FLOATING OFFSHORE WIND ENERGY

A POLICY BLUEPRINT FOR EUROPE

EXCUTIVE SUMMARY

Floating offshore wind (FOW) is a fast-maturing technology with the potential to cement Europe's leadership in renewables globally. European companies are the pioneers as **they lead three quarters of the 50+ FOW projects at different stages of development worldwide today**. Floating offshore wind can extend the frontiers of innovation in renewable energy technologies, however dedicated policies are needed to make it a European success story.

Europe should capitalise its first mover advantage. **FOW needs urgent action from the EU and Member States** to maximise the local economic benefits of a nascent supply chain. These should ensure that cost reduction continues through economies of scale, low financing costs and Research & Innovation (R&I) funding.

This paper sets the policy blueprint needed for FOW in Europe to 2030. It draws from the Industry Vision Statement published in 2017 and the rapid developments in technology and policies worldwide that have occurred since. It describes why FOW needs action from policymakers and projects cost reduction pathways, measured as the levelised cost of energy (LCOE). And it sets out the vast potential and economic opportunities at stake for Europe by developing this industry.

What can policymakers do? - European policy blueprint for floating offshore wind to 2030

1. Member States should set their ambitions for capacity, project pipelines and supporting policies for FOW in their National Energy and Climate Plans (NECPs) to 2030
2. The European Commission should publish the aggregated European volume of FOW projects to 2030 to enable a clear market visibility for investors and industry
3. Member States should coordinate their schedules of deployment and supporting policies for FOW in order to maximise regional cooperation in the development of a European supply chain
4. The EU should earmark funding instruments targeted to provide access to low cost financing for FOW projects and increase the funding to Research and Innovation focused on cost-competiveness
5. The EU should dedicate cohesion funds to support coastal areas and regions upgrading its infrastructure to facilitate FOW development.

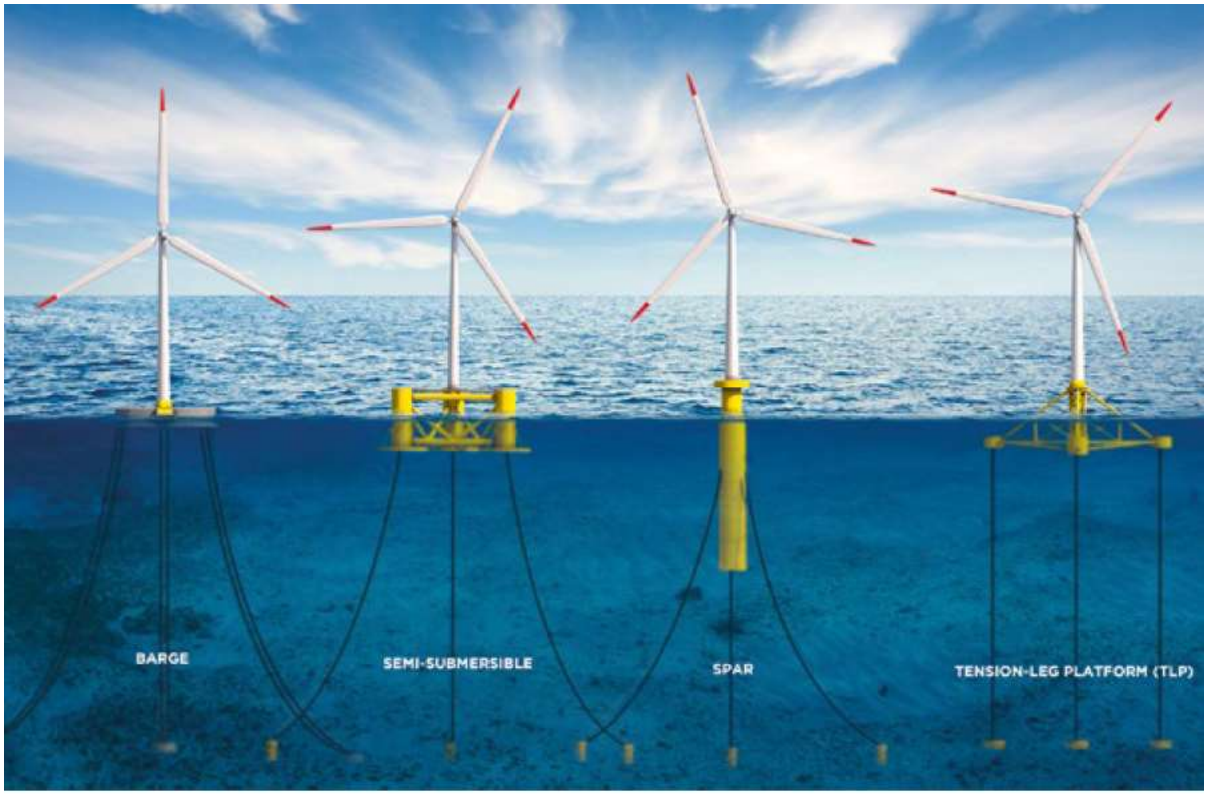
1. REAP THE POTENTIAL: EARLY ACTION FROM POLICYMAKERS PROMISES SOCIETY WIDE BENEFITS

