M3.1 BUSINESS BRIEFS

BELGIAN PILOT

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Authors:

Manuel Lago - ECOLOGIC,
Youssef Zaiter -ACTeon

Editor:

Ivana Lukic,
Submariner Network for Blue Growth EWIV

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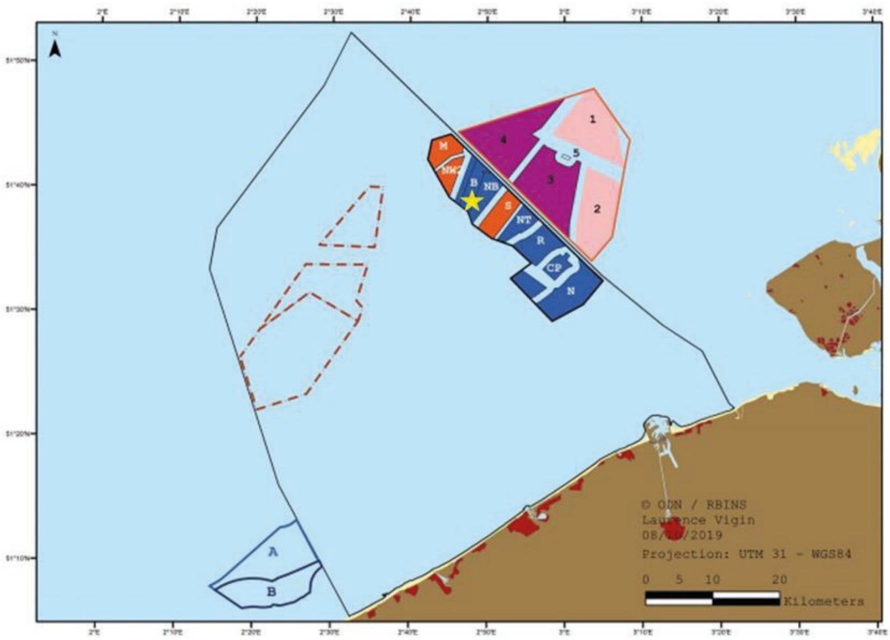
OBJECTIVE OF THE PILOT

The Belgian (BE) pilot had two main objectives. The primary objective was to evaluate Offshore Wind Farms (OWFs) as a suitable location for restoring native flat oyster reefs in combination with culturing flat oysters and seaweed for human consumption. The secondary objective was to compare the growth of sugar kelp cultivated offshore and nearshore.

CONTEXT OF THE PILOT

The BE pilot is situated in the Belgian Part of the North Sea (BPNS), more specifically in the OWF of BelWind (see below illustration), and combines three different activities: Offshore Wind Energy, European Flat Oyster (*Ostrea edulis*) aquaculture and reef restoration, and seaweed (*Saccharina latissima*) cultivation.



Technological readiness level (TRL)

The BE pilot is composed of 56 wind turbines, collectively generating 171 MW of electricity. The production of local aquaculture products and seaweed cultivation is carried out in the same location – the longlines are installed between the empty spaces of the wind turbines.

The technology readiness level (TRL) of the Belgian pilot at the end of the project was set between 5 and 6, which can be characterized as "Technology validated and demonstrated in a relevant environment (with an industrial relevance for key enabling technologies)". The individual TRL level of OWFs is 9. As for the other activities, they are presently undergoing testing in the pre-operational phase of the pilot.

Legal characterisation

The Belgian Marine Spatial Plan (MSP) emphasizes the importance of multi-use as the primary standard for activities in the same area, particularly within OWF zones in the Belgian part of the North Sea. Initially, approval from the wind farm concession holder is necessary for activities like aquaculture, restoration projects, or passive fisheries to operate within the wind farm concession zone. However, this requirement is expected to be eliminated in the future, and new renewable energy proposals will consider multi-use activities as a criterion.

In the case of the Belgian pilot, UGent is responsible for establishing oyster and seaweed activities within the wind farm concession area of Parkwind. They obtained approval from the wind farm concession holder by fulfilling three requirements: performing a risk analysis, submitting a project method statement, and obtaining additional insurance to cover third-party liability.

Currently, single-use permits have been granted for individual projects within the OWF, aquaculture, and seaweed initiatives. These permits come with varying terms, causing discrepancies in expiration dates. It is unclear how these permits will be managed in a multi-use context, especially when one activity continues after another permit expires.

