 **MARIBE** Final Presentation
Marine Investment for the Blue Economy 31 August 2016

*Fixed Offshore Wind and Aquaculture in
the North Sea*



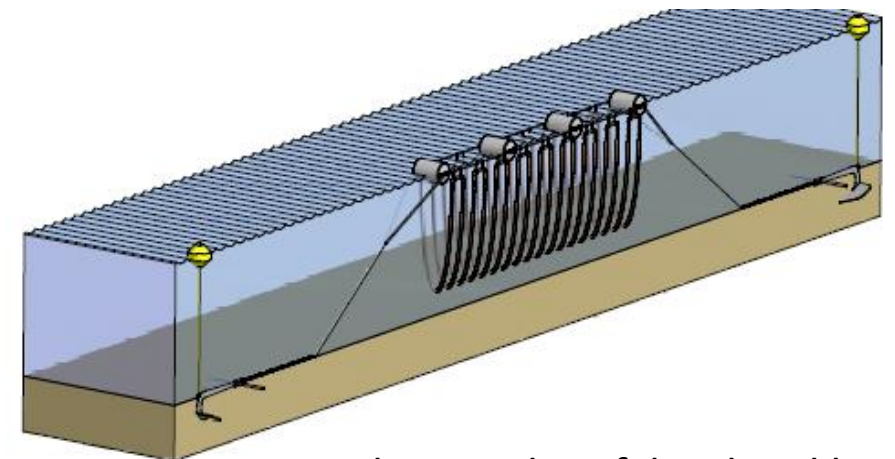
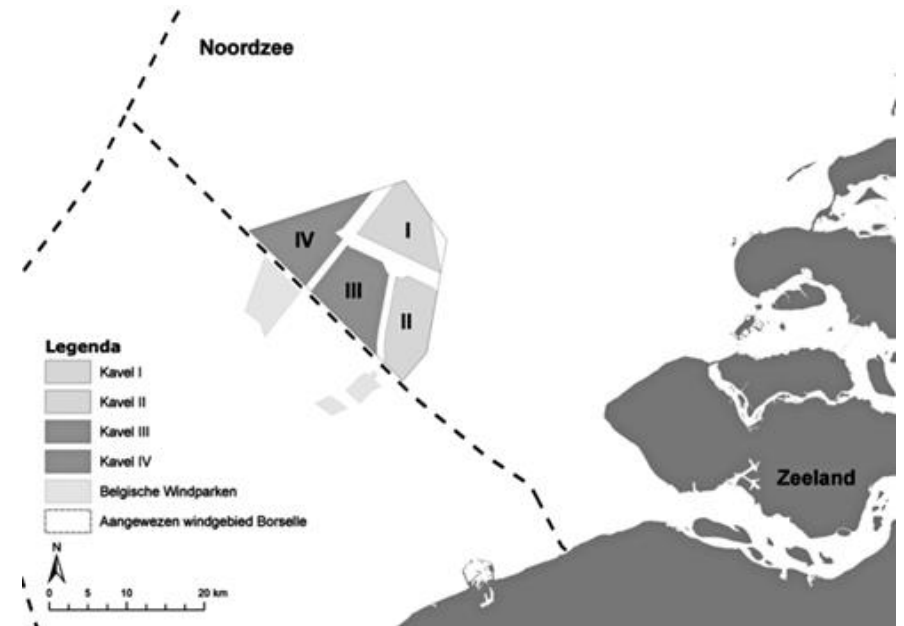
Description of project

- Project combines offshore wind and mussel aquaculture for a multi-use of space
- Site area of 344 km² in total, 22-38 km off the coast, close to ports of Vlissingen and Zeebrugge
- Water depth between 15m and 35m
- Double long lines (continuous) attached to anchors
- Annual production target for mussels: 5.5 million kg of mussel seed, 4 million kg juveniles, 2.8 million kg consumption mussels
- Number of production systems 464 (270 seed, 116 juvenile, 77 consumption)
- Minimum required area 152 ha (1.5 km²)



System characteristics

- Based on the mussel seed collection system deployed in the Wadden Sea
- 6400 m longlines
- Productivity 2.93 kg/m
- 3 ha per unit
- 3 harvesting moments
 - Mussel seed (month 6)
 - Half-grown (month 12)
 - Consumption size (month 1809)



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Commercial Activity

- **TRL 9 - Commercial Phase**

- Wind park 49,5 km², mussel seed aquaculture 235 ha.
- Located 22-38km off the coast of Netherlands and Belgium.
- Wind park with 380 MW installed capacity using 4 to 10 MW turbines.
- Aquaculture output of 5.5 million kg mussel seed.
- Wind turbines and Aquaculture system to be installed by a marine contractor.
- Wind turbines and Aquaculture system to be deployed in 2019.