FOW needs urgent action from policymakers as this can unleash large-scale commercialisation and deliver the clean, competitive and reliable energy society wants. As demonstrated this last decade with bottom-fixed offshore wind, speeding up commercialisation means driving down costs and contributing to European competitiveness. Policy action should focus on removing hurdles to FOW development.

1.1. Unleashing large-scale FOW commercialisation

FOW is becoming a fast-maturing technology with the potential of cementing Europe's leadership in renewables globally. From a niche technology, the industry made a significant step forward in 2017 when Equinor (former Statoil) commissioned the world's first multi-unit FOW farm in Scotland. Ideol followed immediately with the first FOW turbine installation in France. Equinor's project, called Hywind II, comprises five 6MW wind turbines mounted on a spar buoy substructure. Ideol's patented concept is called Damping Pool®, a barge variation. 2016 witnessed also the first decommissioning of a floating turbine off the coast of Portugal, after a successful 5 year demonstration. After dismantling, the Windfloat foundation technology from Principle Power (a semi-submersible type) is now being prepared to be re-used in a pre-commercial project off Scotland. These are some examples out of the four main design types available for FOW competing today for pre-commercial success Currently in Europe there are 4 FOW projects in operation including 3 demonstrators and one pre-commercial farm (see table 2 in annex for a list of ongoing demonstration projects).

Figure 1 FOW design concepts



European companies benefit from a worldwide recognition in terms of FOW. They lead three quarters of the 50+ FOW projects at different stages of development worldwide today. In Europe, at least 6 pre-commercial projects are expected to be commissioned in the coming two years. And at least 11 pre-commercial projects should be in operation within the next 5 years. The main markets in Europe currently include France, Spain, Portugal, Ireland and the UK. All of which have large, deep territorial waters, significant wind resources offshore, high population and industrial activity near the coastline. These conditions make them suitable to lead the development of FOW.

Table 1. Announced pre-commercial FOW projects in Europe (to be commissioned within the next 5 years)

Wind Farm Name	Country	Capacity (MW)	Commissioning date
Hywind Scotland	United Kingdom	30	2017 (in operation)
Windfloat Atlantic	Portugal	25	2019
Flocan 5 Canary	Spain	25	2020
Nautilus	Spain	5	2020
SeaTwirl S2	Sweden	1	2020
Kincardine	United Kingdom	49	2020
Forthwind Project	United Kingdom	12	2020
EFGL	France	24	2021
Groix-Belle-Ile	France	24	2021
PGL Wind Farm	France	24	2021
EolMed	France	25	2021
Katanes Floating Energy Park -Array	United Kingdom	32	2022
Hywind Tampen	Norway	88	2022

In the coming years as FOW projects come online, the industry will demonstrate their commercial viability of such projects. During this critical phase, a strong supportive regulatory framework is needed to capitalise on all past and ongoing R&I and pilot project investments. Policymakers should put in place supportive policies and measures to stimulate FOW growth and full commercialisation.

