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COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future.

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1. Offshore renewable energy for a climate-neutral Europe

The world's first offshore wind farm was installed in Vindeby, off the southern coast of Denmark, in 1991. At the time, few believed this could be more than a demonstration project[1]. 30 years later, offshore wind is a mature, large-scale technology powering millions of people across the globe. New installations have high capacity factors and costs have been steadily decreasing over the last ten years. Today, offshore wind produces clean electricity in a cheaper way than any existing fossil fuel based technology.

Offshore wind is a story of an undisputed European technological and industrial leadership. Europe leads the way, with 42% of the global offshore wind capacity installed in Europe. In 2019, European companies installed 93% of total offshore wind capacity (mainly fixed bottom) in the EU.

Yet, this is only a part of the picture: beside bottom-fixed offshore wind, a range of other technologies to exploit the power of our seas for producing green electricity is being developed fast. European industries are also global leaders in floating offshore wind: 10 out of 15 floating turbines worldwide are produced and located in Europe. European laboratories and industries are always of the forefront: from ocean energy technologies, like wave or tidal where in 2019, 39.5 MW of global 55.8 MW ocean energy installed capacity were in EU waters, to floating photovoltaic installations to the use of algae to produce biofuels. Europe is the global renewable offshore technology and industrial leader and should fully exploit this first mover advantage.

Europe's seas, from the North Sea and the Baltic Sea to the Black Sea, from the Atlantic to the Mediterranean, hold a vast potential for developing renewable energy production. A potential Europe needs to tap into, to achieve its carbon emission reduction targets for 2030 and become climate neutral by 2050. The direct use of electricity in a larger spectrum of end uses in our economy is central to the shift towards a carbon neutral society and scaling up the renewable power generation is the necessary precondition for the success of this transition.

A growing share of renewable electricity is also important to support indirect electrification through hydrogen and other decarbonised gases, as illustrated in the Energy System Integration and the Hydrogen Strategies. The Impact Assessment accompanying the 2030 Climate Target Plan projects that by 2030 more than 80% of electricity should come from renewable sources.

In this scenario, all renewable technologies must expand their contribution. Offshore renewable energy is one with the most significant potential to scale up. Currently, there are 12GW of offshore wind capacity installed in the EU, largely offshore fixed bottom. Floating offshore wind demonstration farms are expected to add 150 MW by 2024, and 13 MW of wave and tidal devices are being tested in EU waters today. The Commission estimates that an installed capacity of 300 GW of offshore wind [and around 60 GW of ocean energies[2]] by 2050 would be needed in the integrated, greener and climate neutral energy system of 2050.

This is feasible for a sector where Europe has gained unrivalled technological, scientific and industrial experience and where strong capacity exists already across the supply chain, from manufacturing to shipping and installation. Nonetheless, it is a very challenging horizon. It

[1] The farm generated 5MW and covered the annual consumption of 2 200 households.

[2] JRC (2019) Technology Market Report Ocean Energy, JRC117349.

means that offshore renewable energy capacity should be multiplied by 25 times by 2050. The investment needed is estimated up to EUR 789 billion[3].

Going for 300GW of wind and 60GW of ocean energy by 2050 means a massive change of scale for the sector in less than 30 years, at a speed that has no equivalent in any other energy technologies in the past. As a reference point, today 3GW of capacity are added per year, a rate that is expected to reach 7GW after 2030. Such a pace change requires overcoming a number of regulatory and practical obstacles and ensuring that throughout the supply chain all players can step up and sustain the expected increase in rates of deployment.

Market forces, technological advances and price developments will continue to drive offshore renewable energy growth in the coming years. Yet, a greater involvement of the EU and Member States government is needed. Under stated policies, the current and projected installation pace would lead to only approximately 90 GW in 2050. To change gear, the EU and Member States should provide a long term framework for business and investors promote the harmonious coexistence of offshore installations with other uses of the sea space without negatively impacting the environment and biodiversity, facilitate grid infrastructure development, enhance cross-border cooperation and coordination, ensure that research funding is channelled to non-mature technologies to bring them to commercialisation, promote the competitiveness and resilience of the entire EU supply chain and encourage it to fully leverage its export potential on global markets.

This Communication proposes an EU strategy to develop offshore renewable energy, in all its technologies and in all European sea basins, so that it can become a core component of Europe's energy system in 2050. The objective is to reach installed capacities of 60 GW of offshore wind and 1-3 GW of ocean energy[4] by 2030, paving the way to the 2050 300-60 GW perspective. The Commission believes that achieving these objectives would not only bring significant benefits in terms of decarbonisation of electricity generation, but also important co-benefits in terms of jobs and growth[5], contributing to the post COVID recovery. The scaling up and developments in offshore wind industry estimated to occupy less than 3% of the European maritime space and can be achieved in a way compatible with strong protection of the environment and biodiversity.

This Strategy has one objective, but requires a diversified approach for different situations. Some of the offshore renewable technologies are at a mature stage, like offshore fixed bottom, others, like floating wind , tidal and wave energy are still in the demonstration phase. Furthermore, every sea basins of Europe has different potential due to its geological situation, is in a different stage of exploiting offshore renewable energy, and is best suited for different technologies.

Thus, the Strategy presents a horizontal enabling framework, as many barriers and challenges are common across the offshore technologies and sea basins, together with tailor-made policy solutions adapted to the different state of development of technologies and regional contexts.

Given the long lead time needed for renewable offshore projects, up to 10 years, it is now the time to set out a strategic direction and roll out the means to get there. The Next Generation

[3] JRC (2020) – Evidence in support of the Offshore Renewable Energy Strategy
[4] Citation: European Commission (2020) - Progress of clean energy competitiveness (SWD (2020) 953 final)
[5] 62.000 people work in the offshore wind industry and around 2.500 in the ocean energy sector. European Commission - The EU Blue Economy Report - 2020.

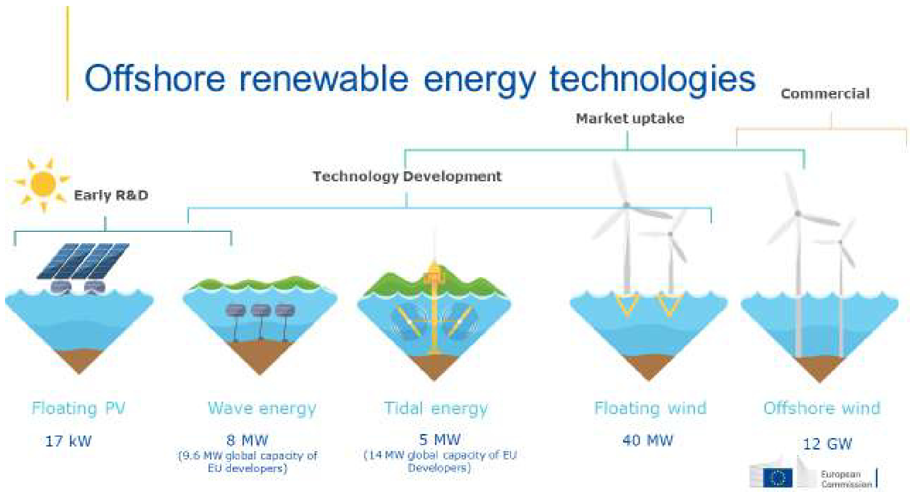
EU, as a unique opportunity to mobilise public capital at a time where private offshore investment is slowing down, adds another reason for action now.

Together with this Strategy the Commission presents, as an annex, a Guidance on electricity market arrangements (the Market Guidance) , while the follow up actions identified will be presented in the coming months.

2. OFFSHORE RENEWABLE ENERGY TECHNOLOGIES AND THEIR OUTLOOK

The term renewable offshore technology encompasses a set of clean energy technologies which are currently at different stages of maturity. Large commercial scale project only exist in European waters for bottom-fixed wind turbines but other technologies are starting to catch up with large commercial projects being launched in some member States for floating wind and ocean energy is reaching a level of maturity that makes them interesting for future applications.

Europe is world champion in offshore wind



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The EU is a global renewable offshore technology and industrial leader. Europe's offshore wind industry benefit from a first-mover advantage in **bottom fixed wind turbines** with a strong home market that accounts for about 91% of worldwide offshore capacity1. The EU27 offshore wind market represents 42% (12 GW) of the global market in terms of cumulative installed capacity, followed by the UK (9.7 GW) and China (6.8 GW). In 2019, 93 % of total offshore wind capacity (almost all bottom-fixed) in the EU was installed by European companies. European companies are also key players on the global offshore wind market[1] even if they face increasing competition from Asian companies. The Levelised Cost of Electricity (LCOE) for offshore wind globally decreased more than three-fold in 10 years, reaching EUR 45-79/MWh in 20191.

EU renewables industries are also strong in the emerging technology of **floating offshore wind**. Today, 10 out of 15 floating turbines worldwide are produced and located in Europe. Multiple floating designs exist and/or are being developed, none of which prevail over the others at this stage[1]. By 2024, 320 MW are expected to be commissioned. Higher ambition and clarity is needed to get to sufficient market size for cost reductions: there is potential for reaching an LCOE of around 50 EUR/MWh in 2030 if large capacities are deployed[1]. The EU industry is the global leader for developing **ocean energy technologies, mainly wave and tidal.** At the end of 2018, 78% of the installed capacity of ocean energy was located within European waters (24.7MW)[1]. EU companies hold 66% of patents in tidal and 44% in wave energy; currently all projects worldwide use EU technology[1]. Ocean energy technologies are expected to make a significant contribution to Europe's energy system and industry as from 2030, in particular by supporting grid stability and playing a crucial role in the decarbonisation of EU islands**.** Currently, there is no specific ocean technology prevailing. Significant cost reduction is needed for tidal and wave energy technologies to exploit their potential in the energy mix. The sector demonstrated ability to reduce costs by 40% since 2015, faster than anticipated. Despite the steps forwards in technology development and demonstration, the sector struggles in the creation of a viable market.

Other technologies remain today at early development stage but could be promising for the future: **algal biofuels** (biodiesel, biogas, and bioethanol)1 and **floating Photo Voltaic installations** (already deployed in land-locked waters but predominantly at the research and demonstration phase at the sea, with only 15 KW installed).

Competitiveness of offshore renewable technologies

Wind turbine manufacturers, companies specialised in the construction of tower and foundation, cable suppliers or vessels operators are all part of a supply chain active for the whole sector, which counts hundreds of actors, many of which are SMEs active in component supply, and employs thousands of workers, engineers, scientists. Today, 62.000 people work in the offshore wind industry[6] and around 2.500 in the ocean energy sector[7]. The offshore renewable technology sector is outperforming conventional energy sector with regard to value added, labour productivity and employment growth, and can provide a stronger contribution to EU GDP growth in the coming years.

Offshore renewable development is a true Europe story and while offshore renewable installations are still concentrated in some sea basins, the industrial activity underpinning them is ensured by a large number of actors spread across EU countries and regions – including inland and landlocked ones. For example, wind turbine components are manufactured in Austria, Czechia or inland regions of Spain, France, Germany and Poland[8].

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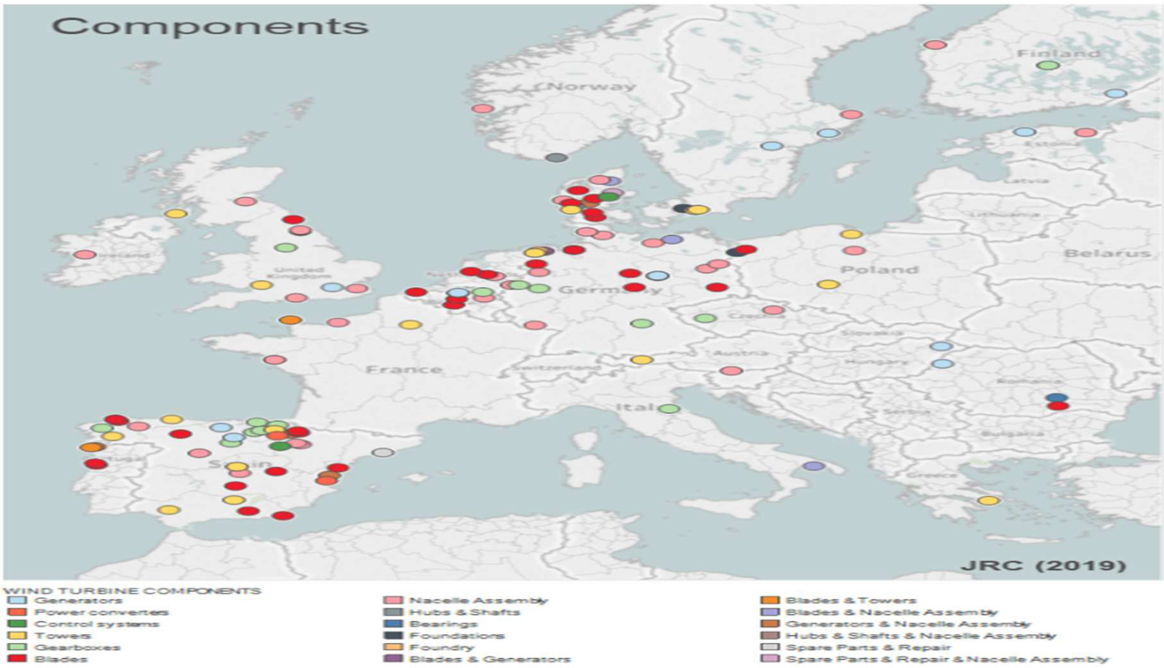
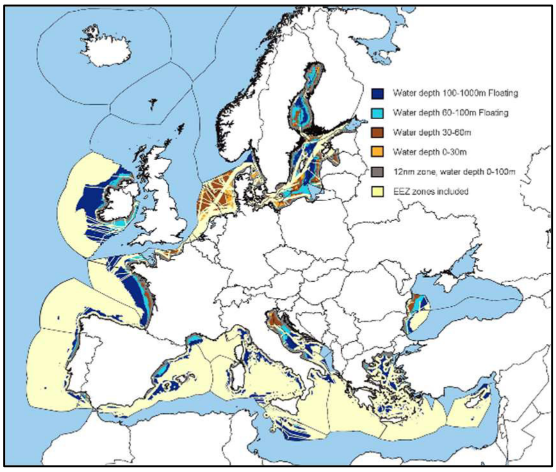
[6] Wind Europe
[7] EC - The EU Blue Economy Report - 2020.
[8] JRC 2019: Technology Market Report Wind Energy, JRC118314



3. EU'S SEA BASINS: A VAST AND VARIED POTENTIAL TO DEPLOY OFFSHORE RENEWABLES

The EU has the largest maritime space in the world and is in a unique position to develop offshore renewable energy thanks to the variety and complementarity of its sea-basins. Such potential has developed in different ways depending on the geological conditions and the proximity to energy demand. Cooperation between Member States on offshore renewable energy exploitation has taken place through specific regional fora.

