BLUE ECONOMY
COOPERATIVE RESEARCH CENTRE

2022-23 ANNUAL REPORT

Australian Government
Department of Industry, Science and Resources

AusIndustry
Cooperative Research Centres Program

BLUE ECONOMY
COOPERATIVE RESEARCH CENTRE

FOREWORD

Established in 2019, the Blue Economy CRC-Co Ltd (ABN 64 634 684 549) is an independent not-for-profit company limited by guarantee and a Cooperative Research Centre under the Australian Government's CRC Program.

With a 10-year life, the Blue Economy CRC brings together 44 industry, government and research partners from ten countries with expertise in aquaculture, marine renewable energy, maritime engineering, environmental assessments and policy and regulation.

Through targeted industry-focussed research and training, the Blue Economy CRC paves the way for innovative, commercially viable and sustainable offshore developments and new capabilities. Our vision is that our blue economy industries in offshore aquaculture and renewable energy are globally competitive, at the forefront of innovation and are underpinned by a robust environmental planning and management framework which consumers trust and value.

Our Participants

Chair & CEO Message

The Blue Economy CRC is developing and leading an ambitious integrated oceans innovation program. Together with our 44 partners, we are building the foundations for Australia's new and emerging ocean industries in renewable energy and food production. We are doing this in an era of unprecedented consumer and community awareness, scrutiny and expectations on integrity, transparency, accountability and trust in ocean governance and use.

At the heart of our work are collaborations, strategic partnerships, and meaningful participation. The Blue Economy CRC Board, management team and research community continue championing and deepening relationships with industry, government, First Nations, communities, corporations, and global blue innovation clusters.

Over the reporting year, the Blue Economy CRC has welcomed two new partners, initiated new strategic partnerships, and participation in local, national, regional and global fora, conferences and workshops. The opportunities for the Blue Economy CRC team to participate and present at NZ Aquaculture Conference '23, Seafood Directions '23, World Aquaculture Society, AOG Energy Knowledge Forum '23, OMAE '23 as well as support the design and roll out of the inaugural Ocean Decade Ocean Business Leaders' Summit have been central to demonstrating the Blue Economy CRCs role in today's ocean conversation.

That is why it was great news to announce the Blue Economy CRC will be hosting the leading global ocean energy event, the 2024 International Conference on Ocean Energy (ICOE) in Melbourne on the 17 – 19 September 2024, the first time it will be held outside the Northern Hemisphere.

As we looked to grow the blue economy, we have transitioned from scoping and foundation studies to projects focussed on high impact and with that comes higher risk. By working with our industry partners and governments the Blue Economy CRC shares the risks of innovation and reduces the barriers to adoption.

Our integrated research portfolio continued to build on our ocean knowledge, exploring technology readiness and performance, further developing our demonstration and pilot network, growing our global and national role, and contemporary ways of contextualising and measuring impact at scale.

It continued our pursuit of new ways of working between industry, government, First Nations, and research while contributing to the major food, energy and nature transition the world is facing.

Greg Johannes
Chair

Dr John Whittington
CEO

Oceans make up 71% of the earth.

They offer a source of food, provide livelihoods, generate commerce, and disseminate and connect people globally. They provide ecosystem services, play a central role in climate regulation and are central as governments and industries reprioritise nature-based solutions.

The responsible growth of ocean food, as well as ocean energy have never been more crucial than today. Untapping the potential from oceans through innovation with industry, academia, community and government working together is fundamental to tackling global challenges of food security and renewable energy. However, this must be done in a way that is balanced by nature and is underpinned by ocean leadership and contemporary governance.

The Blue Economy CRC's $47.4 million integrated research portfolio is supporting twenty-nine active projects focusing on:

- analytical research to support industry decisions and investment certainty;
- technology readiness and technology performance to support moving oceans industries further offshore into open oceans;
- solutions for existing and forecast problems faced by traditional, new, emerging and transitioning industries, such as decarbonisation;
- informing new and contemporary policy, governance and planning;
- inspiring innovation at a local, national, regional and global scale; and
- building and maintaining a cultural and social licence to operate.

We boosted our research portfolio by growing our Blue Economy CRC on-water demonstration and pilot network. This included commissioning a kelp trial research farm in Tasmania's Derwent River, and finalising the baseline survey of the Blue Economy Zone in Bass Strait to support the first aquaculture research trial site in Commonwealth waters.

Our ocean energy MoorPower™ pilot off Fremantle waters WA and the M4 wave energy project off Albany WA were also readied for commissioning. This progress was complemented by the permit approval for the Blue Economy CRC Hydrogen Microgrid, which will see the Blue Economy CRC introduce the first Green Hydrogen DC Microgrid to Tasmania in 2024.

Welcome Dr Maia Schweizer

During the reporting period, we also warmly welcomed Dr Maia Schweizer to the Blue Economy CRC Board and are already greatly benefiting from her contributions. Dr Schweizer has worked in energy and infrastructure for 15 years, moving from oil and gas to renewable electricity and green hydrogen. She has held executive roles in project development and operations in Western Australia at Origin Energy and Fortescue Future Industries and served as CEO of CleanCo Queensland. Maia's passion is tackling difficult climate change challenges while ensuring that the benefits of solving them flow through to communities.

Each year, we host an annual participant's workshop to hear from experts, 'calibrate' ideas with others, celebrate successes, inspire our future workforce and to map out what could be added to our project portfolio to make it stronger. The 2023 Blue Economy CRC Participants Workshop outshone the predecessors, as the Blue Economy CRC team along with partners from aquaculture and ocean energy companies, universities, government agencies -federal and state, supply chain, tech support, associations and a strong and growing PhD base joined a conversation about 'impact' centred on four 'impact portfolios':

- **Reimagining oceans access for certainty and enduring ocean industries and community**
- **A blueprint for sustainable open ocean aquaculture acreage**
- **Harnessing ocean energy for ocean and coastal industries and communities**
- **Decarbonising blue economy industries**

As we look to the year ahead, we will use these four impact portfolios to grow and measure our impact as we continue fostering a meaningful "move the dial" research and innovation portfolio. We are proud to share some our achievements from these past 12 months, as we strive for meaningful innovation, responsible growth, and good governance all within the shared framework and common goal of the responsible and sustainable use of the oceans for today and the generations to come.

29 CURRENT PROJECTS

$47.4M CURRENT PROJECT VALUE

21 MILESTONES ACHIEVED

67 MILESTONES IN PROGRESS

RESEARCH

In 2022-23 the Blue Economy CRC continued to make strong progress towards meeting our objectives described in our Strategic Plan and Grant Agreement milestones. Our research is focused on our Participants' needs, is environmentally and socially responsible, and designed to have commercial impact.

We continue to strengthen our collaborations with our 44 industry, research and government Participants to understand their R&D objectives and priorities. Now into our fourth year, we have a significant research and development program underway. Highlights include:

- The **Blue Economy CRC Hydrogen Microgrid** to be located at BOC's Lutana (Tas) facility is closer to realisation with the Glenorchy City Council issuing a Planning Permit and our 700kW electrolyser passing factory acceptance testing. With our partnerships with BOC, Pitt and Sherry, Griffith University, University of Tasmania, Optimal, Hydro Tasmania, Macquarie Bank and the Tasmanian Government, this project will develop and demonstrate a fully operational, commercial-scale hydrogen DC microgrid running on renewable energy. Our research program will use the operational DC hydrogen microgrid to test and emulate real-world scenarios and it provides the infrastructure for research into DC micogrids, social license, hydrogen markets, supply chains, safety and risk and certification. Learnings from this will be transferred to the process in developing an offshore hydrogen microgrid.
- Our foundational work is on track to identify a framework for Marine Spatial Planning. The project has engaged with over 100 external stakeholders through focus groups, the project Advisory Committee and one-on-one meetings to understand the needs of government, industry and organisations who have an interest in the management of Australia's marine estate.
- Offshore wind remains a focus of the Blue Economy CRC following the **Potential for Offshore Wind in Australia** report published in 2021 that supported the introduction of the Australian Government's **Offshore Electricity Infrastructure Act 2021 (OEI Act).** The Blue Economy CRC has initiated a new project **Pre-conditions for the Development of Offshore Wind Energy in Australia** which is developing resources to support industry pursue ethical best practice, improve knowledge of policy and regulatory arrangements, and understand social values and supply chain constraints. In addition to our Blue Economy CRC partners, Nexsphere, Flotation Energy, Star of the South, Copenhagen Energy Australia, and Tasmanian Ports Corporation are contributing their valuable insights and experience to this research.

87 REFEREED PUBLICATIONS

28,000 WEBSITE VISITORS

34 SCHOLARSHIPS

44 PARTNERS

- Our **Baseline Survey of the Blue Economy Zone (Phase II)** continued this year with ongoing analysis of all field data collected since 2021. The major activities performed included mapping of the seafloor, sediment and benthic habitat, monitoring the local wave, wind and ocean current climates as well as understanding the fish species in the BEZ. This data will inform the **Blue Economy CRC's research trial** that is proposed to be undertaken at the research trial site in Commonwealth waters north of Burnie. This fieldwork was a collaboration between the University of Tasmania, University of Queensland, Griffith University and industry partners Tassal and Xylem.
- The Blue Economy CRC has partnered with the University of Wollongong Blue Futures team and local industry leaders on unlocking regenerative farming along the NSW south coast. This **new collaborative project** is looking at how Indigenous, community and economic values can inform the emerging seaweed farming sector and evolving shellfish farming in waters off the south coast of NSW. The project was successful at securing funds from the Regional NSW Business Case and Strategy Development Fund (Round 1).
- Blue Economy CRC and SmartCrete CRC over 6 months completed two studies that explored the physical, biological, regulatory and socioeconomics of floating artificial reefs for habitat enhancement and fisheries management in offshore developments. SmartCrete CRC assessed the opportunities and challenges of using concrete from aspects of the material characteristics, design of size and shape, and application and management. Following stakeholder workshop, the **projects** published a strategic research map for future development of floating artificial reef systems.
- In November 2022, the Blue Economy CRC released its ambition for **'Tasmania's Sustainable Ocean Economy Beyond 2033'.** The Ambition report offered a new approach to sustainable ocean industries and ocean stewardship for Tasmania. It included a roadmap, a series of opportunities that centre on shared values based on what we heard from a broad range of stakeholders and consolidates best practice principles and case studies. It considered this approach in the context of Tasmania's finfish aquaculture industry. The release of the Ambition followed the release of the **What We Heard Report** that captures what was heard directly from a broad range of stakeholders over 6 months as part of a series of consultative events including the Tasmanian Salmon Symposium hosted by the Blue Economy CRC.

- Data infrastructure frameworks are critical to support evidence-based decision making for activities in the Blue Economy - broadly - and the activities of the Blue Economy CRC and its partners. This year the Blue Economy CRC commenced an important **data infrastructure project** to bring together digital experts, data scientists, engagement specialists, project partners, stakeholders and end-users through a series of workshops to design fit-for-purpose infrastructure to manage Blue Economy CRC knowledge and data, and that is robust, scalable and sustainable to last beyond the CRC.

During 2022/2023, twenty-nine projects were underway across the five research programs. These projects have a combined value of $47.4M.

