Multiple-uses of offshore wind energy areas in the Belgian North Sea

WindEurope

Bibliography review and recommendations for the implementation of the Maritime Spatial Planning 2020-2026

Tender DG5/MM/HV/18011

FPS HFCSE – DG ENVIRONMENT, Marine Environnent Unit

WindEurope

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This document is the Final Report for the tender DG5/MM/HV/18011 from FPS HFCSE – DG ENVIRONMENT, Marine Environment Unit regarding multi-uses of offshore wind energy areas in the Belgian North Sea.

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Executive Summary

This study assesses the feasibility of co-location options in wind farms in the Belgian Part of the North Sea (BPNS). WindEurope analysed more than 90 scientific articles and project reports through an extensive literature review covering most of the countries with offshore windfarms in Europe. We also analysed national regulations governing the use of the seas in two neighbouring countries, the United Kingdom and the Netherlands. The objective is to provide guidance on how these countries address multiple-uses of their territorial waters. Finally we incorporated into our research input from several stakeholders active in the BNPS. This report provides a summary of our findings and a list of recommendations to exploit multiple-uses. These recommendations are specifically addressed to the Belgian government and other Belgian stakeholders, including private sectors and NGOs. In particular, collaborative approaches among these players are key to facilitate the implementation of multiple uses options in the BPNS.

Co-location means the share of the space among different users or activities. In most countries, offshore wind farms represent a no-go area. With the increasing density of activities along the coasts and expansion of the offshore wind energy sector, government can allow different activities to take place within windfarms as tool to solve spatial conflicts and increase the functionality of the seas. Throughout this report we refer to co-location, multiple-use and multi-uses with the same meaning.

The following activities were found to be feasible for co-location with offshore wind energy:

Aquaculture

There is good scientific evidence on the technical feasibility of combining offshore wind energy and aquaculture activities. We identified 5 projects and initiatives and more than 30 scientific articles reporting experiments and pilots on this topic funded by both, public and private sectors. The bibliography review concludes that technical, environmental and economic factors need to be consolidated at larger scale through new pilot projects, while social, legal, and policy factors must be facilitate by governments in order to minimise risks and support commercial deployment.

We recommend to:

- *Promote research and pilot test in order to consolidate technical knowledge. This will allow to decrease the risk of liability in case of damage or accidents;*
- *Explore potential regulatory frameworks to simplify the permitting procedures and allow to reduce costs;*
- *Promote sustainable aquaculture, ensuring a nature inclusive approach to maximise the positive environmental effects.*

Nature conservation and restoration

Wind farm construction and operations have negative environmental impacts that must be addressed properly. However, wind farms also provide positive environmental effects. First of all, the installation of a windfarms causes the ban of all seabed-disturbing activities in the area representing a fundamental preventive measure. Once the human pressure on the benthic habitats is reduced or eliminated, active seabed restoration measures might be applied in the area, such as active oyster bed restoration. In addition, the colonisation of benthonic species in wind turbines is often accompanied by the increase of fish population, mainly due to the advantages of food and shelter from fishing pressure that the windfarms offer. Positive impacts and nature-based approached should always be promoted. Wind farms monitoring protocols and scientific research programmes contribute to documenting real environmental risks and help in filling in knowledge gaps that would in exchange better inform regulators during the consenting processes.

We recommend to:

- *Plan wind farms as preventive tool to reduce human pressure on benthic habitats;*
- *Complement wind farms deployments with active seabed restoration actions;*
- *Promote positive environmental effects, such as the artificial reef effect or biodiversity increase;*
- *Promote collaborations with windfarms operators in environmental monitoring actions, research and innovation, data sharing and implementation of latest technology available.*

Other energy sources

Combining wind with other forms of energy generation, such as wave and tidal energy or with energy storage, could accelerate the development of these less mature technologies. Different solutions are available to combine wave converters and wind turbines, ranging from co-located (independent or combined arrays) to hybrid systems. Co-location is clearly the easiest to implement while also delivering the benefits of sharing permitting, construction, grid connection and O&M costs. In addition, if demonstration projects are facilitated in the North Sea, manufacturing, assembly and maintenance activities will cluster close to the coast, and will serve as a base for future offshore energy activities. This will allow Belgium to translate its wind-wave potential into local jobs, manufacturing activities and exports. However, the wave potential in the southern North Sea needs a more mature technology to become economically viable. Devices able to exploit a considerable amount of energy from short waves are still under development and demonstrators are needed to develop a business case in the BPNS.

We recommend to:

- *Promote pilot tests of co-location options to consolidate the wave technology, allowing governments to gather evidence and design a dedicated framework;*
- *Support research and innovation actions to increase knowledge on synergies between the energy systems and cumulative environmental effects;*
- *Promote the established Belgian Supply Chain which is key to create local value;*

Passive Fishing and navigation within wind farms

Synergies could be created between the energy and fishing sector. When allowing fisheries and other users to navigate within wind farms, access rules will have to be re-designed. Ensuring coherence and appropriate navigation risk assessment is crucial to avoid inefficiencies, such as ships redirected to more congested routes. In addition, health and safety issues as well as national security strategies need to be carefully developed to ensure the maximum efficiency of the sea and safety of the marine users. It is essential that all long-term options for multiple-uses are presented at an early stage in the planning process and discussed systematically. Communication and involvement in the decision making process are also very effective tools in dealing the relations among different sea users.

We recommend to:

- *Collaborate across stakeholders in activities such as sharing data or information;*
- *Learn from experiences from other countries (UKs and the Netherlands, in particular) to understand and overcome issues between the sectors;*
- *Align rules, strategies and objectives with neighbouring countries to unsure the functionality and efficiency at sea-basin level;*
- *Collaborate to develop appropriate navigation risk assessment, requirements and conditions for marine users to navigate in certain areas;*

The recap table below (page 9 and 10) offers an overview of state of play, drivers, main case studies and direct links to the respective sections within the document.

	STATE OF PLAY	DRIVERS	MAIN CASE STUDIES	MORE INFO
Aquaculture	Aquaculture within offshore wind farms is an option that is gaining the interest of the public and private sectors. While technical solutions are being fine-tuned through pilot projects, there is still the need to develop an adequate regulatory framework and provide business cases. This will allow aquaculture to reach full commercialisation. Different assessments in the North Sea showed the feasibility of co-location options. Business cases are currently under development. The most suitable species are bivalve, oysters and seaweed.	Secure renewable energy generation while increasing food security, employment and local production. Sharing assets, permitting and O&M could enable private cost savings and boost the synergies across the two sectors. Multi-trophic and sustainable aquaculture could be implemented as a means to boost the positive environmental effects.	The Mermaid project designed multiple-use concepts for four European basins and developed a roadmap for multi-use options, with a particular focus on mussel aquaculture. The Edulis project is the pilot test for offshore mussel culture in a wind farm. The consortium was a mix of public and private entities. The project assessed technical, economic and environmental feasibility of mussel cultivation within the C-Power farm in the BPNS.	State of Art: 2.1 Potential Uses: 3.1 Mermaid, Edulis, MUSES, Space@Sea Factsheet Sources
Nature conservation and restoration	Windfarm construction and operation can have impacts on environment and wildlife that must carefully avoided, mitigated or compensated. But wind farms can also act as areas of nature conservation and restoration. The ban of seabed-disturbing activities within wind farms serves as a preventative measure, as it reduces human pressure on benthic ecosystems. Pilot studies are showing how the ban of seabed disturbing activities offers opportunities for active seabed restoration (e.g. oyster-reef) and can thus improve site-specific environmental conditions.	It is a priority of any Member State to ensure the co-existence of climate and nature objectives. Co-location options must be investigated and promoted. Wind farms could provide positive environmental impacts: biodiversity increase is often observed around wind turbines due to the introduction of the artificial substrate, and is often accompanied by an increase in fish population due to the advantage of food and shelter that wind farms offer.	In the Netherlands, the Ministry of Economic Affairs established, with the support of partners such as Wageningen University, WWF and Ark Natuur, among others, is managing the Dutch Flat Oyster Consortium (POC). At international level, the Native Oyster Restoration alliance (NORA), established in 2017, promotes international networks and supports restoration projects across the EU and beyond (an overview of the projects is available at NORA's website).	State of Art: 2.2 Potential Uses: 3.2 Benthis, MUSES, Space@Sea, EOWDC, ORJIP, WOZEP Factsheet Sources
Other energy Sources	Many research studies and pilot projects, led by public and private sectors, have brought ocean energy technologies to a pre-commercialisation phase. Combining offshore wind with these could support faster research and development of wave and tidal technologies. Different solutions are available to combine wave converters and wind turbines, ranging from co-located (independent or combined arrays) to hybrid systems. Co-location is clearly the easiest to implement while also delivering the most benefits.	Different offshore generators would have the possibility to share the grid infrastructure, logistics, operations and maintenance. With a proper design, other sources of energy and wind energy could enhance the shadow effect and reduce overall environmental impacts. Energy generation diversification can enable a more stable stream of electricity and increase production in terms of MW/km^2.	The MUSES project provides an understanding of environmental, spatial, economic & societal benefits of co-location and highlights inappropriate regulatory, operational, environmental, H&S, societal and legal aspects. The combination of different energy sources is considered in some of the case studies. Several studies assessed the feasibility of co-locating different sources of renewable energy or combining them with storage. This information is available in Sources.	State of Art: 2.3 Potential Uses: 3.3 Tropos, Mermaid, MUSES Factsheet Sources

	STATE OF PLAY	DRIVERS	MAIN CASE STUDIES	MORE INFO
Passive Fishing	Bottom trawling represents the most common fishing technique in European seas. Due to the high risk of interference with subsea cables and related infrastructures, bottom trawling is often banned within wind farm areas. In addition, recent trends are promoting seabed-friendly fishing techniques to increase the environmental conditions of the sea. Benthic habitats and fish stocks are heavily affected by the current trends of bottom trawling across EU. Encouraging opportunities of co-existence between fisheries and wind farms is crucial. Many countries (UK, FR, and NL, among others) have established channels for involving the two sectors in the decision-making process.	Adopting fishing friendly methods for cable protection and improving the mapping of potential seabed hazards helps increase co-existence between the two sectors. Wind energy developments can create new opportunities and supporting roles for fishing industry entrepreneurs. The creation of a fisheries funds (e.g. a tax on revenues or production) can support local fishermen in converting their vessels or promote studies and community projects. Allowing transit and/or some types of fishing (e.g. using static gear) within windfarm areas has been proven an effective solution.	In the UK, the Fishing Liaison with Offshore Wind and Wet Renewables group (FLOWW) serve to facilitate the interaction of fishing and wind industries, to promote and share best practices, and to encourage liaisons between other sectors. • FLOWW - Best Practice Guidance for Offshore Renewables Developments. • FLOWW - Best Practice Guidance for Offshore Renewables Developments. The Benthis project assessed the adverse impact of fisheries on benthic ecosystems. It aims to promote an 'ecosystem' approach to fisheries management. The project revealed success factors for implementing technological innovations to mitigate trawling impacts, such as passive fishing.	State of Art: 2.4 Potential Uses: 3.4 Benthis Factsheet Sources
Navigation	It is feasible to allow transit to passive fisheries and other users within new wind farms, under certain conditions, including the ban of bottom trawling activities in the area. Extending the transit/access rules to already-functioning wind farms is not recommended but might be potentially granted after careful assessment of test areas and dialogue with wind farm developers. In some countries (e.g. Poland and the UK) transit is allowed while some others (e.g. Netherlands and Belgium) are currently considering to open the transit, under certain conditions. Transit rules (e.g. visibility conditions and vessel requirements) must be clearly stated and communicated. Pilot tests and navigation risk assessments must be conducted before allowing transit through wind farms.	Allowing transit, under certain condition, would benefit certain marine users, such as recreational sailors and fishermen, avoiding inefficiencies, such as vessels being excessively re-routed or re-directed to more congested lanes. With wind park layouts becoming less dense – in terms of number of turbines per km^2 – the risk of collision when allowing transit, under certain conditions, decreases. The creation of blue corridors for safe transit, even under harsh weather conditions, would decrease the risk even more. Mitigation measures – e.g. navigation aids and marking, collision-friendly turbines or equipping wind turbines with first aid or emergency equipment – can also importantly lower the consequences of a collision.	In the UK, the Maritime Guidance Note 372 guides marine users when planning and undertaking voyages near or within offshore renewable energy installations off the UK coast. In the Netherlands, the Dutch government proposed a regulation to explore the possibility to allow transit and co-use of offshore wind farms. Pilot test are taking place in Eneco Luchterduinen, Prinses Amalia and Edgmond Ann Zee. The Dutch government also published a code of conduct containing rules and safety tips for sailing through wind farms. This document states locations and conditions in which passing through windfarms is allowed. The document also contains safety and emergency recommendations	State of Art: 2.4 Potential Uses: 3.5 UK Case Study, NL Case Study Factsheet Sources

Introduction

The Belgian Maritime Spatial Planning (MSP) for the period 2020-2026 will add approximately 285 km^2 as extra zones for wind farm developments, 35 km from the coast. Co-location options are gaining pace among governments as tool to ensure high efficiency of the sea, boost ecosystem services as well as solve spatial conflicts. However, technical and regulatory issues are still under investigation. Multiple-use activities proposed by the Belgian Government in the new MSP include: research activities, commercial aquaculture, combination of renewable energy sources and/or storage, nature protection and passive fishing.

Belgian waters are highly crowded. Maritime Spatial Planning is a key tool to enhance offshore wind development and improve cross-sector cooperation between aquaculture, fishing, energy, military, tourism, transport and other users.

The purpose of this study is to examine how cross sector activities can be combined with future Belgian wind farms. The government vision aims at:

- A four-dimensional use of the sea space;
- Transnational and cross-border cooperation in the economic, environmental, sectoral and scientific fields;
- The creation of added economic value through cooperation between the various actors at sea;
- The preservation, development and restoration of the ecosystem or sub-ecosystems and their associated functions;
- Ensuring the use of the sea for future generations;
- Anticipating possible threats in good time in order to ensure safety for nature, shipping, coastal residents, etc.