1.2. FOW offers significant benefits for Europe

Supporting FOW growth through policy will help unlock new areas for renewable energy generation. FOW is a natural complement to bottom fixed offshore wind, in which Europe is the undisputed leader, and is comes with significant cost reduction potential. it creates new businesses and export opportunities, creating local jobs and impacting local marine infrastructure.

FOW unlocks new renewable energy potential. Around 80% of the offshore wind resources is located in waters of more than 60 meter depth, where bottom-fixed offshore wind (BFOW) is not economically attractive. In addition, average wind speeds are higher and more consistent further from shore. This means floating offshore wind farms can produce more energy throughout the year and have high capacity factors. In addition, FOW opens new markets at home (France, Norway, Spain and Portugal) for the offshore wind energy industry or enables the harnessing of great wind resources in shallower

waters (as low as 30m) where the seabed quality makes bottom fixed offshore wind economically unviable.

Figure 2. Hywind Project in Scotland, Picture credit: Equinor

FOW is a natural complement to bottom fixed offshore wind. There are many synergies between the two technologies, notably regarding turbine design, structures and construction. Realising the potential of FOW will generate more economic opportunities for the entire wind energy supply chain, and in turn create new jobs. Europe is the undisputed leader in bottom fixed offshore wind. FOW is the logical long-term future of Europe's offshore wind energy.

FOW creates new businesses and export potential. FOW will need to carve out its own specific supply chain in particular when it comes to the mooring and electrical cabling systems as well as the offshore installation works. It will also drive the need for new innovative technologies and installation procedures to continue cost reductions.

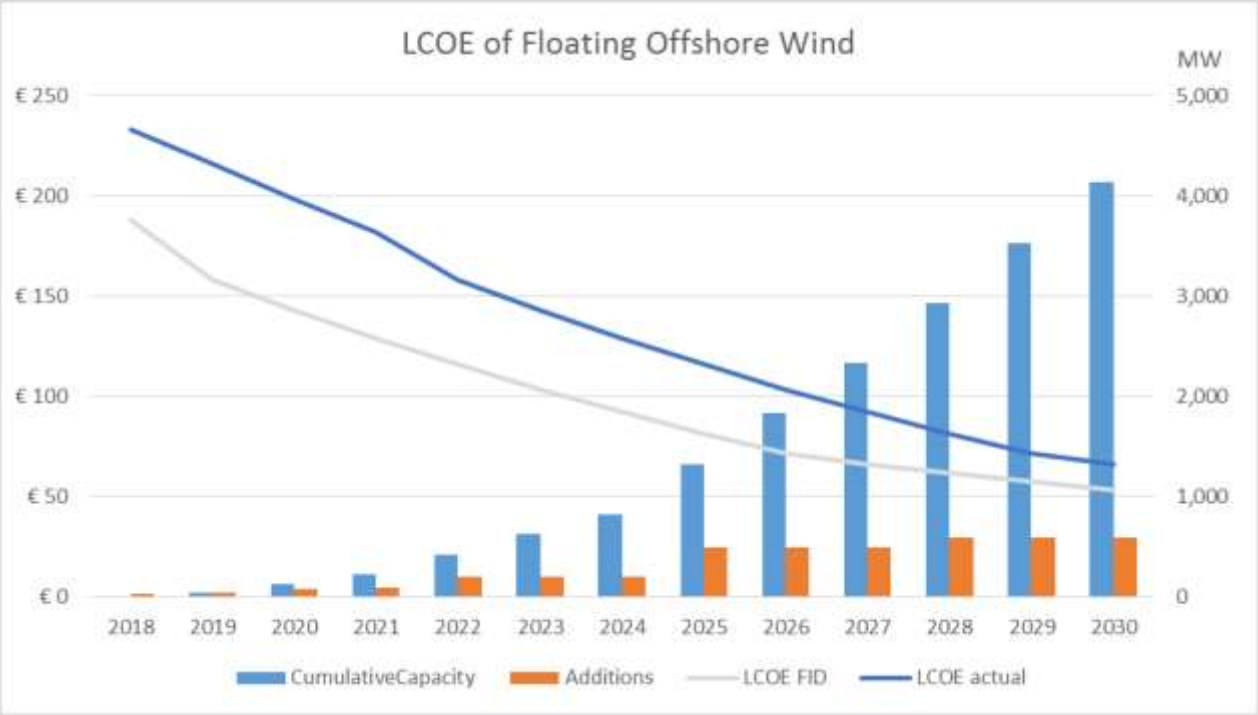
FOW impacts local marine infrastructure positively. It would increase local economic activities in ports and would support job growth in all marine industries at a local, regional and national level. Most floating designs enable manufacturers to perform big operations (maintenance, repair and installation) at ports, be it dry-dock or in the harbour itself. Smaller secondary harbour facilities are perfectly suited for developing the sector too. Industrialised coastal regions affected by the decline in shipbuilding stand to gain the most from investing in floating wind, as they can convert their existing infrastructure.

