Applicability of aquavoltaics in an offshore multi-use setting in the Adriatic Sea

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Aim of the study

- State-of-the-art of existing aquavoltaic systems
- Proposal of conceptual model operable in Adriatic Sea and energy supply calculations

Aquavoltaics – floating solar panels in synergy with aquaculture

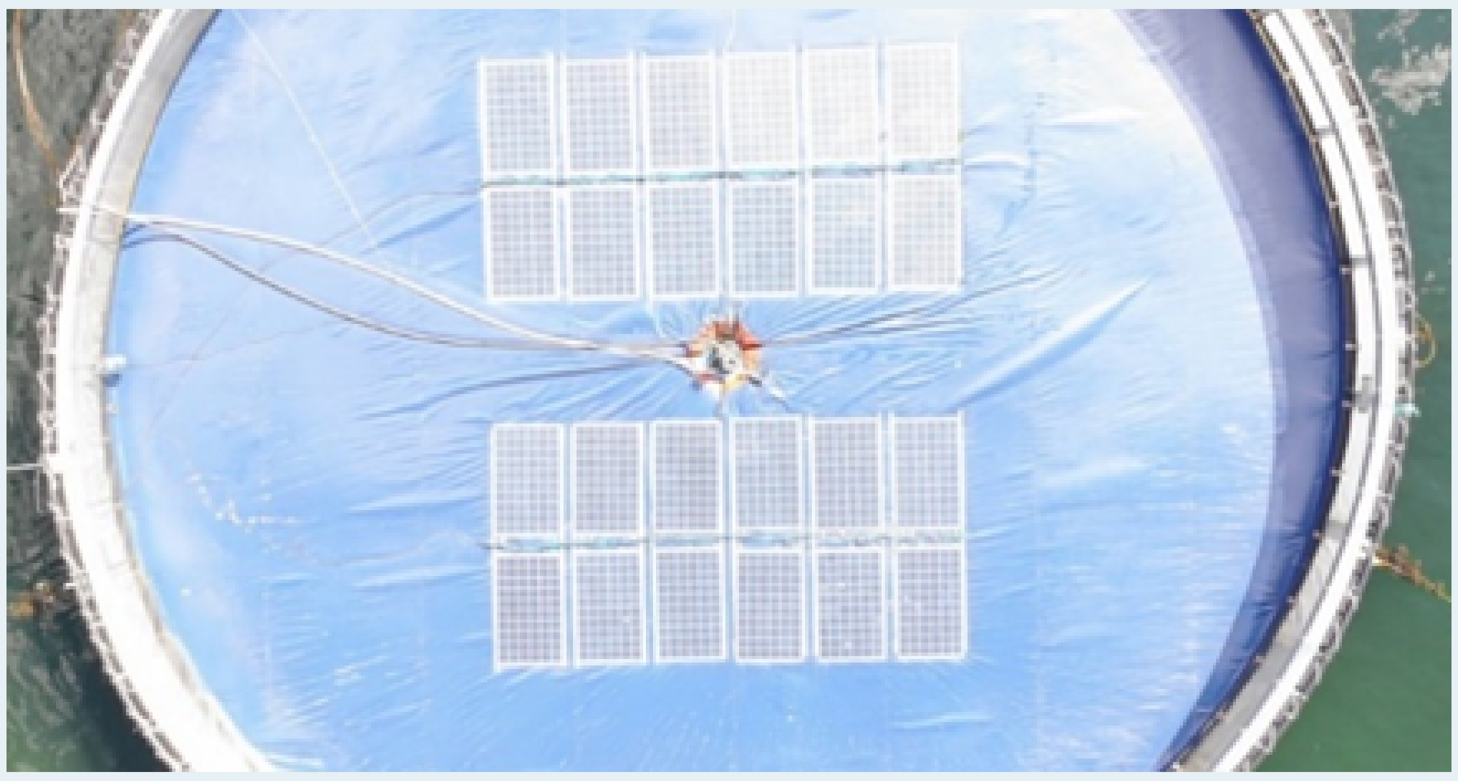
- they ensure sustainable and efficient food and renewable energy production
- its' application is still in its early stages globally, while there is no example of such a system in the Adriatic Sea yet