1. Maritime Spatial Planning

Maritime Spatial Planning is a tool which EU Member States use to organise and optimise their sea space, in line with their national objectives. Increased activity within Europe's marine area has led to increased spatial demands and growing competition between sea users.

In July 2014, the European Parliament and Council adopted the Directive 2014/89/EU establishing a framework for Maritime Spatial Planning. The Directive requires Member States to design a maritime spatial plan, which outlines where each sector can operate. This must be achieved by 31 March 2021.

The minimum requirements for Member States include stakeholder involvement, cross-border cooperation, promoting co-existence of activities and applying an "ecosystem-based approach". Marine ecosystems and human activities evolve constantly. Maritime Spatial Planning must be a continuous process, adapting to the availability of new scientific, social and economic information.

The European Commission published the 'MSP for Blue Growth' study in April 2018, providing Member States with guidelines and indicators to effectively develop spatial planning strategies and enhance cross-border and cross-sector cooperation.

Transnational Maritime Spatial Planning can improve cross-sector cooperation and thus minimise spatial conflicts. However, specific sectorial objectives must be defined in advance, allowing for the smooth definition of ecological, economic and societal objectives for each area. In addition, the MSP process should achieve broader consensus on priority actions, promoting cross-sectorial conflict resolution. For this reason, opening up wind farm areas to other users has clear potential to solve sea-users conflicts. Multiple-uses option must be clearly defined in the MSP but they also need to be backed up by a clear regulatory framework to ensure that such options will take place safely and efficiently.

1.1. Belgian Maritime Spatial Planning 2014 – 2020

Following the European Directive 2014/89/EU, Belgium approved a legally binding MSP via a Royal Decree of 20 March 2014. This was the first MSP implemented in the country covering the 2014 – 2020 period. It comprises the territorial sea, the continental shelf and the EEZ.

The Belgian Part of the North Sea (BPNS) is a densely populated area with ongoing spatial and sectorial conflicts. The main sectors operating in the BPNS are: fisheries and aquaculture, shipping, ports, offshore energy, aggregate extraction, dredging/dumping, tourism and recreational fisheries. These activities interact differently and have different potential for co-existence as well as very different environmental impacts. The shipping sector, which includes commercial shipping, towage and dredging, has important leverage when allocating spaces. However, the main navigation channels were not subject to any modification in the MSP. This is key to not reduce the security of commercial shipping in Belgian and international waters.

Offshore wind energy plays an important role in the current MSP. Belgium has a renewables electricity target of 13% by 2020, 43% of which will come from offshore renewable plants. There are currently 7 operating wind farms (Annex II) with a total of approximately 1.2 GW installed and around 270 wind turbines in the sea. Norther, currently under construction, and Seamade phase I and II (Mermaid and Seastar), currently with permit, will add approximately 850 MW more. This will contribute to passing the 2 GW of installed offshore wind capacity planned by 2020. It is estimated that the total employment will amount to 15.000-16.000 jobs in the Belgian offshore wind energy sector between 2010 and 2030 (Arcadis, 2018).

The current MSP allows multiple-use between different forms of renewable energy, commercial sustainable aquaculture (previous approval by concession holder) and research activities. Governmental operations and emergency response actions are also allowed. For other users, the Royal Decree on Safety Distances regulates no-go areas and minimum distances for navigation around wind farms.

Regulatory framework for the planning of offshore wind farms

Offshore renewable energy installations undergo a consenting process. First, the domain concession (for construction and production) and environmental license. The latter is granted by the Minister for the North Sea and requires the wind farm developer to submit an environmental impact report (EIR). The Navigation Risk Assessment (NRA) fall under the environmental permit procedure. The requirements for the NRA are generally in line with other Member States on the North Sea. These have to include parameters such as vessel traffic, environmental conditions as well as park layout, turbine types and cables. The approach relies on the assessment of different accident risks and needs to be supported by quantitative data.

1.2. Belgian Maritime Spatial Planning 2020 – 2026

The new MSP is based on the core principles of naturalness, functionality and multi-use of space. In particular, all activities foreseen must be in accordance with the good environmental status as from the Directive 2008/56. This will be made through the principles of impact prevention, including the promotion of low-impact activities, and cross-sector cooperation.

New concession zones for offshore wind farms will be partly located in natural protected areas within the Vlaamse Banken Natura 2000 area: the Fairybank & Noordhinder Zuid zones. Building in these zones will require an environmental permit following an Appropriate Assessment. The use of these areas (285 km^2) will add 1.7 GW of capacity by 2030.

In addition, for the new wind farms zones, the MSP foresees the possibility to install renewable energy storage systems. Other multi-use options (aquaculture, research activities and governmental operations) remain, with the addition of sand extraction and fishing. Any seabed disturbing activity will be banned from the moment that the preliminary surveys for the wind farms begins.

The Belgian MSP distinguishes between three forms of use of space:

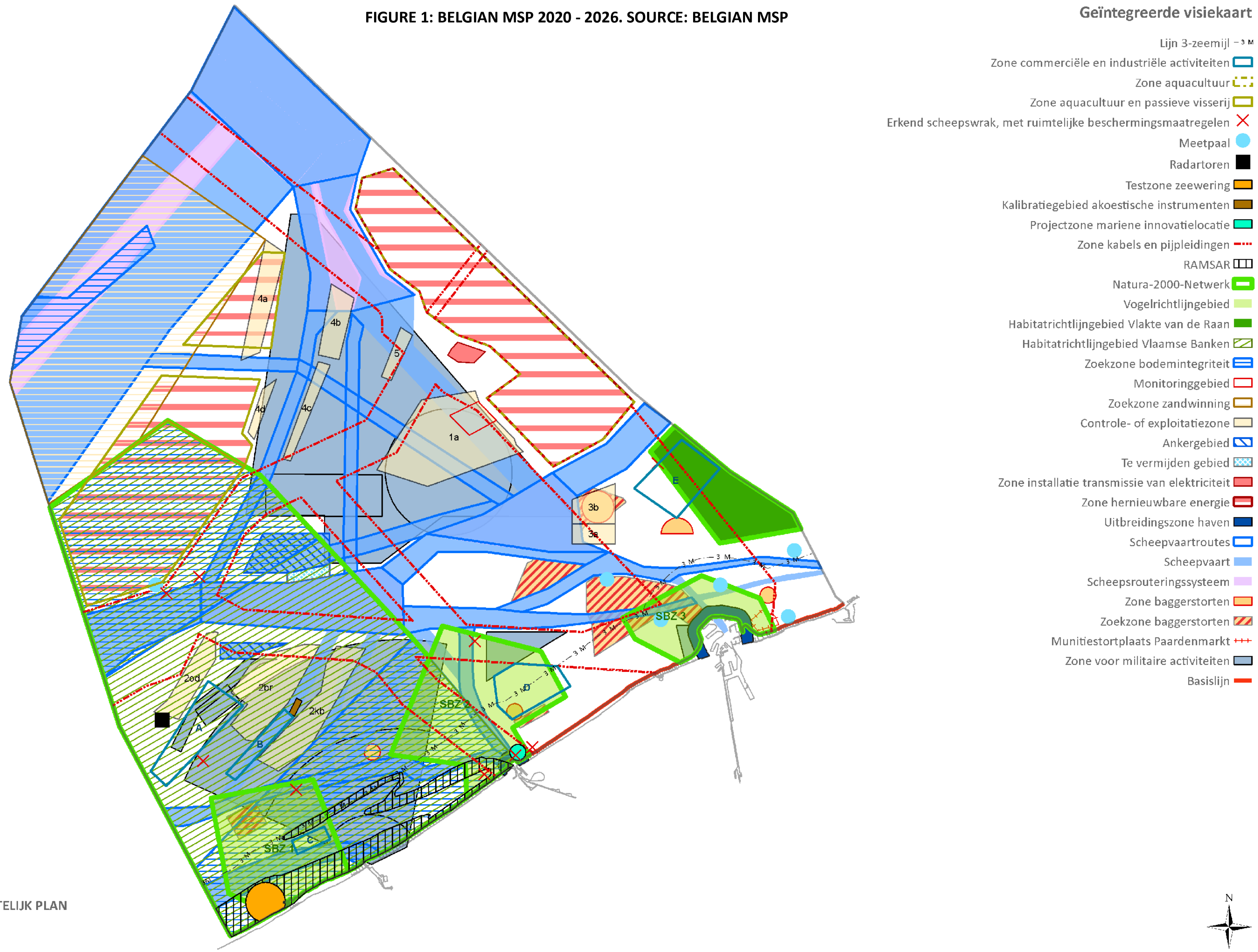
1. Dynamic: activities that only take up space temporarily, e.g. shipping.
2. Semi-dynamic: between a static element and a mobile user. This includes concession zones for wind energy in combination with passive fishing or transit from recreational users.
3. Static: This includes concession zone for wind energy in combination with storage, ocean energy generators, nature conservation areas and/or aquaculture.

Activities granted permission in Belgian waters should adopt an Ecosystem Services approach in order to maximise the functional uses of the Belgian sea. This includes evaluation of:

- Ancillary services, e.g. safety, transport;
- Cultural services, e.g. the presence of cultural heritage, recreational services;
- Regulating services: climate, including carbon sequestration

The MSP delimits zones to preserve seabed integrity from fishing activities with seabed-disturbing gear. Alternative seabed-disturbing gear in these zones might be permitted with a transitional period for fisheries to adapt to the new regulation.

FIGURE 1: BELGIAN MSP 2020 - 2026. SOURCE: BELGIAN MSP



2. State of play of multiple-uses of offshore wind farms

We found at least 7 relevant EU-funded and other projects or initiatives and more than 90 scientific articles - Annex I - on the feasibility of combining offshore activities. Even when not directly related to wind farms, these projects form a solid background of scientific evidence. However, consolidation and new pilot projects are needed in order to reach full commercialisation. This section will briefly present the state of the art of the most relevant co-use options. The factsheets for each activity can be found in Annex III.

2.1. Aquaculture

Increased sea activities alongside the coast, growing consumers demand for sustainable and local food production and technological improvements are pushing aquaculture activities, across EU and worldwide, to move offshore. Co-use of offshore wind farms with aquaculture could secure renewable energy generation while increasing food security, employment and local production.

There is a good scientific evidence regarding the combination of offshore wind farms and aquaculture activities (Annex I - *Aquaculture* and Chapter 2.5). The research in this field was initiated in the early 2000s. Co-location benefits for offshore wind farms and aquaculture include private cost savings for sharing assets, permitting and O&M, boosting local economies, creating jobs, engaging communities and generating local value. These also help countries to reach national and international targets for sustainability and food production.

While suitable species and technologies have already been assessed, the emerging interest in moving further offshore needs greater support. This means increased investment in research, development and commercial-scale demonstration projects, in particular within wind farms. However, liability issues, insurance policies and health and safety uncertainties still represent a barrier for commercial-scale implementation. Cumulative environmental impacts, however, are difficult to assess. For this reason, sustainable aquaculture is often promoted and preferred.

Integrated multi-trophic aquaculture relies on the principle of circularity of the nutrients through a combination of extractive and fed species. A combination of fish, bivalve and seaweed would ensure the recycling of nutrients, meaning a decrease of waste products when compared to singular activities. In addition, an accurate selection of the culture (more extractive or fed oriented) can help regulate site-specific parameters. This is the case of nitrogen, carbon, phosphorous and oxygen, which might create an eutrophication effect, causing water acidification or micro-algal blooms. These bio-remediation properties make aquaculture compatible with most marine environments and conservation strategies while allowing to balance the nutrients and restore the best natural conditions.

Finally, commercial scale is close to deployment, but consolidation of scientific knowledge and pilot tests are still necessary to reduce the perceived risk, especially from insurance companies and wind farm developers. Pilot studies in the North Sea have demonstrated that the biological and chemical conditions along the Belgian North Sea coast are very suitable for growing mussels. The Edulis project (Chapter 2.5) is a world-leading example of aquaculture within offshore wind farms in a climatically harsh environment. Technical challenges have been assessed and the project is now drafting a business plan for the deployment of commercial offshore aquaculture in the North Sea.

2.2. Nature Conservation and Restoration

Wind energy and other renewables contribute to the conservation of biodiversity through the decarbonisation of the electricity supply, which reduces climate change globally. In addition, scientific evidence shows the potential of wind farms to act as nature conservation areas while also indirectly promoting restoration of habitats and ecosystems (Annex I – *Environment protection and restoration*).

On the one hand, wind energy may have impacts on habitat loss, displacement or fragmentation. During the constructing phase of wind farms, there are impacts on marine mammals, and other sea wildlife, mainly due to noise emissions, the increase of traffic in the offshore area and the desturbance of the seabed. This might cause temporary or permanent habitat displacement. Noise mitigation measures shall be put in place in order to minimise the risk of negative effects during the construction phase. In addition, there may be bird and bat collisions with wind turbines during construction and operational phase. These impacts can be significantly addressed by having appropriately sited and well-designed wind farms. National and regional strategic impact assessments are effective ways to manage the potential impacts of wind power on wildlife and the environment. These form the basis for the Environmental Impact Assessment (EIA), which determines the necessary and appropriate mitigation measures in close dialogue with authorities and stakeholders. Mitigation measures should be site-specific.

Research activities have contributed to the creation of a significant body of knowledge on wind turbine impacts on environment and wildlife. This has been done by performing pre-construction, construction and post construction monitoring.

On the other hand, the installation of a windfarms would cause the ban of all seabed-disturbing activities in the area, supporting the protection of degraded habitats. Damage to the seabed, due to a range of human activities, including fisheries and sand-gravel extraction and navigational dredging, has affected large areas across Europe. Reducing human pressure on ecosystems represents a fundamental preventive measure to protect marine habitats and benthic biodiversity.

In addition, biodiversity increase is often observed around wind turbines due to the introduction of the hard-substrate of foundations and scar/scour protections. The colonisation of benthonic species is accompanied by the increase of fish population, mainly due to the advantages of food and shelter that wind farms offer against fishing pressure.

