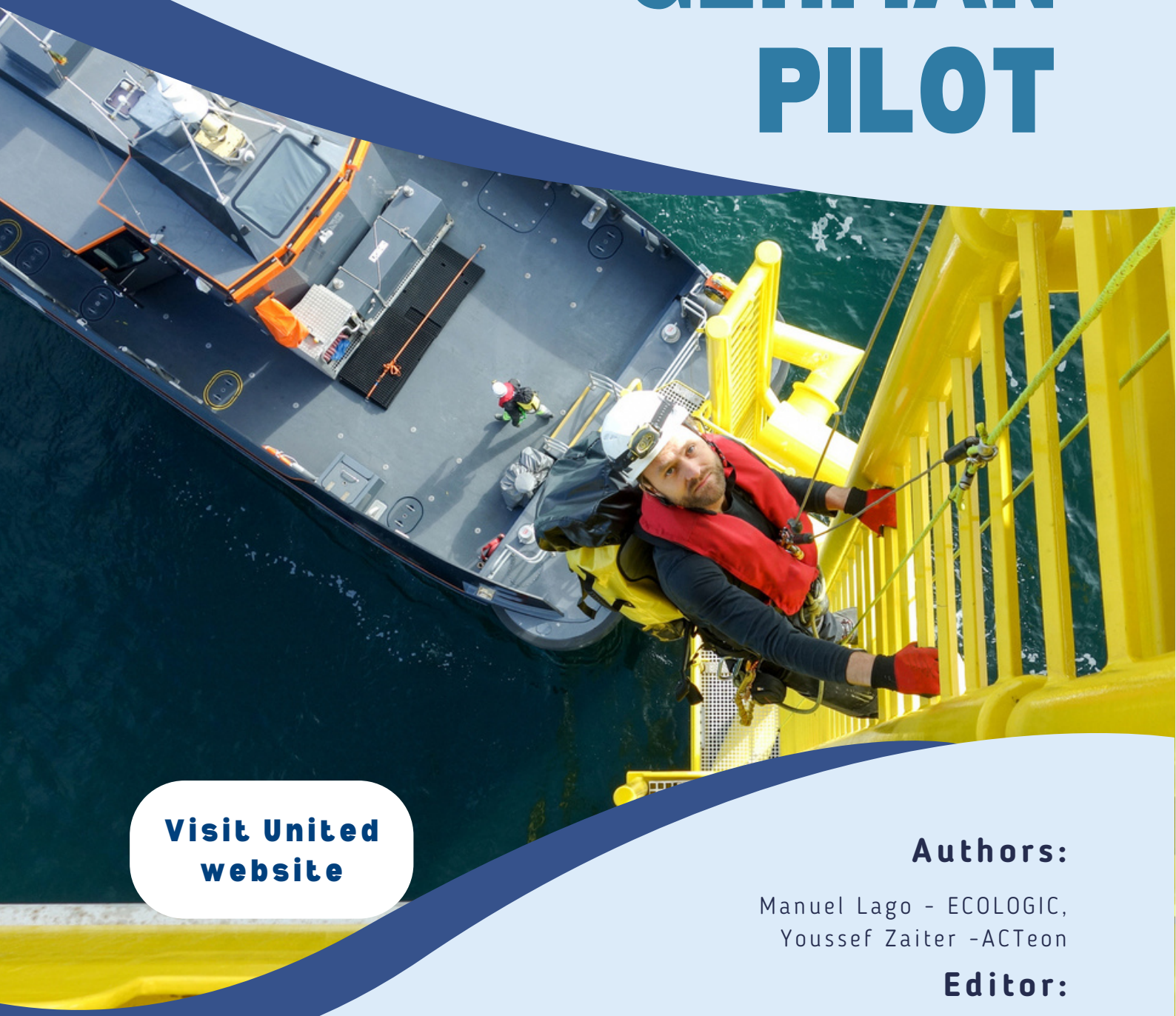
M3.1 BUSINESS BRIEFS

GERMAN PILOT



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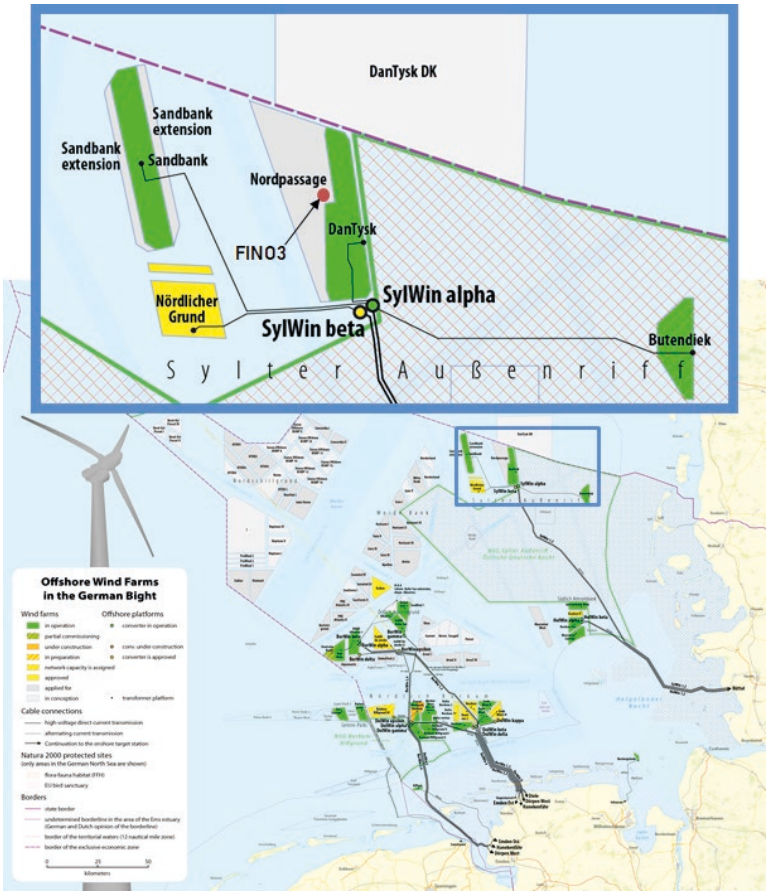
OBJECTIVE OF THE PILOT

The German pilot aimed to develop, operate and evaluate an offshore demonstration aquaculture farm with mussels (Mytilus edulis) and macroalgae (Saccharina latissima) at the offshore research platform FINO3. Another objective was to investigate multiuse possibilities in the North Sea between off-shore wind energy generation and aquaculture.

CONTEXT OF THE PILOT

FINO3 is located in the German North Sea, 80 kilometers west of the island Sylt, and can be considered exemplary for the operation of wind turbines. Because of its research nature, the pilot did not aim to develop a commercially viable multi-use operation of wind power and aquaculture.



Technological readiness level (TRL)

The TRL level of the German Pilot at the end of the project was set at TRL 7, which is defined as "Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies) ". While the single activities (the research platform FINO3 and the near-shore aquaculture farm KMF) are already operational and are thus categorized as TRL 9, their successful adaptation to and implementation in the challenging offshore environment in the North Sea requires complex logistical and technical adjustments.

Legal characterisation

Located in the German EEZ and under the jurisdiction of the federal government, any installation in the pilot area must follow the planning, licensing and operating procedures regulated in the **Marine Facilities Act** (Seeanlagengesetz, SeeAnG) from 2017, including latest relevant amendments of the **Offshore Wind Energy Act** (Windenergie-auf-See-Gesetz, WindSeeG 2017) .