FOW has some specific costs advantages compared to BFOW. It requires less operations taking place at sea compared to BFOW. The installation process is less dependent on weather, soil and sea conditions, but requires the right infrastructure. Developers can assemble and pre-commission wind turbines onshore and tow the entire unit to the site offshore. This means that the assembly takes place in a much safer and more controlled environment. Once at sea operators have the option to tow back the turbines to port when large operations are required (e.g. blade replacement), thus facilitating the operation & maintenance of FOW farms.

1.3. Unleashing FOW will accelerate its path to cost competitiveness

Today FOW remains more expensive than bottom fixed offshore wind given its early stage of development. However, with the right conditions, FOW could potentially decrease costs at an even greater speed than bottom fixed offshore wind. The latter has delivered remarkable progress in only three years. Bottom Fixed offshore wind has gone from 150 €/MWh in 2014 to 65 €/MWh in 2017.

Figure 3 - FOW cost reduction pathway



The cost of FOW in Europe steaming from operational projects today is in the order of €180 to 200/MWh for pre-commercial projects. While these are generally small-scale projects, larger scale projects would bring technology learning effects and reduce the capital expense. Industry expects the costs to reach €100-80/MWh for the first commercial scale projects using existing proven technologies and reaching final investment decision (FID) between 2023 and 2025. During that period FOW would pass 1GW of cumulative installed capacity in Europe and projects financed at that point could be online within 3 years. Costs are expected to decrease even faster at "mature" commercial-scale, reaching €40-60 /MWh by 2030 given the right visibility in terms of volumes and industrialisation.

1.4. Key challenges

Floating offshore wind projects start to attract certain investors today but clearly do not have access to the significant amount of capital and financing conditions enjoyed today by BFOW. Pre-commercial FOW projects require investments of several hundred million euros. They are typically developed by start-ups and SMEs for whom bringing investors on board is often challenging. So far, only a couple of players have been able to attract private equity investments. FOW projects backed by large players from the wind energy sector will have better chances to come to market.

FOW uptake depends on the availability of suitable port and grids infrastructure across Europe. The economics of FOW are largely defined by the amount of operations that can take place in the ports. And most of Europe's ports are not configured to handle FOW today. Converting old industrial harbours to develop FOW requires significant political support at national, regional and European level. Crucially, private investors and local authorities would only invest if they have visibility on project volumes and clear pipelines of business opportunities. Last, grid connection is a challenge for the entire offshore wind sector. The distance to shore and the availability of networks at the point of connection are a bottleneck hampering both FOW and bottom fixed offshore wind.

