

Wave-Powered Aquaculture Farm: Sustainable Source of Food and Power

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This work presents an initial WPAF design and could be a starting point to bring together fish and wave energy stakeholders to enable this promising sustainable source of food and power.

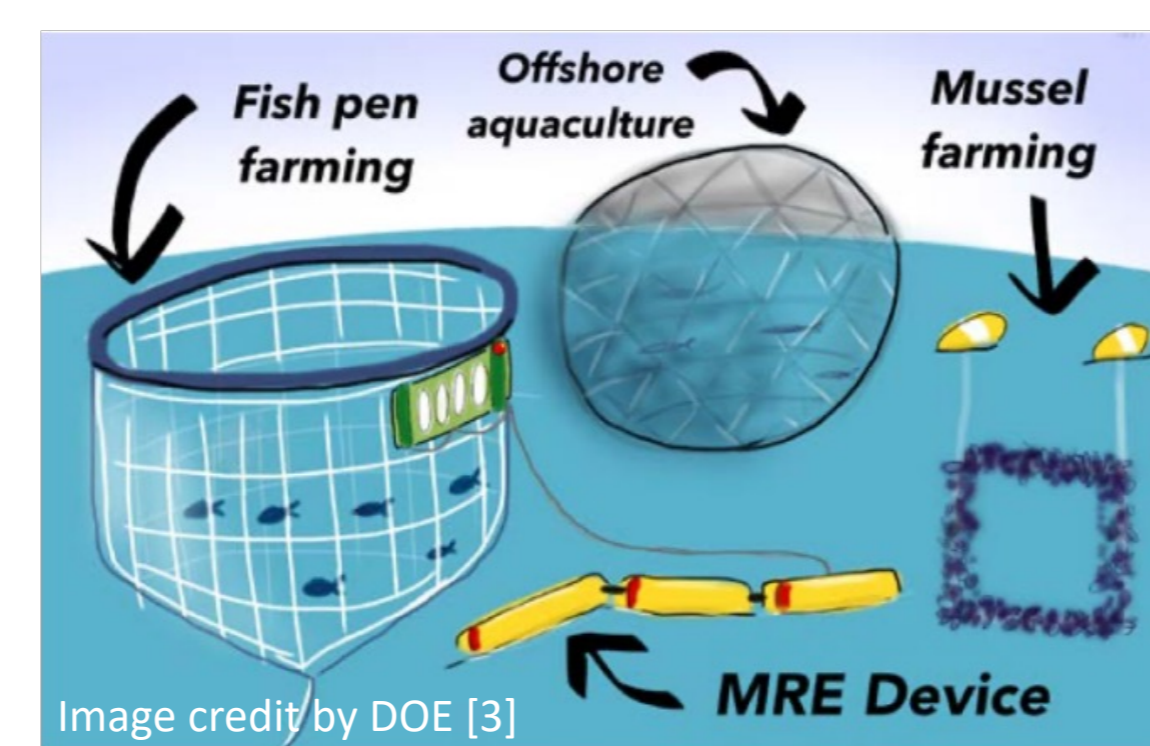
Introduction

As the world's population continues to grow, both onshore and offshore **aquaculture** will be key for adequate **sustainable food supplies** [1].

Why offshore? competition for near-shore space and environmental considerations [2].

Current energy need of aquaculture-for feeding, cleaning, lighting, and sensors - is supplied by diesel generator, while there is a high potential for ocean renewable energy, especially wave energy, in the US [3].

Our goal is to **supply an aquaculture farm with sustainable wave power and design a wave-powered aquaculture farm (WPAF)**.



