MERMAID

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1 Introduction

1.1 General Background to this report

1.1.1 MERMAID project[1]

This report on stakeholder views is part of the MERMAID project that takes place from 2012 till 2015. MERMAID will develop approaches/concepts for the next generation of offshore platforms for multi-use of ocean space. These platforms are offshore structures in sea like wind turbines and wave energy platforms. The project does not envisage building new platforms, but will theoretically examine new approaches for combining structures for energy extraction and aquaculture and the transport related to these activities. The combination of these activities is referred to as a multi-use platform (MUP).

The EU energy strategy "Energy 2020" has the objective of reducing greenhouse gasses by at least 20%. To reach this goal up to 140 GW of offshore wind farms are currently planned. As a result, offshore wind farms will take up large areas of available ocean space. Besides, new energy extracting activities at sea are under development, like wave energy.

In addition, the European Union is well located to profit on the global growth in aquaculture, however the production of the European aquaculture industry has stagnated. Lack of space, access to good quality water, and a strict EU legislation for protection of the environment limits the development of this industry. On top of this, the industry is characterized by small and medium sized companies that have difficulties in attracting risk friendly capital. The European Union does want to put more effort in the growth of aquaculture in Europe and wants to become a major global player in sustainable aquaculture.

The extensive offshore energy developments which will take place within the next 10 years will have to be optimized in order to reduce the energy costs, to find sufficient ocean space for both aquaculture and renewable resources but at the same time minimize the negative environmental impact. An option could be the development of multi-user platforms which combine energy extraction and aquaculture.

In order to help the EU in the fulfilment of EU strategies for the reduction of fossil-based energy and to become a major player in sustainable aquaculture the MERMAID project aims to address the following key-questions:

- What are the best practices to develop a project on multi-use platforms?
- What are the accumulated effects of large scale structures on the marine environment?
- What are the best strategies for installation, maintenance and operation of a multi-purpose offshore platform?
- What is the economic and environmental feasibility of multi-use platforms?

It is essential that all work under the MERMAID project contributes directly towards real design concepts and industrial applications. For this reason, test sites will be studied to develop innovative

[1] www.mermaidproject.eu

plans for multi-use platforms and designs for harvesting ocean energy, aquaculture and related transport.

Four offshore test study sites with different environmental characteristics have carefully been selected for their specific challenges. These four case studies, which represent different environmental, social and economic conditions, are located at four different seas:

1. The Baltic Sea - a typical estuarine area with fresh water from rivers and salt water.
2. The North Sea - a trans-boundary area of the North Sea-Wadden Sea with a typical active morphology site
3. The Atlantic Ocean - a typical deep water site
4. The Mediterranean Sea - a typical sheltered deep water site.

With the results from these four cases, a verified procedure will be created to select the most appropriate multi-use platform design options for a given offshore area. This procedure should be generic so stakeholders and end users can use it for marine planning strategies.

The 28 partner institutes forming MERMAID are from many regions in EU. The group represents a broad range of expertise in hydraulics, wind engineering, aquaculture, renewable energy, marine environment, project management as well as socio-economics.

MERMAID is one of three EU-FP7 funded projects selected for funding in response to Ocean 2011 on multi-use offshore platforms (FP7-OCEAN.2011-1 “Multi-use offshore platforms"). This project shall have a cost of 7,4 million euro. The European Union has granted a financial contribution of 5,5 million euro.

1.1.2 Participation approach in MERMAID

One of the aims of the MERMAID project is to put the integration of technical, economic, ecological, spatial and societal objectives at the heart of the development of MUP designs, by involving stakeholders in the design process. For this, a participatory design process is proposed which focusses on involving all relevant stakeholders in the design process.

The focus is on working together with the users and other relevant stakeholders throughout the design and development process, rather than designing a MUP for them. For this purpose, a participation process is proposed that focusses on a cyclical, iterative and participatory process of scoping, envisioning and learning.

Two principles underlie this approach:

1) The principle of non-linear knowledge generation, which means that knowledge is developed in a complex, interactive process of co-production with a range of stakeholders involved.
2) The principle of social learning, which means that all one can do in complex and search processes for sustainable directions with no ready-made solutions at hand, is to experiment and learn from these experiments in a social environment through interaction with other actors.

The first step in the proposed participatory design process consists of defining the initial opinions and needs of relevant stakeholders in four different cases.

1.2 Aim of report

The overall objective of this report is to describe and analyse the views of relevant stakeholders in the 4 case studies on the design of MUPs in the four MERMAID cases. This report therefore focusses on defining the societal, ecological, and economic objectives of a selected group of stakeholders in the design of the MUPs, the challenges involved and the needs of the stakeholders in each of the four cases. The results are based on the results from one-on-one and group interviews following a questionnaire. The result is a list with the views and needs of stakeholders involved per case study and the challenges involved.

1.3 Outline of report

Chapter 2 describes the methodology of the work which has been executed. As an introductory step, the overall methodology of the participatory interactive design process used in MERMAID is described, followed by a description of the questionnaire development and interview strategy. Chapter 3 describes the results of the interviews that were held in the different case studies. The results are described per individual test site. For each test site the following parts are described:

- Site description
- Selection of stakeholders
- Goals for participation
- Prerequisites for participation
- Obstacles for participation
- Conditions for the design

Chapter 4 gives the conclusions and recommendations to the designers on the basis of the results.

2 Methodology

2.1 Introduction: MERMAID participatory design process

The participatory design process (figure 2.1) in MERMAID is developed to involve stakeholders in the process of designing the MUP. Stakeholders are divided in two groups: 1) Potential users of the MUP, for example energy and aquaculture companies, those that will have needs in the process. 2) Others with a stake, which have interests, related to the MUP, for instance nature organisations, tourist boards, government bodies.

A stakeholder is defined as anybody who can affect or is affected by an organisation, strategy or project. Bryson uses a definition that involves all stakeholders who are affected by a change (Bryson 2004: 22).

The overall design process of MUPs in the four cases will be organised in three steps:

1. Step 1 is to prepare for the design by identifying the views and needs of stakeholders and identify the challenges through interviews (this report)
2. Designing the MUP by organising a round table session involving all stakeholders in December 2013/January 2014
3. Evaluate the design by organising a round table session with all stakeholders in September 2014

The design process is inspired by element of both Transition Management and the theories of Communities of Practice. Transition Management has as an aim to achieve social-economic transitions by engaging actors in a learning process (Moors, et al., 2004: 33). During the learning process, actors are deliberately asked to participate and learn what situation is desirable in the long-term and develop views and practices to modulate the ongoing societal developments.

Developing MUPs can be viewed as a transition, a long term process, taking place over periods of more than 25 years (Geels, 2002; Grin et al., 2010).

The work done during the three steps in the participatory process is not about doing the actual design, but to provide input to the design. In other words, during the MERMAID project communities of practice are formed by people who deliberately engage in a process of collective learning over an extended period of time, with the aim to gain insight in the desired transitions needed.

The stakeholders in these communities of practice involve a shared domain of interest, namely the development of MUPs and want to engage in learning and developing knowledge about this domain. The knowledge developed does not necessarily have to be important to others outside the communities of practice. Communities of practice also entail that the members engage in joint activities, although the degree of participation and interaction may vary widely. The members develop a shared knowledge reservoir. As Wenger argues himself; communities of practice are learning practices: social engagements between actors where learning takes place (Wenger, 1999).

Within communities of practice, two processes are essential for creating mutual understanding: the first process is participation and the second process is reification. These two processes are in a dual relationship with each other. Participation implies that the members of the community shape their identities in relation to each other. The relationships can have different forms; they can be based on conflict and harmony and they can be intimate as well as political (Wenger, 1999). Reification means that the bits and pieces of knowledge that are learned are communicated in a reified form (i.e. tools, language or artefacts) within the community of practice and to the outside world. Reification refers to actions within the community of practice like designing, naming, encoding, interpreting and describing (Wenger, 1999).

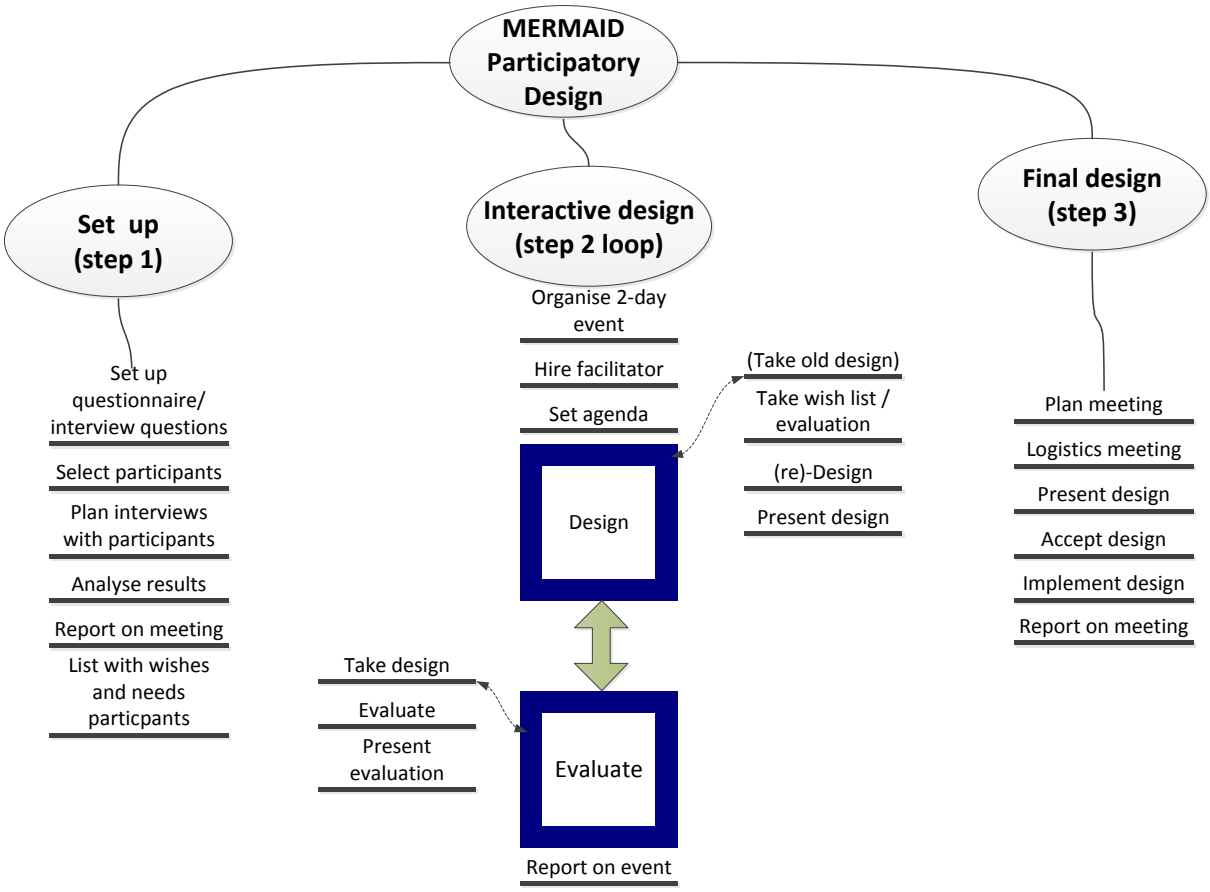

Figure 2.1. Overview of the MERMAID participatory design process.

Inevitably, knowledge production within communities of practice also involves negotiation and conflict management. While actors develop knowledge, they are influenced by existing forms of knowledge, views, ideals and interests. The actors negotiate about what can be considered as true or useful knowledge in their context. This negotiation involves elements of conflict, struggle (Long, 1989; Long and Long, 1992) and alignment. Conflicts confront actors with the variety in opinions and interpretations. This triggers learning and change (Termeer & Koppenjan, 1997; Upreti, 2001). Moreover, in situations of conflict, problems become more urgent and the need to address them becomes more pressing. Problematic issues have to be resolved and new insights may be gained. Conflict also urges the actors involved to formulate what they mean as precisely as possible, in order to respond to the arguments of actors with different views. By contesting the validity of each

other's arguments, groups will be spurred to clarify the validity of their arguments and claims to knowledge (Stuiver, 2006).

