherence with the governance of the MSP (POEM).

Furthermore, foreseeing the evolution of the different technologies for the production of energy from offshore wind and marine energy and their costs, a process of continuous evaluation of public policies is envisaged to assess the achievement and attainment of the objectives and to establish new actions according to the evolution of the needs to reach the established objectives.

MEASURE 4.2: **Updating and Renewal of the Roadmap in 2025.**

Objectives:
Review in 2025 of the challenges and opportunities presented by Offshore Wind, Marine energy and Floating Photovoltaic Solar, updating the measures needed to boost their effective deployment until horizons beyond 2030.

Description:
Updating of the "Roadmap for the development of offshore wind and marine energy in Spain" by 2025, in coordination with the updates of the Integrated National Energy and Climate Plan, in accordance with the timetable established in Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action.

This review would include a specific target for installed and commissioned capacity by 2030, both for Offshore Wind, Marine Energy and Floating Photovoltaic Solar, as well as a range of new targets to 2040, broken down by technology, using as indicators their technological progress and the degree of implementation and success of the policy measures included in this Roadmap.

ANNEX I

FUNDING MECHANISMS

Achieving the objectives of decarbonising the economy and achieving a just energy transition, while stimulating technological innovation, implies mobilising a large volume of public and private financial resources across multiple sectors of activity.

In the marine field, the capital requirement to develop a full-scale test is very high, and the technological risk is also very high. In general, the combined requirement (capital+risk) is higher than any other renewable energy prototype. The means to deploy the devices are expensive and scarce. Marine and underwater work is expensive and highly dependent on sea conditions, which reduces availability, makes it difficult to implement and makes it more expensive.

In the case of offshore wind and marine energy, due to the scarcity of commercial or demonstrative experiences in Spain, the high investment volumes and the fact that some technological concepts are still at an early stage of development, public support is particularly important to stimulate and guide investments and provide clear signals to the different market players.

However, these are capital-intensive projects and their viability may require mechanisms in addition to grant and low-interest credit to make these trials feasible.

This is why there are numerous financing instruments, both at European and national level, totally or partially aimed at favouring the development of projects and technologies for both offshore wind and marine energy, as one of the key elements in the energy transition and for the decarbonisation of the economy.

Some of the main national and European instruments with the potential to finance offshore wind and marine energy projects in Spain are identified below.

EUROPEAN INSTRUMENTS

Within the framework of the European Union (EU), several financial instruments exist or are under negotiation with the potential to support offshore energy projects, as they are totally or partially aimed at favouring the energy transition and the development of technologies for the decarbonisation of the economy. Among these instruments, we can highlight the following:

- **Innovation Fund**

  The *Innovation Fund*[48] is one of the main funding programmes for **innovative low-carbon technology projects** in the pre-commercial or commercial phase. The selection will be based on five criteria in two stages: the first stage will assess (1) emissions avoided, (2) degree of innovation and (3) maturity of the project; the second stage will assess (4) scalability and (5) cost efficiency.

  In total, this Fund is estimated to manage an envelope of around €10 billion (depending on carbon prices) in the period 2020-2030. Revenues will come from the auctioning of allowances under the EU Emissions Trading Scheme (*EU ETS*), as well as from funds left over from the *NER300* programme.

  The grants will take the form of subsidies of up to 60% of the additional costs linked to innovation, both capital and operational, through annual calls for proposals. The first call was launched on 3 July 2020 and ended in October 2020. It is aimed at large-scale projects (CAPEX > €7.5 million) in eligible sectors, including renewable energy generation using innovative technology, and is endowed with €1 billion, plus €8 million for project development assistance.

  These grants will target projects related to highly innovative technologies and large projects with European value that generate significant emission reductions, seeking the optimal balance in the application of innovative technologies involving several European countries and all fields of action: energy-intensive industries (including substitution of carbon-intensive products); carbon capture, storage and use projects; innovative renewable energy generation projects and energy storage projects.

[48] https://ec.europa.eu/clima/policies/innovation-fund_es. 1st call for applications: https://ec.europa.eu/inea/en/innovation-fund/calls-proposal.

In addition, there will be a specific line for small-scale projects with a capital investment (CAPEX) of less than €7.5 million, which will be based on an abbreviated selection procedure in which all five criteria will be applied in a single step, using a more simplified assessment methodology. In this case, in addition, the 60% aid rate would be applied on the total CAPEX, rather than only on the additional costs of innovation.

▸ Horizon 2020 and Horizon Europe

Horizon 2020[49] is the largest funding instrument for research and innovation at European level, with nearly €80 billion. Among its objectives is to support policies for the transition to a low-carbon economy, environmental protection and climate action. Overall, around 35% of the programme is earmarked to fund research and innovation projects related to Climate Change, including those aimed at achieving clean, safe and efficient energy.

The 2018-2020 programme contributes to several focal areas, one of them being *"Building a low-carbon and climate-resilient future"*, to which €3.4 billion has been earmarked, with numerous calls for funding for projects that develop solutions to achieve climate neutrality and climate resilience in Europe in the second half of the century.

Horizon 2020 is the EU's Framework Programme for Research and Innovation that was launched for the period 2014-2020. The new Horizon Europe Framework Programme for the period 2021-2027, the successor to Horizon 2020, was approved on 27 April 2021 by the European Parliament, with a budget of €95.5 billion, of which around 35% will go towards tackling the challenges of Climate Change, supporting policies for the transition to a low-carbon economy and environmental protection.

The *Horizon Europe* programme also incorporates as a novelty the concept of *co-fund* partnerships, which, among other aspects, will provide continuity to the well-known *H2020 Eranets*, which are transnational networks of public R&D&I funding bodies whose objective is to coordinate the national and regional research programmes of the European Union Member States and associated countries, as well as to prepare and execute joint calls to promote transnational research, technological development and innovation projects in strategic areas of high European added value. The countries also undertake to carry out additional activities of interest to them and to their industrial and academic entities in a given area, in order to boost research, knowledge transfer and international cooperation towards the construction of the European Research Area (ERA).

The Centre for the Development of Industrial Technology (CDTI) and the State Research Agency have participated in many of the *Eranets* launched in *Horizon 2020*, as national funding agencies, and their participation in the new *co-fund* instruments for the *Horizon Europe* period is under study. In this sense, within cluster 5, two *co-fund* instruments are in the preparation and approval phase, one focused on clean energy transition, and the other on urban transition (cities). The first *Horizon Europe* calls have been launched in 2021.

▸ European Green Deal[50]

The European Green Deal call is part of the Horizon 2020 programme. The call is made up of eleven areas (eight thematic and three cross-cutting), including: "Clean, secure and affordable energy", "Industry for a circular and clean economy", "Resource and energy efficient buildings" and "Smart and sustainable mobility".

The European Commission has approved a new Horizon 2020 call for proposals dedicating a budget of €1 billion to research and innovation related to the European Green Deal. The new call was published in September 2020, so that projects could be submitted in early 2021.