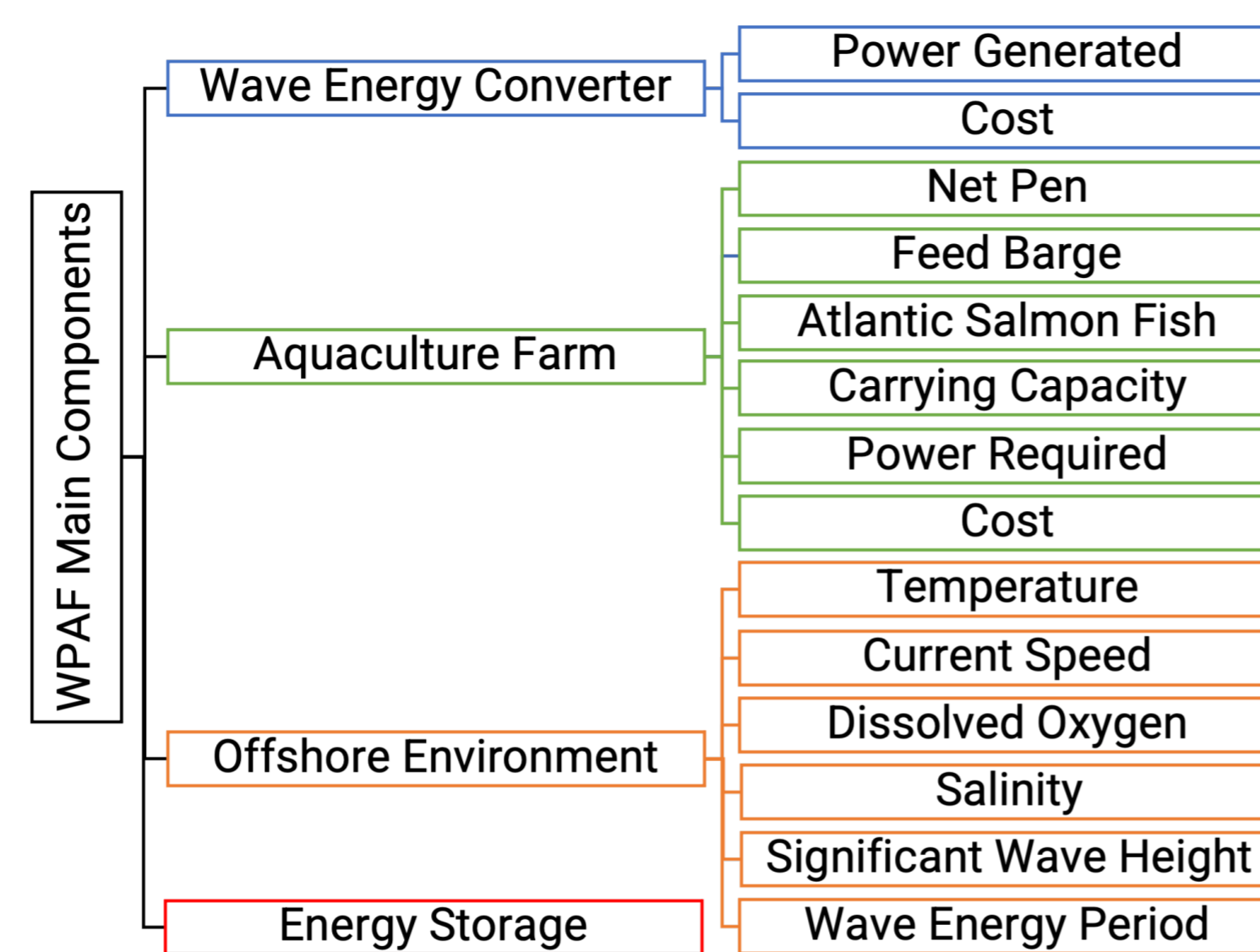
Model and Main Components

To design the WPAF, we consider energy, cost, and environmental models.

This WPAF is initially designed for growing Atlantic salmon with a specific deployment location in the Gulf of Maine.

The main components in the WPAF are wave energy converters (WECs), aquaculture net pens and feed barges, and energy storage

To compensate for wave power variability and ensure a reliable source of power for the aquaculture farm, energy storage is required.



We optimize the size of the wave energy converter (WEC) and energy storage for a medium aquaculture farm to minimize the cost-per-fish yield.

RESULTS

The components of the WPAF are optimized for a sample deployment location in the Gulf of Maine (i) no conflict with other offshore activities, (ii) environmentally suitable for Atlantic Salmon fish. Initial results are presented as a representative WPAF, while presenting the best design needs further research.

Net pen
 Cylindrical submersible net pen, 12 net pens, 30 m diameter, 15 m height, 20 kg-fish/m³ harvest stocking density, total fish yield of 2,545 tonnes

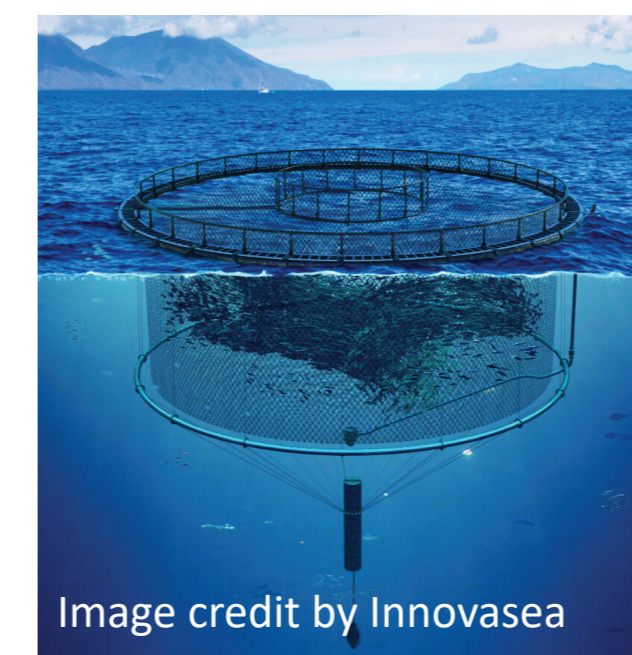


Image credit by Innovasea



Image credit by SCALEAQ

Feed barge
 3 feed barges Bow 200 designed by SCALEAQ
 Up to 6 feeding lines
 200 tones capacity