FOW cost reduction needs targeted R&I in mooring solutions, electrical cables and grid connections. The installation and hook-up of the mooring system and the dynamic electrical cable is a crucial part of the installation process in FOW. Industry needs to reduce the cost of such key components as well as the related offshore operations. Designing the right electric infrastructure for FOW is equally challenging. The movements of the turbine and the floating substructure increase the load on the dynamic section of the cables. Monitoring the aging of these components under cycling loads and marine growth can significantly contribute to cost reduction through lifecycle management. In waters deeper than 100m it is difficult to fix the array cables to the seabed. Different solutions of Electrical substation (fixed, floating, underwater) need to be investigated. Industry needs more R&I to find solutions to overcome these challenges, such as Joint Programming Initiatives dedicated to FOW.

Figure 3. Floatgen Demonstrator, France, Picture credit: Ideol

2. EUROPEAN POLICY BLUEPRINT FOR FOW - WHAT CAN POLICYMAKERS DO?

2.1. Ensure Member States set out FOW volumes in their National Energy and Climate Plans to 2030

The EU has agreed a 32% renewable energy target in final energy demand by 2030. This target means that renewables would meet around 55% of electricity by 2030. Wind energy would meet the lion's share of such renewable electricity with around 30%, out of which offshore wind could meet up to 7%. Offshore wind would increase its capacity five-fold from today, with FOW taking off significantly, from 36 MW today to 4-5GW, provided that the right policies are adopted.

Member States are mandated to produce detailed plans on how they will contribute to the EU-wide renewable target, including deployment volumes per technology, as part of their National Energy and Climate Plans (NECPs). In parallel, the recently agreed post-2020 Renewable Energy Directive mandates Member States to set a clear schedule of renewable energy auctions providing at least three years' visibility.

FOW should feature in these National Energy and Climate Plans. **Member States should set out their physical potential for developing FOW, ambitions on capacity, project pipelines and supporting policies for FOW in their plans to 2030**. This would enable the European Commission to aggregate all Member States' plans and provide long-term visibility of projects at European level. The NECPs should also include the envisaged actions with regards to the Clean Energy for EU Islands[1] initiative. FOW could be a competitive solution to reduce energy costs, pollution and energy dependency on European islands.

Once the European Commission approves the National Energy and Climate Plans, Member States should enshrine supportive measures in national legislation to provide the certainty of a stable regulatory framework.

2.2. Communicate the EU-wide FOW ambition to 2030

The lack of long-term visibility for planning investments and business plans is particularly challenging for FOW in Europe. This increases financing costs as investors perceive higher risks in the long-term prospects of the technology. While Member States should provide the regulatory certainty stemming from their NECPs, the EU should communicate the long-term overall ambition in FOW. The US, China and Japan have done so, announcing significant investment programmes and/or capacity goals already. This has sent a powerful signal to investors in those countries on the outlook of FOW. Japan alone has invested over €1 billion in five demonstration projects and one floating substation. In April 2018, it announced the construction of a large commercial-scale FOW project by 2023, a world's first. To date, only France has earmarked €300m to support four pilot projects and plans to run a commercial-scale tender in 2019. The Norwegian government is set to unveil two sites for floating offshore wind plants later this year. However, there is no EU strategy embedded in any of these plans.

[1] The EU's Clean Energy for EU Islands initiative provides a long term framework to help islands generate their own sustainable, low-cost energy. Communicated by the European Commission in 2017, it forms part of the Clean Energy Package.

Therefore the European Commission should:

- **Evaluate the physical-geographical potential for maritime wind power** as indicated in the National Energy and Climate Plans in Europe.
- **Publish the aggregated European volume of FOW projects to 2030** and the associated measures to support its deployment. This would give a clearer visibility on Europe's plans for the technology and build the market confidence needed to invest in projects, the supply chain and the associated infrastructure for FOW.
- **Produce a digital platform** with an open access database that compiles information on energy infrastructure needs, indicate potential FOW project locations, their physical-geographic conditions and FOW ambitions from all Member States (based on the National Energy and Climate Plans).

That information would allow for deployment and supporting measures are targeted and coordinated.

2.3. Coordinate auction schedules and supporting frameworks

Kick starting a new supply chain requires detailed planning across many parts of the economy. From suppliers' manufacturing capacities to port infrastructure upgrades, from maritime vessels development to grid connections expansion. All this creates significant economic activity. Europe should not do this with a piecemeal approach. The scale of investments would be larger if every country develops its *own* FOW strategy.