The ecosystem-based approach and the quantification of ecosystem services (direct and indirect) is a continuous process, based on scientific indicators which must be streamlined in order to be applied to different contexts and be comparable. Ecosystem services are the direct and indirect contributions of ecosystems to human well-being (e.g. food production, climate regulation, water purification, CO_2 storage, nutrients balance etc.). The national and local objectives of nature conservation and restorations actions should strive to maintain ecosystem services, enhance their capacity and identify clear actions to maintain their resilience. Current pressures and conditions of existing ecosystems need to be evaluated to define the strategy to improve the overall ecological status through targeted ecosystem services approach. Priorities, indicators and actions must be aligned with the definition of good environmental status provided by the Marine Strategy Framework Directive (MSFD). In a marine environment, ecosystems refer to transitional waters, coastal waters, shelf waters, and open ocean.

The EU Birds and Habitats Directives are the cornerstone for protecting Europe's natural capital. They enable all Member States to work together to protect and ensure the survival of Europe's most endangered and vulnerable species and habitat types listed in their respective annexes.
The EU Birds Directive establishes a number of Special Protected Areas (SPAs) for birds, while the Habitats Directive establishes Sites of Community Importance (SCIs) and Special Conservation Areas (SACs); together these sites form the Natura 2000 Network, which aims to ensure the long-term survival of Europe's most valuable and threatened species and habitats.

The European Commission's "*Wind energy developments and Natura2000*" guidelines states that wind energy can be developed in or adjacent to Natura2000, provided that all appropriate impact assessments are done in line with European and national legislation. The document also lists several examples of coexistence between natural protected areas and wind farms and promotes an ecosystem-based approach. Wind farms are required by the permitting authority to conduct an

Appropriate Assessment (AA) according to Art. 6 (3) and (4) of the Habitats Directive. The assessment has to focus on conservation objectives of the site on the basis of the habitats/species for which it has been designated. If necessary, additional mitigation measures may be required to permit the construction and operation of the wind farm. In case there are significant impacts, there is still a way out, in case there is an imperative reasons of overriding public interest (Art. 6).

Finally, the Marine Strategy Framework Directive, adopted in 2008, aims to protect the marine environment and achieve the "good environmental status" by 2020. The directive requires to adopt an ecosystem-based approach in managing the marine environment and promoting environmental protection and sustainable activities. The Belgian marine strategy to reach “good environmental status” was initiated in 2010, transposing the Framework Directive into national legislation (Royal Decree of June 23, 2010.

2.3. Other energy sources

Over the past decade, many research activities and pilot projects, led by public and private sectors, have brought ocean energy technologies to a pre-commercialisation phase. Combining offshore wind with these other forms of energy generation, such as wave, tidal energy or with energy storage, could support a faster research and development of these. Also the energy generation diversification can enable a more stable stream of electricity and increase the production in terms of MW/km^2.

Different offshore generators would have the possibility to share the grid infrastructure, logistics, operations and maintenance. With a proper design, other sources of energy and wind energy could enhance the shadow effect and reduce the overall environmental impacts. The shadow effect is the phenomenon of wave attenuation caused by offshore wave converters harvesting energy. There is evidence (Astariz S. et al., 2016) that this could allow O&M vessels to extend their operational time window due to attenuated wave disturbance. For this reason, a proactive approach in exploring at this early stage, co-location option, is necessary.

Ocean wave technology transforms the potential energy from the waves created by height difference into electricity with the aid of springs and a generator. The most commonly known devices include attenuators and overtopping devices. The first one is a cylindrical floating structure, simulating a ship structure, placed parallel to the direction of the waves. The second is a ‘buoy’’ mechanism with the ability to move in vertically and horizontally, following the wave’s movement.

Ocean tidal technology is a type of hydropower taking advantage of undersea currents to transform kinetic energy into electrical energy with the support of a generator. The Floating Tidal Energy Commercialization (FloTEC) is an important prototype in tidal energy, it is also funded by the Horizon 2020 programme from the European Commission. It focuses on boosting the supply chain to further reduce the cost of the prototype, which will be tested at the European Marine Energy Center at the beginning of 2020. Additionally, SABELLA, a 1 MW horizontal vertical turbine with five blades and modular architecture, was the first tidal project to feed the French grid in the Brittany region in 2015.

Different solutions are available to combine wave converters and wind turbines, ranging from co-located (independent or combined arrays) to hybrid systems. Co-location is clearly the easiest to implement while also delivering the benefits of sharing permitting, construction, grid connection and O&M costs. This combination has surely an important potential and has been studied under EU funding within ORECCA, Tropos (Chapter 2.5), Mermaid (Chapter 2.5) and H2OCEAN.

Belgian ocean energy companies are already exporting their technologies to other European countries and beyond. Laminaria is a leading example of Belgium's technological devices for the use of wave energy. At the moment, Laminaria is focusing on high-energy regions. This is key to develop a demonstrator which will allow to regulate the energy exposure and thus survive in any weather condition, for upscaling the prototype tested in other regions, including the North Sea. The innovative design has indeed the ability to withstand extreme weather conditions by sinking the system under the sea. Laminaria is also coordinating the LAMWEC project, which seeks to develop and test a 200 kW Laminaria wave energy converter (WEC) through complementary research and test activities. The success of this prototype will depend on the large scale deployment of the technology, which is planned to be tested in the European Marine Energy Centre in Scotland in 2019 and is supported by the FORESEA and Horizon2020 MaRINET2 European Commission's projects.

Additionally, the Ocean Energy Scale-up Alliance (OESA) is an accelerator project aiming to develop and deploy large scale marine energy pilots. The transnational partnership under the lead of the Dutch Marine Energy Centre combines expertise from 6 European countries from the North Sea Region. Through its transnational collaboration OESA strives to strengthen the ocean energy sector. To fulfil this potential, the project aims to accelerate the development of existing pilot technologies, so they can reach economic competitiveness. This and other projects are financed both the private as well as the public sector. By accommodating more deployments of larger scale pilots, a better understanding of the various topics surrounding tidal and wave energy converters will be created, supporting the commercialisation of such technologies.

Ocean Energy Systems and the International Energy Agency, in their *Spotlight on Ocean Energy* report, list 20 key projects and 5 initiatives around the globe as examples of emerging technologies in different scenarios. Out of the listed projects, Sihwa Tidal Power Plant Project (1) and Shetland Tidal Array (7) are the only commercial projects. The remaining are technology demonstration projects. This shows that R&D activities still need to be carried out, though the technology remains close to full-scale commercialisation. On the other hand, energy storage systems can balance the fluctuation of wind energy production and control the balance between generation and demand through power plant scheduling and power balancing. Therefore, the power surplus is stored for later use when energy is needed in the grid. To optimise the reserve levels requires a prediction of the accuracy.

There are different methods available to store the energy surplus. Pumped water systems use the exceeding power to pump water to the high reservoir, which is then released to a lower reservoir to produce hydroelectricity when power is needed. Energy storage in high energy density batteries is also possible. Some disadvantages include the specific operating conditions, lifetime and cost. Batteries require a control system to optimise the charge and discharge of the system to prolong its lifetime. Hydrogen is a versatile and widely applicable energy carrier. When deployed on a large scale it could help decarbonise the whole energy system, and the mobility and power sector in particular. Hydrogen could be a key vector for sector coupling, seasonal storage and providing new links between power production and consumption areas. The generation of hydrogen can be done via electrolysis, thermochemical processes, steam reforming, gasification and biological processes. Hydrogen is produced mainly via electrolysis. Some concepts of hybrid or full co-location of wind and ocean energy or wind and storage are available in Annex I.

2.4. Passive Fishing / Navigation within wind farms

Commercial fishing – with seabed-disturbing gears – has a high risk of interference with wind farms and related assets. In general, when a wind farm is under construction, *active* fishing activities – bottom trawling - in the immediate area are always restricted for safety reasons. Once the wind farm is operational, fishing can resume according to national regulations. Passive fishing - with no seabed disturbing gears - might be allowed within operational windfarms (e.g. United Kingdom – Section 2.6.1). Fishing with seabed-disturbing gears is always banned in or close to wind farms and other offshore infrastructures, especially cable pipelines. Thanks to this ban, wind farms provide shelter to local wildlife. Advantages for biodiversity and nature conservation have already been discussed in section 2.2. However, the ban of seabed-disturbing gears can allow for static / passive fishing, including recreational.

Adopting fishing friendly methods for cables protection and improving the mapping of potential seabed hazards would help to increase co-existence between the two sectors. Wind energy developments can also create new opportunities and supporting roles for fishing industry entrepreneurs (e.g. West of Morecambe Fisheries ltd example, which manages community funds).

In the United Kingdom the two sectors have consulted each other on offshore developments since 2002 as part of the Fishing Liaison with Offshore Wind and Wet Renewables group (FLOWW). Its objectives are to enable and facilitate discussion on matters arising from the interaction of the fishing and offshore renewable energy industries, to promote and share best practices, and to encourage liaisons between other sectors in the marine environment. The group is facilitated by a secretariat funded by The Crown Estate.

The two main reference documents are:

- FLOWW - Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison (January 2014);
- FLOWW - Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Disruption Settlements and Community Funds (August 2015).

In addition, navigation rules to access the wind farms will be affected when implementing co-location activities. Ensuring coherence and appropriate navigation risk assessment is crucial to avoid inefficiencies, such as ships redirected to more congested routes, or windfarm layouts being curbed due to overestimation of navigational risks. In addition, health and safety issues as well as national security strategies need to be carefully developed in order to ensure the maximum efficiency of the sea and safety of the marine users.

The North Sea Countries' Offshore Grid Initiative offers another example on how cross-border dialogue can be beneficial. It relies on the cooperation between 10 countries to facilitate the coordinated development of a possible offshore grid infrastructure. Identifying dedicated areas for the construction of an offshore grid could potentially increase wind farms' siting and operational flexibility. The fishing industry was periodically consulted throughout the course of the initiative.

2.5. Projects and initiatives

TROPOS

Project Coordinator: Consorcio para el diseno, construccion, equipamiento y explotacion de la plataforma oceanica de Canarias - Spain

Period: 2012 – 2015

EU Contribution: € 4,877,911

The TROPOS project developed a floating modular multi-use platform system, with an initial geographic focus for use in deep waters but designed to be flexible enough to be widely applied in different geographical areas. The output involves innovative designs, optimum locations and advanced technological solutions for modular multi-use offshore platforms which were developed by taking environmental, social and economic aspects into account. Three different scenarios allowed for site- and concept-specific assessments and the comparison impacts and logistical requirements of the different platform concepts. In particular, the Sustainable Service Hub, in the Dogger Bank, currently has the highest potential for near-term development, as the most economically viable and ecologically sustainable concept. The analysis revealed that an Offshore Wind Service Hub is already cost-effective for wind farms larger than 200 MW. The Sustainable Service Hub will significantly contribute to a reduction of the impact of offshore wind farms on ecosystems as the amount of traffic will be significantly reduced since it will occur in a limited area within the wind farm site. More information is available on the project’s website.

MERMAID

Project Coordinator: Danmarks Tekniske Universitet - Denmark

Period: 2012 – 2016

EU Contribution: € 5,483,411

The project explored concepts for the next generation of offshore platforms which can be used for multiple purposes, including energy extraction, aquaculture and platform-related transport. The project examined new concepts, such as combining structures and building new structures on representative sites under different conditions. It tested design concepts in four test sites with different environmental, social and economic conditions. The results were used to create a verified procedure for selecting the most appropriate design options for a given off-shore area.

MERMAID also assessed the accumulated impacts of large-scale offshore structures by studying interactions with waves, currents and the sea bed, as well as mixing and dispersion processes. A wide range of dissemination activities were undertaken during the course of the project. More information is available on the project’s website.

BENTHIS

Project Coordinator: Stichting Wageningen Research, the Netherlands

Period: 2012 - 2017

EU Contribution: € 5,994,250

This project assessed the adverse impact of fisheries on benthic ecosystems. It aims to promote an ecosystem approach to fisheries management. It studied the diversity of the benthic ecosystem in European waters, mapping the pressure of bottom trawling in European seas and quantifying the environmental impacts, using high resolution data from various fishing fleets. Among its results, the project showed that communities of long-living species are more sensitive to trawling because of their slow recovery compared to short-living communities. The final report (November 2017) also concluded that "[the project] revealed *success factors for implementing technological innovations to mitigate trawling impacts. While economic investment theory predict that economic profitability should lead to investment in innovative gears, it appeared that many other factors play a role in the successful uptake of new technology such as social, regulatory, technological and environmental factors. For the successful development and implementation of gear innovations, collaboration between fishers, gear manufacturers, policy makers, scientist and society is important*". More information is available on the project's website.

EDULIS

Project Coordinator: Ghent University - Belgium

Period: 2016 - 2018

The Edulis project was the first pilot test of offshore mussel culture in wind farm. It was a collaboration between Ghent University, the Institute for Agriculture, Fisheries and Food Research (ILVO), 5 private partners: Belwind, Brevisco, C-Power, Colruyt Group and DEME Group, and a third research partner: OD Natural Environment. Edulis studied the feasibility of mussel culture in offshore wind farms, 30-50 kilometres off the Belgian coast. Project results included important evidence on:

- The biological feasibility of offshore mussel culture in the Belgian North Sea;
- The technical feasibility and requirements for an mussel culture system fit for heavy sea;
- The possibilities for integration of mussel farming with the existing activities in wind farms;
- The profitability of commercial offshore mussel culture farming;
- The sustainability of offshore mussel culture and the impact on seawater quality.

This project was one of the most relevant for this study, but has yet to develop a business case. Additional considerations and learnings will be reported in chapter 3.1. More information is also available on the project's website.

MUSES

Project Coordinator: Marine Scotland - UK

Period: 2016 - 2018

EU Contribution: € 1,982,104

The Multi-Use in European Seas (MUSES) project explored the opportunities for Multi-Use in European Seas across five EU sea basins (Baltic Sea, North Sea, Mediterranean Sea, Black Sea and Eastern Atlantic). The project reviewed existing planning and consenting processes against international quality standards for MSP and compliance with EU Directives. The project provides an understanding of environmental, spatial, economic & societal benefits of co-location and provides highlights on inappropriate regulatory, operational, environmental, H&S, societal and legal aspects.