The precise selection of stakeholders is discussed in the chapter with the results from the different cases. During the methodological choices we made, we identified five stakeholder categories. A stakeholder is defined as anybody who can affect or is affected by an organisation, strategy or project:

- Governing bodies/regulators/policy makers such as regional, national and European officers
- End users of the MUP, e.g. energy companies and aquaculture entrepreneurs
- Suppliers of the MUP such as cable companies and construction businesses
- Stakeholders from other offshore activities such as fisheries, shipping, and mining sectors
- (environmental) NGO's,
- Local citizens

Not many stakeholders were involved in this first step. The goal of this research was to do a qualitative research to get an overview of the stakeholder views in the different sites. Besides, it was difficult to find stakeholders willing to cooperate.

Central steps in this learning process are the interviews in step 1 with the selected stakeholders and the two so-called round table sessions in steps 2 and 3. The goal of step one is to identify different views on MUPs. This first step takes place before June 2013. Steps 2 and 3 have a cyclical, iterative nature. In these round table sessions, the goal is to discuss the design and adapt the design based on consensus between the involved stakeholders, in a sequence of steps. When consensus is reached, the process will be finished. The first round table session (step 2) will take place in December 2013 or January 2014. This will result in a second report in stakeholder views (deliverable 2.3). The second session will take place in September 2014 (step 3). After this session, a report will be generated on platform solutions (deliverable 2.4).

In step 1, interviews are held with a wide range of stakeholders. Step 1 focusses on identifying different views on ecological, economic and societal objectives of MUPs, challenges and (technical, social-economic and natural) constraints faced. Their demands and wishes are important design criteria. The idea is that designers can start working on developing the first MUP draft designs taking the stakeholders' wish list into account. These draft MUP designs are discussed later in step 2, an interactive round table session involving stakeholders. The results of step 1 in the four MERMAID cases are presented in this report.

Steps 2 and 3 constitute an iterative cycle where a draft design is developed. Modifications, additions or new features/designs can then be proposed by the round table, starting the next the design cycle. This ideally leads to a design which is thoroughly analysed, technically feasible and which has taken into account stakeholders input and supported by the stakeholders at the round table. The result of this process leads to a concrete design which can ideally be evaluated by the round table (step 3).

2.2 Development of questionnaire

This report focusses only on the results of the above described step 1: defining the societal, ecological, and economic objectives of different stakeholders in MUPs, the challenges involved and the needs of the stakeholders in each case. The information is based on the results from individual interviews and group interviews following a developed questionnaire. The result is a wish list with the views and needs of all the stakeholders involved per case study.

2.2.1 The main questions

We have built a questionnaire that centres around four main questions: (1) Stakeholders' goals for participating in a MUP, (2) the prerequisites for their participation, and (3) possible dilemmas or obstacles they foresee in the development of MUPs. Further, the stakeholders are asked about (4) what characteristics the MUP should have to fulfil their needs. The final questionnaire is presented in Appendix 1.

2.2.2 The answer options

It was decided, for reasons of comparison throughout the cases, to use structured interviews. This implies that answer options should be given where possible. The developed questionnaire provides a range of predefined alternative answers options to the first three questions formulated above, leaving an option for "other" open. The answer options are based on a literature study (Buck, 2008 #126; Buck, 2010 #143; Buck, 2004 #125), reports, unpublished drafts and experience in other projects (Blauwdruk, TripleP@sea). The interviewees could answer using a Lickert scale. The last question about the characteristics of the MUP was an open-ended question which had three possible answer categories: technical, socio-economic and ecological characteristics.

2.2.3 The development of the answer options

The predefined answer options can be related to three different categories: people (social aspects), planet (ecological aspects) and profit (economic aspects). In the questionnaire, the three answer options are mixed to avoid socially desirable answers. The structure that underlies the first three questions of the questionnaire is a 3x3 matrix consisting of three questions and three answer categories see table 2.1.

Table 2.1. The underlying structure of the developed questionnaire.

	What are the goals?	What are the prerequisites?	What are the dilemmas or obstacles?
People			
Planet			
Profit			

This underlying structure was filled in based on the literature study, which resulted in the answer options per question, see box below.

How important are the following goals for you in order to participate in a multi-use platform (MUP)??

- Increase employment	0	1	2	3	4	5
- Explore new (export) markets	0	1	2	3	4	5
- More efficient use of space	0	1	2	3	4	5
- Improving water quality	0	1	2	3	4	5
- Create social acceptance	0	1	2	3	4	5
- Reduction of costs	0	1	2	3	4	5
- Increase of biodiversity	0	1	2	3	4	5
- Increase cooperation between stakeholders	0	1	2	3	4	5
- Profit maximisation	0	1	2	3	4	5
- More efficient use of energy	0	1	2	3	4	5
- Reduce negative impacts on the ecosystem	0	1	2	3	4	5
- Continuation of my firm on the long term	0	1	2	3	4	5
- Better combination of production & nature values	0	1	2	3	4	5
- I don't know	0	1	2	3	4	5
- Other:	0	1	2	3	4	5
- Other:	0	1	2	3	4	5
- Other:	0	1	2	3	4	5

Space for notes:

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In the following paragraphs we will discuss the development of the answer options per group of anticipated stakeholders. Based on the information below, we had a brainstorm on possible answers per question for each of the stakeholder groups. Because there is a possibility that answers are missing, the other answer category was added.

The answer options relating to end users, suppliers, other relevant offshore companies
Classic economic scientists of business behaviour argue that whether a business will be involved in certain practices – or not – is dependent on two aspects: (1) does it add value to the business and improve the competitive advantage of the business (Porter, 2006) and (2) if this done efficiently, thus without too high transaction cost (Coase, 1937).

These questions are relevant for business behaviour also in the case of MUP development. Participation in a MUP can for example generate additional income, reduce cost, open up new markets or increase access to capital. These arguments can be sorted under the first dimension: profit.

Many researchers claim that the value of business activities should not only be judged by financial criteria but that a wider perspective should be applied (refs). In other words, for business, the added value of participation in MUPs development lies not only in improved financial returns, but it is also to be found in other dimensions. This relates to the notion of Corporate Social Responsibility (CSR) and business sustainability which are often presented as preconditions for long-term performance of business (McDonough and Braungart, 2002; Fisk, 2010). This opens up a new set of tasks and responsibilities for companies, focussing on realising social (people) and ecological (planet) objectives as well.

In the last decade, we have seen on-going conceptual development of CSR (Dyllick, 2002), discussing implications on and expectations of business. Although this process is problematic, because of an inconsistent use of terminology (Hacking, 2008) and a mismatch between the world of business and many sustainability advocates (Porter, 2006), common ground is found in the notion Triple Bottom Line (also called Triple P).

A company that adheres to the principle of the Triple Bottom Line seeks to realise benefits in the people, planet and profit dimensions in their operations. Activities that have positive benefits in one dimension but negatively affects another dimension should then not be undertaken. The Triple Bottom Line principle is used in reporting on CSR, for example in the Global Reporting Initiative's guidelines, but is also believed to inform corporate strategy development (Manuela, 2008) (Hubbard, 2009). In this way, the Triple Bottom Line approach leads to focus on "sustainable profit" rather than "financial profit" (Cramer, 2002).

In addition of the people and planet dimensions to corporate strategy is believed to deliver additional benefits for corporate performance. These benefits could include e.g. lower enforcements costs, less waste or an improved "license to operate" and improved access to labour. The questionnaire aims to identify business interest in the various "profits" of MUPs by asking them about their objective to be realised in MUP development.

The answer options relating to government
An analysis of what determines government behaviour in a MUP context depends on what theory for government is applied. Such theories show a rich variety, ranging from e.g. the view that government behaviour is determined by the self-interest of bureaucrats and politicians (e.g. public choice theory) to the view that the government tries to benevolently maximize the well-being of its citizens. In a MERMAID context, it might be adequate to simplify this issue considerably by assuming that government behaviour is largely about trying to realize objectives from relevant policies that are in fact in place.

These policies are typically about balancing the interests of various groups for finding compromises that are acceptable from an economic, social as well as ecological sustainability point of view. However, the extent to which the different domains of sustainability are emphasized varies among different policies. The policies that are likely to be relevant in a MUP context include the following:

- Marine Spatial Planning (MSP)
- The Marine Strategy Framework Directive (MSFD)
- The Habitats Directive and the Birds Directive
- Common Fisheries Policy
- Energy and climate regulation

As examples of what the policies suggest in terms of what governments should strive at, the following key principles in MSP has been identified within UNESCO's work with defining MSP (Ehler and Douvere, 2009):

- *Ecosystem based*, balancing ecological, economic and social goals and objectives toward sustainable development.
- *Integrated*, across sectors and agencies, and among levels of government.
- *Place-based* or *area-based*

- *Adaptive*, capable of learning from experience
- *Strategic and anticipatory*, focused on the long-term
- *Participatory*, stakeholders actively involved in the process

As to the MSFD, the directive states in Chapter 1, Article 1 that "Marine strategies shall apply an ecosystem-based approach to the management of human activities, ensuring that the collective pressure of such activities is kept within levels compatible with the achievement of good environmental status and that the capacity of marine ecosystems to respond to human-induced changes is not compromised, while enabling the sustainable use of marine goods and services by present and future generations." Thus, while the point of departure for the directive is the need for reaching good environmental status in marine waters, the directive also acknowledges the importance of using the sea as a supplier of goods and services.

The answer categories relating to NGO's and local citizens
Sustainable development is typically associated with public participation as an important part of social sustainability. Public participation might also improve environmental management through the social learning such participation might entail (Franzén et al., 2011). A literature review by Reed (2008) shows that since a couple of years there is an increased demand and implementation of stakeholder participation in both national and international policy guidelines for conducting environmental projects. Even if there is some proof that stakeholder participation processes can increase the quality of decisions related to environmental projects, Reed (2008) states that few research has been done to support this or other potential benefits. Reed (2008) writes that the quality of the decisions is strongly dependent on how the decision process is designed, where the process should focus on the participation itself.

Different degrees of public participation can be described as a scale from "information" to "self-control" (Franzén, 2012), where information is a type of one-way communication and self-control on the other hand where citizens themselves manage some resource. The levels in between are described as "consultation", "co-thinking", "co-designing" and "decision-making" (Franzén, 2012). Chess et al. (2002) present a similar scale for public participation from "authority control" via "information", "consultation level 1" (as a formality), "consultation level 2" (real consultation), "shared power" to the highest level of "community leads". They state that the role of citizens (the public) should be clear from the start but also that different groups should be asked about which level of participation they would prefer.

2.3 Implementation of the questionnaire at the case study sites

The implementation of the questionnaire was different in the 4 case studies. Below is a description of how the questionnaire was used at the different sites. Results cannot be compared; however we will compare the stakeholder processes to learn from these processes. The selection of the stakeholders is described per case in the next chapter.

2.3.1 **Baltic Sea site**

All relevant stakeholders were invited for a round table session in December 2012. A total of 6 stakeholders attended the session and afterwards 3 other stakeholders were interviewed. During the session, the questions of the questionnaire were discussed in the group. The information from this session was used for the description of the results in chapter 3.

2.3.2 North Sea site

The stakeholders have separately been contacted for holding an interview with a representative of either DELTARES or IMARES, both MERMAID partners. The questionnaire was sent one week in advance to the interviewee with the question to fill it in, in advance. It appeared that no interviewee did fill in the questionnaire before the interview. Because of the busy business period at the end of the year, some of the planned meeting was cancelled and postponed to January/February 2013.

Regarding the questionnaire format the first concept was tested in the Netherlands, also at the Istanbul MERMAID plenary meeting (September 2012). After this, the questionnaire was adapted so that the first interviewees filled in a different questionnaire.