Member States should coordinate their schedules of capacity deployment and supporting policies for FOW. They should do this in two steps: first, during the preparation of their NCEPs and second, once the European Commission has assessed whether the individual contributions add up to the EU-wide renewable energy target.

The European Commission should support this bottom-up cooperation and help to identify where projects could benefit from economies of scale coming from larger auction volumes. It should look into possibilities of clustering projects in order to run larger auctions and to plan for grid development. It should also make use of the EU Marine Strategy Framework Directive, which already outlines four possible regions suited for cooperation[2]. In this sense, the EU should already include FOW in the discussions of current regional cooperation initiatives, like the North Seas Energy Cooperation, the Baltic Energy Market Interconnection Plan (BEMIP) and the Energy Islands Initiative. These fora are connecting Member States and industry to discuss harmonisation of maritime spatial planning and permitting, support frameworks and technical standards. FOW should be addressed in these discussions as well.

Crucially **the European Commission should populate an EU-wide calendar of auctions for renewable energy highlighting large FOW project opportunities**. Particularly for projects over 200MW, this would be very important as they could enable the first signs of industrialisation of the supply chain. Regional cooperation should also enable unlocking such minimum scale for projects.

Last, Member States should involve industry in their FOW planning and in their efforts on regional cooperation. A close dialogue with stakeholders is the best means to tap into its potential and anticipate solutions to unlock growth.

[2] These are the Baltic Sea, the North-east Atlantic, the Mediterranean Sea and Black Sea

2.4. Earmark EU funding instruments for FOW

The large-scale deployment of commercial FOW projects will require a combination of public and private investments. Setting the regulatory framework, providing the market visibility and coordinating the deployment are the stepping-stones of a policy blueprint which should include access to low cost financing. This is crucial for pre-commercial and early commercially viable projects, as these pioneer underdeveloped markets and undertake higher risks.

The European institutions, and in particular the European Commission and the European Investment Bank (EIB) can play a decisive role in facilitating such financing. **They should earmark funding instruments targeted to provide access to low cost financing for FOW and increase the funding to R&I focused on cost-competiveness of key components and sensitive offshore operations.**

In particular, the EIB should increase its footprint in financing FOW projects and the associated infrastructure for their deployment. And the EU should set guidelines to the EIB reflecting this mandate. This would improve the bankability of FOW projects as it could attract a larger pool of investors driven by the lead from the EIB. Moreover, it should be easier for Member States to access EU instruments to finance infrastructure upgrades needed for FOW, such as modernisation and expansion of ports and other civil works like dredging for subsea cables. Member States which are cooperating regionally in FOW should have easier access to such instruments.

While the EU should consider such financing instruments to 2030 and beyond, industry urges the European Commission to support FOW with the programmes already running up to 2020. These include the European Structural and Investment Funds (ESIF), the European Regional Development Fund (ERDF) and the Cohesion Fund support regional cooperation.

Finally, the EU should earmark a dedicated budget for large-scale FOW in the upcoming Multiannual Financial Framework in the InvestEU programme, the Innovation Fund and Modernisation Fund. Horizon Europe should continue investing in all offshore wind energy R&I, ranging from fundamental research to pilot demonstrations. Some good examples include the specific joint Action call under the PCP Wave energy[3] in Horizon 2020 and the ERA-NET co-fund dedicated to FOW.

Table 2 Demonstrators FOW projects in Europe

Wind Farm Name-	Country	Capacity (MW)	Commissioning date
SeaTwirl S1	Sweden	0.03	2015 (in operation)
EOLINK	France	0.1	2018 (in operation)
Floatgen	France	2	2018 (in operation)
TetraSpar	Norway	3.6	2019
FLOWocean Demonstrator	Norway		2019
DemoSATH	Spain	2	2020

[3] PCP Wave Energy: http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/lc-sc3-ja-3-2019.html