To this end, one of the priority actions is to further promote offshore wind and the development of technologies associated with the use of offshore energy, in line with the previous objective of consolidating Europe's leadership in these technologies at world level.

---

[49] Horizon 2020: https://ec.europa.eu/programmes/horizon2020/en.
Horizon Europe: https://ec.europa.eu/info/horizon-europe-next-research-and-innovation-framework-programme_en.

[50] https://ec.europa.eu/info/research-and-innovation/strategy/european-green-deal/call_en.

- **Implementing Act on the European Union's renewable energy financing mechanism**

Article 33 of Regulation (EU) 2018/1999 on the governance of the Energy Union and Climate Action provides that the European Commission shall establish by 1 January 2021, by means of an implementing act, the Union's Renewable Energy Financing Facility. The content of this implementing act has already been negotiated between Member States, the vote took place in the second half of July 2020, and the publication in the OJEU was in the last quarter of 2020.

This mechanism has two purposes: on the one hand, it supports new renewable energy projects with the aim of closing a gap in the Union's indicative trajectory. To this end, Member States can make a voluntary financial contribution to the financing mechanism, with part of the energy generated by the installations being subsequently counted towards their targets, irrespective of where the installations are physically located. Furthermore, the financing mechanism contributes to the renewable energy enabling framework as defined in Article 3(5) of Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources, with the objective of supporting an ambitious deployment of renewable energy in the Union.

As part of the support for the renewable energy enabling framework, which can be funded by both Member States and the EU itself, the implementing act establishes that, among others, renewable grid integration projects can be developed, and explicitly states in its preamble that energy storage may be eligible, provided that it is accompanied by new renewable generation capacity, which could be linked to offshore renewable developments.

The way in which financial resources are made available to projects is through calls directly organised by the Commission or one of its agencies. The most likely mechanism for allocation is auctioning, with the price allocation option (pay-as-bid, pay-as-clear, etc.) being defined for each call. The implementing act foresees annual calls, provided that funds are available from both Member States and the Union itself. The mechanism is open to cooperation projects with third countries outside the EU.

- **InvestEU[51]**

The *InvestEU* programme is an EU instrument aimed at mobilising public and private funding for strategic investments in the framework of European policies. It will cover the period 2021-2027 and will bring together under one umbrella the European Fund for Strategic Investments and 13 other existing EU financial instruments. It is expected to generate additional investment of at least €650 billion.

The *InvestEU* fund aims to mobilise public and private investments by granting an EU budget guarantee of €38 billion to financial partners such as the European Investment Bank Group (EIB Group), strengthening their risk absorption capacity. This budget guarantee is divided between the areas of intervention as follows: €11.5 billion for sustainable infrastructure, €11.25 billion for research, innovation and digitalisation, €11.25 billion for SMEs and €4 billion for social investment.

- **Just Transition Fund[52]**

This mechanism shall be provided with 7.5 billion and is intended to support the transition of the regions most affected by the need to move away from a fossil fuel-based economic model and therefore targets the regions that are most carbon intensive or most dependent on fossil fuels.

The eligibility criteria and the typology of the projects to be funded are still under discussion, but it is expected that certain Spanish regions linked to coal may be eligible, with offshore wind and marine energy being possible solutions for the economy and employment in these regions.

[51] https://europa.eu/investeu/home_es; https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/investment-plan-europe-juncker-plan/whats-next-investeu-programme-2021-2027_en#documents.

[52] https://www.europarl.europa.eu/RegData/etudes/STUD/2020/651444/IPOL_STU(2020)651444_EN.pdf.

▸ **European Regional Development Fund (ERDF)[53]**

The ERDF (FEDER by its Spanish acronym) aims to strengthen socio-economic cohesion within the EU by correcting imbalances between its regions. To this end, it focuses its investments on four key thematic areas: research and innovation, the digital programme, support for SMEs and the low-carbon economy. In Spain, the lines of aid in this last thematic area, whose main objective is to promote the transition to a low-carbon economy, are managed by the Institute for Energy Diversification and Saving (IDAE). Within this framework, the IDAE has launched numerous aid programmes for energy saving and efficiency projects, either in the form of subsidies or low-interest loans.

For the next EU budget period, 65-85% of the ERDF will be allocated to the objectives of "a smarter Europe" and "a greener, carbon-free Europe" that implements the Paris Agreement and invests in energy transition, renewable energy and climate action, including support programmes associated with technology development related to offshore renewable energy.

▸ **InnovFin Energy Demonstration Projects**

InnovFin Energy Demonstration Projects is a European Investment Bank (EIB) financing facility, consisting of loans, loan guarantees or equity financing of between €7.5m and €75m, for innovative projects in the field of energy system transformation, including renewable energy and energy storage technologies, aimed at bridging the gap between demonstration and commercialisation.

For a project to be eligible for *InnovFin Energy Demonstration Projects* it must contribute to the energy transition, particularly in the fields of renewable energy, smart energy systems, energy storage and carbon capture; it must be innovative, replicable, be in a demonstration phase close to pre-commercial level, and be attractive for investment. For their part, promoters must be willing to significantly co-finance the project.

▸ **European Fund for Strategic Investments (EFSI)[54]**

The EFSI functions as a guarantee for the EU budget, providing the EIB Group with first loss protection. This means that the EIB Group can provide funding to projects with higher risk than it would normally take on. An independent Investment Committee applies strict criteria to decide whether a project is eligible for EFSI support. There are no quotas, either by sector or by country. Funding is provided on a purely demand-driven basis.

The EFSI aims to overcome current market failures, address market gaps and mobilise private investment. It helps finance strategic investments in key areas such as infrastructure, research and innovation, education, renewable energy and energy efficiency, as well as risk financing for SMEs.

From 2021, the EFSI will be integrated into *InvestEU*.

▸ **Recovery, Transformation and Resilience Plan (Next Generation EU)[55]**

Next Generation EU is a new instrument for recovery from the COVID-19 pandemic crisis, endowed with €750 billion, of which two thirds will be in the form of direct aid and the remaining third in the form of loans.

The central pillar of this instrument is the Recovery and Resilience Mechanism, which aims to mitigate the social and economic impact of the crisis by supporting the green transition and the digital transition, promoting the economic, social and territorial cohesion of the EU by enhancing the resilience of Member States, thereby contributing to restoring the growth potential of EU economies, boosting job creation and sustainable growth.

---

[53] https://ec.europa.eu/regional_policy/es/funding/erdf/.

[54] https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/investment-plan-europe-juncker-plan/european-fund-strategic-investments-efsi_es.