2.3.3 Atlantic Ocean site

The stakeholders' views were investigated by conducting individual interviews. Interviews were held in Santander in December 2012. An additional interview was held trough Skype in January 2013. The questionnaire was used as a basis for the interviews.

2.3.4 Mediterranean Sea site

The development of the MUP was discussed with relevant stakeholders in the area to investigate the views of the stakeholders. First, a round table session was organised in November 2012 to introduce the MUP concept and the site. All relevant stakeholders were invited to this round table sessions. Later, all stakeholders were asked to fill in the questionnaire.

3 Results and analysis

Some of the answers of the questionnaires could be placed in multiple categories (people, planet, profit), causing that in the result this chapter, not all answers (especially for question 2 and 3) could be divided into one of the three categories.

3.1 Baltic Sea site

3.1.1 Site description

The challenge of Kriegers Flak is to plan a multi-use platform with the combination of wind turbines and offshore aquaculture. There are already plans for a wind farm at Kriegers Flak. A wind farm with 600 MW will be installed on the Danish part of Kriegers Flak by 2020 at the latest. On the German side, the wind farm Baltic II with 288 MW is under development. On the Swedish side, project plans are on hold. If these plans will be developed, this would provide a substantial annual energy boost[2]. The preliminary design suggestions are to combine the following activities:

- Wind turbines
- Floating fish cages with trout/salmon production

Kriegers Flak is located at the intersect of Danish, German and Swedish exclusive economic zones, 30 – 40 km offshore. The distance does not seem to be a problem for the transport and maintenance of the exploitation of both the wind- and fish farm. Kriegers Flak has a water depth between 17-40 metres and a stable seabed which are good conditions for fish farm activities. The choice of water depth is important for the windfarm, so that construction costs remain low. The wind velocity is high and uniform and can generate a large amount of energy[2]. Furthermore, it is located on a path for deep water renewal of the Baltic and it is located on the main path for nutrient transport out of the Baltic. Therefore increased vertical mixing may be important for deep water inflow and the Baltic ecosystem.

[2] www.vattenfall.se/kriegersflak

The location of Kriegers Flak (Source: google maps)

3.1.2 Selection of stakeholders

The information is collected on the basis of a round table discussion and interviews, both performed by Stichting DLO (Marian Stuiver). The questionnaire was used in the interviews. Participants were selected on the basis of involvement in the case study area of Kriegers Flak. Different categories of stakeholders can be discerned. First there are the potential entrepreneurs to participate in the development of a multi-use platform: DONG Energy, MUSH Aquaculture. Second there are governmental bodies like Fishery inspection and the Shipping Authority that have a voice in the spatial planning procedures. Third there are the NGO's like the Green Centre that represent societal values. Finally parties from universities are interviewed that have a stake in the research and development of the multi-use platforms.

The respondents represented:

1. DTU Copenhagen: Scientific Institution
2. Green Centre, Environmental Organisation
3. Soefartsstyrelsen: Shipping Authority
4. Fiskerikontrol øst: Fishery Inspection
5. DONG Energy: Energy Company
6. DHI: Scientific Institution
7. Mush: Fish farm Company

3.1.3 Goals for participation

All stakeholders were asked about their objectives/goals for participating in this MUP. The table below lists the goals that were defined in the questionnaire and the average score that was given by all the respondents.

Goals	Average
Increase employment	2.1
Explore new (export) markets	2.3
More efficient use of marine space	3.0
Improving water quality	2.3
Create social acceptance	2.4
Reduction of costs	2.7
Increase of biodiversity	2.1
Increase cooperation between stakeholders	3.4
Profit maximisation	2.3
More efficient use of energy	2.4
Reduce negative impacts on the ecosystem	3.4
Continuation of my firm on the long term	2.6
Combining production and nature values	3.3

Goals to participate in a multi-use platform range from people, planet, and profit motivations that are described below.

People
The new forms of cooperation between the involved stakeholders that will happen in the development of a multi-use platform are an important goal for the participants. Developing a MUP can create social acceptance but also opposition for developing more intensive economic activities at sea and therefore all relevant parties should have a say in the process. One of the goals of developing a MUP is therefore to involve society in the development of economic solutions that make benefits for society. The concept of a MUP is still very unclear for society and it is very important that communication and promotion of the concept to the people are taken care of.

Planet
Participants from nature organisations and R&D centres want to increase a better combination of production and nature values and decrease the negative impacts on the ecosystem. They want to develop a MUP to understand what ecological gains can be pursued and they want to experiment and research how ecological impacts can be low or whether there can be ecological gains achieved. The energy business and fish farm find environmental and ecological issues of big importance, as they acknowledge that they need a licence to produce from society.

Profit
For energy companies, first priority is to optimize the energy production. Aquaculture production in the same geographical area must not have negative influence upon that. If this can be achieved, energy companies are open to cooperate with other kind of offshore activities for the sake of profit maximisation. The fish farm sees this combination as viable for continuation of the firm in the long term. Both their challenge is to combine the production of fish and energy in such a way that costs are reduced more effectively. One example is not to lose energy, but use the energy for the production of fish in confined cages. Hydrogen can be used for energy storage and possible a by-product is oxygen that can be used for the production of fish. Other ways to reduce costs is to use the same ships for transport and maintenance. Fish farms have a big vessel for feed and these can possibly be used by the energy businesses as well. Another option is to build a platform for use where both crewmembers can work and the feeding of the fish can be done.

3.1.4 **Prerequisites for participation**

All stakeholders were asked about the importance of the listed prerequisites for their decision to participate in a MUP. The table below lists the obstacles that were defined in the questionnaire and the average score that was given by all the respondents. The answer categories could not easily be placed under people, planet or profit. For this reason, no distinction has been made.

Prerequisites	Average
Access to education facilities/skilled people	2.0
Uniformity in procedures	1.7
Trust between stakeholders	3.6
License to produce	2.1
Clear roles	2.4
Financially attractive arrangements	2.4
Participation of supply companies	2.6
Multidisciplinary cooperation	2.7
Enough space for production	2.7
Faster licensing	2.4
Stakeholder participation	2.9
Improve companies image	2.3
Sustainable management plans	2.9
External communication	2.0

Trust between stakeholders and stakeholder participation

It is very important to build on trust between the parties involved. Not only the businesses, but also the societal organisations and governmental bodies need to work actively on trust and overcome vested interests to get a shared goal in developing a MUP.

Clear roles and contracts on logistics and risks

Some energy businesses and fish farms feel the need to make an agreement for dealing with logistics and risks for combined transportation and access for monitoring and maintenance. Therefore, an analysis is needed for combined use in which the position of the cabling and the use of shipping are included to prevent risks of damage and accidents. An important aspect in this respect is whether there are insurance companies that are willing to insure against the risks involved

3.1.5 Obstacles for participation

All stakeholders were asked about the importance of the listed obstacles for their decision to participate in a MUP. The table below lists the obstacles stakeholders could encounter when participating in the MUP and the average score that was given by all the respondents. The answer categories could not easily be placed under people, planet or profit. For this reason, no distinction has been made.

Obstacles	Average
Availability personnel	2.4
Government regulation	2.4
Lacking knowledge	2.7
Distrust between stakeholders	3.3
Unpredicted costs	3.1
Short or long term permits	2.9
Unclear roles between stakeholders	2.7
Negative press	2.4
Time investment	2.6
Increase insurance premiums	2.0
Larger risks	2.4

There are different categories of obstacles perceived by the participants that are very dependent on their perceived role in the process of developing a MUP.

Overcome distrust between stakeholders that need to be involved.
Participation should take place with all countries involved as well as the stakeholders that want to develop activities. It is very important that trust between the stakeholders is taken care of. Competing claims between the stakeholders in terms of economy and ecology need to be tackled in a mutual process and should result in new guidelines for the exploitation of the sea.

Unclear procedures for planning
Participants feel the urgent need that clear procedures for stakeholder involvement should be developed among the countries involved. At the moment Germany has a Marine Spatial Plan for the area, but the three countries together are involved in a combined Marine Spatial Plan. Developing a cross-boundary plan that includes the zoning of Kriegers Flak for different purposes is a necessary step. The aim is that there should be an equal division of nature conservation as well as economic activities and present shipping and transport lines should be taken into consideration as well.

Short of long term permits
It is an obstacle for the fish farm companies how to get the right permits for the economic exploitation of the sea. For instance, coastal authorities need to be involved more intensively in the process as they are responsible for giving permissions to constructions at sea. Their job will change when MUPs are developed. They have to develop new guidelines for the administration of the sea territory within their authorities.

Ecological constraints
Part of the sea bed area will be taken up by the foundations of the wind turbines and part of the sea will be destined for the fish cages. This will have an effect on the habitats in their living environment. But the foundation and scour protection of wind turbines have proved to become an artificial reef in which algae and invertebrates appear to do well. The foundations are quickly colonized and create entire communities of marine life[3]. So there are also possibilities for improving sea life and ecological conditions that need to be explored

3.1.6 Conditions for the design (technical, ecological and socio economic)

Different conditions for the design are mentioned by the stakeholders that involve a range of technical, ecological and socio-economic conditions for design.

Technical
There are also different logistic constraints perceived by the participants on maintenance and monitoring, anchoring and transport. When a wind farm and fish farm are combined, more ships will enter the area, which means more traffic and higher risks of accidents for the people and technology involved. However, the entire wind farm will be designated as a cable protection zone, meaning that anchoring, trawling etc. will not be allowed.

There is a practical problem when you are combining wind turbines and fish farms at sea. It is the potential risk of internal damages, for example if the anchors of the fish farm are drifting into the

[3] www.vattenfall.se/kriegersflak

cables of power supply, or if the fish cages are damaged by the wind turbine construction. In order to reduce the risks, the MUP should be clearly marked out and will be armed with technical monitoring equipment. Also a risk assessment is needed. Possibly two shipping routes that pass Kriegers Flak need to be changed, for instance the Ferry to Travemunde. Second, when fish cages are located between the wind turbines this means that transportation is more restricted. Good guidelines and rules need to be endorsed to ensure safety of the people, the vessels, the cages and wind turbines involved.

Ecological

There should be no impact on the environment and the ecological conditions of the seawater and seabed. One condition involves the preservation of the artificial reefs that are located under the surface. Potential scour protection around foundations may act as artificial reefs. Disturbance of these habitats can be avoided when the fish farms are placed far away from the artificial reefs themselves. In the positioning of the fish cages, one should take this into consideration.

Socio-economic

A MUP will affect the landscape to a greater or lesser extent. In the view of the participants there should not be any effect on views from shore. However some of the wind turbine towers at Kriegers flak would be below the horizon, since the wind turbines are located around 30 km off shore. Depending on the weather conditions, the farm will seldom be clearly visible from the coast.

Perceptions of the public and the image of wind turbines and fish farms are variable. Fish farms and aquaculture at sea are less accepted by the audience then wind farms. However, public images can change. There is a debate that argues that aquaculture is not polluting and produces healthy food in an environmentally very efficient and correct way.

Focus or open design

Participants differ in whether they will participate depending on the range of economic options. Some express to start with combining wind energy and fish farms and build from there. However, it might be more practical and economically efficient to divide the area in the sea and separate some of the physical installations, for example the cages and wind turbines, and then combine others, such as feeding stations and the maintenance ships. It does not necessarily have to be one big platform.

Others suggest to leave options open and make the design in such a way that also for instance tourism and energy storage is possible. Others warn that there should not be overriding conflicts between the economic activities and that the sky is not the limit. In the future there could be totally new designs needed that have spatial effects.

3.2 North Sea site

3.2.1 Site description

The North Sea site is an area with typical active morphology and environmental characteristics. The Dutch MERMAID partners have unanimously decided that the interesting test study area lies above the Wadden Sea Islands in the North of the Netherlands.