Business Plan

- **Business model** incorporates two autonomous companies operating each sector:
 - Company A: an offshore wind project developer.
 - Company B: aquaculture company operating an aquaculture farm.
- Both **Market's** are in the Netherlands
 - Company A: sell electricity with revenue from CFD supplied by the government.
 - Company B: sell mussels with revenue from mussel markets.
- **Competition**
 - Wind Energy - DONG, SSE, Vattenfall, E.ON.
 - Aquaculture - Prins & Dingemans, Delta Mosselan, Roem van Yerske.



Value Proposition

- Wind Energy Company will have less expensive and reliable electricity due to the combination.
 - Share O&M
 - Reduce risk of other vessels entering the park
 - A more sustainable brand image due to producing renewable energy.
- Aquaculture company will have cheaper mussels because of the combination
 - A sustainable brand image will be developed from developing mussel production from a wind energy source.
 - Mussels produced will have less toxins



Channels and Customer relationships

- **Sales** channels for aquaculture company will include the **mussel auction** in Yerseke and existing wholesalers and retailers.
- For the offshore wind energy company this includes **sales to the grid** and existing electricity companies.
- New customer relationships will also be built based on **marketing of the multi-use of sea space**.
- Customer relationships will be distant for both companies
 - Company A: will be distant as electricity will have grid preference.
 - Company B: will be distant due to auctions.



Key Resources and Activities

- **Key resources** include

- Safe and reliable technologies for offshore wind and mussel production
- Suitable vessels and expertise for both sectors
- Permitted area for MUS
- Clean ecosystem for mussel production
- Grid connection for electricity



- **Key activities** include

- O&M of the wind farm and maintaining high levels of production.
- O&M of the mussel farm and harvesting mussels.
- R&D of the wind and mussel farm.



Key Partners

- Partnership **between** the wind farm operator and the mussel producer is very important.
- Other **key partners** can include:
 - Company A: Technology suppliers, customers and EWEA
 - Company B: Technology suppliers, customers and environmental agents.



Cost Structure

- **Cost structure** for both companies include:
 - Capital costs
 - Insurance expenditure.
 - Daily operations, such as mussel harvesting for Company B and wind farm monitoring for Company A.
 - Equipment
 - O&M contracts
 - Overheads



Costs – Commercial

Spend item	Spend	Unit
Project Consenting and Development to FID	71.7	€million
Project management	16.1	€million
Construction phase insurance	18.4	€million
Turbine	541.2	€million
Support structure	257.4	€million
Array cables and installation	172.6	€million
Transmission build	192.4	€million
Construction contingency	119.8	€million
Mooring and Infrastructure	59.6	€million
CAPEX	1,449.2	€million

Spend item	Spend	Unit
O&M	565.0	€million
Operating phase insurance	143.5	€million
Transmission	89.7	€million
Maintenance	4.4	€million
Harvesting costs	27.9	€million
Processing and storage	7.3	€million
Insurance	5.0	€million
Materials	17.6	€million
Environmental monitoring	2.3	€million
Management	2.2	€million
OPEX	864.8	€million
DECEX	90.9	€million



Financial Summary – Commercial

Item	Value	Unit
Project rating, FLW	380	MW
Project rating, AQ	5500	tonnes / year
CAPEX	1449	€million
OPEX	865	€million
DECEX	91	€million
Cost of finance	1991	€million
Energy generated	30405	GWh
Product produced	110000	tonnes
Electricity price sold	150.3	€/MWh
Mussel price sold	2880	€/tonne
Levelised cost, FLW	136.11	€/MWh
Levelised cost, FLW	91%	-
Levelised cost, AQ	909.67	€/tonne
Levelised cost, AQ	22.2%	-
Levelised cost, FLW AQ	88.8%	-
Simple payback	7.2	years
Discount rate or WACC	8.9%	-
Operating for	20.0	years
Payback	14.1	years
NPV (yr -4)	164.8	€million
NPV (yr 0)	252.5	€million
NPV (yr 0) / CAPEX	17%	-
IRR	10.8%	-

