Justification Report Template (Maximum 2 pages)

1. **Combination:** Aquaculture and Wind fixed (Offshore wind fixed means large turbines (>5MW) in wind farms (>300MW)).
2. **Basin selected**: Baltic (including North Sea)
   Engaged – Commercial readiness level 3 and/or potential to move to pilot in 2-5 years

3. Description

3.1 Technical

There are three potential synergies between aquaculture and offshore wind farms with fixed foundations:

1. Aquaculture and wind farms work independently but share the same space. Renewable energy generation will dominate this combination with aquaculture is considered as a secondary use of the wind farm location and structures. The wind turbines provide an element of shelter for the aquaculture unit (protected from shipping and fisheries). The wind turbines could serve as tethering points for the aquaculture installations, provided they do not prevent access to the turbines but the spaces in between the turbines are most attractive for farming purposes. The wind farm could offer telecommunication to shore from what aquaculture operations could benefit. Main technical interest lies in the potential to combine infrastructure and logistics (Operation and Maintenance) such as support vessels, inspections, supply vessels etc. O&M costs are very high in wind parks, above all O&M is very inefficient in terms of a lack of continuous activities. Combining the O&M efforts with other activities (both aquaculture and fisheries) make this more cost efficient.
2. The wind infrastructure could be used for extensive aquaculture; e.g. harvest of shellfish from the wind turbines. This enables operation and maintenance of the structures (cleaning) to be performed with a cost return. Wind park infrastructures require to be adapted for this (no anti fowling), and commercially attractive mild cleaning procedures.
3. A small wind turbine, equivalent to the power required by an aquaculture farm, is installed specifically to provide energy supply to the aquaculture farm.

Fixed foundation offshore wind is an established sector in the North Sea and the Baltic, with several wind farms build over the past decade (by DONG Energy, EDF Energy and Vattenfall, Shell, NUON, Eneco, and many others mainly in consortia of companies). The possibility of combining (bivalve) aquaculture in or around wind parks was identified as worthy to be explored in several projects (MERMAID 2013, COEXIST 2011) and has received significant attention over the past decade (e.g. Buck et al 2004, Lagerveld et al 2014, Benassai et al 2014, Gimpel et al 2015). Until now the offshore wind sector has been reluctant to allow other activities within the boundaries of their wind farms and the search for combining functions is mostly driven by policy makers and the research community, but this attitude seems to be changing (Lagerveld et al 2014). Several initiatives for pilot scale offshore mussel culture have been established over the past decade (see overview in Kamermans et al. 2011), but technical feasibility at commercial scale still needs to be proven. Such initiatives are encouraged by the Dutch government, giving new licences for wind farms only when the co-use of space is being explored, thereby creating an incentive for multi-use. This example could be explored as a case/pilot study for the Baltic/North Sea region.

3.2 Socio-economic

According to the recently adopted Operational Programmes Denmark, Estonia, Germany and Sweden plan to support environmentally sustainable, resource efficient, innovative, competitive and knowledge based aquaculture with €157.60 million in the period 2014-2020. Aquaculture is considered as an opportunity in the Baltic and in the North Sea region to create jobs and provide more seafood products. Although demand for seafood products is also growing for this region, growth of aquaculture has halted and even turned to a decline. Environmental constrains in offshore areas mean that to realize an increase in production the aquaculture is searching for alternative offshore areas. At the same time aquaculture needs to develop in a sustainable manner. At the moment, severe eutrophication (=high nutrient input) of the Baltic Sea is a major reason for aquaculture not being able to grow in the region, and the sector should adopt sustainable culture measures (e.g. Integrated MultiTrophic Aquaculture), and/or focus on low nutrient emission cultures (bivalves or seaweeds) (AQUABEST project). There is high wind resource in the Baltic and therefore the energy supply of these offshore aquaculture farms can be provided by wind energy.

3.3 Environmental

The combination of activities is unlikely to add any new environmental impact to those already associated with both industries separately.
Aquaculture in offshore, and thus high dynamic environments, with high flushing rates results in less (local) environmental impact. This will release the pressure on (vulnerable) coastal areas. Given the eutrophied status of the Baltic Sea, responsible, low nutrient emission aquaculture should be developed. Both wind and aquaculture farms may serve as habitat for invertebrates or refuges for (juvenile) fish, positively affecting biodiversity and environmental productivity.

3.4 Financial

The demand for renewable energy is high and still growing in the regions. Investments in the matured green energy industry are viable.
Moving offshore increases the distance that support vessels must travel to reach the aquaculture site, and the cost of labour may increase as managing offshore vessel and equipment requires skilled employees. On the positive side, synergies are expected from combined operations and maintenance between aquaculture and wind energy (Michler-Cieluch, Krause, and Buck 2009), as described under section 3.1.

4. Multi-use platform concept

The two technical descriptions above can be considered as:

1. A multi-use of space. Where the offshore wind farm is predominantly driving the combination.
2. A multi use platform. Where aquaculture is predominantly driving the combination.

5. Key threats/challenges to be solved

Potential conflicts may arise by combining offshore wind and aquaculture. Perhaps the most important criterion for successful multi-use development is which risks arising from combined activities are minimal in relation to the benefits. The risks/conflicts:

- Risk for damage of wind turbines from loose aquaculture ‘items’ after storm events

- Risk of damage to wind turbines and cables due to vessel anchoring (potential to reduce risk by application of safety wires to aquaculture infrastructure)
- Risk of fouling and corrosion of wind turbines due to fouling
- Operational/logistical problems caused by the combinations are unknown (e.g. does aquaculture hamper access to the wind turbines especially for large component replacement)
- High investment costs (e.g. extra anchors etc)
- Impacts insurance opportunities and costs involved
- Safety concerns of workers

6. Costumer/societal problem that can be solved by combining the sector

- More efficient use of maritime space
- Reducing pressure on (vulnerable) coastal ecosystems
- Stimulating aquaculture production leading to more job opportunities and seafood products