DELIVRABLE 7.1

REVIEW OF PILOT TRL, LEGAL ASPECTS, TECHNICAL SOLUTIONS AND RISKS

Work Package 7

Implementation of Multi-Use Concepts Within Pilots

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Author(s)	E. Brouwers, N. Meijer, E. Strothotte, M. Jaeger, A.M. Declercq, I. Drigkopoulou, H. Soerensen
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Approved by	El Serafy, G.
Project Officer	Lucia Pacillo / Giuseppe La Ciura
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ACRONYMES

MUP	Multi-Use Procedure
NSIL	North Sea Innovation Lab
OWF	Offshore Windfarms
Pv	Photovoltaic
OTA	State-of-the art
TRL	Technology Readiness Level
UNITED	multi-Use platforms and co-locatioN pilots boostIng cost-effecTive, and Eco-friendly and sustainable proDuction in marine environments
WiFi	Wireless Fidelity
KMF	Kieler Meeresfarm, Kiel Marine Farm

ABSTRACT

Over the past decade several initiatives have been undertaken to stimulate multi-use solutions and the fundamentals of multi-use have been developed. The challenge before us is to translate these solutions from the development state (TRL5) to demonstration in an operational environment (TRL7). The UNITED project has investigated the needs from pilots for accelerating the implementation of multi-use activities across the North Sea, the Baltic and the Mediterranean. The five pilots within UNITED aim to integrate multi-use activities with energy production, aquaculture or tourism. Interviews with these five pilots were performed to investigate the current status regarding multi-use pilot activities as well as any legal or risk management issues. Thereafter, a comparison of their status against the state-of-the art (SOTA) was made. This report provides insights in the knowledge gaps of multi-use activities as part of UNITED and helps to create synergy between the pilots with the aim of accelerating multi-use in Europe.

1. INTRODUCTION

Aquaculture is the fastest growing food producing sector in the world and the marine environment offers much greater possibilities to expand the earth's surface area for food production. Those activities are stimulated by the Blue Growth strategy initiated by the European Commission, as part of the long-term strategy to support sustainable growth in the marine and maritime sectors. Until recently, offshore platforms claimed unique user rights of the space surrounding the platforms, this position is becoming less tenable and multi-use of marine space and facilities is proposed as the more efficient and sustainable approach for business innovation and investment strategies. Over the past decade several initiatives have been undertaken to stimulate multi-use solutions and the fundamentals of multi-use have been developed. The challenge before us is to translate these solutions from the development state (TRL5) to demonstration in an operational environment (TRL7).[1]

UNITED & UNITED pilots

The UNITED project is part of the Horizon 2020 Research and Innovation Program and will investigate the needs for accelerating the implementation of multi-use activities across the North Sea, the Baltic and the Mediterranean. Within UNITED there are five pilots which are spread across the European seas, and are integrating multi-use activities with energy production, aquaculture and/or tourism.

The 'Noordzeeboerderij' – North Sea Farm

This report is written by the 'Noordzeeboerderij', a Dutch foundation that builds on a Dutch seaweed sector. By combining knowledge and connecting stakeholders, but also by providing input to relevant policies, the 'Noordzeeboerderij' strives for a sustainable and healthy seaweed sector in Europe. The 'Noordzeeboerderij' is part of WP7. As stated in the UNITED proposal, under WP7, there are three phases for the five pilots; 1) pre-operational phase engineering, assessment, redesign & adjustment, 2) operational phase, including installation, operation & monitoring, c) post-operational analysis, assessment and decommissioning. The current report provides insight in the pre-operational phase and reviews the pilots with respect to the knowledge and expertise already available in the project, also in further phases. In this way, this report may form a platform to exchange this knowledge across the pilots in an effective way so that each pilot may become more successful in achieving its goals.

The objective of this deliverable 7.1 (D7.1) is the assessment of the current status of TRL, legal aspects, technical solutions and risks and detailed scope of each of the five pilots after the initial design phase has been started. This allows to assess whether selected design solutions are the best way forward or if alternative solutions exist in the United project that may improve the success rate of the pilots and/or to have more positive impact on the TRL of multi-use solutions. To enable this assessment, this report defines the current state-of-the art (SOTA)[2] of the UNITED pilots. Based on this UNITED-SOTA, improvements for the pilots have been identified or suggested. Via the exchange of knowledge and experiences among the pilots these insights can be used to explore whether it's viable and useful to include these improvements. This report will help to facilitate this knowledge sharing process within UNITED.

Deliverable D7.1 is based on the information provided by D1.1. The newly gained insights of D7.1, regarding the technical status quo of the pilots, the state-of-the art review as well as a tentative consideration of technological risks will form the basis for further and more detailed risk analyses (WP6, D6.1), technological assessments (WP7, D7.2) as well as pre-operational design construction planning (WP2, D2.2).

[1] As stated in: 'UNITED: multi-Use platforms and co-locatioN pilots boostIng cost-effecTive, and Eco- friendly and sustainable proDuction in marine environments' – proposal

[2] Please note that this state-of-the art is a UNITED-internally defined measure to facilitate constructive discussions on the selected pilot approach.

2. METHODOLOGY

To investigate the current status of the UNITED pilots an interview approach was selected for which a protocol was set-up. The interview was set-up in such a way that there was room for exchange of knowledge and experience. The first phase of UNITED allowed for creating synergy between the pilots. The interview protocol is based upon the Multi-Use Procedure (MUP), which tackles different topics in sequence for successful performance of multi-use activities, the latter being elaborated on in chapter 3: Definition of topics and their state-of-the-art. Furthermore, for each of these topics a SOTA within UNITED was identified and also described in chapter 3. The interviews served as the source to identify this SOTA of multi-use topics within UNITED. The interview results were structured in a table and are shown in 4: Interview Results Interview results. Also, a comparison between the current status of each pilot and SOTA was made on a topic by topic basis resulting in an overview as seen in chapter 5: Pilot Performance against SOTA. The conclusion of these results is presented in chapter 7.

2.1. UNITED Pilots

Within UNITED, five pilots are demonstrating the possibilities for upscaling multi-use activities. These five pilots are all located in different parts of the European seas. Below, a brief description on these pilots and the interviewees is presented.

- German pilot: North Sea: FINO3 – Eva Strothotte & Maria Jaeger – the German pilot FINO3 aims to demonstrate (in practice) the economic, technical, environmental, and societal benefits of the multi-use offshore wind farming and aquaculture activities.
- Dutch pilot: North Sea: North Sea Innovation Lab (NSIL) – Zinzi Reimert – the Dutch pilot NSIL aims to investigate the possibilities of floating solar panels and seaweed aquaculture offshore
- Belgian pilot: North Sea (South-East side of the Bligh Bank): Annelies Declercq, Jessica Knoop & Thomas Kerkhove - This pilot aims to improve the design and deployment methods for offshore aquaculture (flat oyster and sugar kelp culture) activities combined with restoration (flat oyster) at offshore wind parks.
- Danish pilot: Baltic sea: Middelgrunden Wind – Hans Cr Soerensen & Julia Fernández Chozas – the Danish pilot Middelgrunden Wind targets the expansion of tourism activities (boat tours, leisure fishing and diving) related to offshore wind farms.
- Greek pilot: Mediterranean Sea: Ioanna Drigkopoulou, Giannis Zanettis & Paraskevas Bourgos- the Greek pilot investigates possibilities to expand tourism activities (leisure scuba-diving) at aquaculture sites.

A more detailed description on the pilots can be found in the Attachment 1: Pilot Descriptions.

2.2. Interview Protocol

The interview protocol is based on the results of an earlier performed project on multi-use in the North Sea and that resulted in the so-called Multi-use procedure (see Figure 1). This procedure has been developed to help multi-users realise their multi-use concept. It is often the case that multi-use locations, such as offshore wind-farms, are complex areas with many regulations. For a multi-user to operate in this area, careful alignment with the wind farm operator is required. The multi-use procedure provides a clear overview of each step that needs to be taken and the conditions that have to be met for successful multi-use activities. The procedure consists of multiple steps, all addressing different topics relevant for the pilots. These topics are elaborated on in chapter 3: Definition of topics and their state-of-the-art. The protocol can be found in Attachment 2: Interview Protocols. The protocol served as a guideline during the interviews. The protocol was set-up in a way that allowed exchange of knowledge, and a bidirectional way of communication. The protocol therefore allowed the sharing of experiences on multi-use activities, which stimulated the interviewers and interviewees to share knowledge and help each other with issues they were facing.

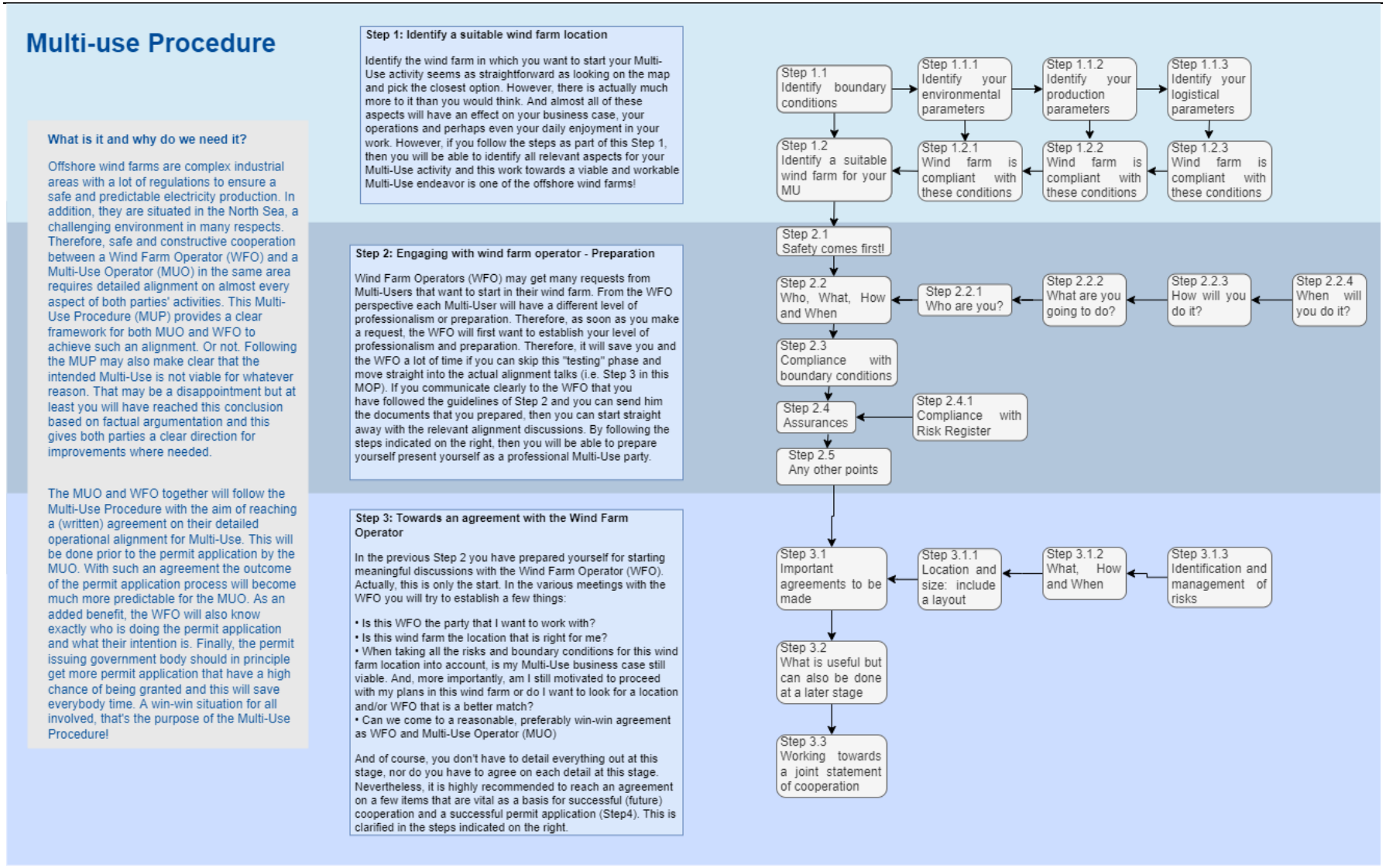

Figure 1: Extract from the Multi-Use Procedure

3. DEFINITION OF TOPICS AND THEIR STATE-OF-THE-ART

Based on the multi-use procedure, as described above, an interview protocol has been setup to asses an as complete as possible status of each pilot in terms of state-of-the art/TRL. Next to the definition of the addressed topics, the state-of-the art (SOTA) is defined based on the initial results from the interviews (Attachment 3). The most relevant topics from the Multi-use Procedure have been included and are defined as follows:

3.1. Pilot Location

The physical location in which the pilot will be taking place. Depending on the individual pilots this may include elements such as:

- (Availability of) the required physical area on-/offshore;
- Onshore based (support) facilities;
- Status of any required permits;
- Status of potentially required demarcation measures and/or other security measures;
- Connectivity (e.g. 4G) for any remote monitoring requirements;
- Level of alignment/cooperation with pilot location stakeholders; and
- Governance of the pilot location.

3.1.1. SOTA Pilot location

The SOTA of the pilot location include the following items with their threshold levels in terms of progress and/or availability, whichever is applicable:

- The applicable pilot location(s) are fully organised and available for the intended UNITED pilot activities including the availability of any required onshore sites/facilities;
- All required permits for the intended activities on the near- and offshore sites are available and/or will be available for when the activities start;
- All required site demarcation measures will be taken/are in place as well as any other measures required for the safe installation, operation & decommissioning of the pilot installations;
- The pilot sites include all connectivity facilities required to perform the intended monitoring & measuring activities as part of the pilot;
- All relevant stakeholders for the pilot sites have been identified and these have been aligned with; and
- For all pilot sites there is a clear governance structure in place for with clearly identified roles and responsibilities for the parties involved in that governance structure.

If individual pilot locations do not meet the above listed threshold levels, they will be considered below SOTA, where these items are applicable for the individual pilot.

3.2. Pilot System Design

3.2.1. SOTA Pilot system design

The pilot modules and any associated equipment and methodologies shall be based on existing designs. These modules and all technical equipment have to be adjusted to the site-specific needs and conditions at each pilot as certain technologies may work in one site but may not work for another without major changes. This may vary for the different components of the pilot modules/equipment, some components/equipment may be in the prototype stage whereas others are off-the-shelve technologies that can be bought in the marketplace. For each pilot module component, the highest available designs shall be selected to be included in the design directly or to improve the design. Only when no previous designs exist, a new design shall be pursued. The existing designs have been identified as follows, in order of priority:

- Off-the-shelve designs available in the marketplace;
- Prototype designs that are available from project partners; and
- Prototype designs that are available in the respective industries (seaweed, shellfish, nature, etc.).

If individual pilots' system designs do not follow the above logic, then they will be considered below SOTA.

3.2.2. Logistic solutions

This topic addresses the details of the logistic activities that are part of the pilot activities. Depending on the individual pilots this may include elements such as:

- Port locations in the vicinity;
- Distance and time from your preferred port;
- Facilities in your preferred port;
- Sufficient trained personnel;
- Maximum size to your multi-use area;
- Potential for future scale-up and expansion; and
- Grid conditions

SOTA Logistic solutions

All onshore and offshore facilities (e.g. workshop, storage for spare parts) have to be available to a sufficient extend. Transportation of material and staff should be organized in time, so that external partners (shipping company) can include it in their often long-term planned schedule. Mandatory certifications (material and staff) have to be organized in time. Shared resource utilization shall be increased, assessing the resulting benefits. The SOTA for logistic solutions is applicable when all required activities have been identified, planned, detailed in methods and the degree of utilization of common resources (vessels, crew, equipment, infrastructure) for all offshore activities (e.g. wind production, aquaculture) has been optimized. Thus, managing dynamic influences, particularly the weather conditions and sea state, requires the standardization of procedures, equipment and pilot components as well as the creation of logistic processes in accordance with the standard practices in the offshore industry.

3.3. Installation Activities

This topic addresses the details of the installation activities that are part of the pilot activities. Depending on the individual pilots this may include elements such as:

- The modules/equipment/facilities that will be installed;
- The general timeline of the installation activities for the entire pilot;
- Installation method/procedure and foreseen vessels;
- Involved crew; and
- Safety aspects;

This is an important aspect to be addressed at an as early as possible stage as it may affect the design and procurement activities.

3.3.1. SOTA Installation activities

SOTA for the installation activities is applicable when all required activities have been identified, planned and detailed in methods consistent with standard practices in the offshore industry. Furthermore, suitable vessels and associated equipment shall have been identified. Finally, suitable safety assessments shall have been performed and associated mitigations shall have been put in place. Where pilots do not have these elements in

place or are not planned to such an extent that the impact on the preceding and subsequent activities as well as the system design and pilot location can be assessed, then they shall be considered below SOTA on this topic.

3.4. Operation & Maintenance

This topic addresses the details of the operational and maintenance (O&M) activities that are part of the pilot activities. Depending on the individual pilots this may include elements such as:

- An overview of the foreseen operational activities;
    - Measurements (remote/on-site);
    - On-site inspections;
    - Tests/demonstrations;
    - Sample collection;
    - Visitors; and
    - Trainings;
- Frequency of the foreseen activities;
- Setup, procedure for the activities; and
    - Type of vessels; and
    - Type of crew/ people required

This is an important aspect to be addressed at an as early as possible stage as it may affect the design, procurement and installation activities.

3.4.1. SOTA operation & maintenance

SOTA for the operation & maintenance activities is applicable when all required activities have been identified, and are planned and detailed in methods consistent with standard practices in the offshore industry. These activities shall be split over the following categories:

- Inspection, maintenance & repair activities for the availability of the production modules and any associated equipment;
- Measurement and sampling activities;
- Remote monitoring activities and satellite data collection from onshore location.

Where pilots do not have these activities in place or planned to such an extent that the impact on the preceding and subsequent activities as well as the system design and pilot location can be assessed, then they shall be considered below SOTA on this topic.

3.5. Decommissioning of the Pilot

This topic addresses the details of the decommissioning activities that are part of the pilot activities. Depending on the individual pilots this may include elements such as:

- Suitability of the system designs for removal;
- Method statement for removal of pilot assets, including aspects such as:
    - Vessels; and
    - Equipment; and
- Budgeting for removal of pilot assets, including aspects such as;
    - Vessels;
    - Equipment;
    - Crew; and
    - Final inspections for permit issuers.

This is an important aspect to be addressed at an as early as possible stage as it may affect the design, procurement and installation activities.

3.5.1. SOTA Pilot location

SOTA for the decommissioning activities is applicable when all required activities have been identified, planned and detailed in methods consistent with standard practices in the offshore industry. These activities shall be split over the following categories:

- Removal of the production modules and all associated equipment;
- Survey works required to confirm adequate removal of all assets from pilot location; and
- Removal & disposal of any assets and materials onshore.

Where pilots do not have these activities in place or planned to such an extent that the impact on the preceding activities as well as the system design and pilot location can be assessed, then they shall be considered below SOTA on this topic.