During 2022/23, the Blue Economy CRC commissioned 9 new projects, with a total value of $13.5M, of which the Blue Economy CRC's cash contribution was $5.4M. Areas of R&D encompassed by the new projects include:

- Development of new engineering designs and risk-management frameworks, to address the specific needs of the aquaculture industry for operation in high-energy environments, (e.g. production biology requirements artificial reefs, seaweed mariculture platforms).
- Investigating the potential of seaweed aquaculture to provide wave energy attenuation for multi-use platforms.
- Development of solutions to decarbonise industry (e.g. decarbonising offshore aquaculture systems and operations through the development of offshore wind, management of hydrogen DC microgrids, green hydrogen production and hydrogen-powered vessels).
- Development of production systems for offshore kelp mariculture, investigating opportunities for the oyster industry in the blue economy and identifying which additional aquaculture species should be prioritised for offshore farming research.

These projects are complemented by projects already underway and others staged into the future to shape the overall research agenda.

Progress Against Milestones

The Blue Economy CRC continues to make progress against its research output obligations, with five milestones completed during 2022-23. The Blue Economy CRC has now completed 21 of its contracted milestones, with a further 67 milestones currently in progress.

The Blue Economy CRC undertook a review of its milestones in the first half of 2022-23, identifying a range of minor amendments to the original milestones formulated in 2019.

Research Program Advisory Committees

Meeting of the Research Program Advisory Committees (RPACs) continued. The RPACs are a group of external independent experts (including international members) who help guide and evaluate our research activity and review outcomes. Through these RPACs we have increased the research impact and continue to enhance the global recognition of the Blue Economy CRC.

Changes to the Research Executive

We farewelled two of our Blue Economy CRC Program Leaders during 2022/23: Dr Kosala Gunawardane (ex- Auckland University of Technology) former deputy program leader of the Offshore Renewable Energy Systems Research Program 3 (RP3); and, Professor Ki-Hoon Lee (ex- Griffith University), former deputy program leader of the Sustainable Offshore Developments Research Program (RP5).

Whilst Kosala has stepped down from her role as Deputy Program Leader, she remains involved with the Blue Economy CRC through the University of Technology Sydney.

Research Program 1 | Highlights

Offshore Engineering and Technology

Program Leader
Professor Chien Ming Wang
University of Queensland

Deputy Program Leader
Dr Nagi Abdussamie
Australian Maritime College,
University of Tasmania

The Offshore Engineering and Technology program brings together industrial engineering expertise to collaborate with the aquaculture and offshore renewable energy sectors to build the required infrastructure for integrated offshore operations.

Novel Offshore Fish Pen Design: Phase 1 (Conceptual Development) (1.21.002)

SeaFisher – A Submersible High-density Polyethylene Offshore Fish Pen

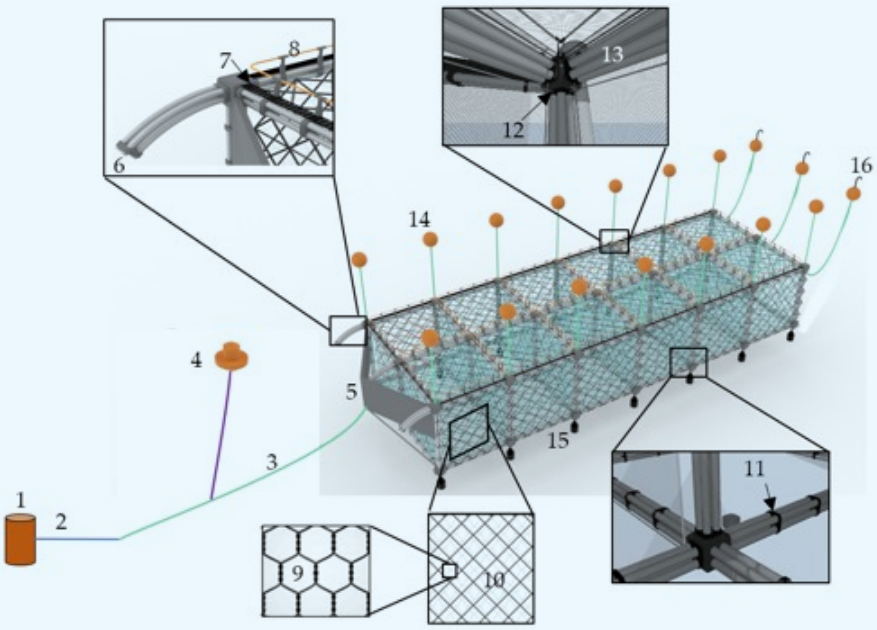
A multidisciplinary project team consisting of architects, structural engineers, geotechnical engineers, offshore engineers and researchers, and fish farm operators has developed the SeaFisher concept design for offshore fish farming with input from participants Huon Aquaculture and Tassal.

The architectural render and drawings of the SeaFisher illustrate a 2 x 6 array SeaFisher comprising 12 cubic fish pen units; each designed to measure 20m x 20m x 20m giving the SeaFisher an overall length of 120m, a width of 40m and a depth of 20m. The total enclosed water volume is 96,000 m3 and the pen is designed to accommodate 1440 tons of salmon.

SeaFisher has emerged from research undertaken in project Novel Offshore Fish Pen Design: Phase 1 (Conceptual Development) 1.21.002), as an innovative, practical, and potentially cost-effective offshore fish pen design that may potentially be deployed in exposed sites across in the world.

SeaFisher as viewed from below (Visualisation by Martin Ziarmal)

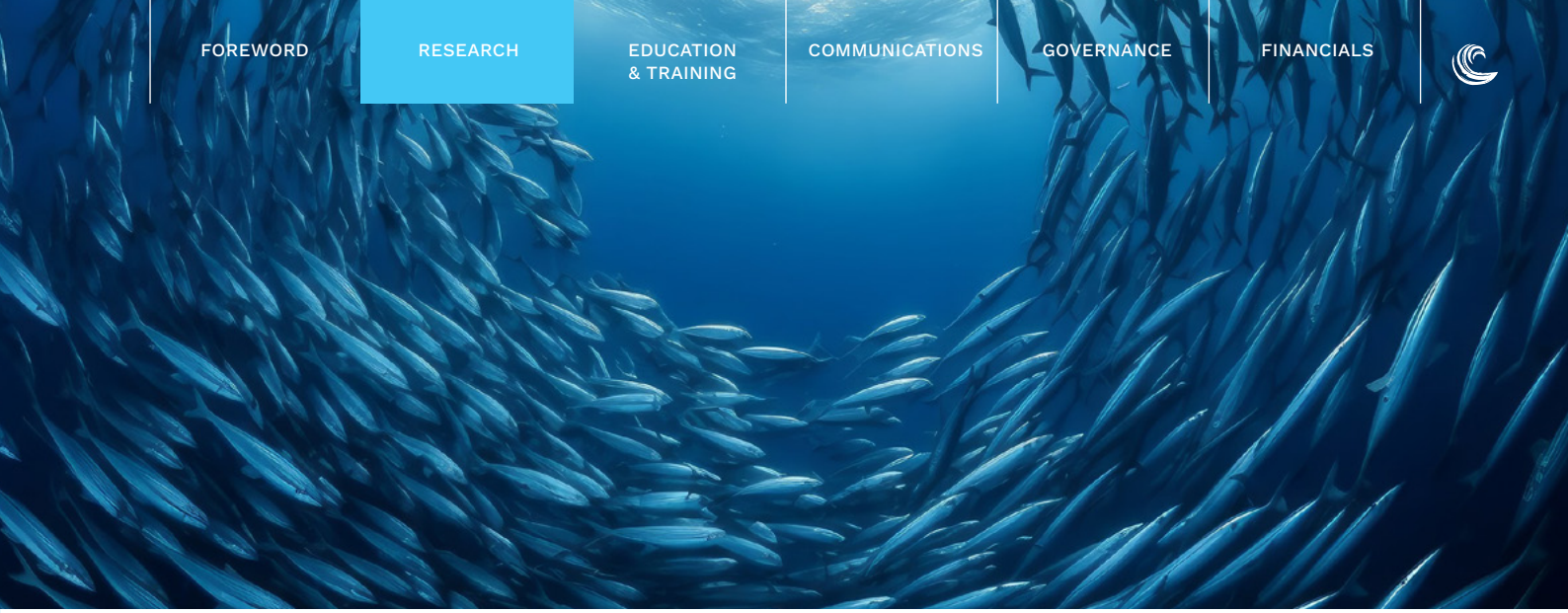
The SeaFisher has the following features: (i) it uses high-density polyethylene (HDPE) pipes to form modular frame structures for easy fabrication and cost effectiveness; (ii) these pipes are bundled together by specially designed connection bracket and joined together with other pipes at a specially designed connector pod as shown in the figure below; (iii) it uses strong and lightweight Polyethylene Terephthalate (PET) net such as Kikkonet for better maintenance due to its antibiofouling characteristics which is stiffened by Glass Fibre Reinforced Polymer (GFRP) diagrid so as to keep out seals and sharks; (iv) its frame flexibility by suitably positioning connection brackets to bundle the HDPE pipes for better resilience to waves and currents; (v) it is submersible to avoid strong surface waves during storms via a ballasting system consisting of top parallel HDPE pipes running the entire length of the SeaFisher; (vi) ship (longitudinal) shaped structure with single point mooring (SPM) that moves like a weathervane to reduce the environmental and vessel collision loads well as for better waste dispersal; (vii) secondary buoys to assist in keeping the SeaFisher in position when it is submerged, and (viii) equipped with a streamlined bow barrier to protect SeaFisher from floating debris and strong surface waves. For more details of the SeaFisher, please refer to a paper published in the Journal of Marine Science and Engineering, 2023, Vol. 11, Issue 9, 1795.



SeaFisher components:
(1) suction anchor
(2) studlink chain
(3) hawser
(4) front buoy
(5) shield
(6) entry valves
(7) walkways
(8) handrails
(9) Kikkonet
(10) diagrid rod
(11) connection bracket
(12) connector pod
(13) HDPE pipe bundle
(14) intermediate buoys
(15) weights
(16) aft buoys

Continuing the development of SeaFisher, a plan for Phase 2 of the novel offshore fish pen project aims to bring the SeaFisher to a concept qualification and design optimisation stage through physical model testing in UTAS and TCOMS (Singapore) wave basins which will be carried out concurrently with digital model simulations as well as physical testing of construction details like the novel HDPE connectors. The successful conclusion of this Phase 2 will raise the SeaFisher concept from a technology readiness level 3 up to levels 4 and 5.

HDPE pipe bundles held by connection brackets and connector pods (Visualisation by Martin Ziarmal).



MoorPower - Scaled Demonstrator (1.21.001)

MoorPower™ was developed by Carnegie Clean Energy with the goal of decarbonising the energy needs of offshore moored operations, particularly in aquaculture.

Starting in late 2021, Carnegie commenced the process to design, install and operate a scaled demonstrator offshore from its research facility in North Fremantle, Western Australia. This is the objective of the project **MoorPower - Scaled Demonstrator (1.21.001).**

Throughout 2022/23, the project team assembled the core structures ensuring a solid foundation for the subsequent construction. Exhaustive structural analysis has yielded good results, and collaboration with skilled professionals has ensured precision in execution.

A data acquisition system was integrated to ensure meticulous monitoring and in-depth analysis of the demonstrator performance. The data acquisition system was customized to align with the specific needs of the project: it will provide sea state and motion data for ongoing research, complementing existing data analysis to ensure minimal disruption to future operations.