[55] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590732521013&uri=COM:2020:456:FIN
https://www.consilium.europa.eu/media/45124/210720-euco-final-conclusions-es.pdf
https://ec.europa.eu/info/strategy/recovery-plan-europe_es#nextgenerationeu

At the European level, the Facility will be endowed with 672.5 billion euros to provide financial support for reforms and investments, of which 312.5 billion euros will be provided in the form of grants and 360 billion euros in the form of loans. Of the amount earmarked for grants, 70% is committed for the first two years. This instrument will provide Spain with around 140 billion euros in the form of transfers and loans for the period 2021-2026. For the implementation of the European funds until 2023, on 27 April 2021, the government approved the "Spain Can" Recovery, Transformation and Resilience Plan, which was submitted to the European Commission on 30 April 2021.

The *Next Generation EU* funds base a large part of their strategy on climate action and the promotion of renewable energy, with priority for offshore wind energy due to its capacity to generate employment, economic driver and industrial implementation, as its objectives include support for the ecological transition towards a climate-neutral economy, and this technology is essential to achieve a high penetration of renewable energy and the decarbonisation of the system. These funds will be deployed through new mechanisms or by reinforcing and increasing the financing of existing mechanisms already mentioned, such as *InvestEU* or the Just Transition Fund.

▸ Eurostars Programme

Eurostars is a programme to support R&D intensive SMEs in the development of market-oriented transnational projects. This initiative is based on Article 185 of the Treaty on the Functioning of the EU concerning EU participation in joint research and development programmes.

It currently involves 25 *EUREKA* Member States and the EU in strong support for innovative European SMEs. Until 2020, the EU will provide €287 million from the *Horizon 2020* SME instrument, to which will be added more than €800 million from the signatory countries.

In Spain, the Ministry of Science and Innovation, through the CDTI, is responsible for the management of the programme.

Further information: https://www.eurostars-eureka.eu/

	Description and characteristics	Endowment	Type of aid	Calls for applications
Innovation fund	• One of the main funding programmes for innovative low-carbon technologies. • Specific storage line. • Selection criteria: 1. Avoided emissions. 2. Degree of innovation. 3. Project maturity. 4. Scalability. 5. Cost efficiency. • Annual calls. • Specific line for projects with CAPEX < 7,5M€.	10.000 M€.	Subsidy. Up to 60% of additional costs arising from innovation.	July 2020. 1000 M€.
H2020	• Europe's largest R&D&I funding instrument. • Among its objectives are: 1. The transition to a low-carbon economy. 2. Environmental protection. 3. Climate action. • It is currently priority area: *"Building a low-carbon and climate-resilient future"*.	80.000 M€. The 2018-2020 programme allocates €3.4 billion to climate.	Various	Various

	Description and characteristics	Endowment	Type of aid	Calls for applications
Horizon Europe	• Next Framework Programme successor to H2020. • Currently under development. • *Climate, Energy and Mobility Cluster.* • It will incorporate co-funding partnerships.	Under negotiation. Estimated at 100.000M€, 35% for Climate Change.	Various.	January 2021.
European Green Deal	11 areas, including: • Clean, safe and affordable energy. • Industry for a circular and clean economy. • Resource and energy efficient buildings. • Intelligent and sustainable mobility.	1.000 M€.	Various.	September 2020.
Implementing act on the Union's financial mechanism	• Support mechanism at EU level, which aims to enable certain Member States to achieve their renewable targets and to promote ambitious development of renewables in the EU. • Storage is envisaged (as long as it is associated with new renewable generation). • Selection criteria: • Price, in the case of auctions associated with the *gap filling* function of the targets. • To be determined for each call, in the case of the facilitating framework.	Not determined.	In the case of *gap filling*, the sole award criterion in the auction shall be price. In the case of the facilitating framework, it shall be determined in each call.	The first call is foreseen in 2021. Should funds become available, annual calls will be launched.
Invest EU	It aims to mobilise public and private investment through guarantees to financial partners such as the EIB Group.	38.000 M€.	Financial guarantee.	2021.
Just Transition Fund	Aimed at supporting the transition of the regions most affected by the need to abandon an economic model based on fossil fuels.	7.500 M€.	Subsidies.	2021.
ERDF	• Objective: to correct imbalances between regions. • It focuses its investments on four thematic areas, one of which is the low-carbon economy.	-	Grants or loans.	Various.
InnovFin	• Financing of innovative projects for the transformation of the energy system. Includes renewable energy and storage. • Objective: to bridge the gap between demonstration and commercialisation.	Financing of between €7.5 and €75 million.	• Loans. • Loan guarantees. • Equity participation.	Various.
CEF	IPCEI are eligible for this funding mechanism.	43.000 M€. 60% for climate. 9 billion for energy.	-	2021.
FEIE	Support for strategic investments in key areas, including clean energy.	-	Financial guarantee.	In 2021 integrated in InvestEU.
Next Generation EU	• New crisis recovery instrument COVID-19. • Among its objectives is support for the ecological transition.	NGEU: 750.000 M€. MRR: 672.500 M€.	Grants and loans.	-
Eurostars	Programme to support R&D-intensive SMEs in the development of market-oriented transnational projects.	287M€ from H2020 + 800M€ from partner countries	-	Various.

NATIONAL INSTRUMENTS

- **Green bonds**

In recent months, taking advantage of the momentum of the Green Pact, several initiatives have been promoted in this area. One of them is aimed at fostering the development of "green bond" markets for public and private financing. Green bonds are fixed income instruments whose principal issued is dedicated to financing or refinancing environmental investment projects.

Spain could benefit from the booming sustainable finance market by diversifying its investor base, especially in Europe where most sustainable investors are concentrated. Moreover, given the appetite in the market for this type of bond, the issuance of the green bond could have a slight cost advantage. It could also generate positive externalities for the Spanish corporate green bond market by establishing a baseline for the market.

- **R&D&I support instruments managed by CDTI**

The Centre for the Development of Industrial Technology (CDTI) is the managing player for aid from the General State Administration for business R+D+i. To this end, the CDTI manages the various aid programmes, applicable depending on the level of maturity and proximity to the market of the project. Below is a list of the different instruments for which projects related to technological development related to the use of **offshore wind and marine energy** could be eligible.

1. R&D grants

Between 2017 and 2020, CDTI has provided close to 30 million euros in the form of R&D aid related to storage. This aid is articulated through two mechanisms: partially reimbursable aid and subsidies.

