Integrated Wave Energy Microgrid Design

Final Report

Project Number: 2022 - 141

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December 2024

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The Fisheries Research and Development Corporation plans, invests in and manages fisheries research and development throughout Australia. It is a statutory authority within the portfolio of the federal Minister for Agriculture, Fisheries and Forestry, jointly funded by the Australian Government and the fishing industry.

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In submitting this report, the researcher has agreed to FRDC publishing this material in its edited form.

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Citation

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Executive Summary

Aquaculture Industry Challenges

Australian aquaculture industry faces increasing pressures from cost increases and regulatory burdens, along with stakeholder and consumer demands for improved sustainable practices. These pressures are compelling aquaculture companies to move their production further offshore and/or change their onshore processing activities. Aquaculture operators are predominately reliant on diesel generation for their ocean-based operations, while shore-based facilities like hatchery production and processing use grid supply electricity, typically with diesel backup power. The growing pressures on the industry necessitates a transition to perpetual, reliable clean energy sources to sustain growth and meet global sustainability expectations.

Ocean Energy Potential

While aquaculture operators are willing to be early adopters of new decarbonization strategies, until recently there have been few available options for the sector to adopt and implement.

To assist the industry, the Fisheries Research and Development Corporation (FRDC), in alignment with its 2020-2025 Strategic Plan, launched a co-investment program in 2022 focused on “developing scalable alternative energy solutions to enhance the resilience and decarbonization of the Australian aquaculture industry.

In response, Project Aquagrid (“Aquagrid”) submitted by Climate KIC Australia in partnership with the Australian Ocean Energy Group (AOEG), was selected as an "early mover micro project" within Seafood Industry Australia’s (SIA’s) 3-year aquaculture decarbonization program.

Aquagrid was designed to address the reliance on diesel generation, rising operational costs, and the limitations of grid power through ocean energy. This is particularly relevant as the aquaculture industry considers renewable energy options as part of their decarbonisation strategy. Additionally, as aquaculture considers expansion into offshore environments away from shoreline facilities, or remote areas, ocean energy, including wave, tidal, current flow energy can be options to replace fuel, gas or battery energy where grid-supplied electricity is not available.

While solar, wind, and battery systems are common and proven in land-based microgrids, the addition of ocean (wave and/or tidal) energy generation offers a promising solution. The Aquagrid project tested the hypothesis that integrating wave energy with other renewables and storage can yield a more reliable, cost-effective and sustainable energy solution than a traditional solar-battery setup.

Project Aquagrid – Objectives & Approach

Project Aquagrid, the team responsible for delivering FRDC Project 2022-141, aimed to validate that ocean energy integration enhances microgrid reliability while reducing emissions. Using Southern Ocean Mariculture (SOM) as a case study in Southwest Victoria, the project documented emissions impacts and developed an optimized wave energy microgrid design. The research included energy modelling with HomerPro software, examining various scenarios to create a practical, replicable solution tailored to SOM’s requirements.

While the detailed results, findings and learnings are documented in the report, the project delivered significant success on all objectives.

Project Aquagrid – Objectives & Approach *continued*

1. Strategic alignment with FRDC objective: Aquagrid resulted in a scalable wave energy microgrid design aligned with SOM's strategic goals. The project's data-driven methodology offers a replicable design model for similar strategic goals for aquaculture energy and power needs, demonstrating the broader potential of ocean (wave or tidal) energy for decarbonization within a microgrid system.
2. Contribution of ocean energy: The addition of wave energy generation was forecasted to significantly reduce calculated emissions, improve reliability of electricity supply, reduce energy costs, help SOM avoid additional land requirements and prove scalable with business changes and growth.
3. "Optimised" design: The modelling provided a decision framework that enabled SOM to determine the optimum scenario(s) to meet their business, operating and strategic goals.
4. Emissions Reduction: Through addition of wave energy, emissions were significantly reduced while maintaining reliable energy supply. This will be calculated to help SOM reduce dependence on volatile grid electricity while supporting SOM's pathway to net-zero emissions by 2050.
5. Scalability and Replicability: The process by which the microgrid was designed is replicable and scalable, and adaptable to wide variety of aquaculture operators. The modelling demonstrated that additional ocean energy devices can be added to a microgrid system, leading to increased energy production and reduced emissions.

Attachment 1 documents the design process, providing a guideline for aquaculture companies to pursue ocean energy microgrid systems for their own operations.

Conclusions

- The modelling and overall methodology documented a replicable, cross-sectoral approach that demonstrated the decarbonization benefits of ocean (wave and/or tidal) energy. This emphasises the innovative, collaborative, and data-driven approach of the modelling which incorporated the practical implementation of the modelling of the proposed microgrid system for SOM.
- The case study approach increased awareness of microgrid energy systems amongst commercial producers, and reciprocally, commercial challenges and considerations of technology adoption of ocean energy systems.
- The results highlight wave energy's unique capability to deliver seasonally and diurnally consistent, renewable power for aquaculture operations, especially those that include hatcheries requiring large power demands during the night. When complimenting with solar energy, the need for battery storage is reduced, compared to stand alone solar power energy systems.
- An optimum wave energy microgrid design will enable SOM to eliminate the need for additional land for solar, while enhancing SOM's sustainability credentials and reducing dependence on grid-supplied electricity mitigating price volatility.
- In addition, once operational, the results predict that implementation of the preferred microgrid design will place SOM on a path to achieving net-zero emissions well before 2050 by replacing grid-supplied electricity with renewable ocean energy.
- The project team's success reflects the balanced focus on technical rigor, collaborative design, and end-user engagement. This highlights the importance of combining technical innovation with team alignment, proactive government support and transparent data-sharing to ensure positive impacts for industry.

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AQUAGRID Project Overview

Introduction

To achieve key goals of their 2020-2025 Strategic Plan, the **Fisheries Research and Development Corporation (FRDC)** launched a co-investment program in 2022 to “develop scalable alternative energy solutions for aquaculture” to strengthen the resilience of Australian aquaculture to a changing climate and help the sector decarbonise.

Project “AquaGrid”, (project 2022-141) submitted by Climate KIC Australia in partnership with Australian Ocean Energy Group (AOEG), was selected by FRDC for project investment and are an “early mover micro project” with Seafood Industry Australia’s (SIA’s) overarching 3-year aquaculture decarbonisation program.

Aerial view of Southern Ocean Mariculture, Port Fairy, Victoria, Australia

Aquaculture Industry Challenges

Australia's Aquaculture sector is facing challenges from rising costs, regulatory shifts, and sustainability demands.

Currently, aquaculture operators are predominately reliant on diesel generation for marine activity in ocean-based operations, while shore-based facilities like hatchery production and processing uses increasingly volatile grid supplied electricity, typically with diesel backup power

With increasing environmental and social pressures for aquaculture to move offshore, securing sources of perpetual, reliable, affordable, secure and low risk clean energy is paramount for the industry's future prosperity in the face of these escalating pressures.

To ensure this occurs, the sector must urgently transition to reliable, clean energy sources to meet global calls for sustainable practices. Early adopters exploring decarbonization may gain competitive advantages in domestic and international markets, enhancing access and branding.

Limitations

Aquaculture operators are driven to consider renewables due to either a lack of power grid access or the presence of weak, costly-to-reinforce grids. Coastal networks often only support local seasonal needs, limiting aquaculture locations in Australia. Additionally, growth of existing facilities is constrained by limited power, restricting options like cool rooms needed for export markets.

Potential Solution – Ocean Energy Microgrids

While land-based microgrids using solar, wind, and battery storage are proven technologies, the addition of ocean energy (wave/tidal) generation offers a promising alternative. ***The focus of this project was based on the hypothesis that combining ocean energy with other renewables and storage could create a more reliable, affordable, and sustainable solution than typical solar and battery systems.***

Proposed Project

In response to FRDC's call for "scalable alternative energy solutions for aquaculture", ClimateKIC/AOEG submitted a proposal to:

- Prove the hypothesis -- that integration of ocean energy enables development of a reliable energy network based on the best combination of renewable energy sources ("the sum is greater than the parts").

Project Objectives

- Document the energy production changes and reduction in emissions when an ocean energy device is connected with other energy generation components in a land-based microgrid system.
- Produce an "optimised" design for an integrated wave energy microgrid system for Southern Ocean Mariculture.

Sub-objectives – additional objectives of the Project Team

Since the project aimed to deliver a practical energy solution for an established abalone aquaculture operation, the team envisioned it as a real-life case study for future ocean energy microgrid development.

- Utilise the methodology and design as a blueprint for aquaculture operators and ocean energy companies to pursue ocean energy microgrid systems in and outside of Australia.
- Demonstrate the value-proposition for ocean energy, leading to new market opportunities.

Desired Project Outcomes

The Project Team aimed for the following key outcomes beyond the basic objectives of the project:

- SOM's strategic and operational objectives are met through design of a microgrid system, acceptable for implementation.
- Clearly demonstrate the benefits of adding wave or tidal energy source in a hybrid energy microgrid.
- Create practical and replicable process for designing an integrated ocean energy microgrid system that is also scalable as part of a decarbonisation solution.
- Produce a blueprint for aquaculture operators and ocean energy companies to co-develop other pilot (and commercial) energy systems in Australia and around the world.

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AQUAGRID

Methodology

Methodology - Overview

The illustration below, provides context for where Project Aquagrid exists within an overarching renewable energy project development lifecycle for commercial entities.

Concept Design
Evaluate project potential & design options

- Assessment
- Modelling & design analysis
- ‘Optimised’ design selection

Project Aquagrid

Pre-build Planning
Project Refinement

- System Engineering
- Permitting, legal
- Stakeholders
- Implementation & Decommissioning Plans

Business & Strategic Assessment
Go/no-decision

- Business & Financial Analysis
- Funding
- FINAL INVESTMENT DECISION

Implementation
System Build & Install

- Procurement
- Assembly & installation
- Test & commission
- Operate Produce Electricity

Methodology – Case Study Basis

SOM – a case study

Project Aquagrid was designed and implemented as an applied research project to investigate the addition of ocean energy generation into a microgrid energy system to provide a clean energy solution for a coastal-based aquaculture company.

Southern Ocean Mariculture (SOM) in South-West Victoria served as the basis to produce a case-study; where the research, analysis and microgrid design were based on SOM's actual energy and operating data as well as their strategic business requirements.

Success of the case study was measured by development of a hybrid ocean energy microgrid model that would:

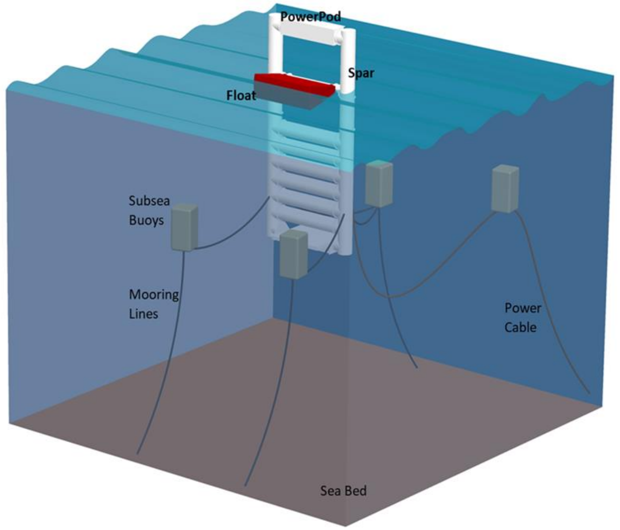
- achieve SOM's strategic and operational energy requirements,
- reduce their cost of energy,
- reduce dependency on diesel leading to a reduction in emissions,
- avoid expansion of solar infrastructure and associated land requirements,
- reduce reliability on the grid while maintaining and/or increasing the reliability of energy supply,
- strengthen their sustainability credentials and increase market access, and
- utilise the wave resource adjacent to their operations.

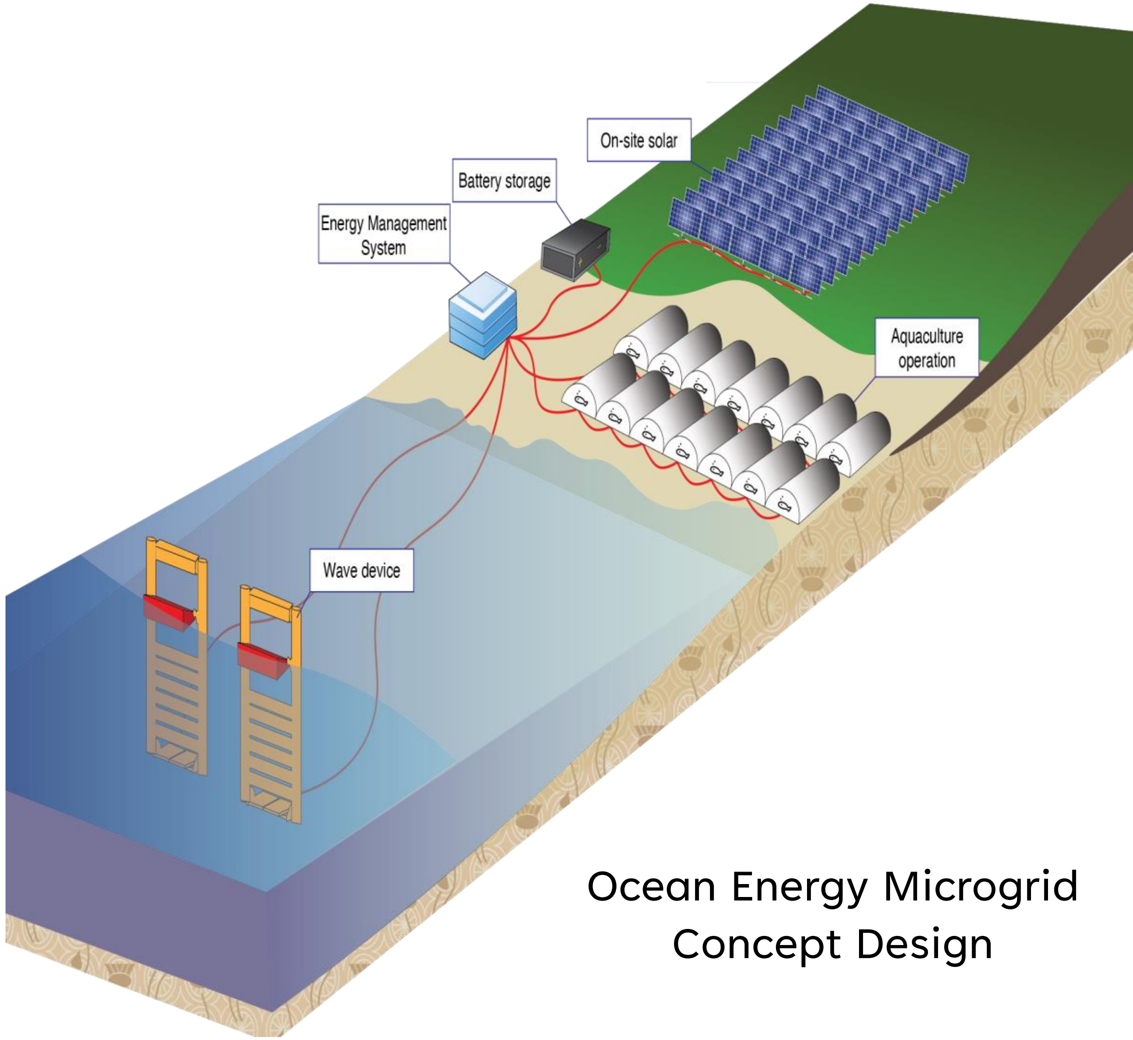
Methodology – Wave Energy

Benefits of AZURA Ocean Technology for this project

- Demonstrated commercial suitability from multiple deployments in conjunction with US DoE. (Hawaii / Oregon / NZ) confirms a Technology Readiness Level (TRL) of 7/8.
- Established multi-year business relationship with SOM and SOM's enthusiasm for renewable ocean energy.
- Dual potential energy conversion / onboard battery storage.
- High efficiency capacity factor >50% per 100kW device.
- Robust (confirmed operational capability >7.5m waves, 2 x Hurricanes).
- Australian / New Zealand design & manufacture.
- Australian / New Zealand owned IP.
- 24/7 electricity production.
- Onboard battery storage enables constant flow of energy negating inherent intermittent supply from other renewable sources.

A·Z·U·R·A
OCEAN TECHNOLOGY





Ocean Energy Microgrid Concept Design

Methodology – Modelling Steps

The methodology followed a 3-step process summarised below.

1 Assessment

- SOM's strategic and energy requirements were documented.
- SOM's current calculated emissions were benchmarked. This included their existing 250kW solar system, and their retrospective carbon emissions without solar. ***See Emissions Reduction plan – Attachment 3.***
- Energy generation components for the microgrid system were identified, with operating requirements assessed based on the location of the wave energy infrastructure offshore and on-shore facility location and other energy input hubs.
- Preliminary wave energy production estimates were created based on technology design and wave resource data captured at the SOM site in SW Victoria.
- Initial integration issues, including connecting two wave energy devices, cable size, and voltage, were also documented.
- Integration issues were identified between the wave device (operating in the ocean), connections among all renewable energy sources, and the land-based microgrid.
- A complete dataset was compiled to begin the modeling process.

2 Modelling & Analysis

- The design process was based on the data collected in the assessment phase.
- HomerPro Software was used to conduct the modelling.
- A suite of modelling scenarios and assumptions, and a corresponding multi-criteria framework to evaluate the outputs of each scenario, were completed.

3 "Optimisation"

SOM selected the "best fit or optimum" concept design(s) from 11 of 18 scenarios to achieve their strategic and energy requirements ***(see slide 20)***.

Methodology – Data Inputs

1 Assessment

HomerPro software was the modelling tool used to evaluate a variety of system configuration scenarios, alongside key business and operational considerations. The table below identifies key data inputs.

Step	SOM/Aquaculture Data Inputs & Assumptions		AZURA/Wave Energy Data Inputs
1 **Assessment** Data gathering	• Daily energy use • Grid electricity prices • Electricity supply and risks • Diesel use and consumption • Electricity production from existing 200kw solar array • CAPEX – diesel, PV, battery • Business/company growth projections • Emissions factors • Project life		• Wave power production estimates based on technology design • Wave energy data - annual estimates • Operating requirements (depth, location from shore, etc.) • Electrical requirements (distribution, connections, etc.) • Wave device – CAPEX, LCOE, OPEX
2 **Modelling** HOMERPro Software	**Scenarios** • Multi-criteria framework	**Site-specific variables (sensitivities)** • Social license • Reliability • Flexibility • Scalability • Affordability • Energy Independence	Evaluated the peaks and troughs of the generation cycle to the shore based microgrid controller system to achieve improved energy flow management integration.
3 **Optimisation Analysis**	Evaluated 18 design scenarios; 11 of which are presented in slide 20. Two (2) scenarios met SOM's business and energy objectives ***See Attachment 2 for detailed results.***		Wave energy device (WEC) design configuration, including moorings and cabling, was finalized,

Methodology – Modelling

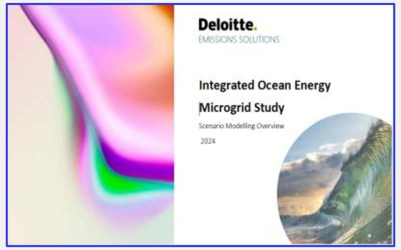
2 Modelling & Analysis

Modelling was based on this multi-criteria framework.

The modelling tool was HomerPro, software used to optimise microgrid design.

Modelling conducted by Syncline Energy & Deloitte Emissions Solutions.

See Attachment-2, Integrated Ocean Energy Microgrid Study Scenario Modelling Overview, for detailed results.



Modelled scenarios

The following technologies were considered in modelling microgrid scenarios for Southern Ocean Mariculture operations. Through the modelling process, any combination of the below technologies were modelled in HOMER Pro, with the sizing, or capacity, of each component in each scenario either:

- Constrained to represent existing (e.g. solar PV, diesel) assets;
- Constrained to meet specified capacities of new technologies for testing (e.g. x2 or x4 100kW wave units); or
- Optimised by HOMER Pro simulation to meet load conditions based on the lowest LCOE (e.g. expanded solar and wave, and battery systems)

Wave energy device	Solar PV system	Battery storage	Diesel generator	Grid
1. No system	1. No system	1. No system	1. No system	or
2. 200kW system (x2 units) + 80 kWh storage	2. Existing 250kW	2. 2.5MWh (size optimised, based on Tesla Megapack units)	2. Existing 550 kVa / 440kW	Off-grid
3. 400kW system (x4 units) + 160 kWh storage				

Methodology – Modelling Output

3 **"Optimisation"**

The modelling produced multiple scenarios, represented as S1, S2, etc., based on a wide range of data inputs and sensitivities. Of the 18 modelled scenarios (S), 11 scenarios have been summarised below. The scenarios and sensitivities together provide sufficient information to provide comparative analysis, followed by fine-tuning to the specific requirements of the end-user (see Attachment 2 for detailed summary).

	S1 - Old SOM energy system (w/o solar)	S2 - Current SOM energy system	S3 - Wave-Diesel Replacement	S4 - Integrating Wave Energy	S5 - Expanded Wave Integration	S6 - Expanded Wave-Diesel Replacement	S9 - Solar, Battery & Grid	S11 - Off-grid + Wave	S16 - Off-Grid Green One	S17 - Off-Grid Green Two	S18 - Off-Grid Green Three
Scenario Components	Diesel + Grid	PV + Diesel + Grid	PV + Wave + Grid	PV + Wave + Diesel + Grid	PV + ExpandedWave + Diesel + Grid	PV + ExpandedWave + Grid	PV + Battery + Grid	PV + Wave + Diesel	PV + ExpandedWave	PV + ExpandedWave + Battery	ExpandedWave + Battery
Meets SOM Energy Load	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Total energy produced (kWh)	1,865,447	1,868,625	2,009,830	2,025,056	2,632,245	2,616,242	1,848,403	2,383,618	2,541,498	2,541,498	2,192,506
Net Present Cost ($)	4,024,727	3,717,862	3,328,619	3,733,038	4,185,244	3,808,244	6,683,922	11,570,140	3,337,435	10,551,990	33,987,250
LCOE ($/kWh)	0.17	0.15	0.13	0.15	0.13	0.12	0.28	0.48	0.68	0.44	1.42
CAPEX ($)	320,000	620,000	1,844,156	2,164,156	3,710,275	3,384,388	2,153,925	2,182,800	3,000,981	7,098,022	19,760,530
OPEX ($/yr)	286,577	239,633	114,830	121,360	36,741	32,787	350,415	726,152	26,026	267,179	1,100,499
Annual Emissions (tCO_2e/yr)	1,400	1,141	423	436	69	56	1,125	766	-	-	-
Cumulative Emissions (tCO_2e/10y)	9,757	7,959	2,930	3,075	523	388	7,782	7,657	-	-	-
Renewable Penetration (%)	-	19	71	70	96	97	19	50	100	100	100
Microgrid Configuration, Capacity & Production (kW, kWh/year)											
Solar PV System	0kW, 0kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	0kW, 0kWh
Wave Energy Device	0kW, 0kWh	0kW, 0kWh	200kW, 1096253kWh	200kW, 1096253kWh	400kW, 2192506kWh	400kW, 2192506kWh	0kW, 0kWh	200kW, 1096253kWh	400kW, 2192506kWh	400kW, 2192506kWh	400kW, 2192506kWh
Diesel generator	440kW, 30289.14kWh	440kW, 27286.32kWh	0kW, 0kWh	440kW, 21795.44kWh	440kW, 16831.05kWh	0kW, 0kWh	0kW, 0kWh	440kW, 938373.3kWh	0kW, 0kWh	0kW, 0kWh	0kW, 0kWh
Wave Battery Throughput	0kWh	0kWh	6594.578kWh	14938.39kWh	116519.4kWh	63233.19kWh	0kWh	18078.53kWh	21.77533kWh	0kWh	0kWh
Tesla Megapack Throughput	0kWh	0kWh	0kWh	0kWh	0kWh	0kWh	2528.887kWh	0kWh	0kWh	86751.84kWh	137960.6kWh
Grid	1835158kWh	1492347kWh	564585kWh	558016kWh	73916.33kWh	74743.76kWh	1499411kWh	0kWh	0kWh	0kWh	0kWh

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Learning Journey: Methodology

Methodology – Learning Journey

Collated Team Learnings about the appropriateness, rigor and clarity of the methods used in this project

Appropriateness of the new methodology to address our project objectives

- The modelling was groundbreaking and replicable.
- The methodology demonstrated cross-sectoral collaboration with definitive decarbonization outcomes through modelling. Having an aquaculture producer as part of the research team added authenticity and ownership of the learnings.
- The modelling made possible via HomerPro software was invaluable in highlighting the advantages of the selected solution against other options.
- The addition of wave energy generation in the methodology was new and required refinement of the modelling inputs.
- The methodologies combined with real data sets developed a robust output.