The project started with an analysis and comparison of the sea basins and identified real multi-use opportunities, actors and specific actions needed to advance development of multi-use in European Seas. Practical solutions were developed in the form of case studies. A total of 10 cases studies were developed, dealing with several different MU combinations in different sea basins. These include:

- Case Study 1, in the North Sea - focuses on offshore wind developments & commercial fisheries/aquaculture; tidal energy development & environmental interactions. It is divided into 3 sub-case studies:

  1A - Alternative solutions for multiple uses of ocean space between commercial fisheries and offshore wind farms and cables of the east coast of Scotland.

  1B – Tidal energy generation interactions with the environment, off the north coast of Scotland, including wild salmon and marine mammals.

  1C – Existing and potential co-use of marine space between offshore wind facilities and the production of food (fisheries and aquaculture) in the southern North Sea.
- Case Study 2, in the northern Atlantic, focuses on marine renewables & aquaculture multi-use (including the use of marine renewable energy near the point of generation).
- Case study 5, in the Baltic Sea, focuses on offshore wind production & marine biomass production & environmental remediation.
- Case Study 7, in the Mediterranean Sea, focuses on tourism, fisheries & energy production.

More information is also available on the project’s website.

Space@Sea

Project Coordinator: Stichting Maritiem Research Instituut Nederland, the Netherlands

Period: 2017 - 2020

EU Contribution: € 6,766,79

The aim of the project is to provide sustainable and affordable workspace at sea by developing a standardised and cost-efficient modular island with low ecological impact. Space@Sea is studying the most suitable shape of floaters for the modular island consulting offshore specialists that contributed to design a shared mooring solution in combination with remote monitoring. This resulted in the decision to use rectangular floaters with a side length of 45 metres for the small floater and 90 metres for the large floater, including an appropriate connection stiffness, the choice for building material and the details of the mooring system.

The Space@Sea concept will be applied to four different cases: farming, transport and logistics hub and energy hub and living. The different applications envisioned within the Space@Sea have their own weight and space requirements. To show the potential of multi-use modular floating islands Space@Sea will conduct the evaluation of three business cases with combinations of applications for various locations throughout Europe.

More information is also available on the project's website.

Scientific research and monitoring programme in offshore wind

A 3 million euros scientific research programme to understand the environmental impacts of offshore wind is currently being funded and facilitated at the European Offshore Wind Deployment Centre (**EOWDC**). The fund aims at consolidating technical knowledge of wildlife behaviour during construction and operations of offshore windfarms.

Panel members includes Vattenfall, Aberdeen Renewable Energy Group, Marine Scotland Science, Scottish Natural Heritage, the Scottish Environment Protection Agency, RSPB Scotland, the Joint Nature Conservation Committee, Whale and Dolphin Conservation, and The Crown Estate.

This ground-breaking offshore wind research programme provides insights into the lives of bottlenose dolphins, salmon, sea trout, sea birds and the communities around the wind farm.

In June 2017 the first four projects to receive funding were announced and are currently ongoing:

- The River Dee Trust, Aberdeenshire and Marine Scotland Science (2018-2020) – analysis of migration routes of salmon and sea trout but raking the wildlife movements;
- Oxford Brookes University, Oxford (2017 – 2019) – focuses on offshore socio and economic positive effects, identifying good practices, especially related to local value creation;

- MacArthur Green, Glasgow (2017 – ongoing) - provides detailed data on the year round movements of adult birds (with focus on guillemots and razorbills) by using geolocation tags to collect movement data over several years.
- SMRU Consulting and the University of St Andrews (2017 – 2020) – assesses bottlenose dolphin movements along the east coast of Scotland.

More information is also available in the project's website.

ORJIP – Study on wind energy impacts on marine mammals and birds

Offshore Renewables Joint Industry Programme (ORJIP), is a UK-wide collaborative programme of environmental research with the aim of reducing consenting risks for offshore wind and marine energy projects. The programmes bring together industry, regulators and academia to work on key environmental and consenting issues that the respective sectors are facing. The Offshore Wind Programme was set up in 2012 by the UK Department for Business, Energy & Industrial Strategy, BEIS (then DECC) and the Crown Estate, Marine Scotland and 16 offshore wind developers. The three work streams of ORJIP are: *Bird Collision Avoidance Study*, *Efficacy of Acoustic Deterrent Devices* and *Impacts on fish from piling at offshore wind sites*.

As part of the ORJIP Programme a study was conducted on understanding the **effectiveness of Acoustic Deterrent Devices (ADDs) on Minke Whale**. Increasing scale and complexity of offshore wind farms and on-going concern for European Protected Species (EPS) has led to interest in identifying alternative mitigation strategies to commonly used visual observation and acoustic detection methods for marine mammals. ADDs have been identified as a potentially effective tool for a number of small cetacean species, but research has been lacking for some other key species that occur within prospective OWF sites.

A controlled exposure experiment (CEE) was designed and implemented to test the efficacy of the Lofitech ADD as a potential mitigation tool for the minke whale during piling operations. The behaviour of the focal animal was tracked during a control, treatment and post-treatment phase in order to understand the potential reactions to the ADD signal.

A total of 46 minke whales were successfully tracked. Of these, 15 included successful deployments of the ADD. The focal animal moved away from the ADD deployment site in all cases.

The results highlight that the Lofitech ADD is effective at evoking a deterrence response in minke whales, suggesting that such devices could be effective at reducing any potential for injurious effects from exposure to subsea noise generated during pile-driving activity at OWF sites.

As part of the ORJIP project a Bird Collision Avoidance (BCA) Study has been designed to improve the evidence base for **bird avoidance behaviour** and collisions around offshore wind farms through the monitoring of seabird behaviour; and to support consenting applications for offshore wind development. The multimillion pound, collaborative study was commissioned by 11 leading offshore wind developers, The Crown Estate, The Crown Estate Scotland and Marine Scotland, was supported with funding from the UK Government and was managed by the Carbon Trust. The project was developed and run with the support and advice from the UK and Northern Europe's leading ornithologists and environmental advisers such as Natural England and RSPB. This is a great example of collaboration between private sector and government to monitor and mitigate impacts of wind energy on birds.

The study included analysis of over 600,000 videos, of which only 12,131 contained evidence of bird activity and only six collisions with turbines were observed. The analysis revealed that collision risk of seabirds was much less than currently expected based on current understanding and during the study seabirds were observed to exhibited avoidance behaviour and change their flight path to avoid the turbines. This will encourage the use of proven, practical and cost-effective monitoring systems to gather an empirical evidence base to reduce uncertainty for developers, advisors and regulators during collision risk modelling for consenting applications.

Offshore Wind Ecological Programme (WOZEP), the Netherlands – 2017 - 2021

The 'Dutch governmental offshore wind ecological programme', Wozep ('Windenergie op zee ecologisch programma') is a five-year research programme, launched by the Dutch government in 2016 to study the knowledge gaps in the ecological effects of offshore wind energy. In particular, the programme looks at common – and not site specific – impacts of windfarms, making the results applicable at least in the whole southern North Sea. The programme is a key tool used by the Dutch government to fully apply an **adaptive management approach** in the consenting of new offshore windfarms. This because it allows to reduce uncertainties about the effect of certain mitigation measures, long term impacts, upscaling of windfarms and create solid data background for the future EIA and Appropriate Assessment. Activities include international working conferences and exploratory studies which serve to define research priorities. Until now, the following species have been explored and are currently under research: birds (habitat displacement and collision risk), bats, marine mammals, fish and benthic ecosystems. More information in the Programme's website.

2.6. Examples from other countries

2.6.1 The United Kington – navigation within offshore wind farms

The UK Marine Policy Statement (MPS) provides the overarching policy framework for developing marine plans. The MPS is a joint UK administrations document, the aim of which is to contribute to the achievement of sustainable development in the UK marine area. Marine plans apply the MPS through detailed policy and spatial guidance for each marine plan area. The Energy Act 2004 established a regulatory regime for wind farms beyond territorial waters, in the UK's EEZ. This supplements the regime which already applies in UK internal and territorial waters and Section 99 deals specifically with navigation (The Energy Act 2004).

The Maritime and Coastguard Agency is responsible for setting UK's maritime standards and regulations, checking and verifying compliance of applicable international and national safety and environment protection standards, providing services to seafarers and monitoring the UK's coasts and seas, including emergency response. Wind farm developers are responsible for planning and practicing contingency arrangements to deal with marine casualties in or adjacent to sites, including responses to environmental pollution, to test their efficiency. Developers are also asked to assess navigational and communication impacts or difficulties around the site area and surroundings to determine any potential obstruction of, or danger to, seafarers or emergency response services.

In general, a 500m Exclusion Safety Zone is requested around all installation vessels and construction area. An Advisory Safety Zone of 50m around each turbine and sub-station structure is also in place after installation. After installation of the export cables, a 250m Anchor Exclusion Zone is also mandatory along the export cables' route.
During construction the wind farm perimeter is marked through cardinal buoys. Temporary LED lights are installed in each sub-structure and sub-station until the wind farm is commissioned.

Port authorities and Vessel Traffic Services operators require effective detection, identification and tracking of vessels navigating in their areas to organise traffic, provide traffic information, provide navigational assistance services and prescribe routing schemes to meet their statutory responsibilities in respect of the safety of navigation.

The Maritime Guidance Note – MGN 372 Offshore Renewable Energy Installations (OREIs): Guidance to Mariners Operating in the Vicinity of UK OREIs highlights the issues to be taken into account when planning and undertaking voyages in the vicinity of offshore renewable energy installations off the UK coast. The guidance document states that access to wind farms is allowed but mariners should choose if accessing on a wind farms based on number of factors including the vessel's characteristics (type, tonnage, draught, and manoeuvrability), the weather and sea conditions and keeping in mind that radar targets may be obscured when close to a wind farm. However, where there is sufficient sea room, the document suggests to avoid the wind farm area and concludes "*Although offshore renewable energy installations present new challenges to safe navigation around the UK coast, proper voyage planning, taking into account all relevant information, should ensure a safe passage and the safety of life and the vessel should not be compromised*".

The Maritime Guidance Note - MGN 543 Offshore Renewable Energy Installations - Guidance on UK Navigational Practice, Safety and Emergency Response contains advice and guidance to consider when assessing navigational safety and emergency response (search and rescue, salvage and towing, and counter pollution), caused by offshore renewable energy installations.

The guidance within MGN 543 is not mandatory. However, failure to accept the principles of the guidance may result in delays or objections from stakeholders during the consenting process.

The document contains definitions and assessment of safety distances and rules for accessing wind farms. This includes mitigation measures that has to be put in place by project developers. In particular, Annex 1.4 of the MGN 543 define which navigation would be feasible within or near the wind farms (Annex V of this document – *Extract from UK's "Marine Guidance Note 543*).
It is a policy requirement that SAR helicopters and rescue vessels are able to operate without significant risk or restriction within wind farms.

Proposed mitigation measures include information, warnings and monitoring actions, safety zones designation and the creation of an Emergency Response Cooperation Plan with the relevant Maritime Rescue Coordination Centre from construction phase onwards.

Related to the MGN 543, the OREI SAR Requirements Document - from the Offshore Energy Liaison Officer, HM Coastguard - provides a description of the Maritime and Coastguard Agency's (MCA) policy, and guidance, advice and specific requirements to assist and enable Search and Rescue, and other emergency response e.g. Counter Pollution operations, to, within, and in the vicinity of offshore renewable energy installations. Additional considerations and learnings will be reported throughout the text.

2.6.2 The Netherlands – Transit and co-use of offshore wind farms

Currently, it is not possible for third-party users (commercial and recreational) to navigate within the Dutch wind farms.

The current 2016-2021 North Sea Policy Document offers integral frameworks for the use of space on the North Sea. It also contains a summary of the Programme of measures for the Marine Strategy Framework Directive (Marine Strategy for the Dutch part of the North Sea 2012-2020). The North Sea Policy Document focuses in particular on measures to implement the Maritime Strategy Framework Directive, offshore wind developments and sand extraction strategy. The documents, which accompany the Dutch MSP and forms part of the National Water Plan, defines a vision that promotes multiple use of space, CO_2 storage, fishing and aquaculture (except in areas with restricted access), and the conservation of cultural heritage and recreational activities. It applies to the Dutch Exclusive Economic Zone and the non-administratively classified territorial sea.
With regard to the spatial planning aspects, the Policy Document constitutes a framework vision as defined by Section 2.3 of the Spatial Planning Act (WRO). In these document the Dutch government started introducing the concept of transit and multiple use of offshore wind farms. This concept has been developed with substantial involvement from relevant stakeholders.

The Policy document states: *"Multifunctional use of the North Sea by 2050 is based on comprehensive planning in terms of space and time by combining functions. The vision for 2050 entails only limiting areas (temporarily or permanently) to a single form of usage if the vulnerability of the marine environment requires this in situ. This means that users will already be obliged to take one another into consideration at an early stage (planning, design, and construction)"*

Current regulation does not allow transit within wind farms to any vessel, with the exception of wind farms O&M or governmental vessels. There's a safety zone of 500m from each individual object (*wind turbines*). The requisite safe distances for shipping are 1.87 NM to 1.57 NM (3,463m to 2,907m) for ships 400 metres in length and 1.54 NM to 1.24 NM (2,850m to 2,296m) for ships 300m in length. The design criterion has not been applied to the wind energy areas Borssele and IJmuiden Ver. In this regard a provisional distance of 2 NM (3,704m) applies for the shipping route.

However, to exploit the vision of multiple use of space in the Dutch North Sea, the government (*Rijkswaterstaat*) recently developed and reviewed a new risk assessment for transit and co-use in three Dutch wind farms:

a) Eneco Luchterduinen – Commissioning date 2015 – Capacity 129 MW (43 MHI Vestas wind turbines) – Approximately 24 km from the coast;
b) Prinses Amalia – Commissioning date 2008 – Capacity 120 MW (60 MHI Vestas turbines) – Approximately 25 km from the coast;
c) Egdmond Ann Zee - Commissioning date 2007 – Capacity 108 MW (36 MHI Vestas wind turbines) – Approximately 12 km from the coast.

There is an additional wind farm currently online but it is excluded by the proposal. The distance from the coast and the size of the wind farm render the enforcement of the conditions for passage cost-ineffective:

d) Gemini - Commissioning date 2016 – Capacity 600 MW (150 SGRE wind turbines) – Approximately 56 km from the coast.