3.6. Communication on Pilot Activities

This topic addresses the details of the communication activities that are part of the pilot activities. It focusses on what has been organised to ensure adequate communication about the pilot activities and the UNITED project is possible. This may include planning for the recording and reporting of the pilot's relevant activities. Depending on the individual pilots this may include elements such as:

- Hiring of photography and video-shoot professionals during various pilot activities;
- Alignment with UNITED and other pilots on what needs to be covered; and
- Recording of technical features:
    - As part of test verifications and validations;
    - important for later lessons learnt; and
    - Important for demonstrating pilot or UNITED goals

3.6.1. SOTA Communication on pilot activities

SOTA for the communication activities is applicable when all required activities have been identified and planned. These activities shall be split over the following categories:

- Identification of relevant activities suitable for communication about UNITED and the planning thereof;
- Alignment with the other pilots where possible on what pilot covers what; and
- Identification of all technical and procedural features that need to be covered for (sub)goal verification, validation and lessons learnt.

Where pilots have not identified these activities and/or the required verification and validation points, then they shall be considered below SOTA on this topic.

3.7. Risk Management

This topic addresses the details of the risk management activities that are part of the pilot activities. Depending on the individual pilots this may include elements such as:

- Setup of the risk management system for the pilot;
- Status of identification of main risks;
- Mitigation of main risks in pilot setup; and

- Availability of required/recommended insurances for the pilot;

3.7.1. SOTA Risk Management

SOTA for the risk management activities is applicable when a suitable risk management system is in place, main risks and adequate associated mitigations have been identified and when suitable insurance has been taken out for the intended pilot activities. Where this is not in place, then the pilot is considered below SOTA on this topic.

3.8. After the Pilot

This topic addresses the point of plans for future, after completion of the pilot and/or the UNITED project. Depending on the individual pilots this may include elements such as:

- Continuation of the pilot site:
  - As a commercial site;
  - Expansion; and
  - After relocation;
- Continuation of the pilot activities (at any location);
- Planned subsequent projects that are dependent on the results of the UNITED pilot(s):
  - Project development activities for commercial follow-ups; and
- Stakeholder management as part of future plans.

3.8.1. SOTA after the pilot

SOTA for the "after the pilot" follow-up is applicable when it has been clearly identified how the pilot results can/will contribute to the future development in offshore multi-use and when these points have been properly incorporated in the various pilot activities and system design. Where this is not in place, then the pilot is considered below SOTA on this topic.

4. INTERVIEW RESULTS

All of the interview results have been captured in a comprehensive table (Table 4.1 below) to enable the assessment of the various responses and pilots' statuses against the assessment topics of chapter 3. In this chapter 4, only a snapshot is provided due to size restrictions. A detailed version is available in Attachment 4: Interviews results summarised in comprehensive table.

Table 4.1 : assessment of pilots responses and statuses

Topic	Question	FINO3	Dutch pilot	Belgium pilot	Middelgrunden	Patroklos
System design	This topic addresses the details of the systems designs that are part of the pilot activities. For each pilot an inventory will be made of items in the following categories: 1. What production modules will be used 2. What equipment (monitoring, measurement) will be used 3. Any other items?	1. Production modules: Nearshore: * no nearshore cultivation of seaweed, seaweed will be obtained from a supplier * Longline with screw anchors - mussel seed collection Offshore: * Longline or nets (currently being examined by FUE engineers and UGent) for seaweed cultivation * Longline for mussel seed collection 2. Equipment: Nearshore: * Lander will be tested at nearshore site, once it is ready, it will be powered via shore connection (cable from lander to power connection on land); regular check-up by KMF with workboat Offshore: * Lander for communication & sensor mounting plus various monitoring measures (sensor list see GA) directly on the longlines (and net?) * Umbilical cable between lander & met mast - offshore + sensors and cameras attached to long lines ; * Additional monitoring devices at the offshore platform as a backup	1. Production modules: * 2xSMAC4.0 modules for seaweed cultivation 2. Equipment: * In-module sensors * Measurement-buoy for reference measurements and communications hub Other: * Remote surveillance service to prevent collision between ship traffic and pilot modules	Production modules: 1. Oyster frame (hung on the backbone of a longline anchored at sea) with SEAPA-baskets for spat collection - nearshore 2. Oyster frames (hung on the backbone of a longline anchored at sea) with SEAPA-baskets, ropes and sticks for spat grow out 3. Oyster restoration table on the bottom – nearshore 4. Seaweed design ongoing, but structures will be also be hung on the backbone of a longline anchored at sea - nearshore 5. Longline to which structures will be hung for oyster spat collection, oyster grow out and seaweed cultivation - offshore 6. Flat oyster restoration on scour materials that will be placed on top of the monopole foundation around a turbine - offshore Equipment: 1. nearshore determined 2. offshore: based on best suited practices nearshore	n.a.	1. n.a. There is an aquaculture/ fishery site which is already operating, within UNITED no extra production module will be added. 2. Different communication cables for high broadband data from cameras and sensors is being considered. Sensors will be installed to measure: * temperature * oxygen * nitrate * aquarid/ aqua real sensor * current meter is planned however this is unsure due to COVID-19 delivery delays
	What designs have been selected for the production modules, equipment and other items as part of the pilot system design: 1. Off-the-shelve designs available in the market place 2. prototype designs that are available from project partners; and 3. prototype designs that are available in the respective industries (seaweed, shellfish, nature, etc.).	1. Production modules: Nearshore * Off-the-shelve mussel longline designs, available in the market place, * Seaweed will be obtained from a commercial supplier Offshore * Longline for mussel seed collection: off-the shelf mussel long lines adapted for offshore conditions and tailored for our site. * Longline for seaweed cultivation: off-the shelf seaweed long lines adapted for offshore conditions and tailored for our site. Prototype designs of project partner and industry are currently examined. 2. Equipment: * Lander for communication & sensor mounting: new design by 4HJena, tailored for offshore conditions * Umbilical cable between lander & met mast: off-the-shelve systems - procured 3. Other: * Fishing boat from north sea	Production modules: 1. 2xSMAC4.0 modules for seaweed cultivation: new design based on latest prototype SMAC3.0 by Noordzeeboerderij Equipment: 1. In-module sensors: : off-the-shelve systems - procured 2. Met-buoy for reference measurements and communications hub: off-the-shelve systems - procured Other: 1. Remote surveillance service to prevent collision between ship traffic and pilot modules: service contracted in marketplace	Designs: 1. Longline for multi-use oyster/seaweed aquaculture, new design by MTD UGent 2. Basket anti-fouling solutions, new design ARC UGent 3. Scouring protection material for oyster reefs, new design from UNITED partners JdN – ARC UGent 4. Tables for colonization experiments on sandy bottom, new design from JdN 5. Grow-out techniques: existing designs will be tested for suitability in the Belgian North Sea	n.a.	1. n.a. 2. off the shelve designs 3. off the shelve designs
Assessment		Nearshore: No direct observations wrt the mussel farm. It appears suitable for its intended smaller scale purpose. Nevertheless, it may be useful to consider adding seaweed cultivation. There are various tests ongoing in Europe with such a setup that may enable year round biomass harvest from the farm. In addition it may be possible to add remote monitoring facilities to the farm in line with the approach of the Patroklos pilot For the production modules in the offshore location it has been suggested to use the same seaweed system as in the Dutch & Belgian pilot to enable comparable results. This system could be modified to suit the FINO3 metocean conditions. Furthermore, it was discussed to then add accelerometers to the seaweed system in addition to the already planned lander. Finally, it may be	The Dutch pilot is building upon latest technology available in the marketplace. The AtSeaNova & SMAC3.0 system. The Duthc pilot is developing the SMAC4.0 system that will be an improvement on the SMAC3.0 system. The improvements will include adding multiple substrates in one single system as well as verification of the best orientation of the system.It will be useful if mooring force measurements as well as remote monitoring systems could be employed	For the nearshore site the existing longline infrastructure will be used to perform various oyster and seaweed grow tests. In addition, an oyster table will be placed on the seabed. Using an existing infrastructure for these tests will limit cost and limit risk as it is apparent the system is suitable for its operational environment. Furthermore, existing techniques will be tested for their suitability in Belgian waters. Communications with similar pilots in the Dutch North Sea have been had to help with using the latest insights for the planned tests. For the production modules in the offshore location it has been suggested to use the same seaweed system as in the Dutch & Belgian pilot to enable comparable results. This system could be modified to suit the Belgian offshore pilot conditions. With respect to the scour protection	No systems or production modules will be used in this pilot, hence this topic is not relevant for this pilot.	No separate production module is being installed but rather (off-the shelf) sensors are being installed in an existing aquaculture farm specifically for the (remote) operation of the farm. In that respect it is recommended to integrate the requirements for (diving) tourism at the farm directly into the monitoring system requirements. In this way it may be possible to test this form of tourism at a commercial farm using automated systems and thus making it easier for future farmers to allow this type of tourism at their site without excessive risk or time.

This Table 4.1 also shows that the risk assessment was not yet completed by all pilots at this stage of the project. The reasons for that are very different and pilot specific. For example, the German and the Danish pilot were not able to completely envision all risks involved in the multi- use activities due to the fact that there are multiple stakeholders/ operators involved in the activities. Table 1 summarizes the currently available results. Most pilots are still in the process of improving their risk management and the risk assessment were not yet fully elaborated at this point of time. However, a streamlined approach across Pilots is foreseen within WP8 and is strongly advised, particularly with respect to future bankability.

5. PILOT PERFORMANCE AGAINST SOTA

The interviews per pilot have been included in Attachment 3: Interviews with the five multi-use pilots. In chapter 3, the SOTA for each interview topic has been described. The results from each pilot interview have subsequently been compared with this SOTA on a topic-by-topic basis. In the comparison it was analysed whether any improvements or recommendations could be identified that could help to have a more successful pilot. The result of this comparison has been summarised in the table below.

It is important to realise that this has been an internal review, i.e. against the available SOTA knowledge in the UNITED pilots as obtained from discussions with the UNITED project partners. This also means that no comparisons have been made with technologies, developments and knowledge outside of the UNITED project. The latter aspect however has been described in deliverable D1.2.

Table 5.1: Comparison of each pilot aspect against the UNITED-SOTA

Pilot	Pilot location	System design	Installation	Operation & maintenance	Decommissioning	Communication	Risks	After the pilot
1. German pilot nearshore								
1. German pilot offshore								
2. Dutch pilot								
3. Belgian pilot nearshore								
3. Belgian pilot offshore								
4. Danish pilot								
5. Greek pilot								
	Improvements recommended	On SOTA, some further improvement possible	Above SOTA	Not relevant/ ready at this time	Not applicable	Unknown		

5.1. Pilot location

In each of these subchapters the evaluation for each pilot on this topic will be included. This will clarify the arguments behind the above listed SOTA-status. In the meantime, these evaluations are available in detail in Attachment 3: Interviews with the five multi-use pilots.

5.1.1. German Pilot

Nearshore site

For the nearshore pilot location all appears to be in place as it is already present and operational. No further improvements identified at this stage.

Offshore site

The offshore pilot location is already fully operational and above and beyond what could be considered SOTA. Perhaps the only thing that could be still checked is if any navigational measures are required for the pilot installations in the 500m safety zone of the research platform.

5.1.1. Dutch Pilot

This pilot location is fully organised with advanced facilities in place. No further improvements identified at this stage.

5.1.2. Belgian Pilot

Nearshore site

For the nearshore pilot location all appears to be in place as it is already present and operational. They only recommendation that could be considered is to clarify the governance (financial responsibility) structure to prevent any surprises during incidents or operational activities. Furthermore, it may be prudent to revisit if all stakeholders have been identified and updated on the latest developments.

Offshore site

The exact offshore pilot location selection is ongoing so an assessment on level of readiness is not yet possible. Nevertheless, there is already quite a lot of knowledge in the consortium on how to organise such a pilot location so it may help to ask for support on this topic. Finally, it may be prudent to check the timeline against the planned offshore activities as these processes may be longer than expected. This may adversely impact the planned pilot activities.

5.1.1. Danish Pilot

The topic "pilot location" is not fully applicable for this pilot as it is an existing and operational site that enables regular visits. These visits are already available with the existing site and permits. Nevertheless, it may be interesting to structure the organisation of the site visits with specific activities, associated procedures and long-term contracts/relationships with suppliers/contractors. They may also enable the latter to participate in improving the service and working practice. Finally, with regards to governance, it may be useful to address the issue of responsibility in case accidents happen.

5.1.2. Greek Pilot

Most of the necessary elements for the pilot location seem to be in place. It may be prudent to check for any permit requirements for the tourism activities. Furthermore, apart from knowing who they are, it may also be useful to already engage with the stakeholders. Finally, it may be useful to further clarify the governance: is it clear who is responsible for permits, damage to aquaculture assets or injuries to divers?

5.2. System design

5.2.1. German Pilot

Nearshore site

No direct observations within the mussel farm. It appears suitable for its intended small-scale purpose. Nevertheless, it may be useful to consider adding seaweed cultivation if research needs on this topic arise in the course of the project. There are various tests ongoing in Europe with such a setup that may enable year-round biomass harvest from the farm. In addition, it may be possible to add remote monitoring facilities to the farm in line with the approach of the Greek pilot.

Offshore site

For the production modules in the offshore location it has been suggested to use the same seaweed system as in the Dutch & Belgian pilot to enable comparable results. Currently it will be investigated whether this system could be modified to suit the German pilot ocean conditions. Furthermore, it was discussed to then add accelerometers to the seaweed system in addition to the already planned lander. Finally, it may be useful to verify what measurement can be performed with the lander that are necessary for research questions associated with the seaweed system.

For the mussel system it is recommended to look into standard cultivation systems that are already available in the market, e.g. smart farm or easy farm systems. The latter is currently being tested in the Dutch pilot and has proven adequate for offshore conditions.

5.2.2. Dutch Pilot

The Dutch pilot is building upon the latest technology available in the marketplace: the AtSeaNova & SMAC3.0 system. The Dutch pilot is developing the SMAC4.0 system that will be an improvement on the SMAC3.0 system. The improvements will include adding multiple substrates in one single system as well as verification of the best orientation of the system. It will be useful if mooring force measurements as well as remote monitoring systems could be employed.

5.2.3. Belgian Pilot

Nearshore site

For the nearshore site the existing longline infrastructure will be used to perform various oyster and seaweed growth tests. In addition, an oyster restoration table will be placed on the seabed. Using an existing infrastructure for these tests will limit costs and risks as it is apparent the system is suitable for its operational environment. Furthermore, existing techniques will be tested for their suitability in Belgian waters. Communications with similar pilots in the Dutch North Sea have been ongoing to help with using the latest insights for the planned tests.

Offshore site

For the production modules in the offshore location it has been suggested to use the same seaweed system as in the Dutch & German pilot to enable comparable results. Currently it will be investigated whether this system could be modified to suit the Belgian pilot offshore conditions. With respect to the scour protection elements for oyster restoration, it may be useful to have a look at the recent paper on nature-inclusive wind farm design (Hermans, A., Bos, O. G., Prusina, I. (2020): Nature-Inclusive Design: a catalogue for offshore wind infrastructure. Technical Report. ResearchGate. DOI:10.13140/RG.2.2.10942.02882).

5.2.4. Danish Pilot

No systems or production modules will be used in this pilot; hence this topic is not relevant for this pilot.

5.2.5. Greek Pilot

No separate production module is being installed but rather (off-the shelf) sensors are being installed in an existing aquaculture farm specifically for the (remote) operation of the farm. In that respect it is recommended to integrate the requirements for (diving) tourism at the farm directly into the monitoring system requirements. In this way it may be possible to test this form of tourism at a commercial farm using automated systems and thus making it easier for future farmers to allow this type of tourism at their site without excessive loss or time.

5.3. Installation

5.3.1. German Pilot

Nearshore site

This will form a smaller part in the overall pilot scope. However, it may be wise to check what level of preparation and safety management is needed for this site especially in relation to the higher working standards in the offshore pilot.

Offshore site

The preparation of the installation activities has not yet started but they have already been fully identified at this stage. Nevertheless, it may be useful, especially for the offshore pilot, to define a general installation procedure setup at an earlier stage to take into account any specific installation requirements into the system design. Furthermore, the training of personnel and safety management system appear to be SOTA and therefore it may be helpful to share this information to the other pilots whereas their safety management systems may be less developed.

5.3.2. Dutch Pilot

The installation activities have been identified and defined in broad terms. Nevertheless, it may still be useful to define the installation in more detail to identify any requirements that will have an impact on the system design. Furthermore, no preparations or actions with respect to personnel and procedural safety have been planned. It is recommended to start these up at this stage as well as installation is already planned for this autumn.

5.3.3. Belgian Pilot

Nearshore site

Nearshore it is already clear in broad terms what needs to be done and some of the activities have already been performed with existing designs that have limited options for modifications. All safety systems appear to be in place as well. The seaweed system may require further attention moving forward.

Offshore site

Offshore the system design is ongoing but in line with recommendations of the other pilots it may be useful to have a general idea of how the installation will be performed prior to completing the system design.

5.3.4. Danish Pilot

No systems or production modules will be installed in this pilot; hence this topic is not relevant for this pilot.

5.3.5. Greek Pilot

The installation activities have been identified in broad terms. However, it is highly recommended to take a few additional actions. These may include the following:

1. Try to identify who will be responsible for the installation works at the site. For the actual work and for any adverse consequences in case of unforeseen failures;

2. Try to identify who will perform the actual work so that that person may receive the proper safety training and certification; and

3. Maintenance of the equipment during and after the pilot may be a point to clarify prior to starting the installation works and potentially before procurement of the sensors.

5.4. Operation & Maintenance

5.4.1. German Pilot

Nearshore and offshore site

The main O&M activities have been identified, as well as the responsibilities and roles of the German pilot team. However, there may still be some value in identifying at an early stage what needs to be maintained and/or measured/sampled as this may have an effect on the system design.

5.4.2. Dutch Pilot

There is little to no information available at this stage regarding the O&M as well as measurement activities. It is highly recommended to start this as soon as possible to identify any major impacts on the system designs.

5.4.3. Belgian Pilot

Nearshore site

For the nearshore site, all O&M activities appear to have been planned. Nevertheless, it may be useful to revisit this in terms of detailed activities. Especially for instance the seaweed system as this has not been fully decided/designed. For this system identifying O&M/measurement requirements may lead to modifications in the system design.

Offshore site

For the offshore site this is not yet applicable as the pilot location and system design is ongoing.

5.4.4. Danish Pilot

The current and potentially future O&M activities have not yet been documented. Although there is no specific system that will be installed, it may still prudent to set this up for the intended activities, whether these are visiting or training activities. Especially with respect to adequate safety measurement and safety performance monitoring this could be an important follow-up action.

5.4.5. Greek Pilot

The setup of the O&M and test measurements is planned but has not been performed yet. It is highly recommended to start this as soon as possible to identify any major impacts on the system designs.

5.5. Decommissioning

5.5.1. German Pilot

Nearshore site

Everything implemented at KMF within the scope of UNITED (Lander, Longlines, anchors, buoys) will be decommissioned after the pre-operational phase. All used materials are recycled or handed over to the respective waste treatment facility.

Offshore site

For the offshore site this appears to be already adequately organised and accounted for. The only extra check that could be added to make the SOTA outstanding is to confirm if any post-survey works are also included in the budget together with the decommissioning works.

5.5.2. Dutch Pilot

There is little to no information available at this stage regarding the decommissioning activities. It is highly recommended to start this as soon as possible to identify any major impacts on the system designs.

5.5.3. Belgian Pilot

Nearshore site

For the nearshore pilot it appears partly clear what needs to be done as part of the decommissioning works. It may be prudent to clarify this at an as early as possible stage as it may have a significant impact on the budget whether assets can remain or need to be removed. The same holds for any disposal requirements.