In addition, the **Decree on the Maritime Spatial Plan (MSP) for the German Exclusive Economic Zone in the North Sea and Baltic Sea** (*Verordnung über die Raumordnung in der deutschen ausschließlichen Wirtschaftszone in der Nordsee und in der Ostsee*) needs to be considered. Offshore installations also need to comply with the **Federal Nature Conservation Act (**Bundesnaturschutzgesetz, BNatSchG**)**.

Environmental characterisation

The location of the German pilot has a temperate oceanic climate. The coldest month has a mean temperature of -4°C while the hottest month has a mean temperature of 21°C. The seabed serves as a habitat for a wide variety of organisms which are an important part of the North Sea ecosystem. Several risks exist to the successful operation of the aquaculture site due to environmental factors:

- **Climate change risk** –increase frequency and intensity of extreme weather events that can lead to a loss of aquaculture products as well as increased difficulties in operating the multi-use projects. Other factors such as rising ocean temperature, or ocean acidification might have impacts on the aquaculture.
- Untested spat fall and growth rates of mussels and macroalgae at offshore location. This makes it difficult to predict yields of offshore aquaculture. Growth rates of mussels and seaweed were comaparable high during the duration of the project indicate a promising opportunity for Europena offshore aquaculture.
- **Low risk of pollution or infestation** of the harvested mussels due to long distance to shore.
- **Degradation of fisheries driving aquaculture** – mussel and macroalgae aquaculture provide a sustainable alternative to overfished fisheries, allowing fish stock to recover.
- **Toxic algae blooms** before the harvest that can lead to contamination of aquaculture products, which as a result can no longer be sold.
- **Sufficient level of nutrients** for growth of mussels and macroalgae at the offshore location. The monitored growth rates indicate a sufficient supply with nutritiens at this site.