There is also uncertainty about whether all installations must be completely removed at the end of the concession or permit period. Legislation regarding partial removal and its associated conditions is lacking.

Within the OWF area, certain activities, such as vessel traffic and fisheries, are strictly prohibited, allowing only specific vessels to enter the concession area, including those related to the OWF operation, governmental vessels, and scientific vessels involved in monitoring.

The permitting process differs for scientific and commercial projects within the wind farm zone. Scientific projects typically proceed more swiftly, while commercial projects involve a more complex permitting procedure with various requirements and obstacles.

Insurance issues were addressed by UGent, which needed to acquire two additional insurances to protect their assets and liability. Market consultation for insurance policies, particularly for public institutions like UGent, can be time-consuming, so planning and budgeting are essential to obtain the necessary insurance on time.

Environmental characterisation

The BPNS is characterized by submerged sandbanks and gullies influenced by tidal currents. The OWF is situated at the northern edge of the BPNS and consists of three sandbanks and adjacent gullies. The region has a temperate oceanic climate with a mean temperature ranging from 3°C in the coldest month to 16.9°C in the warmest month.

The installation of wind turbines has both positive and negative impacts on biodiversity. Positively, the turbine foundations create new habitats for marine species, and the OWF area, restricted to fishing and vessel traffic, has led to an increase in fish populations.

Moreover, the restoration of flat oyster reefs in the BPNS will positively impact the environment and protect the reefs from fishing. Oyster reefs offer ecosystem services, including improved water quality, enhanced fish production, sediment stability, and possibly carbon sequestration. They serve as essential habitats for various fish and invertebrate species, promoting biodiversity. Additionally, the increased abundance of invertebrates and small fish attracts predators like larger fish, seabirds, and marine mammals.

The combination of aquaculture, oyster reef restoration, and seaweed cultivation is a form of extractive aquaculture, providing a sustainable approach. Both oysters and seaweed help purify the surrounding water.

However, potential negative impacts include an increased risk of bird collisions with wind turbines. The multi-use pilot site experiences elevated traffic due to wind turbine maintenance, aquaculture activities, and scientific research, which may increase the risk of accidents, such as collisions and spills of harmful substances.

Socio-economic characterisation

The BE pilot comprises 56 wind turbines with an overall installed capacity of 171 MW, with a yearly production estimated at 550 GWh per year. The electricity generated by the OWF benefits 160 000 Belgian homes. The revenues of the OWF are fixed at (roughly) 30 EUR per MWh with a governmental subsidy equal to 107 EUR per MWh. Thereafter, the revenues of the OWF can be estimated at 75 million EUR per year.

In terms of employment, the number of workers to install the OWF varied between 280 to 300 FTE per day depending on the type of activities to be done. Other activities related to operation and maintenance of the OWF are carried out each year to guarantee the well-functioning and production of electricity from the turbines. However, no information on the number of employees needed for the operation of OWF was provided.

Concerning aquaculture activities:

- Seaweed production in Belgium is currently very small consisting of only small production provided by startups. The socio-economic data revealed that there are currently only three companies operating in the algae (micro and macro) production industry. Looking at companies focusing only on macroalgae (seaweed) production, the turnover is estimated at 0.164 million EUR per year and employs 101 employees.
- Oyster production in Belgium is also considered small and relatively new. The investigations identified two companies located in Ostend (near the pilot site). The first company operates on an 8 to 9-hectare farm and produces flat oysters (10% of total production) and common cupped oysters (90% of total production), with an estimated annual output of around 30 tons, subject to weather conditions. The second company operates with 3 aquaculture lines and produces approximately 10 tons per year. The farm is situated 5 kilometers offshore at the same location as the UNITED pilot. The company is aiming to upscale its production to cover 30 plots, with each plot consisting of 4 aquaculture lines. Hence, the country's total oyster production could be estimated at (approximately) 50 tons/year.

BUSINESS ANALYSIS

Business Model Canvas Results

The Business Model Canvas showed that shared characteristics among the various pilot activities lead to several advantageous synergies. These synergies encompass:

- Cost reduction, especially in monitoring expenses (covering wind turbines, restoration, and aquaculture activities) and transportation costs (the co-location of multiple activities enables the use of the same service vessels and their crews).
- The utilization of the same port facilities.
- The use of shared infrastructure by both the offshore wind farm and the aquaculture activities.