Offshore site

For the offshore site this is not yet applicable, to be taken into account when the site and system design have been finalised.

5.5.4. Danish Pilot

No systems or production modules will be installed in this pilot; hence this topic is not relevant for this pilot.

5.5.5. Greek Pilot

At this stage it is not yet fully clear if the installed equipment in the aquaculture farm needs to be removed after the pilot, hence remains to be clarified.

5.6. Communication

Various communication structures have already been developed in this project. Although all pilots could improve on the communications aspects of their pilot. Both for external communication purposes as well as for the recording of specific technical/procedural details as part of their pilot validation. To enhance the internal communication of the pilots, online accessible files for unifying and streamlining research objectives, and sensor procurement are available for all partners. To support, some general guidelines are included here for all pilots' consideration. Where these activities have not been planned and budgeted for, it is recommended to address this with the project coordinator and the communication work package leader.

- Communication activities and materials have two important goals:
    1. External communication about UNITED and pilot goals that have been achieved as well as providing visual context to reports and subsequent educational material; and
    2. Internal communication: to record specific technical aspects, operational processes and specific measurements that are important to validate the pilot specifics and overall performance:
        - Keep in mind that every milestone and step towards multi-use can be recorded and used for these two purposes both as deliverable within UNITED as well as communication material to the broader/ general public;
- Identify recurring activities that help to increase social awareness of the importance of multi-use activities:
    - These activities are diverse, and often reoccur multiple times per year. Examples are visit of the (offshore) location, sampling activities, diving or maintenance activities. The visuals on these activities make the activities on the pilot location visible and real for a more general public;
- Include points in time for communication to external parties in the detailed planning of the pilot, whether these are recurring activities or achieving specific goals; and
- Collaborate with professional photographers or videographers for high quality material for both communication to the general public as well as for internal recording of UNITED/ the pilots' performance. The pilot can either pay for these services, but if budget is limited be creative and search for hobbyists that are keen to help out for free. Alternatively, these constraints could be discussed with the WP-communication lead.
    - Communication material, photographs, and videos can be used as deliverable within the pilots' reporting and may serve as evidence for certain research and pilot-test questions. It is therefore essential to have high quality communication material.

5.7. Risk management

5.7.1. German Pilot

Nearshore site

A complete risk assessment has been established during the licensing process of the Kiel Marine Farm. Aspects such as waste, sound, radiation (warmth and radioactivity), escapees, chemical seep-ing, and general environmental concerns were covered and are deemed "in good condition and well thought of" by the authorising office (the Ministry of Energy, Agriculture, the Environment, Nature und Digitalization, State Government for Agriculture, Environment and Rural Areas, State Office for Coastal Protection, National Park and Marine Protection Schleswig-Holstein, Fisheries Authority, Na-ture Conservation Agency and the City of Kiel).

Offshore site

There is a general risk assessment done for the offshore activities on the FINO3 platform. The UNITED-specific risk analysis is ongoing and a detailed risk analysis including prevention and mitigation measures will be conducted in parallel to the system design in WP6 (deliverable D6.1).

5.7.2. Dutch Pilot

Due to the lack of an existing risk management system and a risk register, it is recommended to set this up as soon as possible, preferably before the system design is completed. This will allow to incorporate any mitigations into the design.

5.7.3. Belgian Pilot

Nearshore site

For the nearshore site, the risk management system as well as the required risk register appears to be in place and suitable.

Offshore site

For the offshore site this is not yet applicable, to be taken into account when the site and system design have been finalised.

Biosecurity measures

As a bio-security measure the Belgian Pilot ordered adult oysters that are certified Bonamia free, from Norway, which is of utmost importance when translocating specimen from another country. The oysters will again be test-ed in laboratories to exclude parasite infestations of Bonamia and Marteilia. Moreover, eDNA from wild oysters will be collected and examined (via qPCR) for parasite infestations, in order to assess the health status of wild oysters in the Belgian part of the North Sea.

5.7.4. Danish Pilot

Due to the lack of an existing risk management system and risk register it is recommended to set this up as part of the pilot activities. Furthermore, it is recommended to look into this activity as a potential deliverable for any Eu-ropean wind farm that wants to have visitors in its wind farms/multi-use farms for education or training purposes. In that sense, a collaboration with the Greek pilot may be useful.

5.7.5. Greek Pilot

Although risk management is currently ongoing, due to the lack of an existing risk management system and risk register it is recommended to set this up as soon as possible, preferably before the system design is completed. This will allow to incorporate any mitigations into the design.

5.8. Financing, bankability and regulatory framework

In order to assess the Pilots' bankability of a comprehensive risk analysis poses an absolute precondition. In the context of UNITED, bankability is defined as a project that is structured well and powerful enough to ensure profitability and thus would be considered acceptable to be funded by a bank. In other words, bankability refers to the willingness of lenders to finance a project after due consideration of its risks and returns (Delmon, 2015).

Generally, the expression of bankability is vague and may vary over time due to changes in the market or the risk perception of banks. Also, bankability can be transaction-related, meaning that factors, which applied to project A, in terms of bankability, do not necessarily apply to another similar project (Kiefer & Gerspacher 2018). Thus, within UNITED it will be acknowledged that bankability varies and often involves broader macro-economic conditions such as economic and political stability, legal and regulatory conditions, including generic factors such as a reliable public sector, an experienced private sector party and a smart financing structure (Owolabi et al., 2020). Critical success factors (CSF) determining the Pilots' bankability may include robust project profitability, project partner's creditworthiness and reputation, balanced risk distribution, sufficient equity capital, low risk of changes in law during project life, no risk of discriminating fiscal treatment as well as a stable legal system (Kiefer & Gerspacher 2018).

Next to the CSF, the UNITED Pilot operators have to be aware, that in many cases banks have little knowledge of top-level technical details of complex projects, as this is the case for innovative multi-use systems. As such, the financiers' risk aversion is more often than not very high, especially when bankability of completion or severe technical risks in funding proposals cannot be sufficiently justified (Owolabi et al., 2020). In the past, this led to many funding applications being turned down by financiers (Owolabi et al., 2020), which is why this aspect must be thoroughly addressed in UNITED and the outstanding relevant deliverables (under WP3 and WP6).

All Pilot activities fall under the respective national law, as they are located within territorial seas or the exclusive economic zone (EEZ) as prescribed by the 1982 United Nations Convention on the Law of the Sea (UNCLOS). The EEZ (from the baseline to 200 nautical miles from the coast of the respective country) describes the area of the sea in which a sovereign state has certain rights regarding marine exploration and use of resources (e.g.: energy production from water and wind). There are distinct differences between the territorial sea and the EEZ conferring full sovereignty over national waters, whereas for the EEZ the respective country has a "sovereign right" below the surface of the sea. Maritime spatial planning outside national waters or the EEZ must respect the freedoms of UNLCOS, which means the freedom of navigation, overflight and to lay cables and pipelines. The North Sea and the Atlantic are organized within OSPAR (Convention for the Protection of the Marine Environment of the North-East Atlantic) which comprises the regulation of European standards on marine biodiversity, eutrophication, the release of hazardous and radioactive substances into the seas, the offshore oil and gas industry and baseline monitoring of environmental conditions.

As all Pilot activities concentrate within territorial seas or the EEZ, which is why European law may affect the Pilots differently, according to how the respective national law implements EU law and regulates offshore operational endeavours. Most relevant EU/international regulatory frameworks and conventions for multi-use may be the:

- EU Directive on Maritime Spatial Planning (2008/56/EC: The Marine Strategy Framework Directive -MSFD), which provides the legal basis of the German Federal Regional Planning Act (FEP: extended to the EEZ in 2004, and last amended in 2017)
- Flora-Fauna-Habitat Directive of the European Community (Habitats Directive, 92/43/EEC)
- Directive 2009/147/EC on the conservation of wild birds, (Directive 79/409/EEC, commonly known as "Birds directive")
- Directive on Environmental Impact Assessment (EIA Directive 85/337/EEC as amended by 97/11/EC)
- Directive 2001/42/EC: The Directive on Strategic Environmental Assessment (SEA)
- Convention for the Protection of the Marine Environment of the North-East Atlantic – Commonly known as "The OSPAR Convention"
- The Bern Convention on the Conservation of European Wildlife and Natural Habitats
- United Nations Convention on the Law of the Sea of 10 December 1982. Commonly known as "UNCLOS." Also known as Law of the Sea Treaty
- The HELCOM Convention on the protection of the marine environment of the Baltic Sea Area (also known as the "Helsinki Convention") → Danish Pilot
- Council Directive 2006/88/EC on animal health requirements for aquaculture animals, and on the prevention and control of certain diseases → Greek Pilot
- United nations framework convention on climate change (NFCCC)
- International Maritime Organization (IMO) Regulations

As an example for the national regulatory framework the German Pilot is considered. Relevant national regulations for German offshore renewable energy production industries are the Renewable Energy Sources Act (EEG), Wind Energy at Sea Act (WindSeeG), Energy Industry Act (EnWG), Liability regulation, Offshore Installations Ordinance (SeeAnlV) and the Federal Nature Conservation Act. Furthermore, the interviews revealed that the application procedure for offshore activities (e.g. windfarm, aquaculture, etc.) greatly varies between Pilots (and EU member states), and falls to be determined by different national ministries and/or authorities. Albeit, the German and the Greek Pilots are engaged in different multi-use activities, the general application process was very distinct. In the

case of a German offshore windfarm application, the process includes five stages (1. Submission of application, followed by plausibility and consistency checks, 2. Application conference, 3. Compiling expert reports, 4. Publication of application, 5. Issuing construction permits) with different stakeholders (Federal Maritime and Hydrographic Agency, stakeholders, experts/scientists) involved at different stages. Applying for a license to build a fish aquaculture farm in Greece, the applicant has to contact the ministry of fisheries.

This means that all activities that will take place around the area close to the aquaculture unit should follow the rules of the according authorization that has been granted to the aquaculture site: Ministerial Order by the Ministry of Environment, Spatial Planning and Energy, granted in the 28th of February, 2020, with the subject: "Approval of Environmental Terms, which concerns the expansion of an existing floating marine unit for fish farming, in the marine area to 29.76 acres (from 20 acres) and an annual capacity to 462.12 t (from 230 t / y), in the place "Kasidiara", sea area "Stenou Gaidouronisiou", Municipality of Saronikos, Regional Unit East Attica, Attica Region, with "KASTELLORIZO SA" as its body."

5.9. After the pilot

All of the pilots have some ideas on the follow-up of their pilot, however these are not documented or defined as clear goals. However, it is recommended to do this at an early stage. Even if it's not the idea to continue the pilot, it is recommended to identify what future multi-use project could benefit/use form the individual pilots' results. In supporting this definition of follow-up project or lessons learnt for future projects, the following guidelines are provided as suggestions:

- The pilot may identify various possibilities of their activities/designs/research results being used by future offshore multi-use projects. It is recommended to translate these aspects into specific goals for the pilot to be implemented in the systems designs and pilot activities;
- Future needs can be identified by talking to stakeholders and commercial businesses that are already involved in the various specific multi-use activities e.g. seaweed or shellfish farmers. The pilot then actively integrates this feedback and the required follow-up into their design and activities;
- In case the pilot (location) will actually be used in a follow-up project then it is recommended to identify any requirements for such a (scaled-up) project as well as the evidence needed to comply with these requirements. These should then be implemented in the pilot system design and activities such that the stakeholders of the follow-up project may be satisfied already during the course of the UNITED project; and
- In case no follow-up project has been identified, it is recommended to identify and talk to partners or external stakeholders that are working on (or want to start working with) multi-use activities. It may be possible to identify a meaningful follow-up project with them based on what the pilot team intends to do. For this, the networks of the various UNITED partners and communications work package lead could also be activated.

6. INTERACTIONS BETWEEN PILOTS

The interaction between Pilots was promoted by organizing bi-monthly Pilot meetings, during which the planning of the pre-operational as well as the operational phases were discussed. Furthermore, bi-monthly report forms were filled out by the five Pilot leads, to document progress, obstacles and potential solutions (e.g. mooring). One distinct part of the pre-operational phase was the hydrological simulation of the Belgian, Dutch and German seaweed (and mussel) design systems, conducted by the University of Ghent. Here different environmental parameters were considered (e.g. drag, current, significant wave height, etc). Especially, between the German and the Dutch Pilot, close interaction was sought, as the same seaweed cultivation designs will be installed in order to test their functionality at two different locations. The two Pilots will also implement the same data measurement buoy (AquaTroll), which provides a great alignment in terms of data analysis and comparison of environmental conditions at two different Pilot sites in the North Sea. The German, the Dutch and the Greek Pilot also worked closely together in order to develop a common database system that will allow the storage of the environmental parameters, which have been collected over the time.

With regard to seaweed cultivation, several alignment meetings between the German, the Dutch and the Belgian Pilot were organized, to discuss seaweed seeding and cultivation strategies and how to best compare different approaches across the three Pilots. All three Pilots agreed upon using local Saccharina latissima seaweed strains, in order to facilitate scientific research about environmental influences on kelp at different sites in the North Sea. The Danish and the Greek Pilot share a common interest regarding tourist expeditions and how to cope with the COVID19 pandemic struggles, affecting the tourism industry. They both fathom new ways of marketing in order to facilitate touristic growth of the area in combination with social acceptance of offshore (aquaculture) activities already taking place, by developing multi-use literacy concepts and sharing insightful information about their Pilots. Overall, the Pilots are frequently exchanging information and continuously making an effort to align their activities with one another whenever feasible. Another opportunity for the Pilots to collaborate is the joint UNITED workshop series starting 2021. Against the background of these events, Pilots will be given the opportunity, to share their results, hands-on experiences and lessons learned from the pre-operational and operational phases in an interactive framework.

7. CONCLUSIONS AND RECOMMENDATIONS

In the previous chapter, it has become clear that many important steps have already been taken to setup meaningful pilots as part of the UNITED project. Various improvements have been identified and, more importantly, it has been acknowledged that there is already a lot of knowledge and expertise available in the project. Nevertheless, it is quite difficult to mobilise this knowledge and to share it among the five pilots so perhaps the most important recommendation is to find a pragmatic approach to facilitate this and to keep the focus on this. In addition, it may prove very useful to adapt the overall objectives of UNITED specifically to the respective pilots according to the further development of the project. So, the goals for the UNITED project subsequently will be translated into smart goals for the individual pilots. These goals should focus on the impact and positive contributions that the UNITED project wants to make on the offshore multi-use developments that have to start after UNITED. It is recommended that the project coordinator, potentially in collaboration with the Stakeholder Advisory Board and project officer are informed regularly and comprehensively about the implementation of the above recommendations as they are the only body(ies) in the project that have the possibility to stand above the parties in the UNITED consortium.

7.1. Selection of preferred solution and technical risk assessment

In chapter 5, the pilot performance against the state-of-the-art is represented for each pilot and several aspects while differentiating between nearshore and offshore pilot phase, where possible. Thus, this chapter represent the technical risk assessment at that stage. It became clear that, even though important steps have already been taken to set-up pilots, still improvements are possible, while for some aspects and pilots, the pilot performance is still unknown. The technical challenges are herewith identified and a selection of preferred solutions to overcome these challenges would be the next step. However, note that this present deliverable is due in M8 of the project and thus in the beginning of the overall project duration. This revised document still reflects the SOTA of the pilots at that stage. Due to that, no potential technical solutions from the WPs 1 to 6 and WP8 for the previously shown challenges were already identified until M8 of the project. These will be documented at a later stage of the project in the deliverables of WP8 (Assessment and Validation). This also applies to the technical risk assessment because of the same reasons.

8. LITERATURE

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Kiefer, B., Gerspacher, U. (2018): Finanzierung von Exporten und Direktinvestitionen. VDF Hochschulverlag AG an der ETH Zürich.

Owolabi, H. A., Oyedele, L. O., Alaka, H. A., Ajayi, S. O., Akinade, O. O., & Bilal, M. (2020): Critical success factors for ensuring bankable completion risk in PFI/PPP megaprojects. Journal of Management in Engineering, 36(1), 04019032.

ATTACHMENT 1: PILOT DESCRIPTIONS

1. German pilot | The offshore research platform FINO3 in the North Sea is operated by FUE. The basic fundament of the platform follows the same characteristics as has been constructed for the offshore wind farm turbines in the area. The experiences from its operation and the results of the numerous scientific research projects carried out so far on and at the platform have helped the wind farm operators and wind turbine manufacturers in the planning, building, and future operation of offshore wind farms. As such FINO3 is well placed to take up an offshore wind and aquaculture demonstration project and will be able to enhance the development from pilot scale to a possible commercial application. The German pilot will demonstrate and test solutions (e.g. automation, remote monitoring, health and safety measures, synergy effects using the same site) for a multi-use project in an extreme offshore location.

2. Dutch pilot | North Sea Innovation Lab is an independent test site for research, pilots and the upscaling of innovations in the field of seaweed cultivation, floating solar and other renewable energy innovations, and co-use of wind farms. North Sea Innovation Lab is located 12 kilometres off the coast of The Hague – Scheveningen with the following technical specifications:
   • 600ha/ 6km^2;
   • 12 km offshore (harbour Scheveningen);
   • Water depth approximately 18-20m;
   • Officially demarcated (cardinal buoys & registered in hydrographic maps); and
   • Known area by stakeholders.

3. Belgian pilot | The Belgian pilot is divided in three phases (pre-operational, operational and post-operational) and will be carried out at two locations (nearshore and offshore).

- In the pre-operational phase, different aquaculture systems will be tested nearshore at the site of Westdiep at 5km off the coast in front of Nieuwpoort (average depth 15m). The nearshore site of Westdiep has several longlines since April 2017, being part of the Belgian projects "Value@Sea" and "Symapa" and is managed by UNITED partner Brevisco. The lines are currently used for test productions of flat oyster (*Ostrea edulis*), blue mussel (*Mytilus edulis*) and seaweed. In UNITED, the nearshore site will be used for testing different types of growing equipment for flat oyster, nature-inclusive scour protection and for sugar kelp (*Saccharina latissima*) growth. The best performing set-up will be selected and applied in the operational phase at the offshore site.
- The operational phase of the Belgian pilot is situated in the south-east part of the Belgian part of the North Sea (BPNS), more specifically in one of the offshore wind farms (yet to be determined) operated by Parkwind. Parkwind develops, finances, builds and operates offshore wind farms in the North Sea since 2009. The vast experience of the Parkwind team builds on the success of the wind farms Belwind (56 turbines), Nobelwind (50 turbines), Northwind (72 turbines), and Northwester 2 (23 turbines) operating in total 776MW mainly in the Belgian exclusive economic zone. Each turbine is built on a monopole foundation. Around each foundation, a scour protection layer is present, and the turbines are connected with each other and with an offshore transformer station by power cables buried in the seabed, transporting the generated electricity. The offshore wind farm area is situated at the eastern border of the BPNS, has an average depth of 15-35m, and includes several sand banks and adjacent gullies.
- The post-operational phase implies the decommissioning of the longlines at the end of the project.