Rigorous testing and simulation activities are currently being conducted, this includes interpreting data outputs and troubleshooting possible issues. Quality assurance measures were also implemented to ensure the reliability and functionality of the project.

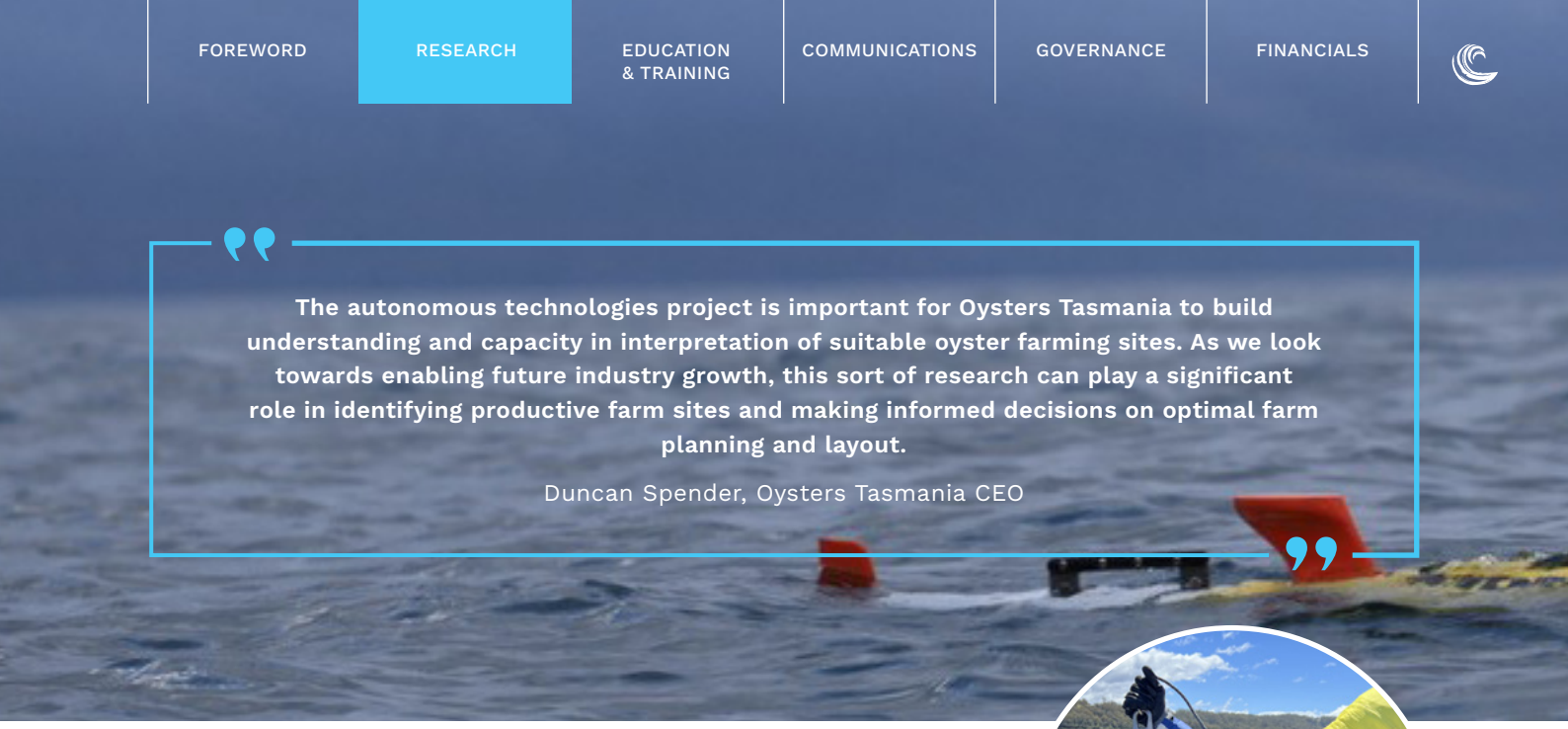
The deployment process scheduled to commence in the following months is undergoing meticulous planning and coordination to ensure a successful implementation. The alignment of technical, operational, and logistical aspects ensures a well-prepared deployment process.

MoorPower™ Opportunity

As the aquaculture sector moves operations further offshore, new challenges are encountered to access clean and reliable energy. Without shore-based power, energy intensive offshore aquaculture operations such as feeding barges are reliant on diesel generators with many associated costs, risks and carbon emissions.

This is also true of many moored vessels across the blue economy. MoorPower™ can play an important role in supporting the transition from diesel to renewable energy.

Carnegie Clean Energy's MoorPower™



> **The autonomous technologies project is important for Oysters Tasmania to build understanding and capacity in interpretation of suitable oyster farming sites. As we look towards enabling future industry growth, this sort of research can play a significant role in identifying productive farm sites and making informed decisions on optimal farm planning and layout.**
>
> Duncan Spender, Oysters Tasmania CEO

Enabling Autonomous Technologies for Aquaculture in Challenging Environments (1.21.004)

The **Enabling Autonomous Technologies for Aquaculture in Challenging Environments (1.21.004)** project, led by Associate Professor Simon Albert at the University of Queensland (in partnership with The University of Tasmania and Oysters Tasmania) is developing new methodologies for the development of autonomous systems for routine and event driven environmental monitoring. Working closely with Oysters Tasmania and farmers, this project has identified autonomous systems required to support transition of shellfish aquaculture into increasingly high energy waters.

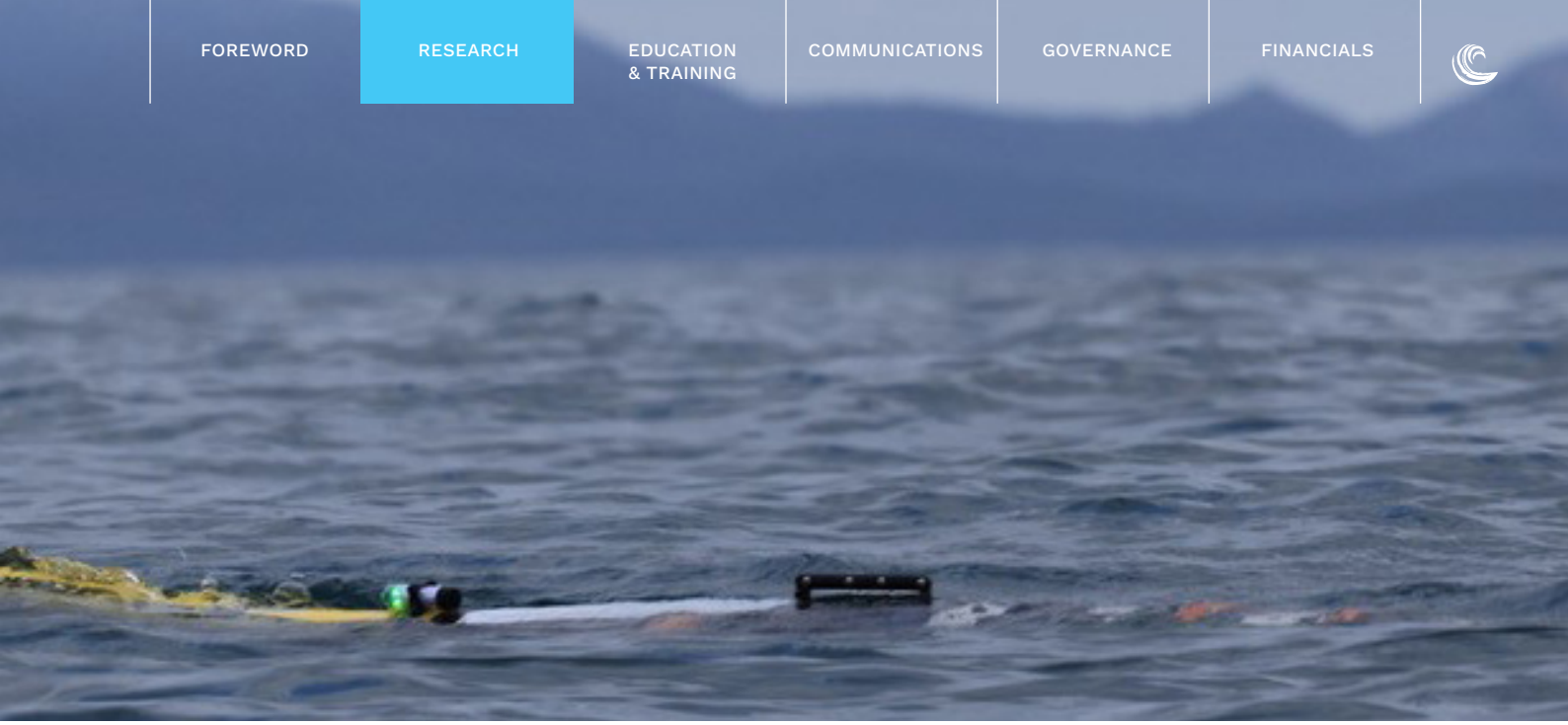
One of the initial achievements of this project has been the implementation of autonomous water quality and sea state monitoring networks at three sites on the east coast of Tasmania (Great Bay, Great Oyster Bay, and Georges Bay). These networks provide valuable data for establishing baseline environmental conditions conducive to oyster growth.

To monitor these conditions, a variety of autonomous systems have been developed and implemented. These include real-time water quality sensors placed both at the surface and at depth.

Pushing the boundaries of innovation, the project has also developed a prototype Autonomous Surface Vessel (ASV) platform equipped with a profiling water quality sonde, stereo camera technology, and a real-time data link.

The portable lightweight vessel is equipped with ample on-board processing fitted with a Nvidia Jetson NX, enabling AI computer vision identification of hazards and points of interest as well as being able perform real-time onboard data processing.

> **Having access to wind speed and wave height measurements is helping our team with daily management decisions around accessing the Great Oyster Bay lease. The chlorophyll counts are allowing for a far greater insight to our empirical knowledge, challenging what we consider to be 'good' or productive water and helping refine management strategies.**
>
> Giles Fisher, Freycinet Marine Farm



> **BMT were delighted to have the opportunity to strengthen our ties with the Blue Economy CRC and the Australian Maritime College through this placement. The Blue Economy CRC is providing BMT access to experienced professionals with broadened knowledge of the growing blue economy. Saeed was able to bring his academic insight and skills to us, while we were able to provide some experience of commercial engineering tasks in return.**
>
> Andrew Harris, BMT Technical Lead - Naval Architecture

Code of Practice for Aquaculture Vessels (1.21.005)

The **Code of Practice for Aquaculture Vessels** project has formulated a draft Australian Code of Practice for Aquaculture Vessels, to provide guidance for the planning, building, surveying, and operation of aquaculture vessels in Australian waters.

This draft Code serves as a resource for those engaged in the design, construction, production, ownership, or operation of aquaculture vessels. Its central objective is to facilitate the certification, commencement, and safe operation of these vessels, to fostering the efficient and secure provision of aquaculture services. Specifically tailored to domestic commercial vessels operating exclusively within Australia's Exclusive Economic Zone, the code addresses the unique challenges associated with aquaculture operations.

The formulation of this Code aligns with ongoing efforts in the shipping industry to produce a guideline that can have broad adoption across industry and government. Accordingly, the Code has drawn upon significant contributions from all segments of the aquaculture industry. Currently the draft code is under review by the project partners and the Australian Maritime Safety Authority (AMSA).During the project, Blue Economy CRC Research Fellow Dr Saeed Mohajernasab (UTAS) completed an industry placement with partner, BMT in Adelaide for 6 weeks. Saeed's placement involved assisting in the preliminary design of two commercial projects – Singapore Support for Floating Pontoon and a transhipment vessel for bulk crushed limestone carriage.