The location of the Gemini site (Source: Google maps)

In this area, the Dutch authorities (Rijkswaterstaat) awarded 3 permits for larger offshore wind farms, the so-called Gemini project[4]. These 3 projects are named Buitengaats (300MW), Clearcamp (275MW) and ZeeEnergie (300MW) and fully acquired by Typhoon Offshore in July 2011. Two projects, Buitengaats and ZeeEnergie, were granted a subsidy in May 2010 and are currently in the process of being brought to financial close (spring 2013). After this, the construction process will start. The third project, Clearcamp is still without subsidy and may serve as a future test field for new offshore wind technologies. This means that for the Gemini site already on going impact studies are conducted regarding safety and stability of monopole and jacket constructions (a.o. Deltares) as well as for the environmental impact (a.o. IMARES)

Gemini project data:

WTG	**Siemens**
Power	600 MW
Depth	30-40 M
Distance from the coast	85 km
Swept area	2 x 34 km2
Hub height	88,5 M (from sea level)
Rotor diameter	130 M

[4] http://www.typhoonoffshore.eu/projects/gemini/

Annual production	2.6 TWh per year
Powering	> 785.000 households
Operational since	Construction starting 2013
CO2-emissions avoidance	1,250,000 Tons

Although these offshore wind farms in development only have licenses for single use, more stakeholders in the Netherlands are starting to discuss the MUP possibilities, such as the regional fishermen and entrepreneurs for aquaculture and tourism. Various MUP concepts and plans are already on the drawing boards and must be further developed in cooperation with all stakeholders. This means that specifically the Gemini wind farm can become an ideal test site for MUP designs, developing procedures and commitment. There is increasingly interest in the MERMAID MUP approach and for near future marine planning strategies off the Dutch coast. On the one hand to fulfil anticipating on the EU strategies reducing fossil based energy and on the other hand stimulating offshore multi-use activities as sustainable aquaculture and fisheries, preferably to combine it with offshore wind farms and/or wave energy.

The challenge of the Gemini wind farm is to combine the farm with offshore aquaculture, fisheries and tourism. The site (54.036 degrees centre latitude, 5.964 degrees centre longitude) is situated near a fishery harbour, Lauwersoog, and a shipping & offshore harbour, Eemshaven. The distance from shore is abt. 85 km, out of sight and in compliance with the MERMAID prerequisites for MUPs.

3.2.2 Selection of stakeholders

Since the first plans in the nineties for near-shore small-scale wind farms off the coast of the Netherlands, there are ongoing discussions about multi-use activities in these areas. In the first place these discussions were started by the fishermen having the earliest fishing rights, but also on governmental and research level that see benefits in multi-use. However, the wind energy industry saw (and still sees) too many barriers and additional risks. Also, the already awarded licenses are for single use. Since a couple of years, the Dutch industry and research are designing Far and Large Offshore Windfarm (FLOW) constructions and installations and with these developments the MUP discussions are full on public-private agendas, either by the fishermen organizations or also by the Dutch offshore aquaculture sector, especially for shellfish. Also many business and governmental institutes are formulating MUP initiatives to give concrete content to the chapter on Corporate Citizenship and Responsibility; see for instance the NUON Corporate Sustainability Report.

For the Gemini site the following groups of Dutch stakeholders are already interested and should be considered:

- offshore wind
- offshore aquaculture
- fisheries
- tourism

Next to these stakeholders, MERMAID wishes to include:

- Governing bodies/regulators/policy makers such as regional, national and European officers;
- Stakeholders from other offshore activities from for example shipping, and mining sectors
- NGO's and local citizens.

The interviews were done by Deltares (Jan Joost Schouten, Patricia Schouten & Mark de Bel) and Stichting DLO (Frans Veenstra & Mascha Rasenberg). In the next section a description is given of the relevant Dutch offshore wind, - aquaculture, fisheries and tourism sectors.

Dutch offshore wind energy

For 40 years now, the Dutch energy companies are working with wind energy, however near-shore wind farms only exists for the past 6 years. About 150 companies play a role in the entire supply chain for the offshore wind industry in the Netherlands, ranging from blade production and hydrography up to foundation constructions and heavy logistics. Since a few years more companies are becoming active in the larger offshore wind farms developments further out at sea, of which the Gemini project is the first one to be built in due time. The other two sites are still concessions off the coast of Ijmuiden (1000MW; middle Netherlands) and Borsele (1000 MW; south Netherlands). By the year 2020 the Dutch Government aims to have installed 6000 MW of offshore wind energy capacity to reach its renewable energy goals. Only approximately 2000-3000 MW can be installed within 50-60 km distance from the shore. The remaining capacity will have to be built further offshore with water depths of more than 30 meters. This presents larger challenges for the installation, operation and maintenance of a wind farm.

Dutch offshore aquaculture (fish cages, shellfish, sea weed)

In contrast with the Dutch offshore wind, the Dutch offshore aquaculture sector is at the beginning of a new development. For example the shellfish companies are in a transition phase, from inshore blue mussel cultures to more offshore cultures. Because of the shallow waters off the coast of the Netherlands, no companies are interested yet in fish cage cultures. Regarding seaweed culture, large volumes are already being imported by Dutch companies from Asia and France for a very competitive price. And only on a very small scale, some experiments are being conducted by research institutes and universities. Once a large scale North Sea seaweed business case has been drafted, and then maybe some companies are interested as well.

Fisheries

Already from the start of the planning and building of the two Dutch wind farms out at sea[5], fishermen (organizations) are discussing either compensation fees for lost fishing grounds and/or additional employment for their fishing vessels, e.g. fishing with static gears and sailing with tourists in/around the farms.

Another development to be mentioned is the Masterplan Sustainable Fisheries project. In this project, which aims for increased sustainability for the Dutch fleet, new fishing vessel designs have been drafted, taking adaptations for service and maintenance work in wind farms, into account. Since 2011 these MUP discussions have been further structured under the umbrella of some fishermen organizations with governmental and offshore wind parties.

[5] The Egmond aan Zee Offshore wind Farm (108 MW, NUON, shell, 2006) and Princes Amalia wind farm (120 MW; Eneco, Econcern, 2008).

Tourism
During the building phase of the two near-shore Dutch wind farms, Egmond aan Zee and Amalia, there was interest of tourists to visit these sites. Some small scale companies with seaworthy old fishing boats are already organizing one day sightseeing trips.

3.2.3 Goals for participation

All stakeholders were asked about their goals for participating in this MUP. The table below lists the goals that were defined in the questionnaire and the average score of importance that was given by all the respondents.

Goals	Average
Increase employment	3.8
Explore new (export) markets	2.2
More efficient use of marine space	4.0
Improving water quality	1.7
Create social acceptance	4.0
Reduction of costs	4.4
Increase of biodiversity	3.5
Increase cooperation between stakeholders	3.7
Profit maximisation	4.7
More efficient use of energy	4.2
Reduce negative impacts on the ecosystem	3.3
Continuation of my firm on the long term	4.4
Combining production and nature values	3.8

People
The number of stakeholders that become involved in process of developing a single-use offshore wind farm increases. In their external communication some of the Gemini companies generally advocate their Corporate Social Responsibilities (CSR). The energy companies mention that a MUP approach is likely to create more social acceptance for offshore wind. Since last year, different persons from relevant Gemini stakeholders are meeting each other regularly to increase their cooperation, which is a very important MUP goal for the interviewed stakeholders as well. Besides, many reports have already been published (We@Sea, 2011; Stichting Energy Valley 2010) on how the large scale offshore wind farms can stimulate the regional employment. Once a MUP concept results in multi-use activities, other groups of stakeholders, like the fisheries can benefit from these MUP developments as well.

Planet
With the experiences of the wind farm pilots in the Dutch coastal zones and because of the maritime spatial plans, all stakeholders are strongly in favour of making better use of marine space and more efficient use of energy.

In 2007, the Dutch government presented their vision on the way the Netherlands should deal with water. Sustainable, climate-proof, and strengthening the economy are key words. The vision was important because it provided input and direction to the first Dutch National Waterplan 2009-2015.

Derived from this, also for the North Sea area and stakeholders, one of the objectives is to make the North Sea more sustainable. Accepted in 2009, the National Waterplan integrates all areas of water, also offshore. For most MUP stakeholders biodiversity, more efficient use of space and energy are very important goals. Instead of seeing the ecosystem approach as a barrier for (combined) offshore activities, it can contribute to increase the biodiversity and companies images. With this public-private acceptance will improve in a broader sense and increasingly environmental NGOs are willing to cooperate along these lines as well.

Profit

Although the renewable energy sector is already a trillion euro industry and the fisheries and aquaculture "just" a billion-euro sector, the most important goal for both is continuation of their firm on the long term, not only through profit maximisation but also by reducing the operational costs. For the wind sector, the Dutch subsidies will decrease in the coming years and for them reduction of costs, even up to 40 %, is a must.

Continuation of the firm is for the energy companies and investors the most important reason that MUP concepts are on the agenda, regardless of all the barriers against MUPs of the past 20 years. For the different groups of MUP stakeholders, combining the same infrastructure for their offshore activities is a possible solution. For the fisheries and offshore aquaculture, exploring new markets is also becoming an important goal. Because new ecosystem management regulations in the estuaries and near shore will increasingly hamper their near shore fishery and aquaculture activities.

3.2.4 Prerequisites for participation

All stakeholders were asked about the importance of the listed prerequisites for their decision to participate in a MUP. The table below lists the obstacles that were defined in the questionnaire and the average score of importance that was given by all the respondents.

Prerequisites	Average
Access to education facilities/skilled people	4.0
Uniformity in procedures	4.0
Trust between stakeholders	4.4
License to produce	4.0
Clear roles	4.0
Financially attractive arrangements	4.8
Participation of supply companies	4.0
Multidisciplinary cooperation	4.0
Enough space for production	4.4
Faster licensing	5.0
Stakeholder participation	4.6
Improve companies image	3.8
Sustainable management plans	3.8
External communication	3.4

Stakeholder participation and trust

Stakeholder participation and trust between stakeholders are very important prerequisites for the North Sea site. For this, all stakeholders require clear roles and input of their expertise. For further developing MUP concepts, multidisciplinary cooperation is an absolutely must as well as an open

mind to share knowledge and experiences. If the MUP on- and offshore activities are being conducted in remote areas like of the Gemini site, easy access to education is also a must. Because of strict risk management in/near offshore windfarms, co-users as fishermen must be professionally trained before they are allowed to work in/near the large scale windfarms. Also a MUP license to produce is an important prerequisite for the stakeholders. So far nobody is working on this important aspect, also urgently needed for a level playing field. Once the MUP license is generally accepted, then all the single windsector investors are obliged to implement the multi-use approach in their building- and operational plans

Attractive financial arrangements

Three groups of MUP stakeholders require financial attractive arrangements for MUP system innovations as the most important prerequisite. Multiple innovations are needed regarding technical and organizational issues as well as governance in this process from single- to multi-use offshore activities. Prerequisites as new or adapted rules are also very important and new forms of funding and collaboration between all relevant MUP stakeholders. To stimulate the offshore MUP approach, the licensing process must be reconsidered and become more business friendly. Nowadays it takes 5-10 years before a permit is applied, let alone if it must be extended for MUP's. Policy makers and regulators have so far not been challenged to handle request for MUP permits. Also, in the spatial plans for the North Sea, there is no area yet designated for offshore aquaculture. Another important prerequisite for the business stakeholders is enough space for production.

Sustainable management plans

For all group of stakeholders sustainable management plans are urgently needed for further developing the MUP concepts. Many stakeholders are worried about the uncertainty of the ecological effects of the multi-use offshore activities. With the positive ecosystem results of the Dutch pilot windfarm monitoring studies the windsector is just starting to make use of it to improve their company sustainable image. Also environmental NGO's are exploring the potential of realising ecological valuable zones within windfarms, still without multi-use activities.

3.2.5 Obstacles for participation

All stakeholders were asked about the importance of the listed obstacles for their decision to participate in a MUP. The table below lists the obstacles stakeholders could encounter when participating in the MUP and the average score that was given by all the respondents.