However, transit and co-use for Gemini wind farms will be reconsidered in 2020.

An extensive amount of analysis, stakeholder consultations and expert meetings were performed from the Dutch government. In addition, to solve any dispute among different stakeholders, the Dutch Ministry of Economic Affairs and Climate Policy asked Arcadis to perform a review of the proposed risk assessment. The review, "Review on risk assessment on transit and co-use of offshore wind farms in Dutch coastal water" (2018), performed additional consultations with Noordzeewind, Eneco, Rijkswaterstaat and the Dutch Coastguard (Kustwacht). In addition, the review assessed site-specific parameters for each proposed wind farm and crossed this information with scientific data and other countries' information. The review followed the IMO-FSA approach, which relies on the identification of the hazards, assessment of the risk and development/review of risk control options. Cost-benefit analyses was out of the scope of the review. The document, in the final recommendations, concluded that "*the proposed risk mitigating measures appear to be reasonable, under the condition of active monitoring and rule enforcement*". In addition, after 2 dedicated Search and Rescue exercises, the review states that "*based on these exercises, it is concluded that SAR-operations in wind farms can be performed safely [in the proposed wind farms]*". However, the Dutch proposal does not apply to all forms of passage. Approval needs to be obtained for each individual initiative.

Annex IV is an extract from the document *"Review of the risk assessment for transit and co-use of Dutch wind farms"* published by Arcadis in 2018, and lists requirements and mitigation measures to apply when transiting in Dutch offshore wind farms.
A communication process has been started and includes an information campaign, a code of conduct (See 3.5) and extensive nautical information about the new regulation. The wind farm developers have entered into agreements about monitoring, incident management and policy evaluation. Rijkswaterstaat and the Dutch Coastguard are entitled to require and communicate additional measures for safety or (environmental) quality.

In addition, in September 2018 the Rijksdienst voor Ondernemen (Netherlands Enterprise Agency – RVO) started a unique initiative: the Community of Practice. The RVO acts as facilitator between research institutes, NGOs, government, and the private sector in solving spatial conflicts and promoting co-location options in the Dutch North Sea. This includes the organisation of recurrent events – usually quarterly – dedicated strategic issues such as financing, nature-inclusivity and other design criteria, and interactive sessions to promote public-private partnerships and cross-sector cooperation.

3. Potential multiple use applications in Belgium

3.1. Aquaculture

Our literature review found that the co-location of offshore wind farms and commercial aquaculture activities is feasible as pilot projects are taking place already in the BPNS.

We recommend to:

- *Promote research and pilot test in order to consolidate technical knowledge. This will allow to decrease the risk of liability in case of damage or accidents;*
- *Explore potential regulatory frameworks to simplify the permitting procedures and allow to reduce costs;*
- *Promote sustainable aquaculture, ensuring a nature inclusive approach to maximise the positive environmental effects.*

The current maritime spatial planning allows for marine aquaculture in a multi-use context within two zones for renewable energy. However, commercial marine aquaculture is currently not developed in Belgian waters. Benefits for society and the nearby communities should be emphasised and additional co-location options – such as fishing and biodiversity measures – should also be promoted.

While technical challenges are being fine-tuned through pilot projects, there are still some barriers that must be solved through an adequate regulatory framework. This includes easing navigation requirements within wind farms and providing information on navigation and vessel rules, definition of rules for O&M activities and reducing costs of insurance policies. On the latter specifically, insurance companies need evidence of the effectiveness and safeness of installations and maintenance activities in order to reduce technology uncertainties and insurance costs. This will allow the parties involved to put in place an insurance coverage which is affordable and will ensure to fully protect all the activities that will take place in the area.

To overcome unsustainable insurance costs that risk to jeopardise the large-scale implementation of offshore aquaculture, the creation of an Insurance Fund for small investors might be an effective solution. Co-location options can also allow for share of operations. An early dialogue between both parties should ensure the feasibility of combined operations and Life Cycle management, including sharing multi-purpose support vessels capable to operate under extreme weather conditions.

In addition, permitting requirements must be simplified on the experience of the ongoing pilot projects. This includes site selection, which should be led by the Government and based on best available data and transparency.

In addition to its simplification, permitting should be carried out in parallel between the aquaculture and the wind farm contesting process in order to avoid overlapping or un-necessary delays. When defining areas for co-location of aquaculture and wind energy activities, a nature inclusive approach should be promoted and defined at an early stage of the project. Stakeholder participation should always be promoted and supported. In particular, legal requirements and standards to adhere needs to be aligned across the sectors.

Certainly, the current science-based approach is fundamental in decision-making. This should be incorporated with an adaptive management so that regulations could be updated on the base of new scientific evidence. To this end, clear environmental standards and an active monitoring strategy represent the basis.

Sustainable aquaculture must be promoted, and the positive effects of growing extractive species need to be emphasized. In fact, the Belgian part of the North Sea is particularly rich in nutrients – nitrogenous, phosphorous and carbon – and sediment. The nutrients' bio-mitigation effect is surely the clearest positive impact, but other ecosystem services, such as carbon sequestration and consequent positive oxygen balance will also play an important role. Social and economic factors, such as jobs and local value creation must be accounted for too.

Species selection should be made according to technological readiness but also in terms of economic potential. Lower trophic species (seaweed and bivalve) have more potential since they have lower technical complexity. Naturalness principles should also contribute in the selection of the culture. Native species should be promoted, especially those with a consolidated scientific background. Growing factors (salinity, temperature, etc.) must be taken into account in order to maximise production. However, alien species, interesting for a commercial perspective, might be allowed too but extra measures must be taken to avoid the spread of those species.

In addition, there is still a need for consolidation of available technical solutions. For example, long-term effects on site-specific parameters, including corrosion of assets, effects on sediment and maintenance, should be dealt with a dedicated risk assessment.

In conclusion, technical, environmental and economic factors needs to be consolidated while social, legal, and policy factors need to be better explored in order to minimise risk and threats. This requires a specific stakeholder involvement strategy. This should be done through stakeholder consultations or workshops in order to connect interested parties. This should include the following sectors: offshore energy, aquaculture, fisheries, tourism, governmental and regulatory bodies at difference scale (regional, national and international), shipping, NGOs and citizens' representatives.

3.2. Nature Conservation and Restoration

Our analysis found that there is a potential to use windfarms as effective restoration and conservation measure in the BPNS. Positive effects and synergies between wind farms developments and national conservation strategy should be promoted and developed using an ecosystem-based approach.

We recommend to:

- *Plan wind farms as preventive tool to reduce human pressure on benthic habitats;*
- *Complement wind farms deployments with active seabed restoration actions;*
- *Promote positive environmental effects, such as the artificial reef effect or biodiversity increase;*
- *Promote collaborations with windfarms operators in environmental monitoring actions, research and innovation, data sharing and implementation of latest technology available.*

Windfarms construction and operation, as any anthropogenic activity, have impacts on environment and wildlife that must carefully avoided, mitigated or compensated during wind farm permitting, construction, operation and decommissioning. This will allow to boost the positive effects of wind farms deployment in the BPNS and exploit the best restoration and conservation measures in line with the national objectives.

In fact, wind farms have the potential of providing positive environmental effects and support the restoration of the habitats in the area, which starts with the ban all those activities that caused the degradation of the ecological status. External pressure relief is a key preventive action in the ecosystem-based approach.

In the 2020-2026 MSP, new concession zones for offshore wind farms will be located in natural protected areas, namely the Vlaamse Banken Natura 2000 area. The area was designated as a Special Area for Conservation (SAC) by Royal Decree of 16 October 2012 and has natural value for different habitats and species. Habitats protected are "*Sandbanks slightly covered by seawater all the time"* (habitat type 1110) with 4 subtidal benthic communities and "*Reefs, including biogenic reefs"* (code 110) and geogenic gravel beds (habitat type 1170). Species protected are Harbour porpoise, Common seal, Grey seal and a variety of birds (*Podiceps cirstatus, Hydircoleaus minutus, Sterna sp., Melanita Nigra Gavia sp.)*.

Various human activities are a concrete threat to habitats and biodiversity. The N2000 Data Form for site BEMNZ0001 – Vlaamse Banken - highlights pelagic trawling (drift-net fishing), benthic or demersal trawling, dredging and removal of sediments as *high-pressure* and *high-threat* activities. Nautical sports and shipping lanes represent a *medium* level of threat and pressure. Eutrophication is also considered *medium* level of (external) threat and pressure to the N2000 area. This becomes relevant when developing aquaculture systems based on extractive species as conservation/restoration measure. Leisure fishing, marine aquaculture, military manoeuvres, oil spills, pipelines are identified as *low* level of threat and pressure. Wind turbines are not mentioned in the form, since are not present in the area at the moment. In the new concession zones, where allowed, sand extraction and gravel extraction could carry on until the preliminary survey for the wind farms will start. Same applies for active fishing.

Wind farms construction will affect the ecological integrity of the habitats, but, most importantly, the establishment of a wind farm will cause the ban all seabed-disturbing activities in the wind farm and cables area. This is an indirect benefit and represents an important step in improving the conditions of the BPNS benthic habitats.

Extra measures could be taken to further increase the ecological conditions of the seabed, such as eco-designs of benthic-friendly scour protection systems or oysters' reef cultures. These actively help promoting a healthy and diverse marine ecosystem. For example, flat oyster restoration actively improves the seabed conditions, increases of water quality through filtration and boosts local ecosystem services, including food production. In fact, this is an example of a measure that might be deployed in combination with aquaculture activities.

In the Netherlands, the Ministry of Economic Affairs established, with the support of partners such as Wageningen University, WWF and Ark Natuur, among others, the Dutch Flat Oyster Consortium (POC). This is currently assessing the feasibility (survival, growth and reproduction) of flat oyster restoration in the Dutch North Sea. The activities started with a desk study commissioned in 2015. The study outlines that intense bottom trawling activities caused the overexploitation and habitat destruction of flat oyster in the Dutch part of the North Sea.

The study also concluded that proper environmental conditions for flat oyster restoration exist in the North Sea and developed a plan for the execution of a pilot phase which consist of 4 projects (Borkum Reef, Wadden Sea Survey – Shipwreck Platform and Voordelta. Lastly). These, among other activities, narrowed down the focus of oyster restoration within current and planned Dutch offshore windfarms. The Wageningen Marine Research report "Flat Oysters on offshore wind farms" assessed the most suitable locations in which restoration of oysters' beds could potentially take place in terms of habitat features, including seabed conditions, stability and potential self-sufficiency of larval dispersal. The study is based on the premise that no seabed-disturbing activities are carried out on those sites.

At international level, the Native Oyster Restoration alliance (NORA), established in 2017, serves as international network promoting and supporting restoration projects across EU and beyond (an overview of the projects is available at NORA's website). The group developed their first recommendation package during the kick-off workshop in Berlin, November 2017.

The primary condition to apply this active restoration measure is to have a bottom trawling free area, another advantage to combine this solution within a wind farm area. Additional benefits of windfarms also needs to be promoted and supported. Larger turbines allow to a wider layout and less piling work. Once the wind turbines are installed, foundations acts as artificial reefs, boosting biodiversity in the area.

The colonisation of benthonic species in wind turbines is often accompanied by the increase of fish population, mainly due to the advantages of food and shelter from fishing pressure that the windfarms offer. Biodiversity increase is often observed around wind turbines due to the introduction of the hard-substrate of foundations and scour protections. The colonisation of benthonic species is accompanied by the increase of fish population, mainly due to the advantages of food and shelter from fishing pressure that the windfarms offer.

There is evidence (Degraer S. et al., 2018) that wind turbines from Thornton Bank caused an increase of fouling communities and fine and organic matter enrichment, but on the small scale only (about 50m from the wind turbine) and dependent on the wind turbine's foundation (most positive effects observed in jacked foundations). This indicates a slow shift towards fine-sediment associated communities in close distances from wind turbines. Larger scale positive effects have also been observed. For example, the introduction of the hard-substrata represent an advantage for several fish species that previously could not survive in the area.

In addition, there is evidence that the artificial reef effect within the Thornton Bank wind farm, is starting to expand beyond the direct vicinity of the wind turbine for epifaunal species such as *Mytilus edulis* and *Anthozoa sp.* (6 to 7 years after the wind farm construction).

There is a clear hierarchy of measures to follow in order to avoid or minimise impact of wind turbines on wildlife. These are the so-called "mitigation hierarchy": Avoid – Reduce – Compensate – Offset. Technology innovation, such as the development of deterrent devices, high resolution visual/thermal cameras and avian radars is contributing to minimise the negative impacts on wildlife. These technologies could be used in specific locations, depending on site circumstances to avoid or reduce the impact on wildlife.

As for the mitigation measures, they should be commonly agreed between wind energy developers and the permitting authorities. The measures should be practicable, appropriate, realistic and cost-effective. Furthermore, this will allow to deploy the latest mitigation technology available. For example, Van Oord and AdBm recently (April 2019) demonstrated a new noise mitigation systems which, in combination with one single bubble curtain, is able to reduce the noise limits in line with both Belgian and Dutch regulations. This will be applied in Brossele wind farms construction, after its demonstration funded by RVO and led by TNO and itap. This is a good example of how R&I supports the continuous improvement of the environmental performance of offshore wind deployments.

Scientific research can also support regulators in dealing with knowledge gaps, which represent today a bottleneck in the consenting processes of offshore wind farms. Sound evidence on environmental impacts resulted from real life monitoring or research programmes (see Section 2.5 – Projects and Initiatives) would allow to take a swift from applying the precautionary principle and propose mitigation measures that are cost-effective and tailored to site-specific conditions.

In this specific context, adaptive management and a clear monitoring strategy are fundamental. The results of the environmental campaigns for the first wind installation(s) in the new concessions zones will allow to gather understanding on short/long term impacts of wind farms in that specific area. Such information will come from surveys, data collection and monitoring of the different wind farm phases, from both private and public sector(s) and will allow to design the optimal framework and mitigation strategy, ensuring to avoid or further minimise the impacts of the subsequent wind farms.

3.3. Other energy sources

Our analysis showed that the co -location of wind farms and commercial-scale wave energy convertors – with different potential layouts – is feasible in the BPNS. However, experiences show that technological innovation should be promoted and actions shall be taken to allow the technology to reach large-scale implementation.