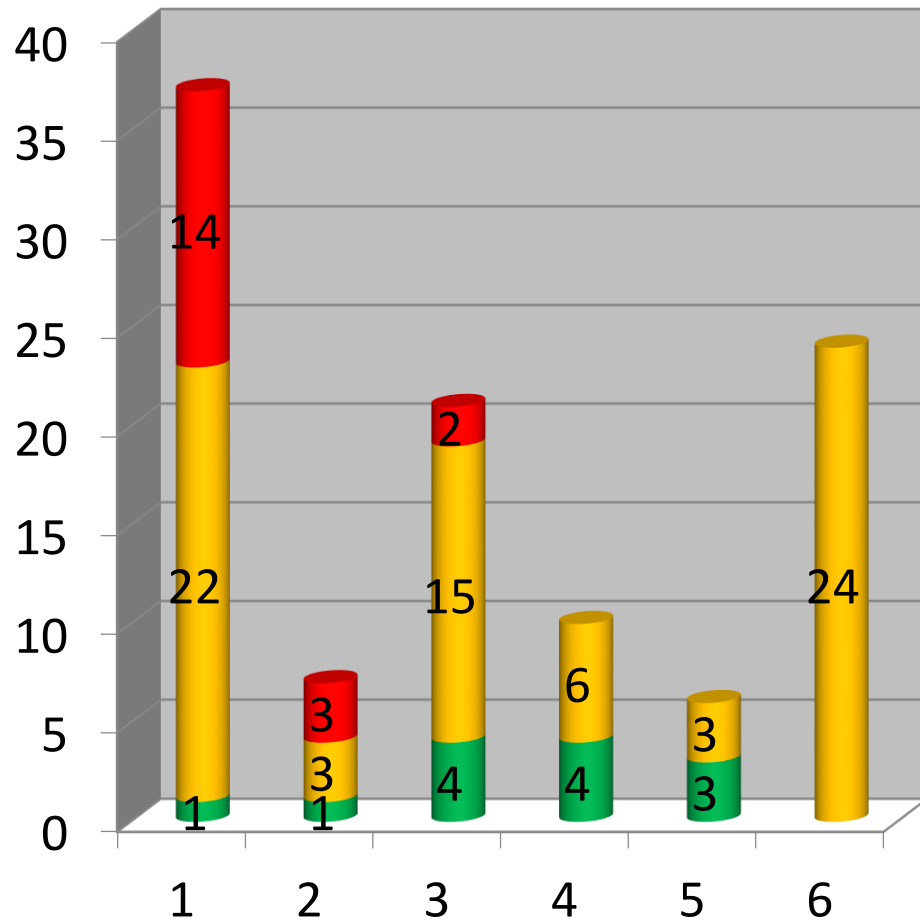
Risk Assessment

- **105 Hazards** identified under 6 categories: 1. Operation -all stages, 2. Economic & Political, 3. Financial, 4. Environment, 5. Socio-Economic, 6. Health & Safety.
- Hazards were color coded (risk matrix 1-25) depending on risk magnitude revealing **19 High** (red), **73 Medium** (orange) and **13 Low** (green).
 - Issues and causes described for each hazard, including the effect (-/+) of multiple industry and technology colocation.
 - A ranking 1-5 used to quantify Consequence and Likelihood with resultant risk magnitude for each hazard.
- Risk response strategy proposed and residual risk magnitude quantified for each hazard.
- **No High Risks** remained following risk response.