Energy storage
 2 battery banks
 Total size of 380 kWh



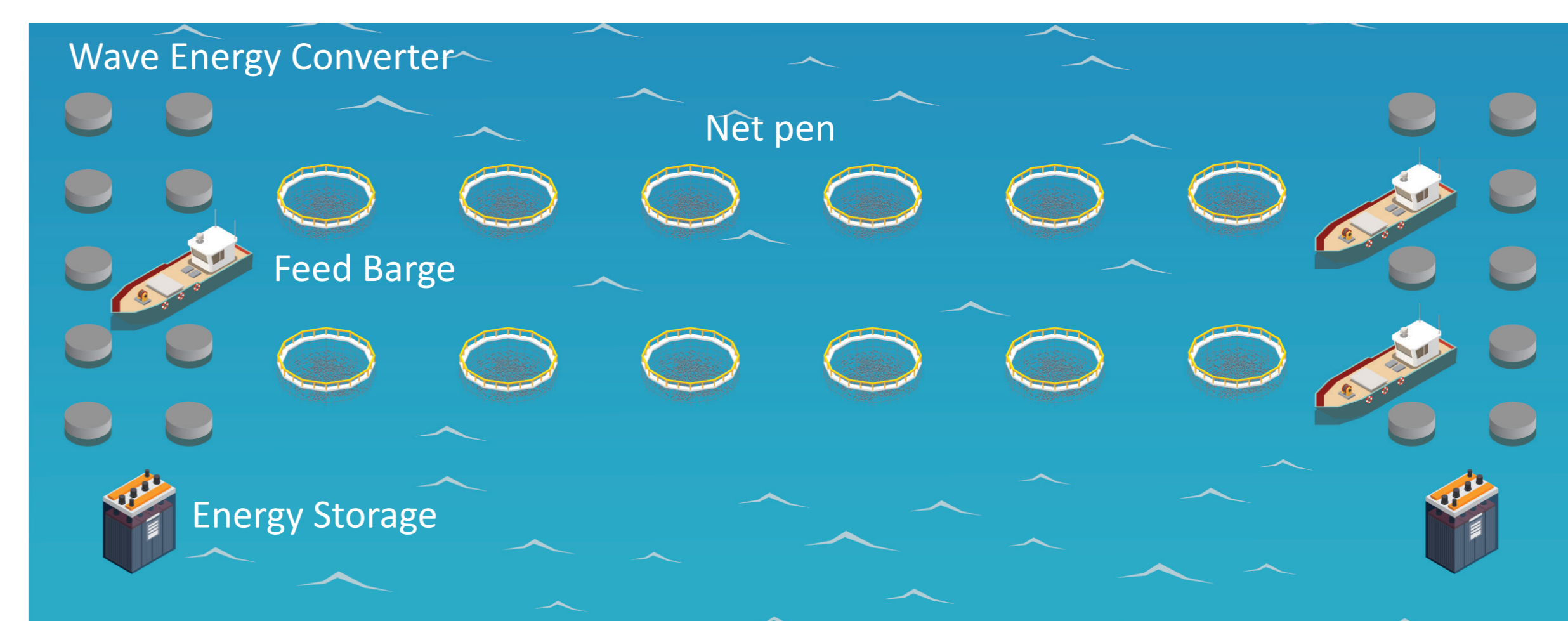
Image credit by WARTSILA



Image credit by DOE

Wave energy converter
 7 Reference model 3 (RM3) designed by Department of Energy (DOE)
 20 m floating diameter

Wave-Powered Aquaculture Farm



Conclusion

WPAF feasibility is shown with the initial results on the WEC and energy storage size for a medium aquaculture farm, where the optimal design is location dependent. Considering that wave energy and aquaculture farming are both niche industries in the United States, they can grow together and realize a sustainable source of food and power to simultaneously address climate change and provide enough food for the growing population.

Future Works

- Present a comprehensive design of a WPAF with a detailed cost model and narrow down the optimal design for a specific deployment location.
- Simultaneous optimization of location and design of WPAF.
- Develop a decision support tool to provide guidance for the fish farm and WEC developers.

References

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Additional Notes

In a parallel task, which is beyond the scope of the current work, we conduct marine spatial planning to find the optimal deployment location for the WPAF to avoid conflicts with other offshore activities, be suitable for fish, also have enough wave energy and appropriate bathymetry for the installation of WPAF.

Acknowledgment

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