We recommend to:

- *Promote pilot tests of co-location options to consolidate the wave technology, allowing governments to gather evidence and design a dedicated framework;*
- *Support research and innovation actions to increase knowledge on synergies between the energy systems and cumulative environmental effects;*
- *Promote the established Belgian Supply Chain which as key to create local value;*

Demonstration projects should be facilitated in the BPNS. This will allow manufacturing, assembly and maintenance activities to cluster close to the coast, and serve as a base for future offshore energy activities. This will allow Belgium to translate its wind-wave potential into local jobs, manufacturing activities and exports.

THV Mermaid was granted in 2015 with an environmental permit to test wave energy converters of 5 MW within the Seastar wind farm (now merged into SeaMade). However, the project got jeopardized by technical challenges caused by the shallowness of the North Sea and the early stage of the converters' technological development. In 2016, NEMOS has introduced a request (including an environmental impact study and a non-technical summary) for an environmental permit for the construction and exploitation of a temporary research structure for wave energy conversion.

Pilot tests and demonstrators are still needed to reach commercialisation of such option, especially considering the resource potential of the BPNS. At the moment, only few devices seems to be eligible for deployment on the BPNS, but as soon as the technology evolves, the industry will provide solutions to exploit conveniently wave potential from shallow waters. The government will play an important role in supporting the marine energy sector in providing cost competitive success stories (supported with any form of subsidy) so that investors and policy makers will gain interest and shape the technology for Belgian waters.

As for storage, Pumped Hydro Storage (PHS) is a consolidated option in the short/medium-term window (hours-day) for *onshore* energy storage, but only few pilot tests are moving this option offshore (e.g. StEnSEA project).

The DEME's Offshore Energy Storage Island is an interesting concept that would take advantage of the 2 zones for wind energy storage in the current MSP. DEME has developed a concept to store large amounts of energy using a Pumped Hydro Storage (PHS) solution. The concept consists on an island equipped to pump water in and out to a reservoir, depending on supply and demand of electricity. If there is an electricity surplus, the water is pumped out into the sea; otherwise, water from the sea is pumped into the reservoir to produce electricity passing through the hydraulic turbines.
Pumped Hydro Storage (PHS) might be applied in the new concession zones, but it should require further preliminary assessments and possibly additional scientific and economic consolidation. DEME concept, for example, can potentially be located anywhere with a water depth of maximum few tents of meters, but costs might make this options not feasible yet and so far from the coast.
Appropriate design could allow the island to provide additional services, such as fish farming or aquaculture. The safety parameter is 500 m around the island. This might change in the case of multi-use of the offshore island, in which third-party users will have to access to the site.

Hydrogen offshore storage systems are hardly applicable in Belgian waters. There are no oil or gas platforms in the BPNS. This means that there's no offshore oil/gas experience and no existing infrastructure (empty gas reservoirs, platforms and pipelines). This latter, in particular, is significant, since it allows to reduce costs for the gas infrastructure. The solution could still be achieved with the creation of dedicated offshore electrolysis platforms or an artificial island - power hub, which could still allow to avoid transport losses. But in the absence of existing platforms and pipelines, the concept is not commercially feasible yet. The creation of dedicated offshore platforms and transport of hydrogen is not believed to be commercially feasible in the BPNS within the next 6 years of MSP. New concepts are also exploring the possibility to produce and store hydrogen within the wind turbine's tower. These solutions might be explored as pilot projects.

Still, limited data is available regarding the environmental impacts and there's no consenting procedure in place yet. Across Europe, an Environmental Impact Assessment is always requested, but specific requirements vary depending on the character of the project. Some countries, such as France, Germany, Ireland and Portugal, require specific monitoring during the construction and operation phases, but the limited availability of real cases makes it difficult to assess the most effective procedure to follow.

For this reason, particular effort should be given to consultation with local stakeholders, experts and the scientific community from around Europe from the very early stages of the planning process.

Wave converters deployment, especially in an optic of co-location, could be de-risked, by exempting the plant from 'balancing responsibility'[1], by providing priority dispatch or allocating specifically designed feed-in tariffs. According to the EU *Electricity Market Design Regulation (2016/0379 (COD)*), the Commission de Régulation de l'Électricité et du Gaz (CREG) has the power to grant priority dispatch and balancing exemption to demonstration projects of emerging technologies. If this is provided, it will reduce risk of the projects and overall costs too. This will be key in supporting the commercial upscale of such technologies and their implementation in the national regulatory system.

Moreover, not precluding other forms of energy generation and storage in regulation creates incentives for private investors as the infrastructure, operation and maintenance activities could benefit from synergies of shared assets. These would require similar personnel qualifications and training, equipment and they could enable faster permitting procedures and a higher ratio of shared costs, which influence CAPEX and OPEX. These positive impacts should be assessed and be balanced with the additional expenses required for insurance and health and safety certifications.

Finally, learning from other countries' experiences and promoting pilot tests would create enough background to facilitate the permitting procedure, for example through the establishment of a coordinated "one-stop shop". Roles and responsibilities, within the consenting authorities, need to be clearly stated as well as the procedure for site allocation, surveys and impact assessments. Data should be publicly available and should be complemented by a risk, based approach, especially ocean technologies located in wind farms areas.

[1] Energy generators must ensure that they generate the correct volume of energy in each settlement period. If they generate too much or too little, or consume too much or too little, they have to pay a penalty. This aims to keep a balance between power generation and consumption in the grid at all times. Exemption from balancing responsibility means that generators are not subject to these penalties

3.4. Passive fishing

Our literature review shows that allowing passive fishing – commercial or recreational – within new offshore wind farms is feasible. Other countries' experiences showed that an extensive dialogue, communication and clear safety rules could allow the two sectors to share the space at sea. Synergies can be developed between the energy and fishing sector. Collaborative approaches should be supported by local authorities and project developers. It is essential that all long-term options for multiple potential uses are presented at an early stage in the planning process and discussed systematically.

We recommend to:

- *Promote and support collaborative approaches with government, fisheries and project developers;*
- *Learn from experiences from other countries (UKs and the Netherlands, in particular) to understand and overcome issues between the sectors;*
- *Promote and further explore potential compensation measures such as alternative employment and Fisheries Funds.*

The Crown Estate, in its research report Changes to fishing practices around the UK as a result of the development of offshore wind farms–Phase 1 (August 2016), gathered stakeholders' suggestions on how to increase the level of co-existence between fishing and offshore wind farms: better knowledge of seabed hazards and their location; fishing-friendly methods of cable protection; monitoring of risks and exposure and regular communication between wind farm developers, maintenance companies and fishers. Such is the case of the Barrow Offshore Wind Farm in the Irish Sea. Developers provide fishermen with information and accurate positions of all the offshore structures thanks to an open dialogue and the creation of a data-sharing platform[2]. This allows fishermen to continue working safely in the vicinity of subsea cables and other related structures.

In addition, UK fishermen have been in close contact with representatives from other countries to share best practices and solutions. Tom Watson, working as Fishery Liaison Officer for the National Federation of Fishermen's Organizations (NFFO), was interviewed by US fishery representatives on how to manage the relationship between the two sectors. What emerged is that the perception of risk is subjective and tends to increase in inexperienced fishermen. In reality, there is no real safety issue when navigating in good weather conditions. The UK's Marine Coastguard Agency has carried out search and rescue operations inside the wind farm; they had a few problems with RADAR interference

[2] The **Kingfisher Information Service - Offshore Renewable & Cable Awareness** project (KIS-ORCA) is a joint initiative between the European Subsea Cables Association (ESCA), Renewable UK and the Kingfisher Information Service of Sea fish.

but never reported any safety hazard. Radar interference could allow vessels to "hide" within wind farm areas, but this problem has already been overcome via the Royal Airforce.

An example of mitigation in the UK was the compensation for disturbance and loss of earnings caused during construction. There is no legal basis in the UK for economic compensation of losses as a consequence of new navigation rules, habitat displacement or disruption of fishing activities (during surveys, construction or operation of the wind farm).

To overcome any remaining friction between the two sectors, the Crown Estate introduced the concept of disruption settlements and Fisheries Community Funds, adopting a case-by-case approach. Guidance is available on how disruption settlements can be calculated in the Seafish's: Best Practice Guidance for Fishing Industry Financial and Economic Impact Assessments, which provides methods for calculating financial impacts as a result of areas closed or restricted to fishing. The document was published in 2012 from the UK Fisheries Economic Network (UKFEN) and relies on the basis of negotiations among sectors, transparency, science-based evidence, alternative employment and honour agreements.

Examples of such initiatives include the West of Morecambe Fisheries Fund and the Thanet Fishermen's Association fuel company. An innovative approach is the case of employment of local fishermen (those who can count on appropriate vessels) in wind farm-related work such as Guard Boat or Stand-by Boat as well as bird and mammal watch for environmental monitoring. This has proved effective especially when fishing quotas were exhausted. In addition, existing vessels may be replaced or upgraded in order to ensure compatibility with cables and other infrastructures as well as environmental goals.

Vessels can then be allowed to fish in the wind farm/cable area using non seabed-disturbing techniques. Amateur fisheries, under certain requirements regarding the specification of the vessels and other conditions, might also be allowed but regulated by Royal Decree, as with any recreational sea-user.

3.5. Navigation within offshore wind farms

Our analysis shows that it is feasible to allow transit to allow passive fisheries and other users within *new* wind farms, under certain conditions, including the absolute ban of bottom trawling activities in the area. Extending the transit/access rules to *already-functioning* wind farms is not recommended but might be potentially granted after careful assessment of test areas and dialogue with wind farms developers. The Navigation Risk Assessment (NRA) for new windfarms needs to be in line with the new access rules.

We recommend to:

- *Collaborate across stakeholders in activities such as sharing data or information and engaging relevant stakeholders;*
- *Align rules, strategies and objectives with neighbouring countries to unsure the functionality and efficiency at sea-basin level;*
- *Collaborate to develop appropriate navigation risk assessment, requirements and conditions for marine users to navigate in certain areas;*

A wide range of stakeholders has to be consulted when exploring terms and conditions in which allowing external users to access wind farms areas. The approach relies on the assessment of different accident risks in the presence (or not) of the wind farm. This needs to be supported by quantitative data as well as the support of the different interested parties.

The United Nations Convention on the Law of the Sea (UNCLOS) allows Member States to set safety distances of up to 500m between wind farms and shipping lanes. On the base of the previous assumptions, the Belgian government determines the safety distance to shipping routes on a case-by-case basis.

To allow navigation to external users within wind farms, the NRA has to be revised in line with new criteria to ensure that transit and operation within wind farms will occur with the lowest risk of navigation accidents. The requirements for the NRA in Belgium are quite in line with other Member States facing the North Sea, the Netherlands in particular. Denmark and the UK, for example, already allow navigation and fishing within wind farms with no restrictions to vessel size but not allowing for trawling/anchoring, which poses the highest risk to subsea cables. Learning from the Dutch, UK and Danish examples will surely speed up the process of implementation of the multiple use strategy in Belgium.

In addition, there is already in place a standardised NRA procedure based on the Samson model, including requirements for calculation methods and data sources, similarly to the Netherlands. This is key to ensure to minimise the risk in trans-border projects. Assessments also need to be made of the consequences of ships deviating from normal routes and recreational or fishing vessels entering shipping routes in order to avoid, or exiting, the proposed sites.

The distinction based on the size of the vessels, as it happened in the Netherlands but not in the UK and Denmark, becomes relevant when assessing the risk with *consequence models*, in contrast of the more spread assessment based on the risk of collision (*probability models*). In this sense, definition of the probability, consequence and overall risk that wind farm poses to ship safety, through the use of various methods, models, tools and even stakeholder feedback, needs to be carefully assessed and standardised.

Mitigation measures should also be investigated – e.g. navigation aids and marking, collision-friendly turbines or equipping wind turbines with first aid or emergency equipment - since they might importantly lower the consequences of a collision. This information will then have to be crossed with site specific details of each wind farms area, such as wave height, tidal strength, water depth as well as the park layout.

In the most recent National Water Plan and its Policy Document on the North Sea 2016-2021 (Chapter 2.6), the Dutch government included the principles of transit and multiple use of wind farm from third-parties. The Dutch approach relies on allowing small sail boats (up to 25m) in some trial periods in order to test the feasibility of allowing transit and co-use by small ships (Annex III). One important finding of the Dutch experience is that transit and co-use can potentially be allowed in already functioning wind farms, depending on the site conditions, park layout and resource needed for law enforcement. However, feasibility studies must be taken into account when considering to adapt the approach to Belgian windfarms. The Dutch approach relies indeed in choosing small windfarms, very close to the coast, as pilot test in order to gather evidence for the upscale of the navigation rules. Layout and distance from shore of the Dutch windfarms played an important role in the designation of the test sites, including the compatibility with SAR operation from the Dutch Coastguard.

This might concern wind farm owners since the currently functioning wind farms were not designed for transit by external users and, most importantly, for co-use activities. Concerns would also arise regarding who will cover the costs of adapting the offshore facilities to the new situation and rules, and how this affects the permit granted from the government to the project developers. Still, the cost of dedicated risk and consequence assessment must be compensated by the benefits of allowing transit and co-use. Another important learning from the Dutch is that Search and Rescue operations (SAR) have been performed safely by the competent authorities (Dutch Rescue Organisation and Dutch Coastguard) in some test areas within wind farms. Vessel rescues have been proven very reliable.

Rijksoverheid also published a code of conduct containing rules and safety tips for sailing through wind farms (Regels en veiligheidstips – Gedragscode voor veilig varen door windparken). This document states locations and conditions in which passing through windfarms is allowed to recreational sailors with ships below 24m, including minatory equipment and safety distances. The document also contains safety and emergency recommendations. This includes the use of updated (digital) charts, radar reflectors and other equipment to carry on board as well as emergency response. As mentioned before, it has been concluded that opening of the wind farms, in combination with the proposed rules, does not lead to a general increase in risks. The proposed mitigation and management measures are also expected to be effective.