Examples of aquaPVC in use

- 292 aquavoltaic plants in China between 2014 and 2022 [1] and government project initiatives launched in Taiwan [2]
- Norwegian offshore mariculture and floating photovoltaic system already developed by Ocean Sun company, estimated to be 2000 GWp on man-made reservoirs alone [3]

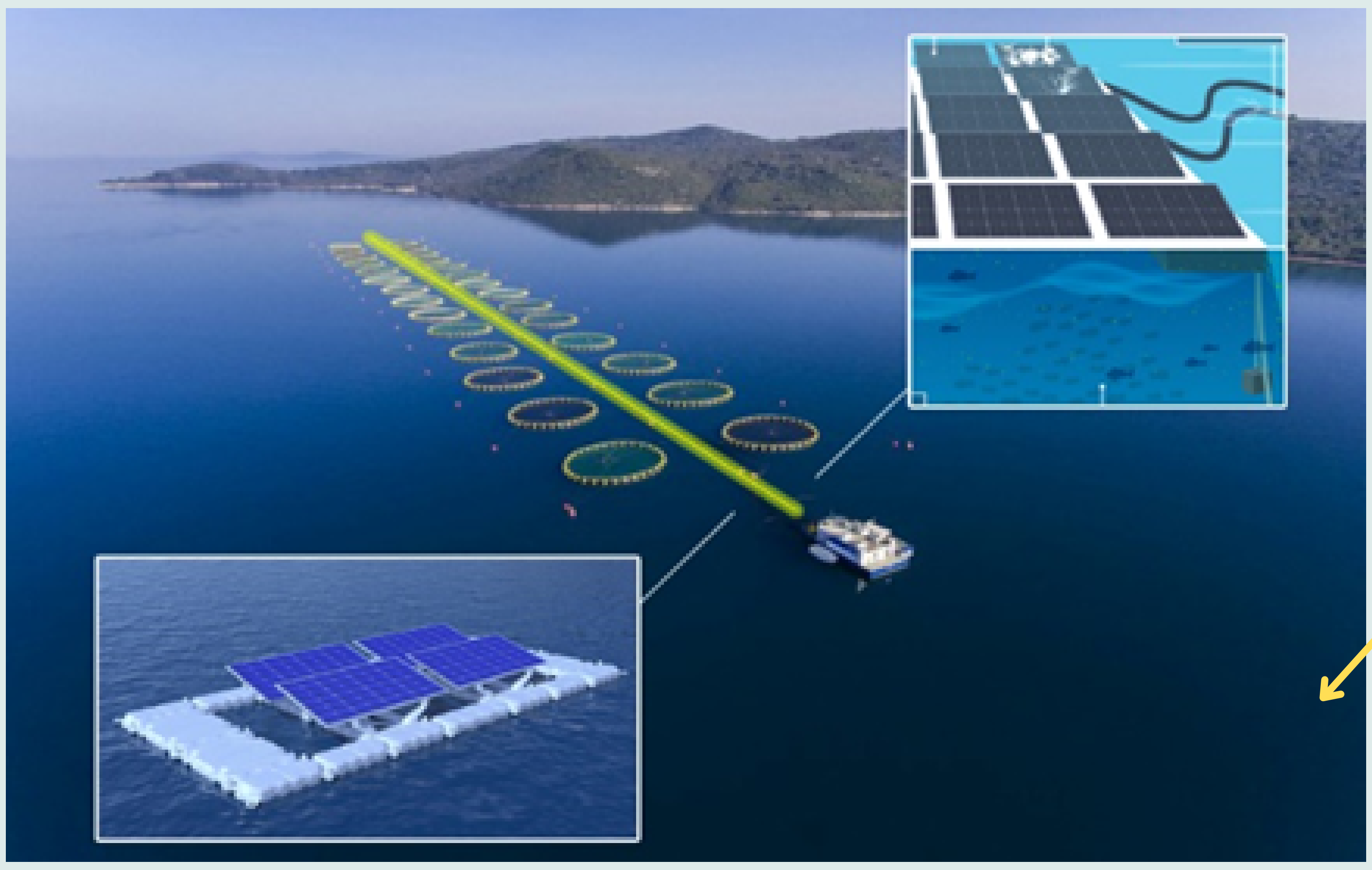
Norwegian aquavoltaic system

- floating cover system mounted on the surface of the fish cage – not completely thick so the light can get through
- shadowing inhibits the growth of photosynthetic species – potential damaging influence on herbivorous fish
- cover effects gas exchange (60% surface covered could still maintain 70% production) [4]
- protection from predatory birds



Norwegian Ocean Sun aquavoltaic system [4]

Conceptual aquaPVC model operable in the Adriatic Sea

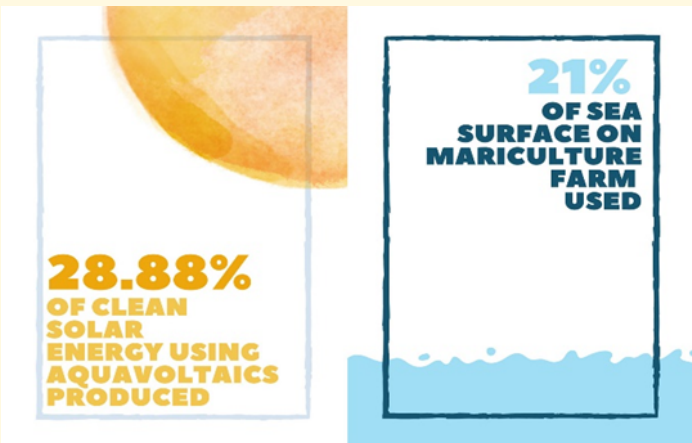


Conceptual aquavoltaic system (adapted from [5])

- floating solars between single cages in the middle of mooring systems – prevents covering fish directly
- cages reachable on the outer banks by boat

Aquavoltaic energy yield calculation

- working example: typical Croatian mariculture farm (200×140 m, 100 t/an production)
- 3.504.000 kWh/an per 100 t of fish produced [6]
- global formula for generated electricity in the output of a PVsystem; $E = A \times r \times H \times PR$



A (surface area) = 6.000 m^2
r (efficiency) = 15 %