Regional collaboration has recently been reinforced within some sea-basins, providing a reference point for other Member States willing to tap to the full offshore renewable potential. Offshore renewable is now a pan-European priority and cooperation at regional level is being extended to all sea basis and Member States. The activities of specific regional entities such as the North Seas Energy Cooperation, the Baltic Energy Market Interconnection Plan (BEMIP), the High Level Group for South-West Europe on interconnections and the Central and South Eastern Europe energy connectivity (CESEC) lead the way. In June 2020 the Memorandum of Split' has addressed offshore renewable in the context of the energy transition of islands.



EU offshore wind technical potential (JRC ENSPRESSO 2019)

The **North Sea** has a high natural potential [FIGURE] for offshore wind and localised potential for wave and tidal. The North Sea is currently the world's leading region for deployed capacities and expertise in offshore wind. It has a solid political and governance foundation with the North Seas Energy Cooperation (NSEC)[9]. It also benefits from the expertise of organisations such as the OSPAR Convention which gathers 15 governments and the EU[10] to cooperate on the protection of the marine environment in the North-East Atlantic.

The **Baltic Sea** offers a potential for offshore wind up to 93 GW[11] and some localised potential for wave energy. Countries have started to cooperate more closely to exploit the potential, including in the Baltic Energy Market Interconnection Plan (BEMIP) High-level Group[12], Vision And Strategies Around the Baltic Sea(VASAB), the Baltic Marine Environment Protection Commission – Helsinki Commission (HELCOM), and the EU strategy for the Baltic Sea Region[13].

EU Atlantic countries (Ireland, France, Spain and Portugal) are developing a strong pipeline of demostration projects, based on high offshore (both bottom fixed and floating) wind potential [FIGURE] and good natural potential for wave and tidal energy. They are also building upon years of experience from installed and grid connected equipment and a world-leading network of test centres. Regional cooperation takes place within OSPAR. The EU Atlantic Strategy and its 2020 revised Atlantic Action Plan[14] identify offshore renewable energy as a strategic area for cooperation. France, Spain and Portugal have also established good regional cooperation practice in the context of the South-West Europe High Level Group.

The **Mediterranean Sea** offers a high potential of [32 to 75 GW] of offshore wind (mostly floating) and localised potential for tidal and wave energy[15]. Regional cooperation on offshore renewables takes place with the Barcelona Convention (environment) and political WestMed

[9] Established in 2016
[10] www.ospar.org
[11] According to the Study on Baltic offshore wind energy cooperation under BEMIP; https://op.europa.eu/fr/publication-detail/-/publication/9590cdee-cd30-11e9-992f-01aa75ed71a1
[12] BEMIP is planning to adopt a work programme for offshore wind development by the spring of 2021.
[13] www.balticsea-region-strategy.eu
[14] COM(2020) 329 final.
[15] [Link to the Study on the offshore grid potential in the Mediterranean region (2020)]

initiative[16]. Recently the MED7 Alliance also specifically referred to supporting offshore renewable energies development in the Mediterranean Sea and in the Atlantic[17]. The Central and South Eastern Europe Energy connectivity (CESEC) High Level Group could foster regional cooperation initiatives, from the Adriatic Sea and eastward. Enhanced cooperation across the Mediterranean on renewables is increasing via the Clean Energy for EU Islands initiative.

The **Black Sea** offers a good natural potential for offshore wind (bottom fixed and floating) and localised potential for wave energy. Regional cooperation already takes place in the context of the Burgas Declaration[18]. The Vision Paper[19] "A Blue Growth Initiative for Research and Innovation in the Black Sea", published in 2018, sets as one of its priorities to incentivise emerging blue economy sectors, such as offshore wind and wave technology. The CESEC High Level Group could also foster regional cooperation initiatives in the Black Sea.

In addition to the sea basins in Europe, many **overseas territories and outermost regions** show a good offshore renewable energy potential and are pioneers for the decarbonisation of islands. New initiatives, including collaboration with neighbouring regions when possible, should help optimising the use of this potential.

4. HOW TO FOSTER THE SCALE UP OF OFFSHORE RENEWABLES DEPLOYMENT IN EUROPE

There are many challenges to realising the vision set out in this Strategy of a 300 GW deployment of offshore renewable energy across all the European Union sea basins by 2050. The following sections review the most important and provide concrete policy and regulatory proposals to address them.

4.1 Maritime spatial planning

. Moving to 300 GW of offshore renewable installed capacity means that by 2050 there will be a much larger number of sites used for offshores renewable energy production and connections to the grid for power transmission [figures on needed share of the sea area]. Planning long term deployment of offshore renewable energy, assessing its environmental, social and economic sustainability and ensuring its co-existence with other activities, such as fisheries, shipping or infrastructure deployment, must therefore become important considerations for public authorities early on.

The choice of the site for an offshore renewable energy project is a delicate one, involving many elements. Suitable sea spaces for offshore energy exploitation should be compatible with biodiversity protection and can also be attractive or already used by other economic activities, with overlaps or possible conflicts of use.

Maritime spatial planning (MSP) is a key and well established tool to anticipate changes, prevent and mitigate conflicts between policy priorities and create synergies between economic sectors.

[16] www.westmed-initiative.eu
[17] www.diplomatie.gouv.fr/en/french-foreign-policy/europe/news/article/ajaccio-declaration-after-the-7th-summit-of-the-southern-eu-countries-med7-10
[18] https://ec.europa.eu/maritimeaffairs/maritimeday/sites/mare-emd/files/burgas-ministerial-declaration_en.pdf
[19] https://ec.europa.eu/maritimeaffairs/maritimeday/sites/mare-emd/files/burgas-vision-paper_en.pdf

Offshore renewable energy can and should coexist throughout sea-basins and in particular in crowded areas with many other activities. In this perspective, national maritime spatial planning should adopt a holistic, **multiuse/multipurpose approach. The practice is increasing throughout the different European member States** in promising ways. It demonstrates that shipping route are not incompatible with the development of energy infrastructures but also that it is possible to fully respect marine protected areas while still promoting the blue economy including wind farms. In this context, projects will also benefit from the latest monitoring and digital tools to ensure such coexistence is efficient. Recent studies shows that minimising the impact of offshore on the habitat and protected species is also due to the application of new IT technologies.

Examples of successful multi-use pilot projects with offshore renewable

*Offshore windfarm and aquaculture: The **MERMAID project** identified environmental benefits of different combinations of aquaculture and offshore renewable energy systems. It led to several pilot projects in BE, DE, ES, FR, NL and PT on molluscs, algae and multi-use offshore platform (e.g. Edulis, TROPOS, Wier en Wind).*

*Marine protected areas and blue economy in the Mediterranean Sea: The **PHAROS4MPAs Interreg project** documented interaction between marine protected areas in the Mediterranean and the blue economy, including offshore wind farms. It provides guidance on how the environmental impacts of key sectors can be prevented or minimized.*

The Maritime Spatial Planning Directive requires all coastal Member States to submit their **national maritime spatial plans to the European Commission by 31 March 2021**. Such plans will be subject to a Strategic Environmental Assessment (SEA) pursuant to Directive 2001/42/EC ('SEA Directive') and possibly to the additional assessments in line with the Habitats[20] and Birds[21] Directives.

A chief challenge is therefore to integrate offshore renewable energy development objectives into Member States' plans for extending offshore renewable energy, based on their National Energy and Climate Plans, when preparing the national maritime spatial planning. This would signal to business and investors the governments' intentions with regard to the future development of the renewable offshore sector, thus facilitating planning by both the private and the public sector.

Further research and practice are ongoing in order to bring multi-use pilot projects one step further and make this approach operational and attractive to investors. For this to happen, it is also necessary to facilitate it within regional cooperation and for Member States to consider including it in the tender and permitting procedure.

Robust maritime spatial planning can also ensure adequate **protection of vulnerable marine ecosystems** in line with the Biodiversity Strategy[22] which calls for the expansion, and the effective management, of the EU's network of protected areas from 11% to 30%, a third of which to be strictly protected (as opposed to the current 1%).

[20] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:01992L0043-20130701.
[21] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0147.

Robust maritime spatial planning is also needed since the areas with the highest potential for offshore renewable energy are also the most exposed to the risks of collisions with vessels, fishing gears, military activities, or dumped ammunitions and chemicals.

To ensure the success of offshore renewable large scale deployment, it will be necessary to reinforce and strengthen regional cooperation.

The Maritime Spatial Planning Directive requires **Member States to work together across borders,** at sea-basin level. This is because while it is for Member States to decide whether, where and to what extent the expansion of offshore renewable energies should take place in their Exclusive Economic Zone, some of the problems of identification of best sites and coexistence with other uses can be overcome addressing them in a regional perspective.

The European Commission will therefore continue working closely with Member States to support the preparation and implementation of the national maritime special plans in a coordinated manner, factoring in regional considerations.

Sea Basin Strategies and Plans[23], as well as **Regional Sea Conventions**[24] can help harmonising and coordinating the development of offshore renewable energies between Member States.

Regional seas conventions[25] aim to protect the marine environment of particular marine regions. They can help **share knowledge** (e.g. OSPAR guidelines on wind farms development) and take legally binding decisions. It is essential to strengthen sea basin cooperation and coordination with other regional fora dedicated to renewable energy and maritime planning. Overseas Territories and Outermost Regions, which are particularly vulnerable to climate change but also rich in offshore energy capacity, natural resources and biodiversity, should be considered with their geographical specificities.

The **public acceptance** of developing a greater number of offshore renewable energy plants will be vital for the timely deployment of new capacity. Public consultation is an integral part of environmental assessments and of maritime spatial planning processes. **Early involvement of all relevant actors is crucial**. Regional or national authorities have a legal obligation and responsibility to proactively inform them about projects, existing rules and potential for the development of multi-use of maritime space. The Commission will further analyse the interactions between offshore renewables and other activities at sea, such as fisheries and aquaculture, and encourages this dialogue with the communities that are most concerned. At national and European level, offshore renewable developers, other users of the sea, NGOs and public authorities should establish a long-term strategic dialogue towards common goals.

Finally, the scale up of offshore renewable energy will only be sustainable if not adversely impacting on the environment. While current evidence suggests that this can be possible, there is a need to monitor the situation and update our scientific knowledge as the scale up develops and new technologies are developed. There is therefore a need to guaranteed greater and systematic **in-depth analysis and data exchange**, with the best available modelling tools, of

[23] https://ec.europa.eu/maritimeaffairs/policy/sea_basins_en.
[24] Helsinki Convention for the Baltic Sea, OSPAR Convention for the North Sea and the North West Atlantic, the Barcelona Convention for the Mediterranean and Bucharest Convention for the Black Sea.
[25] HELCOM, OSPAR, the Barcelona convention, Bucharest convention

the potential cumulative impacts on the marine environment and the interaction between offshore renewables and other activities at sea such as fisheries and aquaculture.

The Commission invites Member States developers and stakeholders to improve the quality and use of the Copernicus Marine Environment Monitoring Service and the European Marine Observation and Data Network (EMODnet), which, as open data platforms, provide highly valuable information to sea users, notably offshore renewable energy developers. Moreover, competent authorities should provide operators with binding provisions for the monitoring of possible impacts on the marine environment, and the respective data should be made public and easily available. In a further step, the data must be analysed and evaluated in order to provide usable findings and support policy decision.

To facilitate a dialogue on environmental and social sustainability of offshore renewable energy, the Commission is ready to facilitate and promote a "community of practice" where all stakeholders, industry, NGOs, scientists can exchange views, share experiences and work on common projects.

Key actions

- The Commission will work together with Member States to integrate offshore renewable energy development objectives, based on their NECPs, in the national maritime plans to be published in March 2021.
- The Commission will facilitate effective cross-border cooperation between Member States within each sea basin in the preparation of maritime spatial plans (MSP).
- The Commission will support multiuse pilot projects with Member States and regional organisations and foster the development of a common holistic approach to maritime spatial planning using the expertise of regional organisations (2021-2025).
- The Commission presents a guidance document on wind energy developments and EU Nature Legislation (18 November 2020).
- The Commission will initiate a community of practice consisting of experts from public authorities, stakeholders and scientists to analyse, evaluate and monitor the impacts of offshore renewable energy on the marine environment (2021).

4.2 A new approach to offshore renewable energy and grid infrastructure

The spatial planning of offshore renewable energy is closely linked with the issue of offshore and onshore grid development. Most of the existing offshore wind farms have been deployed as national projects and are connected radially to shore. This way of developing offshore renewable energy is expected to continue, in particular in areas where offshore development is only taking off. In parallel, the national Transmission System Operators (TSOs) are also expected to continue to build cross-border interconnectors for electricity trade.