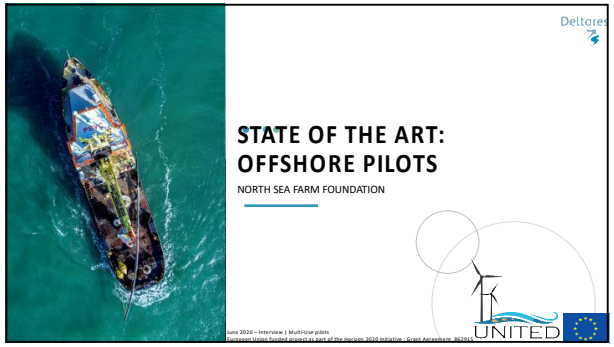
4. Danish pilot | The pilot in Denmark considers multi-use of tourism and offshore wind farms (OWF) that result from shared sea space, joint on and offshore infrastructure and operational activities. These include OWF sightseeing boat tours and shared onshore facilities such as OWF related information

centres and museums. The OWF Middelgrunden Wind outside the harbour of Copenhagen is sporadically used for visits by students from abroad, companies and other people interested in offshore wind. Every two years the cooperative have an open house for the share owners consisting of a boat trip and climbing the wind turbine.

5. Greek pilot | KASTELORIZO AQUACULTURE SA operates a fish-farming unit, on floating facilities in the marine area near island "Patroklos" (the island is located near the coast, 850 meters away). The aquaculture total annual production of marine Mediterranean fish in that area is 230 tonnes. There is great touristic interest in the area, as many tourists visit the coast of Patroklos island mostly with private boats in the summer. The seabed also has great touristic value, as the area has many attractions such as an underwater stolen cars cemetery close to the mainland coast. Other significant attractions are the many shipwrecks that have sunk in that area as well as ancient artefacts, making scuba-diving activities quite popular in that area.

ATTACHMENT 2: INTERVIEW PROTOCOLS

7/9/20



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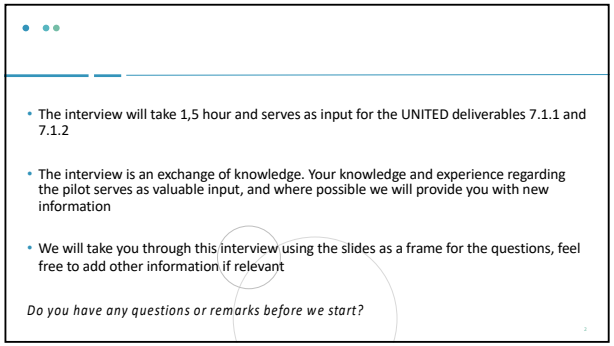

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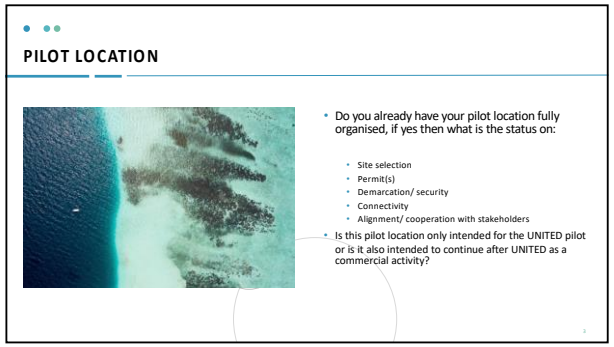

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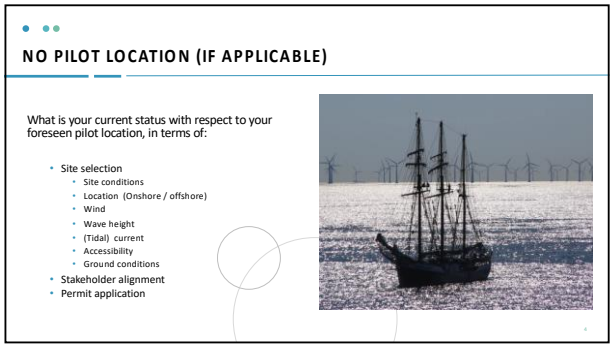


4

1

PILOT: WHAT ARE YOU PLANNING TO DO? - INSTALLATION

What are you planning to do as part of your pilot?

- What modules/equipment/facilities will be installed
- What do they look like
- What's the general timeline
- How will this be installed?
  - Vessels
  - Installation procedure

5

5

PILOT: WHAT ARE YOU PLANNING TO DO? – OPERATION & MAINTENANCE

What are you planning to do as part of your pilot?

- What will be your operational activities?
  - Measurements (remote)
  - On-site inspections?
  - Tests/demonstrations
  - Collecting samples
  - Visitors?
- How do you intend to execute these activities
  - Frequency
  - Vessels

6

6

PILOT: WHAT ARE YOU PLANNING TO DO? – DECOMMISSIONING

What are you planning to do as part of your pilot?

- What will be your operational activities?
  - Measurements (remote)
  - On-site inspections?
  - Tests/demonstrations
  - Collecting samples
  - Visitors?
- How do you intend to execute these activities
  - Frequency
  - Vessels

7

7

PILOT: WHAT ARE YOU PLANNING TO DO? – COMMUNICATION

Do you have any plans wrt communication & dissemination following on from the pilot?

- Preparation (design & construction)
- Installation
- O&M
- Decommissioning

8

8

LOGISTICAL PILOT SOLUTIONS

What is the status of your logistical solutions for the pilot?

- Port locations in the vicinity
- Distance and time from your preferred port
- Facilities in your preferred port
- Sufficient trained personnel
- Maximum size to your multi-use area
- Potential for future scale-up and expension
- Grid conditions

9

HOW ARE YOU DEALING WITH RISKS IN YOUR PILOT?

- Have you already started a risk management activity?
- Do you already have an insurance?
- Are there any specific risks for your pilot that concern you?
- Have you thought about these important risks ?

- Damage to wind farm assets
- Infield cables => loss of production
- WTG foundation => loss of access
- Collision multi-use production unit & vessel
- Collision multi-use vessel and aquaculture/ wind farm assets
- Incidents with multi-use personnel while working in Multi-use area
- Wind farm assets covered in seaweed, shellfish and/or other living biomass
- No or inadequate insurance of multi-user

10

WHAT ARE YOUR PLANS FOR AFTER THE PILOT?

What are you planning to do as part of your pilot?

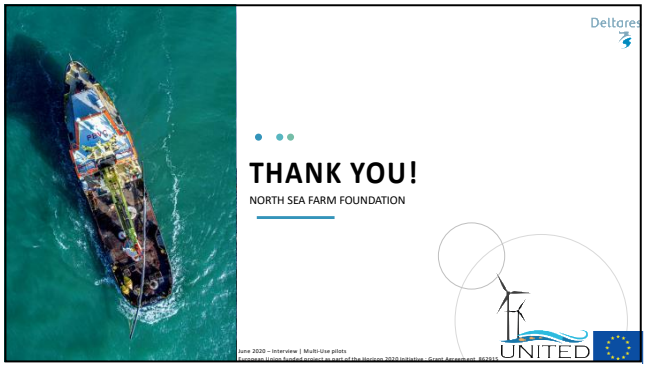
- Pilot location will be transformed into commercial location?
  - Extension/expansion?
  - Current and future business plan
- Relocation?
  - Future location
  - Future stakeholders
    - Need to be involved in today's pilot?

11

ANY OTHER IMPORTANT POINTS

- Do you feel that we have missed other important points regarding your multi-use pilot?
- Current or future barriers?

12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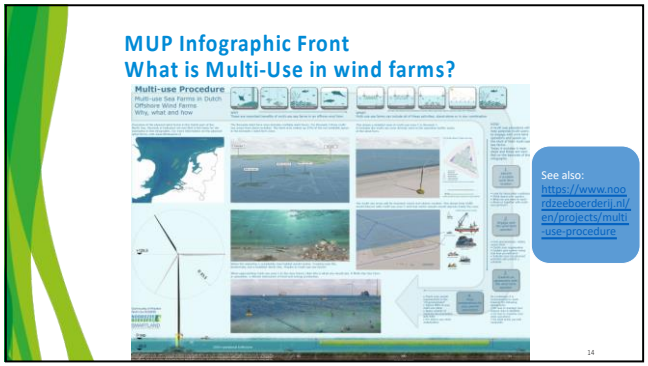
THANK YOU!
NORTH SEA FARM FOUNDATION
UNITED

13


MUP Infographic Front
What is Multi-Use in wind farms?
Multi-use Procedure
See also:
https://www.noordzeeboerderij.nl/en/projects/multi-use-procedure

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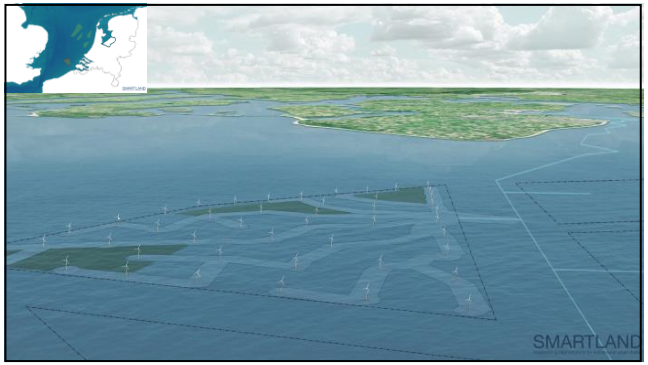
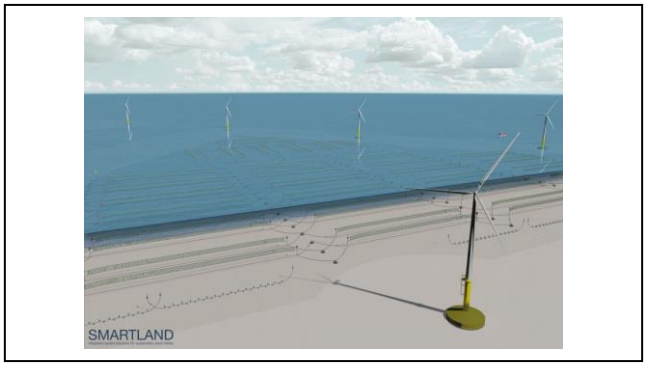

SMARTLAND

15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16

4

ATTACHMENT 3: INTERVIEWS WITH THE FIVE MULTI-USE PILOTS

German Pilot

The German pilot aims to demonstrate (in practice) the economic, environmental and societal benefits of the multi-use offshore wind farming and aquaculture activities. This will be demonstrated through the shared use of environmental monitoring data and surveillance (e.g. database on fish habitats, nursery areas, site attractiveness for invertebrates and fishes), obtaining permissions and licences, training certified offshore staff, optimizing the scheduling of logistics, transportation and maintenance work, reducing energy need, and increasing social acceptance of such multi-use solutions. The automated operation and monitoring will be enhanced through data transmitting and monitoring systems and software, as well as emergency response system.

Pilot location

Nearshore - Kiel Marine Farm (Baltic Sea)

The Kiel Marine Farm (https://www.kieler-meeresfarm.de/) is the leading producer of organic certified blue mussels and sugar kelp in the German Baltic Sea, utilising a long line surface aquaculture installed in Kiel Bay. The near shore situation and location in Kiel combined with the experience of all other partners of the German pilot allow for fast interaction and communication. So it is well organized and all activities for UNITED are planned and updated according to the schedule for this pilot. All permits are available and the site is marked with buoys. Longlines have been installed in April 2020 to test and adjust automation and monitoring equipment before operating offshore. The line is anchored to the bottom with drill anchors and weights. The Kiel Marine Farm operates a harvesting and supply boat from the close harbour and has some on-land storage facilities, power supply and an office to support the pilot. Relevant stakeholders (e.g. Kiel Port Authority) are informed.

Offshore- FINO3

The pilot is located in the North Sea, 45 nautical miles (80 kilometres) west of the German coast (55º 11,7 'N, 007º 9,5' E), close to the German offshore wind farms: Butendiek, DanTysk and Sandbank. Seaweed and mussels will be cultivated within a 500m radius from the research plant FINO3 (operated by FUE). The wind farms as well as the area (500m radius) around the monopile are marked as safety zone in the nautical maps and prohibit any trespassing or entering. All permits are available. The location of the German pilot is characterized by temperate oceanic climate. The minimum water temperature reaches +1 °C, while during summer water temperatures reach 21°C. Especially, the wave height (significant wave height 9.2m (50 years), 8.9m (30 years), 8.3m (10 years)) is a major parameter affecting the stability of longline systems and their mooring. The 50 year maximum wave height reaches 18m (10 year wave reached 16m) and occurred during storms in 2019 and 2018, stressing the importance of a robust and stable seaweed as well as mussel design. Several onshore facilities (office, laboratories, workshops,..) are used for UNITED. An experienced offshore team will be available for regular maintenance and operation work.

Scope

Nearshore – Kiel Marine Farm

The Nearshore Site functions as testing site, mainly to minimize risk of equipment failure in the offshore site. The results will expand the knowledge of KMF. This additional knowledge increases the possibility of future diversification, commercial application and economic security of the company.

Offshore-FINO3

The scope of this pilot is to investigate the upscaling potential of multi-use colocation systems such as the production of offshore energy combined with aquaculture (mussel & seaweed), which is located close to several wind farms. The longline structures will be submerged 4 to 5m below the surface, reducing the wave action on the

installation. Via remote monitoring data on biomass growth (mussel, seaweed), as well as biotic and abiotic environmental parameters are collected to assess the environmental suitability of the offshore site for aquaculture production and evaluate potential impacts of the longlines on marine flora and fauna. For this, a benthic lander will be positioned below the mussel and algae cultivation site while additional sensors are attached directly to the longlines. The collected data will be transmitted to FINO3 via a sea cable from the lander to the platform, from where it is sent via an independent satellite connection onshore. The pilot's objective is to explore synergetic effects between offshore energy production and aquaculture as well as to reduce technological, financial, health and safety, as well as environmental risks for future multi use colocation systems.

Operation & Management

The seaweed and mussel longlines as well as the lander will be installed during the operational phase at the beginning of 2021. A detailed method statement regarding the installation as well as the operation and maintenance of the German pilot is available and will be regularly updated and finally reviewed at the beginning of 2021. All service providers engaged in installation and maintenance activities themselves work according to their method statement. However, in order to plan the installation properly FUE will get together with the chosen diving company/service provider in winter 2020 and discuss a schedule, which will contain detailed information about every single step along the installation process. All preparations will be finished prior to installation (by the end of 2020). The FUE has already drafted a manuscript on „Occupational health and safety organisation in the construction and operation of offshore wind turbines, taking into account the FINO3 research platform as an example of best practice (FINO3 Safety OWES)", which will be used as framework for planning the installation, maintenance procedures as well as decommissioning. Furthermore, best practice guidelines of the DNV GL (https://rules.dnvgl.com/docs/pdf/DNVGL/SI/2016-02/DNVGL-SI-0364.pdf), an international accredited register and classification society headquartered in Høvik, Norway, ISO31000 and other will be included and considered as well.

Decommissioning

Everything implemented at KMF within the scope of UNITED (Lander, Longlines, anchors, buoys) will be decommissioned after the pre-operational phase. All used materials are recycled or handed over to the respective waste treatment facility.
The longline setup (mussels, seaweed, lander, etc.) will remain at FINO3 until late summer 2022 or in case of a prolongation of the project until April 2023. This means, two growing seasons can be realised:

1. April 2021: Mussel installation
   September 2021 – April 2022: Seaweed installation
2. April 2022: Mussel installation
   September 2022 – April 2023: Seaweed installation

A detailed method statement regarding the decommissioning of the German pilot will be discussed with the diving and ship company and drafted by the end of 2022. It will follow the framework of the installation method statement, including time schedules, description of workflows, distribution of responsibilities, etc. At this moment, it is most likely that the same service provider (divers, crew, vessels, etc.) and project partners that already helped with the installation in 2021 will be engaged. The disposal facilities, for the retrieved equipment, are known and have already been frequently used by the FINO3 team. The material can be properly disposed of in Cuxhaven or in Kiel.

Risk management

A complete risk assessment has been established during the licensing process of the Kiel Marine Farm. Aspects such as waste, sound, radiation (warmth and radioactivity), escapees, chemical seeping, and general environmental concerns were covered and are deemed "in good condition and well thought of" by the authorising office (the Ministry of Energy, Agriculture, the Environment, Nature und Digitalization, State Government for Agriculture, Environment and Rural Areas, State Office for Coastal

Protection, National Park and Marine Protection Schleswig-Holstein, Fisheries Authority, Nature Conservation Agency and the City of Kiel.

A detailed risk analysis of the FINO3 research plant was performed before its construction in 2009. An additional consideration of risks, including the installation of longlines in close proximity to the plant, is a main chapter in a feasibility study and was conducted in 2018. A further risk analysis was carried out and will be updated regularly if new information is available.

A detailed risk analysis including prevention and mitigation measures will be conducted in WP6 (deliverable D6.1).

Communication

The internal communication within the German pilot team as well as the external communication to stakeholders is managed by FUE. Within monthly meetings of the German pilot, FUE, 4HJena and the Kiel Marine Farm come together and discuss all further proceedings of the pre-operational (testing of equipment and material), the operational (installation, maintenance and operation, data management) and the post-operational phase (decommissioning, data analysis). In order to keep all Pilot Leads in the loop and updated, bi-monthly WP7 web meetings are scheduled in which every project partner of WP7 has the opportunity to address issues and problems and has a say in decision making processes. Additionally, every Pilot Lead fills out a communication template every second month that documents past, present and planned actions within their Pilots as well as agenda points they would like to address at the next WP7 meeting. The minutes of all internal Pilot and WP7 meetings are available to all project partners to follow up on Pilot activities. Furthermore, FUE provided the WP7 project partners with templates to streamline and organize research objectives, as well as to document the procurement of equipment (sensors, cameras, etc.) and the workflow of the pre-operational, operational and post-operational phase (via a concept description and Excel table). Within the German pilot, two visits to the nearshore site at KMF at the beginning of the pre-operational phase in 2020, allowed the project team (FUE, 4HJena, KMF) to carefully plan the test phase (laboratory functional test and real live environmental test) of their equipment (mussel longlines, lander, buoys). Next to the scheduled meetings, bi-lateral communication is advocated, during which single project partners are consulted with regard to their field of expertise:

- FUE: vast knowledge on (a-)biotic environmental factors affecting mussel and seaweed growth. Giving advice on sensor selection with regard to measurement accuracy and range of variables;
- KMF: extensive experience on mussel and seaweed cultivation on long lines. Giving advice on the selection of longlines and spat collectors, anchorage and submersion of longlines below the surface; and
- 4HJena: professional in the area of submarine sensor technology and construction of benthic landers for remote monitoring and environmental data collection.

The external communication towards stakeholders, such as interviews and presentations of the German pilot is organized by SUBMARINER in WP9. The bi-monthly communication template also contains a chapter on communication, which is regularly updated and shared with SUBMARINER. The WP9 Lead includes relevant news and information about the Pilots in the UNITED newsletter, posts them at the website or shares them in the form of tweeds online.

After the pilot

FINO3 is well placed to take up an offshore wind and aquaculture (blue mussels and seaweed) demonstration project and will be able to enhance the development from pilot scale to a possible commercial application. See also "Scope".

Dutch Pilot

The Dutch pilot North Sea Innovation Lab is an independent test site for research, pilots and the upscaling of innovations in the field of seaweed cultivation, floating solar and other renewable energy innovations, and co-use of wind farms. North Sea Innovation Lab is located 12 kilometres off the coast of The Hague – Scheveningen with the following technical specifications:

- *600ha/ 6km^2;*
- *12 km offshore (harbour Scheveningen);*
- *Water depth approx. 18-20m;*
- *Officially demarcated (cardinal buoys & registered in hydrographic maps); and*
- *Known area by stakeholders.*

Pilot location

The Dutch pilot is located within the North Sea Innovation Lab (NSIL), a test site located 12 km off the coast in front of Scheveningen. Within the NSIL, a UNITED pilot is situated which investigates the multi-use of seaweed production in offshore wind parks.