Obstacles	Average
Availability personnel	2.8
Government regulation	4.6
Lacking knowledge	4.5
Distrust between stakeholders	3.8
Unpredicted costs	4.0
Short or long term permits	4.5
Unclear roles between stakeholders	3.8
Negative press	3.6
Time investment	3.6
Increase insurance premiums	3.2
Larger risks	4.2

Lack of governmental regulations and lack of knowledge
The two most important obstacles for MUPs in the North Sea, according the stakeholders, are lack of government regulation and lack of knowledge. Up to now there are more questions than answers in the field of MUP permits; technical, biological and subsidy issues. The offshore wind sector as single-user is well experienced since 2 decennia; offshore aquaculture is just starting in the Netherlands. Because of a lack of experience in the offshore aquaculture, the wind sector is, at this moment, not in favour of multi-use activities. However the idea and concepts to reduce costs by using the same infrastructure, is very interesting but for this many multi-use innovations and short and long time permits are urgently needed.

Unpredicted costs
Unpredicted costs are seen as an important obstacle as well that could be encountered during the MUP design and implementation. On forehand a clear business case with a sound financial plan must be developed to involve more stakeholders and decreasing the risks of unpredicted costs.

Financing and time investment
Based on the existing viscous license offshore wind procedures, the wind energy sector has many doubts about this MUP process with still so many unknown aspects. However they are increasingly gaining a positive attitude, especially because from 2012 onwards, the Dutch offshore wind is no longer eligible for subsidy under the SDE+ program. Green investors and banks are not the first stakeholders to participate in these MUP developments because of too many uncertainties. This is a very important obstacle for co-financing and time investment.

Ecosystem risks/negative press
Because offshore aquaculture is still considered as an innovation for the North Sea site, it complicates the development of MUPs profoundly. Nobody can clarify yet which MUP (ecosystem) risks can be foreseen and what impact it will have on the insurance premiums. The offshore wind sector doesn't want to become involved in a process of negative press. On the other hand if with MUPs their sustainable image can be improved without running in additional risks then they are on board, at least in the socio-economic discussions.

The wind sector and shellfish sector both mention to proceed according to the following process: the transition process towards implementation of MUP systems needs to start with small pilots, such as off the coast off the Voordelta with offshore mussel culture (longlines). After this new offshore aquaculture has proven to be seaworthy, then the next step must be how it can be combined with offshore wind and the existing infrastructure. As an important goal in the meantime a sustainable MUP management plan must be designed enabling the assessment of both negative and beneficial impacts on the ecosystem; resulting in a possibly eco-optimisation MUP approach. With this new ecosystem approach a negative press can be avoided for all groups of stakeholders.

3.2.6 **Conditions for the design**

The conditions for design have been discussed with the stakeholders during the interviews and during several offshore (aquaculture) meetings in the period August 2012- January 2013. The information below has been summarized from the answers the stakeholders gave in the questionnaire as well as in the other discussions and on-going national MUP projects, such as Blueprint (feasibility of large scale offshore wind and offshore aquaculture in the Netherlands) and TripleP@Sea (valorisation of North Sea seaweed cultures).

Technical

The exact location of the North Sea site is well-known and more details can be found on the website[6]. The granted Gemini wind farm concession and permit are only for single use activities. The MUP possibilities are just conceptually based and fully under discussion. Since half a year many Dutch stakeholders are increasingly interested in more multi-use activities. Especially the wind energy sector is very clear in the technical MUP requirements:

- no hindrance of wind turbines
- no obstacle in case of operational and maintenance activities (O&M)
- preferably modular components and plug and play installations in case of multi-use activities

Besides they are more interested in making use of the same infrastructure for reducing their O&M costs. Also the end user group for offshore aquaculture and fisheries are becoming in favour of sharing infrastructures, on the one hand to lower their O&M costs while on the other hand to earn more money by multipurpose activities. From the investors point of view minimal risks are required in developing single- up to multi-use activities in/near the same area as the windfarms. For offshore aquaculture activities many technical and biological requirements are still unknown. There is such as a dilemma for two groups of multi-users: on the one hand for the fishermen MUP installation should be compact as much as possible attracting more fish while for operation and maintenance sufficient space is needed around the monopoles/jackets.

Ecological

The Egmond and Amalia pilot wind farms have proven that they have a positive effect on the existing ecosystems (We@Sea, 2011). In the transition from single to multi-use it isn't acceptable that the MUP approach will have a detrimental effect. Marine protein production in open water systems per definition interacts with the surrounding aquatic ecosystem. Whether and to what degree this affects ecological sustainability depends on the type of culture and the extent of integration between different culture types and other activities. Multi-use platforms at sea (MUPs) aim at optimal integration of activities, and each activity is thereby placed in a wider ecosystem context. The aim is to manage all activities in such way that it contributes to the sustainable development and equity of the whole. There are different ways of evaluating the eco-sustainability of a production system, whether it is a mono-culture, integrated aquaculture system, or integration of multiple activities as is foreseen for MUP production systems.

In open water for finfish aquaculture there is concern about the negative environmental effects related to nutrients discharged from fish cage aquaculture. One possible solution for this is to utilize the extractive properties of for example seaweeds and bivalves to remove these nutrients. This concept is known as Integrated Multi Trophic Aquaculture (IMTA). In open seas, IMTA fits with the concept of 'ecosystem based management' as each activity is placed in a wider ecosystem context and managed so that it contributes to the sustainable development and equity of the whole. However for the North Sea areas the waters are too shallow (< 30 m) for operating finfish cages and seaweed culture is still in a developing phase in the offshore conditions. Therefore, for this site the main MERMAID focus is on a MUP concept of combining large scale offshore wind farms and offshore shellfish culture and some form of bottom fishing. For the government MUPs should live

[6] www.4coffshore.com/windfarms/gemini-netherlands

up to all nature and environmental legislation. Monitoring should be done in order to measure effects, e.g. faeces of mussels on the bottom. There is an on-going discussion that new permit must be based on the so called Rochdale approach, in which more spatial and functional planning of the site area is leading instead of only the technical installation constraints.

Socio-economic

Before organizing the actual MUP workshop many stakeholders require site-made concepts before deciding to further participate in the MERMAID project. Also they want to know who else is taking part in further developing this North Sea site. For the northern region with much unemployment every action to increase the employment possibilities is more than welcome. Especially the local fishermen (organizations) are very interested in additional work for their fishing vessels. However the technical requirements for these existing fishing boats must be reconsidered as well as the possible operational risks, so that they can get a license to produce in or near the wind farms.

When the different end-users can make use of the same infrastructure and decrease their operational costs, then the MUP case implies a clear win-win situation. The end-users of the wind energy sector are studying very intensively how to decrease their O&M costs substantially, even up to 40 %, that is about 5 M€ /year. The most important reason for this is the decreasing offshore wind subsidies in the Dutch cases. Since a couple of years the Dutch fisheries is in a transition to a more sustainable sector and (re)designing of fishing vessels for more multipurpose fishing vessels. With these types of vessels the fishermen possibly can work in or near the windfarms as well, e.g. for some maintenance work but also for logistic and transport activities. Also sightseeing trips with tourists is being considered.

Also the shellfish sector is looking for additional fishing grounds for mussel seed collectors and breeding of mussels on longlines. Since a couple of years the inshore shellfish grounds are becoming less productive while there is a market for 50 % more volumes (> 50.000 tons of blue mussels)

Small scale fishermen have already granted a limited subsidy to investigate in 2013-2014 what the prerequisites are for the juridical, safety and sustainability aspects for profitable fishing with passive gears in/nearby wind farms.

3.3 Atlantic Ocean site

3.3.1 Site description

The Ubiarco test site was discussed in the interviews with stakeholders. This site is located in Spain, off shore the region of Cantabria. It will be able to manage three floating wind turbines and three wave energy concepts. They will be deployed reducing interaction and wake effects between them. A meteorological mast installed by the R&D Company IDERMAR (June 2010), will monitor the weather.

The location of the Ubiarco site (Source: Google maps)

The site will be fully monitored by the existing operational systems for wind, waves and currents. The floating platforms open up the opportunity of installing wind farms in deep waters because they do not need anchorage, something especially important in Spain, where the continental shelf is narrow. Aquaculture experiences from other deep water sites will be used as a basis for analysing the potential at this site. The site is in particular challenged with very harsh wave conditions, potentially a large problem for aquaculture equipment.

3.3.2 Selection of stakeholders

The marine/coastal community in Santander is small, all stakeholders seem to know each other and on occasions points towards the other for additional information. Selection of the stakeholders was done by the Environmental Hydraulics Institute of Cantabria (IH Cantabria). The interviews were done by Stichting DLO (Sander van den Burg) with the help of an interpreter provided by IH Cantabria. Some of the interviews were done at the IH Cantabria; others were visited in their office. The MERMAID questionnaire was used. A skype meeting was arranged to conduct a last interview.

The respondent represented the following stakeholder categories:

- Governing bodies/regulators/policy makers as regional, national and European officers: 3
- End users of the MUP, e.g. energy companies and aquaculture entrepreneurs: 0
- Suppliers of the MUP such as cable companies and construction businesses: 1
- stakeholders from other offshore activities such as fisheries, shipping, and mining sectors: 2
- Discourse community, including e.g. (environmental) NGO's, local citizens: 2

In the interviews, the concept of MUP itself proved difficult to grasp. In the Cantabria region, there are some developments that the respondents rapidly used as reference point. First, there is Idermar, a public-private company that has installed an offshore measurement system, among others used for research on offshore energy generation. The second reference point mentioned a few times is an offshore wave energy device that is used for experimental purposes. When the respondents talk about MUPs they generally think about similar sized developments and they recognize that a large offshore park is a different thing. We emphasised in the interviews that we are concerned with large scale development, not test sites.

3.3.3 Goals for participation

All stakeholders were asked about their goals for participating in this MUP. The table below lists the goals that were defined in the questionnaire and the average score that was given by all the respondents.

Goals	Average
Increase employment	3.0
Explore new (export) markets	3.4
More efficient use of marine space	2.6
Improving water quality	2.7
Create social acceptance	3.3
Reduction of costs	3.0
Increase of biodiversity	3.3
Increase cooperation between stakeholders	3.7
Profit maximisation	3.2
More efficient use of energy	3.7
Reduce negative impacts on the ecosystem	4.3
Continuation of my firm on the long term	2.7
Combining production and nature values	4.2

People

The involvement of stakeholders in the design process of the MUP may lead to increased cooperation between the stakeholders. Respondents acknowledge that cooperation between stakeholders is an important objective for participation in a MUP. Some respondents provided examples to illustrate the importance of social acceptance. Without that, technically well-designed project can still run into problems. It would be good if MUP development led to the creation of new jobs in the area.

Planet
Among the objectives related to planet are both the most valued and the lowest valued dimensions. Respondent value the following objectives high: ‘more efficient use of energy’, ‘reduce negative impacts on the ecosystem’ and ‘better combination of production and nature values’. These are important for NGO’s and local and regional authorities. Among business actors, these dimensions scored considerable lower (all below 2).

It is insightful to see what goals are the least important as these tell us something about the local situation. There is no conceived lack of space, thus more efficient use is of little interest to all respondents. Idem for water quality, there is no water quality problem to which MUP can be a solution and respondents score this dimension low.

Profit
The goals related to the profit dimension (explore new markets, create social acceptance, reduction of costs, profit maximisation) are generally of moderate importance. The potential interests of business are given less weight which might at first sight be explained by the fact that there were only few industrial parties involved. Indeed, business actors score ‘profit maximisation’ much higher. However, concerns about costs and benefits are not the exclusive domain of private parties. Other stakeholders underwrite the importance of the profit dimension but at this moment there is no concrete business case for offshore MUP in the proposed site. There are other challenges that need to be tackled first.

3.3.4 Prerequisites for participation

All stakeholders were asked about the importance of the listed prerequisites for their decision to participate in a MUP. The table below lists the prerequisites that were defined in the questionnaire and the average score that was given by all the respondents.