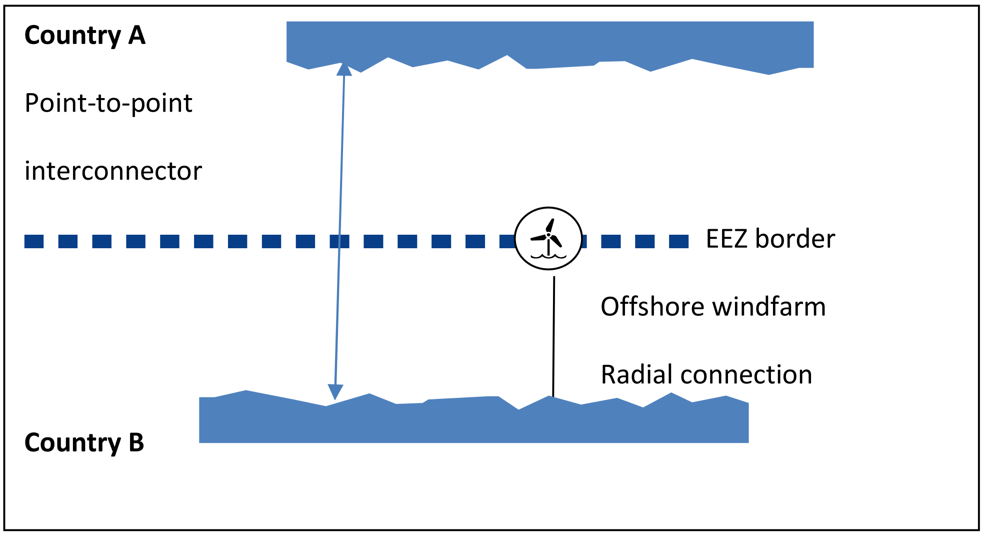


Figure 1 Offshore windfarms connected radially to shore and interconnector

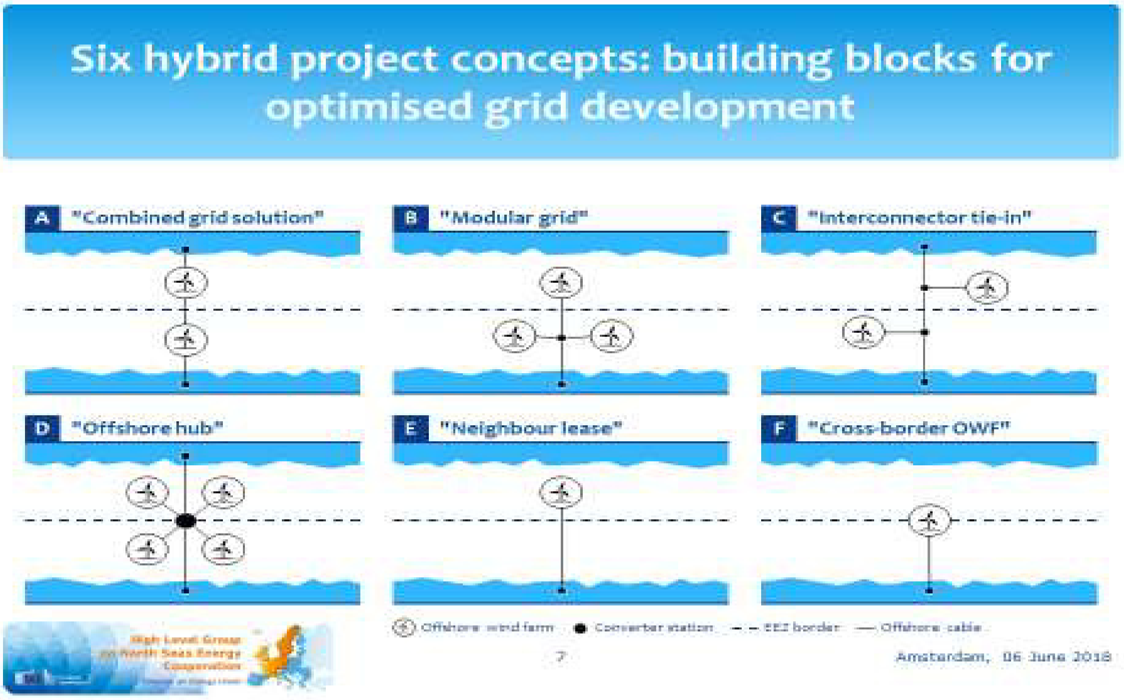
However, it is often more cost effective to address grid connections in a regional context. To ensure the significant scale-up of offshore renewables, the offshore development and the planning of an offshore grid needs to go beyond the national borders and take into account the whole sea basin.

To this end, a share of the future offshore grid will ideally be built around **hybrid projects** [26]. Offshore hybrid projects will allow combining offshore generation and its transmission in a cross-border setting, thus bringing significant cost savings compared to the current approach of developing interconnections between the Member States and national offshore windfarms with radial connections separately. Hybrid projects will form an intermediate step between smaller scale national projects and fully meshed off-shore energy system and grid.

An offshore meshed grid would be even a step further. It is similar to the onshore interlinked transmission grid system, where the electricity flow can take many directions. Grid planning should also consider the onshore needs on linking the offshore energy to hydrogen production, etc.

Figure 2 Example of Hybrid projects, North Sea Energy Cooperation

[26] hybrid projects: grid set-ups with dual functionality; interconnection and evacuation of offshore renewable energy.



Therefore, as a first step, a coordinated approach and long-term commitment to offshore development among the Member States is needed. Member States should set together ambitious targets for offshore renewable deployment in each sea basin while taking into account environmental protection and maritime spatial planning. These targets should be translated into **long-term commitments** which would identify suitable locations for offshore deployment, and planned installed capacity in a specific sea basin for [the medium and long term/ years X, Y and Z]. These could take the form of a **Memorandum of Understanding** between the concerned Member States to set a clear direction.

However, committing to these ambitious targets alone will not be sufficient to see the required gigawatts to take off. Lack of offshore grids or risk of delay in grid development can become an important barrier to faster deployment. The grid itself will need to be capable of efficiently integrating the expected large generation capacities, while minimising the use of scarce marine space. For an investor to make a decision to invest in offshore renewable generation, a clear understanding of the timing and the plans for the offshore and onshore grid infrastructure development are crucial. Grid development has longer lead times (typically 10 years or more) than the offshore power generation itself, highlighting the need for forward-looking grid investment.

Achieving this will require a greater **coordination among Member States** TSOs and National Regulatory Authorities in the same sea basin **on planning of the grid infrastructure**[27]. The current legislative framework, such as the Governance Regulation and MSP Directives, the sea basin strategies and conventions, already provides certain possibilities for better regional cooperation in addressing the need to better align regional planning. The regional cooperation framework established under the TEN-E Regulation to identify projects of common interest (PCIs) offers as well a good model to build upon.

[27] This can yield significant cost savings as illustrated in recent studies. *The Baltic Wind Energy Cooperation under BEMIP, Thema Consulting*

In the short run, a more **structured cooperation between the Member States, TSOs and regulators** leading to a more integrated and optimised regional offshore grid planning, taking into account maritime spatial plans, appears necessary. At a later stage, offshore grid planning could eventually take the form of reinforcing the role of **regional coordination centres** (RCC) to be established to complement the role of the national TSOs in carrying out tasks of regional relevance and which will enter into operation in 2022[28]. In the long run, further strengthening could be foreseen by establishing regional offshore Independent System Operators (ISOs) to operate and develop increasingly meshed offshore grids.

In order for the Member States to jointly commit to deploy offshore renewables and develop the related infrastructure, more clarity is needed on the **distribution of costs and benefits**, both amongst the relevant Member States, but also between the generation assets and the transmission projects. Therefore, there is a need to develop a **robust methodology for allocating costs** according to where the benefits occur. By facilitating cost sharing among Member States, TSOs, and offshore wind farm developers, this would create the necessary pre-condition for the realisation of the integrated vision on sea basin level.

To prepare for higher future offshore energy volumes and more innovative and forward-looking grid solutions, the regulatory framework should enable **anticipatory investments**, for instance to develop offshore grids with a larger capacity than initially needed, or supplied with technological features above what is needed in the short term.

Key actions

- The Commission will establish a framework for the Member States to draw up their joint long-term commitment for deployment of offshore renewable energy per sea basin up to 2050 (2021).
- The Commission will propose a framework under the revised TEN-E Regulation for long term offshore grid planning by the TSOs, with the involvement of regulators, Member States per sea basin, including for hybrid projects (December 2020).
- Within their respective competences, the Commission, Member States and regulators will develop a framework to enable TSOs to undertake anticipatory offshore grid investments to prepare for future upscaling and development (2021 onwards).
- Commission will publish an EU guidance on how the sharing of costs and benefits across borders for the transmission projects could be coordinated with the development of the generation projects (by 2023).

4.3 A Clearer EU regulatory framework for offshore renewable energy

During the transition to a more meshed offshore energy system, networks will become more integrated over time and the projects more complex. In this time of innovation and change, a predictable long term legal framework is key to provide certainty to all actors and fully leverage investors’ financing.

[28] According to Regulation (EU) 219/943, article 35, point 2.

Ideally, a well regulated energy market should provide the **right investment signals**. The Electricity Regulation provides rules on integrating large-scale renewables projects into the energy system and electricity market. For national offshore renewable projects, the market rules to a large extent reflect the onshore market design of the integrated electricity market.

However, while national projects will continue to constitute a large share of offshore projects, more complex, cross-border offshore renewable projects are expected to become increasingly important in most sea basins in Europe in the future. Innovative projects, like **energy islands or "hybrid projects**"[29], face specific challenges and the current regulatory framework was not developed with such projects in mind. A clarification of the electricity market rules is therefore needed and provided in the Market Guidance annexed to this Strategy.

Hybrid projects can already today be designed in a way that is compatible with EU legislation and beneficial for society. Based on consultations and studies[30],[31] it appears that the best approach for hybrid projects is to establish an **offshore bidding zone**, which is better suited to a large scale-up of offshore renewables as it ensures that renewables can be fully integrated into the market by simultaneously integrating renewables and utilising the cross-border interconnection for trade. This approach ensures that renewable electricity can flow to where it's needed, becoming part of the electricity schedules and supporting regional security of supply. It also reduces the need for costly after-market corrective actions by the TSOs. Furthermore, it provides strong price signals to encourage the development of offshore demand, such as green hydrogen from electrolysis.

However, in this configuration, the offshore renewables producer is likely to receive the lower electricity market price among the markets to which it is connected to ensure it is dispatched. Depending on the topology of the projects, this effect on revenues is expected to be limited to around 1%[32] for over half of future hybrid projects. However, for some projects, this effect can be as much as 11%. For those projects with significantly lower electricity market revenues, this occurs because there is congestion in the grid and therefore the congestion income earned by TSOs is proportionately higher. This **redistribution effect needs to be addressed** to align the incentives and to enable these projects to come forward by allowing the total value of the project to be captured.

The rules on the use of congestion income should therefore allow a reallocation to producers active in an offshore bidding zone to ensure that hybrid projects are attractive for a renewables investor. Until this possibility becomes available under EU legislation, any incentive or support schemes should take the above effect into account, ensuring that there is no delay to the rollout of hybrid projects.

Furthermore, the practical physical challenges of connecting projects to several markets with different connection rules needs to be addressed. Although there are rules at EU level on connection to the network, they have not been developed with offshore grids in mind. Therefore, a **common approach to grid connection requirements** for High Voltage Direct Current (HVDC) grids should be developed, based on experience in the North Sea basin.

[29] Recital (66) of Regulation 2019/943 on the internal market for electricity, *OJ L 158, 14.6.2019*

[30] *Market Arrangements for Offshore Hybrid Projects in the North Sea (Thema Report 2020-11).*

[31] www.promotion-offshore.net/results/deliverables/

[32] *Market Arrangements for Offshore Hybrid Projects in the North Sea (Thema Report 2020-11).*

A clearer regulatory framework can also provide more visibility and predictability of expected revenue streams. One of the main objectives of the recently adopted electricity market design is to make the market fit for renewables. Therefore renewables developers should consider wholesale electricity prices as an important part of the revenue. **While investors should bear some market risk, parts of the risk as well as insufficient revenues from market prices can be compensated** through support schemes in conformity with State Aid rules, ensuring the necessary upscale of offshore renewable energy projects.

Given the zero marginal price of offshore renewables generation, wholesale electricity prices tend to be currently low in Member States with high penetration of renewable generation. National support measures with competitive tenders in combination with deployment objectives have played an important role in the development and upscaling of renewable energy technologies and the associated cost reductions to date. A combination of an efficient market framework, and some form of **revenue stabilisation system** (de-risking, guarantees and power purchase agreements) may be required for the envisaged upscale of mature offshore renewable energy technologies. To facilitate this, the Commission will foster best practices and exchanges on the different auction design.

In addition, dedicated support will continue to play a role for **less mature offshore renewable technologies, such as tidal, wave and floating offshore wind and solar** in order to move from the pilot and demonstration phase and enhance the EU's global competitiveness by focusing efforts on the technological solutions which best reconcile the EU's economic and environmental goals.

In the forthcoming revision of the **State aid guidelines on energy and environmental protection**, the Commission will ensure that the revision provides a fully updated and fit-for-purpose enabling framework for a cost-effective deployment of renewable offshore energy, taking into account the specificities of the emerging technologies, and the well-functioning of energy markets.

In the coming years, using the range of **cooperation mechanism** offered in the Renewable Energy Directive[33] (RED II) to achieve a higher share of cross-border projects in the form of joint and hybrid projects is promising. Cooperation mechanisms, allowing among others for statistical transfers or joint projects[34], could also provide landlocked Member States with an opportunity to support investments in offshore renewable energy.

The Commission believes that clear guidance on the key element of proper cost-benefit sharing between the involved stakeholders (including i.a. basic cooperation setup, the cost-benefit sharing and the cooperation agreement), would be beneficial, so as to ensure that the cooperating Member States experience the net benefit of acting jointly.

Based on the application of the Market Guidance, the Commission will assess how the existing electricity market framework supports offshore renewable energy development and examine whether more specific and targeted rules are needed.