Suitability of the tools and techniques

- The right software is available for future projects!
- This was first time HomerPro software included wave energy. This resulted in new templates created that accounted for the ocean energy component, modification of the software to accommodate ocean energy data and identification of the sensitivities as inputs to the modelling.
- The number configurations and scenarios could be less.
- HomerPro softward, was very suitable and without that, it would have been difficult to run the sensitivity analysis and the initial 18 scenarios. Other software tools designed for microgrid modelling are available that may also be suitable.
- The investment of time to setup HomerPro inputs for wave energy was considerable and future projects should get the benefits of the setup and datasheets prepared for Project Aquagrid. Project team members, Syncline Energy and Deloitte Emissions Solutions, hold licenses for HomerPro.

Collated Team Learnings about the appropriateness, rigor and clarity of the methods used in this project

Sufficiency of the data and its sources

Energy Transition Pathway: Modelling identified a phased approach to energy transition—beginning with a modest goal of 70% renewable energy generation and progressing to greater than 90% renewable energy supply over time.

CAPEX Considerations: To find the break-even levelised cost of energy (LCOE) for the wave device, the capex was increased in steps from zero to an amount where the wave device delivered a positive environmental benefit without economic cost to SOM. This allowed a comparative analysis of scenarios under equal conditions. When pre-commercial costs were introduced, the additional expense of adding a wave energy device was made evident, though long-term savings were factored in. As the up-front cost of wave devices decreases, reaching a break-even point will enhance adoption.

Data Availability: This site had ample data resources, potentially more comprehensive than other aquaculture locations, due to prior wave energy assessments and testing. Quality data on grid, solar, diesel, and wave resources, along with cost and emissions information, allowed for a thorough analysis.

Data Diversification for Decision-Making: Integrating data from multiple renewable energy sources can enhance the practicality of decision-making for future users of this methodology.

Lifecycle Analysis of Diesel Gen-Sets: Emissions data included not only operational fuel use but also emissions generated from maintenance activities, providing a comprehensive view of CAPEX and OPEX, making the cost comparison more accurate.

Wave Energy Simplification: Unlike "rule-of-thumb" approaches in the solar industry for estimating output based on Bureau of Meteorology solar data, there are too many variables to develop a simple rule-of-thumb for wave energy. However, over time and with experience with ocean energy microgrids, wave energy data may develop a simplified 'rule-of-thumb'.

Development of Wave Energy Algorithms: The wave energy industry may consider creating algorithms that generate annual time series data in 30-minute increments to predict kWh production at shore. This would allow the sector to present data like, "for this location, the wave resource yields an output of XX kWh from an XX kW machine over a specified time sequence."

Collated Team Learnings about the appropriateness, rigor and clarity of the methods used in this project

Future Refinements of the Methodology

Assumptions and Sensitivity Analyses: Broad assumptions were necessary for the modelling, with sensitivity analyses conducted to help address and compensate for certain gaps.

Methodology Adaptation for Aquaculture: To make the methodology more relevant for other aquaculture operators considering microgrids, refinements could focus on business risks related to reliability, cost, and environmental sustainability under typical energy scenarios (e.g., off-grid, diesel-only, or no solar access).

Generic Methodology Constraints: The methods outlined in the user guide are inherently generic, which may pose challenges for aquaculture entities attempting to replicate this approach without access to the customized modelling tools developed for the case study, limiting its practical utility for future adopters.

Integration of Device Characteristics for Comparison: Populating HomerPro with data on a variety of wave and tidal devices from manufacturers would enable direct comparison of different technologies, aiding in the selection of optimal systems for specific environments.

Engineering Model Innovation: Wave height and period data was converted into a time series for the electrical energy received into the microgrid. This was calculated for each half hour in the year and combined with the half-hourly data for the PV system and SOM's electricity load. Wave activity varies between seasons and during the day. Accordingly, we used a probabilistic method to calculate an average, maximum and minimum estimate for the wave generation contribution. The wave data was sourced from nearby buoys.

Wave Energy Output Characteristics: The statement "Wave energy has a smooth, attenuated output" may require further clarification to convey its significance for the specific operational context.

Limitations of Wave Energy Technology in Analysis: This analysis used only one wave energy technology. An extended analysis could include:

- Replacing AZURA wave energy data with equivalent performance data from 3–4 additional wave energy devices and 1–2 tidal devices of similar capacity.
- Running scenarios without pre-existing solar or grid access.
- Testing with four different load profiles (e.g., scaling factors of 0.5, 2, 4, and 8 for larger and smaller operations).

Energy Price Sensitivity: Due to uncertainties around future diesel and grid energy prices, additional sensitivity analysis was included to reflect potential price fluctuations.

While the results focused heavily on the technical aspects of the project, there were additional non-technical aspects that were equally important in achieving project success

Co-design process

Active End-User Engagement: Success was achieved through continuous, active engagement from the end-user, who participated fully with the team from the project's inception through to completion.

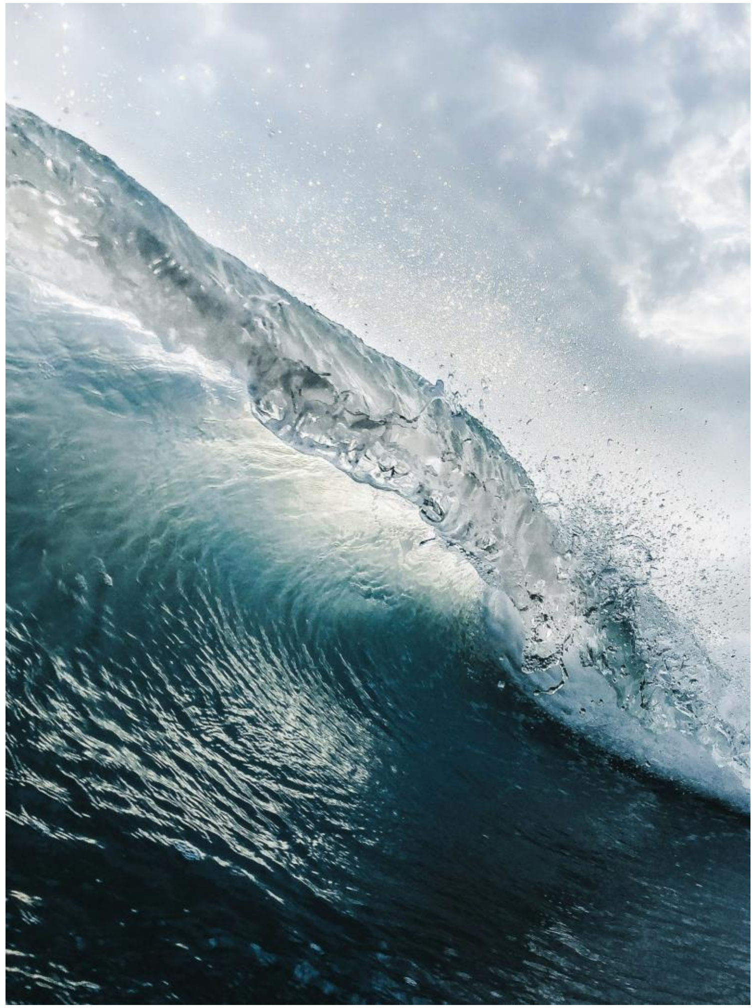
Collaborative and Flexible Problem-Solving: The team adopted an equal, collaborative partnership and a flexible, iterative approach to address SOM's energy challenges effectively.

FRDC Research Funding: Public funding in the form of a grant provided crucial support, allowing the team to commit the necessary time to the project and reducing financial risk for the end-user (SOM). Local, state and/or Commonwealth funding to support decarbonisation innovation is necessary to help enterprises reduce the risk of pursuing and adopting energy solutions.

Needs-Based Co-Design Process: The project followed a co-design approach grounded in the specific needs of the end-user, ensuring that the analysis was directly connected to practical outcomes and solutions for SOM's energy challenges.

Data Sharing Requirement: Effective design relies on open data sharing. Energy generation providers must be prepared to share proprietary information on energy production, while end-users need to provide internal data on energy use.

Aligned and Experienced Team: Team AquaGrid was composed of senior-level professionals with deep knowledge and experience, all fully aligned with the project's vision. Their collective understanding of the challenges and commitment to collaboration was essential to achieving successful outcomes.



Non-technical aspects of the project *(continued)*

Qualities of the End-user

Strong Stakeholder Relationships: SOM maintains positive relationships with key stakeholders, including fishing and diving communities, First Nations, local residents, and other shared users, supporting community buy-in and project success.

Culture of Innovation: With a long history of innovation, SOM embraced fresh perspectives and a novel approach to addressing their energy needs.

Ideal Location for Ocean Energy: SOM's site of approximately 800m from shore offered an optimal setting for the project, with abundant wave resources and a nearshore location that minimizes cabling costs and simplifies permitting requirements.

Contributions: SOM contributed valuable resources, guidance, technical insights, and significant time to support the team's efforts.

Enhanced Strategic Alignment: The design process fostered stronger strategic alignment and mutual understanding between SOM's Management Team and its Board, ensuring cohesive support for the project.

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Results

Results – Documenting Project Results and Success

Important metrics of project success are how well the work and outcomes align with the initial objectives. The success of Project Aquagrid is documented in the following slides.

Core Project Objectives	Status	Detailed Results
FRDC Objective Develop scalable alternative energy solutions for aquaculture to strengthen the resilience of Australian aquaculture to a changing climate and help the sector decarbonise.	**Achieved!**	**See slide 29**
Project Objective – Ocean Energy Prove the hypothesis that ocean energy enables development of a reliable energy network based on the best combination of renewable energy sources.	**Achieved!**	**See slide 30**
Project Objective – Optimum System Design Produce an "optimised" design for an integrated wave energy microgrid system that meets SOM's strategic objectives and is accepted for implementation.	**Achieved!**	**See slide 31**
Project Objective – Emissions Reduction Document the energy production changes and predicted reduction in emissions when an ocean energy device is connected with other energy generation components in a land-based microgrid system.	**Achieved!**	**See slide 33**

Results –Project Objective, FRDC

Objective

Develop scalable alternative energy solutions for aquaculture to strengthen the resilience of Australian aquaculture to a changing climate and help the sector decarbonise.

FRDC

Objective Met!

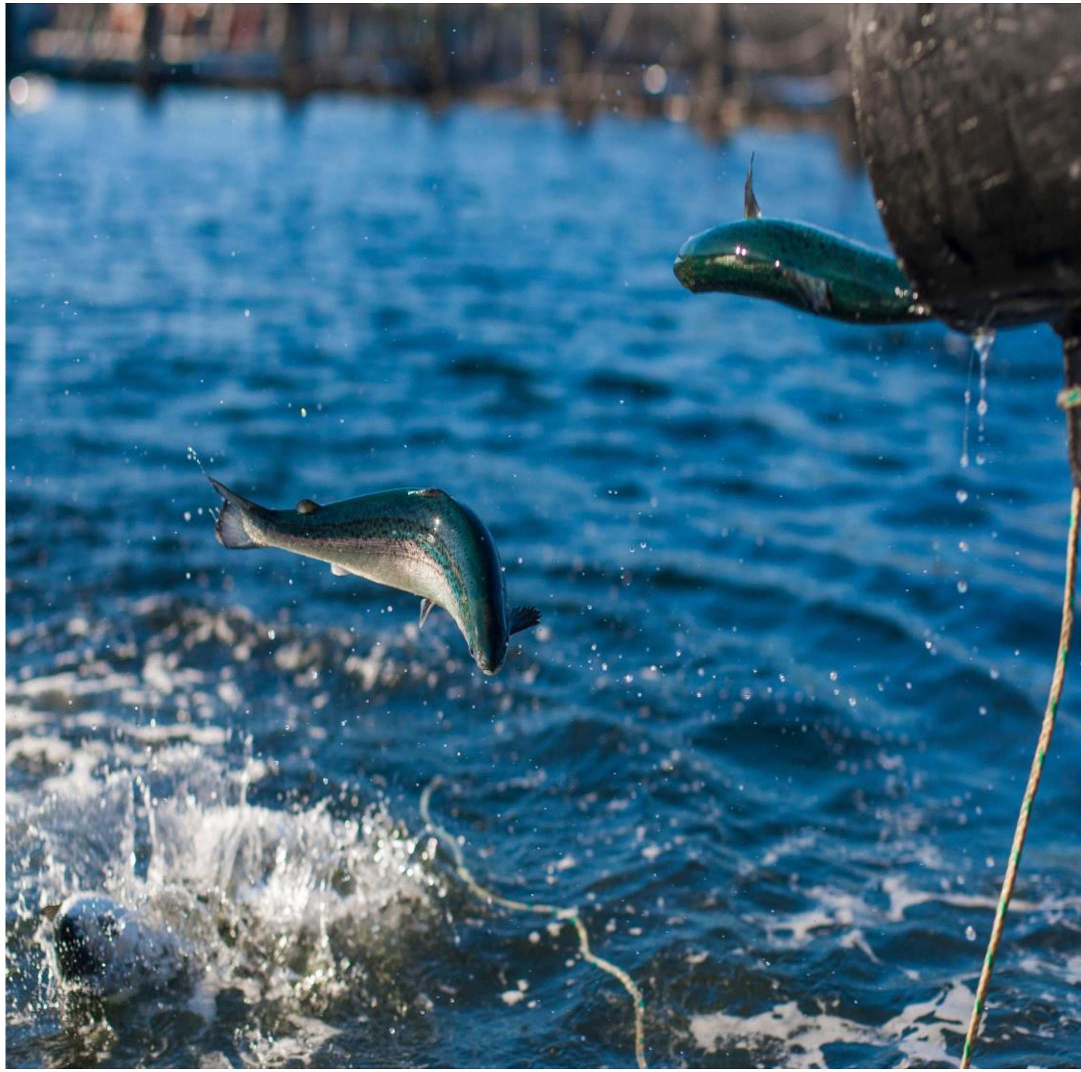
The modelling documented that adding solar generation alone would not provide sufficient energy to meet SOM's requirements (due to the intermittency) without the addition of extensive storage. Additional storage would be an impractical outcome. Expansion of solar was also not possible due to lack of physical space.

Yet, adding more wave energy devices increased energy generation while significantly reducing emissions.

See *slide 31-S9 and Attachment-2 for reference.*

The modelling also demonstrated the replicability of the modelling process.

See slide 34 for explanation.



Results – Project Objective, Ocean Energy

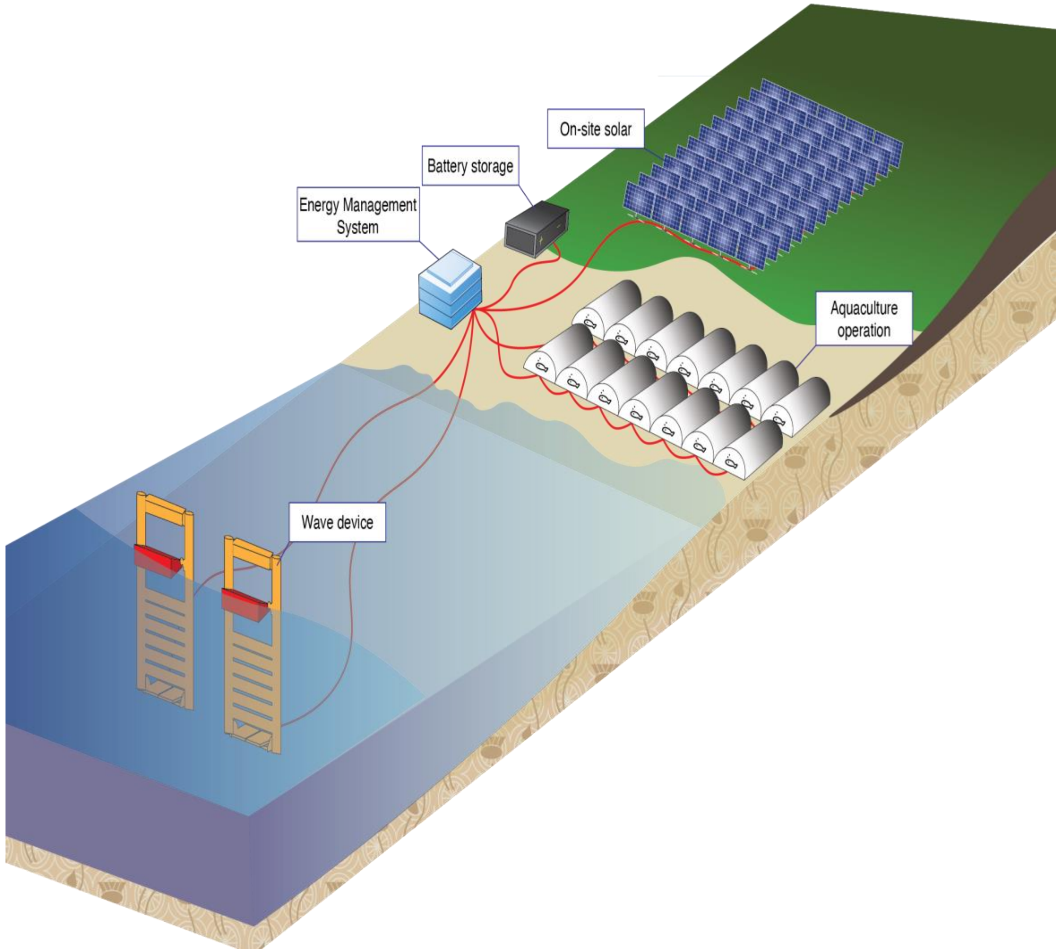
Objective

Prove the hypothesis that ocean energy enables development of a reliable energy network based on the best combination of renewable energy sources.

Objective Met!

The project results forecasted:

- Emissions reduction by ~50% with 2 wave devices, delivering 2 x 100kW, and close to 94% of 24/7 energy requirements with 4 Azura devices in the waters at SOM (4 x 100kW) - *(see slide 31 & Attachment-2 for details).*
- Whole of system energy supply consistency improved and increased significantly in the off-grid energy scenario.
- OPEX was lowered.
- Separate battery storage was avoided thereby saving capital costs of energy storage needs required with solar energy alone for nighttime power needs of the SOM operation.
- Load profile with wave devices was better than other scenarios
- Additional land for battery and/or additional solar was avoided which would be an added cost to SOM if they were to further expand their existing solar array of 250kW.
- System scalable for future load increases.
- Exposure to grid prices was reduced.
- Potentially eligible for Large Generation Certificates (LGCs).



Results – Project Objective, Southern Ocean Mariculture

Objective

Produce an "optimised" design for an integrated wave energy microgrid system that meets SOM's strategic and operational objectives, acceptable for implementation

Objective Met!

The modelling provided a decision framework that enabled SOM to determine the optimum scenario(s) to meet their business, operating and strategic goals.

	S1 - Old SOM energy system (w/o solar)	S2 - Current SOM energy system	S3 - Wave-Diesel Replacement	S4 - Integrating Wave Energy	S5 - Expanded Wave Integration	S6 - Expanded Wave-Diesel Replacement	S9 - Solar, Battery & Grid	S11 - Off-grid + Wave	S16 - Off-Grid Green One	S17 - Off-Grid Green Two	S18 - Off-Grid Green Three
Scenario Components	Diesel + Grid	PV + Diesel + Grid	PV + Wave + Grid	PV + Wave + Diesel + Grid	PV + ExpandedWave + Diesel + Grid	PV + ExpandedWave + Grid	PV + Battery + Grid	PV + Wave + Diesel	PV + ExpandedWave	PV + ExpandedWave + Battery	ExpandedWave + Battery
Meets SOM Energy Load	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Total energy produced (kWh)	1,865,447	1,868,625	2,009,830	2,025,056	2,632,245	2,616,242	1,848,403	2,383,618	2,541,498	2,541,498	2,192,506
Net Present Cost ($)	4,024,727	3,717,862	3,328,619	3,733,038	4,185,244	3,808,244	6,683,922	11,570,140	3,337,435	10,551,990	33,987,250
LCOE ($/kWh)	0.17	0.15	0.13	0.15	0.13	0.12	0.28	0.48	0.68	0.44	1.42
CAPEX ($)	320,000	620,000	1,844,156	2,164,156	3,710,275	3,384,388	2,153,925	2,182,800	3,000,981	7,098,022	19,760,530
OPEX ($/yr)	286,577	239,633	114,830	121,360	36,741	32,787	350,415	726,152	26,026	267,179	1,100,499
Annual Emissions (tCO2e/yr)	1,400	1,141	423	436	69	56	1,125	766	-	-	-
Cumulative Emissions (tCO2e/10y)	9,737	7,959	2,930	3,073	523	388	7,782	7,657	-	-	-
Renewable Penetration (%)	-	19	71	70	96	97	19	50	100	100	100
Microgrid Configuration, Capacity & Production (kW, kWh/year)											
Solar PV System	0kW, 0kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	0kW, 0kWh
Wave Energy Device	0kW, 0kWh	0kW, 0kWh	200kW, 1096253kWh	200kW, 1096253kWh	400kW, 2192506kWh	400kW, 2192506kWh	0kW, 0kWh	200kW, 1096253kWh	400kW, 2192506kWh	400kW, 2192506kWh	400kW, 2192506kWh
Diesel generator	440kW, 30289.14kWh	440kW, 27286.32kWh	0kW, 0kWh	440kW, 21795.44kWh	440kW, 16831.05kWh	0kW, 0kWh	0kW, 0kWh	440kW, 938373.3kWh	0kW, 0kWh	0kW, 0kWh	0kW, 0kWh
Wave Battery Throughput	0kWh	0kWh	6594.578kWh	14938.39kWh	116519.4kWh	63233.19kWh	0kWh	18078.53kWh	21.77533kWh	0kWh	0kWh
Tesla Megapack Throughput	0kWh	0kWh	0kWh	0kWh	0kWh	0kWh	2528.887kWh	0kWh	0kWh	86751.84kWh	137960.6kWh
Grid	1835158kWh	1492347kWh	564585kWh	558016kWh	73916.33kWh	74743.76kWh	1499411kWh	0kWh	0kWh	0kWh	0kWh

Two options were selected through multi-criteria assessment framework across scenarios:

Scenario	Wave	Solar PV	Battery	Diesel (backup)	Grid
INITIAL PROJECT DEVELOPMENT Scenario 4: Integrating Wave Energy	200 kW	250 kW	-	550 kVA / 440 kW	NEM
EXTENSION PROJECT DEVELOPMENT Scenario 6: Expanded Wave Integration	400 kW	250 kW	-	550 kVA / 440 kW	NEM

The emphasis on long term operating cost reduction, a blend of increased renewable energy (ahead of grid available), reliability from layers of redundancy determined these 2 scenarios for implementation planning.