Consequently, the combination of these activities results in advantages for the various stakeholders involved in the pilot. These benefits are translated into monetary gains, primarily derived from cost savings related to transport vessels, decommissioning expenses, and monitoring activities. On the other hand, considering the differences, the pilot's Business Model Canvas comprises distinct key activities, each offering unique value propositions to end consumers and targeting different customer segments.

SWOT Analysis for multi-use set up in the Danish pilot.

Strengths	*Weaknesses*
• Synergies between different activities could reduce cost of each activity individually • Combination of multiple activities means multiple streams of revenues, which can make the pilot more robust • Strong marketing story in relation to sustainability • Ecosystem services might bring in extra money • Partners with expertise in engineering, sustainability, offshore, aquaculture, product quality, market insights	• Harvest and structures itself are dependent on the occurrence of (big) storms • The wind parks are relatively far from the coast, which increases the cost per boat trip and fuel use • Oysters are high-maintenance products due to need for anti-fouling • High insurance cost because of new activity and because of combination with wind energy • Currently no revenues from ecosystem services like restoration of oyster reefs
Opportunities	***Threats***
• New Belgian Marine Spatial Plan: new zone for energy production has strict condition that it needs to be coupled with extra activity • New developments in antifouling techniques • New developments in automation of activities at sea • New developments in robust, offshore materials • Strong tendency to buy locally • Strong tendency to buy more sustainable products • Shift towards alternative protein sources • It is prohibited for fisheries and other vessels to enter the wind parks, which makes it a suitable zone for restoration and aquaculture • Success of Belgian hatcheries and oyster reef restoration to ensure qualitative spat of oysters	• Disease outbreak – oysters getting sick because of viruses and bacteria's. • Offshore location is highly dynamic environment, which poses a risk for loss of product or materials • Regulations (FAVV, MER): Environmental Impact Assessment could pose limitations; FAVV: required quality testing is very extensive, sampling has high cost • Market for flat oyster is relatively limited in comparison to market for Japanese oyster • Market for flat oyster is mostly concentrated during the end of the year, which poses challenges for processing • Market for seaweed is very new • Dependency on concession holders • Dependency on boat operator or processor if not in-house • Weather dependency: not possible to do maintenance or harvest when weather is not good enough or too unpredictable (weather poses a risk to the structures) • Dependency on delivery of oyster spat or starting material for seaweed • Climate change: increasing occurrence of (big) storms, acidification, & increase in sea surface temperature • Uncertainty of the future of (monetarization of) ecosystem services • Inherent safety and security risks at sea

The establishment of the pilot is highly influenced by many external and internal factors. These factors are various and may have positive and/or negative impacts on the development of the pilot.

On the first hand, regarding the positive factors, the pilot is positively influenced by the political factors where the new Belgian Marine Spatial Plan requires the new OWFs to include other activities including extractive aquaculture, passive fisheries, and other renewable energy activities. This is seen as insurance for the development of several activities in offshore wind farms, in particular activities related to aquaculture. Also, pushing to have more aquaculture activities within the OWF, by the political decision-makers, is an opportunity for the Belgian pilot to develop its activity.

Adding to the political factors, technological development and improvement will positively influence the development of the pilot. This is true for the aquaculture activity where a) the technology improvement in OWFs and having bigger turbines allows to have more space to install larger lines for aquaculture activities, and b) the automation of monitoring for aquaculture activities leads to cost reduction and gain in time to detect any anomaly. Concerning the environmental factors, they also have a positive influence on the Belgian pilot, especially for habitat creation and restoration. Finally, on social acceptance, the new consumer trends to consume local products allow an increase in the sales of the pilot and increases the social acceptance of such activities. These factors (political, technological, environmental, and social) are seen as opportunities for the pilot which the pilot needs to take advantage of.

On the second hand, even though the Belgian pilot has several opportunities to develop, several threats and weaknesses exist. These factors are related to: (a) the location of the pilot leading to an increase in transportation, installation, and operation and maintenance costs; (b) dependance on weather conditions, where the increase in the frequency of storms and ocean acidification negatively influences the development of the pilot activities; and (c) several European and national regulations related to food safety and food quality leading to additional testing of the products and therefore additional cost, and time before putting the products on the market.