[33] Directive (EU) 2018/2001, OJ L 328, 21.12.2018

[34] Article 6, Article 7 and Article 11 of the recast Renewables Energy Directive. See also https://ec.europa.eu/energy/topics/renewable-energy/renewable-energy-directive/cooperation-mechanisms_en

Key actions

- The Commission is clarifying the regulatory framework, in particular as regards offshore bidding zones as target model for hybrid projects in the Market Guidance annexed to this strategy.
- The Commission will propose an amendment to legislation to provide an option for Member States of a more flexible allocation of congestion income with regard to offshore hybrid projects (2022).
- The Electricity Stakeholder Committee[35] to prepare amendments to the Grid Connection Network codes for offshore High Voltage Direct Current (HVDC) grids (2021).
- The Commission will ensure that the revision of the State aid guidelines on energy and environmental protection provides a fully updated and fit-for-purpose enabling framework for a cost-effective deployment of renewable offshore energy, and the well-functioning of energy markets (by end 2021).

4.4 Promoting public and private investment in offshore renewables

The investment needs for the large scale deployment of offshore renewable energy technologies by 2050 are estimated to be almost EUR 800 billion, around two thirds of which for associated grid infrastructure and a third with offshore generation. This means that a significantly larger amount of capital will have to be channelled to this sector than has been directed so far. Annual onshore and offshore grid investments in Europe in the decade leading up to 2020 have been around EUR 30 billion; however they would need to increase to above EUR 60 billion in the coming decade. A further increase is expected after 2030.

Private capital is expected to provide the bulk of those investments, but an efficient and well targeted use of EU public funds will play a strategic catalytic role. Grid development is a precondition i every sea basin for offshore generation to reach the customers. For mature offshore energy technologies, public funding can address the increased risk from launching a greater number of projects with a larger size, step in in case of market failures or helping to reduce that high costs of large-scale offshore renewable deployment are transferred to customers through increased tariffs. For less mature technologies, or projects still at an experimental stage, EU public funding will be crucial for improving competitiveness, bring down costs and accelerate progress towards early deployment and commercialisation

The new **InvestEU programme,** through its Strategic Investment Window, can provide seed funds, guarantees or risk insurances for emerging technologies to accelerate private investments. As capital costs represent an important share of total investment costs for new offshore projects, de-risking and reducing cost of capital can be important for crowiding in private capital and incentivising new investments. EIB lending can play a crucial role in supporting private investment in offshore renewable energy.

In the context of the **Next Generation EU** recovery plan, the **Recovery and Resilience Facility** of 672.5 billion EUR could directly or indirectly support investments in offshore renewable energy, through one of the three “Green Deal” flagship areas, “Power up”. It aims

[35] https://www.acer.europa.eu/en/Electricity/FG_and_network_codes/Pages/European-Stakeholder-Committees.aspx

to frontload and accelerate the development and use of renewable energy technologies. If Member States would use a third of this budget for the “Power Up” flagship on future-proof clean technologies and deployment of renewables, more than EUR 80 billion could be available for those projects, including offshore renewable energy.

As RRF funding will need to be committed by end of 2023, it is crucial for the Member States to have a **pipeline of mature projects** very rapidly, in close cooperation with companies that are already preparing investments. The Commission stands ready to provide technical assistance to Member States through the RRF Technical Support Instrument and to project promoters through the InvestEU Advisory Hub for the development of such project pipeline. Moreover, funding under the RRF can support offshore renewable energy also in terms of investmentsin **grid connections**, and for **associated reforms** needed to facilitate deployment of offshore renewable energy and its integration to the energy systems (e.g. through streamlined permitting procedures, grids and maritime spatial planning and offshore renewable energy auctions).

A key challenge is how to mobilise funding to promote cross-border renewable energy solutions and joint projects. The **Connecting Europe Facility** with its **novel window for cross-border renewables generation** incentivises cross-border cooperation the field of renewables, and can be used to map potential offshore development sites, support the necessary studies and exceptionally construction works, for projects between two or more Member States. A case in point could be the joint development of a floating wind farm to support European technology leadership. The CEF **infrastructure window** has already supported offshore energy projects, such as the North Sea Wind Power Hub project, and could in the future focus more on cross-border offshore grid infrastructure development, including hybrid and meshed projects.

Furthermore, the **Renewable Energy Financing Mechanism,** operational as of 1 January 2021, can offer ways of sharing the benefits of offshore energy projects also with the Member States that do not have a coastline. Land-locked Member States can make financial contributions to the mechanism, setting out their preference for the type of projects and technology they would like to support, including offshore project. These Member States will in turn receive statistical benefits from the renewable energy produced by the projects and practically would share the renewable energy potential of the Member States that host the project.

This mechanism can provide support to wide range of projects – from small-scale installations and innovative technologies (such as floating offshore wind parks) to large-scale, cross-border and hybrid projects. It can award grants to the renewable generation aspect of projects focused on production of renewable fuel from “Power-to-X”, on energy production and storage, as well as projects that receive other forms of support for infrastructure or grid connection. The Commission plans to launch the **first EU-wide tenders**, already in 2021.

Horizon Europe and the Innovation Fund will offer support for the research and innovation activities underpinning the development and deployment of offshore energy in Europe. In particular through **Horizon Europe** it will be possible to support the development and testing of new and innovative offshore renewable energy technologies, components and solutions[36].

[36] See section 4.7

The **Innovation Fund** can support the demonstration of innovative clean technologies at commercial size, such as ocean energy, new floating off-shore wind technologies or the coupling of off-shore wind parks with battery storage or hydrogen production. Its support could be combined with InvestEU or CEF to increase the viability of such innovative projects as well as to ensure the financing of adjacent infrastructure. Member States eligible for the **Modernisation**[37] can make use of its resources for the development of the offshore renewable energy industry.

Key actions

- Commission will encourage Member States to use of the Recovery and Resilience Facility for renewables deployment, including offshore, under the "Power up" flagship (2020 - 2021)
- Commission will facilitate the development of cross-border cooperation projects under the new Connecting Europe Facility as well as under the Renewable energy financing mechanism, including through a blending facility within Invest EU (as of 2021).
- Commission, the EIB and other financial institutions will work together to support strategic investments in offshore energy through InvestEU including for higher risk investments which advance EU technological leadership (as of 2021).

4.5 Research and innovation at the service of offshore projects

Boosting research and innovation is an important precondition for the large-scale deployment of offshore renewable energy. Currently, investments in clean energy R&I are mainly coming from the private sector. In recent years, the EU has invested an average of nearly EUR 20 billion a year in clean energy[38], with business contributing an estimated 77%, national governments 17% and EU funds 6%. For wind energy, the private sector plays even bigger role with around 90% of EU's R&I funding in onshore and offshore wind[39]. R&I investments in wind energy in Europe are highly concentrated in Germany, Denmark and Spain[40].

Public R&D&I investments in the wind value chain have played an important role in ensuring the sector develop, scale up and move to deployment. R&D has grown from EUR 133 million

[37] Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia.

[38] COM(2015)80; renewables, smart system, efficient systems, sustainable transport, CCUS and nuclear safety. JRC SETIS https://setis.ec.europa.eu/publications/setis-research-innovation-data;
JRC112127 Pasimeni, F.; Fiorini, A.; Georgakaki, A.; Marmier, A.; Jimenez Navarro, J. P.; Asensio Bermejo, J. M. (2018): SETIS Research & Innovation country dashboards. European Commission, Joint Research Centre (JRC) [Dataset] PID: http://data.europa.eu/89h/jrc-10115-10001, according to:
JRC Fiorini, A., Georgakaki, A., Pasimeni, F. and Tzimas, E., Monitoring R&I in Low-Carbon Energy Technologies, EUR 28446 EN, Publications Office of the European Union, Luxembourg, 2017.
JRC117092 Pasimeni, F., Letout, S., Fiorini, A., Georgakaki, A., Monitoring R&I in Low-Carbon Energy Technologies, Revised methodology and additional indicators, 2020 (forthcoming).

[39] JRC, Low Carbon Energy Observatory, Wind Energy Technology Market Report, European Commission, 2019, JRC118314.

[40] JRC, Low Carbon Energy Observatory, Wind Energy Technology Market Report, European Commission, 2019, JRC118314.

in 2009 to EUR 186 million in 2018[41]. In the last ten years, EU R&I programmes[42] granted about EUR 496 million to offshore wind, putting the strongest emphasis on offshore technology followed by floating offshore wind, new materials & components and maintenance & monitoring[43].

Current R&I priorities in offshore wind revolve mainly around wind turbine design, infrastructure developments and digitalisation. Other recent innovations target the logistics/supply chain e.g. the development of wind turbine gearboxes compact enough to fit into a standard shipping container[44] as well as applying circular economy approaches along the life-cycle of installations. Harmonisation of technical standards can help to create scale and efficiency in this regard. Further innovations and trends expected to increase most over the next ten years include superconducting generators, advanced tower materials and the added value of offshore wind energy (system value of wind). As offshore wind energy by now is a mature technology, future R&I funding should support the optimisation of existing manufacturing processes in sectors such as large-scale blade production.

Floating applications seem to become a viable option for EU countries and regions lacking shallow sea beds[45]: the technology for **floating offshore wind** in deep waters and harsh environments further away from shore is progressing steadily towards commercial viability[46]. Recently, floating offshore wind has experienced a strong development with different prototypes and small-scale projects already operating, while continuing to create business opportunities for EU players.

Between 2007[47] and 2019, total R&D expenditure in Europe on **ocean wave and tidal energy** amounted to EUR 3.84 billion with the majority of it (EUR 2.74 billion) coming from private sources[48]. In the same period, national R&D programmes have contributed EUR 463 million to the development of wave and tidal energy and EU funds[49] have amounted to EUR 493 million. A further EUR 148 million had been made available through the NER300 Programme. On average, EUR 1 billion of public funding (EU and national) leveraged EUR 2.9 billion of private investments in the course of the reference period.

Tidal technologies can be considered as being at the pre-commercial stage and most of the wave energy technological approaches are still at the R&D stage. **Floating PV** has experienced industrial scale deployment in natural and artificial inland waterbodies and could have promising future developments in coastal and near-shore areas. **Algae** are also a promising source of sustainable biofuels which merits further R&I.

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[41] *Source **Fehler! Nur Hauptdokument** ICF, commissioned by DG GROW - Climate neutral market opportunities and EU competitiveness study (Draft, 2020)*

[42] Horizon 2020 and its predecessor FP7, for period 2009 – 2019

[43] JRC Wind Energy Technology Development Report (2020)

[44] SET-Plan, Offshore Wind Implementation Plan (2018).

[45] Floating offshore wind farms are suited for depths between 50 and 1000 metres.

[46] UNEP & BloombergNEF, Global trends in renewable energy investment, 2019.

[47] Start of the SET plan initiative

[48] Private investments areestimated from the patent data available through Patstat. Sources: Fiorini, A., Georgakaki, A., Pasimeni, F. and Tzimas, E., (2017) Monitoring R&I in Low-Carbon Energy Technologies, JRC105642, EUR 28446 EN and Pasimeni, F., Fiorini, A., and Georgakaki, A. (2019). Assessing private R&D spending in Europe for climate change mitigation technologies via patent data. World Patent Information, 59, 101927.

[49] including the European Regional Development Fund (ERDF) and Interreg projects

Despite advances in technology development and demonstration, the ocean energy sector faces a struggle in creating a viable market. National support appears low, reflected by the limited commitment to ocean energy capacity in the NECPs. EU support can be key to incentivise further national-level public and private funding for de-risking ocean energy investments as well as promoting further testing and reducing demonstration cost. To harness the potential of lighthouse projects, the Commission will develop an investment programme by 2025 for **10 large-scale demonstration projects** for ocean energy technologies across the EU, that combines Horizon Europe, InvestEU, national support and private funding.

The increasing amount of energy generated offshore by these various offshore technologies has to be supported also by further development of **infrastructure and grid technologies**. R&I should therefore support new approaches to connect these infrastructures in a meshed grid, taking into account efficiency increases through reducing losses.

For long distances transmission of the electric power generated, high voltage direct current (HVDC) is an efficient and economical option compared to the Alternate Current (AC) transmission. The latest HVDC technologies[50] can interconnect windfarms and grids ensuring the dispatch of the offshore energy generated to the right market and with the necessary grid security and resilience requisites. However, deployment at large-scale is not straightforward due to high cost, different configuration testing and validation among different operators, and interoperability issues among different vendors' converters. Therefore, through Horizon Europe support for design and test phase of HDVC systems, the Commission will work to have the **first Multi-Vendor Multi-Terminal HVDC system installed** in Europe by 2030.

Facilitating **testing of novel technologies** for future offshore grids, flexibility, storage (Power-to-X), batteries and digitalisation will be important for effective integration of offshore wind farms into the energy system, as well as developing enablers and carriers such as hydrogen and ammonia. In the medium to longer term, the possibility for on-site conversion of renewable electricity into hydrogen should be considered as well as shipping or on-site fuelling. The R&I support through the Batteries Action Plan, the Hydrogen Strategy and the respective Alliances are therefore also key for a successful deployment of offshore energy.

Future efforts need to address the R&I challenges and opportunities linked to the development and deployment of offshore energy, such as infrastructure integration, circularity by design and critical raw materials substitution, environmental impacts of the offshore technologies, as well as skills and job creation.

Key Actions:

- *Through the first work programme of Horizon Europe of 2021 and 2022 the Commission will work to:*

1) improve industrial efficiency across the value chain of offshore wind;
2) develop new floating technology design;
3) develop an investment programme by 2025 for 10 large-scale demonstration projects for ocean energy technologies across the EU, that combines Horizon Europe, InvestEU, national support and private funding;
4) support cooperation between TSOs, manufacturers and offshore wind developers to start a

[50] Voltage Source Converter HVDC

large-scale HVDC-grid demonstration project in 2022.