Objective

Produce an “optimised” design for an integrated wave energy microgrid system that meets SOM’s strategic and operational objectives, acceptable for implementation

Objective Met! Benefits of Selected Design

- Meets expected load requirements
- Significantly reduces emissions *(see slide 31 and Attachment-3)*
- Avoids additional battery storage
- Modelling identified an energy transition pathway – that is, start small/achieve 70% renewable generation and progress to >90% renewable energy supply over time
- Avoids additional land for energy production (eg, solar)
- Improved value of the SOM brand by strengthening sustainability credentials
- Reduces dependency on grid-supplied electricity and exposure to variable grid prices
- May be eligible for Large Generation Certificates (LGCs)
- Potential for additional revenues from sale of excess energy

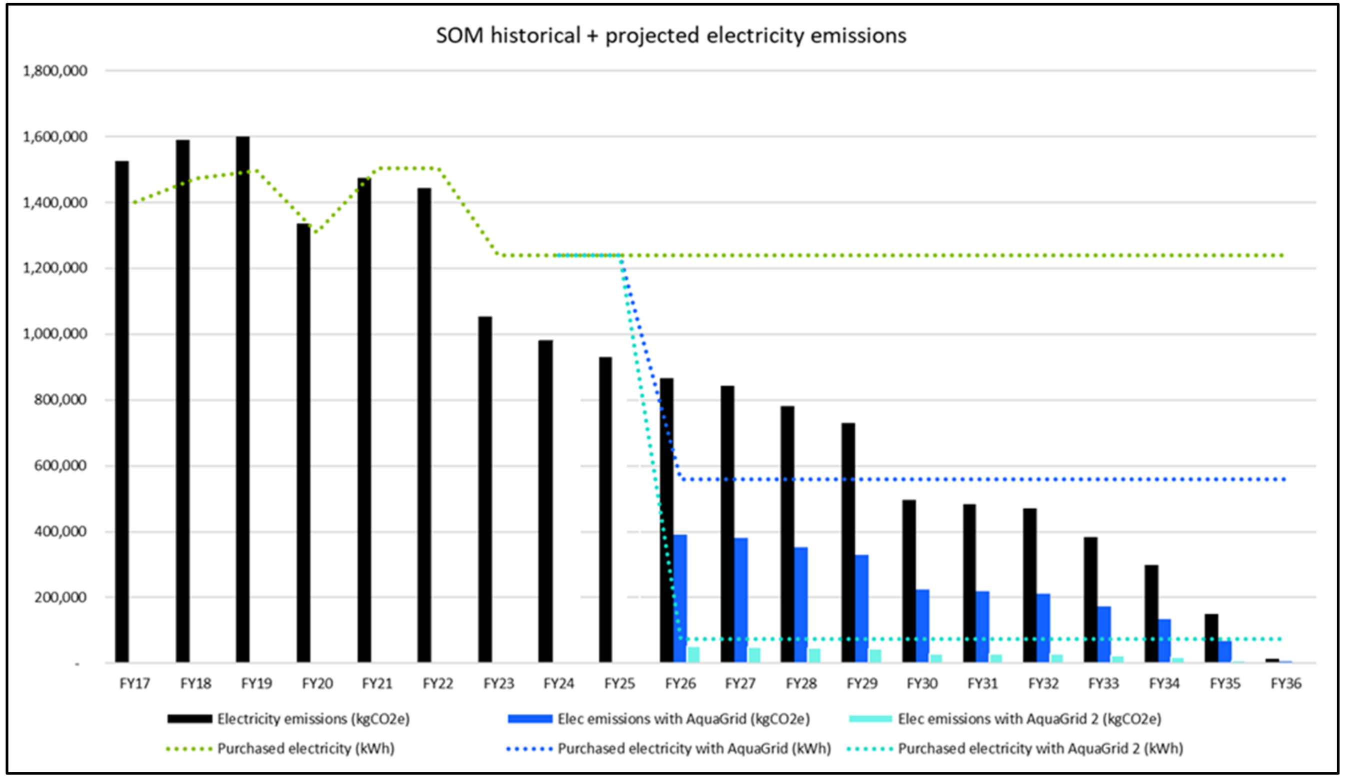
Results – Project Objective, Emissions Reduction

Objective

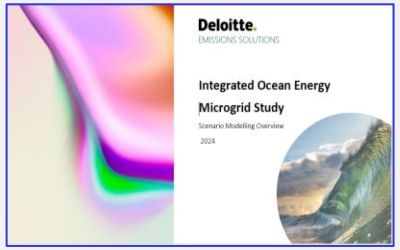
Document the energy production changes and reduction in emissions when an ocean energy device is connected with other energy generation components in a land-based microgrid system.

Objective Met!

The integration of ocean energy in the microgrid, along with ongoing grid decarbonization, significantly reduced emissions. Project team member, Deloitte Emissions Solution (DES) decarbonization assessment highlights that the target installation puts SOM on track for net-zero well before 2050. Once the ocean energy microgrid is commissioned, targeted for FY26, it will replace much of the grid-supplied electricity with renewable ocean energy.



See Attachment-3, Decarbonisaton Advice Report, for detailed results.



Results – Reliability, Scalability, Repeatability

Energy Reliability

The modelling demonstrated that energy reliability of the microgrid was improved through addition of wave energy resource, leading to reduced risk of energy supply.

Ocean energy provides 24/7 electricity generation, helping to offset intermittency of other renewable generation. It contributed a "smoothing" element to electricity production.

Because solar has high rate of change of voltage and power output, solar-only in micrograds can be unreliable and can trip the circuit breakers due voltage spikes. Addition of wave energy reduced the rate of change of system voltage, creating more stable microgrid.

If land is restricted, the addition of ocean energy allows expansion capacity and growth of electricity supply.

Scalability

The modelling demonstrated that additional ocean energy devices can be added to the microgrid system, leading to increased energy production and reduced emissions.

Based on this result, SOM intends to start with two (2) wave devices delivering 200kW renewable energy consistently 24/7, and add an additional two (2) 100kW devices (for a total of 400kW) as their electricity demand increases over time.

Common use infrastructure, such as shared cabling, shared power management and transmission systems, are also a consideration in terms of scalability,

Repeatability

The process by which the microgrid was designed is replicable. However, each microgrid system is bespoke due to each end-user's specific variables. These include:

a) the end-user's individual energy objectives and requirements,

b) Resource characteristics, the type of wave or tidal technology and its location relative to project site and energy strength,

c) the ocean energy device (wave or tidal) selected for the site may differ and result in energy production capacity and corresponding operating requirements unique to its operating location, and

d) variable and changeable energy supply considerations (eg, costs of grid electricity, volume of use and cost of diesel, land availability for other renewable generation, etc.)

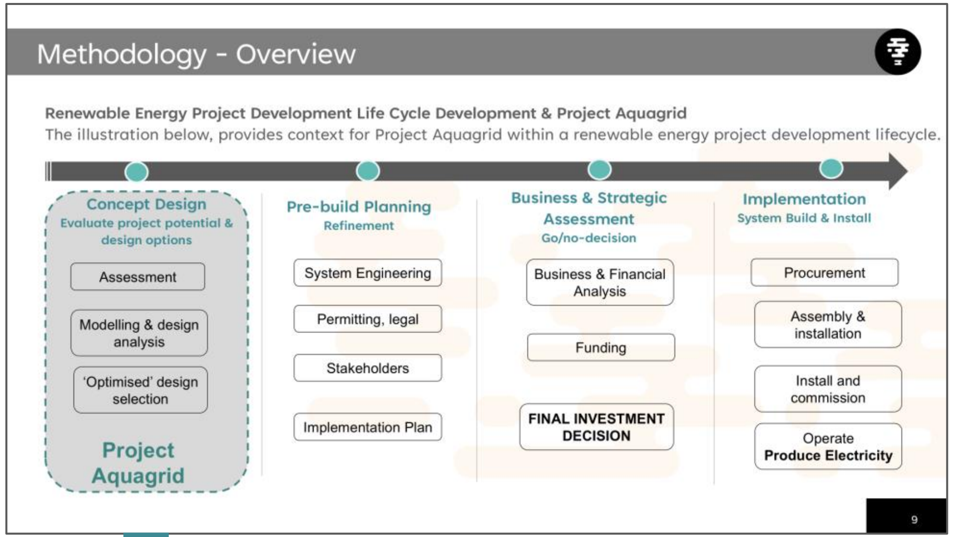
See Attachment-1 for A summary of the Aquagrid design process.

Results: Sub-objectives

Beyond the core objectives, the Team wanted to leverage the successful results to further benefit the aquaculture and ocean energy sectors. These sub-objectives and corresponding results are described in the following slides.

Project Sub-objectives	Status	Detailed Results
Utilise the methodology for the Aquagrid design process as a blueprint for aquaculture companies to pursue ocean energy microgrid systems for their own operations.	**Achieved!**	**See Slide 36 & Attachment-1**
Demonstrate the value-proposition for ocean energy, leading to new market opportunities.	**Achieved!**	**See slide 37**

Results: Sub-objective, Design Process Summary

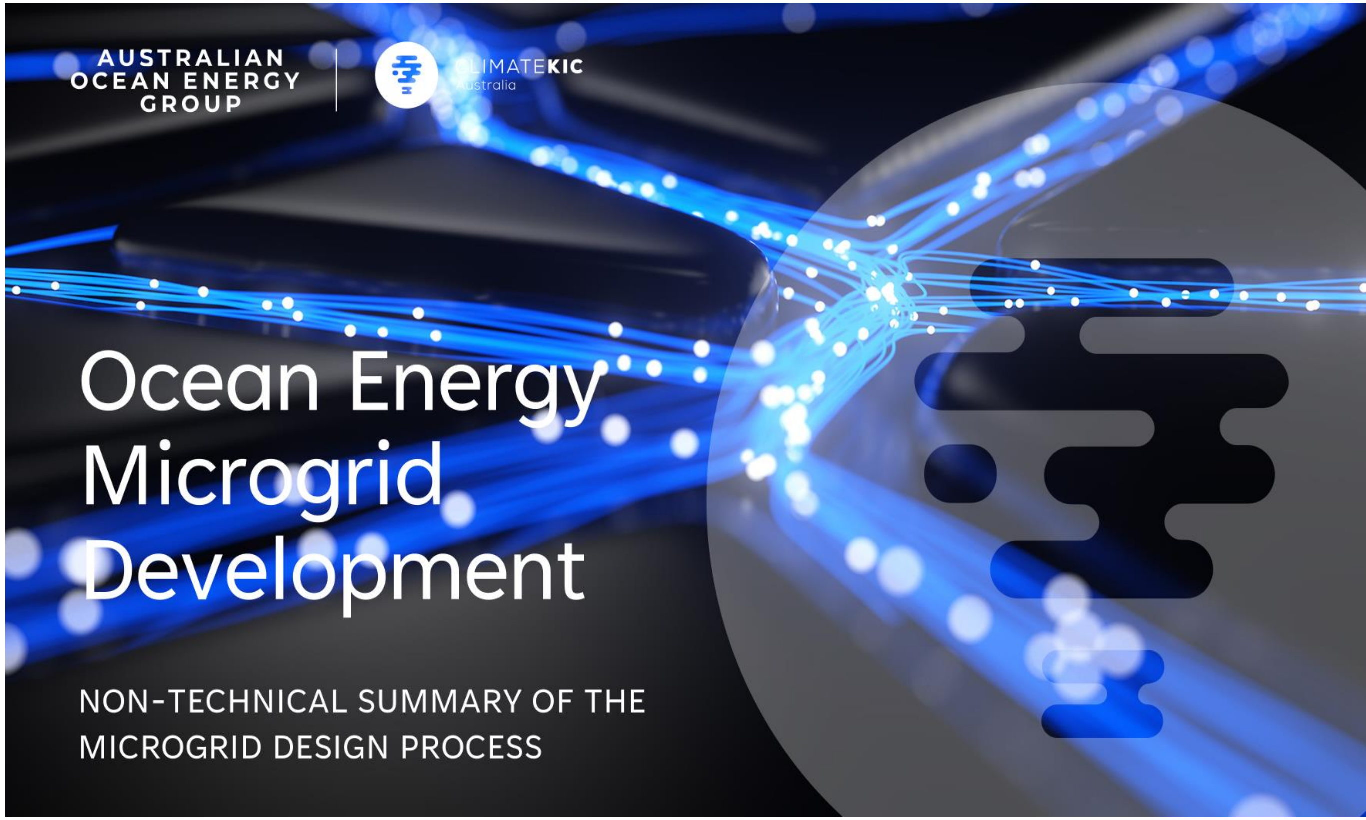


Sub-objective Met!

Utilise the methodology for the Aquagrid design process as a blueprint for aquaculture companies to pursue ocean energy microgrid systems for their own operations.

Attachment 1

provides summary of the Aquagrid design process.



Results: Sub-objective, Ocean Energy Sector

Sub-objective Met!

Demonstrate the value-proposition for ocean energy, leading to new market opportunities

Slide 30 documented the benefits of adding wave energy with other renewables and storage into a microgrid system (per slide 31 and Attachment-2). The following benefits to the ocean energy industry may result from increasing demand for ocean energy microgrid systems.

- Demand for different types of wave and tidal devices will increase as a diversity of aquaculture operators and other coastal-based businesses pursue development of an ocean energy microgrid systems.
- Ocean energy technology developers will be able to secure customers, which will help attract investment.
- As the benefits of ocean energy microgrids are demonstrated through additional applications, demand will continue to increase domestically and internationally.

Results - Communications

Communicating the results of Project Aquagrid was an important aspect of our project

Project Web Page

A project web page was produced to direct interested parties to an overview of the project: www.oceanenergygroup.org.au/aquagrid

Stakeholder Forum

Team member DES, held a breakfast forum with a specially invited group of individuals representing a variety of organisations. The purpose was to seek stakeholder feedback on the project results and provide input and ideas on ways to progress development of the microgrid into the next phase. Attendees included: FRDC, DECCA, RDV, Iberdrola, Mondo, Exxon Mobil, Energise-Renewables, Impact Investor and CIS.

Industry Roundtable

The Project Team held an industry roundtable to share Project Aquagrid's results with aquaculture and ocean energy leaders and seek their interest in adopting a similar microgrid system. Additional attendees also included FRDC, Blue Economy CRC and Seafood Industry Australia (SIA).

Conference Presentations

Results from Project Aquagrid were formally presented at Seafood Directions and the International Conference on Ocean Energy in September 2024.

Article

FRDC commissioned a comprehensive article about Project Aquagrid, which will be completed in December 2024.

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AQUAGRID
Learning Journey: Results

Results – Learning Journey

Collated Team Learnings about how well the project results aligned with the project goals & validity of the outputs

Proving the hypothesis

Validated Hypothesis: The hypothesis was supported by a comprehensive analytical framework and extensive sensitivity analysis (*per slides 27-32 and Attachments 2 & 3*).

Subjectivity of Affordability: The concept of "affordability" remains subjective. Further data from actual system deployment would help validate the hypothesis by providing concrete evidence to support—or challenge—the initial thesis.

Limitations of the Results

Site-Specific Design Requirements: Each future site will require a customized design, tailored to its unique variables in renewable energy access and system optimization.

Complexity of Off-grid Analysis: Fully off-grid systems involve additional complexity. While the SoM model included off-grid scenarios, these results may not be universally applicable. In many cases, existing diesel generators may be too lightly loaded to operate effectively alongside wave energy, requiring various generator sizes and a sophisticated switching mechanism between units.

Need for Assumptions in Certain Variables: Some assumptions were necessary for specific variables. While this stage provides a preliminary view of optimal solutions, further analysis—including business planning, implementation strategy, and stakeholder engagement—would be essential before making a final investment decision.

Transformative Results

Breakeven Analysis Framework: The breakeven approach revealed the actual costs and benefits of each scenario, establishing a precedent for others to evaluate integrated microgrids as a viable option for current or future clean energy planning.

Wave Energy as a 'load balancer': A key insight was the capability of wave energy systems to 'load-balance' fluctuations in solar output, which can vary rapidly. Wave energy helps dimmish sudden changes in the system.

Credibility of Ocean Energy: The AquaGrid project addressed numerous unknowns, significantly enhancing the credibility of ocean energy as a clean energy solution.

Collated Team Learnings about how well the project results aligned with the project goals & validity of the outputs

Benchmarking for comparison in future projects

Exemplar Methodology for Comparative Analysis: The AquaGrid methodology serves as a model for evaluating and comparing scenarios across multiple dimensions, including emissions reduction, fossil fuel redundancy, cost analysis, and an integrated systems approach.

Future Methodology Enhancements: The next iteration could further highlight wave energy potential in fully off-grid applications, requiring minimal or no additional solar input.

Broad Applicability to Aquaculture: The findings are relevant to the aquaculture sector, where continuous 24/7 seawater pumping and reliable energy supply are critical requirements, as seen with SoM's operations.

Foundational Benchmark with Scope for Expansion: While AquaGrid provides a valuable foundation for comparison, future applications should broaden in scope to address greenfield sites without pre-existing renewable infrastructure or established cost structures, unlike this brownfield example.

Implications Beyond Ocean Energy Microgrids

Adaptability: The methodology is adaptable to coastal, island, remote community, and infrastructure grids.

Application: The process and methodology can be applied to various microgrid applications, whether or not wave energy is included, such as tidal energy, waste-to-energy, community energy initiatives, and other emerging renewable technologies.

Economies of scale: Integrating wave energy with aquaculture systems offers economies of scale and creates opportunities to export excess power to the grid.

Suitability: The methodology is suitable for any integrated renewable energy planning. With access to device specifications and output data, various modeling combinations can be explored, enriching the data sets and enhancing the value of the outputs.

Large-scale project application: There is potential to use the Aquagrid design methodology in large-scale projects incorporating wave energy as a power source.

Collated Team Learnings about how well the project results aligned with the project goals & validity of the outputs

Additional Learnings – Ocean Energy

Wave Energy as a Complementary Power Source: Integrating wave energy provided system inertia as well as an effective alternative to chemical batteries, functioning like a natural battery with a lower carbon footprint and a more favourable social license.

Cost-Benefit Analysis: The financial feasibility of a wave energy microgrid can be neutral or even advantageous in locations with inherent benefits for wave energy capture. Factoring in reliability and sustainability can enhance the business case, potentially converting operating expenditures (OPEX) into capital expenditures (CAPEX) for long-term savings.

Mooring System Considerations: The design and cost efficiency of the mooring systems that secure the devices to the seafloor were identified as crucial factors for project success.

Cable Installation Strategy: Cabling is a significant cost component. Traditional ocean cable installations involve trenching or laying cables on the seabed. This project employs a "sub-surface" or tunnelled cable installation method to help reduce cost, minimize ecological and cultural impacts while enhancing the cable's longevity and structural integrity.

Additional Learnings – Implementation Prerequisites

While the suitability of wave technology is a critical requirement for project implementation, other essential factors include securing regulatory and environmental permits, obtaining community consent, and ensuring robust cost justification.

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Learning Journey: Project Execution

Results – Learning Journey, Project Execution

Collated team learnings about overall execution of the project

Potential Project Obstacles

At the project's outset, key concerns included the availability of wave energy data and the quality of load information from SoM. These challenges were successfully addressed.

The AquaGrid project employed HomerPro, marking the first use of the software with wave energy inputs. This effort resulted in the creation of a unique methodology and data sheets designed for the integration of new components.

Discovered Unknowns

The potential to export excess energy capacity had not been considered at the start of the project or into the modelling analysis.

The project's method of structuring wave energy capital expenditure (CAPEX) as break-even costs yielded valuable insights into cost competitiveness across different scenarios, without depending on uncertain future projections.

Expansion of solar alone to meet SOM's current and future load requirements would not provide sufficient energy to meet SOM's requirements (due to the intermittency) without the addition of extensive storage. Neither expanded solar or battery storage were practical for SOM. However, separate studies evaluating the range of energy generation options for a variety of aquaculture operations, would be useful.

The system inertia benefits derived from the mechanical wave energy device, along with its hydraulic and electrical systems, are OEM-dependent but present an area worthy of further investigation.

Collated Team Learnings about overall project execution

Project Delivery

The diverse and skilled project team was a key asset, contributing significantly to the project's success.

Aquagrid incorporated a well-balanced and effective mix of technical expertise, project management, and facilitation.

Effective planning and management, including substantial initial investment in understanding the aquaculture industry's decision-making processes, were essential for achieving successful outcomes.

Project Aquagrid emphasized ongoing communication and secured active engagement from all team members.

The project achieved positive outcomes by integrating activities beyond technical work, such as presenting results at industry conferences and hosting stakeholder events, which generated visibility and secured buy-in *(see slide 36 for list of communication activities)*.