Scope

Within UNITED, a seaweed aquaculture net structure is investigated. Moreover, research will be performed on remote monitoring, data collection and anchoring of the systems. Within NSIL there is another pilot that investigates the possibilities of floating solar panels in an offshore windfarm. The knowledge and experience gained within NSIL was taken into account when the UNITED proposal was written, in that way that only the most relevant and up-to-date systems and equipment regarding multi-use is being tested.

Installation

For UNITED, the NSIL will install a net construction for the culture of seaweed in the North Sea. The first phase of this pilot will focus on the current questions that have not been answered yet regarding offshore seaweed systems, whilst successfully harvest seaweed. These questions relate to the measurement of data, remote monitoring and anchoring. The second phase of UNITED may focus on the interlinkage between a different plot within NSIL which investigates the possibilities of floating solar panels in offshore windfarms. The first year is focused on retrieving knowledge on the behaviour of the net system, where the second year will be on optimising the net system if needed.

It is the aim to install the first system in October 2020 so that the seasons after, the system will produce seaweed and will be harvested over multiple seasons. Harvesting is planned in May 2021, October 2021 and May 2022.

Operation & Management

From the NSIL there is no standard protocol for operations and maintenance regarding seaweed production offshore. This is something to be explored maybe within UNITED. This would be a good guideline for other (commercial) seaweed production pilots/ companies.

The security of the NSIL outsourced to an external party, who monitors the trespassing of boats in the area of NSIL. In the rule, there should be no trespassing through the NSIL location, as the pilot is demarcated. However, this has happened in the past. A way of securing the NSIL even better could be looked at.

Logistic pilot solutions

NSIL is making use of the existing infrastructure which is located in the vicinity of Scheveningen. Moreover, personnel are trained for the regular operations on the NSIL. If personnel with specific skills are required, these are hired.

Risk management

Within the NSIL it is obliged if you make use of the facilities, to have an insurance. Moreover, the NSIL has a risk register in which the common and fewer common risks are listed. Together with the party interested in using the facilities, and permits of NSIL, the options and reasonable risks are discussed and if needed tackled. An example of this is adding a GPS to the aquaculture systems.

Communications

The NSIL is part of the Noordzeeboerderij, a foundation which has employees working on the communication of activities regarding seaweed culture and other multi-use activities. If wanted, the party making use of the NSIL can make use of the Noordzeeboerderij communication channels. The Noordzeeboerderij strives for a commercial seaweed sector, thus a lot of communication tools are available for the parties within NSIL. Communication is via website, social media channels, newspapers and flyers. Most of the communication is planned, but ad hoc is always possible as there is always interesting news happening in the seaweed sector.

After the pilot

There are no plans regarding the phase after the UNITED pilot, however NSIL always takes out the systems that are placed after a certain period. The UNITED pilot will think of what the plans should be after the project ends.

Belgian Pilot

The Belgian pilot aims to improve the design and deployment methods of offshore aquaculture (flat oyster and sugar kelp) activities and restoration (flat oyster) at offshore wind parks. The main objective is to optimize scheduling of these multi-use activities, identify and supply source biological materials, and identify optimal off-shore equipment (grow-out systems, longlines, scour material, seed collector, holding system, matrass). Moreover, water quality variables, oyster growth, changes and predation and biodiversity will be monitored using field-measurements and predictive models. The findings will be used to develop business cases and financial analysis of integrating the offshore wind and aquaculture and restoration activities.

Pilot location

This pilot exists of two test-phases; the preoperational phase will be performed nearshore (5km off the coast in front of Nieuwpoort, the site of Westdiep), the operational phase will be offshore (50km off the coast in the south east side of the Belgian part of the North Sea) in one of the parks operated by Parkwind. The nearshore pilot is currently fully operational whereas the offshore pilot is in development. The exact selection of the offshore location is ongoing and will depend on the ongoing risk analysis of the site location.

Nearshore

The near shore site is well-organised and serves as a work plan and test site for the activities scheduled for the offshore site. The nearshore site is in progress of testing structures for the activities for offshore. For the nearshore site the permits are organised and in place, as this site is handled as a scientific project, which eases the process for applying for permits. Brevisco is the permit owner at this nearshore site. At last, the nearshore site had been used by other scientific projects as well. The nearshore site of Westdiep has several longlines since April 2017, being part of the Belgian projects "Value@Sea" and "Symapa" and is managed by UNITED partner Brevisco. The lines are currently used for test productions of flat oyster (*Ostrea edulis*), blue mussel (*Mytilus edulis*) and seaweed. In UNITED, the nearshore site will be used for testing different types of growing equipment for flat oyster, sugar kelp, and nature-inclusive scour protection of flat oyster. The best performing set-up will be selected and applied in the operational phase at the offshore site.

Offshore

The first requirements of the offshore site (South-East side of the Belgian part of the North Sea) were chosen based on research performed by UNITED partner RBINS *in* "De Mesel I., D. Kapasakali, F. Kerckhof, L. Vigin, G. Lacroix, L. Barbut and S. Degraer (2018). *Ostrea edulis* restoration in the Belgian part of the North Sea: Feasibility study. Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Marine Ecology and Management. pp. 89.". The initial requirements are:

- Suspended particulate matter (SPM) of <50mg/L;
- Average (residual) current of 0.5-1m/s; and
- Hard substrate provision with preference of gravel or in case not naturally present, to be added artificially. However, no sand banks/sand dumping in the area, no fishing allowed that can disturb the bottom.

Moreover, the depth of the site should be less than 30m, mostly because of practical reasons. The next step, determining the exact location within the preselected area, will be chosen based on the ongoing risk management performed by MTD-UGent for site selection and longline design (applying MoorDyn-UGent) within the parks operated by Parkwind that fulfil all requirements mentioned higher.

The organisation of this offshore site will be handled by Parkwind, as well as the permits for the site and aquaculture structures. The locations within the OWF are not open to commercial users. Therefore, UGent has an advantage as their pilot is scientific, which allows them to use the OWF for multi-use activity testing.

UNITED & pilot

The main activities within the pre-operational phase are

- Collection of oyster spat;
- Aquaculture of oysters and seaweed culture; and
- Restoration of flat oysters.

1.1 Oysters nearshore

The oyster aquaculture is done via baskets in a frame attached to a longline. The system that works best will be applied in the operational phase offshore. The systems that are now in place are:

- SEAPA baskets hung in frames attached to a longline for oyster spat collection and oyster growth
- Restoration table for flat oyster

1.2 Seaweed nearshore

The final seaweed cultivation design is ongoing and will integrate existing infrastructure on longlines. For sugar kelp (*Saccharina latissima*), one of the designs being looked into is a net structure (in total 50m) which will be attached to the backbone consisting of a longline anchored at sea. The Phycology division of UGent will investigate the effect of cultivation technology and genetic background to optimise growth of sugar kelp in the BPNS by testing different seeding methods and seaweed strains. However, the strain selection of sugar kelp with different genetic background was severely impacted by COVID-19.

The nearshore phase functions as a test for which systems and materials can be exploited in the offshore site.

Operation & management

Vessels for the nearshore location are provided/ owned by Brevisco.

The existing infrastructure (ports & facilities) is used for both the offshore and the nearshore site. Material is stored near the coast from where the organisation leaves with the boat.

Risk management

The insurance and required permits for the nearshore pilot are all present, and partners Brevisco, Colruyt, and UGent have an extra insurance for personnel. Since the pilot is a scientific experiment (not commercial business), the permits were granted for this type of activities.

The offshore risk analysis is ongoing and is being done by the maritime division (MTD) of UGent.

A general note needs to be made that there is a big difference between risk analysis and permit granting for scientific versus commercial activities.

Communication

Communication is planned. The activities of the pilot are carefully communicated to both UNITED WP9-lead and via Ghent University communication channels. Moreover, the UGent Blue Growth Liaison Officer is intertwined with this project. The communication on the pilot activities will help to increase social acceptance of the multi-use OWF activities.

Decommissioning

UGent is responsible for the decommissioning, and this phase is foreseen at the end of the project. The plan is to remove all structures at both the nearshore and offshore sites from the water. Regarding the oyster restoration, the pilot would strive for leaving the structures in the water based on the outcome of the pilot.

Danish Pilot

The Danish pilot targets the expansion of tourism activities (boat tours, leisure fishing and diving) related to offshore wind farms. The pilot therefore serves as a demonstrator of the improved multi-use information technology (boat scheduling system) and physical technology (facilities for divers on platform). The pilot also aims to advise on the health and safety practices and on related regulations (safety zone measures, permission for fishing, and insurance with tour operator) of such multi-use activities.

Pilot location

The pilot is located in an offshore wind park, in front of the coastline of Copenhagen. This OWF is partly (50%) owned by the public owned utility HOFOR, and partly (50%) by shareholders as organised in a cooperative with 8.552 shareholders. This pilot site will not be decommissioned in the near future as there is an agreement that this site will be running for at least the next 10 years. The location of this pilot is not being used for marine culture, as the soil might be heavily polluted. The location has been a waste deposit site up to 1975, which could have led to high concentrations of heavy metals. This is unknown at this stage, and should be investigated further, to conclude whether there is a possibility for marine culture.

Currently this pilot provides visits to the OWF. Visitors can or visit the OWF by boat, or climb the wind turbines. Moreover, the pilot provides lectures about the energy company Wave Dragon. Most of the visits to the OWF are from people coming from abroad. Usually (pre-COVID-19) there would be 20 visits during the spring.

Scope

The pilot already performs activities for tourists, such as providing boat trips to the OWF, providing trips to the base of the windmill, and providing boat trips to the mill to climb the mills. The scope of this pilot is to further investigate the possibilities on tourism, add activities for recreation, and to visualise the activities of an OWF onshore. More specifically:

1.1 Extend tourism activities

The pilot will investigate whether it is preferable to distinguish in certain types of visitors. It is proposed to distinguish different types of visitors, as there are different types of reasons to visit the OWF. The following categories are suggested:

- Professional visitors;
- Recreational visitors; and
- Educational visitors (schools).

By using a categorisation, this will help to make a blueprint for other windfarms in the EU, looking to perform multi-use activities.

1.1.1 Activities for recreational purposes

The pilot will investigate the possibilities to install a diver's platform. The location has potential to be a great diving location. Currently diving activities can be performed in the OWF, however there is a need for a camp where the diving equipment can be stalled.

1.1.2 Activities on education and training

1.2 Increase social acceptance of multi-use activities in OWF

This pilot focusses on increasing the public acceptance of OWF and multi-use activities. The pilot will investigate the possibilities on how to visualise the activities done in an OWF for people that are onshore. There is a need for this, as the pilot is too far away from the shore, making it impossible for many people to visit the location. This scope of the pilot strives to make the OWF activities better understandable for everyone interested/ every stakeholder. Thereby increasing social acceptance of wind farms or other multi-use offshore activities:

1. Create a virtual tour to the turbine;
2. Make this tour accessible for audience at places from where the OWF can be seen. It has already been discussed with a museum. This is a way of integrating the OWF tourism into the existing (onshore) infrastructure;
3. Install a webcam, so that many people can access the OWF online. This will help to increase the social acceptance of multi-use activities; and
4. There could be reason to investigate the possibilities to create a visitor centre for this pilot.

Risk management

The pilot has not completely envisioned all risks involved in the multi-use activities. This is due to the fact that there are multiple stakeholders/ operators involved in the activities. Up to entering the foundation of the windmill, the visitors fall under the responsibilities of the boat operator. Once the foundation is accessed, the visitors will become the responsibility of the tour operator.

Communication

Currently, there are leaflets with information on the pilot, which are handed out to visitors.

Greek Pilot

The Greek pilot investigates possibilities to expand tourism activities (leisure scuba diving) at aquaculture sites (fisheries). Based on existing activities of aquaculture and tourism in the shared marine space, several actions will be taken to increase the TRL level of such multi-use solution. The pilot aims to increase aquaculture production efficiency, monitor technologies to synchronize activities, and demonstrate the use of Decision Support System for new development. In addition, the pilot will investigate challenges in terms of insurance issues, profitability,

risk/health impact, economic sustainability, while minimizing pollution prospects and facilitating touristic growth and social acceptance of aquaculture activities.

The Greek pilot, denoted as the Patroklos pilot site, includes an aquaculture unit situated in the Mediterranean Sea at the Greek coast. KASTELLORIZO operates a fish-farming unit on floating facilities in the marine area near island "Patroklos" (the island is located 850 metres from the coast).The wider area now is protected under NATURA 2000 and the Treaty of Barcelona due to a number of significant characteristics that this pilot site has. The pilot site for project UNITED is considered the wider area between the island and the mainland, with in between those two sites the fish farm. Currently, there is some tourism activity in the form of scuba diving. Moreover, other leisure activities take place in the site such as swimming, tourist' visits with private vessels anchoring in the island as well as other inland coasts.

Scope

The pilot will investigate the possibilities of combining aquaculture with scuba diving activities:

- Scuba diving near the NATURA 2000 private island "Patroklos";
- Scuba diving in the aquaculture site;
- Plan tours with boats for people to see how the aquaculture farm works. This needs to be investigated further due to necessary permits that these vessels should acquire in order to carry tourists;
- Professional scuba diving can help the aquaculture site with some of their operational activities.

There is no particular permit required for scuba diving in aquaculture sites.

UNITED & Pilot

The aim of this pilot is to investigate the possibilities of combining scuba diving tourism with aquaculture. Within the UNITED project, this pilot will install hardware which will monitor and collect data in the aquaculture farm. There is a lacking network at the aquaculture site. There is no 4G network available at that point. Therefore, the pilot is installing connectivity equipment, which is connected to the shore, where telecom network is available. The pilot is thinking about making a platform where any necessary equipment can be stored. It is undecided yet who will build this platform, but it will probably be the farmer.

At this point in time, all necessary hardware has been ordered and most of the equipment has arrived. Due to COVID-19 crisis though, there has been significant delays leading to final deployment of the sensors and equipment in the site around September 2020. The initial installation of the hardware will be done by the Greek pilot team (Giannis and Paraskevas), in collaboration with the aquaculture farm employees. However, so far there is no structured plan who will maintain the equipment thereafter. Insurance regarding this equipment is currently under investigation.

The hardware will exist of transmission technology, which will transfer the collected information from series of sensors and cameras to a network. Different communication gateways for high broadband data from cameras and sensors is being considered. KASTELORIZO AQUACULTURE (the aquaculture unit owner), has already constructed and installed a floating warehouse in the site to facilitate the housing of these gateways and any other equipment that needs to be protected from environmental conditions (see Figure 2).

Figure 2: Floating warehouse in the Greek pilot Patroklos aquaculture unit

WINGS, who is in charge of the technical installations onsite, along with KASTELORIZO, has already carried out a lot of investigative visits to the site in order to plan effectively the final deployment. Till now, some important information has been gathered:

1) Internet Connectivity on site: 4G access point with WiFi and Ethernet access
2) Power Connectivity on site: Installed photovoltaic (pv) panels with 7V output in the floating warehouse.

   Aquaread (sensor) device: It will be connected to either (1) available PoE through a local switch (power and internet) or (2) directly to the power source (pv) for power and the WiFi for internet.

3) Camera and current sensor device: It will be connected to a waterproof PoE cable located 15 meters away from the local switch. Power should be provided by an extra autonomous installation by panels and batteries. The device will be installed in a custom structure at the periphery of the fish cage. Two sensors have been purchased to be installed on site: Aquaread (multi-parameters measuring sensor), and Valeport Model 106 (P redox-current meter sensor).

   Sensors will be installed to measure:

   - Salinity;
   - Temperature;
   - Dissolved oxygen;
   - pH;
   - Turbidity;
   - Chlorophyll; and
   - P redox-current meter.

Operation & management

The hardware which will be installed has a goal to monitor and manage the aquaculture site. The sensors will collect data on the production parameter of the farm. The hardware will also monitor whether the farm site experiences effects from the touristic scuba diving. Measurements will be collected to keep track of how the production of aquaculture site is going. Environmental parameters will be checked in order to see whether the environment is not negatively affected by the multi-use activities. A camera will be installed to monitor potential increased stress behaviour of the fish. The latter to assure that the farm production is not affected by the scuba diving expeditions.

Risk management

Currently the pilot is carrying out an analysis of risk management aspect of the multi-use activities.

Communication

Communication of the pilot's activities will mostly be through local public press and magazines. Other means are being investigated.

By having communication materials on the pilot site, one is able to show the progress of the pilot. Moreover, it will help to increase the social acceptance of the multi-use activities.

After the project

A first attempt to create a business model has been done for the multi-use activities on the site. The business model canvas is also reported in D1.2 and is shown in Figure 3. However, after the UNITED project, multi-use activity partners need to re-examine the overall benefit of this synergy in order to finally decide if they plan to continue with the multi-use scenarios.

Business model Canvas — Aquaculture and tourism Business Plan (Pilot: Patroklos)

Problem	Solution	Unique Value Proposition	Unfair Advantage	Customer Segments
• Lack of societal acceptance of aquaculture unit • Lack of new scuba-diving attractions • Difficulty in monitoring aquaculture infrastructure in great depths • Limited monitoring of environmental footprint in aquaculture site	• Combination of aquaculture and scuba-diving, using software platform for scheduling activities • Scuba-diving tourist visits to the aquaculture site • Aquaculture farmers used as tour guides • Scuba diving equipment (ROVs) to be used for aquaculture monitoring • Installation of sensors in farm to track environmental footprint • Installation of cameras to monitor fish stress levels **Key Metrics** • Number of scuba-diving tourists • Number of aquaculture infrastructure failure cases • Revenues	1) Clean water 2) Increased touristic activity in site 3) Social acceptance of aquaculture farm 4) Cost reduction of infrastructure failures 5) Increased revenue 6) Increased crop yield	• Introducing an alternative touristic attraction • A potential win-to win combination compared to same activities existing individually in the pilot site **Channels** 1) Local newspapers/ press 2) Partners 3) Website / social media	• Foreign tourists • Local tourists • Local residents • Regional authorities

Cost Structure	Revenue Streams
1) Marketing costs 2) Licensing costs 3) Sensors and cameras installation 4) SW development costs 5) Deployment/Hosting costs	1) Scuba diving participation fees 2) Fish products sold 3) Grants

Figure 3: Business model canvas for aquaculture and tourism business plan for the Greek pilot

ATTACHMENT 4: INTERVIEWS RESULTS SUMMARISED IN COMPREHENSIVE TABLE

Topic	Question	German pilot	Dutch pilot	Belgian pilot	Danish pilot	Greek pilot

Pilot location	Is the pilot location fully organised already?	Yes, both nearshore and offshore The pilot location will be within the safety zone of the research platform FINO3. It is located 80 km West, of the coast of Sylt, Germany. The pilot location is surrounded by 3 offshore windfarms (OFW). The Meeresfarm Kiel (Kiel Marine farm) (KMF) is also part of this pilot, this farm is located nearshore. This location is used for testing equipment and machinery prior to moving to the offshore side.	The Dutch pilot includes a single offshore site and this is designated as the North Sea Innovation Lab (NSIL). This site is already fully available for the intended UNITED pilot activities	Belgian pilot | The Belgian pilot is divided in three phases (pre-operational, operational and post-operational) and will be carried out at two locations (nearshore and offshore). • In the pre-operational phase, different aquaculture systems will be tested nearshore at the site of Westdiep at 5km off the coast in front of Nieuwpoort (average depth 15m). The nearshore site of Westdiep has several longlines since April 2017, being part of the Belgian projects "Value@Sea" and "Symapa" and is managed by UNITED partner Brevisco. The lines are currently used for test productions of flat oyster (*Ostrea edulis*), blue mussel	Yes the location for the offshore pilot is available The pilot is located in an offshore wind park, in front of the coastline of Copenhagen. This OFW is half owned by a private public energy company (Kopenhagen Utility HOFOR), the other half is owned by shareholders as organised in a cooperative with 8.552 members. This pilot site will not be decommissioned in the near future. There is agreement that this site will be running for at least the next 10 years. The location of this pilot is not being used for marine culture, as the soil might be heavily polluted. The location has been a waste deposit site up to 1975, which could	1. Yes This pilot is located near the Natura2000 island of Patroklos. Between the island and the mainland, a fish farm is situated. Currently there is some tourism activity in the form of scuba diving. The pilot site is the farm site.