- The Commission will review SET Plan targets on ocean energy and offshore wind and the implementation agendas, and launch an additional SET Plan group on HDVC;
- The Commission will study how technology development in offshore energy generation and infrastructure can be embedded sustainably in socio-economic ecosystem and value chain for the marine environment".

4.6 A stronger supply and value-chain across Europe

If the upscaling to 300 GW is to happen, with maximum benefits for the EU economy, the offshore renewable energy supply chain must be able to **ramp up its capacity** as well to sustain higher installation rates. Wind turbine manufacturers, tower, foundation, and cable suppliers will all need investments to expand production, ports will need upgrades and new vessels must be built and put into operation. For example, only a few European seaports are currently suitable for offshore energy assembly, manufacturing and servicing.

According to industry estimates, around EUR 0.5 to 1 billion of investments are necessary to upgrade port's infrastructure and vessels. Hundreds of component suppliers, many of which are SMEs, will need to upgrade, too.

Policies on the demand side, such as long term planning, regional cooperation and a clear regulatory framework can provide the signals and the visibility of future volume needs that industry and investors need for anticipatory investments and the further **industrialisation of manufacturing capacity**.

At the same time, supply side policies may be needed. The European offshore renewable energy supply chain is dynamic and highly competitive, but will face the challenge to scale up and preserve its excellence in a context of growing competitive pressure on global markets. In its Communication on "A new Industrial Strategy for Europe", the Commission highlighted the need for **a more strategic approach to renewables industries and the supply chains** underpinning them, so as to maintain Europe's global leadership and excellence.

The Commission proposes to use the **Clean Energy Industrial Forum on Renewables**, established by the 'Clean energy for all Europeans' package, to bring together national and regional authorities, industry leaders, industrial clusters, companies and service providers, TSOs, investors and the research community. Within the *Forum,* a dedicated [working group] [platform] will be established for offshore renewable energy to identify and address barriers that stand in the way of the rapid scale up of a pan-European offshore renewable supply chain, facilitate collaborative efforts and pooling of expertise. The *[Offshore Renewable Energy Platform]* will help track progress and advance the implementation of the actions in this Strategy. Given the growing trend towards developing renewables installations in their portfolios, traditional oil and gas offshore industry could be interested in joining the platform, to ensure that knowledge, skills and installations are transferred.

The skills challenge

A large scale increase in deployment offshore renewable energy and related value chain should benefit a large number of regions and territories, and may offer diversification opportunities for regions most affected by the transition to a climate neutral economy, such as carbon intensive and coal regions, those where gas and oil offshore industry needs to reconvert or **peripheral and outermost regions**. Maintenance of offshore energy infrastructure could have balancing economic effects in locations with seasonal activity variations (tourism, fishing periods, etc.), by ensuring a stable and predictable workflow for local workers and SMEs all over the year.

Reaching this potential means overcoming a number of challenges in terms of the labour force, its skills, including in terms of Information and Communication Technologies (ICTs) literacy and its presence in the right locations. Already today, the sector has difficulties in recruiting and training workers with the right skills. 17-32% of companies are experiencing skills gaps, and in technical occupations, 9-30% are experiencing skills shortages. Moving forward, Member States will need to use better the opportunities under the "Skills Agenda" and **design and shape more education and training schemes** targeting the offshore renewable energy sector in line with their expected development targets[51]. In 2019, only 12 different EU countries have relevant programmes[52], and even some countries with big offshore potential have none or few of them. Significant job opportunities will arise in particular for researchers and engineers as well as science and engineering technicians. Member States can use the **Cohesion Funds** and the **Just Transition Mechanism** to support these programmes.

Technical and academic educational programmes in Member States should take account of the increasing needs by 2050 to bring young workers with the appropriate profiles towards offshore renewable jobs. Furthermore **'Centres of Vocational Excellence' (CoVEs)** can contribute to reskilling needs, by bringing together a wide range of local partners, such as vocational education and training providers (at both secondary and tertiary levels), employers, research centres, development agencies, and employment services, to develop "skills ecosystems".

A circular economy approach

Decommissioning, re-using and recycling of wind turbines components, in particular blades made of composite material, is another challenge that must be addressed. **Research on recyclability and the impact on (eco)design** is still rather fragmented and often based on niche non-generic applications. It is necessary to inform more systematically renewables research & innovation with the principle of 'circularity by design'. This will imply that existing technologies are improved (and new technologies are developed) having in mind on the one hand the efficiency of the production processes and on the other hand the longer life-time of installations and the 'end of life' of components. This will increase the value retention of products and services of the renewable energy manufacturing industry and decrease pressure on natural resources. A thorough assessment of materials used for offshore renewable technologies is needed. This not only concerns cost and toxicity aspects but also issues such as material reuse and recyclability, sourcing constraints, and increased security of supply of critical materials. Regarding reusing and recycling, links with onshore wind turbines should be explored, as they will need to be decommissioned in the near future.

The EU renewable offshore value chain is embedded in a **global supply chain**, relying on imported raw materials and components for its production (rare earth for permanent magnets,

[51] Only 5% of available education and training programmes directly address offshore renewable energy and major gaps concern the fields of electro-mechanics, assembling, diving, metalworking and health & safety

[52] Source: project MATES (Maritime Alliance for fostering the European Blue Economy through a Marine Technology Skilling Strategy), "Baseline report on present skills gaps in shipbuilding and offshore renewables value chains" www.projectmates.eu

steel and composite materials). As demand for those materials is projected to increase - for instance, rare earths used in permanent magnets could increase tenfold by 2050[53] - it is necessary to focus on how to ensure undistorted supply but also reduce dependency and shorten supply chains. The new **European Raw Materials Alliance**[54] should help to increase supply chains resilience. Improving circularity of the full supply chain will play an important role in mitigating increased dependencies.

EU industry and global markets

The EU offshore renewable energy industry is highly competitive on the global market and has a strong **export capacity,** with China and India being the key global competitors. Between 2009 and 2018, the EU trade balance remained positive, showing a rising trend. In 2018, EU companies had 47% of global exports. 8 out of 10 global exporters are EU countries. The global market represents a significant commercial opportunity for EU industries. Within Asia offshore wind capacity is expected to reach around 95 GW by 2030 (out of a projected global capacity of almost 233 GW by 2030)[55]. Nearly half of global offshore wind investment in 2018 took place in China[56]. The global market for new technologies such as floating wind, and in perspective ocean energy, can also provide promising new outlets for EU industry. Thus, through climate and energy diplomacy, the EU should **support the creation of favourable environment** for offshore renewables development in partner countries, including low income countries and emerging markets. Such support could concern the regulatory framework, technical standards, port infrastructure development, local/national trade associations, capacity building for connection and grid management, and professional training.

As a technology developer (including for grid technology), **the EU must take a more resolute approach when it comes to promoting its interests through trade policy.** Increasingly, some markets are imposing **local content requirements** or adopting other discriminatory regulations in order to promote domestic industries. The Commission will take an active role in promoting regulatory convergence and dissemination of EU standards, while opposing the introduction of local content requirements in third countries. Free Trade Agreements and international collaboration should strive for undistorted trade and investment and ensure reciprocity of market access, but also factor in the need for the convergence of norms and standards, flexible electricity markets and fair grid access in third countries.

Key actions

- The Commission and ENTSO-E will promote standardisation and interoperability among converters of different manufacturers (to be operational by 2028).
- The Commission will establish a dedicated platform within the Clean Energy Industrial Forum on Renewables, to bring together national and regional authorities, key industry clusters, companies and service providers along the value chain, TSOs, investors, research community (2021)

[53] European wind generator production, depends on imports of graphite (of which 48% comes from China), cobalt (of which 68% comes from the Democratic Republic of Congo), lithium (of which 78% comes from Chile) and rare earths (of which nearly 100% come from China). – source: European Commission's 2020 Strategic Foresight Report (https://ec.europa.eu/info/strategy/priorities-2019-2024/new-push-european-democracy/strategic-foresight/2020-strategic-foresight-report_en)
[54] COM(2020) 474 final
[55] GWEC 2020, Global Offshore Wind Report, 2020.
[56] IRENA – Future of wind (2019, p. 52).

- The Commission will encourage Member States and regions to use the Just Transition Mechanism, in particular the Just Transition Fund where applicable, and the 2021-2027 Cohesion Policy Funds to support investments in renewable offshore energy as a way to reinforce economic diversification, create new jobs and deploy re-skilling/upskilling schemes.
- The Commission will facilitate development of new export markets for offshore renewables and strengthening existing ones through exchanging on policy frameworks and sector developments in the EU's energy dialogues with partner countries (on-going).
- The Commission will support national and regional authorities in creating and delivering specific technical and academic educational programmes to develop an offshore skill pool and bring young workers with the appropriate profiles and re/upskilled workers, towards offshore renewable jobs.

5. Conclusions

Exploiting all the potential of our seas to produce offshore renewable energy will only be possible if all are mobilised to ensure Europe deliver on its commitment to become Climate neutral by 2050. T Europe is moving fast in a sector that is extremely competitive. It also means Europe needs to significantly increase its renewable energy generation. This can only be achieved if we draw on the lessons learned from the first movers, such as offshore wind technologies, and ensure a flexible framework for Europe industry.

The richness of our offshore environment and European sea basins is an advantage to build on in a sustainable and efficient manner. This strategy looks at ways to effectively tap the enormous potential of our seas for renewable energy.

For offshore wind fixed bottom and floating, the challenge is to create the best environment for preserving and accelerating the momentum begun in the North Sea, extending this best practice experience to other sea basins, starting from the Baltic Sea, and supporting a global expansion. For other technologies, the challenge is to mobilise adequate and well targeted funding for research and demonstration, bring down costs and accompany these technologies to the commercialisation stage in time for making a difference to 2050.Succeeding in offshore renewable energy can bring large benefits to Europe. Firstly, it is necessary to bring the EU on a path towards climate neutrality in 2050. Secondly, it can also bring a major contribution to the post Covid 19 recovery, as a sector where Europe's industry enjoys a world leadership role and which is forecasted to grow exponentially in the decades to come.

The EU is willing and ready to share its leading experience and **cooperate with third countries** in different forms, from exchanging best practices and regulatory approaches to developing joint projects with neighbouring countries, depending on the level of alignment of the regulatory frameworks and coherence with the EU policy priorities in terms of environmental and other standards.

This strategy will require engagement of all concerned parties, Member States, regions, EU citizens, social partners, NGOs, industry. The Commission invites the EU institutions and all stakeholders to discuss the policy actions proposed in this Strategy and contribute to take them forward.

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ANNEX

ANNEX

to the

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future.

ANNEX

to the

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future.

Guidance on electricity market arrangements: A future-proof market design for offshore renewable hybrid projects

I. Introduction

The European Union is set to become the first climate neutral continent by 2050, delivering on an inclusive affordable and green transition. Offshore renewable energy will play a key role in the transformation of our energy sector and the covering Communication sets out the extent of the challenge. A huge upscale is needed in order to achieve the fivefold increase required by 2030 and twenty-five fold increase by 2050 to reach approximately 300GW – and this is just for offshore wind. Other technologies in earlier stages of development also have their part to play. To achieve these ambitious objectives, there must be a significant step change in how we work to enable the cross-border cooperation required to deploy the required levels of offshore renewable energy.

Today, offshore wind is deployed mainly through *national projects*, with offshore windfarms connected *radially* to shore and cross-border interconnectors developed separately. While a significant proportion of offshore projects is likely to continue to be developed in this way[1], it can also be expected that some projects would come forward more efficiently and with significant welfare gains if developed as generation hubs connected to two or more Member States. These projects, known as hybrid projects, because they combine generation and interconnection, can provide estimated cost savings of up to 10 %[2] but also come with additional risks – due to legal uncertainties related to regulatory treatment and other issues such as the distribution of costs and benefits among project parties. This moment in time represents a unique opportunity to ensure preparedness for a large up-scale of renewable energy and avoid a sub-optimal development from fragmented national approaches in scarce maritime space.

The key challenge concerns how to deploy these projects in a way that achieves the least-cost transition for consumers and maintains social acceptance of the energy transition as a whole. While there are clear benefits to a more integrated offshore grid for renewables production, such projects are complex to set up. Additionally, the market rules for the electricity system have been designed for a renewables-based energy future in a way that optimally supports security of supply and the integration of large amounts of renewables over a wide area. However, they were not designed specifically with offshore hybrid projects in mind.

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[1] "Progress on Meshed HVDC Offshore Transmission Networks" modelled a large scale up of offshore wind energy projects and energy hubs in the North Sea: www.promotion-offshore.net

[2] Roland Berger GmbH (2019), Hybrid projects: How to reduce costs and space of offshore developments, North Seas Offshore energy Clusters study https://op.europa.eu/en/publication-detail/-/publication/59165f6d-802e-11e9-9f05-01aa75ed71a1

The focus of this paper is mainly on the specific category of offshore hybrid projects. These projects raise complex questions, which should be addressed to ensure that the regulatory framework is not a barrier to deployment. The objective of this Guidance is to address some of the key questions facing Member States, Regulatory Authorities, TSOs and projects promoters concerning the application of the electricity market legislation to the offshore context. In particular:

- It explains how to design offshore projects in line with the current rules, in particular unbundling, market dispatch and cross-border trading rules.
- It considers whether an adaptation of the current regulatory framework to address the particularities of investment incentives for hybrid projects is needed.
- It examines the need for coordination on technical rules regarding connection to the electricity grid.

This Guidance is technology neutral, although may be primarily of interest to offshore wind which is currently the most mature of offshore renewable energy technologies. Additionally, some elements outlined below can also be applied also to more traditional offshore generation projects connected only to one market.

II. A market framework for offshore renewable energy

The EU electricity regime (namely Electricity Directive 944/2019 and Regulation 943/2019 aims to ensure that the integrated EU electricity market operates in a way that is fair and fit for renewables. In particular, the rules in the Regulation strengthen shorter-term markets, which will provide several benefits for renewable energy – enabling variable renewables to participate on a more equal footing as the markets close at the day-ahead and intraday stages when more accurate forecasting of generation is possible. This allows power generation using variable renewable sources to manage their risks but also supports security of supply by allowing the full flexibility of our interconnected electricity system to integrate renewables over a wider area and respond to unforeseen events. These changes are all intended to enable renewables to become the backbone of our electricity system.