It provided Saheed with an opportunity to collaborate with a team of experienced engineers and naval architects to gain a deeper understanding of the industry and develop technical skills and exposure to commercial engineering.

Hydrogen Powering of Vessels (1.21.007)

The **Hydrogen Powering of Vessels** project, led by Andrew Harris (BMT) commenced in February 2023. This project is assisting the maritime industry in its efforts to pave the way for a sustainable and zero-emission maritime sector by harnessing the potential of hydrogen as a sustainable and efficient marine fuel. To date, key activities include completion of the literature review report and draft information book on hydrogen-powered vessels, ongoing case study implementation for hydrogen utilisation on reference vessels, and acceptance of a conference paper for the International Maritime Conference (IMC) 2023.

The literature review report has found that hydrogen fuel cell (FC) systems are well-established in the automotive sector and can be utilised on vessels. Meanwhile, hydrogen-fueled internal combustion engines are under development, holding promise as a potential option in the future. Also, both compressed hydrogen and cryogenic liquid hydrogen storage methods are feasible in the near term. Metal hydrides offer safety advantages and high storage efficiency, making them suitable for maritime applications in the future. The total cost total cost of ownership (TCO) for a hydrogen FC-powered vessel is approximately three times that of a traditional diesel-powered vessel with equivalent propulsion power. However, the TCO of hydrogen-powered vessels holds the potential to decrease through the scaling up of fuel cell system and hydrogen storage tank production.

The project is developing a conceptual hydrogen powertrain design for selected target vessels in Australia, is evaluating and comparing TCO of potential hydrogen-powered vessels with other zero-emission solutions and assessing and comparing the lifecycle GHG emissions of hydrogen-powered vessels with other zero-emission solutions.

Layout of a conceptual hydrogen powered vessel (BMT)

Energy-optimal control for mobile robotic platforms in offshore aquaculture (1.20.011)

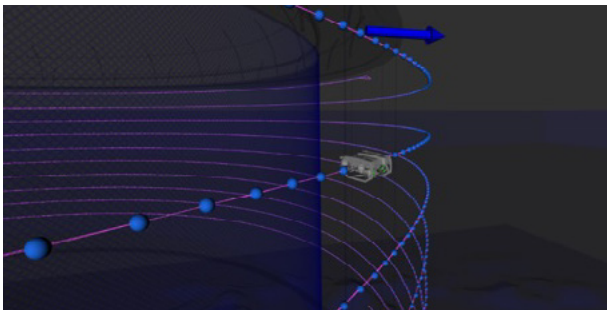
Unmanned underwater vehicles (UUVs) will play an increasingly crucial role in assisting offshore aquaculture operations in harsh working environments. One of the applications is the fish net-pen visual inspection which is routinely conducted to inspect netting, mooring systems, and biofouling.

As a tethered power supply to UUV is not feasible for a continuous visual inspection around a fish pen, a UUV must rely on the limited onboard battery for the allowable inspection time and thus, energy optimality is essential. Moreover, due to the constrained and challenging operational environment, highly manoeuvrability is required.

New Zealand King Salmon has provided valuable assistance to Thein Than Tun's PhD project **Energy-optimal control for mobile robotic platforms in offshore aquaculture** with the cross-validation of the operational constraints of both UUV capabilities and fish farm maintenance activities.

To validate those operational constraints before the actual deployment the Robot Operating System (ROS) is adapted to conduct high-fidelity simulations of UUV with the proposed controllers under different underwater current disturbances.

This understanding will provide the operations team with what to expect under specific operational circumstances and facilitate more safe and efficient fish pen inspections.



BlueROV2 Heavy Configuration conducting fish net-pen visual inspection along the purple-coloured helical path. The blue arrow is the direction of irrotational current disturbance.

Use of Multispectral imagery to enhance aquaculture operations (1.20.013)

The aquaculture industry in Tasmania is monitoring an increasingly dynamic environment. In Avik Nandy's PhD project **Use of Multispectral imagery to enhance aquaculture operations (1.20.013),** Landsat-8 satellite imagery is being used to map surface chlorophyll-a levels around aquaculture areas.

Landsat 8 is a highly effective tool for monitoring the near-coastal waters of Tasmania, demonstrating a robust and noteworthy correlation between its data and in-situ measurements.

Mapping surface chlorophyll-a, which serves as an indicator for water quality and primary productivity, using Landsat-8 multispectral imagery, highlights the synergy between remote sensing technology and on-the-ground observations.

With support from Oysters Tasmania, an in-situ sensor (the Xylem exo-2 sensor), was installed on a stationary buoy. This integrated approach provides a visual representation of chlorophyll-a distribution, offering important insights into the changing dynamics of aquatic ecosystems.

Further, the intention of enhancing this methodology by integrating multiple sensors (such as Sentinel-2 and Planet data) will provide more frequent and detailed data, enabling a closer examination of aquaculture areas and facilitating adaptive management strategies in response to rapid environmental change.

This research has broader implications – it deepens our understanding of changing ecosystems and allows monitoring of remote and hard-to-access areas.

This advance in satellite-based monitoring has benefits beyond the aquaculture industry with implications for environmental protection, resource management, and regulatory compliance.

Research Program 2 | Highlights

Seafood and Marine Products

Program Leader
Professor Chris Carter
Institute of Marine and Antarctic Studies, University of Tasmania

Deputy Program Leader
Professor Lindsey White
Auckland University of Technology

The Seafood and Marine Products Program supports existing industries move offshore and develop, test and evaluate innovative production and processing systems for a range of seafood species and develop offshore aquaculture systems that provide viable and sustainable growth opportunities.

Offshore Seaweed Production

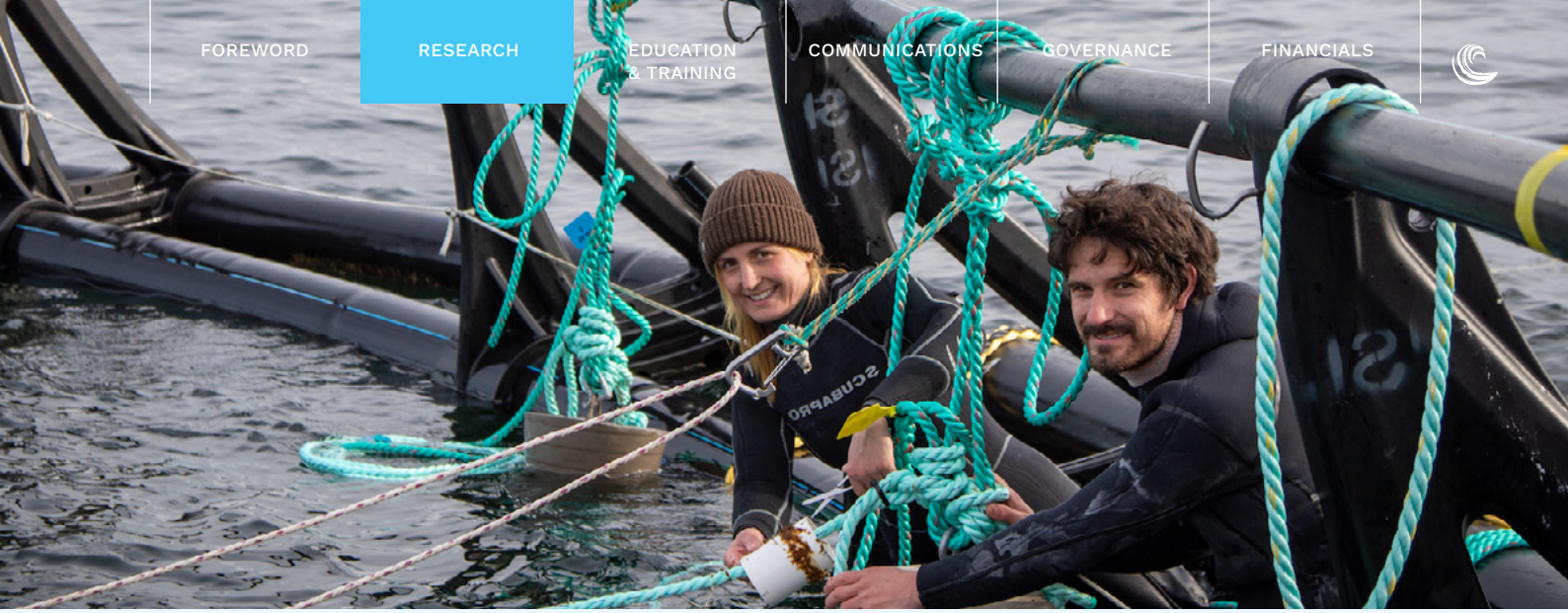
The Blue Economy CRC is undertaking research to help inform the potential for offshore seaweed cultivation in Australia. Central to this is the project led by Professor Craig Johnson (UTAS) Developing production systems for offshore kelp mariculture (2.21.005) which is translating theory into practice. At our Tinderbox site in Tasmania, state-of-the-art infrastructure plays host to various seaweeds including Macrocystis pyrifera cultivars that have been selected to exhibit resilience under changing global temperatures. Novel instrumentation (e.g., AWAC, PAR, and FLNTU sensors) are now shedding light on the seaweed's living conditions with the use of advanced sensors.

The project Creating opportunities for Bull Kelp aquaculture (2.21.003) led by A/Professor Jeff Wright (UTAS) is spearheading our deep dive into the biology of bull kelp. Through the efforts of PhD students Jessica Roach(AUT) and Vincent Yap (UTAS), alongside Ewan Barry, and Marianne Pelletier we are uncovering the life cycles, reproduction, and hatchery requirements of several Durvillaea species. But our investment in seaweeds doesn't stop at biology. Professor Craig Johnson's (UTAS) team is paving the way for seaweed development's infrastructural and policy frameworks. Engineering innovations, policy studies, and global benchmarking are happening in tandem, ensuring our seaweed ventures are sustainable, efficiently regulated, and globally resonant.

With support from the NSW Government and with the Blue Economy CRC, A/Professor Michelle Voyer and Dr Tillmann Boehme (University of Wollongong) have partnered with local aquaculture industry leaders to undertake social, economic, and cultural research to support regenerative farming in waters off the south coast of NSW, focusing on the emerging seaweed farming industry and shellfish farming.

Four further projects are planned to commence in 2023/24 that will explore the multidimensional benefits of seaweed farms including coastal protection, hydrodynamics of artificial kelp fields and advanced modeling techniques, reshaping seaweed mariculture by leveraging marine permaculture, and co-located farms that synergize sustainable cultivation and clean energy generation.

In summary, our investments are sculpting the offshore seaweed sector's future, intertwining cutting-edge biology, innovative engineering, and a commitment to a sustainable, socially responsible and interconnected ecosystems.



Updates on these projects are provided below.

In the project Developing production systems for offshore kelp mariculture (2.21.005), field operations at the Tinderbox site have successfully completed pre-deployment monitoring and installed comprehensive infrastructure, including concrete anchors, aquaculture rings, and grow lines. Various cultivars of Macrocystis pyrifera microsporophytes have been out-planted both at Tinderbox and North Zuidpool.