				(*Mytilus edulis*) and seaweed. In UNITED, the near-shore site will be used for testing different types of growing equipment for flat oyster, nature-inclusive scour protection and for sugar kelp (*Saccharina latissima*) growth. The best performing set-up will be selected and applied in the operational phase at the offshore site. • The operational phase of the Belgian pilot is situated in the south-east part of the Belgian part of the North Sea near the Bligh bank, more specifically in one of the offshore wind farms (yet to be determined) operated by Parkwind. Parkwind develops, finances, builds and operates offshore wind farms in the North Sea since	have led to high concentrations of heavy metals. this is unknown at this stage, and should be investigated further, to conclude whether there is a possibility for marine culture.	

				2009. The vast experience of the Parkwind team builds on the success of the wind farms Belwind (56 turbines), Nobelwind (50 turbines), Northwind (72 turbines), and Northwester 2 (23 turbines) operating in total 776MW mainly in the Belgian exclusive economic zone. Each turbine is built on a monopole foundation. Around each foundation, a scour protection layer is present, and the turbines are connected with each other and with an offshore transformer station by power cables buried in the seabed, transporting the generated electricity. The offshore wind farm area is situated at the eastern border of the BPNS, has an average depth of 15-35m, and includes		

				three sand banks (amongst which the Bligh Bank) and adjacent gullies. • The post-operational phase implies the decommissioning of the longlines at the end of the project		

	What is today's availability of the required physical area for the pilot on-/offshore	The nearshore pilot (KMF) location is already in use, and the offshore pilot location at FINO3 is available and ready to use	The NSIL site is fully available for the UNITED pilot	Nearshore site is available to use. The offshore site will be available after long-line design, risk management and consent of the owner by the wind farm in which the pilot will be built	The pilot is located in an offshore wind park, in front of the coastline of Copenhagen. There is no defined physical area for the onshore activities defined.	The physical area for this pilot is available and ready to use This pilot is located near the Natura2000 island of Patroklos. Between the island and the mainland, a fish farm is situated. Currently there is some tourism activity in the form of scuba diving. The pilot site is the farm site.
	Are there any onshore based (support) facilities required? And if yes, what is the status on their availability?	Yes there are onshore based facilities required. These have been identified and are available for the pilot. Ports: Esbjerg and Cuxhaven (vessel, tank ship), Brunsbüttel (divers start from there), Sylt/Husum (Helicopter leaves from there) See below for an elaborate description:	Scheveningen and Rozenburg are the main onshore operating points required for storage, assembly and load-out. These sites are available for the pilot	Nieuwpoort and Ostend are the main onshore operating points required for storage, assembly and load-on. These sites are available for the pilot. In the operational phase, it might be possible ships will leave from the coast of Zeebrugge too, but will depend on the vessel type needed at the time of operation.	Yes there are onshore facilities required, such as vessels for the transport of visitors to and from the windfarm. These facilities are available, however are not organised in a structured manner, but are organised ad hoc.	1. Yes, there is onshore facilities required 2. Yes, this in place there is a port

		The offshore operation will be organised and monitored by Forschung und Entwicklung (FUE). A team of offshore engineers is based at the FUE office in Kiel to jointly implement all activities. Onshore waste disposal facilities are located in Kiel. A workshop for necessary maintenance works is available at FUE, Kiel. A landbased storage (spare parts, buoys) is at the nearshore site at KMF in Kiel. Biologists are based at the FUE office in Kiel and at the office facilities of KMF in Kiel. The central workshop of 4HJena in Jena will be used to construct the lander and the office and technical laboratories of 4HJena in Kiel are available for testing monitoring				

		equipment. The German pilot will also relay on the onshore facilities of the seaweed supplier (not yet determined which one). The onshore facilities of the UGent will serve the German pilot to test the design of the seaweed installation.				
	What is the status of any required permits for the pilot locations (on- and offshore)	The permit for the offshore site is available, the pilot nearshore has a permit as well, but belongs to KMF not to FUE.	All required permits are already available and valid for the coming 8 years	Permits for the nearshore site are ok, permit for the offshore operational phase (research) will be organised by Parkwind as soon as the ongoing risk assessment for location has been completed (end of summer 2020)	There are no permits required for this pilot lead to perform multi-use activities. The permits that are required for the OWF are in place and organised by the OWF owner. Same holds for the transport of the visitors, the boat company has the required permits in place.	The required permits; * for aquaculture in place * for scuba diving no permit needed * unknown for the transport of visitors from and to the diving platform

	What is the status of potentially required demarcation measures and/or other security measures for the nearshore/offshore pilot sites;	Nearshore: The operation site is marked with buoys according to the official requirements. Offshore: Currently there are no buoys marking the area. However, this is not required as there is a 500m safety zone defined. The final clarification will be provided in fall 2020.	Offshore site demarcation is required by law and as such installed and available for the NSIL. Remote monitoring to prevent any inadvertent ship passage through the area is being monitored by an external organisation.	For the nearshore site this has to stay within the research area demarcated by Brevisco. As situated in a NATURA2000 area, the surface area of the bottom structures (restoration tables) has to be less than 1m^2. Offshore the demarcation area will depend on the results of the ongoing risk assessment study performed by MTD-UGent	There is no demarcation in and around the pilot location. The pilot is aware of security risks, however minimal security measures are in place.	The farm is demarcated, other security measures have not been defined yet
	What is the status of the connectivity (e.g. 4G) for any remote monitoring requirements at the near/offshore site	Nearshore: There is no need for connectivity, however, the lander that will be placed offshore will be tested here as well. **What is the lander tested for then, drag forces?** Offshore: There is sufficient remote connection to the met mast and the pilot installations will	There is adequate 4G connectivity on the site for any remote monitoring & measurements activities. Furthermore a communications hub (buoy) is available in the offshore site.	Nearshore 4G present. Also Marine network for wireless internet. 4G is also available on the offshore site. For the latter, the provider is BASE.	n.a.	The status of the connectivity for remote monitoring is ongoing, sensors will be placed and connected to the cloud. The pilot is currenly installing connectivity equipment, which is connected to the inland, where telecom network is available.

		be connected to the mest mast via a umbilical				
	What is the level of alignment/cooperation with pilot location's stakeholders	Nearshore: There is a good/ excellent level of alignment between the nearshore stakeholders. Offshore: Excellent level of cooperation with the pilot location's stakeholders. See below: * The operator of all three wind parks is Vattenvall Europe GmbH, with whom the FUE has a good relationship * The area around FINO3 is restricted and no sail through parties are allowed to enter that zone. * Research institutes (Fraunhofer	As the NSIL has been in place since 2016. All stakeholders have been identified and with all good relations are being maintained	Operational phase pilot: from Parkwind, our stakeholders are : MUMM – Windpark owner (including technical, financial and insurance support). Parkwind will coordinate/align the information between the United project and his stakeholders : - permit requirement : agreement from the MUMM to execute this R&D project within the windpark concession - wind park conditions : o obligations toward the windpark permits o obligations coming from the technical	The pilot is allowed to rent a boat and go into the windpark. However, there is no proper allignment with the operating energy company.	The level of alignment with the stakeholders is good, all involved parties have been identified

		Gesellschaft, Helmholtz-Zentrum Geesthacht, GMA Büsum, other), University of Applied Science of Kiel * Enterprises/companies (e.g. Vattenfall Europe GmbH) * Public institutions (Federal Ministry for Economic Affairs and Energy, Building and Nuclear Safety, Ministry of Economic Affairs of Schleswig-Holstein with funds from the European Union, European Fund for Regional Development, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Federal Maritime and Hydrographic Agency)		and financial advisors from the windpark owner o obligations coming from the windpark owner : workprocedures – Emergency plan - workpermits		

	What is the setup of the governance of the pilot locations (near-/offshore)	Nearshore: Kiel Marine Farm (KMF) operates the nearshore site and leases the area from the state Schleswig-Holstein. KMF has the permit and the ultimate responsibility. The partners of the German pilot decide together what activities take place and how. Offshore: FUE has the responsibility for FINO3 and decides, which projects will be conducted under consideration of legal requirements. The regulatory authority is the Federal Maritime and Hydrographic Agency (BSH).	The Noordzeeboerderij BV (subsidiary of Stichting Noordzeeboerderij) governs the NSIL pilot site. All relevant coordination, safety and legal requiremts are being addressed by Noordzeeboerderij in accordance with the legal permit requirements	Nearshore/offshore: Ghent University as pilot lead has ultimate responsibility but only decides after a go and after informing all partners involved. We can of course not do anything that would not be allowed based on risk assessment.	The governance of this pilot is by Spok Denmark and Kopenhagen Utility HOFOR (utility)	WINGS, KASTELORIZO AQUACULTURE

Assessment		For the nearshore pilot location all appears to be in place as it is already present and operational. They only recommendation that could be considered is to clarify if the test activities with the lander are allowed under the permit of Meeresfarm Kiel. The offshore pilot location is already fully operational and above and beyond what could be considered State of the Art. Perhaps the only thing that could be still checked is if any navigational measures are required for the pilot installations in the 500m safety zone of the met mast.	The pilot location is considered above SOTA as it is fully operational and because it includes a dedicated communications facility (metbuoy) and additional safety measures in the form of active ship traffic monitoring	"For the nearshore pilot location all appears to be in place as it is already present and operational. They only recommendation that could be considered is to clarify the governance (financial responsibility) structure to prevent any surprises during incidents or operational activities. Furthermore, it may be prudent to revisit if all stakeholders have been identified and updated on the latest developments. The offshore pilot location has just not been selected so an assessment on level of readiness is not yet possible. Nevertheless, there is already quite a lot of knowledge in the consortium on how to organise such a pilot location so it	The topic "pilot location" is not fully applicable for this pilot as it is an existing and operational site that enable regular visits. These visits are already available in the with the existing site and permits. Nevertheless, it may be interesting to structure the organisation of the site visits with specific activities, associated procedures and long term contracts/relationships with suppliers/contractors. The may also enable the latter to participate in improving the service and working practice. Finally, w.r.t. governance, it may be useful to address the issue of responsibility in case accidents happen	Most of the necessary elements for the pilot location see to be in place. It may be prudent to check for any permit requirements for the tourism activities. Furthermore, apart from knowing who they are, it may be also be useful to also already engage with the stakeholders. Finally, it may be useful to further clarify the governance: is it clear who is resonsible for permits, damage to aquaculture assets or injuries to divers?

				may help to ask for support on this topic. Finally, it may be prudent to check the timeline against the planned off-shore activities as these processes may be longer than expected. This may adversely impact the planned pilot activities.		

System design	This topic addresses the details of the systems designs that are part of the pilot activities. For each pilot an inventory will be made of items in the following categories: 1. What production modules will be used 2. What equipment (monitoring, measurement) will be used 3. Any other items?	1. Production modules: Nearshore: * no nearshore cultivation of seaweed, seaweed will be obtained from a supplier * Longline with screw anchors - mussel seed collection Offshore: * Longline or nets (currently being examined by FUE engineers and UGent) for seaweed cultivation * Longline for mussel seed collection 2. Equipment: Nearshore: * Lander will be tested at nearshore site, once it is ready, it will be powered via shore connection (cable from lander to power connection on land); regular check-up by KMF with workboat	1. Production modules: * 2xSMAC4.0 modules for seaweed cultivation 2. Equipment: * In-module sensors * Measurement-buoy for reference measurements and communications hub Other: * Remote surveillance service to prevent collision between ship traffic and pilot modules	Production modules: 1. Oyster frame (hung on the backbone of a longline anchored at sea) with SEAPA-baskets for spat collection - nearshore 2. Oyster frames (hung on the backbone of a longline anchored at sea) with SEAPA-baskets, ropes and sticks for spat grow out 3. Oyster restoration table on the bottom – nearshore 4. Seaweed design ongoing, but structures will most likely consist of nets hung on the backbone of a longline anchored at sea - nearshore 5. Longline to which structures will be hung for oyster spat collection, oyster grow out and seaweed cultivation - offshore 6. Flat oyster restoration on scour	n.a.	1. n.a. There is an aquaculture/ fishery site which is already operating, within UNITED no extra production module will be added. 2. Different communication cables for high broadband data from cameras and sensors is being considered. Sensors will be installed to measure: * temperature * oxygen * nitrate * aquarid/ aqua real sensor * current meter is planned however this is unsure due to COVID-19 delivery delays

		Offshore: * Lander for communication & sensor mounting plus various monitoring measures (sensor list see GA) directly on the longlines (and net?) * Umbilical cable between lander & met mast - offshore **+** sensors and cameras attached to long lines ; * Additional monitoring devices at the offshore platform as a backup		materials that will be placed on top of the monopole foundation around a turbine - offshore Equipment: 1. nearshore determined 2. offshore: based on best suited practices nearshore		

	What designs have been selected for the production modules, equipment and other items as part of the pilot system design: 1. Off-the-shelve designs available in the market place 2. prototype designs that are available from project partners; and 3. prototype designs that are available in the respective industries (seaweed, shellfish, nature, etc.).	1. Production modules: Nearshore * Off-the-shelve mussel longline designs, available in the market place, * Seaweed will be obtained from a commercial supplier Offshore * Longline for mussel seed collection: off-the shelf mussel long lines adapted for offshore conditions and tailored for our site. * Longline for seaweed cultivation: off-the shelf seaweed long lines adapted for offshore conditions and tailored for our site. Prototype designs of project partner and industry are currently examined. 2. Equipment: * Lander for communication & sensor mounting: new	Production modules: 1. 2xSMAC4.0 modules for seaweed cultivation: new design based on latest prototype SMAC3.0 by Noordzeeboerderij Equipment: 1. In-module sensors: : off-the-shelve systems - procured 2. Met-buoy for reference measurements and communications hub: off-the-shelve systems - procured Other: 1. Remote surveillance service to prevent collision between ship traffic and pilot modules: service contracted in marketplace	Designs: 1. Longline for multi-use oyster/seaweed aquaculture, new design by MTD UGent 2. Basket anti-fouling solutions, new design ARC UGent 3. Scouring protection material for oyster reefs, new design from UNITED partners JDN – ARC UGent 4. Tables for colonization experiments on sandy bottom, new design from JDN 5. Grow-out techniques: existing designs will be tested for suitability in the Belgian North Sea	n.a.	1. n.a. 2. off the shelve designs 3. off the shelve designs

		design by 4HJena, tailored for offshore conditions * Umbilical cable between lander & met mast: off-the-shelve systems - procured 3. Other: * Fishing boat from north sea				

Assessment		Nearshore: No direct observations wrt the mussel farm. It appears suitable for its intended smaller scale purpose. Nevertheless, it may be useful to consider adding seaweed cultivation. There are various tests ongoing in Europe with such a setup that may enable year round biomass harvest from the farm. In addition it may be possible to add remote monitoring facilities to the farm in line with the approach of the Patroklos pilot For the production modules in the offshore location it has been suggested to use the same seaweed system as in the Dutch & Belgian pilot to enable comparable results. This system could be modified to suit the	The Dutch pilot is building upon latest technology available in the marketplace. The AtSeaNova & SMAC3.0 system. The Duthc pilot is developing the SMAC4.0 system that will be an improvement on the SMAC3.0 system. The improvements will include adding multiple substrates in one single system as well as verification of the best orientation of the system.It will be useful if mooring force measurements as well as remote monitoring systems could be employed	For the nearshore site the existing longline infrastructure will be used to perform various oyster and seaweed grow tests. In addition, an oyster table will be placed on the seabed. Using an existing infrastructure for these tests will limit cost and limit risk as it is apparent the system is suitable for its operational environment. Furthermore, existing techniques will be tested for their suitability in Belgian waters. Communications with similar pilots in the Dutch North Sea have been had to help with using the latest insights for the planned tests. For the production modules in the offshore location it has been suggested to use the same seaweed system as in	No systems or production modules will be used in this pilot, hence this topic is not relevant for this pilot.	No separate production module is being installed but rather (off-the shelf) sensors are being installed in an existing aquaculture farm specifically for the (remote) operation of the farm. In that respect it is recommended to integrate the requirements for (diving) tourism at the farm directly into the monitoring system requirements. In this way it may be possible to test this form of tourism at a commercial farm using automated systems and thus making it easier for future farmers to allow this type of tourism at their site without excessive risk or time.

		FINO3 metocean conditions. Furthermore, it was discussed to then add accelerometers to the seaweed system in addition to the already planned lander. Finally, it may be useful to verify what measurement can be performed with the lander that are necessary for research questions associated with the seaweed system For the mussel system it is recommended to look into standard cultivation systems that are already available in the market, e.g. smartfarm or easyfarm systems. The latter is currently being tested in the Dutch pilot and has proven adequate for offshore conditions.		the Dutch & Belgian pilot to enable comparable results. This system could be modified to suit the Belgian offshore pilot conditions. With respect to the scour protection elements, it may be useful to have a look at the recent paper on nature-inclusive wind farm design, attached to this document.		

Installation activities	This topic addresses the details of the installation activities that are part of the pilot activities: 1. What are you planning to do in terms of instalaltion activities as part of your pilot, i.e. what modules & equipment will be installed?	Nearshore: Testing of the offshore production modules and lander, and where needed adjust the modules for offshore conditions Offshore: * Two production modules (seaweed & mussels) will be installed * One seabed lander with sensors attached will be installed * One umbilical cable between lander and met mast will be installed * Computer for data collection, storage etc. installed at FINO3 platform	2 SMAC4.0 seaweed modules	NEARSHORE 1. Spring 2020: the backbone for 1 longline has been installed at sea nearshore and 4 frames containing SEAPA-baskets with different flat oyster settlement materials are hung on the backbone of the longline. 2. Autumn 2020: on the same longline as in point 1, 4 oyster frames with SEAPA-baskets, ropes and sticks will be hung at the backbone for spat grow out 3. Summer 2020: 2 oyster restoration tables have been placed at the bottom, a third table was not installed due to COVID-19 delays 4. Autumn 2020: seeded seaweed structures (design ongoing, might be nets, might be other structures) will be fixated at the backbone	1. In terms of planning, there is no need for installation activities, the visits to and from the OWF can continue without extra systems/ equipment being installed.	* install hardware which will monitor and collect data in the aquaculture farm. There is a lacking network at the aquaculture site. Probably in september. The initial installation of the hardware will be done by Giannis, however there is no structured plan who will maintain the equipment thereafter. * the pilot is thinking of making a warehouse where any necessary equipment can be stored (already installed at this point in time) * different communication cables for high broadband data from cameras and sensors will be installed

				of a longline already installed nearshore OFFSHORE 1. summer 2020: design of the longline to be installed offshore in April 2021 is ongoing. Software used for design and risk assessment: MoorDyn-UGent tool. Once designed, the backbone to attach the longline will be anchored at sea after which the best-suited materials from the pre-operational phase results will be attached to it for offshore experiments.		