This paper recognises that the electricity market rules were not designed with the particular case of offshore hybrid projects in mind and therefore describes the current market framework. It sets out the Commission's view on certain areas where stakeholders have had questions about complex topics such as market dispatch, unbundling, cross-border electricity trading and bidding zone configuration. In addition, it analyses the rules on congestion income and the Grid Connection Network Codes to determine if adaptations are needed to ensure that these rules are fit for purpose for a large scale up of offshore renewable energy projects.

I. Explanation of the main relevant market rules

a) Market Dispatch and Balance Responsibility

In the early days of renewable energy deployment, renewable energy was an emergent technology and protected from competition and market dynamics on the wholesale electricity market by support mechanisms, priority dispatch, priority access, and other types of specific frameworks. Nowadays, although not all renewable technologies are at the same stage of development, technologies such as wind and solar are highly competitive and renewables constitute around one-third of all electricity generation in the EU[3]. The current market framework and, in particular, the recast Electricity Regulation therefore takes account of the considerable progress made over recent years and recognise that renewables are becoming the foundation of our electricity system.

This is an important change in the regulatory framework for renewables producers because, in the past, they were often not exposed to market dynamics and obligations. Existing support schemes are not terminated by the Regulation – indeed Article 12(6) provides a guarantee that producers on existing schemes may continue to benefit from any priority dispatch granted under those schemes. However, while exemptions exist for small generation assets and demonstration projects[4] – especially important in the context of emerging offshore technologies – there are now clear rules for how large new investment projects should operate.

Article 12 of the Electricity Regulation sets out the rules on power generation dispatch. Large new renewable installations no longer benefit from priority dispatch, which implies that future offshore wind generation will need to operate according to market base dispatch. Existing installations already benefiting from priority dispatch retain it and priority dispatch is also maintained for new small-scale installations up to 400kW, decreasing to 200kW from January 2026 and demonstration projects for innovative technologies, therefore potentially for innovative tidal or wave offshore investments.

It is worth noting that, when considering hybrid projects, the issue of priority dispatch is not simply about access to a market. It is inherently linked to the issues of third-party access and cross-border trade flows. In order to allow all generation to have the possibility to compete for scarce interconnection capacity, fair and non-discriminatory treatment is critical. Indeed, Article 12(7) states that priority dispatch shall not be used to reduce cross-border capacities. This is to ensure that the cheapest sources of renewable energy will be dispatched and traded throughout the Union.

Article 5 of the Electricity Regulation sets out rules on balancing responsibility. In principle, all market participants shall be responsible for the imbalances they cause in the system. For renewable generators active on the market, this means that they need to bear the risk of

[3] Source: Eurostat, 2018
[4] Small generation assets and demonstration projects may be granted priority dispatch and an exemption from balancing responsibility under the Electricity Regulation.

incorrect predictions for production, e.g. due to incorrect wind forecasts. This creates incentives to improve forecasts or pay for better forecast services. Derogations from balancing responsibility may be maintained for small installations, demonstration projects and installations benefitting from support already approved under Union State aid rules commissioned before 4 July 2019.

These provisions mean that, as a starting point, the electricity producer bears the responsibilities related to buying and selling the electricity they generate. The responsibilities and complexities of operating in the wholesale market can be assumed by the electricity generator itself or delegated contractually to a third party (an aggregator, a supplier, or another type of service provider). It would of course be a commercial decision to outsource to a third party service provider.

Another aspect of market operation crucial for offshore hybrid renewables is that of curtailment (or other forms of downward redispatch) – especially as we achieve higher levels of renewables integration into our electricity systems. The Regulation distinguishes between market-based redispatch and non-market based redispatch. Market-based redispatch will always require the agreement of the operator of the facility to be redispatched, e.g. by having made an offer for redispatch services (or using offers from other markets such as the balancing market). If however, exceptionally, non-market based redispatch is used, the Regulation provides strong protection for renewables which should only be subject to downward redispatching as a last resort once all other technologies that can reasonably respond have been exhausted first. Any such curtailment should also receive adequate compensation pursuant to Article 13(7). It should be noted that the compensation is linked to the price at the day ahead level in the bidding zone of the renewable generator, and therefore impacted by the definition of bidding zones. It should also be noted that a renewable producer would not be remunerated if a commercial decision is made not to generate due to low or negative market prices.

Additionally, there is a provision that is especially relevant for large renewables installations with a significant impact on cross-border electricity trading. Article 12(7) expressly sets out that priority dispatch is no justification for reductions in cross-border capacity available for trade[5]. Therefore, where priority dispatch creates internal congestion, this does not allow deviation from the cross-border trading requirements under Article 16, which are explained further below in this Guidance.

Finally, it is important to acknowledge that in a system based on market dispatch with full balancing responsibility, renewable generators are exposed to several types of risks. These are most notably price risks (if the market price is lower than expected, reducing revenues) and imbalance risks (if the production is not as forecast and scheduled, thus creating imbalance costs). Generators can reduce those risks, and partly hedge against their impact themselves or through third-party service providers. Lower than expected prices on short-term markets can

[5] Always with the caveat that system operators may take the measures that are necessary to maintain system security, in accordance with the Electricity Regulation.

be hedged by trading electricity on long-term markets (e.g. via specific power purchase agreements selling renewable electricity but also on general forward markets). If the expected risks are due to price differences between different geographical areas (e.g. between an offshore bidding zone and a neighbouring market), they can be mitigated by trading forward transmission capacity (be it financial or physical transmission rights). To mitigate imbalance risks, producers of weather-dependent generation should use the best forecasting methods available as a basis for scheduling. Relevant national authorities should also consider providing clear explanations of how the market rules will affect producers[6] in their specific bidding zone and circumstance.

b) Unbundling

Unbundling, in application since the Third Energy Package of 2009[7] to ensure non-discriminatory system operation and third party access, also applies to the offshore renewable electricity sector. That means that there has to be a separation between transmission of electricity on one hand and production of electricity as well as storage or hydrogen production on the other hand. Therefore, whereas owners of offshore generation could also own and operate storage or electrolysers, for example, this would in principle not be allowed for system operators.

Indeed, the fundamentals of third party access and ensuring non-discriminatory treatment will become increasingly important in the growing offshore sector. Unbundling is crucial for a level playing field and for setting the right incentives on TSOs to take their decisions independently, ensuring transparency and non-discrimination towards network users and as regards extending these grids where necessary. Importantly, even under a full ownership unbundling regime, it is not only the incumbent TSOs who are allowed to build networks as long as there is separate ownership and operation of generation and transmission assets once projects are operational. This separation requirement is due to the potential for distorting the market if the transmission owner operates generation assets in the connecting markets or hampering competition by restricting third party access to the transmission network.

There are alternatives to the traditional TSO model (where solely the TSO builds and operates the grid) that satisfy the unbundling rules as interpreted and applied by the Commission and avoid conflicts of interest or incentives for discriminatory behaviour. The Commission has

[6] For example, an Industry Guide to new market rules was provided in Ireland in 2017: https://www.sem-o.com/documents/general-publications/I-SEM-Industry-Guide.pdf

[7] In order to respond to the shortcomings identified in the 2007 Sector Inquiry and improve the functioning of the internal energy market, notably by addressing the problem of systematic network foreclosure through generator-owned grid operators, the operation of transmission networks was fully separated from the activities of energy supply and generation, thereby opening up European electricity markets to competition, innovative business models and increased transparency and oversight. System operators must apply for certification as an unbundled operator with their national regulatory authority and the Commission provides its opinion on the certification procedure.

published a Staff Working paper[8] on "*Ownership Unbundling: The Commission's practice in assessing a conflict of interest including in the case of financial investors*" to set out the possibilities in more detail. One example of such a model is the UK's Offshore Transmission Owner (OFTO) regime, which allows project developers to design, install and connect each project to shore with its own transmission link. The ownership of the finished cable is then tendered by the national regulatory authority (NRA) to a separate transmission operator (or OFTO), which can earn a regulated rate of return on the costs of operating these networks. The structure of this model works well and the UK has seen a reduction in the cost of building these transmission cables due to competitive downward pressure. Recent Commission certification opinions have highlighted concerns about the tenders awarded to OFTO companies that also have a commercial interest in the electricity market and potentially an ability to exert their influence on that market[9]. In this context, it is important to note that offshore wind assets in particular are often considerable in size and could therefore have a significant market impact. This is something that the Commission continues to follow closely.

It is currently not clear whether the benefits of a model where the investor builds both generation asset and grid or the planned deployment undertaken by the national TSO is more conducive to the scale of the decarbonisation challenge. The former may result in a speedier build out due a lower need for coordination between stakeholders while the latter may result in better optimisation for limited maritime space and potentially more deployment than a project-by-project approach. The Commission will continue to monitor the performance of all approaches, including also the degree to which they facilitate the commercialisation of new solutions such as HVDC and digital services as well as storage and conversion investments.

In the longer term and looking ahead to the development of meshed and integrated offshore grids, models that work well in other sectors or geographic regions could also be considered. For example, a group of TSOs could plan, build and operate the meshed assets, with support from the competent Regional Coordination Centre. They could suggest the bidding zone configuration, including the designation of a TSO to manage the bidding zone(s), and relevant NRAs and Member States would approve the deployment plans. Today this set up is well known when Member States build interconnectors between countries, but this would be a more complex model – with more parties involved, additional responsibilities and operational tasks to be carried out by a designated TSO. Alternatively, a common model used often in the U.S. is that of an Independent System Operator (ISO)[10]. In Europe, it would mean relevant Member States or relevant system operators setting up an ISO together to develop and operate offshore assets in a well-coordinated manner, including managing the bidding zone and

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[8] https://ec.europa.eu/transparency/regdoc/rep/10102/2013/EN/10102-2013-177-EN-F1-1.PDF

[9] The Commission has remarked that given the increasing share of renewable electricity production and the increasing importance of energy storage solutions, the cumulation of smaller generation capacities should be fully taken into account when assessing if there is an incentive and ability for a shareholder in a TSO to influence the TSO's decision-making to the detriment of other network users.
https://ec.europa.eu/energy/sites/ener/files/documents/2019_157_walney_uk_en.pdf

[10] PJM, ISO New England, CAISO, for example. This should not be confused with the ISO model under the EU Electricity and Gas Directives.

ensuring operational security. Commercial parties would own the infrastructure and receive a regulated return. Such a model is also used for gas infrastructure in the North Sea region. This model could be established on a multilateral basis in the electricity sector, in a way that is fully compliant with unbundling requirements.

c) Cross border electricity trading through an offshore hybrid asset

The free flow of electricity across the European Union is key to achieving secure, affordable and clean energy for EU citizens and businesses. To support the integration of electricity markets, increase flexibility and ensure that larger amounts of renewable energy can be connected over wider areas, billions of Euro are spent each year on cross-border interconnection projects. This is primarily paid for by European consumers through tariffs on their electricity bills but also strongly supported by the Union.[11] It is important that interconnectors between EU Member States, once built, are used in the most efficient way possible to deliver the intended benefits to consumers, to support a greener electricity system and to ensure that all Member States can rely on imports to support security of supply when needed. This should also apply to interconnectors combined with a renewable generation asset (hybrid project).

In the EU, the schedules for cross-border trading are determined through a common process known as market coupling. Market coupling uses bidding zone prices, which have been determined via marginal pricing, combined with cross border grid constraints to determine the trade flows between transmission systems. These bidding zones (or price zones) are market areas within which electricity should not encounter bottlenecks and flow freely. Therefore, within a bidding zone there is one wholesale electricity price. When different prices in neighbouring bidding zones occur, the electricity trade flows from the lower to higher priced zones.

In the past, there have been problematic cases of TSOs closing their borders to electricity imports – even renewable electricity imports – in a structural way to manage congestion within their own control areas[12]. This runs counter to key principles of the Treaty of the Functioning of the European Union relevant to electricity market design, which include the principles of free movement of goods and non-discrimination between internal and cross-zonal exchanges. Such actions may also be considered contrary to the competition rules enshrined in the Treaty, in particular Article 102 TFEU. These principles and rules deriving from the TFEU apply to the electricity sector and are specifically set out in Article 16 of the Electricity Regulation, which obliges TSOs to maximise the available capacity for trade and to ensure non-discrimination between internal and cross-zonal exchanges.

[11] From the Commission alone, the total grant budget to support energy projects for the 2014-2020 period under the CEF Energy programme was €4.7 billion.

[12] See for example the recent Commission Decision in case AT 40461 DE/DK Interconnector: https://ec.europa.eu/competition/antitrust/cases/dec_docs/40461/40461_462_3.pdf

Article 16 of the recast Electricity Regulation also introduced an explicit target for cross-zonal trade. The rules impose a maximum limit of 30% for the deductions from the interconnector capacities that TSOs can make[13]. The rest (minimum 70% of capacity) should be made available for trade. This provides flexibility to TSOs for deductions for specific reasons, namely loop flows, internal flows and reliability margins, and ensures that there is a guaranteed minimum capacity available for trade applying to all Member States from January 2026 at the latest. These rules are crucial for the proper functioning of the EU electricity market, as electricity should flow without undue barriers to where it is most needed.

Furthermore, all renewables projects – both offshore and onshore – should have fair and non-discriminatory access to the transmission network and electricity markets[14]. Therefore, in order to keep the transition affordable and to allow for fair competition, it is crucial that renewables are fully integrated into the electricity market in a non-discriminatory manner. The competition, trade and export of electricity generated from renewable sources, based on demand and supply rather than pre-defined flow patterns, is crucial to the effective functioning of the internal energy market and the achievement of our decarbonisation goals.