Prerequisites	Average
Access to education facilities/skilled people	n.a.
Uniformity in procedures	2.3
Trust between stakeholders	4.0
License to produce	1.8
Clear roles	3.7
Financially attractive arrangements	3.0
Participation of supply companies	3.3
Multidisciplinary cooperation	3.8
Enough space for production	2.5
Faster licensing	3.3
Stakeholder participation	4.3
Improve companies image	3.8
Sustainable management plans	3.8
External communication	1.8

Stakeholder participation
Among the highest ranked prerequisites for participating in MUP are the process oriented prerequisites (trust between stakeholders, clear roles, multidisciplinary cooperation, and stakeholder participation). Interesting that these score so high, it underwrites the importance of mutual

adjustment and stakeholder participation in development of the MUPs. A few people questioned at what point in the process stakeholders should participate, emphasizing that there is a difference between participation from the start and informing at the end of the design process.

Trust between stakeholders
Most respondents acknowledged that trust is an important factor for successful collaboration in a participatory design process. Respondents referred to other projects (IDERMAR) in which they experience the importance of trust.

Improve company's image
These prerequisites score high. It is remarkable that it received high scores two local authorities and an independent advisor, but low scores from the business respondent. When asked for elaboration, one of local authorities argued that it could also help in strengthening their public image.

Multidisciplinary cooperation
Multidisciplinary cooperation is seen as important prerequisites for almost all stakeholders. Cooperation between different stakeholders is required if a MUP is to be realised in this difficult environment.

Sustainable management plans
This prerequisite scores rather high. What was said about 'improve companies' image' is also valid here; some of the local authorities give high scores whereas business actor gives a low score.

Clear roles
This prerequisite gets quite high scores from almost all respondents. The exception is business stakeholder who gives a low score (1) to this prerequisite, arguing that roles always change during the project and that a clear demarcation of roles is thus not possible.

Other
The majority of respondents were from non-commercial organisations. They assigned little importance to the prerequisites associated with supply chain or financially attractive arrangements. Aspects such as license to produce and external communication were of little to no interest to most of the respondents. Another prerequisite that was mentioned to be of high importance is 'marine certification' where requirements posed by external certifiers are considered influential in determining if MUP can be realised. The prerequisite 'access to education/skilled people' was not understood by respondents and only one answer was given.

3.3.5 **Obstacles for participation**

All stakeholders were asked about the importance of the listed obstacles for their decision to participate in a MUP. The table below lists the obstacles stakeholders could encounter when participating in the MUP and the average score that was given by all the respondents.

Obstacles	Average
Availability personnel	2.4
Government regulation	3.2
Lacking knowledge	2.3
Distrust between stakeholders	2.8
Unpredicted costs	3.0
Short or long term permits	3.0
Unclear roles between stakeholders	3.8
Negative press	1.7
Time investment	2.6
Increase insurance premiums	2.8
Larger risks	2.0

Unclear roles between stakeholders
Unclear roles and distrust between stakeholders are seen as obstacles during the participation process.

Government regulation
Existing regulation was seen as an obstacle to participation. There are some experiences with offshore developments that did not materialize, hindered by regulation. Various respondents considered this issue of less importance, arguing that regulation can change as new developments and knowledge are available.

Unpredicted costs
Unpredicted costs are seen as an important obstacle that could be encountered during the MUP design.

Short or long term permits
At present, it is not easy to get a permit for offshore developments. Permits for MUP are 'unknown' and procedures for requests need to be developed.

Other
It is interesting to mention two obstacles that not considered important: 'availability personnel' and 'lacking knowledge'. Respondents argued that there are sufficient technical personnel available in the region and good education. Also, there are specialized businesses in the region for offshore works. The development of MUP should not be hindered by these two aspects.

3.3.6 **Conditions for the design**

Technical
The most important obstacles, according to the respondents, relate to the condition on this site and the subsequent technical demands. The Bea of Biscay is known for the large waves that can occur here. Respondents report that waves up to 20m height have been measured, off the Cantabrian coast and off the Bilbao coast. A second obstacle is the water depth in the Bay of Biscay. In the area, the continental shelf is relatively short, not far from the coast the depth increases strongly. At 1 km off the coast, water depths are circa 100 m, at 5 km off the coast this has already increased to 400 – 1000 m water depth. The combination of deep water and large waves makes it difficult to design

and built secure systems that can withstand these conditions. Also given the negative experiences with buoys (some got loose) respondents emphasize the importance of designing robust and safe systems. The design challenge is to come up with robust and safe systems that can withstand the harsh offshore environment in the Bay of Biscay.

When it comes to combinations of functions, aquaculture does not appear as the most evident co-use of the MUP. There is no experience with offshore aquaculture in the region and the conditions are deemed problematic. Other possible combinations of use functions that were discussed include combinations of offshore wind, wave and/or tidal energy; combination of offshore wind with sensors to gather information on the marine environment and combination of offshore wind with a temporal island that could be used during sports events.

The shape of a MUP ("what would it look like") was discussed but participants generally found it difficult to visualize a multi-use platform. Ideas mentioned were:

- Single wind turbines with aquaculture cages attached to them;
- An floating construction on which various turbines are constructed and providing space for other use

Good signalling systems are required to avoid accidents with other users of the ocean.

Ecological

Various stakeholders argued that it is important to choose the right site where interference with other functions is minimal. Other uses include e.g. fishing, tourism, transport, entrance to ports, bird and wildlife protection. The Atlantic case-study focusses on the Ubiarco site. This site is not of special value for birdlife, is not of special value for the fishermen, is not of special value for the sailing association and does not lie within existing shipping routes. The only concern is that it is nearby the mouth of the Rio Saja River where there is also a small port.

Generally, stakeholders argued that the MUP should not be near to the coast to reduce visual impact. Distances of ca. 5 kilometres from the coast were mentioned.

A significant negative impact on the ecosystem is not expected, also given the experiences in other countries with which some respondents are familiar. Here, it must be emphasized that the respondents consider aquaculture not possible and do not include it in their assessment of ecosystem impact.

Socio-economic

The respondents all discussed the technical design challenge, specific for this environment. Other conditions received far less attention in the interviews. MUP development could be an opportunity for bringing more employment to the region. Technically trained personnel are available in the region. Also, experienced offshore workers are available.

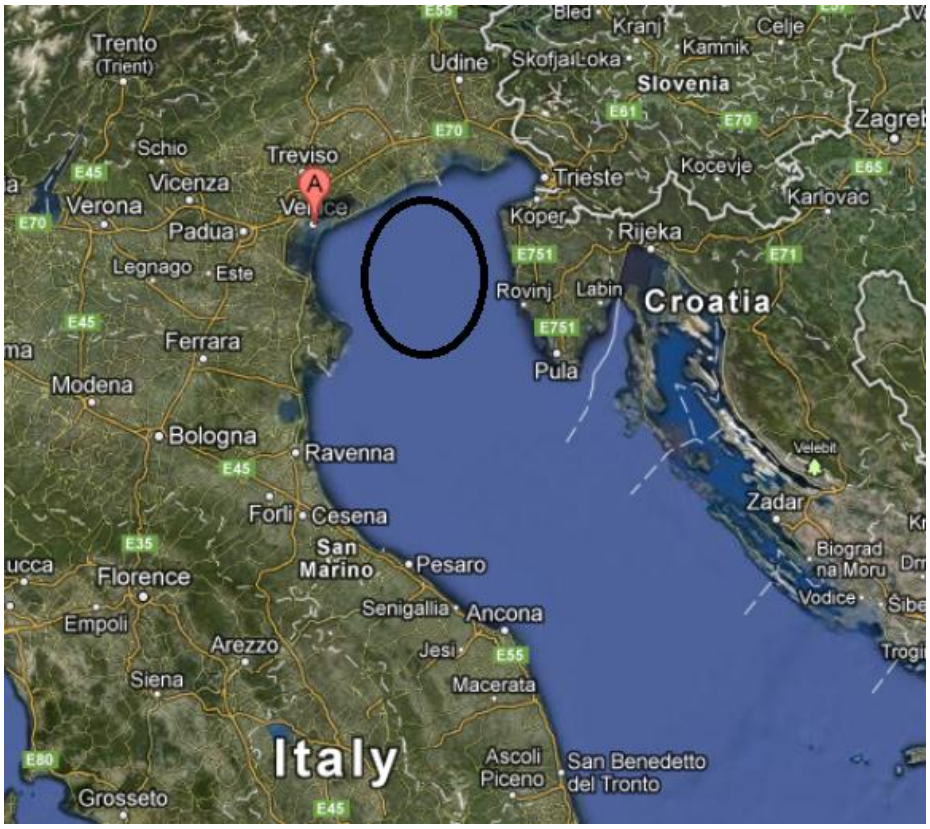
Various respondents emphasize that the local fishing community is an important stakeholder and that MUP development should not interfere with their interests. It is also argued that development of MUP can provide new jobs to the fishing community.

It is expected that the attraction of sufficient funds will be a difficulty. Also, it is emphasised that it is important to find a way to provide revenues to the local community and/or the fishermen.

3.4 Mediterranean Sea site

3.4.1 Site description

The Mediterranean Sea site is a sheltered deep water site with a depth of 16 m. The suggested site for multi-use is the Acqua Alta platform. It is a research platform held by CNR (Centro Nazionale Delle Ricerche = National Research Centre) about 12 km from the coast line of Venice.



The location of the Acqua Alta platform (Source: Google maps)

The challenge of this research platform is to combine the research activities at the existing platform with energy generating activities and offshore aquaculture. The site has moderate wind and wave energy potential, but the research platform could be combined with multiple energy converters, i.e. wind and waves. During the process was decided that a tailored Wave Energy Converter should be designed, to be installed around this platform, although the precise location is a decision variable. Next to this, there is also a potential for combining research and wave energy with the cultivation of microalgae or fish.

3.4.2 Selection of stakeholders

The stakeholders were selected by the University of Bologna (UNIBO). Stakeholders were invited to join an introduction session, organised by UNIBO, in which the MUP concept and the site were introduced. Stakeholders were invited on the basis of relevant involvement for the project (end-users, governmental agencies, suppliers, NGO's and discourse community). After the introduction session, the participating stakeholders were asked to fill in the questionnaire.

The first group of stakeholders that were selected are the potential entrepreneurs to develop the research site into a multi-use platform. These are two energy companies and an aquaculture company. Both energy companies might be interested in investing financial and human resources, if they are properly involved. The aquaculture company that has been selected is the strongest economic and political stakeholders from fish production in Venice. Second, different governmental agencies were invited to the introduction session. These parties could have a strong voice in the planning procedures. On national level, three governmental bodies were invited, a research body, an energy agency and an environmental agency. Locally, a water authority attended the meeting. On municipal level, a harbour authority and energy agency attended the introduction session. Furthermore, three private companies attended the meeting. All these parties are private consulting agencies and could be consulted during the design process. One of the consulting agencies might be interested in investing financial and human resources, if they are properly involved. Finally, two NGO's, a tourist operator and a citizens group were invited and attended the meeting.

All stakeholders attended the meeting; however from three stakeholders no questionnaire was received.

3.4.3 Goals for participation

All stakeholders were asked about their goals for participating in this MUP. The table below lists the goals that were defined in the questionnaire and the average score that was given by all the respondents.

Goals	Average
Increase employment	2.5
Explore new (export) markets	3.2
More efficient use of marine space	3.6
Improving water quality	2.4
Create social acceptance	2.4
Reduction of costs	3.2
Increase of biodiversity	2.5
Increase cooperation between stakeholders	3.6
Profit maximisation	2.5
More efficient use of energy	3.9
Reduce negative impacts on the ecosystem	3.0
Continuation of my firm on the long term	2.9
Combining production and nature values	3.8

People

The involvement of stakeholders in the design process of the MUP may lead to increased cooperation between the stakeholders. In the list above can be found that the stakeholders find the goal of increasing the cooperation between stakeholders important for participating in the MUP. The stakeholders mentioned that the project seems to be interesting as a socio-economic lab to integrate private and public institutions in order to use marine resources in a conscious and responsible way, in a long run perspective preserving the ecosystem.