	This topic addresses the details of the installation activities that are part of the pilot activities: 1. What is the general timeline of the foreseen activities	Nearshore: Longlines are installed according to the schedule since the end of April 2020. Offshore: Installation of all items in Apr 2021 The systems will be kept in place until april 2023, meaning there will be two growing seasons and more possibilities to harvest.	The seaweed aquaculture is planned to be done over 2 years; meaning three times harvesting: May 2021, Oct 2021, May 2022	See higher	1. The pilot will investigate the possibilities to install a diver's platform. The location has potential to be a great diving location. Currently diving activities can be performed in the OFW, however there is a need for a camp where the diving equipment can be stalled. Next to that, the pilot was thinkin about extending the pilot activities to an onshore visitors center. For the possible extension of activities, there is no planning.	1. Currently (april - oct) installation will be done, thereafter the O&M phase will start. This includes the monitoring of aquaculture site, the scuba diving by tourists

	This topic addresses the details of the installation activities that are part of the pilot activities: 1. What vessels have been foreseen? 2. Are method statements in place or will they be prepared prior to the actual instalaltion? 3. Do these method statements comply with the general offshore practices	1. Most likely service vessels or offshore installation vessels but the company has not yet been decided on. We will probably choose a service provider, who FUE has worked well in the past and who owns vessels with cranes and employs divers. 2. All service provider themselves work according to their method statement. However, in order to plan the installation properly FUE will get together with the chosen diving company/service provider in winter 2020 and discuss a schedule, which will contain detailed information about every single step along the installation process. Hence, all preparations will be finished prior to	The SMAC4.0 will be installed in a two step process, first the anchoring will be placed, whereafter the net will be installed. The vessels that will be used are lent from the Dutch Ministry of Infrastructure and Water Management Method statements are standardised for operations at NSIL and will be put in place prior to the actual instalaltion activities - these are compliant with offshore practices	NEARSHORE 1. Spring 2020: the backbone for 1 longline has been installed at sea nearshore and 4 frames containing SEAPA-baskets with different flat oyster settlement materials are hung on the backbone of the longline. 2. Autumn 2020: on the same longline as in point 1, 4 oyster frames with SEAPA-baskets, ropes and sticks will be hung at the backbone for spat grow out 3. Summer 2020: 2 oyster restoration tables have been placed at the bottom, a third table was not installed due to COVID-19 delays 4. Autumn 2020: seaweed structures (design ongoing, might be nets, might be other structures) will be fixated at the backbone of a	There is no exact procedure defined within this pilot, it is therefore suggested that following activities should be taken within the UNITED project. 1. Create a virtual tour to the turbine 2. Make this tour accessible for audience at places from where the OFW can be seen. This is a way of integrating the OFW tourism into the existing (onshore) infrastructure. 3. Install a webcam, so that many people can access the OFW online. This will help to increase the social acceptance of multi-use activities. 4. There could be reason to investigate the possibilities to create a visitors centre for this pilot.	1. **vessels tbc** 2. **to be clarified** **3. to be clarified**

		installation (by the end of 2020). 3. Yes. The FUE already has drafted a manuscript on „Occupational health and safety organisation in the construction and operation of offshore wind turbines, taking into account the FINO3 research platform as an example of best practice (FINO3 Safety OWES)", which will be used as framework for planning the installation, maintenance procedures as well as decommissioning.		longline already installed nearshore OFFSHORE 1. summer 2020: design of the longline to be installed offshore in April 2021 is ongoing. Software used for design and risk assessment: MoorDyn-UGent tool. Once designed, the backbone to attach the longline will be anchored at sea after which the best-suited materials from the pre-operational phase results will be attached to it for offshore experiments. 2. April 2021: installation of the backbone at the offshore location 3. April 2021: attach structures for oyster growth to the backbone 4. June until beginning of August 2021: attachment of structures for flat oyster spat collection to the		

				backbone 5. Autumn 2021: remove oyster spat collection structures from the water, check/remove structures for oyster growth from the water (to be determined) and attach seaweed structures to the backbone 6. April 2022: attach structures for oyster growth to the backbone 7. June until beginning of August 2022: remove seaweed structures from the water (to be determined), attachment of structures for flat oyster spat collection to the backbone 8. Autumn 2022: remove oyster spat collection structures from the water and attach seaweed structures to the backbone, check/remove structures for oyster growth (to be		

				determined) 9. Summer 2023: remove all structures from the water 10. Decommissioning of all structures end of the project (end of 2023). If restoration seems to work well: perhaps leave them in – to be determined		

	This topic addresses the details of the installation activities that are part of the pilot activities: 1. What partners are involved in the installation activities 2. What external parties will be involved in the installation activities 3. Is it foreseen that all offshore involved parties will receive adequate training?	Nearshore: 1. KMF & FUE 2. No external parties were identified here Offshore: 1. FUE engineers will install everything at the offshore platform. The aquaculture farm will be also installed by contractors. FINO3 Offshore engineering team from FUE, Eva/Julian/Maria (FUE), (Tim Staufenberger as consultant (KMF)), Jack Triest (4HJena) 2. Installation vessel and crew (service provider), divers (service provider) 3. Every person, entering the FINO3 (via ship or helicopter), will have received the appropriate and required training beforehand. The FINO3 offshore engineering team (FUE) regularly	Partners involved in the offshore activiteis 1. Noorzeeboerderij 2. The Seaweed Company External parties involved in the offshore activities 1. Rijkswaterstaat 2. Boeg Nautic 3. CIV den Oever All parties involved in the offshore activities shall be requested to follow required trainings unless they register as visitors	Nearshore: vessel Stream Offshore: GEO10 or Multicat, based on work (and weight) that needs to be put in and out of the water	1. Spok Denmark Kopenhagen Utility 2. not defined yet 3. not defined yet	1. WINGS, KASTELORIZO AQUACULTURE 2. Scuba diving company 3. **to be clarified**

		conducts all relevant trainings. Tim Staufenberger (KMF)), Jack Triest (4HJena), Eva/Julian/Maria will receive trainings in the case of attending trips to FINO3. The trainings will most likely take place by the end of 2020/beginning of 2021.				
	This topic addresses the details of the installation activities that are part of the pilot activities: 1. Is safety adequately addressed for	**Still to clarify what safety measures are in place**	Not yet, it is the intention to include suitable RIEs items for the foreseen activities in alignment with involved personnel and external parties	Partners involved in the offshore activities 1. Expert from UK (external party), Brevisco, UGent, ILVO, JDN, Parkwind 2. UK expert for installation of anchors 3. Yes, all parties involved in the offshore activities have	Safety aspects are not well defined, should be clarified and documented for this pilot	1. to be clarified

	the installation activities			followed or will follow the required trainings. E.g. UGent personnel will follow a STCW A-VI/6 in order to be able to go at sea offshore.		
Assessment		This will form a smaller part in the overall pilot scope. However, it may be wise to check what level of preparation and safety management is needed for this site especially in relation to the higher working standards in the offshore pilot. The preparation of the installation activites has not yet started but they have already been fully identified at this stage. Nevertheless, it may be useful, especially for the offshore pilot to define a general installation procedure setup at	The installation activities have been identified and defined in broad terms. Nevertheless, it may still be useful to define the installation in more detail to identify any requirements that will have an impact on the system design. Furthermore, no preparations or actions with respect to personnel and procedural safety have been planned. It is recommended to start these up at this stage as well as installation is already planned for this autumn	Nearshore: It is already clear in broad terms what needs to be done and some of the activiteis have already been performed with existing designs that have limited options for modifications. All safety systems appear to be in place as well. The seaweed system may required further attention moving forward. Offshore: The system has not yet been design but in line with recommendations of the other pilots it may be useful to have a general idea of how the	No systems or production modules will be installed in this pilot, hence this topic is not relevant for this pilot.	The installation activities have been identified in broad terms. However, it is highly recommended to take a few additional actions. These may include the following: 1. Try to identify who will be responsible for the installation works at the site. For the actual work and for any adverse consequences in case of unforeseen failures 2. Try to identify who will perform the actual work so that that person may receive the proper safety training and certification 3. Maintenance of the equipment during

		an earlier stage to take into account any specific installation requirements into the system design. Furthermore, the training of personnel and safety management system appear to be state of the art and therefore it may be helpful to share this information to the other pilots whereas their safety management systems maybe less developed		installation will be performed prior to completing the system design.		and after the pilot may be a point to clarify prior to starting the installation works and potentially before procurement of the sensors

Operation & maintenance	This topic addresses the details of the operational and maintenance (O&M) activities that are part of the pilot activities For the inspection, maintenance & repair activities, have they been: 1. Identified, including required vessels and (type of) personnel 2. Detailed in method statements 3. Planned in the pilot timeline	1. To be discussed, as several trips are planned. It still needs to be decided on which service provider and crew as well as which service vessel will be chartered. 2. To be discussed, as several trips are planned for maintenance and sampling of longlines. For the FINO3 plant in particular, a detailed maintenance plan exists, that requires the FINO3 engineering offshore team to frequently visit the plant by helicopter. Often the FINO3 team is supported by service providers, when it comes to special O&M procedures (corrosion protection and the acceptance of all measures via an assigned certification body).	1. This has not been detailed out. It is expected that there will be 1 inspection activitiy per month in the growth season. There should be no required maintenance. After harvest there may be some maintenance prior to reseeding in the subsequent autumn of 2021. For maintenance the larger RWS vessel has been selected, for smaller inspection works the RIB of Noordzeecharters - or similar 2. No detailed method statements yet available - will be prepared at later stage 3. The seaweed aquaculture is planned to be done over 2 years; meaning three times harvesting: May 2021, Oct 2021, May 2022	NEARSHORE Yes, all required operation and maintenance is carefully planned per semester and is executed with vessel Stream OFFSHORE Communication was started up April 2020. However, detailed planning will be done after ongoing risk assessment has finished (foreseen end of summer 2020)	O&M within this pilot refers to the visiting and climbing the OWF, and in the future the onshore based visitors centre. 1. Required vessels and type of personnel are identified 2. No 3. No	1. Yes, this will be done by the scuba diving party 2. Unknown 3. Yes

		3. TBD				

	For the measurement and sampling activities, have they been: 1. Identified, including required vessels and (type of) personnel 2. Detailed in method statements 3. Planned in the pilot timeline	1. TBD, as several trips are planned. It still needs to be decided whether sampling will be done via harvesting vessel (mussel/seaweed) and crew (service provider), or service vessels and crew (service provider). 2. TBD. The service provider himself has a method statement for his crew. FUE will get together with the service company in spring 2021 and discuss a schedule which will contain detailed information about every single step along the sampling process. Hence, all preparations will be done prior to sampling or maintenance trips (roughly at least 2 months prior). The method statement will follow the guidelines and advice stated in the	1.To be clarified 2.To be clarified 3.To be clarified	NEARSHORE Yes, required sampling and diving activities are carefully planned per semester and then reevaluated if necessary. The samplings are executed with vessel Stream and Brevisco/ILVO diving team and UGent personnel OFFSHORE Communication was started up April 2020. However, detailed planning will be done after ongoing risk assessment has finished (foreseen end of summer 2020). Hence to be determined end of 2020. There is a rough timeframe for planned samplings, but needs to worked out in more detail.	n.a. there is no need to samples	1. Yes, this will be done by the scuba diving party 2. Unknown 3. Yes

		manuscript on „Occupational health and safety organisation in the construction and operation of offshore wind turbines, taking into account the FINO3 research platform as an example of best practice (FINO3 Safety OWES)“ as well as other best practice guidelines regarding offshore working (DNVGL, etc.). 3. TBD				

	For the remote monitoring activities, have they been: 1. Identified 2. Detailed in method statements, including vessel identification? 3. Planned in the pilot timline	1. Lander and sensors attached to longlines will cover remote monitoring. Also, FINO3 has cameras installed, offering a real time view of the surrounding area, which can be used for rough observation of the setup (mainly buoys). 2. n.a. 3. Remote monitoring during cultivation 2021-2022/23	1.To be clarified 2.To be clarified 3.To be clarified	OFFSHORE: As partner for LANDER-system has dropped out, the Belgian pilot will only gather data via national monitoring buoys and via satellite systems as there is no budget foreseen for any of the partners to buy sensors. Hence Sea surface water temperature, SPM, chlorophyll A and parameters which can be found on https://meetnetvlaamsebanken.be/ will be monitored for an area close to where the offshore pilot will be set up. Unfortunately, this way, forces will not be measured but all input to have this monitored welcome. Communication with NSF has been set up to verify whether some sensors could be shared.	n.a.	1. Yes, this will be done by WINGS 2. Unknown 3. Yes

Assessment		The main O&M activities have been identified, as well as the responsibilities and roles of the FINO3 team. However, there may still be some value in identifying at an early stage what needs to be maintained and/or measured/sampled as this may have an effect on the system design	There is little to no information availble at this stage regarding the O&M as well as measurement activities. It is highly recommended to start this as soon as possible to identify any major impacts on the system designs	For the nearshore all O&M activities appear to have been planned. Nevertheless, it may be useful to revisit this in terms of detailed activities. Especially for for instance the seaweed system as this has not been fully decided/designed. For this system identifying O&M/measurement requirements may lead to modifications in the system design. For the offshore site this is not yet applicable as the pilot location and system design is still to be decided upon	The current and potentially future O&M activities have not yet been documented. Although there is no specific system that will be installed, it may still prudent to set this up for the intended activities. Whether they are visiting or training activities. Especially with respect to adequate safety measurement and safety performance monitoring this could be an important follow-up action	The setup of the O&M and test measurements is planned but has not been performed yet. It is highly recommended to start this as soon as possible to identify any major impacts on the system designs

Decommissioning	This topic addresses the details of the decommissioning activities that are part of the pilot activities For the removal of the production modules and all associated equipment activities, have they been: 1. Identified, including required vessels and (type of) personnel 2. Detailed in method statements 3. Planned in the pilot timeline	1. The site has to be decommissioned as a whole in 2023. Therefore the production systems (and all associated equipment) will have to be taken out. Vessel and personnel involved unknown at this stage will be decided on 2. According to schedule of German pilot and planning activities of external companies (e.g. in third and fourth quarter of 2020 for the installation in 2021) 3. Single decommissioning in 2023	1. All production modules will be removed after the pilot. For this the Rijkswaterstaat vessel and personnel will be used 2. No form of method statements yet available 3. Planned for May 2022	1. UGent is responsible for the decommissioning and the original plan is to remove everything from the water. Regarding the oyster restoration, the pilot would strive for leaving the structures in the water but this will depend on the outcome of the pilot and whether this will be permitted to leave structures in the water offshore. 2. Nearshore: Stream. Offshore (depending on what will be removed): GEO10 or Muticat 3. End of project	n.a.	1. Decommissioning is dependent on the succes of the combination of touristic scuba diving and aquaculture, this an ongoing process 2. ongoing 3. ongoing

	For the survey works required to confirm adequate removal of all assets from pilot location, have they been: 1. Identified, including required vessels and (type of) personnel 2. Detailed in method statements 3. Planned in the pilot timeline	TBD, probably same service provider and partner as for installation	1. This will be required but it will be done by means of keeping a log of what was installed. At the removal stage all items will be accounted for or otherwise recovered from the seabed 2. Not applicable as this will not be a separate activity but part of the removal activity 3. Not applicable	Unknown if this is required, to be clarified	n.a.	n.a.
	For the activities for the removal & disposal of any assets and materials onshore, have they been: 1. Identified, including required transport and disposal facilities	1. Yes, the disposal facilities are known and have already been frequently used by the FINO3 team. Either the material can be properly disposed of in Cuxhaven or in Kiel. 2. TBD, prior to transport and disposal. All necessary information on these procedures are	1. This will be required but not a major issue as no complicated items or materials are involved. It could be included in the budget however 2. Not available, not planned 3. After May 2022	Unknown if this is required, to be clarified	n.a.	1. Decommissioning is dependent on the succes of the combination of touristic scuba diving and aquaculture, this an ongoing process 2. ongoing 3. ongoing

	2. Detailed in method statements 3. Planned in the pilot timeline	known and have been applied according to legal requirements. 3. Not mentioned				
	Have these activities been budgetted for?	Yes (see GA, p 198, 224 000EUR) Installation and decommissioning costs including specialized far-offshore divers with specific capacity to conduct offshore platform installations and decommissioning of the MUCL design elements	Not at this stage	To be clarified	n.a.	unknown
Assessment		For the nearshore this appears not to be applicable as it involves temporary use of an existing farm that will not be decommissioned after the pilot tests. For the offshore site this appears to be already adequately organised and	There is little to no information availble at this stage regarding the decommissioning activities. It is highly recommended to start this as soon as possible to identify any major impacts on the system designs	For the nearshore pilot it appears partly clear what needs ot be done as part of the decommissioning works. It may be prudent to clarify this at an early as possible stage as it may have a significant impact on the budget whether assets can remain or need to be	No systems or production modules will be installed in this pilot, hence this topic is not relevant for this pilot.	At this stage it is not yet fully clear if the installed equipment in the aquaculture farm need to be removed after the pilot, to be clarified

		accounted for. The only check that may be outstanding is to confirm if any post-survey works are also included in the budget together with the decommissioning works		removed. The same holds for any disposal requirements. For the offshore site this is not yet applicable, to be taken into account when the site and system design have been selected.		
Communication activities	This topic addresses the details of the communication activities that are part of the pilot activities. It focusses on what has been organised to ensure adequate communication about the pilot activities and the UNITED project is possible.	1. Yes, however professional photographs and videos are unfeasably due to very strict safety restrictions at FINO3. No budget forseen for that. Videos and photos are regularly taken by all project partners of the German pilot and forwarded to WP9 and other dissemination partners. 2. There is no strict communication plan on these things, however the pilot is aware about the	1. No 2. No	The ongoing and planned communication is (was) on start of the Belgian pilot (communicated in March via UGent and West-Flanders communication), next press release end of summer 2020 and then upon interesting results. We do have a camera on board of each sea mission that takes photos of/films everything we assume is important for the article we plan to write on Belgian pilot experiments. We	1. No 2. No	1. Yes 2. No, will be done adhoc

	With respect to the identification of relevant activities suitable for communication about UNITED and the planning thereof: 1. Have these activities been identified? 2. Have they been planned in the pilot timeline?	activities which can be photographed.		also had a diving team with cameras to make underwater video material. For the offshore part, this needs to be planned.		
	With respect to the alignment with the other pilots on what pilot covers what: 1. Has this been done?	1. Several tables, worksheets and regular meetings, minutes, documents are provided for this at TEAMS by FUE.	1. No	1. No	1. No	1. No
	With respect to the identification of all technical and procedural features that need to be covered for	1. No 2. No	1. No 2. No	1. No 2. No	1. No 2. No	1. No 2. No

	(sub)goal verification, validation and lessons learnt: 1. Have these activities been identified? 2. Have these activities been planned in the pilot timeline?					