Socio-economic characterisation

The German OWF sector had 24,400 employees in 2018. Sales have been estimated at a level of around 8.1 billion euros and in the same year, 2018, the direct gross value added in Germany in amounts to 1.9 billion euros. The largest share of direct employees (14.5%) is working in the manufacturing of turbines.

According to aggregated data for the Federal States of Lower Saxony and Schleswig Holstein (federal states with access to the North Sea coast) there are approx. 3000 ha of areas designated for mussel fishing and up to 500 ha used mussel spat production in aquaculture, in total 12 fishing vessels with special permission for fishing mussels distributed among 10 companies for a total of approximately 50 direct employees

BUSINESS ANALYSIS

Business Model Canvas Results

The Business Model Canvasses for the German OWF and aquaculture companies show that there are similarities between the activities allowing for synergies that could reduce costs. Realising these synergies would require coordinating means of communication, operations and maintenance timetables, training requirements and procedures (e.g. emergency responses). There is potential for synergies, and thus costs reductions, from sharing:

- transportation (ships, helicopters) for routine monitoring and maintenance trips – which would also reduce environmental impact of transportation;
- offshore maintenance work;
- onshore and offshore storage spaces and workshops;
- environmental monitoring data and surveillance;
- certified offshore staff and training;
- insurance premiums.

In addition to benefits for both parties of the multi-use, there are some advantages of multi-use which only accrue to the aquaculture business. First, the offshore location would allow the aquaculture to make use of economies of scale which it could not exploit in the nearshore area. In addition, the monitoring and surveillance program (type of sensors, possible parameters, duration of measurements) will not be limited by the availability of batteries, as the aquaculture farm can be supplied with power from the platform. It would also be possible for the aquaculture farm to benefit from equipment present on the wind turbine fundaments, e.g. cranes. It would even be technically feasible to use the turbine's monopile for mooring the longlines, if this is taken into account in the design of the wind turbine from the beginning. In general, realising the benefits of multi-use is easier if both activities are planned together from the outset.

SWOT Analysis for multiuse setup in the German pilot

Strengths	Weaknesses
• Cost savings from synergies • Improved reputation and acceptance of offshore wind and aquaculture • Mitigation of spatial conflicts • Positive environmental impact through nutrient removal • Potential for certifications of products • Possibility to produce uncontaminated mussel spat • Alleviate pressure on fish stocks and land-based production systems	• Lack experience with offshore aquaculture • Challenging offshore environment • High demand for automation • Delays due to complexity of multi-use • Potentially interfering operations • Ambiguous assignment of rights and duties between partners • High investment and lack of finance • Uneven financial benefit from multi-use
Opportunities	**Threats**
• Fast-growing blue economy • Political support for multi-use at EU and national level • Finance possibilities opened up by positive social and environmental externalities • Potential for setting up local cooperative ownership structures	• Uncertainty about biological feasibility • Unknown cumulative environmental impacts • Contamination from algal blooms • Shortage of staff and sub-contractors • Social acceptance issues • High insurance costs • Unclear legal status, lack of clarity on permit and EIA procedures

Wind power and aquaculture multi-use projects in Germany can take future advantage of existing political support at the national and European levels for aquaculture, renewable energy, the blue economy, and multi-use. There are existing markets for mussels and developing markets for macroalgae, as well as additional business opportunities for these products to be developed in the future. The societal attitude towards multi-use is generally positive.

This pilot shows that there are some suitable key environmental factors for the growth of the proposed mussels and macroalgae species at the studied offshore location. Currently, there are also several external challenges, such as a lack of political incentives and support for multi-use projects in Germany and a lack of finance. There are also social acceptance issues regarding aquaculture products and insufficient connection and trust between the wind and offshore sectors. In addition, the high-energy offshore environment is challenging, and there is a lack of certainty about regulations and difficulties to obtain permits.