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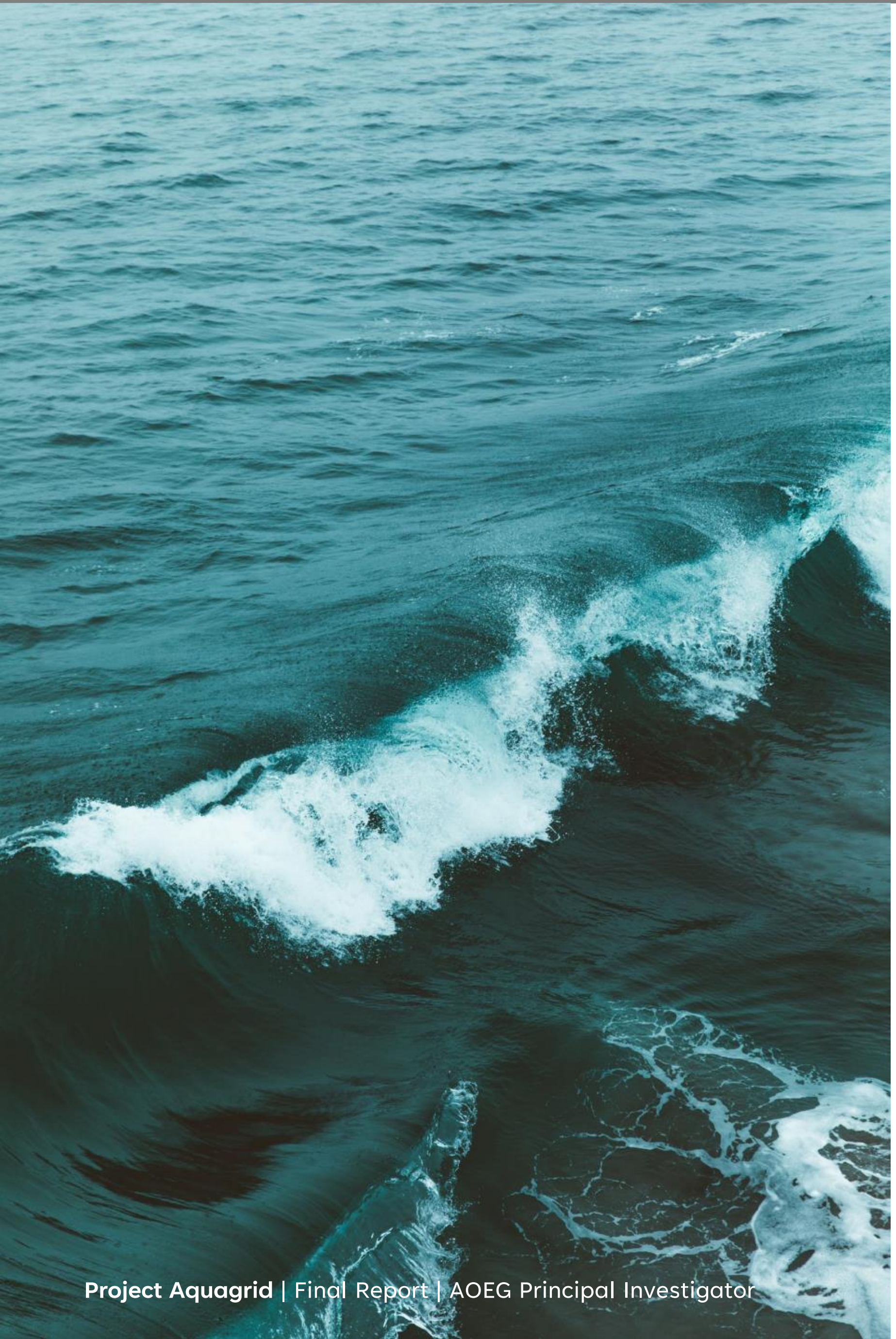
Conclusions



Scalable Alternative Energy Solution

The modelling and overall methodology provided a replicable, cross-sectoral approach that demonstrated the decarbonization benefits of wave energy for an aquaculture operation, though further refinement is needed to address project delivery risks specific to wave energy adoption. This conclusion emphasizes the innovative, collaborative, and data-driven approach of the modelling or the proposed microgrid system for SOM, along with the need for additional considerations for practical implementation of the microgrid system. The case study approach increased awareness of microgrid energy systems amongst commercial producers, and reciprocally, commercial challenges and considerations of technology adoption of ocean energy systems.

Contribution of Ocean Energy

- **Ocean energy facilitates the development of a reliable energy network by optimizing combinations of renewable energy sources. Wave energy, in particular, offers a sustainable solution for meeting the energy demands of aquaculture, enhancing climate resilience and supporting decarbonization efforts.** The results highlight wave energy's unique capability to deliver seasonally and diurnally consistent, renewable power for aquaculture operations, especially those that include hatcheries requiring large power demands during the night. When complimenting solar energy, the need for battery storage is reduced, compared to stand alone solar power energy systems.

Optimised Design & Strategic Alignment

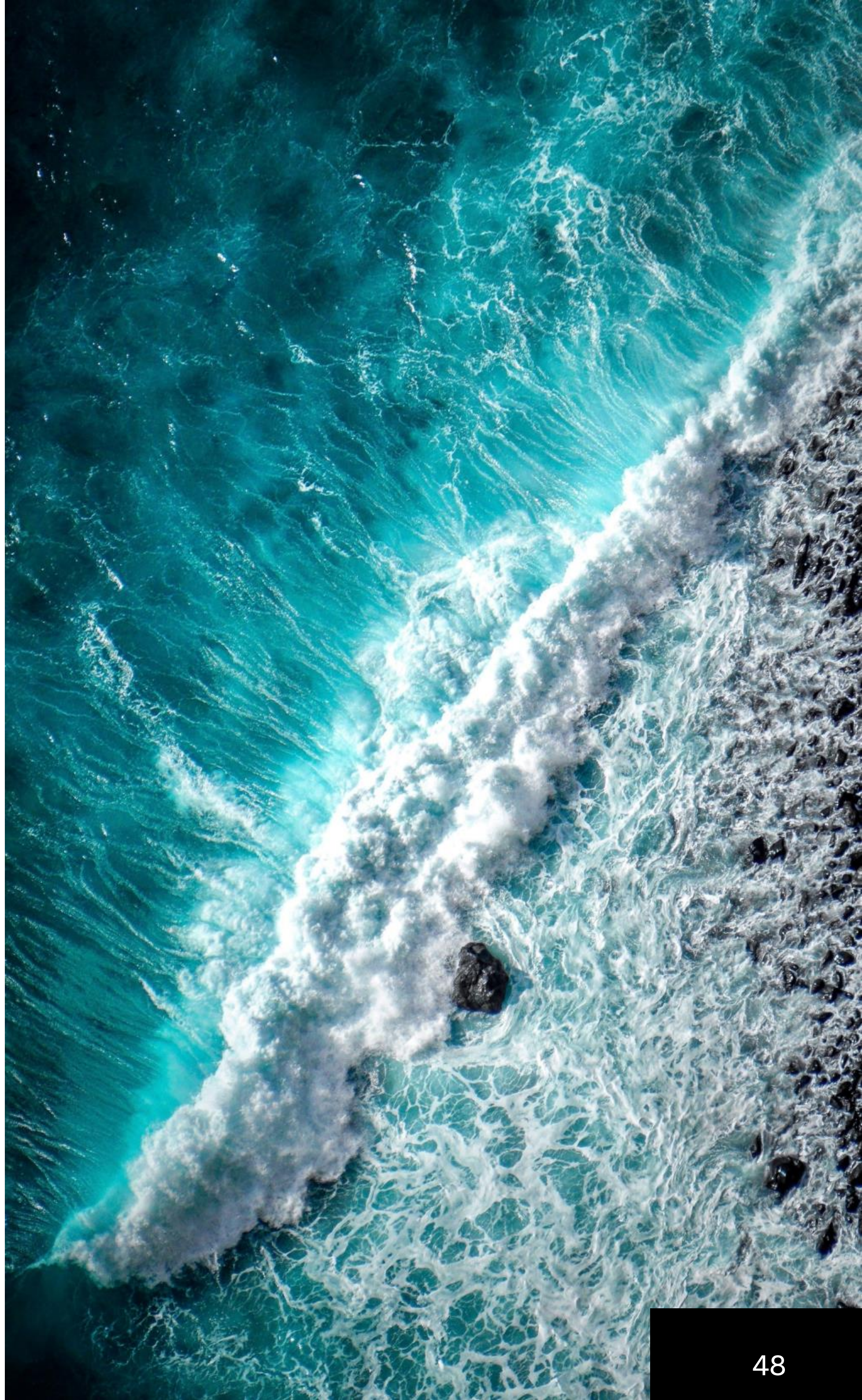
A preferred or 'optimized' wave energy microgrid design was developed to align with SOM's strategic and operational goals; providing a practical solution that meets load requirements, significantly reduces emissions, and outlines a clear energy transition pathway through advanced modeling. By eliminating the need for additional land, such as for solar installations, it preserves natural landscapes while enhancing SOM's sustainability credentials and reducing dependence on grid-supplied electricity, mitigating price volatility. Additionally, the system offers the potential for extra revenue through the sale of excess energy, contributing to long-term financial sustainability.

Emissions Reduction

The integration of ocean energy into a land-based microgrid system, combined with ongoing grid decarbonization efforts, reduced calculated emissions. The analysis indicated that implementation of the Aquagrid design would place SOM on a path to achieving net-zero emissions well before 2050. Once the ocean energy microgrid becomes operational, it would substantially replace grid-supplied electricity with renewable ocean energy, further advancing SOM's sustainability goals.

Non-technical

The project's success was driven by a balanced focus on both technical and non-technical aspects, emphasizing a collaborative co-design process, strong team alignment, end-user engagement, proactive government support, and transparent data-sharing. This highlights the importance of integrating technical rigor with team collaboration along with flexible, needs-based approaches for achieving effective outcomes.



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Attachment - 1

NON-TECHNICAL SUMMARY OF THE MICROGRID DESIGN PROCESS

Non-technical Summary of the Microgrid Design Process

A sub-objective of this project was to utilise the methodology for the design process as a blueprint for aquaculture companies to pursue ocean energy microgrid systems for their own operations *(see slide 12)*.

The process by which the microgrid was designed is replicable. However, each microgrid system is bespoke due to each end-user's specific variables. These include:

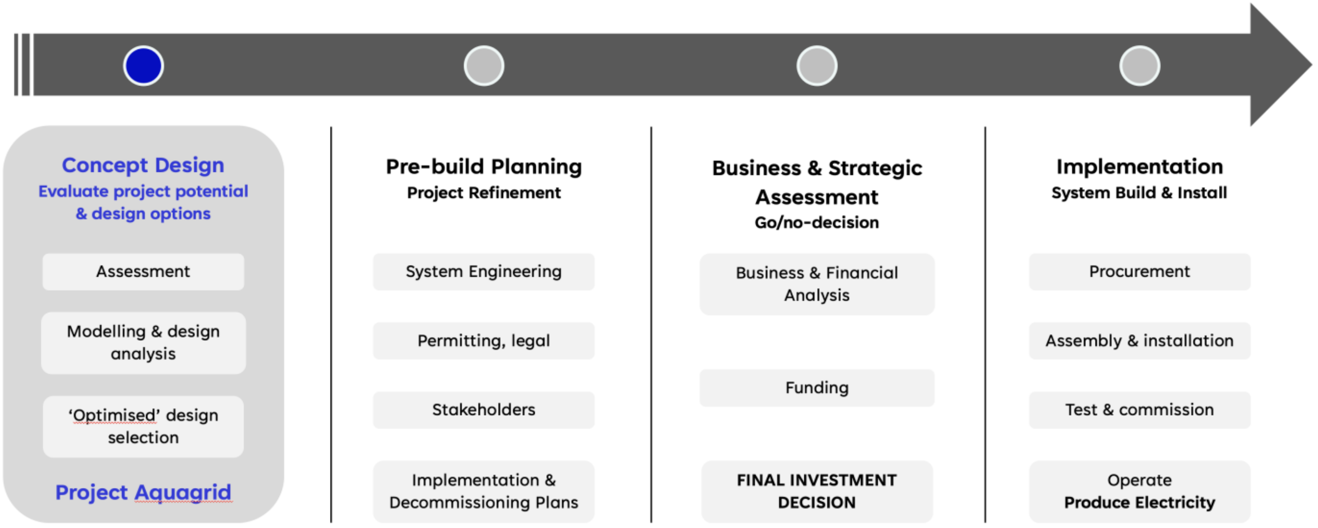
a) the end-user's individual energy objectives and requirements,

b) Resource characteristics, such type (wave or tidal) and its location relative to project site and energy strength,

c) the ocean energy device (wave or tidal) selected for the site may differ and result in energy production capacity and corresponding operating requirements unique to its operating location, and

d) variable and changeable energy supply considerations (eg, costs of grid electricity, volume of use and cost of diesel, land availability for other renewable generation, etc.)

It is important to note that the process described in this section is by definition generic. To develop a successful design, an aquaculture entity will need to build their own data set and have access to (or re-creation of) the modelling tools developed for this case study.



Each of the three (3) steps were guided by a set of questions to assess readiness to proceed to the next step

1 Assessment

Challenges: What specific energy issues are we aiming to address?

Energy Objectives: What are our primary energy goals and how do they align with broader sustainability targets?

Readiness: Are we prepared to integrate a new energy system to effectively address these challenges?

Resource Availability: What renewable energy resources, including ocean energy, are accessible at our location?

Design Approaches: Should we explore a microgrid-based solution, or would alternative measures—such as energy efficiency improvements, equipment upgrades, or offsets—better meet our objectives?

Data Availability: Do we have sufficient data to initiate modelling and scenario assessments to guide our decisions?

2 Modelling/Design

Modelling Tool provider: HomerPro software is proven to be the right modelling tool. Who has the expertise to conduct the modelling?

Data Set Adequacy: Is the dataset compiled from Step-1 comprehensive and reliable?

Modelling Assumptions: Do we have a complete list of assumptions for input into the modelling scenarios?

Scenario and Assumption Range: Are the range of scenarios and assumptions for the modelling sufficiently comprehensive. For example, consideration for future expansion to meet potential growth or changing needs.

Feasibility of Results: Did the completed modelling yield one or more scenarios that appear feasible and align with our strategic energy objectives?

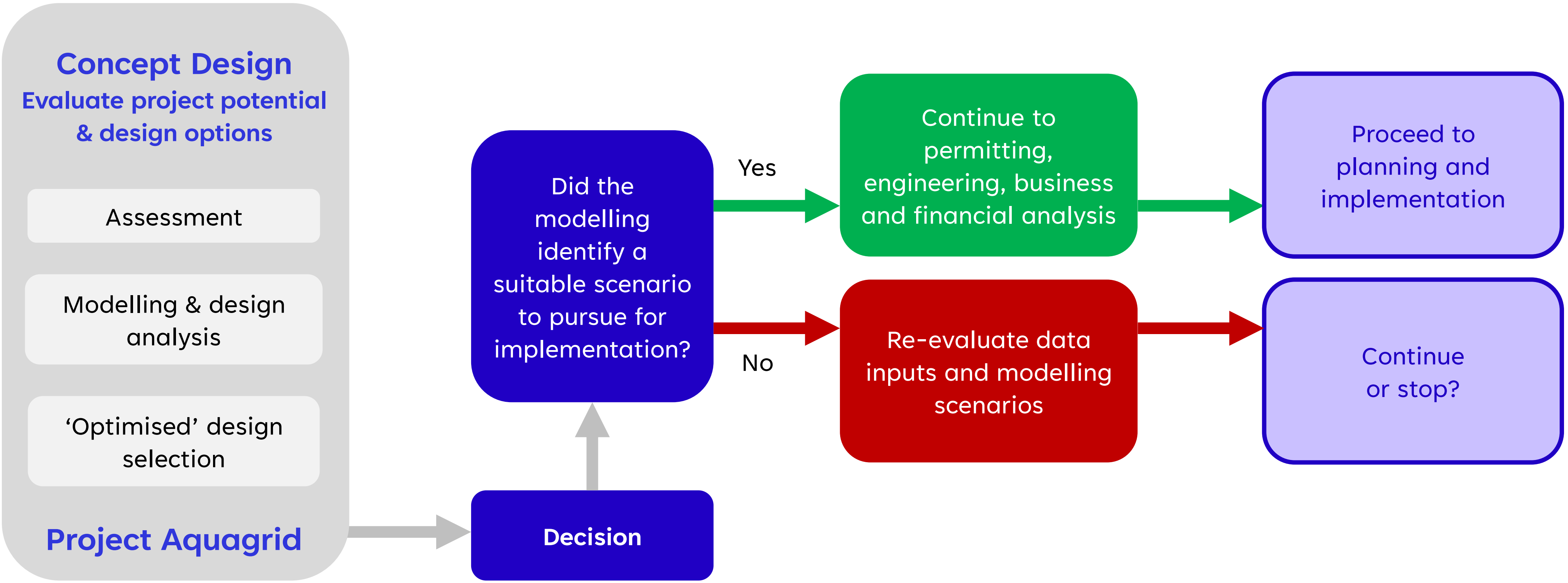
3 Optimisation

Meeting Objectives: Do one or more modelling outputs meet our strategic, energy and operational requirements?

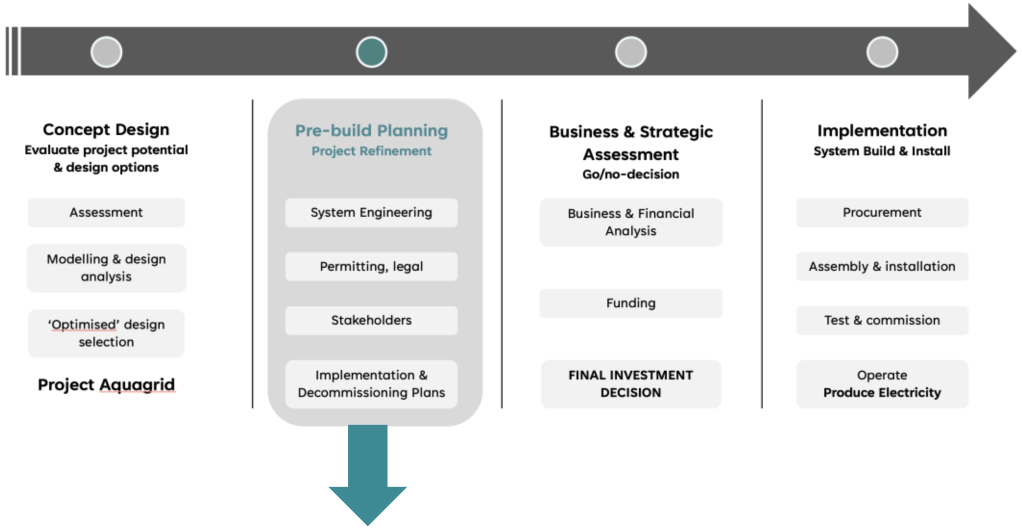
Basis for Business Case and Implementation Strategy: Will the preferred design scenario support the development of a robust business case and implementation strategy?

Stakeholders: Have we engaged all relevant stakeholders—including community, cultural, heritage, and environmental groups—and incorporated their needs and concerns into our planning?

The decision to proceed to system build and implementation is based on the quality of the design outputs.



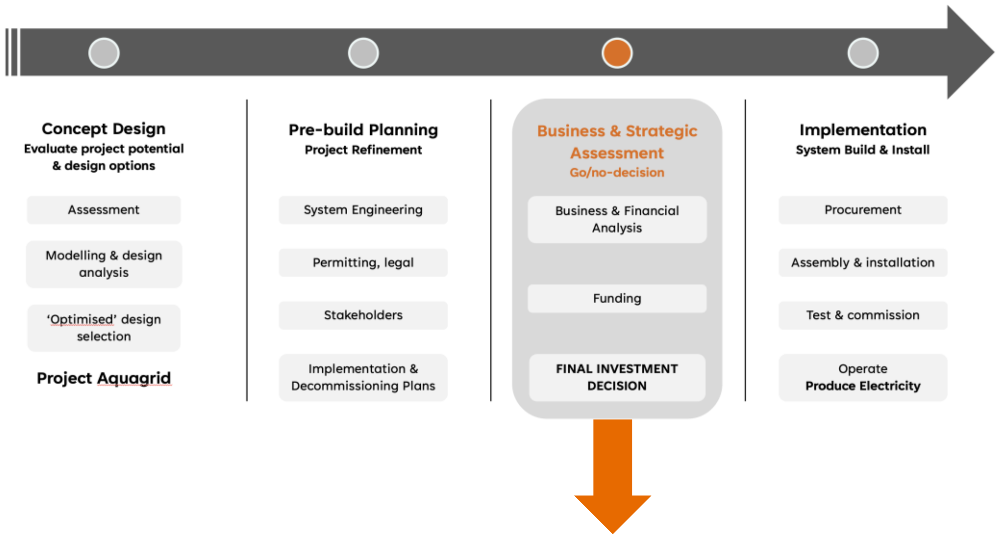
Attachment 1 – Indicative Implementation Checklist



While the scope of Project Aquagrid did not include system planning beyond the design phase, below are a set of questions to facilitate the **pre-build planning** process.

Stage	Pre-build Planning – Project Refinement
Pre-build Planning Project Refinement	**Engineering, Implementation and Decommissioning Plans:** Are comprehensive engineering and system delivery implementation plans finalized? **Permitting Strategy:** Is the permitting strategy finalized and fully understood, including identification of each permitting agency, their approval requirements, timeline, and costs? Have permit applications been submitted? **Understanding our Stakeholders:** Do we understand who our key stakeholders are? b) Have we engaged all relevant stakeholders, including community, cultural, heritage, and environmental groups, and considered their needs and concerns? c) Do we know which stakeholders may oppose the project? d) Can we identify which stakeholders are prepared to provide letters of support for permit applications? **Preliminary funding strategy:** Have preliminary funding sources been identified? Do we have sufficient feedback from target funders to establish a funding strategy? **Supplier readiness:** Will energy generation providers be ready for deployment upon approval from the permitting agencies?

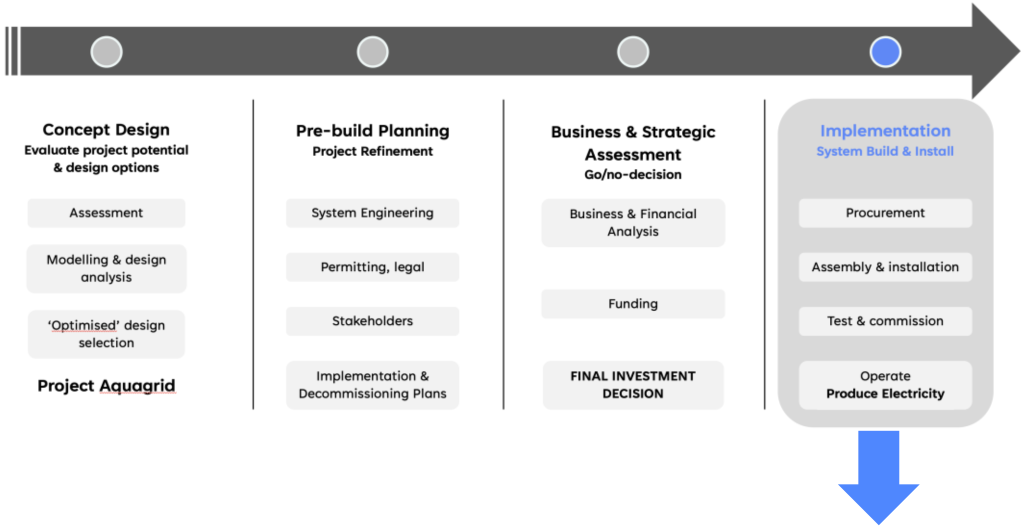
Attachment 1 – Indicative Implementation Checklist continued



While the scope of Project Aquagrid did not include system planning beyond the design phase, below are a set of questions to facilitate the **business and financial** assessment.

Stage	Business & Financial Analysis
Business & Strategic Assessment Leading to Final Investment Decision	**Whole of project cost estimate:** Are detailed engineering plans completed and adopted internally? Are we satisfied with the assumptions used to prepare the initial implementation plan, including governance aspects (eg, system ownership & operation, etc?) **Implementation plan:** Have we completed a comprehensive implementation plan that provides a complete picture for development (eg, project delivery team, data management/IT, risks, suppliers, assembly, etc.)? **Procurement:** Have we secured all suppliers, have they provided final cost estimates, and are they ready to implement? **Funding:** Do we have achievable funding targets? What are the potential barriers and/or risks? **Stakeholder Support:** Have letters of support from stakeholders been included with all permit applications? Do we have an ongoing stakeholder engagement strategy to support the system build? Are all communications material produced and ready to use and/or disseminate? **Permits:** Have all permit requirements been addressed and are permit applications pending? Are there any potential barriers to approval? **FINAL INVESTMENT DECISION:** Are we ready to decide whether to proceed with system build or not?

Attachment 1 – Indicative Implementation Checklist continued



While the scope of Project Aquagrid did not include system planning beyond the design phase, below are a set of questions to facilitate the **system build and execution**.