POTENTIAL FINANCIAL AND ECONOMIC IMPACTS AND ADDED VALUE.

Aside from potential financial gains, several environmental, social, and economic positive impacts have been identified in our study from combining offshore wind energy and aquaculture.

The following table summarizes the impact analysis results of the DK pilot.

Impact name	*Multi-Use Impact Description*	*Multi-use impact size* Low/Medium/High: Positive/Negative
Substitution of non-renewable energy, and energy provision, independence, and security	The integration of aquaculture and seaweed longlines with OWF foundations is not expected to have any specific multi-use impacts on energy provision, independence, and security. The OWF foundations are installed in advance of the aquaculture and seaweed long-lines, which means that energy production activities will not be interrupted. It is anticipated that clean and sustainable energy production can continue at the same rate in a multi-use context as in a single use context.	Low; Positive
Reduction in GHG and carbon sequestration	Each of the three activities (aquaculture, sea-weed cultivation, and OWF) contribute to carbon sequestration and the reduction of greenhouse gas (GHG) emissions on their own. The OWF has the potential to reduce 270 000 tons of $CO2$ per year. In a multi-use context, it is expected that the reduction in GHG emissions will continue and may even be enhanced. However, to present, there is no scientific evidence supporting this hypothesis, nor quantification of the GHG reduction from a multi-use context. Therefore, no impact (positive or negative) can be assumed on the potential reduction of the combined activities.	Low; Positive.
Local sustainable food provision	The production of aquaculture and seaweed is conducted within the empty space of the OWF. Consequently, there is no influence on the OWF activity due to the presence of aquaculture and seaweed activities. On the contrary, the combination of activities results in a positive impact on the environment through the reduction of the use of marine space and subsequently reduction in the pressure on the marine environment.	Medium; Positive

Habitat and fish stock improvement	Each of the three activities can contribute to improving habitat and fish populations on their own. However, the location combining the different activities may be considered as a protected area, making the OWF off-limits to fishing and vessel traffic gives it this effect of a protected area. As a result, the OWF foundations will constitute an artificial reef and help in protecting and enhancing biodiversity. Moreover, the foundations of the OWFs can attract various fish species, and the installation of aquaculture activities is likely to increase their attraction to the area. In addition, it is important to note that the installation of aquaculture and seaweed activities was made possible by the existing foundations of the OWF. Therefore, the OWF foundations played a crucial role in enabling the development of these activities, mainly related to reducing transportation cost for aquaculture and seaweed activities (the companies will use the maintenance and operation vessels of the OWF to install and carry out other monitoring and operation activities), and, potentially, a reduction in investment cost (the companies will use the already existing OWF installation and install their lines in the empty space between the turbines).	High; Positive

OUTLOOK AND RECOMMENDATIONS

For the economic potential of multi-use to materialize in the Belgian pilot, it is first crucial to address currently existing regulatory challenges. The complexity associated with multi-use projects demands clear and comprehensive regulatory frameworks to facilitate quicker and more straightforward permitting and licensing procedures. As part of this process, early-stage planning could be encouraged to ensure that multi-use activities are integrated into the initial design of offshore wind farms, avoiding the complications of retrofitting additional activities later. An example can be found in the recent Belgian initiative, which mandates the consideration of multi-use activities in offshore wind farm development. An ex-post analysis of the implementation of these requirements would be very helpful to evaluate whether such regulatory measures could facilitate or not new OWF applications, for instance by giving OWF a comparative advantage against other uses because of the potential positive impacts of multi-use.

Such regulatory challenges also underpin the need for a larger political support for multi-use, which at the moments is not sufficiently recognized as a valuable tool to bring forward a variety of strategic EU policies, for instance on climate change mitigation through the promotion of renewable energy or the development of the blue economy. Only through a decisive political support it will be possible to create the required incentives for multi-use projects to develop, such as the licensing requirement in Belgium. Also, there is a pressing need to create new financing opportunities, for instance through dedicated grants, that will allow the relatively new multi-use businesses to establish themselves in a competitive market. Moreover, policy makers could also play a crucial role in facilitating trust between the wind and other offshore sectors to bolster collaborative efforts and streamline multi-use implementation.

Discover United follow-up project: ULTFARMS

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