Planet

All stakeholders focus strongly on the environmental goals as most important goals in the development of the MUP. The participants see a MUP as a method to make more efficient use of energy. All participants want to increase a better combination of production and nature values in order to make more efficient use of marine space. At the moment, Italy has no national maritime spatial plan. One NGO mentioned that they favour an integrated plan of marine areas within the maritime spatial planning. Two stakeholders mentioned that they are worried about the environmental impacts of the combination of energy generation and aquaculture at sea.

Profit

Both energy companies and a technical consultant have strong economic goals for participating in a MUP. The energy companies designed a wave energy generating prototype which they would like to test on the site. Both see potential in combining these activities with aquaculture. The most important goals mentioned by these stakeholders are exploring new markets and reduction of costs. Wave energy is a new market in Italy in which both the invited energy companies see potential and in which they would like to invest.

3.4.4 Prerequisites for participation

All stakeholders were asked about the importance of the listed prerequisites for their decision to participate in a MUP. The table below lists the prerequisites that were defined in the questionnaire and the average score that was given by all the respondents.

Prerequisites	Average
Access to education facilities/skilled people	3.9
Uniformity in procedures	2.8
Trust between stakeholders	3.2
License to produce	2.4
Clear roles	3.7
Financially attractive arrangements	3.3
Participation of supply companies	2.9
Multidisciplinary cooperation	4.2
Enough space for production	2.5
Faster licensing	2.0
Stakeholder participation	3.6
Improve companies image	3.3
Sustainable management plans	4.1
External communication	3.3

Multidisciplinary cooperation

Multidisciplinary cooperation is seen as the most important prerequisites for almost all stakeholders. They mentioned that a MUP design is a complex and multidisciplinary work, involving economic, scientific and technical issues in a long-run perspective. This implies that cooperation between (direct and indirect/institutional) stakeholders is essential, in order to identify a harmonic strategy for the public welfare. A well-known scientific and independent institution could favour these strategic choices.

Sustainable management plans
Many stakeholders are worried about the uncertainty of the ecological effects of the MUP. To encounter these uncertainties, a sustainable management plan should be developed.

Access to education facilities/skilled people
A MUP design is seen as a complex and multidisciplinary work involving skilled people from different backgrounds. The prototype development implies the involvement of skilled people, with an overall increase in technical knowledge.

Clear roles
In order to successfully involve all stakeholders, the roles in the process must be clear from the start. Not only the role of the investors must be made clear, also the role of non-governmental organizations and the citizen group must be made clear from the start.

Stakeholder participation
Stakeholder participation is mentioned as a prerequisite by almost all stakeholders. Stakeholders should be involved during the whole process. Correct behaviour between stakeholders is mentioned as a separate prerequisite in stakeholder involvement.

Financially attractive arrangements
Especially the energy companies and the technical consultant mentioned economic prerequisites for participation. They favour financially attractive arrangements to execute the plans.

Other
It is mentioned that the site location should not be fixed in advance. Since contrasting interests are involved and affected by location, stakeholders said that location should not be fixed in advance, but it should be something to bargain.

3.4.5 Obstacles for participation

All stakeholders were asked about the importance of the listed obstacles for their decision to participate in a MUP. The table below lists the obstacles stakeholders could encounter when participating in the MUP and the average score that was given by all the respondents.

Obstacles	Average
Availability personnel	3.4
Government regulation	3.3
Lacking knowledge	3.6
Distrust between stakeholders	3.5
Unpredicted costs	3.8
Short or long term permits	3.3
Unclear roles between stakeholders	3.6
Negative press	3.4
Time investment	3.2
Increase insurance premiums	2.9
Larger risks	3.3

Unpredicted costs

Unpredicted costs are seen as an important obstacle that could be encountered during the MUP design. A financial plan could be developed and should take into account cost variability (material costs, insurance, and investment costs) to reduce the negative impact of unpredicted costs on the MUP development.

Lacking knowledge

Some stakeholders have doubts about the selected site. However, knowledge is absent on potential conflicts with other projects, for example the offshore port that is planned before the coast of Venice for Asian ships. Additional information on potential conflicts with naturalistic areas, fishery activities or tourism activities is lacking, apart from the conservation of an interesting ecological area. New and different fishery activities could be detrimental to biodiversity as well as to the current fishery sector. Attention is needed for the potential conflicts around the site before they become an obstacle.

Minimise environmental impacts is important to all stakeholders. Attention should be paid to direct and indirect environmental impacts. Knowledge is lacking on how many trips will be done and how large the boats will be that will be used daily to feed and transport the fish, apart from other trips related to multiple uses. The pollution impact from feeding fish (once a week) should be taken into account as well. Fish feeding could lead to water eutrophication; however knowledge about this potential impact is absent. As an experimental project MERMAID could be useful, but to what dimension will this project be replicable without negative environmental impacts being larger than the benefits.

Unpredicted outcomes could depend on several factors: size of the unpredicted impacts, the timing of the impact and the reversibility of activities performed up to the unpredicted event. Impacts of these events could be mitigated by paying attention to uncertainties in designing the MUP and by improving flexibility in implementing the MUP.

Unclear roles and distrust between the stakeholders

Unclear roles and distrust between stakeholders are seen as obstacles during the participation process.

Availability personnel

The various stakeholders related this obstacle to the design process and not the actual realisation of the MUP. The aquaculture company is not interested in participating in this project. Main reason is that they are already involved in other project and do not have the human and financial resources available to invest in more projects. Other stakeholders mentioned as well that they might not have enough staff available to work on the design of the MUP.

Government regulations/short or long term permits
Energy companies are worried about the permits that are needed to conduct their activities. At the moment there are not sufficient permits are available to conduct the activity on the platform.

Other
One of the stakeholders mentioned that the choice of the study site must be justified as it seems very costly and far away.

In the coming years, an off shore port will be built before the coast of Venice for Asian ships. This port is seen as an obstacle by the stakeholders. The offshore port is located closely to the research site. Nonetheless, there are no relationships between CNR platform and the offshore port. Until a specific location has been chosen for the wave energy converter, we must consider the potential development of the offshore port in choosing the location for the wave energy converter.

3.4.6 **Conditions for the design**

The conditions for design have not been discussed with the stakeholders during the introduction session and the questionnaire. The information below is derived from the answers the stakeholders gave in the questionnaire.

Technical
The major issue raised by the stakeholders was the determination of the exact location of the MUP. The location that has been choses could be costly and is far away. Additionally, it is not clear if the chosen location may be in conflict with the planned offshore port and other activities in the area like shipping and fishing. The stakeholders argue that the site location should not be fixed in advance. Contrasting interests are involved and affected by the choice of the location. The choice of the location is something that could be taken into account during the design process.

People
The design process is important for the stakeholders. Roles must be clear during the process. Besides, stakeholders with different expertise must be involved for multidisciplinary cooperation. A MUP design is a complex and multidisciplinary work, involving economic, scientific and technical issues in a long-run perspective. This implies that cooperation between stakeholders of different expertise is essential.

Profit
The combination of wave energy with aquaculture seems difficult to accomplish as the only aquaculture company that has been interviewed does not want to participate in a MUP design process due to a lack of personnel and financial resources. To successfully develop a MUP design, another aquaculture company must be found.

Planet
The MUP should not have any negative impacts on the ecosystem. Information is lacking on the necessary amount of trips and the size of the ships that need to be used daily to feed and transport the fish, apart from other trips necessary for the MUP. Fish feeding could cause problems as it could lead to water eutrophication; however knowledge about this potential impact is absent as well.

4 Conclusions and recommendations to designers

Table 4.1 gives an overview of the stakeholder views from the four different sites. This overview can be used as input for the multi-use designs. The sections 4.1 – 4.4 below provide a more detailed text.

4.1 Input to preliminary design: Baltic Sea site

At Kriegers Flak, the combination of wind turbines and offshore aquaculture by floating fish cages with trout/salmon production is envisioned.

The main technical aspects for design that were discussed were maintenance and monitoring, anchoring and transport, and associated risks. With a combined use of marine space, not only will more ships enter the area creating higher probabilities for accidents, the combination of different technical constructions may also create new risks. Thus, a technical risk assessment of the MUP is important and guidelines and rules to minimise risks must be developed to ensure the safety of people, vessels, cages and wind turbines. Further, the entire wind farm area will be designated a cable protection area, and possibly shipping lines which today pass Kriegers Flak need to be altered.

Some of the participants state that the wind turbines should not be visible from the shore, and depending on weather conditions, the wind turbines will seldom be visible as they are planned today. The public image of wind turbines is positive in contrast to the public image of aquaculture, which is negative. However, public images may change and the stakeholders find it important to involve society in the development of MUPs to promote the concept. The stakeholders point out that there should be no negative effects on ecological conditions, and that the artificial reefs on the wind turbines foundations should be protected as they have positive ecological effects. As a consequence, fish cages should be placed at sufficient distance.

The participants differ in whether they want to participate in a MUP session and a MUP depending on the range of economic options that will be developed. How these economic options may be designed were discussed, e.g. to start with one combination (wind energy + aquaculture) and build from there, or to already from the start design for additional combinations (e.g. tourism, energy storage).

4.1.1 Conclusions Baltic Sea site

There is a high degree of knowledge about the site and the MUP concept, however alternative ways to develop a MUP were discussed; to start with a single combination and to build further from there later on, or to open up from the start for more combinations. This is also related to the willingness to invest and participate: how the economic options are designed. Entrepreneurs, discourse community and researchers are willing to participate in a MUP. The shipping authority did not want to be involved in a MUP and the energy company only wanted to participate if there are no impairments to the operation of wind farms. However, all four want to be involved in the MUP session. Technical and ecological risk assessments are crucial to manage these types of risks.

4.1.2 Recommendations for developing a design

- Execute a technical and ecological risk assessment and formulate guidelines and rules.
- Involve society.
- Explore strategies for developing a MUP in order to find alternative economic options.

4.2 Input to preliminary design: North Sea site

Regarding the conditions for design at the Gemini site in the Wadden Sea, the potential wind energy producers are very clear about the technical requirements: no hindrance of wind turbines, no obstacles for O&M operations, and preferably modular components and plug and play installations for multi-use activities. Being able to share infrastructure among energy producers and aquaculture producers (and others) to reduce O&M costs is crucial. For fishers this is in line with a process to redesign fishing vessels for multipurpose activities in order for the sector to become more sustainable. Further, the shellfish sector is looking for additional fishing grounds.

It is not seen as acceptable that the development of a MUP will cause negative environmental effects. However, marine protein production in open water systems interacts with the surrounding aquatic ecosystem. The resulting effect is depending on the type of culture and the combination of different culture types. Open water finfish aquaculture is typically associated with nutrients discharge and related negative ecological effects. Possible solution is a concept known as Integrated Multi Trophic Aquaculture (IMTA), where the extractive properties of e.g. seaweed or bivalves are used to remove excess nutrients. However, at this site the water is too shallow for finfish cages, and seaweed culture has not proven itself in offshore conditions. Therefore focus should preferably be on offshore shellfish culture and some form of bottom fishing in combination with wind farms.

4.2.1 Conclusions North Sea site

Many stakeholders see the benefits in participating in a MUP. The level of knowledge in the subject is high and focus is on optimisation with regard to sharing infrastructures to reduce O&M costs and create win-win solutions. In order to create increased employment and to support the fisheries sector in its transition period to new demands on sustainability, it is important to consider their vessels, possibly redesigned, as part of an infrastructure. That is, focus is on finding profitable/economically feasible solutions for all stakeholders. However, sustainable solutions for aquaculture need to be identified as well. In order to find investors, the license procedure needs to be faster than today and uncertainties need to be minimised. Most stakeholders are willing to participate in a session for MUP designs, however depending on a clear agenda and organisation of the workshop.