Stage	Implementation - System Build
System Build & Operation	**Delivery Team:** Are all delivery team members secured and ready to implement the build? **Permits:** Have all the permits and consents been approved and finalised? **Procurement:** Are all suppliers confirmed and ready to implement? Is all required equipment and necessary resources secured? **Stakeholders:** Have we responded to all stakeholder concerns and/or are there any remaining stakeholder concerns that may hinder the system build? Are all communications material produced and ready to use and/or disseminate? **System components:** Are all system components on site and ready for assembly? **System testing:** Are test activities defined, test criteria for passing and compilation of results completed? **System commissioning:** Is testing complete and formally or informally certified to operate? **System fully operating and producing electricity!**

Attachment - 2

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Integrated Ocean Energy Microgrid Study

Scenario Modelling Overview

2024

Scenario Modelling Overview: Summary

Southern Ocean Mariculture's Abalone farm in Port Fairy VIC was used as a reference to model a typical aquaculture energy solution

- Typical energy usage to many aquaculture farms in Australia where energy use dominated by water pump and cooling/heating of water for on-site aquaculture processes, including a hatchery and packaging plants.
- The site is located on the coastline with direct access to a premium wave energy environment on the shoreline of their abalone processing operations.
- A 12-month sample period (2023) for energy use was an annualized at 1,800,000 kWh

Key stakeholders representing the site operations selected potentially viable energy generation scenarios for the modelling and were engaged throughout to determine the performance requirements for future energy systems for the site. They

- 18 (S1 – S18) scenarios modelled using HOMERpro micogrid software.
- Sensitivity analysis conducted for 5 variables.

Two options were selected through multi-criteria assessment framework across scenarios:

Scenario	Wave	Solar PV	Battery	Diesel (backup)	Grid
INITIAL PROJECT DEVELOPMENT Scenario 4: Integrating Wave Energy	200 kW	250 kW	-	550 kVA / 440 kW	National Electricity Market (NEM)
EXTENSION PROJECT DEVELOPMENT Scenario 6: Expanded Wave Integration	400 kW	250 kW	-	550 kVA / 440 kW	National Electricity Market (NEM)

The emphasis on long term operating cost reduction, a blend of increased renewable energy (ahead of grid available), reliability from layers of redundancy determined these 2 scenarios for implementation planning.

Southern Ocean Mariculture = Microgrid Design Optimisation

Assessment of energy solutions for the site in Port Fairy, VIC

Phased Activities

THIS STUDY = Microgrid Analysis

FURTHER PROJECT DEVELOPMENT = Microgrid Implementation (1-2 years)

Current state assessment

Identification

Confirmed the broader business rationale for alternative energy solutions.

Confirmed support for Board and key operational stakeholders.

Clarified potential ownership models for both 100% owner-operator, and blended community sharing of excess generation

Energy Efficiency

Years of operational decarbonisation programs have clarified a sustainable energy load profile for the future operational needs

Future options assessment

Perform Assessment

Applying a screening scenarios for assessment and optimisation. Considering available energy sources.

Confirmed scenarios to be assessed with operations teams and industry experts.

Select a Microgrid

The Microgrid design modelling assessed scenarios using a suitable design tool once inputs and assumptions agreed:

- System capacity with expected demand profile
- Usage data (12months)
- Baseline technology scenarios
- CAPEX / OPEX assumptions
- Estimated lifetime

Evaluated scenarios through multi-criteria framework for selections across scenarios

Business case feasibility & implementation

Implementation

After key decision makers support confirmed. Next is to develop out the project adopting the preferred scenario AquaGrid Implementation Plan to assist the pathway to Final Investment Decision (FID)

Activate a stakeholder engagement to select and confirm project delivery partners and agree project governance and ownership models. Obtain required approvals and guidance on environmental and regulatory approval processes.

Feasibility/ FEED

Develop a Bankable Feasibility Study including full commercial model, consideration for LGCs / carbon offsets and other incentives to subsidise the project implementation.

Final Investment Decision

Secure funding for confirmed project financing model, project implementation scope and schedule. Project Kick Off.

Project Delivery

Complete detailed engineering, procurement construction commissioning and final operational handover. Clarify state-based permits and approvals i.e EnergySafe VIC and equivalent

▲ Go/ No Go stage gate

HOMER Pro

HOMER Pro is a powerful software tool designed to assist in the planning and optimisation of microgrids. It enables users to model and evaluate various energy solutions by simulating different scenarios. Here's how it works:

- Scenario Modelling: HOMER Pro allows you to create and compare multiple scenarios to find the most cost-effective and reliable microgrid solutions. You can input data on energy demand, resources (like solar, wind, and diesel), and economic parameters.

- Technology Evaluation: The software evaluates various technologies (solar panels, custom energy generation devices, batteries, diesel generators, etc.) to determine their performance in the microgrid. It considers factors such as cost, efficiency, and environmental impact.

- Optimisation: HOMER Pro runs simulations to optimise the configuration and operation of the microgrid. It helps identify the best combination of technologies and operational strategies to meet your energy needs at the lowest cost.

- Decision Support: The results include detailed insights into costs, emissions, and system reliability, enabling informed decision-making for the design and implementation of microgrid projects.

By using HOMER Pro, you can confidently design microgrids that are both economical and sustainable, tailored to specific energy requirements.

Modelled scenarios

The following technologies were considered in modelling microgrid scenarios for Southern Ocean Mariculture operations. Through the modelling process, any combination of the below technologies were modelled in HOMER Pro, with the sizing, or capacity, of each component in each scenario either:

- Constrained to represent existing (e.g. solar PV, diesel) assets;
- Constrained to meet specified capacities of new technologies for testing (e.g. x2 or x4 100kW wave units); or
- Optimised by HOMER Pro simulation to meet load conditions based on the lowest LCOE (e.g. expanded solar and wave, and battery systems)

Wave energy device

1. No system
2. 200kW system (x2 units) + 80 kWh storage
3. 400kW system (x4 units) + 160 kWh storage

Solar PV system

1. No system
2. Existing 250kW

Battery storage

1. No system
2. 2.5MWh (size optimised, based on Tesla Megapack units)

Diesel generator

1. No system
2. Existing 550 kVa / 440kW

Grid

or

Off-grid

Key inputs and assumptions – core scenarios

SOM Electricity Demand / Load Profile

Daily load profile for SOM operations based on historical metered data over a 12mo period (2023). Annual consumption approx. 1,800,000 kWh

Project Life

The model simulates the microgrid operating for 25 years. Replacement costs accounted for component replacement occurring during the 25-year period.

Weighted average cost of capital (WACC)

8%

Diesel Price

$1.60 per L which accounts for the government rebate currently claimed by SOM

Grid electricity prices

Based on SOM electricity bills. This pricing includes peak and off-peak pricing as reflected in the real-time use by SOM on their selected energy supply contract. The full inputs is available in the data pack.

$0.15 per kWh (average)

Wave Energy Device - CAPEX

CAPEX based on break-even cost (~$1.5m) to match current SOM system (diesel, grid and PV) that accounts for CAPEX of PV and diesel

Wave Energy Device – Technical

Power output based on device-specific power curve/matrix and the site's wave resource. Daily production for a single unit over a 12mo period provided by Azura.

Wave and Solar Resources

Based on climate and marine/wave information specific to the proposed microgrid site at SOM in Port Fairy.

CAPEX – Diesel, PV, Battery

Diesel CAPEX/Replacement = $320,000

Solar PV CAPEX = $1.20 per W

2.5MWh battery CAPEX = $2m (Based on Tesla Megapack. Data sourced from website)

Emissions Factors

Aligned to the National Greenhouse Accounts Factors (2023). Projected emission factor for the Victorian electricity grid in future years is taken from DCCEEW Emissions Projections (2023)

Model runs simulated

Sensitivity analyses assess the impact of a changed assumption / variable with all other assumptions remaining the same.

CORE SCENARIOS

CAPEX accounted for diesel, PV, and wave (wave capex = breakeven cost)

SENSITIVITY ANALYSES

SA1: WAVE CAPEX

CAPEX impact for wave systems are analysed from 0, 200 and 400kW. Each 100kW unit from Azura cost $1.4m installed

SA2: DIESEL PRICE

Changing diesel prices are analysed from $1.60 per L up to ~$5 per L

SA3: WAVE ENERGY RESOURCE

Impact of reduced (~halved) and increased (~doubled) wave resource is analysed

SA4: SUNK COSTS

Sunk costs for wave systems from 0 to $1.5m for 100kW unit or $3m for 2 x 100kW units. Costs are replacement costs only without depreciation

SA5: GRID Pricing

Grid prices are projected to increase at a growth rate of 2.81% p.a. (which reflects annual growth of ave. VIC grid price for last 25y)

Results – definitions of metrics

- Net Present Cost (NPC): the present value of all the costs of installing and operating the system over the project lifetime, minus the present value of all the revenues that it earns over the project lifetime.
- LCOE ($/kWh): Measures the average cost per unit of electricity generated, considering both CAPEX and OPEX over the system's lifetime.
- CAPEX: Initial capital investment required to deploy the system.
- OPEX: Annual operational and maintenance costs of the system.
- Renewable Penetration (%): The percentage of energy supplied to the system that is being serviced by renewable energy sources.
- TCO2-e/year: Annual carbon dioxide equivalent emissions, reflecting the environmental impact. Provided for 2024.
- 10 Year Cumulative Emissions: Total emissions over a ten-year period, providing insight into the long-term environmental impact.

HOMER-generated scenarios

	Wave	PV	Battery	Diesel	Grid
Base case 1: Old SOM energy system (w/o solar)	-	-	-	550 kVA / 440 kW	NEM*
Base case 2: Current SOM energy system	-	250 kW	-	550 kVA / 440 kW	NEM
Scenario 3: Wave-Diesel Replacement	200 kW	250 kW	-	-	NEM
Scenario 4: Integrating Wave Energy	200 kW	250 kW	-	550 kVA / 440 kW	NEM
Scenario 5: Expanded Wave-Diesel Replacement	400 kW	250 kW	-	-	NEM
Scenario 6: Expanded Wave Integration	400 kW	250 kW	-	550 kVA / 440 kW	NEM
Scenario 7: Wave and Grid only	200 kW	-	-	-	NEM
Scenario 8: Solar and Grid only	-	250 kW	-	-	NEM
Scenario 9: Solar, Battery & Grid	-	250 kW	2.5 MWh	-	NEM
Scenario 10: Disconnect from the Grid	-	250 kW	-	550 kVA / 440 kW	-
Scenario 11: Off-grid + Wave	200 kW	250 kW	-	550 kVA / 440 kW	-
Scenario 12: Off-grid with Solar only	-	250 kW	-	-	-
Scenario 13: Off-grid Solar + Wave only	200 kW	250 kW	-	-	-
Scenario 14: Off-grid with Diesel only	-	-	-	550 kVA / 440 kW	-
Scenario 15: Grid only	-	-	-	-	NEM
Scenario 16: Off-Grid Green #1 (wave + solar + battery)	400 kW	250 kW	-	-	-
Scenario 17: Off-Grid Green #2 (wave + solar + battery)	400 kW	250 kW	2.5 MWh	-	-
Scenario 18: Off-Grid Green #3 (wave + solar + battery)	400 kW	-	2.5 MWh	-	

* National Electricity Market (NEW)

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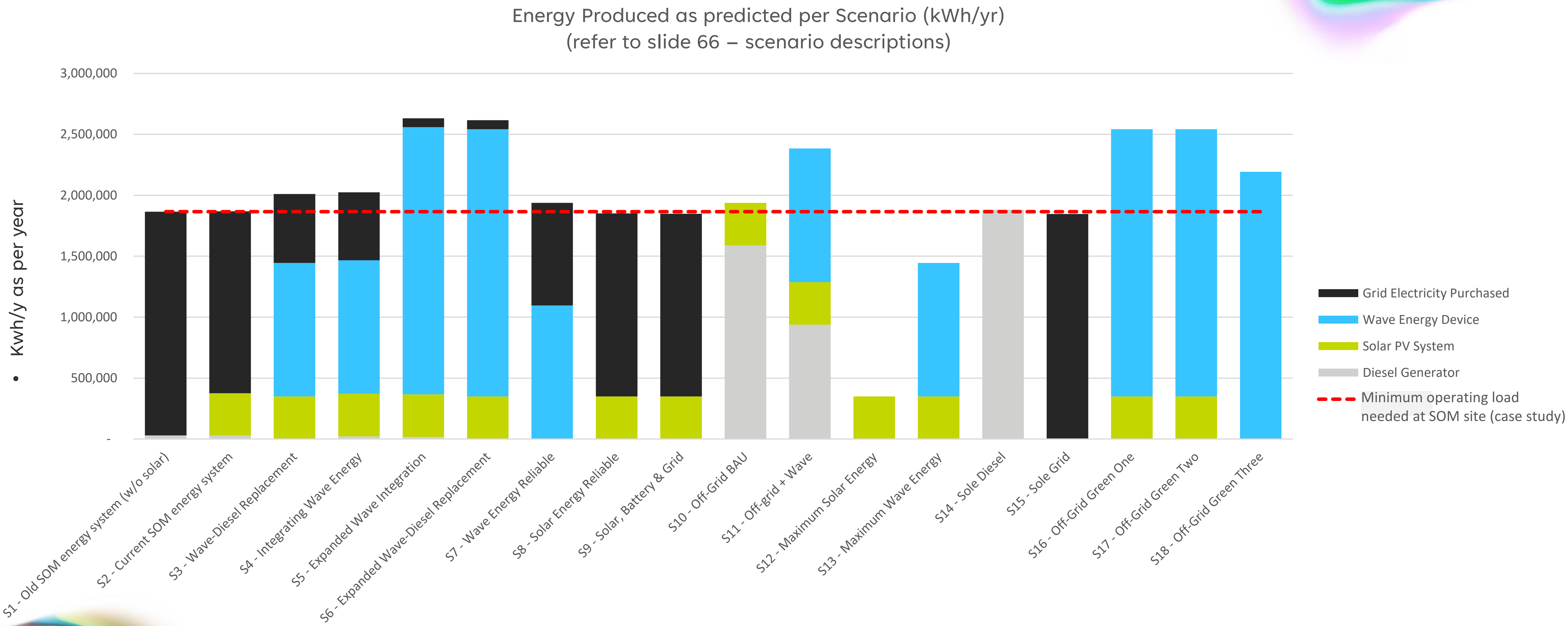
Results – Core Scenario

	S1 - Old SOM energy system (w/o solar)	S2 - Current SOM energy system	S3 - Wave-Diesel Replacement	S4 - Integrating Wave Energy	S5 - Expanded Wave Integration	S6 - Expanded Wave-Diesel Replacement	S9 - Solar, Battery & Grid	S11 - Off-grid + Wave	S16 - Off-Grid Green One	S17 - Off-Grid Green Two	S18 - Off-Grid Green Three
Scenario Components	Diesel + Grid	PV + Diesel + Grid	PV + Wave + Grid	PV + Wave + Diesel + Grid	PV + ExpandedWave + Diesel + Grid	PV + ExpandedWave + Grid	PV + Battery + Grid	PV + Wave + Diesel	PV + ExpandedWave	PV + ExpandedWave + Battery	ExpandedWave + Battery
Meets SOM Energy Load	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Total energy produced (kWh)	1,865,447	1,868,625	2,009,830	2,025,056	2,632,245	2,616,242	1,848,403	2,383,618	2,541,498	2,541,498	2,192,506
Net Present Cost ($)	4,024,727	3,717,862	3,328,619	3,733,038	4,185,244	3,808,244	6,683,922	11,570,140	3,337,435	10,551,990	33,987,250
LCOE ($/kWh)	0.17	0.15	0.13	0.15	0.13	0.12	0.28	0.48	0.68	0.44	1.42
CAPEX ($)	320,000	620,000	1,844,156	2,164,156	3,710,275	3,384,388	2,153,925	2,182,800	3,000,981	7,098,022	19,760,530
OPEX ($/yr)	286,577	239,633	114,830	121,360	36,741	32,787	350,415	726,152	26,026	267,179	1,100,499
Annual Emissions (tCO2e/yr)	1,400	1,141	423	436	69	56	1,125	766	-	-	-
Cumulative Emissions (tCO2e/10y)	9,757	7,959	2,930	3,075	523	388	7,782	7,657	-	-	-
Renewable Penetration (%)	-	19	71	70	96	97	19	50	100	100	100
Microgrid Configuration, Capacity & Production (kW, kWh/year)											
Solar PV System	0kW, 0kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	250kW, 348992kWh	0kW, 0kWh
Wave Energy Device	0kW, 0kWh	0kW, 0kWh	200kW, 1096253kWh	200kW, 1096253kWh	400kW, 2192506kWh	400kW, 2192506kWh	0kW, 0kWh	200kW, 1096253kWh	400kW, 2192506kWh	400kW, 2192506kWh	400kW, 2192506kWh
Diesel generator	440kW, 30289.14kWh	440kW, 27286.32kWh	0kW, 0kWh	440kW, 21795.44kWh	440kW, 16831.05kWh	0kW, 0kWh	0kW, 0kWh	440kW, 938373.3kWh	0kW, 0kWh	0kW, 0kWh	0kW, 0kWh
Wave Battery Throughput	0kWh	0kWh	6594.578kWh	14938.39kWh	116519.4kWh	63233.19kWh	0kWh	18078.53kWh	21.77533kWh	0kWh	0kWh
Tesla Megapack Throughput	0kWh	0kWh	0kWh	0kWh	0kWh	0kWh	2528.887kWh	0kWh	0kWh	86751.84kWh	137960.6kWh
Grid	1835158kWh	1492347kWh	564585kWh	558016kWh	73916.33kWh	74743.76kWh	1499411kWh	0kWh	0kWh	0kWh	0kWh

Energy Production – Core Scenario



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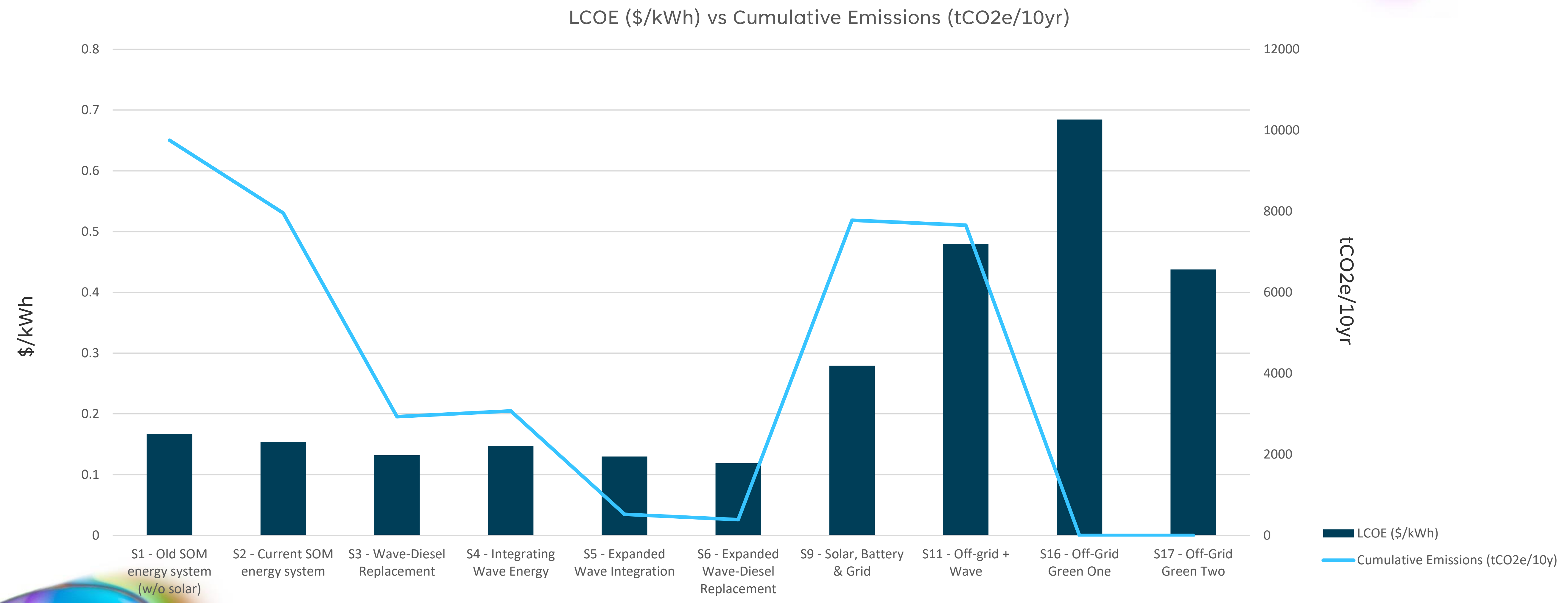
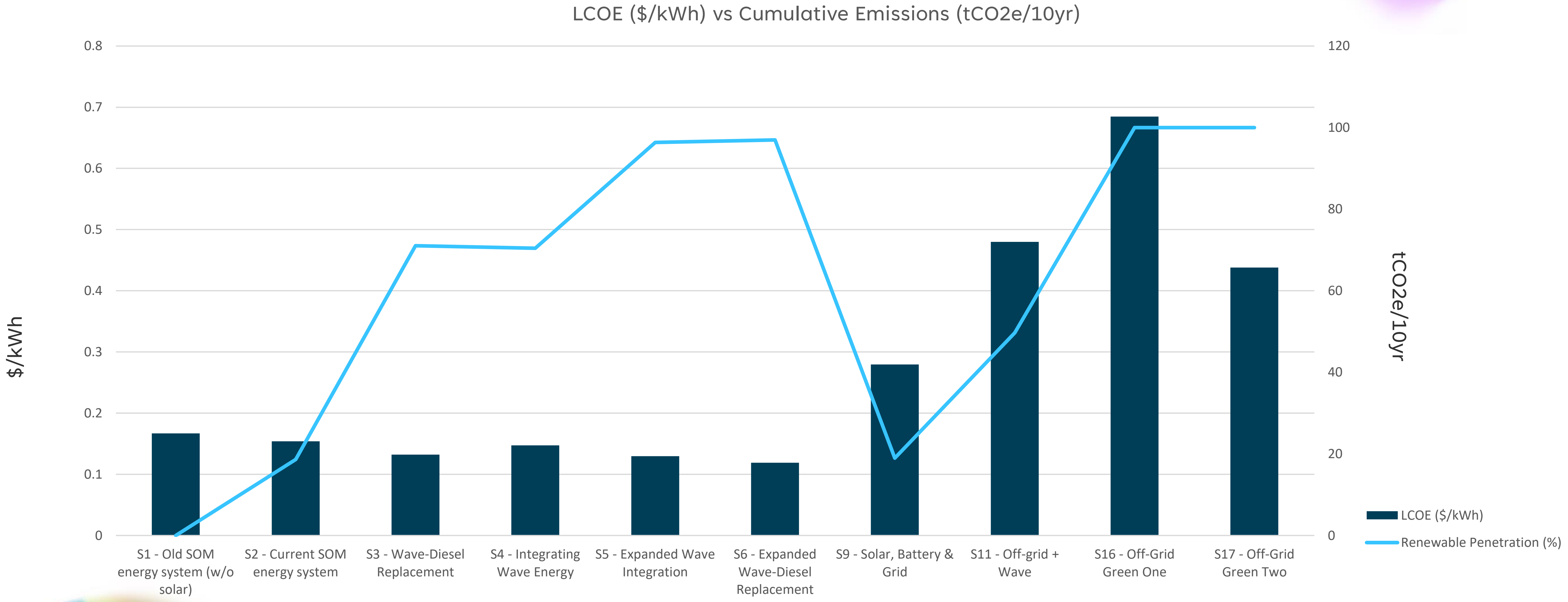
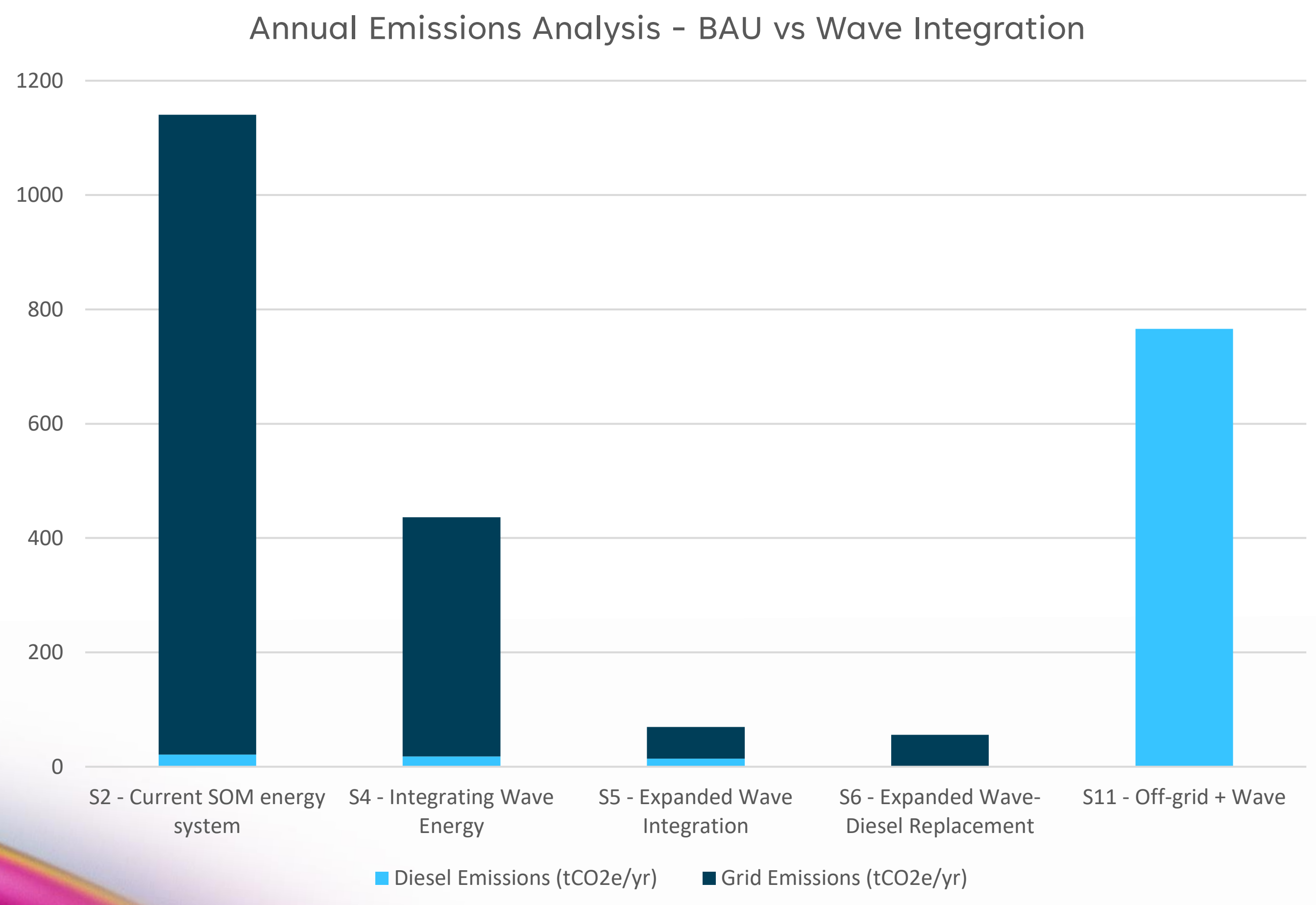
LCOE vs Cumulative Emissions – Core Scenario

