Aquaculture in Offshore Wind Farms: Multi-use Concepts to Reduce Spatial Conflicts in the Marine Realm

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North Sea: Continental Shelf/Exclusive Economic Zone (EEZ)

EEZ: 28,600 km²

Baltic Sea: Continental Shelf/Exclusive Economic Zone (EEZ)

EEZ: 4,500 km²

Courtesy of the Federal Maritime and Hydrographic Agency (BSH)
What means Multi-Use“

- multifunctional use
- secondary use
- additional use
- co-use
- co-location
- trans-location
- multi-use
- offshore synergies

Leatherman
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<th>User/Infrastructure is in planning stage</th>
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<td>Renewables</td>
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<td>Shipping (26)</td>
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<td>Anchoring Areas/Roads (27)</td>
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<td>Offshore Terminals (28)</td>
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<td>Marine Missions (29)</td>
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<td>Others</td>
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<td>Pipelines &amp; Cables (30)</td>
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<td>Dumping Zones (31)</td>
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- combination possible
- combination may be possible but more information/research is needed
- combination impossible
- no decision yet/blank

Buck et al. 2017, Buck et al. 2011
Multi-Use examples to maximize a local benefit:

1. Ecosystem Protection
   - Creating MPA’s
   - Set-up of artificial reefs

2. Eco-Tourism

3. Other Energy Resources

4. Offshore-Aquaculture

5. Bio-Remediation / Bio-Extraction

6. Use of Fouling
Need for space efficiency (eminent driver in small EEZs)

Drive aquaculture to expand and move offshore → easier in combination with existing offshore infrastructures

Environmental synergies (i.e. IMTA, restauration, bioremediation)

Economic and societal benefits → synergies in operations, licensing, job creation, acceptance, etc.
OOA in Offshore Wind Farms

Economic feasibility and stakeholder conflicts
Site-Selection: Seaweed as an example

First Stage:
Gather advance information

Information of the potential sites:
- Data availability (GIS, satellite)
- Maps with geologic/geographic/bathymetric/topographic/navigational and hydrographic data (!)
- Previous usages, future plans by the local community
- Other stakeholders
- Jurisdiction and regulations (current/future use) (!)

Information of the local area (land-based):
- Accessibility from land (roads, harbour, electricity, phone cables, land-based facilities, etc.) (!)
- Experiences/educated workers available (!)
- Equipment available (spare parts, farm harness) (!)
- Subcontractors available (deployment at sea, security, harvest vessels, further processing, transport, etc.)
- Proximity to processing plants, airport, other ports, markets
- Community related support: Permit, taxation and co-finance (!)

Site-specific and oceanographic parameter:
- Current velocity, wave height, and direction (!)
- Year-round climate conditions (wind exposure, fetch, storm conditions, ice drift, etc.) (!)
- Depth and seafloor conditions (!)
- Distance from shore and tides (!)

Water quality parameter:
- Temperature, pH and salinity regime
- Oxygen/nutrient concentrations (!)
- Turbidity and attenuation
- Effects of river run-offs
- Red tides and plankton blooms
- Predators

Other important requirements:
- Potential of expansion
- Technical feasibility (!)
- Economic feasibility (!)

Second Stage:
Environmental baseline, assessment and monitoring

Third Stage:
Other emerging issues

First sites selected
Selected sites reduced
Final site selected

Buck & Grote (submitted)
Springer
Courtesy of Vanessa Stelzenmüller – Thünen Institute Germany
He et al. 2015 modified in Buck et al 2017, Buck et al. 2010

100 units 10 MW WTS
16 groups of fish cages

Offshore substation, 66 kV / 220 kV

Array cables
Export cables

8 mussel culture systems
18 seaweed culture systems

Onshore substation
Potential approval procedure of multi-use offshore installations (here exemplified by offshore wind farm and offshore aquaculture) in the German EEZ according to the Marine Facilities Ordinance.
MUSES
Multi-Use in European Seas
Aquaculture Perspective of Multi-Use Sites in the Open Ocean

The Untapped Potential for Marine Resources in the Anthropocene

Editors: Buck, Bela H., Langan, Richard (Eds.)

The first-of-its-kind compilation that comprehensively explores the scientific, engineering, economic and policy aspects of marine aquaculture multi-use of offshore platforms

A timely analysis of the rapid development of offshore energy production platforms and the massive projected global seafood deficit

Individual chapters written contemporaneously with EU “Oceans of Tomorrow” developments as well as proposals by the Food and Agriculture Organization (FAO), authored by highly-respected, international experts in the field
Future Multi-Use Scenarios:

- Do not reinvent the wheel
- Follow guidelines defined by the FAO, OSPAR, ICES, etc.
- Foster cooperation with experts within the EU + X
- Develop innovative technologies to allow co-use concepts
- Set-up an inter. offshore test facility
Thank you for your attention!