2. Offshore Bidding Zones – a way forward

a) The concept of Offshore Bidding Zones

The current approach for onshore renewable generation where it is considered as part of an existing "home" electricity market is not well suited to offshore hybrid projects, and not conducive to the large scale-up necessary to achieve our climate objectives. This is because, in line with the principle of non-discrimination of cross-zonal flows, the hybrid project would either need to be curtailed to allow imports and exports over the interconnectors or the cables would need to be oversized in order to make capacities available for trade. In principle, the integration of high volumes of offshore renewable generation will be difficult if hybrid projects would need to rely on exemptions or derogations under EU law[15]. Although, it is not excluded for individual projects to exceptionally qualify, these long-term projects require a conducive legal and regulatory framework to allow them to expand and upscale.

In order to achieve cost-effective decarbonisation and to provide a level playing field among all forms of generation and demand response, it is the Commission's view that the

[13] The capacity offered can be reduced for specific reasons, namely loop flows, internal flows and reliability margins up to a maximum of 30%. The rest of the capacity (minimum 70% of capacity) should be made available for trade by offering it to the Regional Coordination Centre for capacity calculation – where further deductions for the N-1 standard and transit flows are possible. See Art. 16 of the Electricity Regulation.

[14] Non-discrimination and fair competition are fundamental market principles. See Article 3 of 943/2019

[15] The Commission notes in this context that it has received a derogation request under Article 64 of the Electricity Regulation for the Kriegers Flak project, which is an offshore wind installation, connected to both the German and Danish markets and a request was submitted in July 2020 seeking derogation from certain articles in the Electricity Regulation.

establishment of offshore bidding zones[16] provides a good approach to ensure compliance with the cross-border trading rules. Modelling results and a detailed assessment of the available options[17] show that, from the models that have been under discussion, offshore bidding zones are better for overall efficiency compared to a "home" zone approach. This is because they lower costs to TSOs due to a reduced need for after-market corrective actions, support regional security of supply and system operation by ensuring that electricity flows to where it is most needed and are more future-proofed for a large upscale of offshore projects. The extent of the benefits depends on the degree to which lower priced trade is displaced and the extent of the resulting costs to TSOs and consumers for correcting inefficient market outcomes.

An offshore bidding zone ensures that the generation from the offshore project is fully integrated into the market, that the total generation can be exported from its own zone and dispatched according to market coupling schedules throughout Europe.

The offshore bidding zone approach is better suited to a large scale-up of offshore renewables as it ensures that renewables can be fully integrated into the market. In the short term, it ensures that offshore generation can flow to where it's needed, becoming part of the electricity schedules and supporting regional security of supply rather than becoming something for which TSOs have to correct, which would place limits on how much can be deployed. This will become increasingly important as the share of renewables increase and become the backbone of our electricity system as we move towards climate neutrality by 2050. Furthermore, this model does not discriminate in favour of technology types, is fully compliant with competition law and therefore provides the legal certainty needed for long-term and large-scale projects. In the medium to longer-term, offshore bidding zones create locational incentives for the installation of new demand, e.g. for storage or the production of green hydrogen via electrolysis.

However, offshore bidding zones can result in a changed incentive structure. Modelling results have shown that a redistribution of parts of the revenue from offshore generation assets to transmission system operators can be expected. The extent of redistribution depends on the topology: based on a recent study[18], for more than half of the projects, the redistribution is of less than 1 % of total revenues, but for a small share of projects, this can rise to 11 % of revenues. This effect needs to be addressed to ensure that projects beneficial for society can be realised and is discussed in more detail further on in this paper.

Offshore bidding zones could also be an appropriate solution for NRAs and TSOs at national level, even when offshore projects are connected radially to the home market. This can happen, for example, if there is not sufficient transmission capacity to take the electricity from

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[16] It should be noted that offshore bidding zones can also include near-shore onshore areas. Bidding zones should be based on where congestion occurs, so if the congestion occurs when transporting electricity further from the shore, the areas "before" the congestion could be seen as part of the offshore zone, thereby incentivising investment in electricity intensive demand in those areas.

[17] *Market Arrangements for Offshore Hybrid Projects in the North Sea (Thema Report 2020-11).*

[18] *Market Arrangements for Offshore Hybrid Projects in the North Sea* (Thema Report 2020-11).

the coast to cities further inland due to delays in permitting procedures or due to the practice of not building capacity for the few peak hours of wind. An offshore bidding zone would give the right price signal and can give incentives for demand such as power-to-gas technology to be located close to offshore generation. Without a separate bidding zone, a TSO may need to curtail offshore wind generation and redispatch power plants closer to the cities. This is not efficient and a separate bidding zone offshore could help to ensure that only the required amount of electricity is dispatched by the market.

Offshore bidding zones are adaptable and can be scaled up over time. An important consideration is that the transmission network to connecting markets should be well-sized to ensure that the electricity can flow to the onshore network. For example, if extra wind farms are added to an offshore bidding zone, the connected markets will only benefit if additional cables are laid to increase the transmission capacity. Demonstration projects can also be situated in offshore bidding zones – be they demand or generation projects[19]. If it is a generation project, the importance of ensuring that the transmission capacity is well-sized remains crucial. Where demonstration projects provide increased flexibility (via storage, for example) in offshore bidding zones, they can fully leverage the advantages of direct access to affordable offshore generation and contribute to an optimal usage of the offshore network.

b) Establishment and Governance of Offshore Bidding Zones

Bidding zones, as explained above, are market areas within which there is one wholesale electricity price. The bidding zone price varies from zone to zone due to different generation and demand patterns and these price differences are the signals for trade, determining the direction of power flows i.e. if electricity is scarce in a zone, the price rises and imports follow. The 70% minimum target for trade, as described above, applies to bidding zone borders. Largely for historical reasons and the gradual integration of the EU electricity system over time, bidding zones have tended to follow political borders, rather than the underlying physical reality of the grid, although this is not always the case.

Establishing new offshore bidding zones for renewable energy projects connected to more than one market – and that potentially cross national borders – raises questions about how these zones should be established and regulated and how system operation should be performed. Although new in an offshore context, European TSOs and NRAs already have quite a lot of experience in dealing with these issues and research conducted on behalf of the Commission has shown that suitable governance arrangements can be implemented under current legislation[20]. For all of the options set out below, legislative changes are not required.

At national level, offshore bidding zones that do not cross national boundaries can be governed using existing domestic arrangements. The Nordic countries and Italy have

[19] A demonstration project in an offshore bidding zone may be granted priority dispatch and an exemption from balance responsibility in line with the Electricity Regulation.
[20] *Market Arrangements for Offshore Hybrid Projects in the North Sea* (Thema Report 2020-11).

considerable experience where the TSOs manage several bidding zones at national level. For a multinational zone, regulatory governance could be provided for through NRA cooperation, possibly institutionalised in a joint committee, while real-time system operation could be supported through the use of TSO service and cost sharing agreements and the coordination of actions at regional level through the relevant Regional Coordination Centre. In both cases, these arrangements are possible under existing legislation and the experience of the Irish Single Electricity Market and other cross-border bidding zones is very useful.

A regulatory process for bidding zone determination already exists and it is the Commission's view that the establishment of appropriate governance arrangements for offshore bidding zones can be suitably addressed through the sensible application of existing legislation and procedures.

Establishment of a new bidding zone

For the establishment of a new bidding zone, two pieces of legislation are relevant – the Electricity Regulation 943/2019 and the Guideline on Capacity Allocation and Congestion Management 1222/2015 (CACM). The detailed procedures and requirements are set out in Articles 32 and 33 of CACM and, in all cases, the level of coordination and consultation with neighbouring TSOs depends on how big an impact a reconfiguration of the bidding zones is likely to have on their bidding zones. Following the entry into force of the Electricity Regulation, a pan-European bidding zone review was launched but, as clarified in Recital 19 of the Electricity Regulation, it is still possible to launch a national or regional bidding zone review in accordance with existing procedures in CACM.

At national level, if there is a negligible impact on a neighbouring TSO's control area, one single NRA or TSO with the approval of its competent NRA can launch a bidding zone review with a view to amending the existing configuration in its own control area. In this case, the relevant TSO and NRA must give prior notice of the planned review to neighbouring TSOs and be fully transparent on the reasons and conditions of the review. The results of the review need to be published and if the result is a proposal to amend the bidding zone configuration, this should also be published. Given that each bidding zone is located in a Capacity Calculation Region (CCR), the next step is to update the list of borders in that CCR to account for the new offshore bidding zone. The TSOs of the CCR should update the list and then send it to relevant NRAs for approval.

For a bidding zone review with a regional impact, CACM also sets out the ways to launch the review and the detailed procedures to follow in Articles 32 and 33. At a high-level, the process is as follows:

- The participating TSOs shall develop the methodology, assumptions and alternative bidding zone configurations and submit these to participating NRAs. Once this is approved by NRAs, the bidding zone review shall be conducted in accordance with the criteria and process set out.

- The final proposal on whether to amend the bidding zone configuration is sent to the participating Member States (or designated competent authority) for an agreement within 6 months.

The Electricity Regulation 943/2019 adds the following elements to the CACM process:

- The time horizon assessed in the bidding zone review should be 3 years.

- There are now strengthened governance arrangements and ACER can decide if the NRAs do not agree on the methodology, assumptions and alternative bidding zone configurations as proposed by TSOs.

- There are also strengthened governance arrangements for the decision-making process following the review. The Electricity Regulation requires the report to be submitted to "relevant Member States or their designated competent authorities" for a decision. The relevant Member States are those participating in the review and those in the same CCR as the affected bidding zones.

Therefore, in order to establish an offshore bidding zone following a review, Member States in a CCR have 6 months to agree whether and how to proceed[21]. In addition, the list of borders contained in a CCR should be updated by TSOs and sent to NRAs for approval in line with existing procedures. The Regional Coordination Centre coordinating TSO actions in relation to the new offshore bidding zone will be the one responsible for that particular CCR.

Governance of a new bidding zone

…at national level

Where a new bidding zone has been established at national level in the exclusive economic zone of one Member State, the governance arrangements are relatively straightforward. Most EU Member States have one TSO that is responsible for system operation – this TSO would retain responsibility for the new bidding zone. Many TSOs already have extensive experience of managing several bidding zones, for example, TERNA in Italy, Energinet in Denmark and Svenska Kraftnät in Sweden. The regulatory oversight flows directly from this arrangement. The NRA in that Member State would oversee the establishment and operation of new bidding zone by the TSO and issues such as market monitoring would fall under the remit of that competent NRA. Again, experience from Italy, Denmark and Sweden can prove to be a useful blueprint.

…at multi-national level

[21] In case Member States fail to reach agreement, the decision is automatically escalated to the Commission in line with the process set out in Article 14 of the Electricity Regulation.

At multinational level, there are various levels of cooperation and governance arrangements that can be envisaged when exploring how to manage a cross-border bidding zone. The existing examples of multinational bidding zones in the EU today provide a good starting point e.g., the experience of the past German-Austrian-Luxembourgish bidding zone, the existing arrangements for the German-Luxembourgish bidding zone and also the experience of the all-island integrated Single Electricity Market in Ireland.

For an offshore bidding zone located in the exclusive economic zone or territorial waters of more than one Member State, Member States and their competent NRAs can decide on the most efficient arrangements and how close and how formal they would like the cooperation to be. For example, one option would be to appoint a TSO (permanently or on a rotating basis) to perform the system operation for the bidding zone and assume all related responsibilities – this would be formalised in TSO service and cost sharing agreements, under the supervision of the competent NRAs. Specifically for the offshore bidding zone, NRAs would also need to cooperate in order to jointly decide, to the extent needed, on issues such as the applicable tariffs, the grid connection regime, etc. Austrian, German and Luxembourgish NRAs had a good experience of informal cooperation in allowing for coordination and cooperative decision making in relation to the regulation of the Austria-Germany-Luxemburg bidding zone. Their experience in the context of a larger and more complex bidding zone suggests that such informal cooperation can work successfully under the existing European framework.

It is too soon to say whether more formal governance arrangements in an offshore bidding zone are needed but this will become apparent over time. For example, as offshore renewable projects expand and begin to include demand, and link up to other offshore hubs or additional Member States, the challenges might be better addressed through dedicated processes for decision-making and governance. If this need arises, formalised arrangements for joint decision-making could be arranged on the basis of delegated authority from the NRAs. Such an approach would not necessarily require the transfer of legal authority to a multilateral body.

One example of institutionalised NRA cooperation cited in the study by THEMA, is the Irish Single Electricity Market (SEM) Committee. The SEM Committee oversees the joint Irish electricity market (spanning two separate jurisdictions) and has formal regulatory responsibility for the following:

- management of the applicable Trading and Settlement Code;
- the Market Monitoring Unit (which monitors compliance, notably in relation to market power abuses);
- the Market Modelling Group; and
- Single Market Operator regulation.

All regulatory matters that do not fall under the aforementioned scope remain in the hands of each of the respective NRAs respectively. The Committee consists of three members from the

Republic's NRA, two members from Northern Ireland's NRA, and two independent members.

Jointly, the NRAs work together through the Committee to harmonise transmission policy and define the systems and processes that constitute the high-level design of the integrated SEM. The NRAs continue to be ultimately responsible for regional cooperation, however specific functions have been transferred to the joint body with the agreement of the national governments. Under EU legislation, ACER maintains responsibility[22] in the event of a dispute regarding relevant methodologies and could take a decision in the case of continued disagreement. However, the SEM Committee provides a more practical mechanism to undertake ongoing regulatory tasks that cover both NRAs, as well as to support cooperative regulatory development as needed.

The approach used in I-SEM could thus serve as a useful model for NRA cooperation as part of a multinational offshore bidding zone. Although the Committee is based on bilateral cooperation, the institutional arrangements that it embodies could be readily adapted to cover a multinational bidding zone.