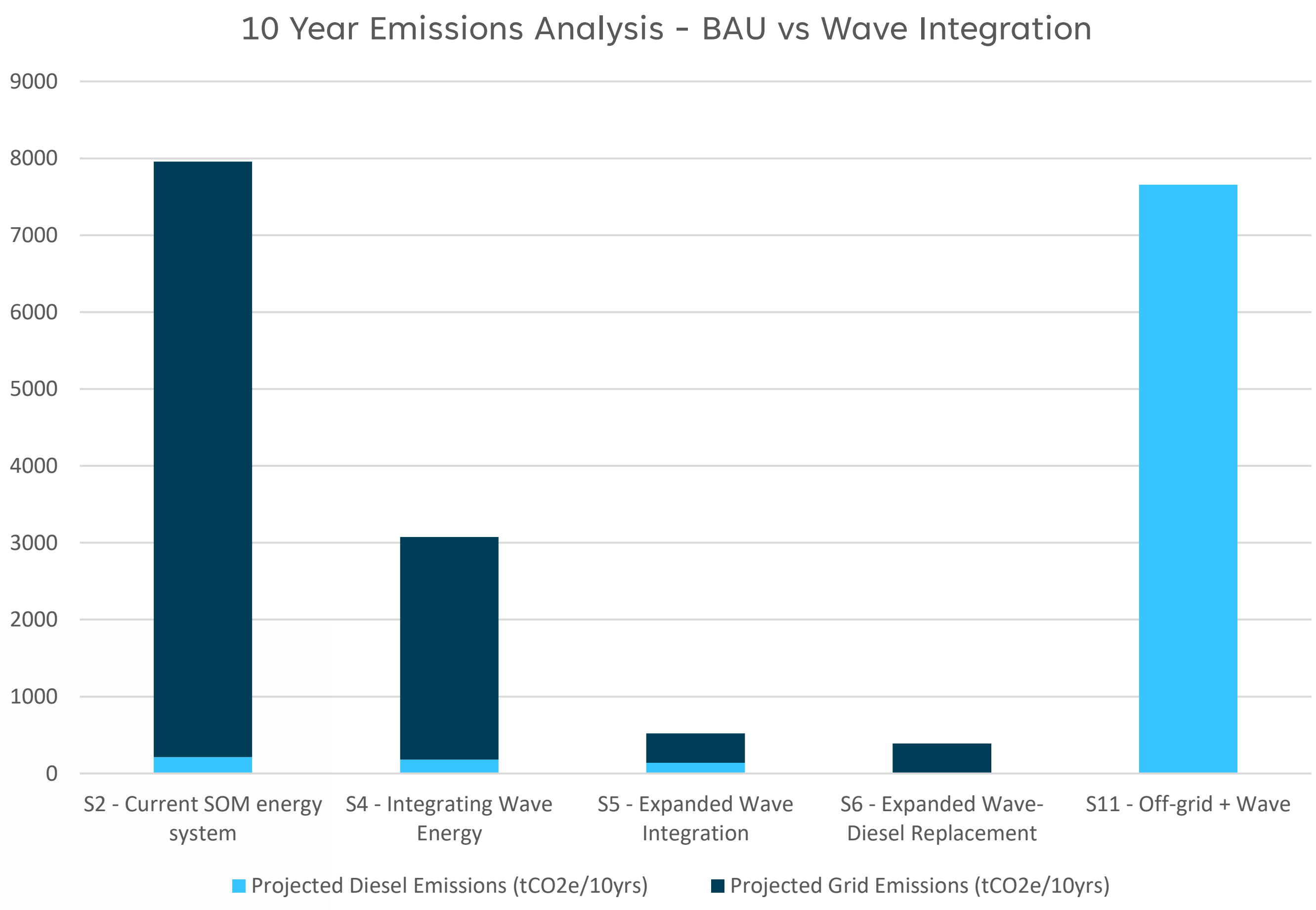


LCOE vs Renewable Penetration – Core Scenario



Results: Current SOM Emissions Profile vs AquaGrid Scenarios





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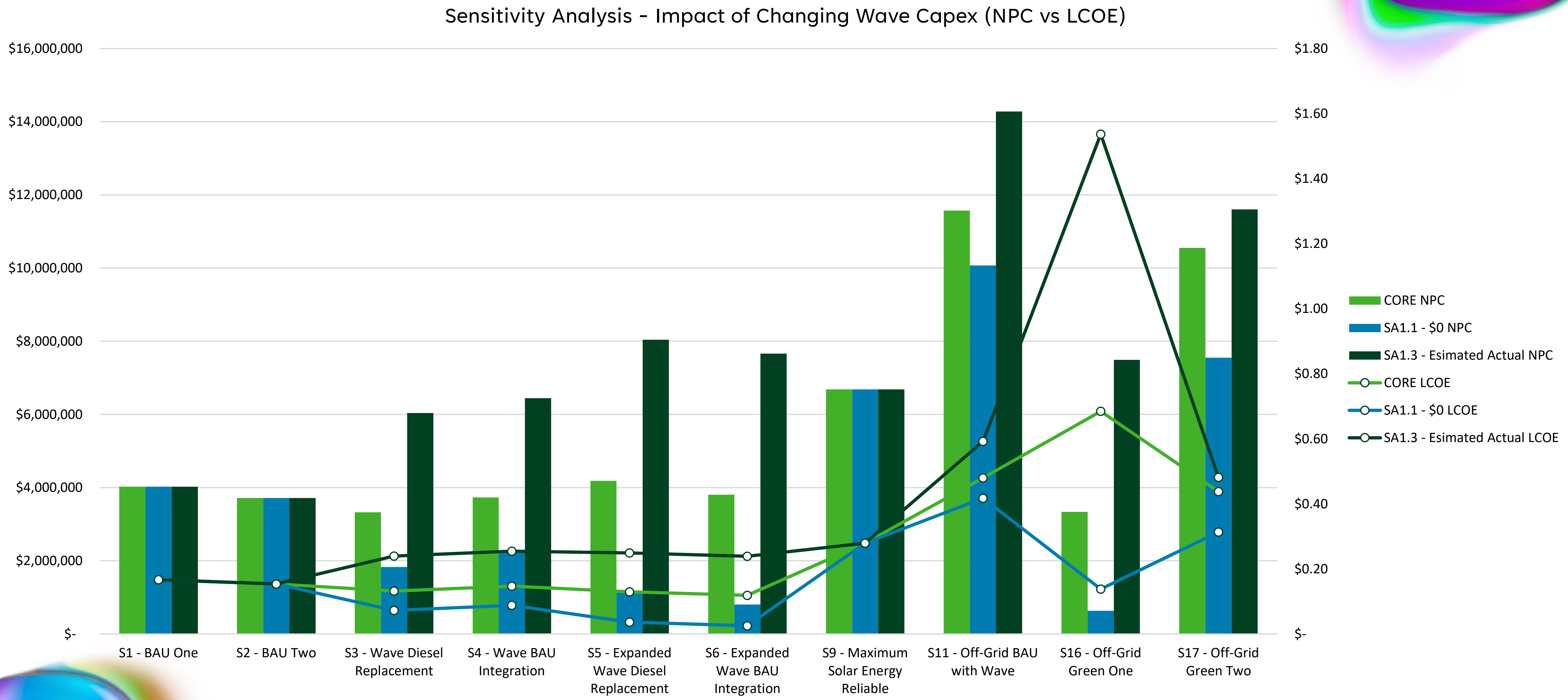
Sensitivity Analysis One – Varying Wave CAPEX



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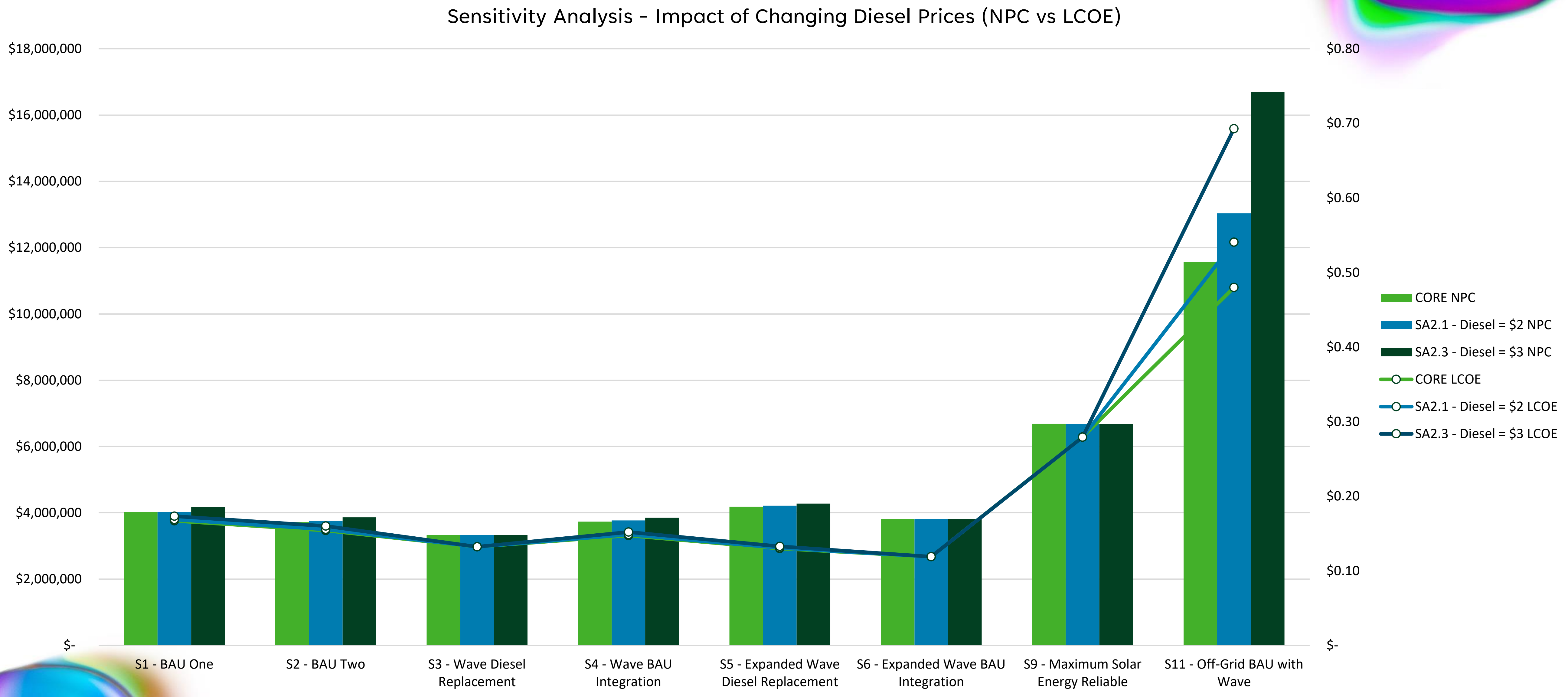
Sensitivity Analysis Two – Varying Diesel Price



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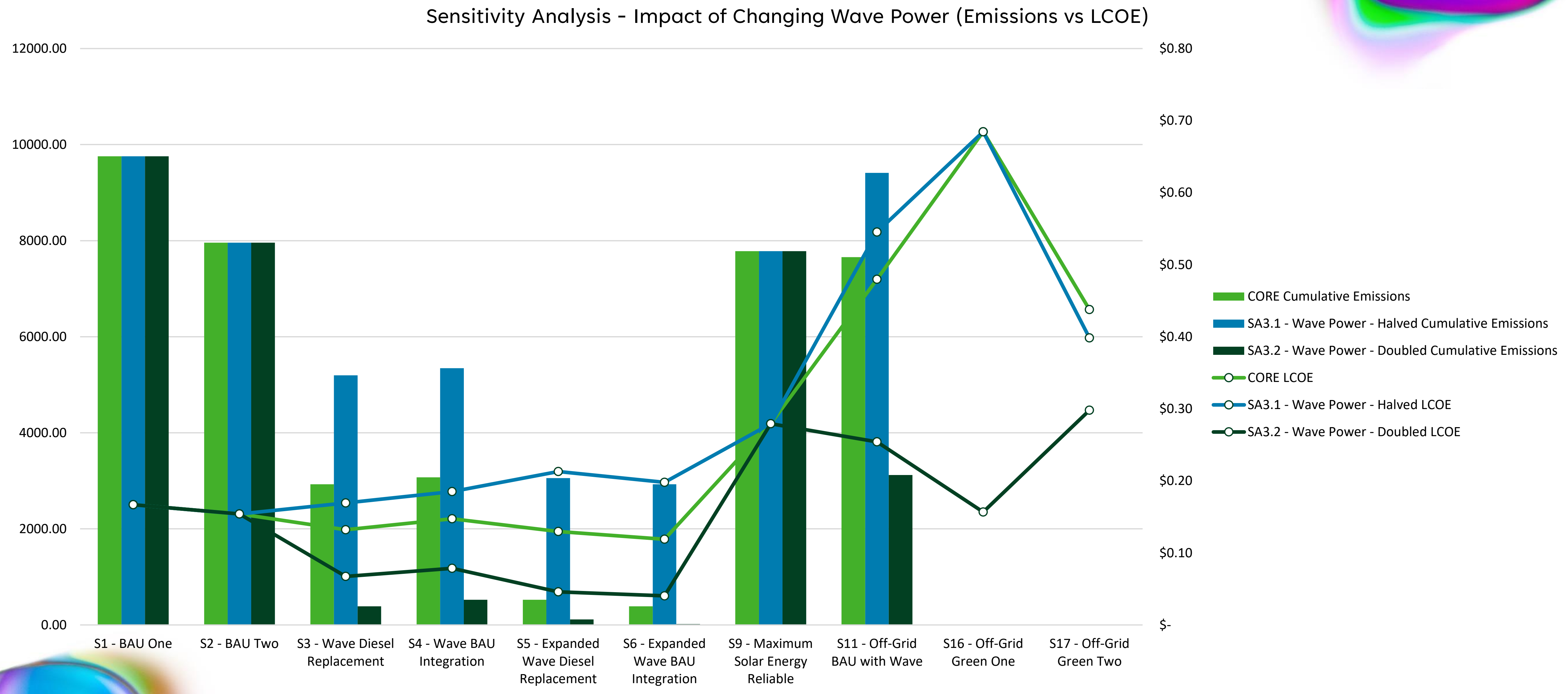
Sensitivity Analysis Three – Varying Wave Power



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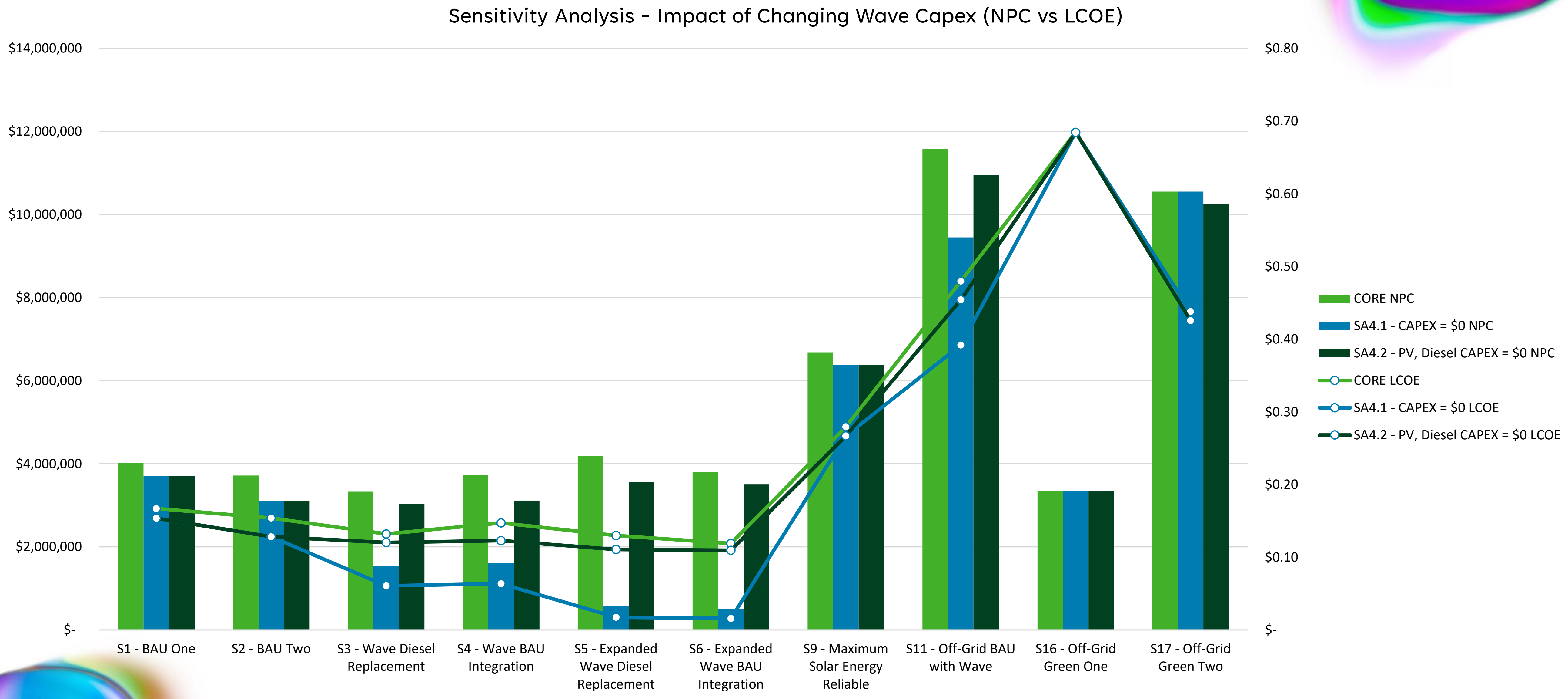
Sensitivity Analysis Four – Varying System CAPEX



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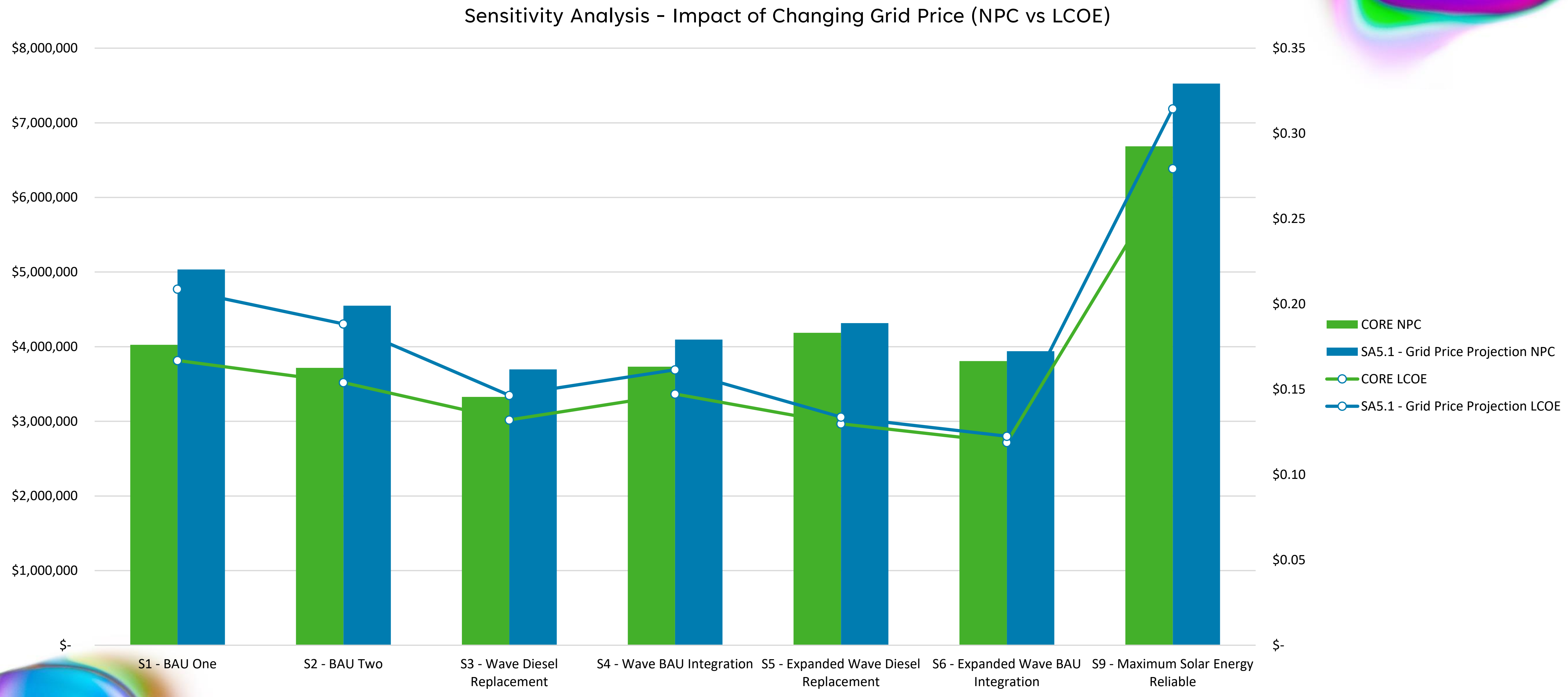
Sensitivity Analysis Five – Projected Grid Pricing