Despite some delays due to supply-chain issues, a Lander instrument pack equipped with several sensors is now operational at Tinderbox. In the engineering domain, multiple options for nutrient pumping and kelp depth cycling are under evaluation, with conclusions expected by July-end.

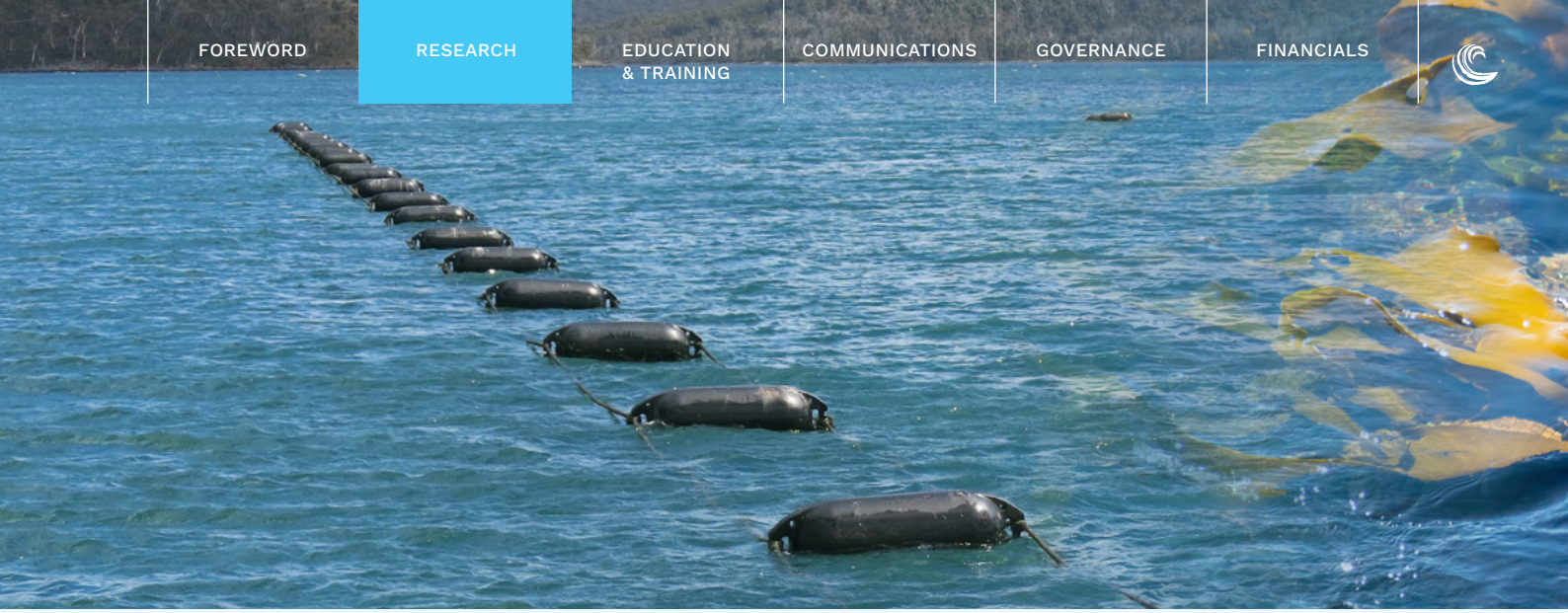
The policy and regulatory analysis is progressing well, having studied both domestic and international kelp farming frameworks. The economic assessment team is closely working with engineers and remains on track.

We are pleased and proud to be industry partners of the Blue Economy CRC. Working closely with the outstanding world class academics and other industry participants has accelerated and evolved our commercial offerings considerably and de-risked our work immensely.

Adam Brancher, Southern Ocean Carbon Company Founder

The Creating opportunities for Bull Kelp aquaculture (2.21.003) project is making strong progress in understanding the reproductive biology, hatchery and at-sea cultivation methods for Durvillaea. PhD student Vince Yap has been undertaking monthly field surveys to determine the reproductive cycle in Durvillaea in Tasmania.

He has developed methods to assess fertility using sections of blades and by releasing gametes. His findings to date indicate Durvillaea are fertile from early winter (June) to mid spring (September/October) and this appears consistent among three sites (Eaglehawk Neck, Bicheno and Binalong Bay). Other project team members at UTAS (including Wouter Visch, PostDoc) have been working on a range of critical aspects of the hatchery systems required for Durvillaea cultivation.



Hatchery reared Undaria growing on lines at Tinderbox (3 months after outplanting)

Outplanting the cultivated giant kelp at Tinderbox in June

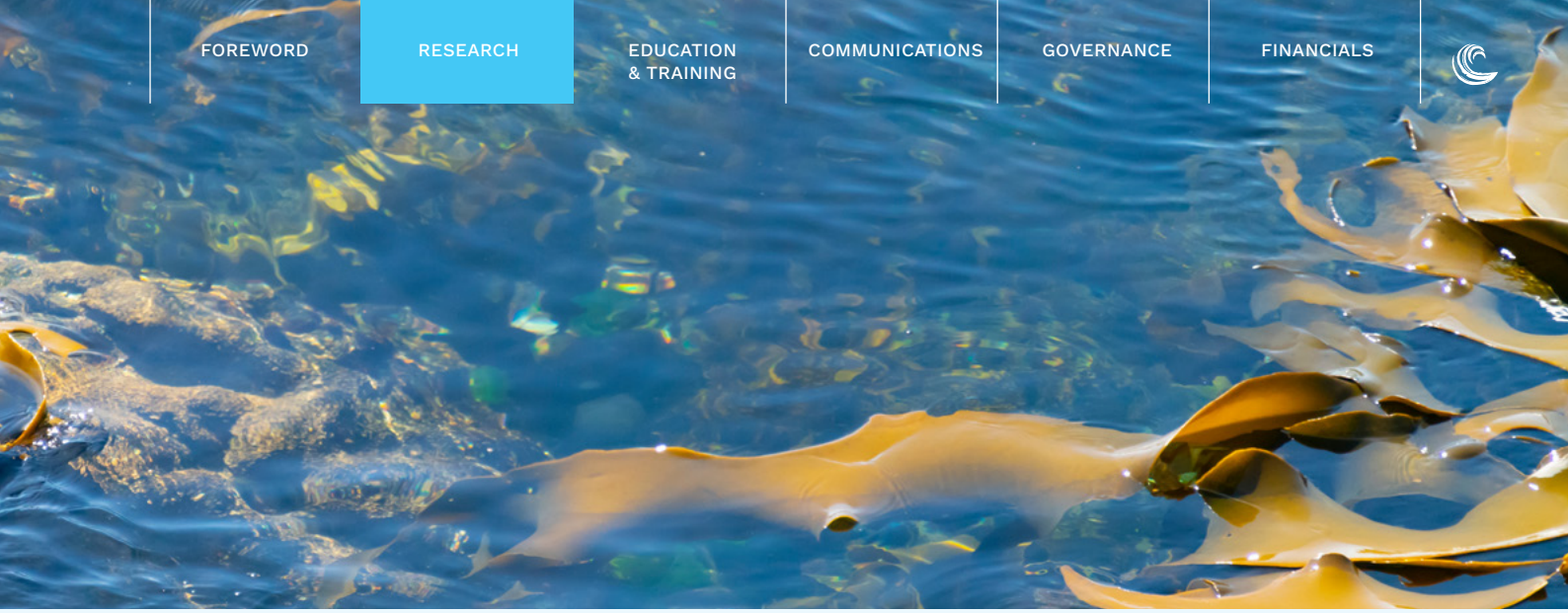
Deploying hatchery reared bull kelp on lines at Tower Bay

They have developed and largely optimised methods to release gametes and quantify gamete concentrations, achieve successful fertilisation of eggs by sperm, and ensure successful post-fertilisation growth and survivorship of juveniles in the hatchery. Several substrates suitable for the settlement of zygotes, and subsequent growth and survivorship to a size for outplanting to the marine farm, have been tested.

The type of substrate for outplanting will likely vary depending on whether the Durvillaea will be outplanted to artificial reefs (relevant to project partner Southern Blue Reef), or grow-lines on the marine farm (for biomass production as required by project partner Seasol International). PhD student Jessica Roach (AUT) is progressing with monthly sampling and hatchery method development for Durvillaea species in NZ at Cawthron.

> **Our project is a great example of collaboration, focused on overcoming knowledge gaps in cultivating kelp in the open sea and investing in new sustainable offshore industries, which would not be possible without the CRC scheme.**
>
> Tony Arioli, Seasol CEO

An experiment testing the impact of different parameters on hatchery-reared juveniles is underway at Tower Bay. The growth has been tested on lines at Tower Bay of outplanted juveniles (~ 10 cm in length), collected from nearby wild populations. The PostDoc is also working on developing molecular methods to identify the two Durvillaea species.



The University of Wollongong (UOW) and Blue Economy CRC are collaborating with the NSW Government and industry to identify social, cultural and economic impacts and opportunities that may be associated with future development of a regenerative aquaculture industry on the South Coast of NSW, in a new project that started late-2022. Regenerative farming involves the natural environment providing the inputs needed for growth, allowing stock to grow on its own using natural food sources and conditions.

The collaborative research project will examine the potential to further develop regenerative farming in the waters off the south coast of NSW, including optimising marine space through the co-location of seaweed and shellfish on the same sites. The project team will work alongside community, Indigenous rights holders and other marine estate users to understand what matters to them when it comes to growing the blue economy, and what is needed to address community sentiment and grow community support for regenerative aquaculture opportunities in the local area.

The project team and industry leaders hosted a series of community sessions in September 2023 as they continue to identify the social, cultural, and economic impacts and opportunities that may be associated with development of Kelp and Mussel farming on the South Coast of NSW.

Experimental Platform for Aquaculture Production (2.21.002)

The Experimental Platform for Aquaculture Production (2.21.002) project led by Professor Chris Carter (IMAS-UTAS) has made major progress with the completion of two large experiments based on-shore at the Experimental Aquaculture Facility (EAF) at IMAS Taroona and in marine test pens. The same cohort of salmon, consisting of more than 160 families, from the Selective Breeding Program were assessed at two sizes over simulated sub-optimum summer and autumn recovery phases. Over the two experiments salmon were grown from around 400 g to 3.5 kg, despite long exposure to sub-optimum conditions.

A key focus of the research is using omics technology to understand underlying physiology and potentially the basis of differences between low and high performing fish. Many other analyses are also underway and include being able to assess the translation of research data between experiment tanks and marine test pens and ultimately to commercial pens.

These include investigations of changes to salmon heart morphology and biochemical composition, and the impacts on digestive tract physiology and function. One of the main objectives is establishing the EAF as a viable research tool. It has already allowed the finding of a moderately high genetic correlation (0.57) between growth in the EAF and marine test pens, under comparable water temperature and dissolved oxygen conditions.

Lewis Rands (SALTAS) “These observations underscore the valuable role of the EAF in offering us unique insights crucial for fine-tuning our breeding program to better adapt to future climate conditions. By exposing our salmon to future water temperatures at the EAF, we take a significant step towards climate-proofing our stocks.”

PhD student Atshaya Sundararajan (UTAS) joined the Experimental Platforms for Aquaculture Production (2.21.002) project to investigate how two critical environmental factors, elevated temperature and low dissolved oxygen, affect Atlantic salmon performance under sub-optimum and recovery phases that reflect summer and autumn conditions.