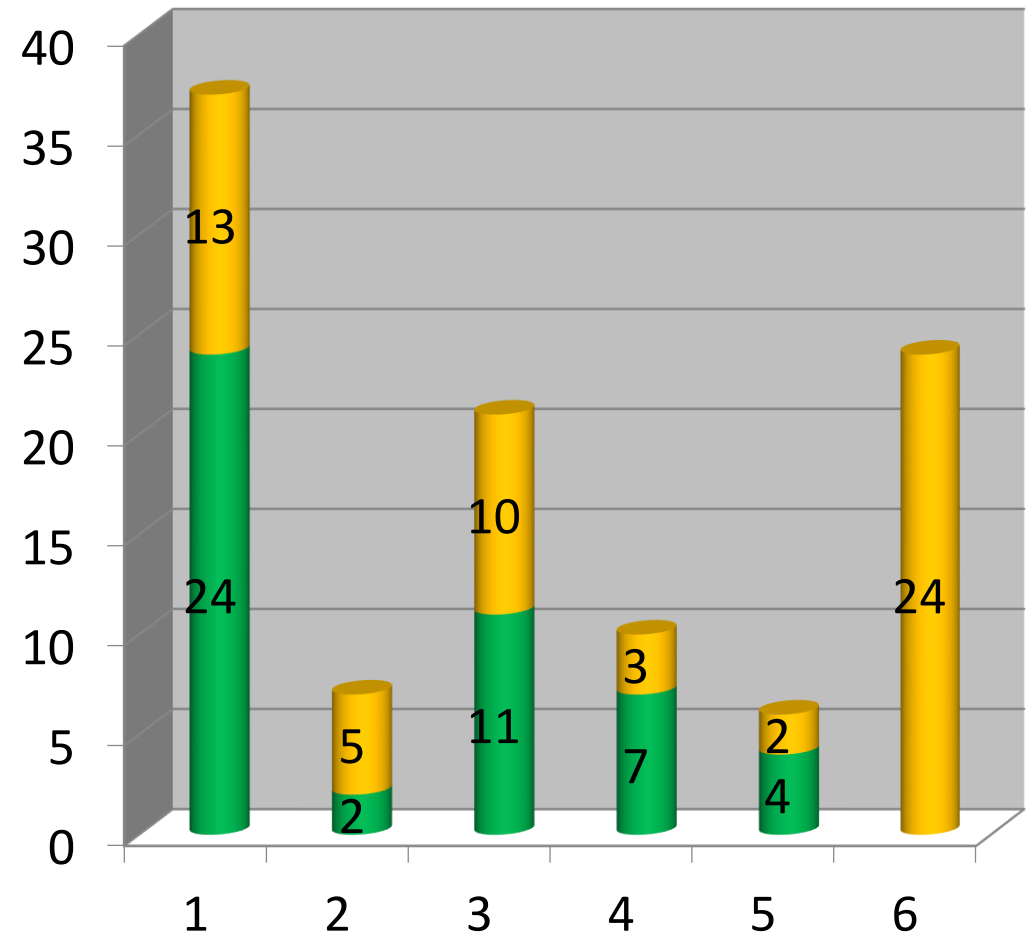


Risk Assessment

Hazards before mitigation



Hazards Residual Risk



Feedback from advisory session

- Looking at expert-rating
 - High score on technology
 - Average on financials, risk assessment
 - Low on business plan
- Looking at the comments
 - Technologically feasible, can start
 - Recognition of 'problem' of mussel sector
 - At same time: mussel sector is too small, not the capacity to pilot this combination
 - Benefits of combination are not clear, who benefits?
- How to organize this?
 - Lack of companies involved in illustrative
 - Mussel and wind sectors are really different (culture/size)
- Government obligation needed



Conclusion

- Appealing commercial model for increased returns in offshore wind farms with current support schemes
- Proven technologies, some development of mussel growing technology is needed
- Relation to existing mussel sector and infrastructure remain highly important



The synergy of multi-use of space

- Early focus on shared O&M
- Requires further investigation
 - Wave-dampening
 - Reduce illegal access to wind park
 - Positive public image
- Negative effect of fouling