- **Partially repayable grants:** Financing of up to 85% of the budget by means of a loan at a fixed interest rate (1-year Euribor), to be repaid in 7 to 10 years, with a grace period of 2 to 3 years. Non-repayable tranche: 33%.
  - **CDTI R&D projects:**
    - **CIEN projects[56]:** large R&D projects, developed in effective collaboration by business groups and aimed at carrying out planned research in strategic areas of the future and with potential international projection. Candidate projects for CIEN projects will be evaluated on the basis of a series of criteria grouped into 4 categories:
      - Assessment of the business plan .
      - Valuing technology and innovation.
      - Capacity of the consortium in relation to the project.
      - Socio-economic and environmental impact assessment.
    - **R&D projects:** developed by companies and aimed at the creation and significant improvement of production processes, products or services.
  - **Cervera Transfer Projects[57]:** aid for individual R&D projects developed by companies that collaborate with state-level Technology Centres in Cervera priority technologies, including: hybrid generation systems.
- **Grants::**
    - **Science and Innovation Missions[58]:** The programme finances large strategic initiatives, intensive in Industrial Research, that incorporate the most recent trends, developments and scientific-technical challenges to

[56] https://www.cdti.es/index.asp?MP=100&MS=802&MN=2
[57] https://www.cdti.es/index.asp?MP=100&MS=881&MN=2
[58] https://www.cdti.es/index.asp?MP=100&MS=902&MN=2&TR=C&IDR=2902&r=1252*783

identify and solve the challenges faced in the future by critical productive sectors for the Spanish economy and for the generation of employment. It has 5 priority lines or "missions", including "Safe, efficient and clean energy for the 21st century" and "Sustainable and intelligent mobility".

- **Announcements**. Annual. The last one ended in July 2020.
- **Endowment.** The last call for proposals had a budget of 95 million euros.

2. Innovative public procurement[59]

This involves the acquisition by the CDTI of prototypes of first products or services in the pre-commercial phase, in the form of test series, which are technologically innovative and meet public needs. The prototype, if developed, will be transferred to the Spanish Public Administration that is interested in it and can provide the real environment necessary to validate the proposed technology. The prototype must be used exclusively to validate technology, with no subsequent commercial purposes.

3. INNVIERTE[60]

Co-investment programme with private investors in specialised capital aimed at stimulating investment in Spanish technology and innovative companies.

4. Innovation grants[61]

Support for projects of an applied nature, very close to the market, with medium/low technological risk and short payback periods, which improve the competitiveness of the company through the incorporation of emerging technologies.

The innovation hotline is partially repayable aid in the form of a loan for 75% of the budget. The interest rate depends on the repayment period: for 3-year repayment, Euribor + 0.2% and for 5-year repayment, Euribor + 1.2%. Non-repayable tranche: 2% in general and 5% if co-financed with ERDF.

- **Nationally managed R&D&I support instruments**

1. Aid for investment in electricity generation facilities using renewable energy sources, eligible for co-financing from Community ERDF (FEDER by its Spanish acronym) funds[62]

The ERDF aims to strengthen socio-economic cohesion within the EU by correcting imbalances between its regions. To this end, it focuses its investments on four key thematic areas: research and innovation, the digital agenda, support for SMEs and the low-carbon economy.

In Spain, the lines of aid in this last thematic area, whose main objective is to promote the transition to a low-carbon economy, are managed by the Institute for Energy Diversification and Saving (IDAE).

Within this framework, the Institute for Energy Diversification and Saving (IDAE) is currently developing an aid programme to promote the development of innovative projects throughout Spain that meet the new requirements of the European Directives for the integration of renewable energy into the electricity network. Furthermore, this aid can also contribute to the economic development and social cohesion of those areas particularly affected by the Energy Transition. Within the typology of renewable installation projects, Offshore Wind Installations with or without storage and Offshore Wind Installations with or without for the production of renewable Hydrogen are

59 https://www.cdti.es/index.asp?MP=100&MS=882&MN=2
60 https://www.cdti.es/index.asp?MP=100&MS=819&MN=2
61 https://www.cdti.es/index.asp?MP=100&MS=812&MN=2
62 https://www.idae.es

contemplated. And for Marine Energy, it includes installations for the use of marine energy (waves, currents, etc.) in technology centres or platforms.

The aid will take the form of subsidies covering between 10% and 80% of eligible costs, depending on the action, through calls for proposals in each of the corresponding Autonomous Communities, with a total budget estimated at 316 million euros, although part of this will be earmarked for existing programmes in non-peninsular territories focused on wind and solar photovoltaic energy. The first calls under these regulatory bases were launched in September 2020, being developed specifically for each Autonomous Community through bilateral working groups with the IDAE.

For the next EU budget period, between 65% and 85% of the ERDF will be allocated to the objectives of "a smarter Europe" and "a greener, carbon-free Europe" that implements the Paris Agreement and invests in energy transition, renewable energy and climate action, where offshore wind farms, offshore wind farms with hydrogen storage/production, as well as offshore wind energy installations (waves, tidal streams,...) in technology centres or platforms have a place.

ANNEX II

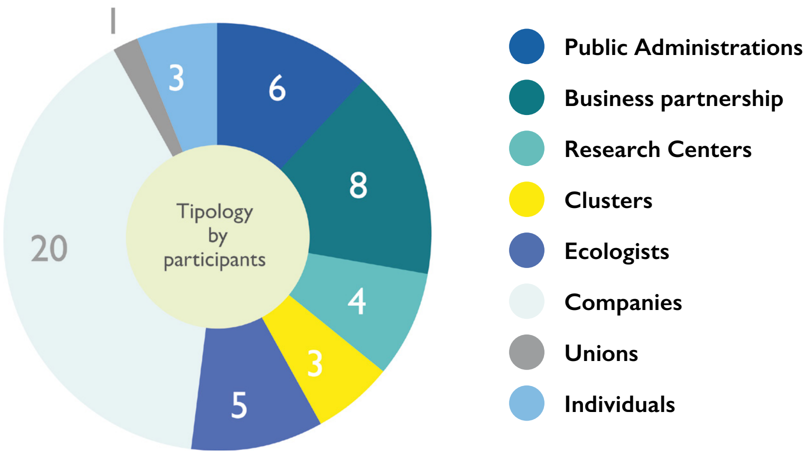
CONTRIBUTIONS RECEIVED IN THE PUBLIC CONSULTATION OF THE ROADMAP FOR THE DEVELOPMENT OF OFFSHORE WIND AND MARINE ENERGY IN SPAIN

Between 30 April and 5 July 2020, a Public Consultation process was carried out prior to the Roadmap for the Development of Offshore Wind and Marine Energy, in which 36 entities and/or individuals participated. The Public Consultation was carried out through the Public Participation section of the website of the Ministry for Ecological Transition and the Demographic Challenge, asking participants to answer 11 questions published in that section, in order to gather, directly or through their representative organisations, the opinion of the people and entities potentially involved in the Roadmap for the Development of Offshore Wind and Marine Energy in Spain, on its content, the identification of priorities and necessary resources, as well as the main challenges for the development of offshore renewable energy and the possible measures to overcome them.

On 7 July 2021, the Draft "Roadmap for the development of offshore wind and marine energy in Spain" was published on the MITECO-SEE website, with the aim of gathering, directly or through their representative organisations, the opinion of citizens and entities potentially involved in the value chain of offshore renewable energy.