Proteomics provides a benchmark technique to explore changes in the muscle and liver proteomes to potentially highlight differences between low and high performing salmon. To date, she has completed the extraction and proteomic analysis of liver samples producing a quantitative dataset of 6,350 proteins. This will provide an excellent resource to investigate the relationship between salmon performance and metabolic processes in the liver of Atlantic salmon exposed thermal stress and post-recovery.

EPAP PhD candidate Atshaya Sundararajan carrying an Atlantic salmon to the lab for processing and sample collection during EPAP Experiment 2.

Dr Gianluca Amoroso (EPAP Deputy Project Leader) carrying out fish anaesthesia and measurements with Saltas and EAF staff carrying out fish processing at the end of EPAP Experiment 2.

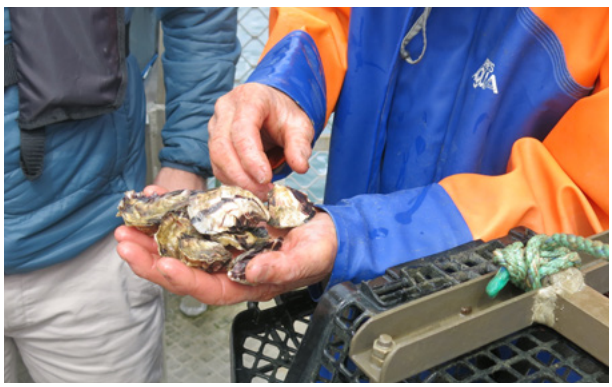
Opportunities and Challenges for the Oyster Industry in the Blue Economy (2.21.001)

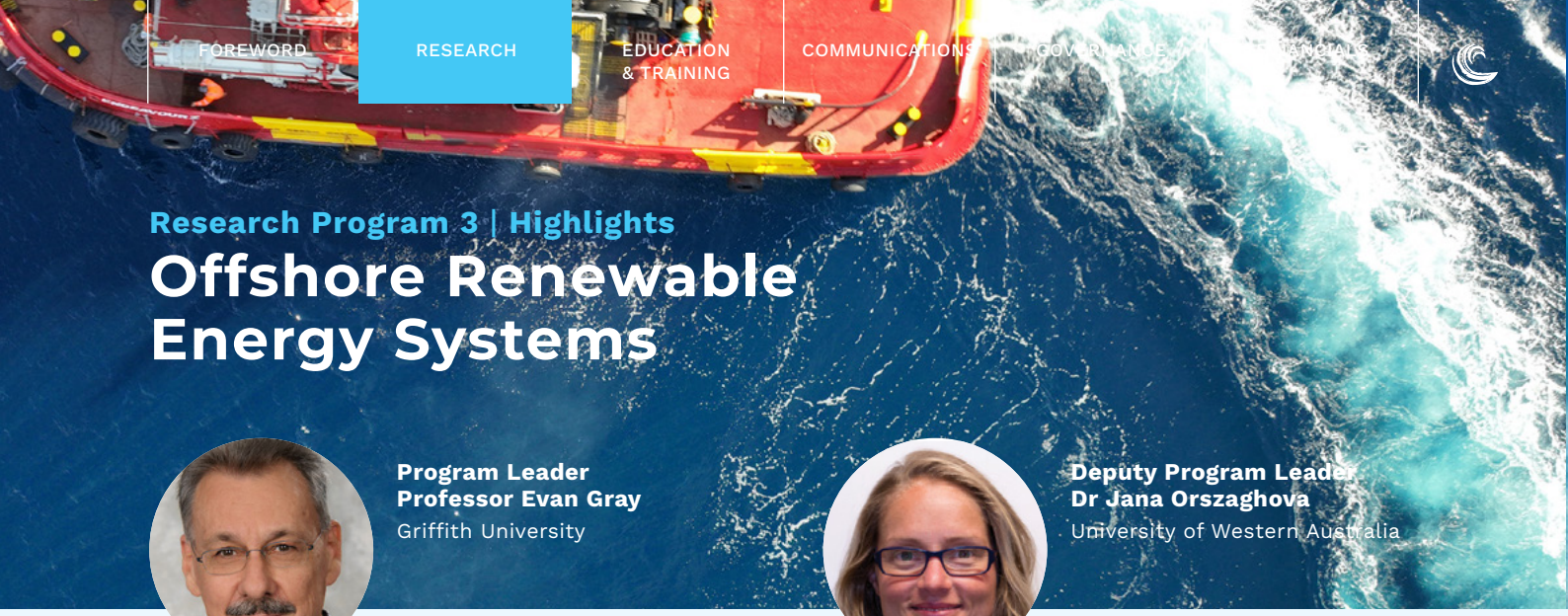
Oysters Tasmania project, Opportunities and challenges for the Oyster Industry in the Blue Economy (2.21.001), is investigating possibilities for the oyster industry to successfully transition production to deep water and high-energy sites in Tasmania.

There are few intertidal leases remaining unlicensed and an increasing influence of coastal urbanisation means a low likelihood that further intertidal shellfish lease space will be allocated. Conversely, deep water shellfish growing leases remain underutilised.

As of June 2021, 83% of allocated Tasmanian shellfish leases that can be characterised as deep-water/more exposed were not currently used for farming. The availability of these deep-water leases presents a tangible opportunity to grow production.

To date, the project has identified the constraints and benefits of this transformation, increased our understanding of what it will take to move farming into deeper water and identified research and extension opportunities that meet the current and future needs of the industry.





Research Program 3 | Highlights

Offshore Renewable Energy Systems

Program Leader
Professor Evan Gray
Griffith University

Deputy Program Leader
Dr Jana Orszaghova
University of Western Australia

The Offshore Renewable Energy Systems program is advancing the technological and commercial readiness of emerging offshore renewable energy technologies, so they can fulfill their potential to decarbonise offshore industries, including aquaculture, and export energy as electricity and hydrogen.

DC Microgrids for Offshore Applications (3.20.004)

The project DC microgrids for offshore applications (3.20.004), is being led by Professor Evan Gray at Griffith University. The ability of microgrids to harness diverse energy generation and storage technologies means that they will play an important role in replacing centralised fossil-fuel generators by decentralised renewable energy sources. Microgrids are especially important in isolated communities, such as islands and in offshore industries.

While microgrids serving communities and industries are typically alternating current (AC), there are powerful reasons to employ direct current (DC) in harnessing renewable energy.

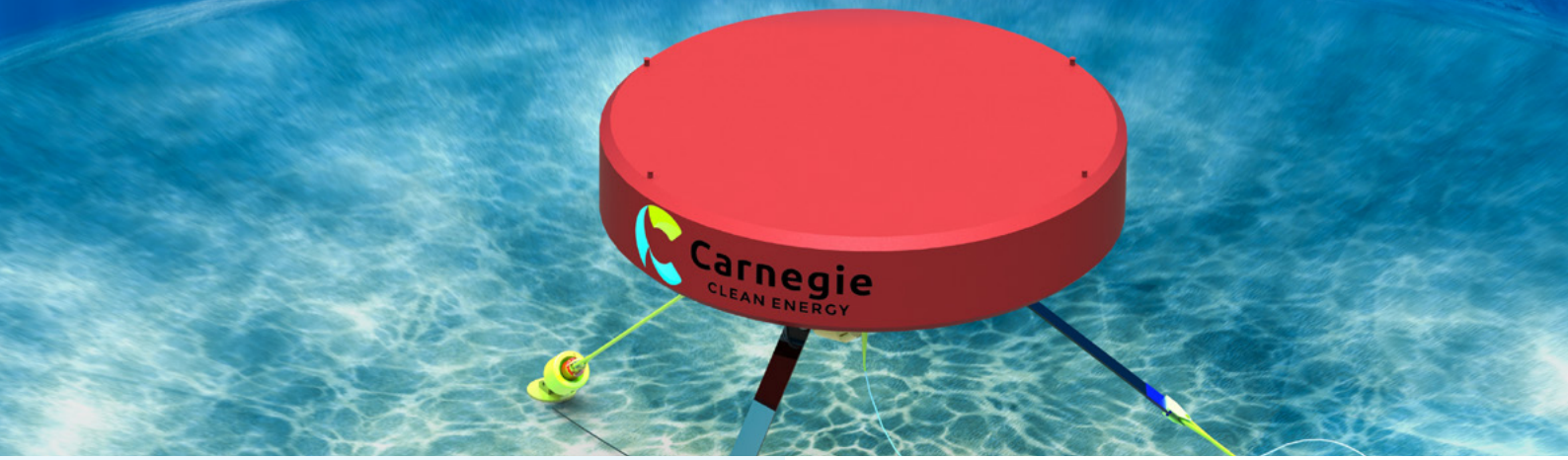
The most important reason is that essentially all the technologies available to capture and store renewable energy are “DC inside”, including photovoltaics, batteries, electrolysers for producing hydrogen from electricity and fuel cells for producing electricity from hydrogen. In addition, DC–DC conversion with very high efficiency is possible, and system complexity is reduced through needing fewer converters.

This project takes an important step towards real-world DC microgrids by building a bench-scale DC microgrid at the 10-kilowatt level, to explore the stability and optimal management of DC microgrids. The project feeds into the Blue Economy CRC’s flagship demonstration project under which a DC microgrid including hydrogen production, storage and supply will be deployed in the ocean within several years.

The first phase of the demonstration project, construction of an onshore hydrogen microgrid in Hobart, is rapidly approaching fruition.

The pure-DC bench-scale microgrid has been completed at Griffith University and is being commissioned ahead of its first use for experiments on microgrid control.

> **Optimal is looking forward to bringing the learnings from our participation in the Blue Economy CRC’s bench-scale DC microgrid project to our upcoming real-world hybrid power systems.**
>
> Craig Dugan, Optimal CEO



Alamgir Hossain (UTAS) commenced his PhD in September 2022 with a Blue Economy CRC PhD scholarship for his project DC Microgrid for Offshore Applications, which is an integral part of the general project DC microgrids for offshore applications (3.20.004).

Alamgir is studying the stability of DC microgrids, which have application in offshore industries owing to their ability to integrate diverse renewable energy sources, such as wind and wave generators, and energy storage systems, that are intrinsically or effectively DC rather than AC.

In an AC microgrid, the challenges are to maintain the bus voltage and synchronise with the bus or grid frequency. In a DC microgrid the DC bus voltage may fluctuate owing to load changes, converter operating conditions, and controller tuning.

Maintaining a stable DC bus voltage poses a significant challenge. Alamgir has developed a mathematical model to analyse DC microgrid stability following sudden changes in power entering or leaving the microgrid and proposed a suitable controller design to ensure system stability.

The proposed controller has been demonstrated to regulate the DC bus voltage successfully while maintaining overall system stability, for a small DC microgrid simulated in MATLAB/Simulink.

Mooring Tensioner for WECs – MoTWEC (3.20.006)

Ocean waves remain a largely untapped renewable energy resource. Wave Energy Converters (WECs) convert energy from waves into electricity, but the Levelised Cost of Energy (LCoE) for WECs hasn't yet reduced sufficiently to trigger significant uptake. Ocean Energy Europe predicts this will change and forecasts the market potential of WECs to be €653b by 2050.

Recent developments in WEC technology have seen leading developers, including Carnegie Clean Energy (CCE) converge toward rotary Power Take Off (PTO) systems. The PTO is a critical mechanism within the WEC, converting prime mover kinetic energy to electrical energy. To unlock this technology, implementation of a method for rotary mechanical energy storage and mooring line pre-tension balancing is required.