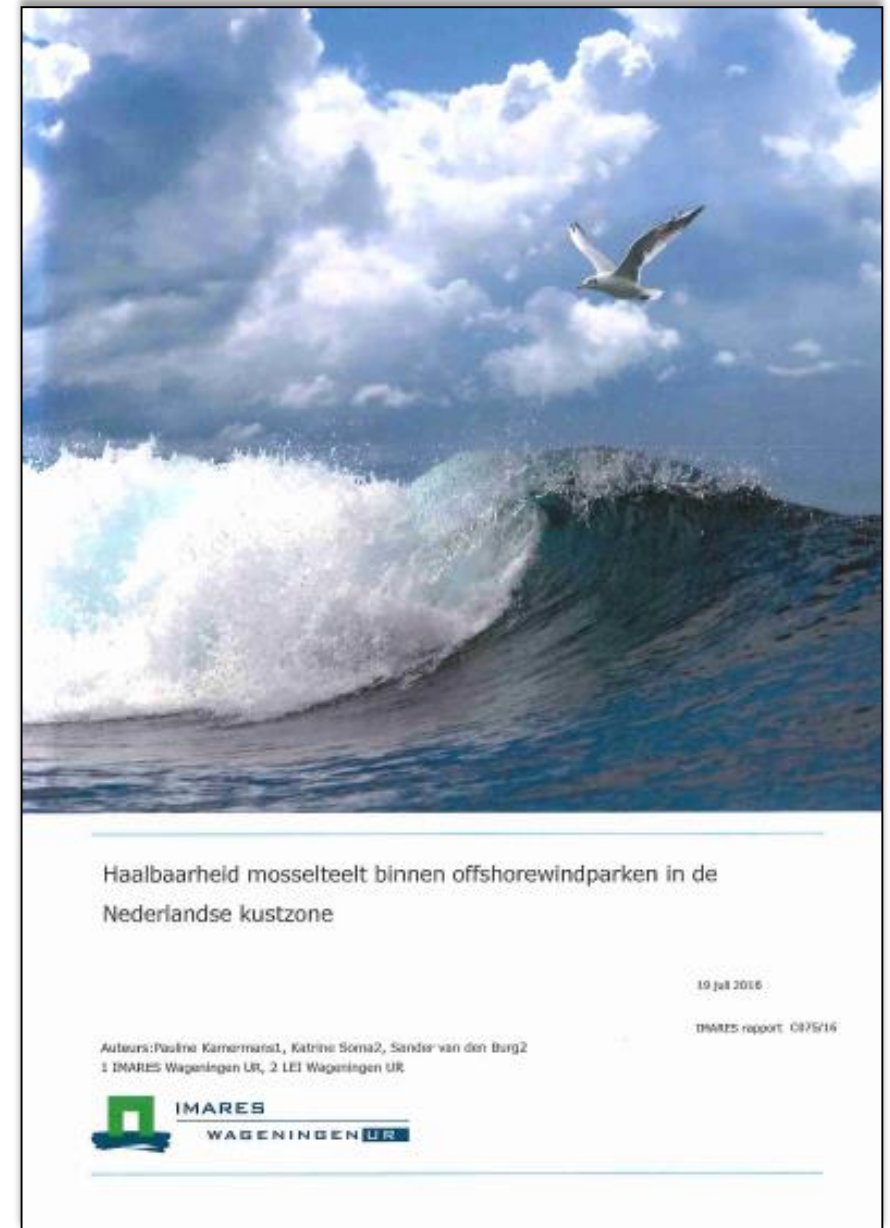
Developments in the Netherlands

- One of the Borssele tenders included offshore mussel cultivation (it didn't win)
- Protest from fishermen against restricted areas and discard ban
- Continued discussion about co-use of windparks



MARIBE in its context

- Multi-use is on the agenda of policy-makers
- Starting 2016 Government has allowed access in offshore wind parks for vessels <24m
- Research into biological feasibility of mussel cultivation in North Sea
- Contribution of MARIBE:
 - Advanced cost-benefit calculation
 - Risk assessment



Next steps

- European Maritime and Fisheries Fund (EMFF)
 - EMFF is the fund for the EU's maritime and fisheries policies for 2014-2020.
 - The total available funding available for the Netherlands is €101.5 million for the entire period.
- Horizon2020 call BG-04-2017.
 - Call is aimed at the multi-use of space within the European maritime economy.
 - Total funding available for the entire period is €8 million.
- INTERREG North Sea Region Programme 2014 – 2020 is a European regional development fund.