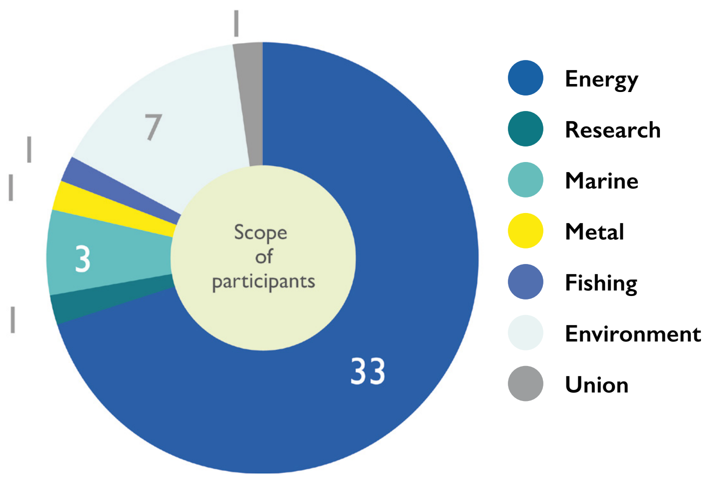
A total of 273 allegations have been received from 50 claimants, including Associations, Clusters, Administration, Companies and Universities, etc., as shown in the following graph:

Figure 60. Typology by participants. Source: MITECO-IDAE



With regard to the field or sector to which the participants belong, the following graph shows the distribution. Most of the entities are linked to the energy sector (public and private), followed by the Environment and Marine sectors.

Figure 61. Scope of participants. Source: MITECO-IDAE



The following is a summary of the main allegations that have been included in the Roadmap, with respect to the draft published for public consultation:

- **New generic concepts::**
  - **Update of the Roadmap targets in 2025**, which would then bring forward a range of new targets to 2040, already after the implementation of the regulatory measures and the publication of the auctions. [In Action 4.2 "Update and Renewal of the Roadmap in the decade 2020-2030"].
  - **New section 1.3, including the commitment to implement the main regulatory measures of the Recovery, Transformation and Resilience Plan (PRTR, by its Spanish acronym) by Q2/2023**, as well as the specific mention of the sub-milestones for compliance with the RRTP and the identification of the Roadmap measures associated with these sub-milestones.
  - Express mention of the short-term **support lines associated with this Roadmap, in accordance with the publication in the PRTR**, in measure 1.2 (Technological Development Programmes), mentioning the forecast **launch of the first lines during 2022**, under the investment subsidy mechanism, to give a greater level of concreteness in the €200 million in 2021-2023. In addition, it is clarified that innovative financing mechanisms may be used to facilitate the early development of new technological concepts.
  - New specific section 2.3 in the HR on the **State of the Art of Floating Photovoltaic (FPV)**, with no targets of its own during the decade. New mention of Floating Photovoltaic (FPV) in Action 4.2 to be considered in the 2025 Review of the Roadmap, with horizons beyond 2030.
  - Emphasis and relevance of the **Just Transition (JT) strategy** in the national context and the possibility of also considering FT criteria in competitions.
  - In line with the Draft Maritime Spatial Planning - MSP (POEM, by its Spanish acronym) (in public consultation), the POEM include **offshore renewable energy as one of the future uses within the maritime space that should be assigned areas of priority use and/or high potential.** [In Action 3.1: "Definition and approval in the MSP (POEM) of zoning for the development of offshore wind farms"].
  - Mention is made of the **current regulations identified for review and adaptation in the short term**. [In measure 3.4 "Adaptation of the administrative framework", among others, the necessary extension of the administrative deadlines for offshore wind projects is made explicit, in relation to the expiry of access and connection permits and others.
  - **General features of the competition framework for commercial offshore wind projects** are specified [In measure 3.5 "Framework for the promotion of investment in offshore wind and marine energy"]. Among others, it includes the possibility of including mechanisms or incentives for the successful bidder for the development of commercial offshore wind farms, in the marine area covered by the concession, to consider or allocate positions for testing prototypes or pre-commercial technological wind farms or hybrids.
  - **The cross-referencing of the list of TJ nodes in Annex I of RD-Law 23/2020 with those required for the deployment of offshore wind** in the areas defined in the MSP (POEM) and the presence of shipyards is contemplated. [In measure 2.6.].

- **New measures:**
  - **New measure 1.4 "Improving knowledge of the marine environment"** which would provide certainty and would serve to implement measure 3.7 Guide to environmental and biodiversity guidelines on the implementation of renewable energy in the marine environment.
  - **New measure 2.9** for the "**Creation of cross-sectoral WGs"** including Navigation and Fisheries, to seek synergies, shared uses and compensation mechanisms.
  - **New measure 3.8 on the creation of a "Technical Office for the deployment of Offshore Renewable Energy".**
- **Environmental issues, fisheries, navigation and maritime traffic:**
  - Reference is included to the study 'Impact of the use of offshore wind and other marine renewables on European fisheries', commissioned by the European Parliament's Committee on Fisheries, as well as references to **good practices in Europe linked to the compatibility and exploitation of synergies between offshore wind and fisheries**. The desirability of offshore wind development to include socio-economic benefits for fishermen and local communities is assessed as a facilitating element for a greater consensus to make commercial offshore wind projects viable.
  - Rewording of Action 3.7 on the Guidance on environmental guidelines, to also address **good practice in environmental monitoring.**
  - Inclusion of the consideration of the **fisheries sector** as a **key sector for the economy** with reference to the 'Progress Report 2021 and Sustainable Development Strategy 2030.
  - The **considerations and risks identified by the fisheries sector** are included under the heading "Interactions with the environment".
  - Emphasis is placed on the use of forums for meeting and **dialogue with fishermen's organisations in the early stages of the projects**, both under the heading of "Interactions with the environment" and in the new measure for the creation of cross-sectoral WGs.
  - Specific consideration of **navigation, traffic and maritime safety** issues in the different sections and measures of the Roadmap.
- **Other drafting issues and nuances:**
  - It is included that new test platforms will be considered to have the capacity to connect prototypes of higher unit power than those currently available, in order to increase the testing and validation capabilities of prototypes closer to their commercial release [In Action 1.1].
  - Clarification that the timetable for the development of offshore wind projects (in 5 years) contains "target dates", which would be reached after the implementation of measure 3.4, among other things.
  - Updating of section 2.1 of the State of the Art: Inclusion of SWOT analysis, incorporation of new figures from recent international reports (World Bank Group 2021), considerations on new technological developments and offshore renewable technologies, among others.

- Clarification that measures to support technological development would also be aimed at strengthening existing test areas [In measure 1.2].
- Drafting modifications are included to clarify potential support for pre-commercial wind farms.
- Clarification on the implementation of the identification of weaknesses or gaps that may exist in the domestic industrial chain, in order to try to fill them with domestic industry". [In Measure 2.2].
- Emphasis is placed on the existence and relevance of clusters, considering the potential creation of hubs or forums per Marine Subdivision [In measure 2.3].
- Mention is made of European initiatives under the European Capability Agenda. [Measure 2.5].
- It includes clarifications on potential offshore grid nodes and possible synergies with international interconnections.