The UK experience showed how, from the moment that transit is allowed within wind farms, there is a peak in traffic within the wind farms of a few months' length (three in the UK case). This is because an area previously forbidden to navigation becomes accessible and stimulates the interest of sea users. This trend will then decrease and transit will be made only by those users that necessarily have to pass by the wind farms, who are also very well aware of risks and limitations imposed in the wind farm area. It has been shown that sea-users generally avoid wind farm areas and interaction with related assets (when not intentionally breaching the law). Similar considerations are observed on fishing vessels that tend to avoid fishing in wind farms to preserve their own safety.

There's not enough gain in allowing commercial shipping within wind farms. Shipping lanes, transited by commercial vessels, should not be modified for any reason related to wind farm developments and safety distances shall remain the same and in line with international regulations. When safety distances and mitigation measures are in force, wind farms poses no threats to commercial shipping.

In conclusion, wind farms will never be built within existing international recognised shipping lanes but they might have an influence on overall traffic flows. Multiple use options might influence the overall traffic flow in the Belgian sea, affecting the access to the main international routes – e.g. a fishing vessel exiting from the wind farms area in a direction perpendicular to the shipping lane. Additional mitigation measures should be investigated. Traffic management and communication must be in accordance with international standards and local regulations in order to ensure that navigation, in the BPNS, and access to wind farm areas will happen in the safest possible way.

4. Final Remarks

Concerns still arise among wind farm developers when allowing third-party users to navigate within wind farms, due to increased risk of collision and damage to offshore assets. Other navigation issues – changes in traffic, routes and safety zones, as well as national security concerns –also need to be addressed.

Experiences from other countries suggest that it is key to define responsibilities regarding the legal enforcements given to state authorities, monitoring, emergency response and response to law-breaking. The navigation risk assessment needs to be reviewed, but there is evidence that opening wind farms to transit will not cause an increase of risk of collision. This mainly depends on the wind farm's layout as well as the cost-effectiveness of law-enforcement measures. Appropriate risk control and mitigation measures need to be defined and clearly communicated to the marine users. This has the potential to decrease the risk to acceptable limits.

Governments play a key role as facilitator between marine users for the implementation of multiple use options by supporting the creation of business models, financing or supporting mechanisms and dialogue amongst different stakeholders. As any technology at an early stage of development, subsidies will be most probably needed for certain technologies (e.g. for combination of energy sources or storage) while governmental funds will also be essential for activities such as nature protection or restoration and aquaculture.

Clear roles and responsibilities must be stated well in advance of starting the planning process. There should be a clear framework which can safeguard wind farm owners concerning potential damages, loss of business and eventual increased construction and operational expenses which can affect the overall price of the wind farms. This should also include compensation in case of accidents or damages in wind farm areas. Increased safety measures for wind farm developers will facilitate the implementation of co-use options.

Furthermore, allowing third-party users within a wind farm means a change in the security landscape, with new users having access to an area previously banned. The framework in place shall clearly state how the responsibilities will change for emergency response and SAR operations, since wind farm operators are not trained for it. Synergies between wind farm owners and coastal security operations can also support an overall improvement of governmental active monitoring and rule enforcement. For example, wind farm operators could support governmental surveillance activities, reporting to competent authorities safety infringements from unauthorised users.

Wind farm operators could potentially share their asset, allowing to install governmental sensors, radars and other communication equipment or even sharing the data collected privately for internal monitoring. This will decrease the overall risk of security infringements within wind farms, especially in a multiple-use set-up, while increasing the security of offshore operations. In this sense, a mutual agreement would ensure full cooperation and eventual compensation schemes.

Wind farm operators might be asked to support risk assessment and monitoring associated with the activities that will take place within the wind farms in each phase of the project, from pre-construction to decommissioning. For example, in the UK the Emergency Response Co-Operation Plan (ERCoP) is based on good practices developed by the International Maritime Organisation for communication and information on emergency response. This includes SAR Helicopter Operations within wind farms, which are depend from visibility conditions at the time and circumstances of the incident. This process is made in close collaboration between wind farm developers and regulatory and permitting bodies. In case of co-location options, any additional user must be included in the plan.

To further reduce the risk of accidents, law infringements or collision, it’s very important to communicate clearly detailed natural charts, possibly in form of online tools, which are easier to update and update with real time data of exact location of wind farms and related assets as well as exclusion (temporary or permanent) and security zones. Wind farm developers should support the sharing of this data. In additional, the stakeholders involved must assess procedures or equipment required to carry on board, such as radar reflectors, emergency beacons or recording/tracking devices.

The governments plays a fundamental role not only in relation to legal, permitting and national safety and security aspects, but also in facilitating the creation of knowledge, sharing of experiences – across sectors and countries – and supporting small business in deploying co-use activities. Such is the case of the Community of Practice (CoP) in the Netherlands (Chapter 2.6). The role of the CoP is to actively stimulate multiple use instead, concepts and pilot projects and support entrepreneurs. The government (RVO, Directorate of Strategie, Kennis en Innovatie van LNV, Directorate Water, Ondergrond en Marien van I&W) acts as an oiling machine among different stakeholders, offering financial advice and supporting the scale-up of local initiatives.

This is made by sharing practical knowledge, expertise and experiences while also developing new practices and approaches. The CoP, lunched in September 2018, can already count on more than 190 members that represent governmental institutions, NGOs and the private sector. The CoP is already bringing results, such as a cooperation agreement with the Flat Oyster Consortium (Platte Oysters

Consortium, see Section 2.6), the development of a joint business plan for a nature-inclusive seaweed cultivation and innovative fishing within wind farms (with the support of WWF, Ark, SeaHarvest, a fisherman association in Urk, Wageningen University and Van Oord). Combination with wave energy generators has also been discussed. Upcoming discussion points for future activities relate to the implementation of a Multi-annual Innovation Programme for Sustainable Energy and the development of an assessment framework for co-use based on real cases. It is highly recommended to emulate this approach (RVO).

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Annex II – Details of Belgian online and planned windfarms[3]

Project Name	Status	Year	Total Capacity	N. of WT[4]	WT Power	WT Manufacturer	GIS Latitude	GIS Longitude	Distance To Shore (Average)	Water Depth (Average)	Wind Farm Area	Foundation
Thornton Bank I **(C-Power)**	Online	2009	30 MW	6	5 MW	Senvion	51.5454	2.9378	28.5 m	19.5 m	10 km²	Gravity Base
Belwind I	Online	2010	165 MW	55	3 MW	MHI Vestas	51.6691	2.8015	48.5 m	26 m	17 km²	Monopile
Belwind GE Haliade Demonstrator	Online	2013	6 MW	1	6 MW	GE	51.688	2.836	45 m	26 m	0 km²	Jacket
Thornton Bank II+III **(C-Power)**	Online	2013	295.2 MW	48	6.15 MW	Senvion	51.556	2.969	28.5 m	21 m	22 km²	Jacket
Northwind	Online	2014	216 MW	72	3 MW	MHI Vestas	51.619	2.901	37.5 m	24 m	14.5 km²	Monopile
Nobelwind **(Belwind II)**	Online	2017	165 MW	50	3.3 MW	MHI Vestas	51.664	2.816	47 m	26 m	-	Monopile
Rentel	Online	2018	308.7 MW	42	7.35 MW	Siemens Gamesa	51.591	2.945	34 m	29 m	-	Monopile
Norther	Under construction	2019	369.6 MW	44 (44 -0)	8.4 MW	MHI Vestas	51.527	3.014	24 m	22.5 m	38 km²	Monopile
SeaMade phase 1 **(Mermaid)**	With Permits	2019	235 MW	28 (0-0)	8.0 MW	-	51.718	2.739		29 m	17 km²	-
Northwester 2	With Permits	2020	218.5 MW	23 (0-0)	9.5 MW	MHI Vestas	51.986	2.757	46 m	32.5 m	15 km²	-
SeaMade phase 2 **(Seastar)**	With Permits	2021	252 MW	30 (0-0)	8.4 MW	-	51.632	2.86	40 m	23 m	20 km²	Monopile

Total installed capacity – end of 2018: **1,186 MW**. Total installed capacity – end of 2021: **2,261 MW**

[3] **Source**: WindEurope's Offshore Database. Last update January 2019. Partial data is freely available at www.windeurope.org. Complete data is available in WindEurope's Member's Area.
[4] **WT:** Wind Turbines. Numbers in brackets (a-b) – a: number of foundations installed; b: number of turbines installed.

Annex II – Factsheets

Aquaculture

SUMMARY

- ***Maritime Spatial Planning*** *can* ***improve cross-sector cooperation*** *and thus* ***minimise spatial conflicts****.*
- *Co-use of offshore windfarms with aquaculture could increase the* ***functionality of the sea*** *while creating* ***food security, employment and local value.***
- *The emerging interest in moving further offshore needs greater support through* ***increased investment in research, development and commercial-scale demonstration projects.***

Maritime Spatial Planning and co-location

Maritime Spatial Planning (MSP) is a tool which Member States use to organise and optimise their sea space, in line with their national objectives.

Increased activity within Europe's marine waters has led to increased spatial demands and therefore growing competition between sea users. **MSP is key to enhancing offshore wind development and improve cross-sector cooperation** (aquaculture, fishing, energy, military, tourism and transport) and thus minimize spatial conflicts.

Co-location is the sharing of the space among different users or activities. In most countries, offshore wind farms represent a no-go area. With the increasing density of activities along the coasts and expansion of the offshore wind energy sector, government can allow different activities to take place within windfarms as concrete tool to solve spatial conflicts and increase the functionality of the sea.

Multiple use of offshore windfarms and aquaculture

Increased sea activities alongside the coast, growing consumer demand and technological improvements are pushing aquaculture to move offshore.

There is **good scientific evidence on the technical feasibility** of combining offshore wind energy and aquaculture activities. The research in this field was initiated in the early 2000s. Co-location benefits for offshore wind farms and aquaculture include **private cost savings for sharing assets, permitting and O&M, boosting local economies, creating jobs, engaging communities and generating local value.** These also help countries to reach national and international targets for sustainability and food production. However, **liability issues, insurance policies and health and safety uncertainties** still represent a barrier for commercial-scale implementation. Cumulative environmental impacts, are also difficult to assess. For this reason, sustainable aquaculture is often promoted and preferred.

Integrated multi-trophic aquaculture, indeed, relies on the principle of circularity of the nutrients through a combination of extractive and fed species. This allows to regulate site-specific parameters and avoid an eutrophication effect, which causes water acidification or micro-algal blooms. These bio-remediation properties make aquaculture compatible with most marine environments and conservation strategies while allowing to balance the nutrients and restore the best natural conditions.

Pilot studies in the North Sea have demonstrated that the **biological and chemical conditions along the Belgian North Sea coast are very suitable for growing mussels.**

However, technical, environmental and economic factors need to be consolidated at larger scale through new pilot projects. This will allow to reduce the perceived risk, especially from insurance companies and wind farm developers.

Social, legal, and policy factors should be facilitated by governments in order to minimize risks and support commercial deployment.

Recommendations

Benefit for society and the nearby communities should always be emphasized. **Additional co-location options** – such as passive fishing, and oysters' reef restoration – should also be investigated.

In general, there's a need to develop real-cases impacts and risk assessment as well as business case which will emphatise the common benefits.

A **framework for access rules, emergency response and mitigation measures should also be developed.** This should be led by the governments and involve both wind farm owner and co-use entrepreneurs to facilitate the cooperation between the involved parties.

In conclusion, we recommend to:

- Promote research and pilot test in order to consolidate technical knowledge. This will allow to decrease the risk of liability in case of damage or accidents;
- Explore potential regulatory frameworks to simplify the permitting procedures and allow to reduce costs;
- Promote sustainable aquaculture, ensuring a nature inclusive approach to maximise the positive environmental effects.

Case Study: Edulis project

The Edulis project is a world-leading example of aquaculture within offshore wind farms in a climatically harsh environment. The project, led by Ghent University during the period 2016 – 2018, studied the feasibility of mussel culture in offshore wind farms, 30-50 kilometres off the Belgian coast. Project results included important evidence on:

- The biological feasibility of offshore mussel culture in the Belgian North Sea;
- The technical feasibility and requirements for an mussel culture system fit for heavy sea;
- The possibilities for integration of mussel farming with the existing activities in wind farms;
- The profitability of commercial offshore mussel culture farming;
- The sustainability of offshore mussel culture and the impact on seawater quality.

Nature protected areas and restoration measures

SUMMARY

- *Maritime Spatial Planning can improve cross-sector cooperation and improve the functionality of the sea;*
- *Wind energy is not in principle excluded from Natura 2000 sites. Developments are allowed only after successfully obtaining a Natura 2000-permit (including an appropriate assessment).*
- *If properly planned, wind farms can have positive effects on the local habitats. They can be used as prevention measures and offer a suitable location for active restoration options*
- *There is no a "one size fits all" mitigation option available: the approach must be site-specific.*

Maritime Spatial Planning and co-location

Maritime Spatial Planning (MSP) is a tool which Member States use to organise and optimise their sea space, in line with their national objectives.

Increased activity within Europe's marine waters has led to increased spatial demands and therefore growing competition between sea users. **MSP is key to enhancing offshore wind development and improve cross-sector cooperation** (aquaculture, fishing, energy, military, tourism and transport) and thus minimize spatial conflicts.

Co-location is the sharing of the space among different users or activities. In most countries, offshore wind farms represent a no-go area. With the increasing density of activities along the coasts and expansion of the offshore wind energy sector, government can allow different activities to take place within windfarms as concrete tool to solve spatial conflicts and increase the functionality of the sea.

Co-location of offshore windfarms and nature protected areas

Wind energy can be developed in or adjacent to Natura 2000 areas, provided that the Appropriate Assessment is done in line with European and national legislation. In case there are significant impacts, there is still a way out, in case there is an imperative reasons of overriding public interest (art. 6, §4).

The European Commission's guidance document "Wind energy developments and Natura 2000" offers guidance in interpreting the EU Birds and Habitats Directives. This document does not exclude a priori wind energy developments in or adjacent to Natura 2000 sites.

Windfarms construction and operation, as any anthropogenic activity, **have environmental impacts that must carefully avoided, mitigated or compensated** during wind farm permitting, construction, operation and decommissioning and must be addressed properly.

