BLUE ECONOMY
COOPERATIVE RESEARCH CENTRE

Australian Government
Department of Industry, Science, Energy and Resources

AusIndustry
Cooperative Research Centres Program

SHORT SUMMARY

3.20.003 Energy Demand Analysis of Offshore Aquaculture Systems

INTRODUCTION

The Offshore Renewable Energy Systems program has the objective to develop and demonstrate offshore renewable energy systems optimised to meet the demands of offshore industry. Aquaculture is an example of an offshore industry which requires electricity to support several offshore operations, which at present are met via off-grid diesel generators. As the aquaculture companies look to more exposed and offshore lease sites, meeting these demands via diesel generators becomes less economic. This offers an opportunity for emerging renewable energy technologies, in that the target LCOE to match the status quo will be higher than if the demand was being met with grid-connected electricity. Prior to this study however, the electricity and other energy intensive resource demands of the offshore operations of the aquaculture sector were poorly known. This project set-out to address that knowledge gap

KEY POINTS

This study provided a number of insights into the opportunity for a potential sustainable energy transition for the offshore operations of the aquaculture sector. These include:

- The demand for energy intensive resources of the offshore operations of the aquaculture industry were assessed.
- The study focused on energy demands of sea-cage aquaculture systems, with particular emphasis on the salmon sector of Tasmania and New Zealand.
- Resources required include electricity (typically provided by diesel generator) for feed barge operations, lighting, venturation, and other miscellaneous electrical loads for monitoring and domestic use; freshwater for bathing, which could be delivered via electrified desalination of seawater; and fuel for other vessel movements (supply and recovery).
- Daily stationary electrical demand for an offshore salmon facility, with an annual production of 10,000 HOG t pa, is estimated at approximately 6000 kWh/day, with an additional 9000 kWh/day load for vessel transport. This is an order of magnitude larger than demand estimates derived from literature for salmon sector in Norway.

THE CHALLENGE

Electricity required for offshore aquaculture operations are most typically met using diesel generators. Expansion of the aquaculture sector offshore is anticipated to introduce further complexities and costs associated with diesel use, including transport expense, site access, fuel storage, and spillage risks in addition to the environmental costs of diesel generated electricity. The volume of diesel used could be greatly reduced with incorporation of renewable energy generation at the offshore site.

Concurrently, emerging offshore renewable energy technologies seek pathway markets via which their technology can be demonstrated to meet demand, enabling further cost reductions and an increased value chain. This study seeks to resolve the energy (and other energy intensive resource) demands of the aquaculture sector, in an offshore setting, and determine the size of the opportunity for emerging offshore renewable energy technologies.

The Blue Economy CRC is funded in part under the Australian Government's CRC program administered by the Department of Industry, Science, Energy and Resources.

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THE OPPORTUNITY

The relatively high cost of diesel generated electricity in an off-grid, off-shore setting presents a potential market opportunity for emerging offshore renewable energy technologies. This cost sets a more accessible threshold at which emerging technologies can be competitive, potentially enabling further development and cost reductions for these technologies, spurring access to potential further markets.

Aquaculture is one such market currently dependent on diesel powered operations, that might benefit from increased energy efficiency and transition to more sustainable power operations, to further reduce the footprint of their business.

However, it should be recognised that aquaculture will be a limited market for deployment of emerging technologies, and will likely have limited impact as a market to aid commercial maturity of these technologies. The program must have a broad view of potential markets for technologies.

OUR RESEARCH

The offshore operations of sea-pen aquaculture systems, and their associated energy and resource demands, were reviewed. The bulk of the stationary electricity demand occurring offshore is associated with the distribution of feed to the pens, via the feed-barge. Sub-sea lighting, venturation and net-cleaning add further load. Site monitoring and domestic use on the feed barge also use electricity. The freshwater bathing requirements of salmon as treatment for AGD could add further electricity demand in scenarios where the freshwater is supplied via desalination of seawater.

In addition to the stationary electricity demand, vessel movements have an energy demand at least as large as the stationary demand. Our best estimates of the daily stationary electricity demand for an offshore salmon facility with an annual production of 10,000 HOG t pa is estimated at approximately 6000 kWh/day, with an additional 9000 kWh/day load for vessel transport. This is an order of magnitude larger than demand estimates derived from literature for salmon sector in Norway.