ANNEX III

SYNERGIES OF THE ROADMAP FOR THE DEVELOPMENT OF OFFSHORE WIND AND MARINE ENERGY IN SPAIN WITH OTHER STRATEGIC PAPERS

National Integrated Energy and Climate Plan (PNIEC)

The Roadmap for the development of offshore wind and marine energy in Spain fulfils the mandate of Action 1.1 of the PNIEC to develop a strategic document that takes into account the high energy potential and the strong base of companies in the offshore wind and other marine energy value chain. In addition, several of the measures foreseen in this Roadmap specifically contribute to the achievement of several of the measures foreseen in the PNIEC, as illustrated below.

Measures in the Roadmap for the development of offshore wind and marine energy in Spain	Measures or objectives of the PNIEC to which it contributes
Offshore renewables deployment targets	It contributes to 74% of renewable penetration in the electricity sector and 42% of renewables in final energy use.
Measure 1.1 – 1.2 Spain as a reference hub for R&D&I in offshore renewable technologies.	• Measure 1.12 Singular projects and strategy for sustainable energy on islands. • Measure 1.18 Review and simplification of administrative procedures. • Measures 5.1-5.18 Research, innovation and competitiveness dimension.
Measure 2.1 – 2.8 Accompanying and boosting the value chain.	• Measure 1.14 Promoting the proactive role of the public in decarbonisation. • Measure 1.15 Just Transition Strategy. • Measure 1.17 Training of professionals. • Measure 1.19 Knowledge generation, dissemination and awareness-raising.
Measure 3.1. MSP (POEM). **Measure 3.7.** Environmental Guidance.	Strategic Environmental Assessment of the PNIEC.
Measure 3.4 Adaptation of the administrative framework for the authorisation of offshore renewable installations.	• Measure 1.18 Review and simplification of administrative procedures.
Measure 3.5 Framework for boosting investment.	• Measure 1.3 Adaptation of electricity grids for the integration of renewables.
Measure 3.5 Framework for boosting investment.	• Measure 1.1 Development of new electricity generation facilities using renewables. • Measure 1.12 Singular projects and strategy for sustainable energy on islands.
Measure 3.6 Early development of offshore wind deployment in the Canary Islands.	• Measure 1.12 Singular projects and strategy for sustainable energy on islands.

EU Strategy on Offshore Renewable Energy

A component in the 'EU Strategy on Offshore Renewable Energy'	Relevant references in the Roadmap for the development of offshore wind and marine energy in Spain
4.1 Maritime Spatial Planning.	• Measure 3.1. Definition and approval of zoning for the development of offshore wind farms in the MSP (POEM by its Spanish acronym). • Measure 3.6. Early development of offshore wind deployment in the Canary Islands.
4.2 New approach to offshore renewable energy and grid infrastructure.	• Measure 3.3. Coordination of the access and connection framework and new management models for electricity networks.
4.3 Regulatory framework for offshore renewable energy.	
• Specific regulatory framework for innovative projects: on islands, hybrid and offshore hydrogen projects.	• Measure 3.6. Early development of offshore wind deployment in the Canary Islands.
• Support schemes, in accordance with state aid rules, to ensure that offshore renewable energy projects are scaled up as needed.	• Measure 3.4. Adaptation of the administrative framework for the authorisation of offshore renewable installations. • Measure 3.5. Framework for the promotion of investment in offshore wind and marine energy.

A component in the 'EU Strategy on Offshore Renewable Energy'	Relevant references in the Roadmap for the development of offshore wind and marine energy in Spain
• Specific support systems offshore renewable energy.	• Measure 1.1. Development and strengthening of testing platforms. • Measure 1.2. Technology development programmes. • Measure 1.3. 'Plug & play' framework for the replacement of experimental prototypes on offshore renewable energy test platforms. • Measure 3.4. Adaptation of the administrative framework.
4.4 Mobilising private sector investment in offshore renewables: the role of EU funds.	• Measure 1.2. Technology development programmes. • Annex I.
4.5 Focusing research and innovation on support for offshore renewable energy projects.	• Measure 1.1. Development and strengthening of testing platforms. • Measure 1.2. Technology development programmes. • Measure 1.3. 'Plug & play' framework for the replacement of experimental prototypes in offshore renewable energy test platforms.
4.6 A stronger supply and value chain across Europe.	
• Offshore renewable energy supply chain must be able to increase its capacity.	• Measure 2.1. Assessment of port infrastructure for the construction and assembly or export of components associated with offshore renewable installations. • Measure 2.2. Monitoring and accompanying the national maritime industry and value chain for the development of offshore wind and marine energy projects.
• Offshore renewable energy Sector Forum.	• Measure 2.3. Public-private and private-private partnership hub for the development of offshore renewable energy.
• Use cohesion policy funds 2021-2027, including the European Social Fund Plus, as well as the Just Transition Facility where appropriate, to support investment in offshore renewables.	• Measure 2.6. Contribution to Just Transition.
• Capacity-building and training programmes for the offshore renewable energy sector "skils challenge".	• Measure 2.5. Capacity building, training and professional qualification in the offshore renewable energy sector.
• Circular Economy "a circular economy approach".	• Measure 2.7. Circular Economy: boosting eco-design and the end-of-life value chain.
• *EU industry and world markets.*	• Measure 2.4. Strengthening Spain's position in the international context.
• International collaboration to help create an enabling environment for offshore renewable energy development. • The EU must adopt a more assertive approach to promoting its interests through trade policy.	• Measure 2.3. Public-private and private-private partnership hub for the development of offshore renewable energy. • Measure 2.4. Strengthening Spain's position in the international context.

ANNEX IV

MARITIME SPATIAL PLANNING IN SPAIN (POEM)

Maritime Spatial Planning (hereinafter MSP) is understood as the process by which competent authorities analyse and organise human activities in marine areas in order to achieve ecological, economic and social objectives.

The MSP (POEM by its Spanish acronym) is therefore configured as a cross-cutting strategic instrument that allows public authorities and stakeholders to apply a coordinated, integrated and cross-border approach, allowing for a more optimal use of maritime space, reducing conflicts, as well as enhancing coexistence and synergies.

MSP (POEM) is also a very useful tool to ensure the protection of sensitive and vulnerable ecosystems, habitats and species, including those protected by regional, national or supranational regulations.

One of the tools identified by the EU Integrated Maritime Policy to promote blue growth is maritime spatial planning. In this context, **Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning** was developed. This Directive was transposed into Spanish law through **Royal Decree 363/2017, of 8 April, which establishes a framework for maritime spatial planning**, including the obligation for Spain to draw up a maritime spatial plan for each of the five Spanish maritime subdivisions: North Atlantic Subdivision, South Atlantic Subdivision, Strait and Alboran Subdivision, Levantine Balearic Subdivision and Canary Island Subdivision.