However wind farms have also the **potential of providing positive environmental effects.**

The **colonisation of benthonic species** in wind turbines – artificial reef effect - is often accompanied by the **increase of fish population,** mainly due to the advantages of food and shelter from fishing pressure that the wind farms offer. For this reason, it is also important to assess **and promote the positive impacts of renewable energy installation** when screening co-location options. Wind farms also support the **restoration benthic ecosystems decreasing human pressure.**

Wind farms supporting restoration of habitats

The installation of a windfarms causes the **ban of all seabed-disturbing activities** in the area representing a fundamental preventive measure to further degradation. Damage to the seabed, due to a range of human activities, including fisheries, sand-gravel extraction and navigational dredging, has affected large areas across Europe.

In this sense, the establishment of a windfarms will serve as an indirect benefit**, supporting the restoration of the benthic ecosystems**. Once the human pressure on the benthic habitats is reduced or eliminated, **active seabed restoration measures** might be applied in the area to further increase the ecological conditions of the seabed. This is the case of **flat oyster restoration**, which **actively help promoting a healthy and diverse marine ecosystem**. It improves the seabed conditions, increases of water quality through filtration and boosts local ecosystem services, including food production.

In fact, this is an example of a measure that might be deployed in combination with aquaculture activities. The primary condition to apply this active restoration measure is to have a **bottom-trawling free area**, another advantage to combine this solution within a wind farm area.

Recommendations

Positive effects and synergies between wind farms developments and national conservation strategies should be promoted and developed using an ecosystem-based approach.

Scientific research can support regulators in dealing with the knowledge gaps, which represent today a bottleneck in the consenting processes of offshore wind farms. Sound evidence on environmental impacts resulted from real life monitoring or research programmes would allow regulators to take a swift from applying the precautionary principle and propose mitigation measures that are cost-effective and tailored to site-specific conditions.

<u>In conclusion, we recommend to:</u>

- *Plan wind farms as preventive tool to reduce human pressure on benthic habitats;*
- *Complement wind farms with active seabed restoration actions;*
- *Promote collaborations with windfarms operators in environmental monitoring actions, research and innovation, data sharing and implementation of latest technology available.*

Other forms of energy and storage

SUMMARY

- *Maritime Spatial Planning can improve cross-sector cooperation and thus minimise spatial conflicts.*
- *Combining offshore wind with other forms of energy generation, such as wave, tidal energy or with energy storage, could speed up research and development of these technology.*
- *Large scale demonstration projects are still needed in order to maximise the gain of co-locating different energy sources or storage.*

Maritime Spatial Planning and co-location

Maritime Spatial Planning (MSP) is a tool which Member States use to organise and optimise their sea space, in line with their national objectives.

Increased activity within Europe's marine waters has led to increased spatial demands and therefore growing competition between sea users. **MSP is key to enhancing offshore wind development and improve cross-sector cooperation** (aquaculture, fishing, energy, military, tourism and transport) and thus minimize spatial conflicts.

Co-location is the sharing of the space among different users or activities. In most countries, offshore wind farms represent a no-go area. With the increasing density of activities along the coasts and expansion of the offshore wind energy sector, government can allow different activities to take place within windfarms as a concrete tool to solve spatial conflicts and increase the functionality of the sea.

Co-location of offshore windfarms with other energy sources

Over the past decade, many research activities and pilot projects, have brought ocean energy technologies to a pre-commercialisation phase. **The energy generation diversification can enable a more stable stream of electricity and increase the production in terms of MW/km^2** while speed up research and development of these technology.

Different offshore generators would have the possibility to **share the grid infrastructure, logistics, operations and maintenance.** With a proper design, other sources of energy and wind energy could **enhance the shadow effect** and **reduce the overall environmental impacts.** The shadow effect is the phenomenon of wave attenuation caused by offshore wave converters harvesting energy. There is evidence that this **could allow O&M vessels to extend their operational time window due to attenuated wave disturbance.** For this reason, a proactive approach in exploring at this early stage, co-location option, is necessary.

Different solutions are available to combine wave converters and wind turbines, ranging from co-located (independent or combined arrays) to hybrid systems. **Co-location is clearly the easiest to implement** while also **delivering the benefits of sharing permitting, construction, grid connection and O&M costs**.

However, the wave potential in the southern North Sea needs a more mature technology to become economically viable. Devices able to exploit a considerable amount of energy from short waves are **still under development** and **demonstrators are needed** to develop a business case in the BPNS.

This combination has surely an important potential and has been studied under EU funding within ORECCA, Tropos, Mermaid and H2OCEAN.

Co-location of offshore wind farms and storage

Energy storage systems can **balance the fluctuation of wind energy production** and control the balance between generation and demand through power plant scheduling and power balancing. Therefore, **the power surplus is stored for later use** when energy is needed in the grid. To optimise the reserve levels requires a prediction of the accuracy.

There are different methods available to store the energy surplus. **Pumped water systems** use the exceeding power to pump water to the high reservoir, which is then released to a lower reservoir to produce hydroelectricity when power is needed.

Energy storage in **high energy density batteries** is also possible. Some disadvantages include the specific operating conditions, lifetime and cost. Batteries require a control system to optimise the charge and discharge of the system to prolong its lifetime.

Hydrogen is a versatile and widely applicable energy carrier. Hydrogen could be a key vector for sector coupling, seasonal storage and providing new links between power production and consumption areas. However, in the absence of existing oil and gas platforms and pipelines, offshore hydrogen storage is not commercially feasible yet.

Recommendations

Governments and private sector should keep **promoting research activities**, especially in a co-use perspective, for ocean energy technologies. if demonstration projects are facilitated in the North Sea, manufacturing, assembly and maintenance activities will cluster close to the coast, and will serve as a base for future offshore energy activities. This will allow Belgium to translate its potential into **local jobs, manufacturing activities and exports.**

Governments also play a role in facilitating the smooth implementation of the projects as **a key-demonstrator** of wind-wave combination in their waters, helping to de-risking projects - e.g. by exempting it from ‘balancing responsibility’, by providing priority dispatch or allocating specifically designed feed-in tariffs.

In conclusion, we recommend to:

- *Promote pilot tests of co-location options to consolidate the wave technology, allowing governments to gather evidence and design a dedicated framework;*
- *Support research and innovation actions to increase knowledge on synergies between the energy systems and cumulative environmental effects;*
- *Promote the established Belgian Supply Chain which is key to create local value;*

Fishing

SUMMARY

- *Maritime Spatial Planning can improve cross-sector cooperation and thus minimise spatial conflicts;*
- *Other countries' experiences showed that an extensive dialogue, communication and clear safety rules could allow the two sectors to share the space at sea*
- *Long-term options for multiple potential uses should be tackled at an early stage in the planning process and discussed systematically with the fishing sector.*

Maritime Spatial Planning and co-location

Maritime Spatial Planning (MSP) is a tool which Member States use to organise and optimise their sea space, in line with their national objectives.

Increased activity within Europe's marine waters has led to increased spatial demands and therefore growing competition between sea users. **MSP is key to enhancing offshore wind development and improve cross-sector cooperation** (aquaculture, fishing, energy, military, tourism and transport) and thus minimise spatial conflicts.

Co-location is the share of the space among different users or activities. In most countries, offshore wind farms represent a no-go area. With the increasing density of activities along the coasts and expansion of the offshore wind energy sector, government can allow different activities to take place within windfarms as concrete tool to solve spatial conflicts and increase the functionality of the sea.

Co-location of offshore windfarms and fisheries

Wind farms might be located in waters shared with the fishing industry.

Commercial fishing – with seabed-disturbing gears – **has a high risk of interference** with wind farms and related assets. Passive fishing - with no seabed disturbing gears - might be allowed within operational windfarms (e.g. United Kingdom).

Adopting **fishing friendly methods for cables protection** and **improving the mapping of potential seabed hazards** would help to increase co-existence between the two sectors. **Wind energy** developments can also **create new opportunities and supporting roles for fishing industry** entrepreneurs. For example, **for guarding, safety and surveying roles**, work that can be welcome when fishing opportunities are restricted or fish quotas exhausted (West of Morecambe Fisheries ltd example, which manages community funds).

There are risks in allowing fishing vessels, even with with passive gears, to sail close to or within wind farms. **Co-location options will depend on site-specific characteristics** – such as ecological importance and park layout - and site management plans. Certain areas may become more difficult to access in order to avoid interference or collision with wind turbines and underwater structures and cables.

In the case of the **United Kingdom,** the two sectors have consulted each other on offshore developments since 2002 as part of the **Fishing Liaison with Offshore Wind and Wet Renewables group (FLOWW).** Its objectives are to enable and facilitate discussion on matters arising from the interaction of the fishing and offshore renewable energy industries, to **promote and share best practices, and to encourage liaisons between other sectors** in the marine environment. The group is facilitated by a secretariat funded by The Crown Estate. Another example is West of Morecambe Fisheries, which manages projects funded by offshore wind farm owners that will benefit the whole fishing community.

Another example of mitigation in the UK is the **compensation for disturbance and loss of earnings caused during construction**. However, there is no legal basis in the UK for economic compensation of losses as a consequence of new habitat displacement or disruption of fishing activities (during surveys, construction or operation of the wind farm).

The document Best Practice Guidance for Fishing Industry Financial and Economic Impact Assessments, provides methods for calculating financial impacts as a result of areas closed or restricted to fishing.

The document was published in 2012 from the UK Fisheries Economic Network (UKFEN) and relies on the basis of negotiations among sectors, transparency, science-based evidence, alternative employment and honour agreements.

Recommendations

Synergies can be developed between the energy and fishing sector. **Collaborative approaches should be supported by local authorities and project developers**. It is essential that all long-term options for multiple potential uses are presented at an early stage in the planning process and discussed systematically.

Innovative approaches should be promoted, such as the employment of local fishermen (those who can count on appropriate vessels) in wind farm-related work such as Guard Boat or Stand-by Boat as well as bird and mammal watch for environmental monitoring. This has proved effective especially when fishing quotas were exhausted. In addition, existing vessels may be replaced or upgraded in order to ensure compatibility with cables and other infrastructures as well as environmental goals.

In conclusion, we recommend to:

- *Promote and support collaborative approaches with government, fisheries and project developers;*
- *Learn from experiences from other countries (UKs and the Netherlands, in particular) to understand and overcome issues between the sectors;*
- *Promote and further explore potential compensation measures such as alternative employment and Fisheries Funds.*

Annex III – Proposed mitigation measures for transit and co-use from the Dutch government

List of proposed mitigating measures 2015 dossier, as described in *Uitwerking besluit doorvaart en medegebruik van windparken op zee, in het kader van Nationaal Waterplan 2016 – 2021* (Rijkswaterstaat, 2015). Source: Arcadis, 2018.

a) Conditions that will be part of the policy as described in the 'waterwet':
   a. Transit of the wind farm safety zone is allowed solely for ships up to 24 meters length;
   b. Transit of the wind farm safety zones is allowed by day light only;
   c. Transit of the wind farm safety zones is allowed for ships with active VHF communication equipment which is used to communicate while crossing the wind farm area;
   d. Transit of the wind farm safety zones by professional fishers is allowed when their bottom disturbing fishing gear is carried in a position above the waterline, where it is visible;
   e. Bottom disturbing activities, like anchoring, dragging of fishing gear, are forbidden within the wind farm safety zone;
   f. Within the wind farm safety zone, third party diving activities are forbidden;
   g. Professional fishing is allowed if, and only if, the fishing gear is specified as permissible by the Dutch government. This will be written in a framework in which the risks for wind farms, ecological risks, economical potential and enforcement possibilities are taken in consideration;
   h. Within the wind farm safety zone, it is forbidden to perform activities that endanger or obstruct the wind farm exploitation. Any third-party activity within 50 meters from a turbine is considered to be dangerous or obstructing;

b) The 500 m safety zones around offshore transformation zones, or offshore high voltage stations will not be changed;

c) **The Dutch government will develop and implement an information strategy to inform and instruct all stakeholders of the policy changes regarding the wind farm safety zones.** A code of conduct will be developed containing examples of preferred behavior which is not caught in obligatory rules. Amongst other, attention will be paid to the risks of entering a wind farm with bad visibility or storm and the advantages of Personal Location Beacons and AIS-SART. Activities to provide information, as well as the development of the code of conduct will be organized in cooperation with the stakeholders;

d) The Dutch government will develop a plan to monitor and evaluate the proposed relaxation of the safety zone. The behavior of third party persons will be monitored and evaluated over a period of two summer seasons, in which above proposed rules are applied. In this monitoring and evaluation program, surveillance and enforcement activities performed by the State will be included. Also, attention will be paid to the options and costs of monitoring systems and equipment, both evaluating and looking forward. Part of this system will be an exchange of information between wind farm owners and the Dutch coastguard;

e) Newbuild wind farms will be opened when the entire area is developed. This starts with the Borssele wind farm area. Necessary measures and conditions will be determined based on the above-mentioned evaluation;

f) The Dutch government will take care of the installation of the necessary sensors and systems to effectively monitor the affected wind farm areas;

Annex IV – Extract from UK's "Marine Guidance Note 543"

Annex 1.4. Assessment of Access to and Navigation Within, or Close to, an OREI

It should be determined to what extent navigation would be feasible within or near to the OREI site itself by assessing whether:

a) Navigation within and /or near the site would be safe :
   - for all vessels, or
   - for specified vessel types, operations and/or sizes.
   - in all directions or areas, or
   - in specified directions or areas.
   - in specified tidal, weather or other conditions.

b) Navigation in and/or near the site should be :
   - prohibited for specified vessels types, operations and/or sizes.
   - prohibited in respect of specific activities,
   - prohibited in all areas or directions, or
   - prohibited in specified areas or directions, or
   - prohibited in specified tidal or weather conditions, or simply
   - recommended to be avoided.

c) Exclusion from the site could cause navigational safety, emergency response or routeing problems for vessels operating in the area, e.g. by causing a vessel or vessels to follow a less than optimum route or preventing vessels from responding to calls for assistance from persons in distress (as per SOLAS obligations).

d) Guidance on the calculation of safe distances of wind farm boundaries from shipping routes can be found in Annex 3 "MCA Template for assessing distances between wind farm boundaries and shipping routes".

SOURCE: gov.uk