A preliminary techno-economic optimisation was carried out using the software tool HOMER energy, to evaluate potential renewable energy systems optimised to meet the identified energy demand profile. A number of scenarios were explored, with consideration of diesel, PV, wind and wave technologies, with and with-out subsea cable connection to the grid. Under considered assumptions, the optimisation points to an off-grid hybrid diesel energy system providing electricity at lowest cost to the system.

A number of assumptions should be clarified before results are relied upon, but this preliminary assessment provides some guidance for the CRC to consider in its support of emerging technologies.

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OUTCOMES

This study has provided key underpinning data to resolve the magnitude of the demand for energy offshore, to support aquaculture operations. Furthermore, it has provided initial guidance on optimal technology options to meet the demands of aquaculture offshore. Daily stationary electricity demand for an offshore salmon facility with an annual production of 10,000 HOG t pa is estimated at approximately 6000 kWh/day, with an additional 9000 kWh/day load for vessel transport. This translates to an installed capacity of approximately 1 MW offshore renewable energy generation. With 10,000 HOG t pa representing approximately 1/10th of the total 2030 salmon production target for Tasmania, the market should be recognised as small. Accurate reliability assessment of MPOPs would not be possible without dealing with challenges regarding flexibility of structural components, unique structural features of renewable energy and aquaculture systems, high level of non-linearity, multi-scale features, etc. that make load analysis of the intended system difficult.

NEXT STEPS

The recommendations from this project are listed below.

- Continued monitoring of energy use at an offshore marine farm site, beyond the two-week time-period obtained in the scoping study, to resolve variations in energy demand for operations by season / fish maturity.
- A thorough audit of energy use by vessels used in marine operations be carried out in order to improve on understanding of the energy requirements for vessel movements.
- The energy system optimisation should be revisited with more accurate estimates of costs (existing and proposed), site location, resource information, once available. This presents a valuable tool for navigating an optimal ORES for offshore application.
- The CRC has opportunity to have impact in reducing energy costs, more sustainably, for aquaculture partners via efficiencies and transition to sustainable more mature RE options. The CRC must find an appropriate balance between support for operational blue industries with visible impact during the life of the CRC, and horizon 3 program objectives whose impact will not be seen in the CRC's life.
- Diesel-hybrid systems identified here as being most cost-effective systems should be factored into program plans as pathway towards full renewable systems.
- To identify market opportunities for offshore conversation technologies (solar, wind, wave, tidal), there is opportunity for the CRC to quantify offshore renewable energy resources available to existing offshore industry locations (being that of prospective pathway market opportunities). The recommendation includes mapping from modelled products (existing and new), and purpose in-situ monitoring of resource(s).
- Maintain momentum in determining resource (electricity, freshwater, transport fuel, oxygen and other) demands of the aquaculture sector, and resolving relative cost:benefits (economic, environmental and social) of supply of these resources via renewables vs status quo. Expand the scope of energy demand assessments beyond aquaculture to determine demands of other offshore systems/sectors. This presents international collaboration opportunities to other ocean energy market development activities.

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- Australia's 2030 targeted offshore aquaculture market is a potentially sufficient pathway market to support development of emerging ORES technologies to meet diesel competitive LCOE targets, opening further commercialisation opportunities. Additional pathway markets are required to support development to be competitive in broader markets. There remains a need to determine the energy demands of other potential off-grid markets for ORES, and size of potential markets. Further market identification is warranted to map out path of growth for ORES via these market opportunities.
- Account for GHG emissions associated with Australia's blue economy industries, and establish whether emissions associated with Australia's blue economy are proportionally equivalent to their contribution to GDP.
- The CRC consider lifecycle assessments of emerging technologies in its assessments and suitability in an expanding blue economy.

PROJECT TEAM

- Blue Economy CRC
- CSIRO
- Huon Aquaculture
- MERIC, Chile
- New Zealand King Salmon
- Tasmania Oyster Research Council Ltd
- Tassal Group Ltd
- Universidad Austral de Chile
- University of Tasmania

PROJECT REPORTS/PUBLICATIONS

Hemer, M., E. Franklin, J. Hayward and M.A Shoushtari (2020) 'Energy demand analysis of Offshore Aquaculture'. A report for the Blue Economy Co-operative Research Centre. 66p.

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