From a business perspective, offshore wind power and aquaculture multi-use projects would require significant investments and thus be only profitable in the medium to long-term. Unknown growth rates of mussels and seaweed at offshore locations, long distance transportation of products, as well as fluctuating market prices for aquaculture products, need to be considered when developing a business model in this field.

From the multiuse perspective, there are opportunities for cost savings from sharing transportation, monitoring, and maintenance work, land-based and offshore facilities, staff and training, as well as insurance premiums between the aquaculture and offshore wind partners.

The business model of the German pilot showed the potential benefits of synergies between the different activities at the research platform. Due to the research nature of the pilot, further research is required in the future to determine the revenues associated with these benefits.

POTENTIAL FINANCIAL AND ECONOMIC IMPACTS AND ADDED-VALUE

The objective of this assessment is to evaluate the added value that can be expected from the German pilot activities. For the theoretical full-scale pilot, we consider a OWF exactly equal to the Belwind Windpark in Belgium but situated in the location of the already existing Dantysk Windpark (nearby the FINO3 research platform, where the German Pilot is situated) combined with the maximum amount of aquaculture systems that the location and German regulations would allow, independently of existing feasibility levels for the activity to take place.

Under different scenarios, the financial analysis shows that only by upscaling the aquaculture farm to a size seven times as large of that currently allowed and selling 25% of the yields at the highest possible market price (13€/kg) there is scope for the activity to break-even in the long run.

In addition, multi-use aquaculture operation co-located within an ocean wind farm can save up to 5% of annual business costs. Available studies show that the production of blue mussels with longline technology is profitable, especially if existing OWF facilities and equipment can be used

Aside potential financial gains, several environmental, social and economic positive impacts have been identified in our study from combining offshore wind energy and aquaculture (mussels and seaweed). Most importantly, these include:

Economic impact	Definition	Scale
Increased social acceptability	A driver for the OWF-sector to become involved in multi-use projects would be the assumption, that the acceptance of OWF would enhance when coupled with other uses (in this case aquaculture).	High; positive
Added value creation and local food production	Expanding aquaculture offshore in a multi-use context with OWF could make this sector go beyond the niche status it has and develop also the potential for selling to novel industries such as bio-technology (higher added value) and implementing circularity measures to generate move value per kg of production for instance through the valorisation of waste in line with a circular bioeconomy. This is added to the potential of offering local, sustainable delicacies for local populations in the districts of Dithmarschen and Nord-friesland	Medium; positive
Substitution of non-renewable fossil fuels, GHGs mitigation and carbon sequestration	OWF energy can replace fossil fuels. Offshore wind can abate in average 3.5 Mt of CO2 equivalents per GW energy produced when substituting coal, and 1.6 Mt when substituting natural gas. Mussel and Seaweed can support CO2 sequestration if harvested and left to fall to the seabed.	High; positive
Habitat and fish stock improvement	Areas with OWF lead to a reduction of fishing activities, therefore can reduce ecosystem pressures. Off-shore aquaculture can increase the abundance and species richness of wild mobile macrofauna. In addition, «non-fed» aquaculture has the potential to enhance various ecosystem services, including benefits for fisheries enhancement.	Medium; (potentially) positive.

OUTLOOK AND RECOMMENDATIONS

For the economic potential of multi-use to materialize in the German pilot, it is first crucial to evaluate the potential financial impact of existing regulatory challenges. There is currently a high-degree of complexity associated with multi-use projects, which is linked to businesses demands for clear and comprehensive regulatory frameworks to facilitate quicker and more straightforward permitting and licencing procedures in Germany. As part of this process, early-stage planning could be encouraged to ensure that additional multi-use activities are integrated into the initial design of offshore wind farms, avoiding the complications of retrofitting additional activities later during the implementation stage of the project. Such regulatory measures could facilitate especially new OWF applications, for instance by giving OWF a comparative advantage against other uses because of the potential positive impacts of multi-use. This may have important consequences for future investment opportunities in the sector.

Regulatory challenges highlight 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 or the provision of energy security. Only through political support, it will be possible to create the required incentives for multi-use projects to develop in Germany. In addition, 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 competitive markets. Moreover, policy makers could also play a crucial role in facilitating trust between the wind and other offshore sectors as this could bolster collaborative efforts and streamline multi-use implementation.

Discover United follow-up project: ULTFARMS

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