CCE's solution to the tensioning problem, christened "MoTWEC", delivers high efficiency energy exchange, high cycling life and robust reliability Mooring Tensioner for WECs – MoTWEC (3.20.006). It is expected that successful delivery of MoTWEC will lead to a step-change in the cost of WEC-produced electricity, supporting lower cost of energy supply to the land-based electricity grid, offshore platforms and aquaculture sites.

MoTWEC relies on robust materials that can be used to make a spring-like structure able to be cycled millions of times without failure. Composite materials supplied by Advanced Composite Structures Australia (ACSA) are being subjected to detailed microanalysis at the University of Queensland, to establish a benchmark for spring quality and identify the damage modes that are incurred during fatigue testing and accelerated aging.

Most recently, the team at Carnegie Clean Energy has been focusing its efforts on cyclic testing of prototype mooring tensioners manufactured by ACSA. The test program has already reached about 1 million cycles of the 5 million required to simulate a 20-year service life.

The Hon. Alannah MacTiernan MLC and Dr Wiebke Ebeling Centre Manager Wave Energy Research Centre at the M4 Wave energy project launch in Albany.

Seeding Marine Innovation in SW WA with a WEC Deployment in Albany (3.21.004)

The project Seeding marine innovation in SW WA with a WEC deployment in Albany (3.21.004) will deploy a prototype-scale Wave Energy Converter (WEC) in King George Sound off Albany, Western Australia.

The deployment will support surrounding activities including a virtual exercise powering aquaculture facility and development of a test site/market demonstrator. In a significant departure from the closely guarded innovation environment in which technology developers typically operate, all research data produced by this prototype deployment will be publicly available, and benefits will include demonstration of local (Great Southern, WA) and national capability, interaction across CRC partners, advancement of the technology, community engagement, training and more.

King George Sound is ideally co-located with aquaculture, including the Albany Shellfish Hatchery adjacent to the demonstration site and Harvest Road Group's Albany Rock Oyster operation nearby.

The M4 WEC has been developed at the University of Manchester, UK, with involvement of academics from many places, including the University of Western Australia. Machine size, survivability and available power in open water at Albany have been assessed.

In the past year the M4 project has progressed through recruitment of PhD students (University of Queensland and the Australian Maritime College), detailed design (BMT Commercial Australia Pty Ltd and UWA), wave basin testing (AMC and UWA), Power Take-Off design and procurement (M4WP Ltd, University of Manchester and UWA), environmental approvals and stakeholder engagement (BMT and UWA) and is now moving into fabrication and integration.

> **BMT have successfully completed the detailed structural and mechanical design of the M4 wave energy converter and the environmental impact assessment/management plan, and are supporting the head contractor as they move into fabrication, assembly and deployment. We are very proud of what the project has so far achieved, and can't wait to see the culmination of many hours of hard work across all of the project partners come to fruition with the successful deployment, operations, and retrieval stages of the project.**
>
> Chris Shearer, BMT Principal Engineer | Technical Lead - Mechanical Engineering

Risk-based Procedures for Safe and Reliable ORES (3.21.005)

The pressing demand for energy generation from renewable resources, as well as the increasing activities in the offshore environment, are driving significant progress in the research, development and implementation of new technologies.

The project Risk-based Procedures for Safe and Reliable ORES (3.21.005) is developing an assessment and decision framework that will enhance the safety, value-adding and cost-effectiveness of Offshore Renewable Energy Systems (ORES). Emerging offshore technologies including are complex to design, commission and operate, mainly due to the uncertainties involved with planning and managing their life cycle, given the newness of concepts, randomness of the offshore environment and lack of reliable procedures. Hence, the provision of risk management procedures will greatly assist in enhancing social acceptance, accelerating ORES developments to replace fossil fuels fostering efficiency and sustainability for the infrastructure and operations in the blue economies. The project is utilising the MoorPower™ concept (see project 1.21.001, above) as an example to develop its risk-based decision framework.

System Level Modelling to Improve the Performance of Offshore Sustainable Power (3.22.001)

The project System level modelling to improve the performance of Offshore Sustainable Power (3.22.001) recognises that reliability and safety are critical for any successful power system operation. A well-designed power system ensures robust performance and maximises the withstanding capability under all normal and transient operating conditions.

Further, a power system primarily supplied by renewable energy sources needs to be able to accommodate highly fluctuating input due to the inherent variability of the sources. Power analysis tools and methods can be used to evaluate the performance of newly designed power systems before the actual implementation. This project is designed in association with bench-scale Hydrogen DC microgrid to carry out real-time and hardware in the loop analysis to determine some vital factors such as energy forecasting, fault protection, energy storage, and demand-side management. The outcome of the project will provide a solid grounding of the fine technical details supporting the decision-making of the offshore hydrogen DC microgrid architecture.

Literature reviews have been completed. The research is now focused on developing: (i) a high-level guidance document for renewable energy potential forecasting; (ii) a DC Microgrid simulation case in Opal-RT and a basic hardware in the loop implementation; and (iii) the demand side management methods and a DC Microgrid model including an electrolyser.

Avy Sheina (AUT) commenced her PhD in October 2022 with Blue Economy CRC PhD scholarship for a project on protection and control mechanisms of DC microgrids in offshore applications, under the umbrella project System level modelling to improve the performance of Offshore Sustainable Power (3.22.001). By providing power at sea and reducing the dependency on diesel, offshore renewable energy is expected to reduce the environmental impact of offshore aquaculture operations and other offshore industries. Microgrids are needed to integrate several renewable energy resources like solar, wind, wave and tides that may be harnessed at a particular location. Avy's research proposes an adaptive approach for DC microgrid protection systems by using a control algorithm that employs artificial intelligence.

The research approach is to simulate real systems in MATLAB/Simulink software, with several operation scenarios and configurations. The algorithm will be optimized to achieve the fastest response to clear any faults and the best topology configuration. It will also be tested in a hardware-in-the-loop (HIL) testbed using Opal-RT. Overall, Avy's research will benefit the entire power distribution system by addressing critical issues affecting safe, robust and reliable operation of DC. So far, Avy has developed a DC microgrid model in Simulink and able to control circuit breakers with HIL through Opal-RT.

Avy's first research paper has been to the 5th International Conference on DC Microgrids (ICDCM 2023).

Research Program 4 | Highlights

Environment and Ecosystems

Program Leader
Professor Chris Frid
Griffith University

Deputy Program Leader
Dr Remo Cossu
University of Queensland

The Environment and Ecosystems Program offers an integrated, whole of life-cycle, adaptive approach to placement, operation and decommissioning of offshore infrastructure and livestock. Novel monitoring systems will deliver real-time data and information for use by government, industry, and the public.

Marine Spatial Planning for a Blue Economy (4.21.002)

The Marine Spatial Planning for a Sustainable Blue Economy (4.21.002) project is consulting with stakeholders, analysing research, collating national data sets, and developing tools and approaches to support growth in Australia's blue economy.

MSP initiatives are being implemented across multiple regions of the globe, including to facilitate the sustainable energy transition, with many offshore wind developments implemented through an MSP process. The intention of this research is to showcase MSP to government and industry in Australia and design an integrated approach that is adapted to the Australian context.

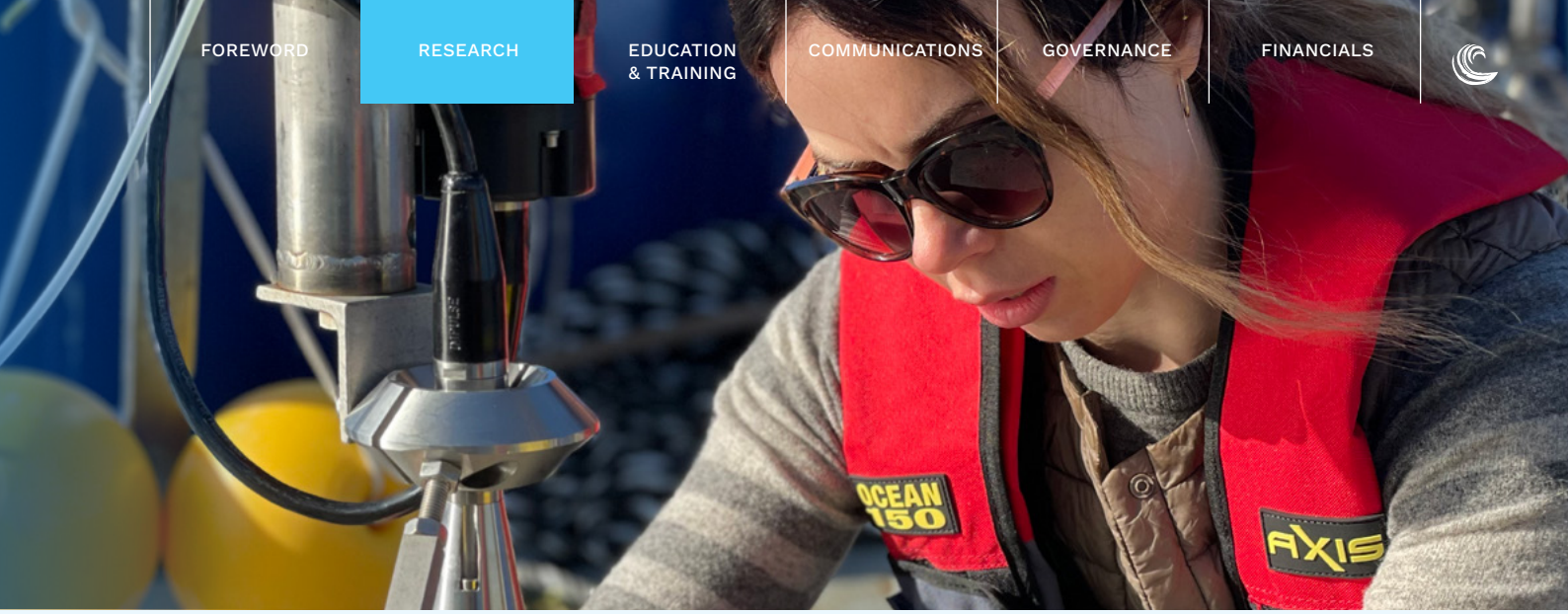
Consultation with over 100 stakeholders has been undertaken to understand stakeholder needs and aspirations for an integrated marine planning framework, including an understanding of their data needs and areas of conflict. Stakeholders include state and federal government, industry, peak bodies and non-government organisations.

There is broad support for an integrated process in Australia's marine estate throughout the states and territories, federal agencies and industry. The Sustainable Ocean Plan that is currently under development, provides an opportunity for a national discussion on Australia's need for marine planning and explore options and processes for taking it forward. Stakeholders are keen to learn how an MSP approach can alleviate conflict, guide decision-making, and make the process more equitable for industry.

A summary of the shared vision for an Australian Marine Spatial Planning Framework developed from the stakeholder engagement (figure above):

Analysing research has enabled the project team to understand how integrated frameworks commonly used around the world have supported growth in the blue economy and enabled emerging industries to become established. The analysis includes evaluation of the mutual benefits and perceived risks among ocean users and the environment and developing decision-support tools to guide site selection of offshore aquaculture and renewable energy.