4.2.2 Recommendations for developing a design

- No hindrance for wind energy companies (wind turbines, O&M operations).
- No negative environmental impact: execute environmental impact assessment.
- Focus on solutions for sharing infrastructure and identifying sustainable aquaculture solutions (identifying a business case).

4.3 Input to preliminary design: Atlantic site

The technical demands are high at this site due to the harsh sea conditions, waves up to a height of 20 m has been reported. Therefore, aquaculture as a possible activity at a MUP at this site was deemed very difficult and instead focus lay upon the possible combination of offshore wind, wave and/or tidal energy, or the combination of offshore wind energy generation with sensors to gather information on the marine environment or the combination of offshore wind with a temporal island which could be used during sports events. Regardless of use, safety and robustness of the construction is required as well as a good signalling system to avoid accidents. The stakeholders also argued that it is important to select a good site where conflicts with other interests are minimal. In general, the stakeholders argued that the MUP should be sufficiently far away from the coast (5 km was mentioned). For the Ubiarco site, there was one concern: that it is nearby the mouth of the Rio Saja River with its present port.

The participants found it difficult to visualise a MUP, but some ideas were single wind turbines with aquaculture cages attached to them and a floating construction on which various turbines are constructed and providing space for other uses.

It was found important that a MUP should not cause negative impacts on the local fishing community, but instead that a MUP could be a way of provide revenues to both the local fishing community as well as the local community in general. However, it was envisaged that it would be difficult to attract sufficient funds. Negative impacts on the ecosystem were not of large concern, perhaps since aquaculture was seen as difficult to implement.

4.3.1 Conclusions Atlantic site

The safety and robustness of a challenging technical construction combining wind and wave/tidal energy production is at the heart of the Atlantic Sea site. Offshore aquaculture is not seen as realistic; however a temporal island for sports events was suggested, but regardless, a good signalling system for sea vessels is crucial. The MUP must be located sufficiently far away from the coast. Funding may be difficult and clear profit must be shown to the local community and fishers. The interviewed stakeholders are willing to participate in the participatory design process, but struggle to see how they can participate in a MUP.

4.3.2 Recommendations for developing a design

- Try to find multi-use combinations that can stand harsh conditions.
- A safe and robust construction is required.
- No negative impacts on local fishing community.
- Focus on potential benefits so that all stakeholders can see possibilities.

4.4 Input to preliminary design: Mediterranean site

Input to a preliminary design was not explicitly discussed with the stakeholders at the Mediterranean site. However, the stakeholders were very concerned about the location of a MUP, and that this should be thoroughly investigated as a part of a design process. Potential conflicts with a planned offshore port and other activities as well as high costs associated with the large distance to the shore, were issues that were highlighted.

A multidisciplinary cooperation was found critical for the design process, and as a combination of wave and wind energy and aquaculture is aimed at, a new aquaculture stakeholder who is willing to participate must be identified. There are large concerns about negative impacts on the ecosystem, and all in all, the discussion is characterised by a large degree of uncertainty about costs and environmental effects.

4.4.1 Conclusions Mediterranean site

There is a high degree of uncertainty among the stakeholders about site location, environmental effects and economic and social impacts. A multidisciplinary cooperation was found critical for the design process, and as a combination of wave and wind energy and aquaculture is aimed at, a new aquaculture stakeholder who is willing to participate must be identified. The stakeholders are in general positive to participate in a MUP but more reluctant to join a session for participating in a MUP. The participating energy companies are willing to invest in wave energy.

4.4.2 Recommendations for developing a design

- Discuss the location with the stakeholders
- Focus on the site selection procedure: involve multiple stakeholders
- Focus on analysing possible environmental effects: execute an environmental impact assessment.

Table 4.1. Summary of input to preliminary design

	Baltic Sea site: Kriegers Flak	**North Sea site: Gemini**	**Atlantic Sea site: Ubiarco**	**Mediterranean Sea site: Acqua Alta**
Site conditions	Strong and uniform winds. Water depth 17-40 m, 30-40 km offshore, stable seabed.	Active morphology. Water depth 30-40 m, 85 km offshore.	Harsh wave conditions, deep sea > 100 m (narrow continental shelf).	Moderate wind and wave conditions. Sheltered water, depth 16 m, 12 km off the coast.
Potential MUP activities	Wind farm and offshore aquaculture. Wind turbines and floating fish cages with trout/salmon production. Future possibilities: tourism and energy storage.	Wind farm, offshore shellfish aquaculture, fisheries and tourism.	Three floating wind turbines and three wave energy concepts, meteorological mast. Offshore aquaculture seems very difficult. Addition: temporal island to be used during sports events.	Existing research platform. Tailored Wave Energy Converter designed and installed around platform. Potential for combining research and wave energy with offshore microalgae or fish aquaculture
Technical aspects	Maintenance and monitoring, anchoring and transport, and associated risks. Technical risk assessment.	No hindrance of wind turbines, no obstacles for O&M activities. Modular components, plug & play installations. Co-use of infrastructure to reduce O&M costs. Technical requirements for fishing boats. Many unknown technical & biological requirements for offshore aquaculture	Difficult site conditions. Safety and robustness very important as well as a good signalling system for sea vessels.	
Ecological aspects	Must be no negative impact on the ecological conditions. Foundations of wind turbines possibly positive effects (reef formation). Place fish farms at enough distance to protect artificial reefs.	Not acceptable that MUP has a detrimental effect on existing ecosystems. Focus in MERMAID: offshore shellfish and bottom fishing due to shallow water.	Not expected to give a negative impact on the ecosystem.	Should not have any negative impacts. Lack of information regarding necessary amounts of trips, size of ships, and possible eutrophication due to fish feeding.
Socio-economic aspects	Should not be any effects on landscape views from the shore. Involve society.	Reduction of O&M important. Combination of fishing, O&M, tourism if possible. Additional fishing grounds for shell-fish sector.	Site selection to avoid interference with other activities. Revenues to local community and fishermen.	Site selection. No interference with other activities. Important to find new active aquaculture stakeholder. Lack of information regarding necessary amounts of trips.
Other aspects	How should the development proceed? Open for future options?		At least 5 km off the coast which means a water depth of 400 – 1,000 m.	High concern about negative environmental impact.

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Appendix 1. Questionnaire

MERMAID Questionnaire: feasibility of large scale offshore (wind)energy and aquaculture

General information

For many years there is an on-going discussion about the feasibility of combining large-scale offshore (wind)energy & aquaculture (fish farming, shellfish cultures as well as seaweed cultures). Already various knowledge driven offshore concepts have been designed, however proven seaworthy installations haven't been tested yet in practise. For different coastal areas in Europe there are already plans for (wind)energy parks and many stakeholders are in favour of combining these plans with marine production. We are looking for drivers of these plans and stakeholders that are involved or willing to be involved in the designs so that it can be further developed together with the end users.

In various countries, there a number of on-going research projects with the focus on multi-use platforms (MUP). One of them is MERMAID, which is a EU project (2012-2015). In this project EU public-private partners are studying the MUP possibilities for different locations; Baltic sea, North Sea, Gulf of Biscay and the Mediterranean Sea. The research question is: *to investigate existing and new designs to shift from single (wind)energy use towards multi-use combining it with aquaculture*.

Within MERMAID, various aspects will be studied such as: ecosystem impact, technical feasibility of new designs, logistics and social-economic prospects. Within MERMAID, a stakeholder approach and participation is essential in the design process. For this, protocols have already been designed. The first step in the stakeholder approach is visiting relevant companies, ministries and NGO's, who are asked to fill out a MUP questionnaire. After collecting all questionnaires, a participative design workshop will be planned and the relevant stakeholders will be invited to participate in this process. During the MERMAID project the participative design process will also be evaluated. More information can be found on the website: http://www.mermaidproject.eu/

We would like to ask you to fill in the questionnaire below.

Questionnaire
Organisation:
Name stakeholder:
Date:
Do you give permission to use your name/companies name in the report? Yes / No

Please answer the questions in this questionnaire. Could you indicate for each answer how important the answer is for you? Please circle the correct answer. You can use the numbers for more than 1 answer, as long as they are of the same importance. When no answers are circled, this answer is not relevant for organization.
5: most important
4: very important
3: important
2: neutral
1: not important
0: least important

Would you like to participate in a MUP? Yes / No Why (not)?
……
……
……
Would you like to join in a session for participating in a MUP?
……
……
……
How important are the following goals for you in order to participate in a multi-use platform (MUP)??

- Increase employment	0	1	2	3	4	5
- Explore new (export) markets	0	1	2	3	4	5
- More efficient use of space	0	1	2	3	4	5
- Improving water quality	0	1	2	3	4	5
- Create social acceptance	0	1	2	3	4	5
- Reduction of costs	0	1	2	3	4	5
- Increase of biodiversity	0	1	2	3	4	5
- Increase cooperation between stakeholders	0	1	2	3	4	5
- Profit maximisation	0	1	2	3	4	5
- More efficient use of energy	0	1	2	3	4	5
- Reduce negative impacts on the ecosystem	0	1	2	3	4	5
- Continuation of my firm on the long term	0	1	2	3	4	5
- Better combination production & nature values	0	1	2	3	4	5
- I don’t know	0	1	2	3	4	5
- Other: ……	0	1	2	3	4	5
- Other: ……	0	1	2	3	4	5
- Other: ……	0	1	2	3	4	5

Space for notes:

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How important are the following prerequisites for you in order to participate in a MUP?

- Access to education facilities/skilled people	0	1	2	3	4	5
- Uniformity in procedures	0	1	2	3	4	5
- Trust between stakeholders	0	1	2	3	4	5
- License to produce	0	1	2	3	4	5
- Clear roles	0	1	2	3	4	5
- Financially attractive arrangements	0	1	2	3	4	5
- Participation of supply companies	0	1	2	3	4	5
- Multidisciplinary cooperation	0	1	2	3	4	5
- Enough space for production	0	1	2	3	4	5
- Faster licensing	0	1	2	3	4	5
- Stakeholder participation	0	1	2	3	4	5
- Improve companies image	0	1	2	3	4	5
- Sustainable management plans	0	1	2	3	4	5
- External communication	0	1	2	3	4	5
- I don’t know	0	1	2	3	4	5
- Other: ……	0	1	2	3	4	5
- Other: ……	0	1	2	3	4	5
- Other: ……	0	1	2	3	4	5

Space for notes:

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Below, we wrote down a list of obstacles people could encounter when participating in a MUP. How important are these for you before you decide to participate in a MUP?

- Availability personnel	0	1	2	3	4	5
- Government regulation	0	1	2	3	4	5
- Lacking knowledge	0	1	2	3	4	5
- Distrust between stakeholders	0	1	2	3	4	5
- Unpredicted costs	0	1	2	3	4	5
- Short or long term permits	0	1	2	3	4	5
- Unclear roles between stakeholders	0	1	2	3	4	5
- Negative press	0	1	2	3	4	5
- Time investment	0	1	2	3	4	5
- Increase insurance premiums	0	1	2	3	4	5
- Larger risks	0	1	2	3	4	5
- I don’t know	0	1	2	3	4	5
- Other: ……	0	1	2	3	4	5
- Other: ……	0	1	2	3	4	5
- Other: ……	0	1	2	3	4	5

Space for notes:

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……
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Can you describe how you see the design of the MUP?

……
……
……

How important do you think it is to involve stakeholders in the process? (circle the answer)

0 1 2 3 4 5

……
……
……

What technical characteristics does the design of the platform need to have for your organization?

……
……
……

What ecological characteristics does the design of the platform need to have for your organization?

……
……
……

What socio-economic characteristics does the design of the platform need to have for your organization?

……
……
……

When reading the information above, how big do you think the chance will be that MUPs will be realized within 5 years? (please give a percentage)

……%

……
……
……

How big do you assess the chance that your organization will play a role in it? (please give a percentage)

……% why this percentage?

……
……
……

How will your organization play a role in the MUP?

……
……
……