The ultimate aim of **Directive 2008/56/EC, or Marine Strategy Framework Directive** (MSFD), is to achieve or maintain, by 2020 at the latest, good environmental status in the marine environment. The MSFD was transposed into Spanish law through **Law 41/2010, of 29 December, on the Protection of the Marine Environment**, which established the obligation to draw up and implement five marine strategies, one for each of the five established marine subdivisions.

The existing links between both directives have been transferred to the national regulatory sphere in the same way. Article 7 of Law 41/2010 establishes that "Marine strategies are the planning instruments for each marine subdivision and constitute the general framework to which the different sectoral policies and administrative actions with an impact on the marine environment must necessarily conform, in accordance with the provisions of the corresponding sectoral legislation".

Law 41/2010, even before the Maritime Spatial Planning Directive had been approved, already conceives maritime spatial planning as a tool to guarantee sustainability and the achievement of good environmental status, and thus includes it in its Annex V, which lists the types of measures that could be included in the programmes of measures of marine strategies, including "Maritime Spatial Planning" as one of these types of measures.

For all of the above reasons, RD 363/2017, of 8 April, was conceived as a regulatory development in application of the provisions of article 4.2 of Law 41/2010, of 29 December, on the protection of the marine environment. Thus, RD 373/2017, of 8 April, indicates that "This management framework will constitute a common guideline for all marine strategies, in accordance with the provisions of article 4.2.f) of the Law for the Protection of the Marine Environment".

SCOPE OF APPLICATION

Royal Decree 363/2017, regulates the content of the MSP (POEM), so that they will establish the spatial and temporal, existing and future distribution of, among others, the following uses and activities:

- aquaculture zones;
- fishing zones;
- facilities and infrastructure for the exploration, exploitation and extraction of oil, gas and other energy resources, minerals and mineral aggregates, and the production of energy from renewable sources;
- maritime transport routes and maritime traffic;
- dumping areas at sea;
- the different types of areas defined in Law 8/1975 of 12 March 1975 on areas and installations of interest to the National Defense, as well as marine areas used for the conduct of Armed Forces exercises;

- protected areas, sites and habitats that deserve special attention due to their high environmental value and protected species, especially those available in the Spanish Inventory of Natural Heritage and Biodiversity;
- raw material extraction areas;
- scientific research;
- submarine cables and pipelines;
- tourism, recreational, cultural and sporting activities;
- underwater cultural heritage;
- the listed or additional elements that should form part of the green infrastructure of Article 15 of Law 42/2007 of 13 December 2007 on Natural Heritage and Biodiversity.

In addition to these uses and activities, the Interministerial Commission for Marine Strategies approved a set of activities that are also important to consider in maritime spatial planning, due to their relevance in Spanish marine waters. These activities are:

- The extension of port service areas;
- Water abstraction and brine disposal areas in desalination plants;
- CO_2 storage areas;
- Areas intended for the creation of artificial reefs.

All these uses have therefore been included in the Diagnosis section in two groups: "Uses of general interest" and "Uses of maritime sectors".

The Spanish marine environment, for the purposes of applying the Marine Environment Protection Act, is divided into two marine regions, the Mediterranean and the Northeast Atlantic, subdivided into three marine sub-regions: the Bay of Biscay and Iberian coasts, the Western Mediterranean, and Macaronesia. In turn, the law establishes the following five Marine Subdivisions:

- **North Atlantic marine subdivision:** includes the marine environment under Spanish sovereignty or jurisdiction between the northern limit of the waters under Spanish jurisdiction and Portugal and the limit of the waters under Spanish jurisdiction and France in the Bay of Biscay.
- **South Atlantic marine subdivision:** includes the marine environment under Spanish sovereignty or jurisdiction between the limit of the jurisdictional waters between Spain and Portugal in the Gulf of Cadiz and the meridian passing through Cape Espartel (Morocco).
- **Strait and Alboran Marine subdivision:** includes the marine environment under Spanish sovereignty or jurisdiction between the meridian that passes through Cape Espartel and the imaginary line with an orientation of 128° with respect to the meridian that passes through Cape Gata, and the marine environment under Spanish sovereignty or jurisdiction in the area of Ceuta, Melilla, the Chafarinas Islands, the Perejil islet, the Vélez de la Gomera and Alhucemas rocks and the island of Alboran.
- **Levantine-Balearic marine subdivision:** includes the marine environment under Spanish sovereignty or jurisdiction between the imaginary line oriented 128° with respect to the meridian passing through Cape Gata and the limit of the jurisdictional waters between Spain and France in the Gulf of Lions.
- **Canary Islands marine subdivision:** includes the marine environment under Spanish sovereignty or jurisdiction around the Canary Islands.

Royal Decree 363/2017, of 8 April, establishes that **five Maritime Spatial Plans (MSP, POEM by its Spanish acronym) must be drawn up, one for each of the five Spanish marine subdivisions.**

Marine protected areas shall be governed by the management regulations applicable to them, without prejudice to their classification in these plans as priority use areas for the conservation of biodiversity.

Areas I and II of the State Ports, as well as the service areas of the regional ports, are outside the scope of these plans.

The management of these plans is based on the respect and maintenance of the uses, activities and processes that, at the date of their entry into force, are taking place in Spanish marine waters, regulated by their specific regulations, and without prejudice to the modifications that they may undergo in the future.

The geographic information on the scope of the MSP (POEM) is reflected in Annex II and in the geographic viewer of the MSP http://www.infomar.miteco.es.

With regard to the time horizon, it is planned that the revision of the MSP will be carried out 6 years after their approval by Royal Decree, in line and coordinated with the periodic revisions every 6 years of other closely related planning tools, such as the marine strategies and, to a lesser extent, the hydrological plans. Consequently, the MSP will be reviewed and updated by 31 December 2027 at the latest.

GUIDING PRINCIPLES

The plans will follow a set of guiding principles, which will guide the spatial planning process. These are:

- Sustainable development.
- Ecosystem approach, considering biodiversity, geological and hydrological diversity of marine ecosystems, including the landscape, the interactions between them, as well as the use of ecosystem services by society.
- Improving the competitiveness of maritime sectors.
- Improved use of marine space.
- Improving governance.
- Active involvement of public and private actors including local coastal communities.
- Adaptive management.
- Green transition to a low-carbon, resource-efficient economy and, linked to this, a Just Transition in terms of employment.
- Economic diversification, seen as key to the economic sustainability of maritime sectors.
- Gender mainstreaming in the planning process.
- Circular Economy.
- Facilitating access to marine information and data by ensuring that it is kept up to date.
- Preponderance of objectives of general interest.
- Use of the best available scientific information, and the most appropriate scale of analysis.

Furthermore, the objectives must generate synergies and be compatible with the objectives previously established in the sectoral planning tools in force, as well as with the environmental objectives approved in the framework of the marine strategies, i.e. they must ensure that the good environmental status of the marine environment is not compromised. This ensures that the objectives defined do not contradict or overlap with these planning instruments.