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Results – Sensitivity Analysis 1: Wave Capex

Metric	NPC ($)	Cumulative Emissions (tCO2e/10y)	Renewable Penetration (%)	LCOE ($)
Model Run One - Wave CAPEX = $0				
S1 - BAU One	$ 4,024,727	9,757	0.00	0.17
S2 - BAU Two	$ 3,717,862	7,959	18.64	0.15
S3 - Wave Diesel Replacement	$ 1,828,619	2,930	71.04	0.07
S4 - Wave BAU Integration	$ 2,233,038	3,075	70.43	0.09
S5 - Expanded Wave Diesel Replacement	$ 1,184,895	522	96.36	0.04
S6 - Expanded Wave BAU Integration	$ 808,189	388	96.98	0.03
S7 - Wave Energy Reliable	$ 2,053,451	4,364	55.26	0.08
S8 - Solar Energy Reliable	$ 3,289,952	7,794	18.86	0.14
S9 - Maximum Solar Energy Reliable	$ 6,683,922	7,782	18.98	0.28
S10 - Off-Grid BAU	$ 13,374,510	11,878	14.86	0.55
S11 - Off-Grid BAU with Wave	$ 10,070,140	7,657	49.69	0.42
S12 - Maximum Solar Energy	$ 325,855	-	100.00	0.07
S13 - Maximum Wave Energy	$ 481,381	-	100.00	0.10
S14 - Sole Diesel	$ 14,456,790	13,714	0.00	0.60
S15 - Sole Grid	$ 3,584,805	9,584	0.00	0.15
S16 - Off-Grid Green One	$ 636,511	-	100.00	0.14
S17 - Off-Grid Green Two	$ 7,551,836	-	100.00	0.31
S18 - Off-Grid Green Three	$ 30,987,250	-	100.00	1.29

Metric	NPC ($)	Cumulative Emissions (tCO2e/10y)	Renewable Penetration (%)	LCOE ($)
Model Run One - Wave CAPEX = $1.41m				
S1 - BAU One	$ 4,024,727	9,757	0.00	0.17
S2 - BAU Two	$ 3,717,862	7,959	18.64	0.15
S3 - Wave Diesel Replacement	$ 3,238,619	2,930	71.04	0.13
S4 - Wave BAU Integration	$ 3,643,038	3,075	70.43	0.14
S5 - Expanded Wave Diesel Replacement	$ 4,005,244	522	96.36	0.12
S6 - Expanded Wave BAU Integration	$ 3,628,244	388	96.98	0.11
S7 - Wave Energy Reliable	$ 3,463,451	4,364	55.26	0.14
S8 - Solar Energy Reliable	$ 3,289,952	7,794	18.86	0.14
S9 - Maximum Solar Energy Reliable	$ 6,683,922	7,782	18.98	0.28
S10 - Off-Grid BAU	$ 13,374,510	11,878	14.86	0.55
S11 - Off-Grid BAU with Wave	$ 11,480,140	7,657	49.69	0.48
S12 - Maximum Solar Energy	$ 326,251	-	100.00	0.07
S13 - Maximum Wave Energy	$ 1,891,381	-	100.00	0.41
S14 - Sole Diesel	$ 14,456,790	13,714	0.00	0.60
S15 - Sole Grid	$ 3,584,805	9,584	0.00	0.15
S16 - Off-Grid Green One	$ 3,457,435	-	100.00	0.71
S17 - Off-Grid Green Two	$ 10,371,990	-	100.00	0.43
S18 - Off-Grid Green Three	$ 33,807,250	-	100.00	1.41

Results – Sensitivity Analysis 1: Wave Capex (Pt. 2)

Metric	NPC ($)	Cumulative Emissions (tCO2e/10y)	Renewable Penetration (%)	LCOE ($)
Model Run Two - Wave CAPEX = $1.41m + $1.4m per Unit				
S1 - BAU One	$ 4,024,727	9,757	0.00	0.17
S2 - BAU Two	$ 3,717,862	7,959	18.64	0.15
S3 - Wave Diesel Replacement	$ 6,038,750	2,930	71.00	0.24
S4 - Wave BAU Integration	$ 6,443,504	3,075	70.38	0.25
S5 - Expanded Wave Diesel Replacement	$ 8,040,114	522	96.36	0.25
S6 - Expanded Wave BAU Integration	$ 7,663,114	388	96.98	0.24
S7 - Wave Energy Reliable	$ 6,263,451	4,364	55.26	0.26
S8 - Solar Energy Reliable	$ 3,289,952	7,794	18.86	0.14
S9 - Maximum Solar Energy Reliable	$ 6,683,922	7,782	18.98	0.28
S10 - Off-Grid BAU	$ 13,374,510	11,878	14.86	0.55
S11 - Off-Grid BAU with Wave	$ 14,280,140	7,657	49.69	0.59
S12 - Maximum Solar Energy	$ 326,251	-	100.00	0.07
S13 - Maximum Wave Energy	$ 4,692,305	-	100.00	0.96
S14 - Sole Diesel	$ 14,456,790	13,714	0.00	0.60
S15 - Sole Grid	$ 3,584,805	9,584	0.00	0.15
S16 - Off-Grid Green One	$ 7,492,305	-	100.00	1.54
S17 - Off-Grid Green Two	$ 11,606,860	-	100.00	0.48
S18 - Off-Grid Green Three	$ 35,042,120	-	100.00	1.46

Results – Sensitivity Analysis 2: Diesel Prices

Metric	NPC ($)	Cumulative Emissions (tCO2e/10y)	Renewable Penetration (%)	LCOE ($)
Model Run Two - Diesel Price = $2				
S1 - BAU One	$ 4,069,203	9,757	0.00	0.17
S2 - BAU Two	$ 3,758,738	7,959	18.64	0.16
S3 - Wave Diesel Replacement	$ 3,328,619	2,930	71.04	0.13
S4 - Wave BAU Integration	$ 3,767,289	3,075	70.43	0.15
S5 - Expanded Wave Diesel Replacement	$ 4,211,928	523	96.36	0.13
S6 - Expanded Wave BAU Integration	$ 3,808,244	388	96.98	0.12
S7 - Wave Energy Reliable	$ 3,553,451	4,364	55.26	0.15
S8 - Solar Energy Reliable	$ 3,289,952	7,794	18.86	0.14
S9 - Maximum Solar Energy Reliable	$ 6,679,965	7,782	18.98	0.28
S10 - Off-Grid BAU	$ 15,650,870	11,878	14.86	0.65
S11 - Off-Grid BAU with Wave	$ 13,037,550	7,657	49.69	0.54
S12 - Maximum Solar Energy	$ 25,855	13,714	100.00	0.01
S13 - Maximum Wave Energy	$ 1,681,381	9,584	100.00	0.36
S14 - Sole Diesel	$ 17,085,180	-	0.00	0.71
S15 - Sole Grid	$ 3,584,805	-	0.00	0.15
S16 - Off-Grid Green One	$ 3,337,435	-	100.00	0.68
S17 - Off-Grid Green Two	$ 10,551,990	-	100.00	0.44
S18 - Off-Grid Green Three	$ 33,987,250	-	100.00	1.42

Metric	NPC ($)	Cumulative Emissions (tCO2e/10y)	Renewable Penetration (%)	LCOE ($)
Model Run Two - Diesel Price = $3				
S1 - BAU One	$ 4,180,393	9,757	0.00	0.17
S2 - BAU Two	$ 3,860,929	7,959	18.64	0.16
S3 - Wave Diesel Replacement	$ 3,328,619	2,930	71.04	0.13
S4 - Wave BAU Integration	$ 3,852,820	3,074	70.43	0.15
S5 - Expanded Wave Diesel Replacement	$ 4,278,425	522	96.36	0.13
S6 - Expanded Wave BAU Integration	$ 3,808,244	388	96.98	0.12
S7 - Wave Energy Reliable	$ 3,553,451	4,364	55.26	0.15
S8 - Solar Energy Reliable	$ 3,289,952	7,794	18.86	0.14
S9 - Maximum Solar Energy Reliable	$ 6,679,965	7,782	18.98	0.28
S10 - Off-Grid BAU	$ 21,341,770	11,878	14.86	0.89
S11 - Off-Grid BAU with Wave	$ 16,706,050	7,657	49.69	0.69
S12 - Maximum Solar Energy	$ 25,855	13,714	100.00	0.01
S13 - Maximum Wave Energy	$ 1,681,381	9,584	100.00	0.36
S14 - Sole Diesel	$ 23,656,160	-	0.00	0.98
S15 - Sole Grid	$ 3,584,805	-	0.00	0.15
S16 - Off-Grid Green One	$ 3,337,435	-	100.00	0.68
S17 - Off-Grid Green Two	$ 10,551,990	-	100.00	0.44
S18 - Off-Grid Green Three	$ 33,987,250	-	100.00	1.42

Results – Sensitivity Analysis 3: Wave Power Output

Metric	NPC ($)	Cumulative Emissions (tCO2e/10y)	Renewable Penetration (%)	LCOE ($)
Model Run One - Wave Power = Halved				
S1 - BAU One	$ 4,024,727	9,757	0.00	0.17
S2 - BAU Two	$ 3,717,862	7,959	18.64	0.15
S3 - Wave Diesel Replacement	$ 4,094,193	5,197	46.45	0.17
S4 - Wave BAU Integration	$ 4,506,649	5,344	46.02	0.19
S5 - Expanded Wave Diesel Replacement	$ 5,386,452	3,056	70.55	0.21
S6 - Expanded Wave BAU Integration	$ 4,983,825	2,931	71.01	0.20
S7 - Wave Energy Reliable	$ 4,380,572	6,921	28.05	0.18
S8 - Solar Energy Reliable	$ 3,289,952	7,794	18.86	0.14
S9 - Maximum Solar Energy Reliable	$ 6,679,965	7,782	18.98	0.28
S10 - Off-Grid BAU	$ 13,374,510	11,878	14.86	0.55
S11 - Off-Grid BAU with Wave	$ 13,146,200	9,411	35.82	0.55
S12 - Maximum Solar Energy	$ 25,937	13,714	100.00	0.01
S13 - Maximum Wave Energy	$ 1,681,381	9,584	100.00	0.36
S14 - Sole Diesel	$ 14,456,790	-	0.00	0.60
S15 - Sole Grid	$ 3,584,805	-	0.00	0.15
S16 - Off-Grid Green One	$ 3,337,435	-	100.00	0.68
S17 - Off-Grid Green Two	$ 7,096,759	-	100.00	0.40
S18 - Off-Grid Green Three	$ 5,412,606	-	100.00	0.36

Metric	NPC ($)	Cumulative Emissions (tCO2e/10y)	Renewable Penetration (%)	LCOE ($)
Model Run Two - Wave Power = Doubled				
S1 - BAU One	$ 4,024,727	9,757	0.00	0.17
S2 - BAU Two	$ 3,717,862	7,959	18.64	0.15
S3 - Wave Diesel Replacement	$ 2,153,114	388	96.98	0.07
S4 - Wave BAU Integration	$ 2,529,765	522	96.36	0.08
S5 - Expanded Wave Diesel Replacement	$ 2,654,616	117	99.65	0.05
S6 - Expanded Wave BAU Integration	$ 2,324,193	20	99.91	0.04
S7 - Wave Energy Reliable	$ 2,134,164	655	94.23	0.08
S8 - Solar Energy Reliable	$ 3,289,952	7,794	18.86	0.14
S9 - Maximum Solar Energy Reliable	$ 6,679,965	7,782	18.98	0.28
S10 - Off-Grid BAU	$ 13,374,510	11,878	14.86	0.55
S11 - Off-Grid BAU with Wave	$ 6,129,420	3,122	79.74	0.25
S12 - Maximum Solar Energy	$ 25,855	13,714	100.00	0.01
S13 - Maximum Wave Energy	$ 1,681,381	9,584	100.00	0.36
S14 - Sole Diesel	$ 14,456,790	-	0.00	0.60
S15 - Sole Grid	$ 3,584,805	-	0.00	0.15
S16 - Off-Grid Green One	$ 3,743,631	-	100.00	0.16
S17 - Off-Grid Green Two	$ 7,136,335	-	100.00	0.30
S18 - Off-Grid Green Three	$ 6,813,118	-	100.00	0.28

Results – Sensitivity Analysis 4: Sunk Costs

Metric	NPC ($)	Cumulative Emissions (tCO2e/10y)	Renewable Penetration (%)	LCOE ($)
CAPEX (PV, Diesel, Wave) = $0				
S1 - BAU One	$ 3,704,727	9,757	0.00	0.15
S2 - BAU Two	$ 3,097,862	7,959	18.64	0.13
S3 - Wave Diesel Replacement	$ 1,528,619	2,930	71.04	0.06
S4 - Wave BAU Integration	$ 1,613,038	3,075	70.43	0.06
S5 - Expanded Wave Diesel Replacement	$ 564,895	523	96.36	0.02
S6 - Expanded Wave BAU Integration	$ 508,189	388	96.98	0.02
S7 - Wave Energy Reliable	$ 2,053,451	4,364	55.26	0.08
S8 - Solar Energy Reliable	$ 2,989,952	7,794	18.86	0.12
S9 - Maximum Solar Energy Reliable	$ 6,383,922	7,782	18.98	0.27
S10 - Off-Grid BAU	$ 12,754,510	11,878	14.86	0.53
S11 - Off-Grid BAU with Wave	$ 9,450,144	7,657	49.69	0.39
S12 - Maximum Solar Energy	$ 25,937	-	100.00	0.01
S13 - Maximum Wave Energy	$ 181,381	-	100.00	0.04
S14 - Sole Diesel	$ 14,136,790	13,714	0.00	0.59
S15 - Sole Grid	$ 3,584,805	9,584	0.00	0.15
S16 - Off-Grid Green One	$ 3,337,435	-	100.00	0.68
S17 - Off-Grid Green Two	$ 10,551,990	-	100.00	0.44
S18 - Off-Grid Green Three	$ 33,987,250	-	100.00	1.42

Metric	NPC ($)	Cumulative Emissions (tCO2e/10y)	Renewable Penetration (%)	LCOE ($)
Model Run Two - CAPEX (PV,Diesel) = $0, Wave = Breakeven ($1.5m for Two Units)				
S1 - BAU One	$ 3,704,727	9,757	0.00	0.15
S2 - BAU Two	$ 3,097,862	7,959	18.64	0.13
S3 - Wave Diesel Replacement	$ 3,028,619	2,930	71.04	0.12
S4 - Wave BAU Integration	$ 3,113,038	3,075	70.43	0.12
S5 - Expanded Wave Diesel Replacement	$ 3,565,244	523	96.36	0.11
S6 - Expanded Wave BAU Integration	$ 3,508,244	388	96.98	0.11
S7 - Wave Energy Reliable	$ 3,553,451	4,364	55.26	0.15
S8 - Solar Energy Reliable	$ 2,989,952	7,794	18.86	0.12
S9 - Maximum Solar Energy Reliable	$ 6,383,922	7,782	18.98	0.27
S10 - Off-Grid BAU	$ 12,754,510	11,878	14.86	0.53
S11 - Off-Grid BAU with Wave	$ 10,950,140	7,657	49.69	0.45
S12 - Maximum Solar Energy	$ 25,855	-	100.00	0.01
S13 - Maximum Wave Energy	$ 1,681,381	-	100.00	0.36
S14 - Sole Diesel	$ 14,136,790	13,714	0.00	0.59
S15 - Sole Grid	$ 3,584,805	9,584	0.00	0.15
S16 - Off-Grid Green One	$ 3,337,435	-	100.00	0.68
S17 - Off-Grid Green Two	$ 10,251,990	-	100.00	0.43
S18 - Off-Grid Green Three	$ 33,987,250	-	100.00	1.42

Results – Sensitivity Analysis 5: Future Grid Pricing

Metric	NPC ($)	Cumulative Emissions (tCO2e/10y)	Renewable Penetration (%)	LCOE ($)
Model Run One – Grid prices grow (above inflation) based on annual growth rate experienced in last 25 years (2.81% p.a.)				
S1 - BAU One	$ 5,036,039	9,757	0.00	0.21
S2 - BAU Two	$ 4,549,672	7,958	18.64	0.19
S3 - Wave Diesel Replacement	$ 3,694,966	2,932	71.04	0.15
S4 - Wave BAU Integration	$ 4,095,279	3,075	70.44	0.16
S5 - Expanded Wave Diesel Replacement	$ 4,314,969	528	96.33	0.13
S6 - Expanded Wave BAU Integration	$ 3,940,349	394	96.95	0.12
S7 - Wave Energy Reliable	$ 4,062,115	4,367	55.23	0.17
S8 - Solar Energy Reliable	$ 4,126,885	7,794	18.86	0.17
S9 - Maximum Solar Energy Reliable	$ 7,524,730	7,793	18.86	0.31
S10 - Off-Grid BAU	$ 13,375,040	11,878	14.86	0.55
S11 - Off-Grid BAU with Wave	$ 11,570,140	7,668	49.69	0.48
S12 - Maximum Solar Energy	$ 325,855	13,714	100.00	0.07
S13 - Maximum Wave Energy	$ 1,981,381	9,584	100.00	0.43
S14 - Sole Diesel	$ 14,456,790	-	0.00	0.60
S15 - Sole Grid	$ 4,602,256	-	0.00	0.19
S16 - Off-Grid Green One	$ 3,337,435	-	100.00	0.68
S17 - Off-Grid Green Two	$ 10,551,990	-	100.00	0.44
S18 - Off-Grid Green Three	$ 33,987,250	-	100.00	1.42

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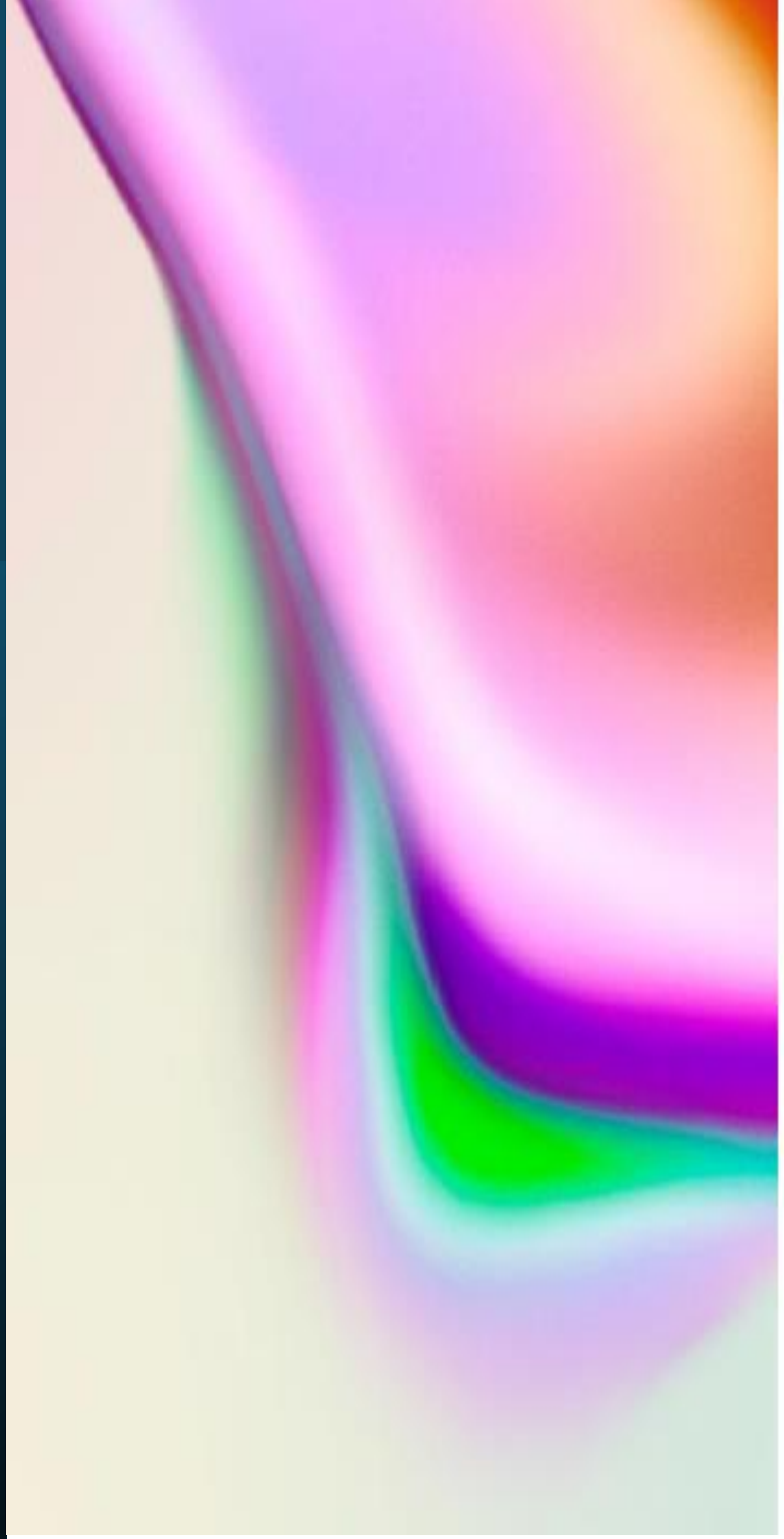
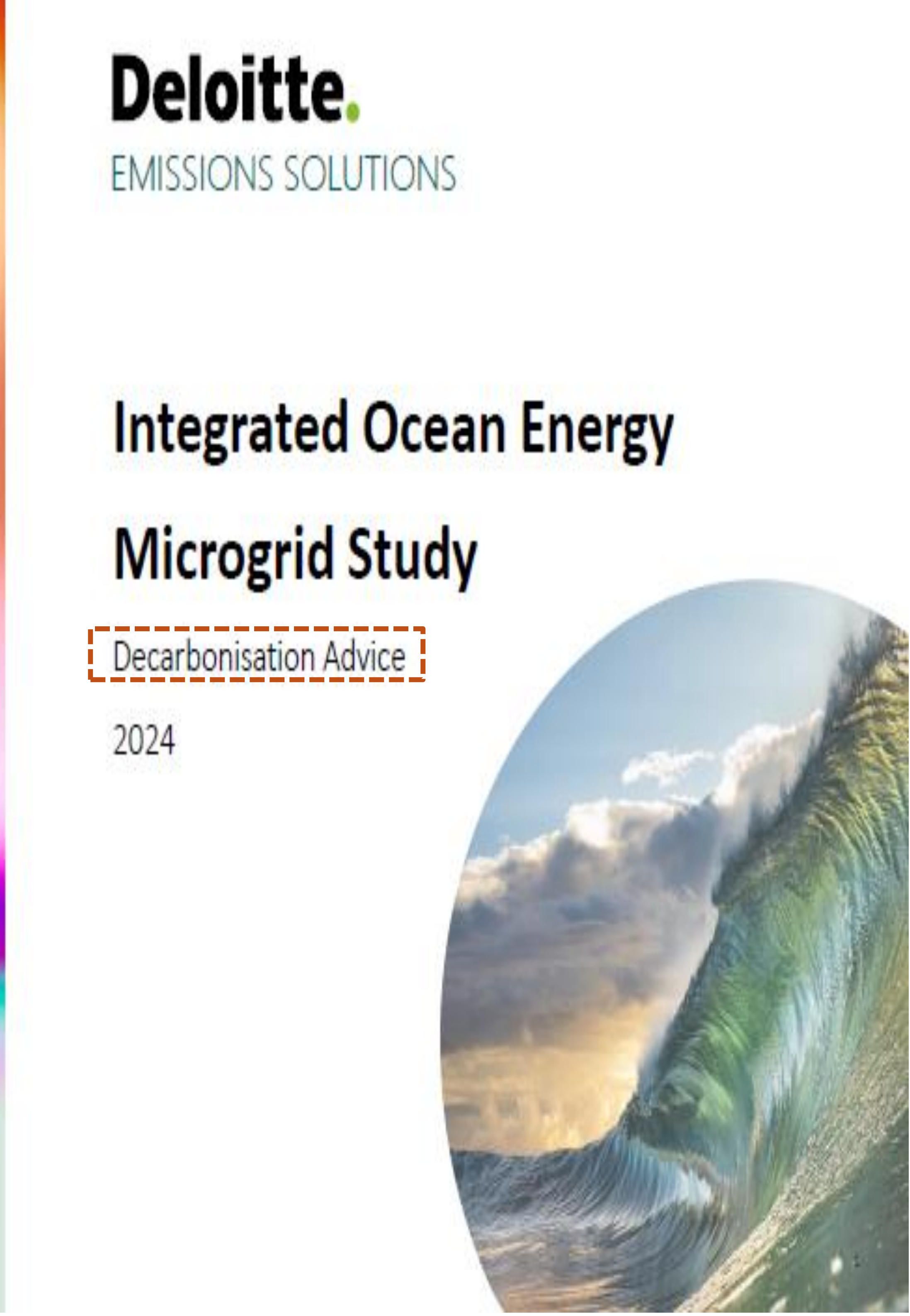
Attachment - 3