…and for future offshore highly-meshed grids

As we look ahead to the size of the investments in renewable energy that will be needed to achieve the 2050 decarbonisation targets, and the ambitious plans of Member States to roll out offshore wind and other forms of tidal and ocean energy, there will naturally be some maritime areas that will become crowded physically with large amounts of offshore generation. These areas will also experience very specific technical challenges in the types of system operation issues faced – from interacting with other renewable energy hubs to the difficult task of managing the large amounts of non-synchronous generation. It is important to note that mechanisms to support TSO coordination already exist. Regional Coordination Centres could support coordination among onshore system operators and their tasks are sufficiently adaptable to be tailored over time to the needs of the offshore system. Article 37 (2) of the Electricity Regulation 2019/943 also provides for the possibility of assigning additional advisory tasks to Regional Coordination Centres.

However, where real-time system operation becomes increasingly complex and intricate, a more holistic approach to the system operation in an offshore region in the future could be warranted. TSOs could appoint one TSO to manage the entire offshore area (possibly consisting of several offshore bidding zones) or TSOs and NRAs may decide to establish an independent system operator (ISO) for this purpose, potentially as a joint venture. An ISO established for this purpose would develop significant expertise in the technical challenges associated with offshore DC infrastructure and could become a global leader in managing a variable renewables-based electricity system.

[22] ACER's powers in the Irish context are exclusively those afforded by the relevant European legislation, most notably in relation to regional methodologies in the CACM Guideline (2015/1222), the System Operation Guideline (2017/1485) and the Electricity Balancing Guideline (2017/2195).

Other benefits could flow from such an arrangement. One or more offshore ISOs would be a model case for regional cooperation. An ISO could function as a system architect to develop the long-term master plan for offshore meshed grid development, map locations for offshore wind, as well as undertake the required grid investments allowing for a European wide grid optimisation. It would provide the relevant NRAs the possibility to consider in a neutral and coordinated way, the best type of incentive regime and tariff design for a variable renewables-based electricity system. It would also have the advantage of solving coordination challenges and could help to de-risk anticipatory investments. At the same time, close cooperation between the ISO and onshore TSOs would remain necessary, e.g. to ensure sufficient transmission capacity onshore at the designated landing points for offshore cables.

It is highly likely that the governance arrangements for a multilateral ISO would need to be formalised, along the lines of the arrangements outlined above for multilateral bidding zones – or ACER, as the existing body for the cooperation of European NRAs, could potentially take on the regulatory function. This structure could be complemented by a regional regulators' forum and, at governmental level, a high-level Ministerial regional energy policy forum.

c) Conclusion on Offshore Bidding Zones

Offshore Bidding Zones provide the long-term legal certainty required by hybrid projects and are the most efficient and affordable way for consumers to integrate large-scale offshore renewables into the system.

They also support system security and have benefits beyond this by ensuring reliable access to imports and the potential to incentives for efficient investments. It is possible already under the current regulatory framework of the Clean Energy Package to establish offshore bidding zones and to find appropriate governance arrangements. Even more far-reaching solutions, such as the establishment of offshore ISOs, are in principle possible under the current legislative framework. Different approaches can, to a large extent, co-exist. However in the long run, and with the significant build-up of offshore renewable generation that is expected and necessary to achieve the Union's climate objectives, the offshore bidding zone approach appears best suited. This being said, it should also be acknowledged that this approach impacts renewables developers, most notably in relation to price dynamics.

3) Price dynamics and links with support schemes

As explained in the section on offshore bidding zones, if the offshore zone contains only renewable generation and no demand, the price in that zone will be determined by the demand from the markets to which it is connected. Additionally, the offshore generation will need to compete with the connecting markets in order to ensure that it is in the merit order and dispatched – pursuant to the principle of marginal pricing and the market coupling process, one which has worked well for the onshore electricity markets for years.

However, this provides challenges for offshore generators. Stakeholders have raised concerns, also been recognised in supporting studies for the Commission, that because the offshore bidding zone price will be dependent on the demand of its connected markets, the price will be volatile, revenues may be lower and the volumes to be sold more uncertain. It is also true that these are significant long-term investments and additional risks, such as price volatility and uncertainty about the evolution of negative price periods can increase overall project costs and reduce the attractiveness of such projects for investors. Any support schemes for offshore hybrid projects should take this into account. It is necessary to separately approach the rules for a functioning electricity market, which apply to all, and schemes to support certain forms of energy production through state-aid.

4) Networks and connection regimes

It is important to recall that the elements discussed above cannot be considered in isolation. The European market framework is a mix of rules set at EU and national level, the combination of which will determine the overall environment for renewables in that Member State. For offshore hybrid projects, network planning and the interaction of the tariff design with national support schemes are particularly relevant.

The social welfare benefits in developing hybrid assets and considerably scaling up offshore renewable energy with more meshed offshore grids may not be fully realised unless the onshore *network planning and deployment* can keep up with the pace of offshore developments. It will be crucial to bring the electricity onshore to strong, well-connected parts of the grid and ensure that the reinforcements to the onshore network allow the offshore renewable electricity to be transported from the coast to consumers. Well-designed onshore and offshore bidding zones that are aligned with structural congestion in the grid should be ensured and they may also provide investment signals for power-to-gas installations or incentives for large consumers to locate near the coast to benefit from lower electricity prices.

The *tariff design* and the charges to which generators are exposed, including for connection, are also essential for the overall business case. The tariff design should provide the incentives for efficient network use but also need to ensure the financing and cost recovery of the grid connection. Currently, there are significant differences between the relevant tariffs and charges, which could hamper cooperation between Member States in joint cross-border projects. There are broadly three types of connection charging regimes: ‘deep’ connection charging (generators pay for the cost of their connection to the nearest grid as well as the cost of reinforcements), ‘shallow’ connection charging (generators only pay for the connection to the grid, while the TSO pays for reinforcements) and so-called ‘extra shallow’ charging (TSO pays for both connection and reinforcements). What is apparent is the strong link between the socialisation of certain costs through grid connection regimes and the clearing price of renewables auctions across Member States. Those with deep connection charging have higher bidding prices than those with shallow connection charging This is because consumers do not pay for the connection and this cost is internalised by the developers into their bid.

The advantages of a deep charging regime could be a lower risk that the connection is not provided on time through better coordination and sequencing from the developer. In addition, for joint projects by Member States, more of the total cost is internalised in the project which may make cost sharing easier. On the other hand, a shallow charging regime has the benefit that the network connection can be written off by the TSO over a longer period and the cables can be re-used for future projects.

Assuming that cost-sharing arrangements can be solved between NRAs, shallow charging may fit better overall to areas that use pre-developed or clearly designated sites for offshore projects, whereas deep charging could be better for systems where developers have a choice of sites and incentives to consider the network cost impact of different sites could be beneficial. What is clear is that strong coordination of national policies on tariffs and charges by NRAs will be needed to enable these projects to come forward. Currently, the rules at EU level on these elements are very limited, and a harmonisation would require a voluntary alignment of national rules for the offshore bidding zone.

III. Possible adaptation of EU market rules

a) Congestion Income

Congestion income is the price differential between markets that TSOs receive as income. This income must be spent on the priority objectives of reducing congestion by maintaining or increasing interconnection capacity in accordance with Article 19 of the Electricity Regulation. In the case of renewable electricity projects in offshore bidding zones, the value of a hybrid asset is split between the electricity market revenues and congestion income.

In a more integrated meshed grid that supports competition and price convergence, it is currently unclear how the levels of congestion rents will evolve. For example, there is a high correlation of wind generation in northern Europe and, at these times, electricity prices in Europe in general would tend to be lower. However, it is clear that in an offshore bidding zone configuration, there will be a redistribution of parts of the revenue from offshore electricity generators to transmission system operators. The extent of this depends on the topology of the project and, for more than half of the projects, the redistribution is expected to be less than 1 % of total revenues, but for a small share of projects, this can rise up to 11% of revenues[23]. This effect needs to be addressed to ensure that the total value of viable hybrid projects can be captured and that the incentives are aligned to encourage these projects where they are beneficial to society. An amendment to the rules on the use of congestion income, for example opening up the possibility for Member States and NRAs to allocate them to renewables producers active in an offshore bidding zone, could ensure that hybrid assets are no less attractive for a renewables investor. There are three main benefits to this approach: it

[23] *Market Arrangements for Offshore Hybrid Projects in the North Sea* (Thema Report 2020-11).

could reduce the level of subsidies needed through support schemes, it could enable a transition for generators to market participation once the support scheme has ended and it could limit the need for support schemes entirely by enabling projects to come forward in a market-based way.

A further risk to note in the context of hybrid projects is that if the offshore generation was expanded but the corresponding interconnection cables are not built to schedule, this would mean limited interconnection capacity, and the offshore price could be close to zero until this congestion is relieved. In these cases, the congestion income would be very high for a temporary period resulting in a type of redistribution from generation to TSOs. Where those congestion rents are used to increase the missing interconnector capacity, they address the core of the issue, thereby helping with the integration of offshore wind. However, interconnection projects can also incur significant delays for various reasons.

For these reasons, granting some flexibility by way of a legal revision of the rules on the allowed use of congestion rents, to enable a partial transfer of congestion income for hybrid projects will be explored further by the Commission. Possible approaches to this include changes to Financial Transmission Rights, Auction Revenue Rights or support scheme design, as outlined in supporting studies for the Commission[24]. The Commission has not concluded on this issue. However, a partial transfer of congestion income could strike a good balance to encourage market-based investments and still ensure that TSOs are remunerated for making the interconnection capacities available for trade. Therefore, the Commission will put forward a proposal for this purpose as early as possible.

b) Technical Connection Requirements for offshore HVDC grids

The EU framework for connecting to the electricity grid is set out in three Network Codes: the Requirements for Generators (Commission Regulation 2016/631), the Demand Connection Code (Commission Regulation 2016/1388) and the Network Code on High Voltage Direct Current Connections (Commission Regulation 2016/1447). One of the key findings from the PROMOTION study is that the Codes were written with the onshore network mostly in mind and that even the HVDC Network Code focuses on supporting the onshore AC grid rather than an interface with an offshore DC electricity grid. Therefore, one of the recommendations of the study is to streamline the technical connection requirements for generators and HVDC cables in order to speed up the connection of offshore projects where multiple parties and Member States are concerned.

The current EU framework allows a lot of national flexibility for TSOs to define requirements. In a study conducted on behalf of the Commission, Tractabel analysed these requirements with a view to creating a best practice for technical connection requirements for

[24] THEMA Consulting has suggested ways that this could be addressed in research conducted on behalf of the Commission. *Market Arrangements for Offshore Hybrid Projects in the North Sea* (Thema Report 2020-11).

offshore HVDC grids in the North Seas region[25]. Where justified, common requirements for certain elements were proposed. This study can be a useful tool for Member States and TSOs when considering the specifications of common projects.

Additionally, it would be beneficial for the deployment of offshore renewables projects across the EU to amend the Network Codes and set common EU standards for some technical elements. There are Expert Groups currently working on amendments to the Grid Connection Network Codes[26] as part of the ongoing work in the Grid Connection European Stakeholder Committee. The Commission will pass the results of this study to relevant experts to ensure that the findings and recommendations of this report are considered in the amendment process.

IV. Conclusions

Offshore renewable energies can be scaled up in a way that is compatible with EU legislation. It is paramount to do so in line with existing EU legislation to achieve the goal of delivering a decarbonised electricity market that is flexible, integrated and secure at least cost to consumers.

In the future, offshore renewable energy projects are expected to play a significant role in achieving our climate neutrality target. These projects are expected to be built in a mix of ways – through both single radial connections and hybrid projects that are connected to more than one market.

In the case of hybrid projects, establishing an offshore bidding zone is the best way to integrate these projects into the electricity system. In the short-term, an offshore bidding zone ensures that electricity can flow to where it is most needed, ensuring that offshore renewables contribute to regional security of supply. In the medium to longer-term, they also provide price signals to incentivise the development of storage and other offshore demand. An offshore bidding zone is more efficient overall, reduces the need for costly TSO corrective actions such as redispatching and countertrading and keeps costs down for consumers.

However, it should also be acknowledged that although this model is more efficient, it affects the risk borne by project developers and trading revenues may be lower due to increased competition. This risk could be accounted for in well-designed support schemes for hybrid projects. Furthermore, hybrid projects can have a redistributive effect on incomes and, depending on the topology of the projects, can lower trading revenues while increasing congestion income. To ensure that there are no structural impediments to viable hybrid projects coming forward in a market-based way, the Commission will consider changes to the rules on the spending of congestion income.

[25] *Technical requirements for connection to HVDC grids in the North Sea* (Tractabel Report 2020-11)
[26] https://www.entsoe.eu/network_codes/cnc/expert-groups/

The governance arrangements required for offshore bidding zones are possible under today's legislation and would flow from the individual projects – ranging from a simple extension of national TSO and NRA tasks to more complex multilateral arrangements. Looking further ahead and beyond the deployment of the first hybrid projects, for complex meshed grids, the delegation of TSO tasks to one responsible TSO – including bidding zone management and operational security – or the creation of an ISO could be an efficient and strategic regional initiative to ensure the optimal planning and operation of the offshore grid. However, this is not a prerequisite. Multilateral governance arrangements with a clear allocation of tasks and oversight, agreed by relevant Member States, NRAs and TSOs can be defined under existing legislation and work well, as seen from experience today in the existing electricity market.

Finally, it is important to highlight the links with elements of national law and policy and note that the efficiency of network planning and the socialisation of project costs like connection and site surveys all contribute significantly to the investment case for projects and overall costs of offshore renewable energy deployment. The Commission will work with the Grid Connection Electricity Stakeholder Committee to check that the Grid Connection Network Codes are suitable for the deployment of more meshed and complex offshore projects.

In conclusion, the creation of offshore bidding zones for hybrid projects provides the right framework for a massive upscale in offshore renewable energy, allowing this electricity to become the backbone of our system as we move towards our 2050 climate neutrality objective. It provides the certainty required for these long-term projects and strong investment incentives for the further development of offshore demand, such as storage and the production of hydrogen from green electricity.