MARITIME SPATIAL PLANNING

- **Management Scheme**

  Firstly, it is assumed that marine waters can be subject to coexistence between different uses and activities, and that these uses and activities can be carried out without compromising the good environmental status of the marine environment.

This coexistence, as well as the non-affection of the good environmental status and the favourable conservation status of habitats and species, are partly guaranteed by the existing regulations, which in some cases establish limitations of use, both in terms of their spatial component and in terms of the characteristics that each use and activity must comply with.

The MSP (POEM) maintain and incorporate the existing restrictions on uses derived from sectoral and environmental regulations and, in addition, provide general application criteria to guarantee the coexistence of uses and activities while maintaining a good environmental status.

In a next step, within the management process, special relevance is given to the uses and activities of maritime space that derive from aspects of general interest, and that facilitate the achievement of the general interest objectives of the MSP (POEM).

To this end, the zones where the different uses of general interest are carried out are identified, and these zones have been defined with their corresponding perimeters. In each typology of priority use zone, provisions are established for the regulation/restriction of uses and activities to ensure that the priority use is not compromised. **Criteria are also established for possible situations of spatial overlap between two or more priority use zones**. Within these priority use zones, some of the areas identified for the development of renewable energy, specifically offshore wind energy, have also been included. This is due to the strategic character given to this future use of marine waters within the MSP (POEM).

Once the uses and activities of general interest have been guaranteed, the MSP (POEM), in their task of promoting the sustainable development of the maritime sectors, pay special attention to certain sectoral activities whose future development is foreseeable, and in which it is also necessary to identify the most suitable space for their development. To this end, high potential areas (for different uses and activities) are established. The mechanisms by which the high potential of certain areas for a specific use has been identified are varied. Some zones have been extracted from technical-scientific work including spatial modelling, others have been based on expert judgement, in the context of projects and through participatory processes. Regulations are established for uses and activities that may favour the development of the activity within their high potential zones, and criteria are also established for the overlap between different high potential zones.

The sustainable coexistence of different uses, activities and interests will be pursued. To this end, in addition to compliance with the sectoral regulations in force, developers and users of the sea, as well as the competent administrations during the process of authorising the activity, apply a series of horizontal and sectoral criteria.

- **Priority Use Zones (according to its Spanish acronym, ZUP "*Zonas de Uso Prioritario*")**

Some of the **uses of general interest** identified in the MSP (POEM) take place in specific areas of the maritime space, and therefore the plans must ensure that these uses of general interest are given priority status. To this end, a number of priority use areas have been identified, in which certain measures are put in place to ensure that each use is not put at risk:

- ZUP for the protection of biodiversity: Marine Protected Areas.
- ZUP for the protection of cultural heritage: Sites of Cultural Interest and Landscape Protection Zones around elements of cultural interest located on the coast.
- ZUP Research, development and innovation (R&D&I).
- ZUP National Defense.
- ZUP for navigation.
- **Offshore wind energy Priority Use Zones (ZUPER by its Spanish acronym):** these have been defined to give priority to the possible deployment of infrastructures for the exploitation of commercial offshore wind energy, without prejudice to the fact that such projects may include hybridisation with other offshore renewable technologies. The criteria used for the definition of the zones may vary with the progress of the basic scientific information, as well as with the development of the technology, without prejudice to what may be established during the environmental assessment process for each project.

- **High Potential Zones (according to its Spanish acronym, ZAP "Zonas de Alto Potencial")**

  The plans also pay special attention to **certain sectoral activities, or also of general interest, whose future development is foreseeable**, and in which it is also necessary to identify the most suitable space for their development, all with the aim of promoting the sustainable development of the maritime sectors:

  - ZAP for biodiversity conservation: Marine Protected Areas.
  - ZAP for research, development and innovation (R&D&I).
  - ZAP for port activity.
  - **Offshore wind energy High Potential Zones (ZAPER by its Spanish acronym):** The areas identified in this category meet the same technical criteria as the ZUPER, although interactions have been detected with some areas of priority use, or high potential, or with other uses of the space, which will have to be considered in detail at project level. As these areas have a greater number of interactions with other uses, activities and interests, it is foreseeable that, during the project authorisation process, including the environmental assessment of the projects, more requirements will be made, with special attention to those areas that overlap with some type of aeronautical easement.
  - ZAP for marine aquaculture.

IMPLEMENTATION, EVALUATION AND MONITORING OF THE PLANS

The plans have a monitoring programme, designed to detect the evolution of the different human uses and activities in the marine environment, the effectiveness and possible shortcomings that the plan is showing, and thus facilitate adaptive management and guide the steps towards the revision and updating of the plans that will take place in 2027.

- **MSP (POEM) measures**

  During the design of the plans, a set of measures have been identified that need to be addressed during the period of validity of the plans in order to improve the management of uses and activities, whether they are aimed at obtaining better baseline information, management at a more detailed scale, or improved governance.

- **Strategic Environmental Assessment**

  Law 21/2013, of 9 December, on environmental assessment, establishes Environmental Assessment as the main instrument for incorporating environmental considerations into the process of preparing and adopting plans and programmes. Therefore, the five maritime spatial plans will be subject to a strategic environmental assessment process, including public consultation, analysis of the consultations and the preparation of a report on the proposals, observations and suggestions that have been submitted, for the incorporation of those considered appropriate in a final version.

  Once the final version of the maritime spatial planning and their strategic environmental study have been submitted to the environmental body, this body must draw up the Strategic Environmental Statement to integrate the environmental aspects into the proposal for the plans, which must be included in the final approval of the MSP (POEM).

- **Monitoring of the MSPs (POEM)**

  The MSP (POEM) will be monitored periodically so that their effectiveness can be evaluated, as well as to detect possible changes in the context (geographical-environmental or socio-economic) in which they are applied, which may require their adaptation or revision. The plan monitoring programme will be fed with information from different sources and planning tools, which will be used to construct a set of specific indicators that will provide information on the effectiveness of the plans, the degree of achievement of the objective and, if possible, also on the obstacles associated with its non-achievement.

Furthermore, Royal Decree 363/2017, of 8 April, establishes that each Department affected by the MSP (POEM), within the framework of its competences, will draw up an annual report on the implementation of these plans, which will be sent to the Directorate General for the Coast and the Sea, which, in turn, will send an analysis of the same to the Inter-ministerial Commission for Marine Strategies to ensure the coordinated implementation and management of the MSP (POEM) and their updates.

ANNEX V

INDEX OF FIGURES

Financiado por la Unión Europea
NextGenerationEU

GOBIERNO DE ESPAÑA
VICEPRESIDENCIA TERCERA DEL GOBIERNO
MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

Plan de Recuperación, Transformación y Resiliencia

STRATEGIC ENERGY AND CLIMATE FRAMEWORK