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EMISSIONS SOLUTIONS

Integrated Ocean Energy

Microgrid Study

Decarbonisation Advice

2024

Industry context

CUTTING VICTORIA'S EMISSIONS 2021–2025

Agriculture sector emissions reduction pledge

Minister's foreword

Victoria's agricultural sector is the nation's largest exporter of food and fibre products, and a vital part of the state's economy. The sector's future prosperity will be closely linked to the success or otherwise of global efforts to cut greenhouse gas emissions.

It is therefore vital that agriculture plays its part in achieving a net-zero emissions economy by 2050 – which is why the Victorian Government has an emissions reduction pledge for the sector.

Farmers across Victoria know too well the issues caused by climate change and are ready to work together to tackle the challenges. The Victorian Government will invest almost $20 million in emissions reduction activities over the next four years, including flagship trials of leading research and technological innovations that help farmers reduce emissions while maintaining productivity and profitability. In this first pledge period to 2025, the government

Victoria's farming community is already reducing emissions on-farm, including throug improving the energy efficiency of their operations. The Victorian Government has already provided support to enable farmers to continue these practices through an additional $30 million in funding committed the *Agriculture Energy Investment Plan* in the *Victorian Budget 2020–21*. Farmers can also consider the role of revegetation on-farm, wi support available through the *Victorian Carb Farming Program*.

I look forward to working closely with industry, community and across government to support these programs and effectively transition the agriculture sector to a net-zerc emissions economy. We aspire for Victorian farmers to be leaders in low-emissions agricu in line with *Strong, Innovative, Sustainable: A New Strategy for Agriculture in Victoria*.

Government

Victorian Climate Change Act

Net zero by 2045
45-50% by 2030
75-80% by 2035

Climate Change Strategy, including 5-yearly sector emissions reduction pledges

VRET – 65% renewables by 2030 and 95% by 2035

Distributed energy resources policies for businesses and households

Industry

FRDC / SIA decarbonisation and energy transition actions

International export carbon levies – e.g. EU Carbon Border Adjustment Mechanism (fully imposed in 2026 – scope 1 and 2 currently)

Food carbon labelling (e.g. Denmark to introduce state-controlled climate label for food products)

Race to deliver low carbon products and services in the market to gain competitive edge and become leaders

Ocean energy microgrids can unlock both emissions reductions and energy independence for aquaculture operators

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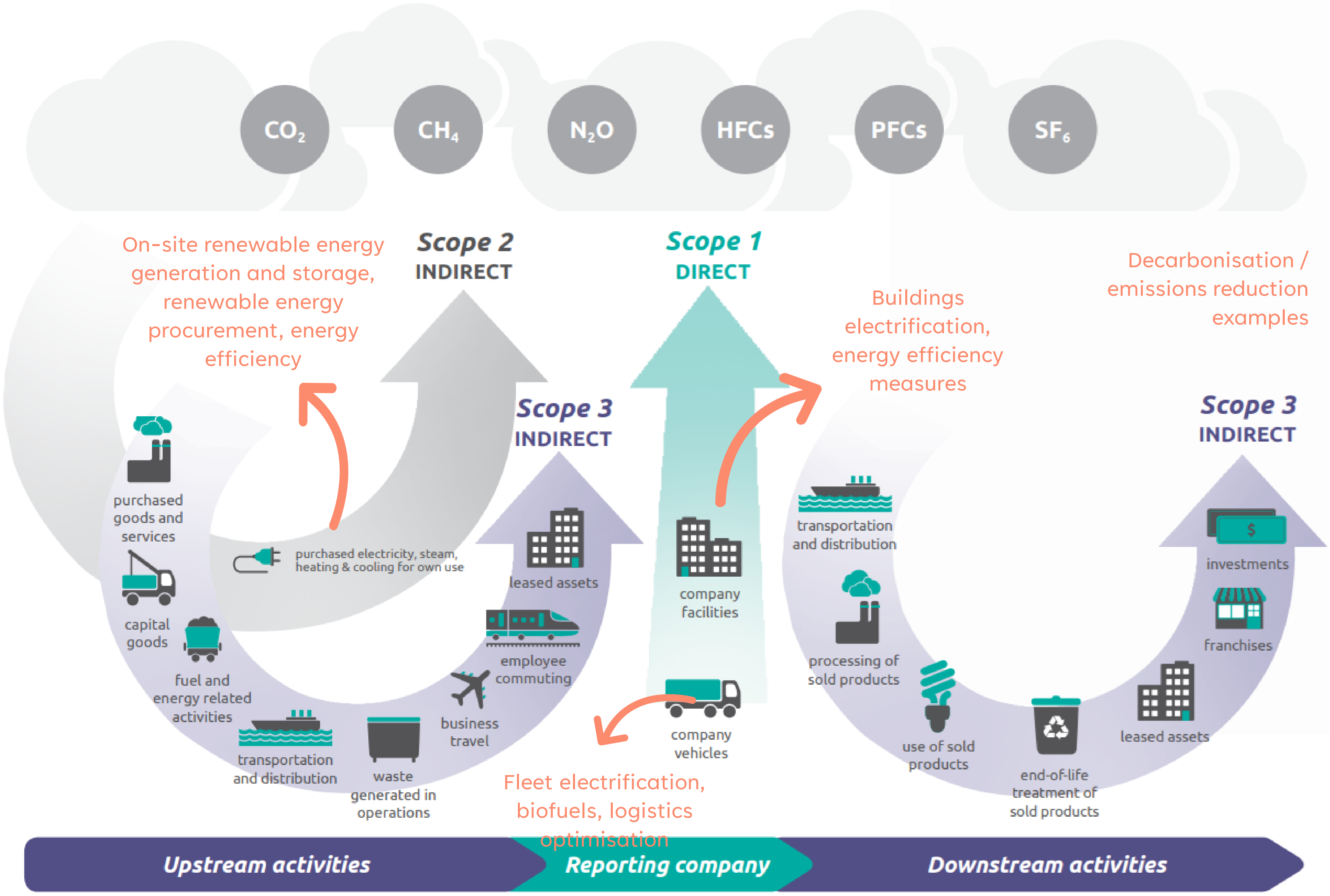
SOM’s emissions profile

Profiling and reducing emissions for businesses



Baselining an organisations emissions

Collating activity data (e.g. fuel and electricity consumption) for a base year, applying emissions factors to calculate a baseline. Net zero targets are measured against a defined baseline.

Decarbonisation

Reducing intensity of, or eliminating, carbon from activities and processes

Emissions reduction

Reducing the amount of emissions released into the atmosphere

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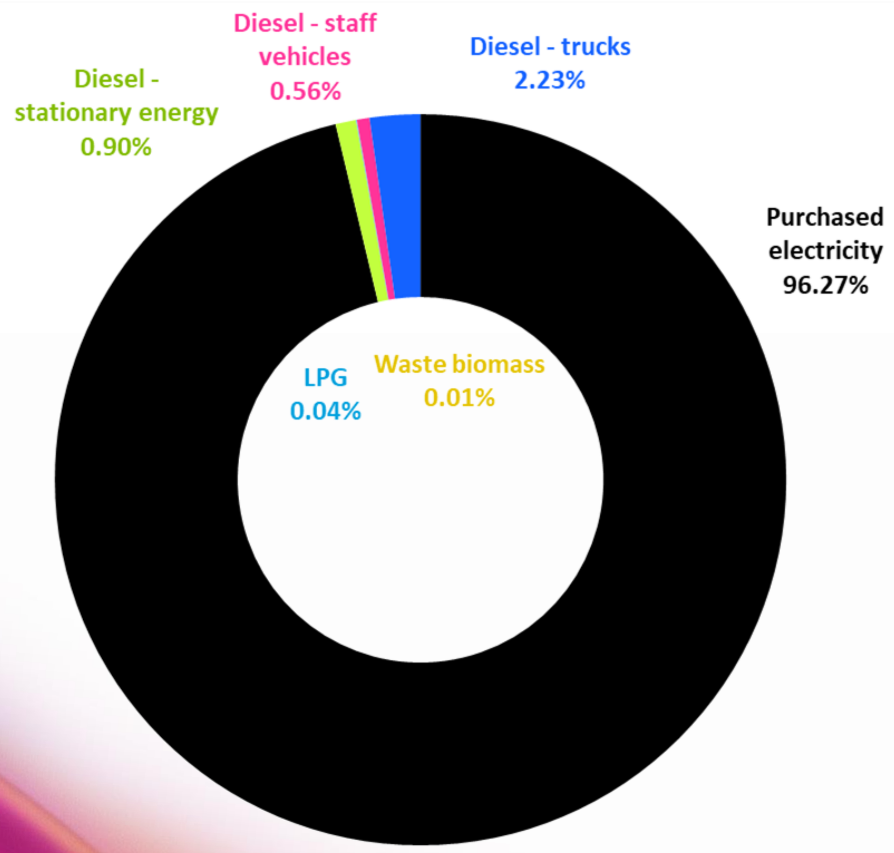
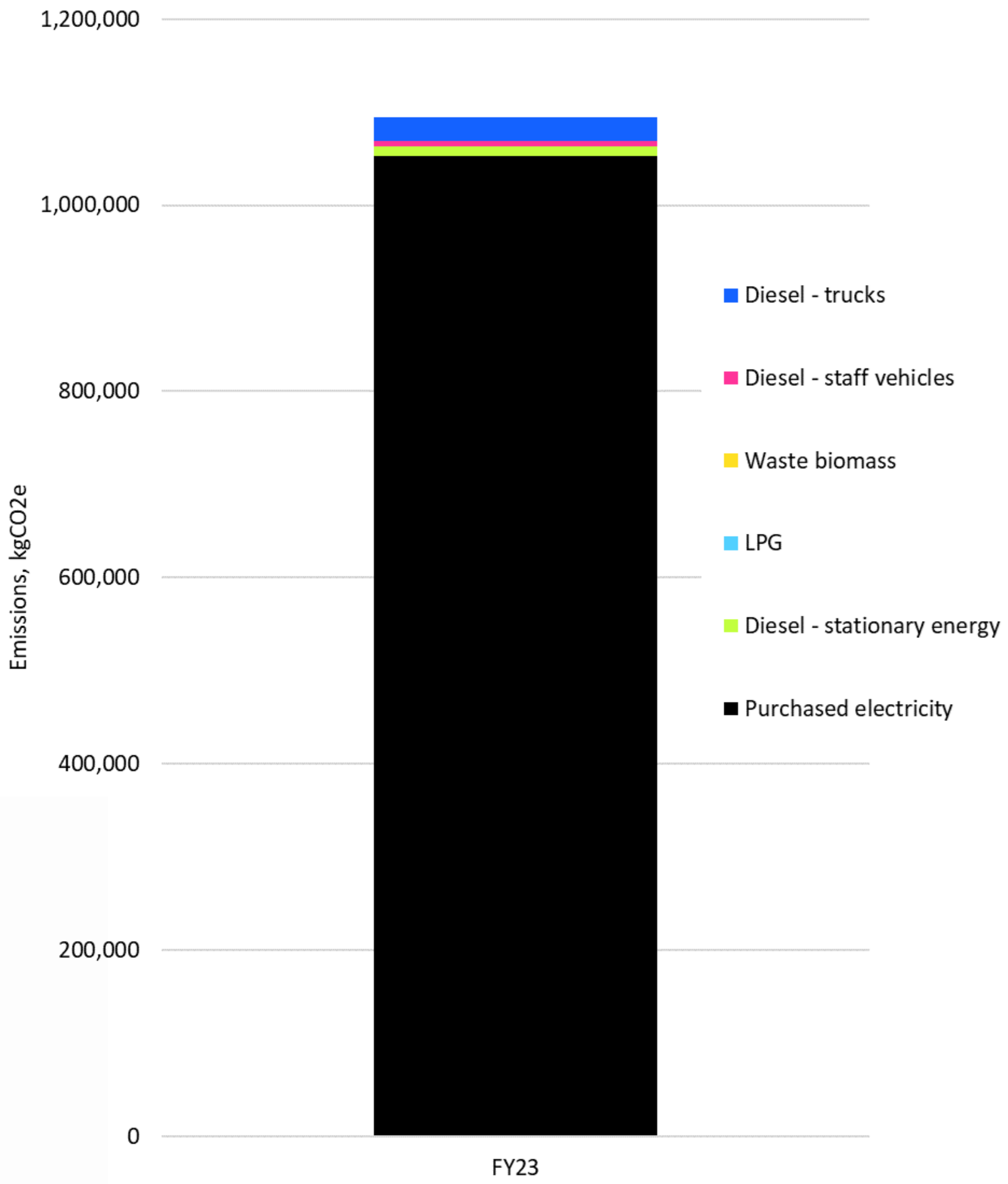
SOM's emissions profile – FY23

- SOM's emissions estimated at approximately 1,093,960 kg CO_2e in FY23, dominated by electricity sourced from the grid.
- Purchased electricity emissions are Scope 2 (indirect)
- All other displayed are Scope 1 (direct)
- Scope 3 emissions (indirect) not yet defined nor quantified. These are likely to primarily come from; Purchased Goods and Services (e.g. production of feed purchased, packaging materials), Capital Goods (e.g. equipment such as tanks, pumps), Fuel and Energy production, Transport and Distribution (e.g. inbound and outbound logistics, waste management), Business Travel, Employee Commuting, Waste Disposal, and Use of Sold Products (e.g. energy required by consumers to store and prepare abalone – refrigeration/freezing).

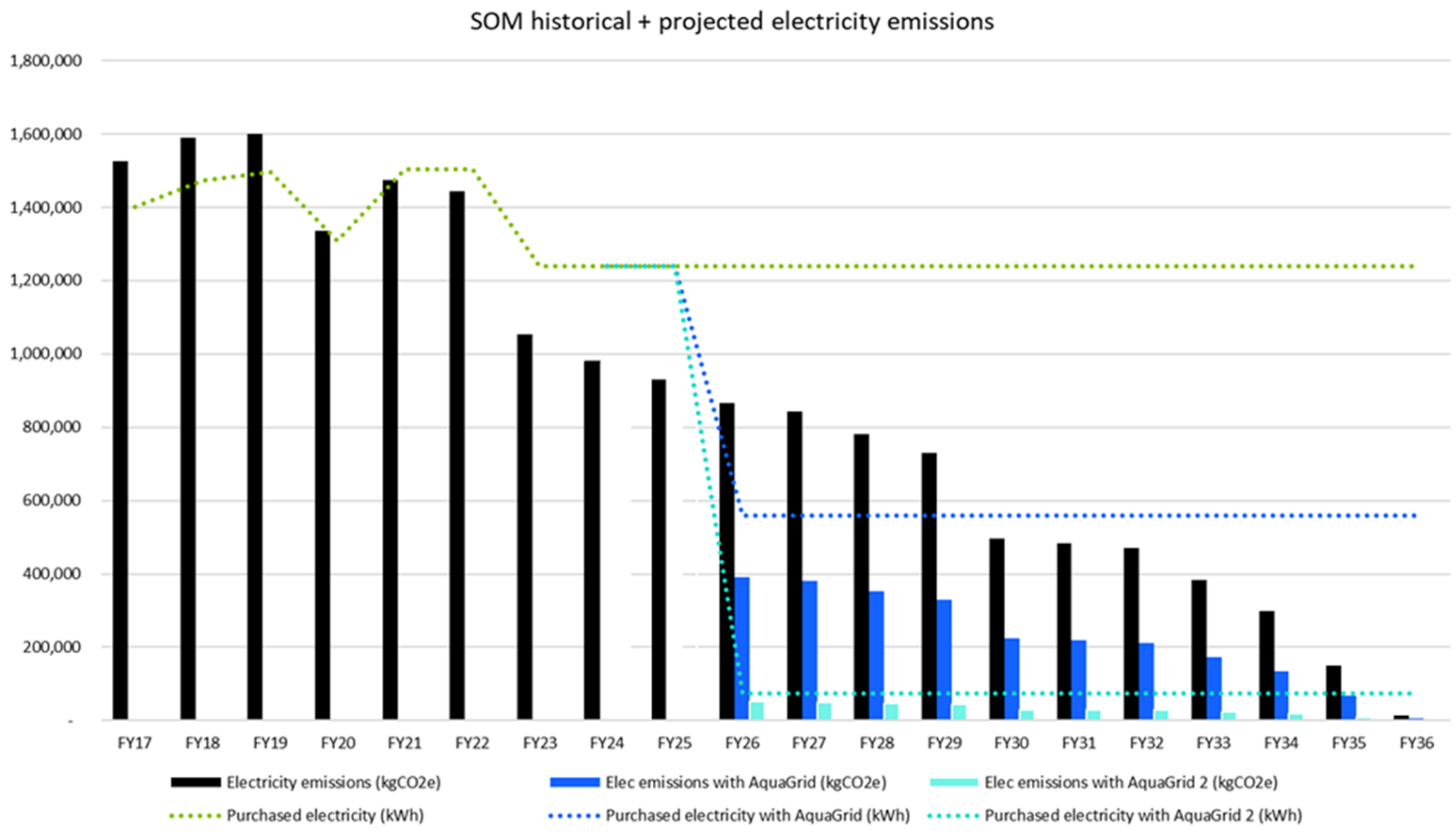




AquaGrid project

AquaGrid – impact on SOM's electricity emissions

- Based on microgrid scenario modelling results via HOMER. Where two scenarios were identified to pursue:
  - AqauGrid: 200kW of wave energy integrated
  - AqauGrid 2: 400kW of wave energy
- Although grid decarbonising, AquaGrid provides further emissions reductions on top of this as well significant OPEX savings. Green bars represent no changes to SOM's energy system (do nothing scenario) but emissions reduce as the grid decarbonises
- Analysis assumes electricity demand for the projection period (FY24 to FY36) remains constant and is equal to FY23 demand
- AquaGrid provides a 55% reduction in annual purchased electricity from the grid, equating to 55% emissions reduction compared to BAU / do nothing scenario
- AquaGrid 2 provides a 94% reduction in annual purchased electricity from the grid, equating to 94% emissions reduction
- Renewable energy certificates (e.g. LGCs and VEECs) or carbon credit markets can likely be claimed from installation of AquaGrid, providing considerable rebates or revenue that can offset the project's cost.



Project-specific emissions

Construction projects typically generate emissions and embodied energy/carbon

Materials
Concrete
Steel
Asphalt

Construction energy
Diesel generators
Machinery
Transport
Site lighting
Site offices

Waste & land clearing
Top soil
Demolition waste
Construction waste
Cleared vegetation

What can we do to reduce construction emissions?

Specify low carbon products and materials

Sustainable procurement strategies

Electric machinery

Utilise portable renewable energy

Biofuels / low carbon fuels

1:1 planting replacement

Targets for construction and demolition waste (diverted from landfill)

Emissions reduction strategies for construction projects need to be identified early in design and documented / specified

Achieving net zero emissions

Potential actions to unlock net zero

Expand on-site renewable energy generation and use
- Solar PV
- Wave energy
- Small-scale wind
- Energy storage could help further reductions but critical mass of RE generation required
- Biogas from mortality pit

Optimise energy efficiency
- Given previous initiatives likely little opportunity for further significant emissions reductions

Renewable energy procurement
- PPAs (direct, virtual)
- GreenPower contracts
- Through the grid, these mechanisms allow procurement of 100% RE, offsetting grid emissions

Low carbon fuels
- Renewable diesel
- Green hydrogen (long-term)

Electrification
- Electric machinery such as forklifts
- Electric or hybrid staff vehicles
- Diesel generator replacement with energy storage solutions

Management
- Develop emissions reduction strategy / plan
  - Define objectives and relevant certifications / schemes (e.g. Climate Active, eco-food labelling requirements etc)
  - Identify, evaluate and prioritise emissions reduction initiatives and develop net zero pathway
  - Setting of emissions reduction targets
  - Implementation planning
  - Emissions monitoring strategy and system
    - Tracking emissions and impact of initiatives

Carbon sinks / offsets
- On-site revegetation / afforestation to enable carbon sequestration
- Purchase of carbon offsets to offset residual emissions

After installation of the wave energy microgrid, net zero is well within reach for SOM to achieve well before 2050. SOM could become a leader in Australia's seafood industry by achieving net zero in the not too distant future and provide climate friendly products to domestic and export markets.

The above advice is high-level and summary in nature, as such it is advised further investigation and assessment of options and initiatives be undertaken before proceeding with any significant investments or business/operational changes.