Assess-ment		All pilots could im-prove on the commu-nications aspects of their pilot. Both for external communica-tion purposes as well for the recording of specific tech-nical/procedural de-tails as part of their pilot validation. To support, some gen-eral guidelines are included here for all pilots' consideration. Where these activi-ties have not been planned and budg-eted for, it is recom-mended to address this with the project coordinator and the communication work package leader. • Communication ac-tivities and materials have two important goals: 1. External communi-cation about UNITED and pilot goals that have been achieved as well as provid-ing visual context to	All pilots could im-prove on the commu-nications aspects of their pilot. Both for external communica-tion purposes as well for the recording of specific tech-nical/procedural de-tails as part of their pilot validation. To support, some gen-eral guidelines are included here for all pilots' consideration. Where these activi-ties have not been planned and budg-eted for, it is recom-mended to address this with the project coordinator and the communication work package leader. • Communication ac-tivities and materials have two important goals: 1. External communi-cation about UNITED and pilot goals that have been achieved as well as provid-ing visual context to	All pilots could im-prove on the commu-nications aspects of their pilot. Both for external communica-tion purposes as well for the recording of specific tech-nical/procedural de-tails as part of their pilot validation. To support, some gen-eral guidelines are included here for all pilots' consideration. Where these activi-ties have not been planned and budg-eted for, it is recom-mended to address this with the project coordinator and the communication work package leader. • Communication ac-tivities and materials have two important goals: 1. External communi-cation about UNITED and pilot goals that have been achieved as well as provid-ing visual context to	All pilots could im-prove on the commu-nications aspects of their pilot. Both for external communica-tion purposes as well for the recording of specific tech-nical/procedural de-tails as part of their pilot validation. To support, some gen-eral guidelines are included here for all pilots' consideration. Where these activi-ties have not been planned and budg-eted for, it is recom-mended to address this with the project coordinator and the communication work package leader. • Communication ac-tivities and materials have two important goals: 1. External communi-cation about UNITED and pilot goals that have been achieved as well as provid-ing visual context to	All pilots could im-prove on the commu-nications aspects of their pilot. Both for external communica-tion purposes as well for the recording of specific tech-nical/procedural de-tails as part of their pilot validation. To support, some gen-eral guidelines are included here for all pilots' consideration. Where these activi-ties have not been planned and budg-eted for, it is recom-mended to address this with the project coordinator and the communication work package leader. • Communication ac-tivities and materials have two important goals: 1. External communi-cation about UNITED and pilot goals that have been achieved as well as provid-ing visual context to

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		reports and subsequent educational material. 2. Internal communication: to record specific technical aspects, operational processes and specific measurements that are important to validate the pilot specific and overall performance. • Keep in mind that every milestone and step towards multi-use can be recorded and used for these two purposes both as deliverable within UNITED aswell as communication material to the broader/general public • Identify recurring activities that help to increase social awareness of the importance of multi-use activities 1. These activities are diverse, and often reoccur multiple times per year.	reports and subsequent educational material. 2. Internal communication: to record specific technical aspects, operational processes and specific measurements that are important to validate the pilot specific and overall performance. • Keep in mind that every milestone and step towards multi-use can be recorded and used for these two purposes both as deliverable within UNITED aswell as communication material to the broader/general public • Identify recurring activities that help to increase social awareness of the importance of multi-use activities 1. These activities are diverse, and often reoccur multiple times per year.	reports and subsequent educational material. 2. Internal communication: to record specific technical aspects, operational processes and specific measurements that are important to validate the pilot specific and overall performance. • Keep in mind that every milestone and step towards multi-use can be recorded and used for these two purposes both as deliverable within UNITED aswell as communication material to the broader/general public • Identify recurring activities that help to increase social awareness of the importance of multi-use activities 1. These activities are diverse, and often reoccur multiple times per year.	reports and subsequent educational material. 2. Internal communication: to record specific technical aspects, operational processes and specific measurements that are important to validate the pilot specific and overall performance. • Keep in mind that every milestone and step towards multi-use can be recorded and used for these two purposes both as deliverable within UNITED aswell as communication material to the broader/general public • Identify recurring activities that help to increase social awareness of the importance of multi-use activities 1. These activities are diverse, and often reoccur multiple times per year.	reports and subsequent educational material. 2. Internal communication: to record specific technical aspects, operational processes and specific measurements that are important to validate the pilot specific and overall performance. • Keep in mind that every milestone and step towards multi-use can be recorded and used for these two purposes both as deliverable within UNITED aswell as communication material to the broader/general public • Identify recurring activities that help to increase social awareness of the importance of multi-use activities 1. These activities are diverse, and often reoccur multiple times per year.

		Examples are visit of the (offshore) location, sampling activities, diving or maintenance activities. The visuals on these activities make the activities on the pilot location visible and real for a more general public • Include points in time for communication to external parties in the detailed planning of the pilot,whether these are recurring activities or achieving specific goals. • Collaborate with professional photographers or videographers for high quality material for both communication to the general public as well for internal recording of UNITED/ the pilots' performance. The pilot can either pay for these services, but if budget is limited be	Examples are visit of the (offshore) location, sampling activities, diving or maintenance activities. The visuals on these activities make the activities on the pilot location visible and real for a more general public • Include points in time for communication to external parties in the detailed planning of the pilot,whether these are recurring activities or achieving specific goals. • Collaborate with professional photographers or videographers for high quality material for both communication to the general public as well for internal recording of UNITED/ the pilots' performance. The pilot can either pay for these services, but if budget is limited be	Examples are visit of the (offshore) location, sampling activities, diving or maintenance activities. The visuals on these activities make the activities on the pilot location visible and real for a more general public • Include points in time for communication to external parties in the detailed planning of the pilot,whether these are recurring activities or achieving specific goals. • Collaborate with professional photographers or videographers for high quality material for both communication to the general public as well for internal recording of UNITED/ the pilots' performance. The pilot can either pay for these services, but if budget is limited be	Examples are visit of the (offshore) location, sampling activities, diving or maintenance activities. The visuals on these activities make the activities on the pilot location visible and real for a more general public • Include points in time for communication to external parties in the detailed planning of the pilot,whether these are recurring activities or achieving specific goals. • Collaborate with professional photographers or videographers for high quality material for both communication to the general public as well for internal recording of UNITED/ the pilots' performance. The pilot can either pay for these services, but if budget is limited be	Examples are visit of the (offshore) location, sampling activities, diving or maintenance activities. The visuals on these activities make the activities on the pilot location visible and real for a more general public • Include points in time for communication to external parties in the detailed planning of the pilot,whether these are recurring activities or achieving specific goals. • Collaborate with professional photographers or videographers for high quality material for both communication to the general public as well for internal recording of UNITED/ the pilots' performance. The pilot can either pay for these services, but if budget is limited be

		creative and search for hobbyists that are keen to help out for free. Alternative, these constraints could be discussed with the WP-communication lead. 1. Communication material/ photographs and videos can be used as deliverable within the pilots' reporting and may serve as evidence for certain research and pilot-test questions. It is therefore essential to have high quality communication material.	creative and search for hobbyists that are keen to help out for free. Alternative, these constraints could be discussed with the WP-communication lead. 1. Communication material/ photographs and videos can be used as deliverable within the pilots' reporting and may serve as evidence for certain research and pilot-test questions. It is therefore essential to have high quality communication material.	creative and search for hobbyists that are keen to help out for free. Alternative, these constraints could be discussed with the WP-communication lead. 1. Communication material/ photographs and videos can be used as deliverable within the pilots' reporting and may serve as evidence for certain research and pilot-test questions. It is therefore essential to have high quality communication material.	creative and search for hobbyists that are keen to help out for free. Alternative, these constraints could be discussed with the WP-communication lead. 1. Communication material/ photographs and videos can be used as deliverable within the pilots' reporting and may serve as evidence for certain research and pilot-test questions. It is therefore essential to have high quality communication material.	creative and search for hobbyists that are keen to help out for free. Alternative, these constraints could be discussed with the WP-communication lead. 1. Communication material/ photographs and videos can be used as deliverable within the pilots' reporting and may serve as evidence for certain research and pilot-test questions. It is therefore essential to have high quality communication material.

Risk management activities	This topic addresses the details of the risk management activities that are part of the pilot activities: 1. Is there a risk management system in place?	1. Yes, a risk analysis was performed for longline activities at FINO3 (Geissler et al. 2018). This risk analyses is used for all activities in the German pilot and was recently updated and will serve as a base for upcoming risk analyses in UNITED (e.g. WP6).	1. No, there is not a clear risk management system in place for the NSIL site	Nearshore: Yes A governing risk management system is in place for the nearshore part as it was needed to obtain the insurance. For Offshore: Ongoing the offshore site, risk assessment is ongoing but analyses approaches are welcome	1. No The pilot has not completely envisioned all risks involved in the multi-use activities. This is due to the fact that there are multiple stakeholders/ operators involved in the activities. Up to entering the foundation of the windmill, the visitors fall under the responsibilities of the boat operator. Once the foundation is accessed, the visitors will become the responsibility of the tour operator.	1. Currently the pilot is carrying out an analysis of risk management aspect of the multi-use activities.

	This topic addresses the details of the risk management activities that are part of the pilot activities: 1. Have the main risks been identified 2. Have suitable mitigations been identified for these risks 3. Have the identified mitigations been communicated to the relevant pilot activities and system design?	1. Yes the main risks have been identified; *Availability and limited access to technological know-how and solutions * Availability of skilled labour (offshore experience) * Need of great flexibility for the implementation planning (schedule) due to risk of severe weather conditions * Insufficient existence of biological data for that location, e.g. time and scale of spat fall, growth rates of mussels and seaweed * Limited knowledge about mooring prerequisites for mussel and algae long lines at site 2. Ongoing, after the UNITED-specific risk analysis or the FINO3 platform, the mitigations will be further identified.	1. For other projects within the NSIL a risk register was created, this is being used for all parties that want to make use of NSIL. However, for the UNITED pilot such a risk register should still be setup 2. No 3. No	Nearshore 1. Yes 2. Yes 3. Yes Offshore: 1. The offshore risk analysis is ongoing and is being performed by the Maritime Division of UGent. 2. Ongoing, input welcome 3. Ongoing, input welcome	1. Yes, based on previous experience with the pilot activities 2. No 2. No	1. Ongoing 2. Ongoing 3. Ongoing

		3. To be discussed after UNITED-specific risk analysis for the FINO3 platform				
	This topic addresses the details of the risk management activities that are part of the pilot activities: 1. Is there a suitable third party liability insurance in place 2. Is there a asset	1. yes, the FINO3 has a liability insurance as well as a hull insurance 2. **to be verified**	1. Unclear for both solar & seaweed. For the communications element a third party liability insurance is available 2. For the seaweed part not, for the solar part there is an insurance	Nearshore 1. The insurance for the nearshore pilot is okay, both Brevisco, Colruyt and UGent have an insurance. The site is insured as a scientific experiment (not commercial business) => what type of insurance 2. Unclear Offshore:	1. Yes, either via the boat company or the windfarm operator 2. No	1. Yes, aquaculture site 2. Unknown

	damage insurance needed and in place?			1. Process is ongoing 2. Process is ongoing		
Assessment		There is a general risk assessment done for the offshore activities on the FINO3 platform. The UNITED-specific risk analysis is in the making, and thus in process. It is assumed that this will be performed in parallel to the system design. No specific risk analysis/management activity was identified for the nearshore site sofar. It may be prudent to verify if this is covered by the general offshore risk	Due to the lack an existing risk management system and risk register it is recommended to set this up as soon as possible, preferable before the system design is completed. This will allow to incorporate any mitigations into the design	For the nearshore pilo the risk management system as well as the required risk register appears to be in place and suitable. For the offshore site this is not yet applicable, to be taken into account when the site and system design have been selected.	Due to the lack an existing risk management system and risk register it is recommended to set this up as part of the pilot activies. Furthermore, it is recommended to look into this activity as a potential deliverable for any European wind farm that wants to have visitors in its wind farms/multi-use farms for education or training purposes. In that sense a collaboration with the Patroklos pilot maybe useful.	Although it is currently ongoing, due to the lack an existing risk management system and risk register it is recommended to set this up as soon as possible, preferable before the system design is completed. This will allow to incorporate any mitigations into the design

		management process or if required a specific solution				
After the pilot follow-up	This topic addresses the alignment between pilot goals and overal UNITED project goals: 1. Has it been adequatly identified how the pilot results should and will contribute to the future needs of offshore multi-use? 2. Have these points been adequately incorporated/fedback to the	1. There are multiple offshore parties, commercially oriented, that would like the information and research from this UNITED project, so that they can use it for their business model. Currently, there are commercial activities allowed in offshore windparks in Germany. It is however foreseen that due to societal changes, this will soon change and that businesses can perform commercial activities within windparks. So for all the activities within UNITED, it is kept in	1. Depending on the outcome; however the aim is to create a viable business model for commercial use in offshore windparks. 2. No	1. Research questions have been set-up at the onset of the UNITED-project (during proposal writing and revised upon practical start). Moreover, the set-up of an LCA and business case is ongoing (one of the goals of UNITED for the Belgian pilot). Furthermore, Colruyt is applying to set-up a commercial business in the nearshore site of UNITED, and is interested to know whether offshore this will also be feasible within the foreseen zones of the Marine Spatial Plan.	**to be clarified**	1. A first attempt to create a business model has been done for the multi-activities in site. The business model canvas is also reported in D1.2 and is shown in see report.

	intended pilot activities and system design?	mind what the research can contribute to a possible commercial business/ activitie in the future. 2. The after pilot follow-up goals have not been documented or defined		2. The design was adjused to the research questions we have.		
	1. Is there any follow-up project planned that is intended to build upon this pilot? 2. If yes, have the prerequisites for the follow-up project been adequately addressed in the scope of	1. Yes, lessons learned should be used in future projects, commercial operators will use those! FUE is already planning/plans to conduct future aquaculture projects based on the results of UNITED to improve this sector. 2. The after pilot follow-up prerequisites have not been well addressed within the	1. No, not yet	**1. Unclear** **2. Unclear**	**to be clarified**	1. After the UNITED project, multi-activity partners need to re-examine the overall benefit of this synergy in order to finally decide if they plan to continue with the multi-use scenarios.

	the United pilot?	scope of the UNITED projects				

Assess-ment		All of the pilots have some ideas on the follow-up of their pi-lot, however these are not documented or defined as clear goals. However, it is recommended to do this at an early stage. Even if it's not the idea that the pilot location will be con-tinued then it's rec-ommended to iden-tify what future multi-use project could benefit/use form the indi-vidual pilots' re-sults. In supporting this definition of fol-low-up project or les-sons learnt for future projects, the follow-ing guidelines are provided as sugges-tions: • The pilot may iden-tify various possibili-ties of their activi-ties/designs/research results being used by future offshore multi-use projects. It is recommended to	All of the pilots have some ideas on the follow-up of their pi-lot, however these are not documented or defined as clear goals. However, it is recommended to do this at an early stage. Even if it's not the idea that the pilot location will be con-tinued then it's rec-ommended to iden-tify what future multi-use project could benefit/use form the indi-vidual pilots' re-sults. In supporting this definition of fol-low-up project or les-sons learnt for future projects, the follow-ing guidelines are provided as sugges-tions: • The pilot may iden-tify various possibili-ties of their activi-ties/designs/research results being used by future offshore multi-use projects. It is recommended to	All of the pilots have some ideas on the follow-up of their pi-lot, however these are not documented or defined as clear goals. However, it is recommended to do this at an early stage. Even if it's not the idea that the pilot location will be con-tinued then it's rec-ommended to iden-tify what future multi-use project could benefit/use form the indi-vidual pilots' re-sults. In supporting this definition of fol-low-up project or les-sons learnt for future projects, the follow-ing guidelines are provided as sugges-tions: • The pilot may iden-tify various possibili-ties of their activi-ties/designs/research results being used by future offshore multi-use projects. It is rec-ommended to	All of the pilots have some ideas on the follow-up of their pi-lot, however these are not documented or defined as clear goals. However, it is recommended to do this at an early stage. Even if it's not the idea that the pilot location will be con-tinued then it's rec-ommended to iden-tify what future multi-use project could benefit/use form the indi-vidual pilots' re-sults. In supporting this definition of fol-low-up project or les-sons learnt for future projects, the follow-ing guidelines are provided as sugges-tions: • The pilot may iden-tify various possibili-ties of their activi-ties/designs/research results being used by future offshore multi-use projects. It is recommended to	All of the pilots have some ideas on the follow-up of their pi-lot, however these are not documented or defined as clear goals. However, it is recommended to do this at an early stage. Even if it's not the idea that the pilot location will be con-tinued then it's rec-ommended to iden-tify what future multi-use project could benefit/use form the indi-vidual pilots' re-sults. In supporting this definition of fol-low-up project or les-sons learnt for future projects, the follow-ing guidelines are provided as sugges-tions: • The pilot may iden-tify various possibili-ties of their activi-ties/designs/research results being used by future offshore multi-use projects. It is recommended to

		translate these aspects into specific goals for the pilot to be implemented in the systems designs and pilot activities. • Future needs can be identified by talking to stakeholders and commercial businesses that are already in-volved in the various specific multi-use activities e.g. seaweed or shellfish farmers. The pilot then actively in-tegrates this feedback and the required follow-up into their design and activities. • In case the pilot (location) will actually be used in a follow-up project then it is recommended to identify any requirements required for such a (scaled-up) project as well as the evidence required to comply with these requirements. These	translate these aspects into specific goals for the pilot to be implemented in the systems designs and pilot activities. • Future needs can be identified by talking to stakeholders and commercial businesses that are already in-volved in the various specific multi-use activities e.g. seaweed or shellfish farmers. The pilot then actively in-tegrates this feedback and the required follow-up into their design and activities. • In case the pilot (location) will actually be used in a follow-up project then it is recommended to identify any requirements required for such a (scaled-up) project as well as the evidence required to comply with these requirements. These	translate these aspects into specific goals for the pilot to be implemented in the systems designs and pilot activities. • Future needs can be identified by talking to stakeholders and commercial businesses that are already in-volved in the various specific multi-use activities e.g. seaweed or shellfish farmers. The pilot then actively in-tegrates this feedback and the required follow-up into their design and activities. • In case the pilot (location) will actually be used in a follow-up project then it is recommended to identify any requirements required for such a (scaled-up) project as well as the evidence required to comply with these requirements. These	translate these aspects into specific goals for the pilot to be implemented in the systems designs and pilot activities. • Future needs can be identified by talking to stakeholders and commercial businesses that are already in-volved in the various specific multi-use activities e.g. seaweed or shellfish farmers. The pilot then actively in-tegrates this feedback and the required follow-up into their design and activities. • In case the pilot (location) will actually be used in a follow-up project then it is recommended to identify any requirements required for such a (scaled-up) project as well as the evidence required to comply with these requirements. These	translate these aspects into specific goals for the pilot to be implemented in the systems designs and pilot activities. • Future needs can be identified by talking to stakeholders and commercial businesses that are already in-volved in the various specific multi-use activities e.g. seaweed or shellfish farmers. The pilot then actively in-tegrates this feedback and the required follow-up into their design and activities. • In case the pilot (location) will actually be used in a follow-up project then it is recommended to identify any requirements required for such a (scaled-up) project as well as the evidence required to comply with these requirements. These

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