H (annual average solar radiation) = 1500 kWh/m^2
PR (performance ratio) = 0.75

1.012.500 kWh/an

Conclusion

- sustainable aquaculture + renewable energy = sustainable and resilient marine ecosystem
- further layout research and detailed economic analysis needed

Selected publications:

[1] Chen, X., & Zhou, W. (2023). Performance evaluation of aquavoltaics in China: Retrospect and prospect. Renewable and Sustainable Energy Reviews, 173. doi:10.1016/j.rser.2022.113109
[2] Hsiao, Y. J., Chen, J. L., & Huang, C. T. (2021). What are the challenges and opportunities in implementing Taiwan's aquavoltaics policy? A roadmap for achieving symbiosis between small-scale aquaculture and photovoltaics. Energy Policy, 153. doi: 10.1016/j.enpol.2021.112264
[3] Château, P. A., Wunderlich, R. F., Wang, T. W., Lai, H. T., Chen, C. C., & Chang, F. J. (2019). Mathematical modeling suggests high potential for the deployment of floating photovoltaic on fish ponds. Science of the total environment, 687, 654-666. doi:10.1016/j.scitotenv.2019.05.420.
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[6] Bujas, T., Koričan, M., Vukić, M., Soldo, V., Vladimir, N., & Fan, A. (2022). Review of Energy Consumption by the Fish Farming and Processing Industry in Croatia and the Potential for Zero-Emissions Aquaculture. Energies, 15(21), 8197. doi: 10.3390/en15218197.

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