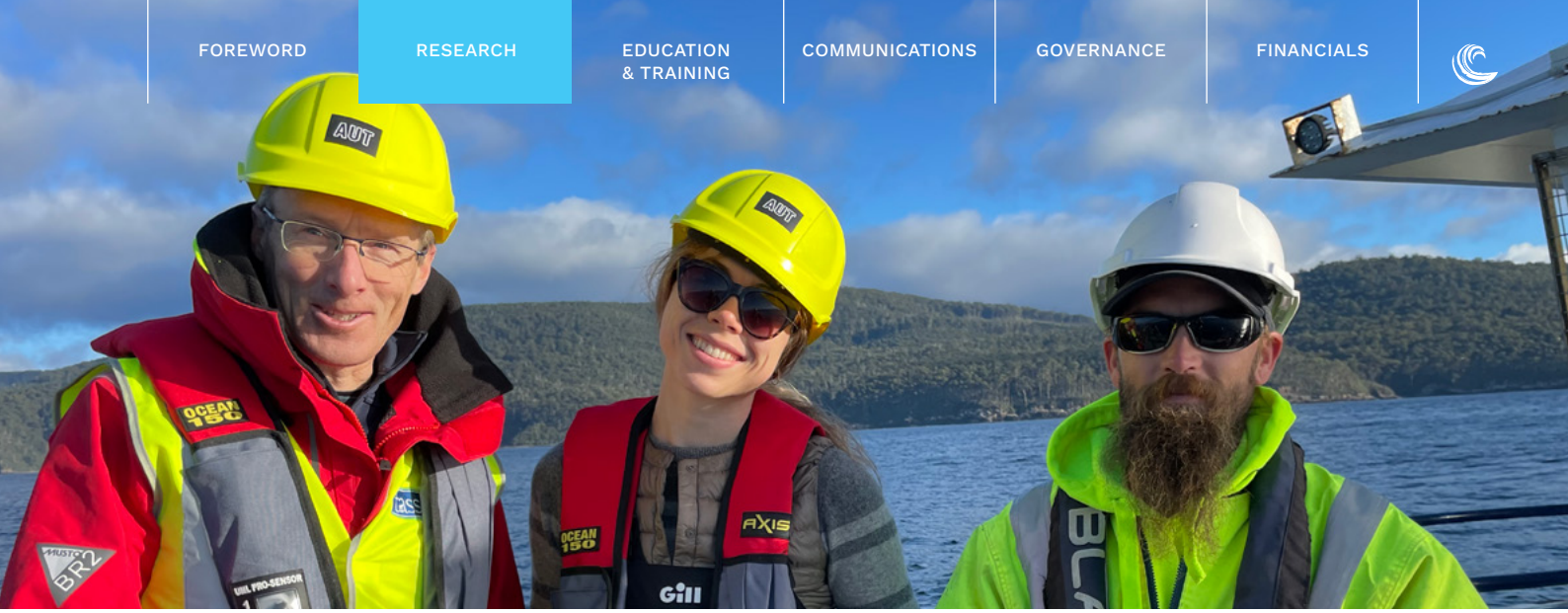
National data layers are being collated and data holders contacted to understand their data needs to inform decision-making. The feedback from stakeholder consultations and research learnings are informing the design of the MSP framework.



Coming up - The project team are engaging with Traditional Owners of Sea Country to ensure that the MSP framework is consistent with the values and aspirations to those living on and managing Sea Country.

Shared vision for an integrated framework

GOALS	OBJECTIVES	
High-level leadership	→ Overarching governance framework through a coordinated process	GOVERNANCE
Integrate sectors	→ Retain sector-based processes, have regards to existing planning processes	
Transparent process	→ Transparent decision-making that considers trade-offs	
Clear and efficient	→ Centralise application processes to make more efficient & clear for proponents	
Equitable	→ Pro-active management based on agreed goals & principles, driven by government priorities	EVIDENCE -BASED
Reduce conflict	→ Access to data products	
Evidence-led	→ Process informed by science & risks (incl. cumulative impacts)	
Participative	→ Early & consistent engagement, meaningful participation	STAKEHOLDER ENGAGEMENT
Inclusive	→ All stakeholders engaged & interests defined, acknowledgement of indigenous rights & values	
Access to stakeholders	→ Indigenous stakeholders, rightsholders & public	
Adaptive and flexible	→ A politically adaptive & flexible process	FUTURE -PROOFED
Future-orientated	→ Changing climate & changing/emerging user needs	

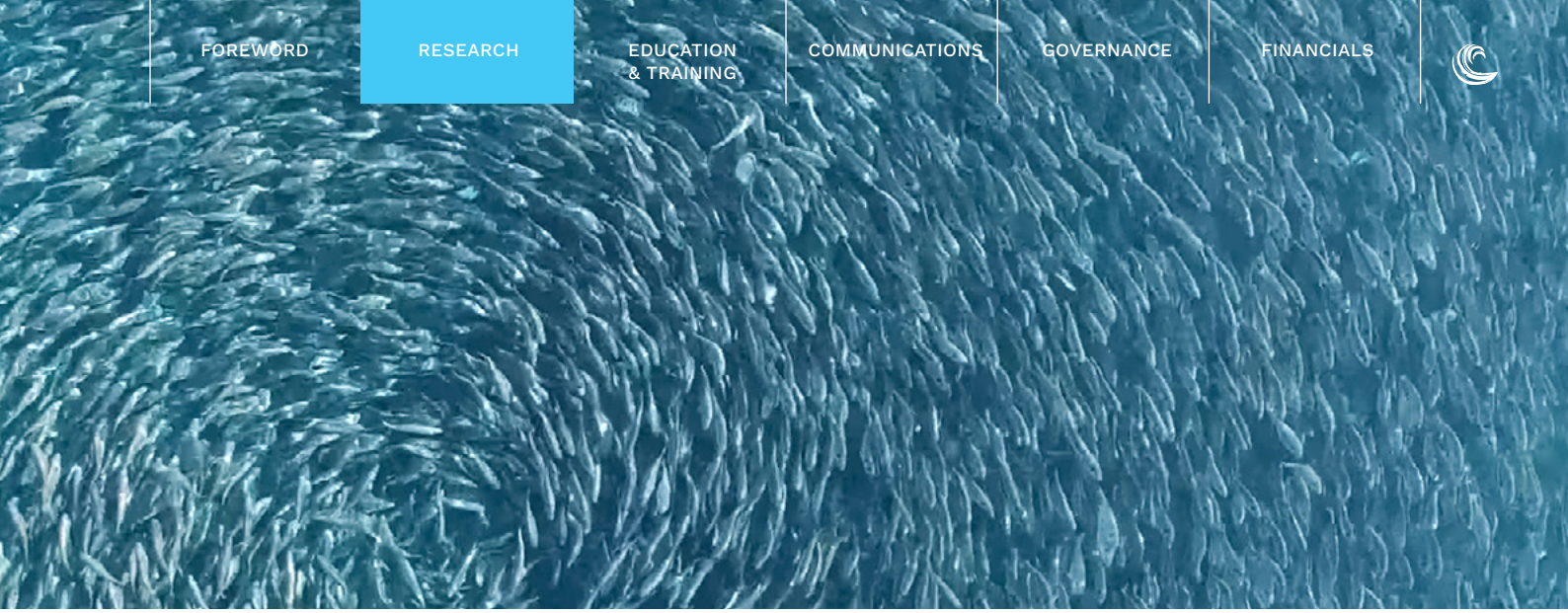


A Novel Approach to Measuring the Depositional Footprint of the Blue Economy (4.20.004)

In June 2023, the team delivering the project A novel approach to measuring the depositional footprint of the Blue Economy (4.20.004) completed the fifth and final sea voyage, deploying three eddy-covariance and one chamber lander along a 3 km transect heading away from TASSAL's East of Lippies farm, Southern D'Entrecasteaux Channel, Tasmania. Prior to this, in May 2023, the IMAS project team performed sediment redox measurements around this farm to inform the transect layout.

Overall, 12 eddy-covariance and 21 chamber lander deployments were completed, in 45-50m water depth. These deployments mapped the gradient in organic enrichment around pens, measured as 'total sediment oxygen demand'. The steepness, defined by the maximum sediment oxygen demand in the immediate vicinity of the pen, and spatial extension (distance at which the sediment oxygen demand reaches background levels) of this gradient, respectively, describe the depth and size of the farm footprint in the seafloor ecosystem.

PhD student Elianna Zoura, supervised by Associate Professor Kay Vopel (AUT), joined the team in late 2022. Her research investigates how animal–sediment interactions determine the seafloor ecosystem's capacity to mineralize organic fish farm waste. Defining this capacity is crucial for predicting the offshore seafloor ecosystem's response to organic enrichment. Such predictions further inform adaptive farm management strategies that support the sustainability of offshore aquaculture. Elianna is based in Auckland, New Zealand, and collaborates with the Northland Aquaculture Centre of the National Institute of Water and Atmospheric Research (NIWA) in Bream Bay.



Advanced Monitoring to Maximise Fish Welfare in Offshore Aquaculture (4.21.001)

Automated monitoring of fish and the environment is essential to support the transition of aquaculture to offshore and remote environments. Feed cameras, deployed within fish pens, enable fish and the environment to be monitored remotely from shore.

Computer vision is emerging as an essential tool to assist farm managers to detect critical changes in fish behaviour, condition, and the environment. The project Advanced monitoring to maximise fish welfare in offshore aquaculture (4.21.001) is developing machine learning models that enable the video footage from hundreds of cameras to be monitored continuously and automatically.

Numerous types of jellyfish occur in Tasmanian waters, including stinging and non-stinging species. Stinging jellyfish can kill and injure fish but non-stinging types (e.g. comb jellies and salps) impact fish by depleting oxygen within pens. The team is using machine learning to train a model to detect and identify different species of jellyfish in the video footage streamed from feed cameras. The jellyfish early warning system will be an important tool that industry can use to support rapid decision making in response to jellyfish ingress.

Fish experience respiratory distress when oxygen concentrations decrease, or when experiencing gill disease or injuries, such as those caused by stinging jellyfish. Dr Lukas Folkman and PhD student, Quynh Le Khahn Vo, are also training models to detect changes in fish ventilation rates by automatically measuring the rate at which individual fish open and close their mouths.

During her PhD, Quynh will use the model to examine the range of environmental conditions that cause respiratory distress, and to determine whether computer vision can be used to monitor aspects of fish health that are currently done during manual gill health checks.

Model detection of open and closed mouth positions used to measure ventilation rates.

PhD Student Jillian Conrad (Griffith University) started her PhD on Empowering Traditional Saltwater Management under the supervision of Professor Chris Frid at Griffith University in 2022.

Her project, An ecosystem based blue economy on Sea Country will contribute to developing a toolkit for advancing Indigenous equity and justice in Australia's Blue Economy.

Outcomes will include culturally sensitive guidelines for government and industry seeking to collaborate with Aboriginal and Torres Strait Islander peoples on projects related to their Sea Country.

This project was initially developed with QYAC as the focus has shifted to a broader, Australia wide perspective CSIRO has joined the project as the 'industry partner'. This has allowed Jillian to interact with a wider geographic range and diversity of community groups.

At the International Conference on 'Achieving Ocean Equity: Innovative, Fair, Inclusive, and Sustainable Strategies and Blue Impact Investments' in Wollongong, New South Wales. The event was co-organized by ADBI, the Australia National Centre for Ocean Resources and Security, and the Ocean Policy Research Institute of the Sasakawa Peace Foundation.

Research Program 5 | Highlights

Sustainable Offshore Developments

Program Leader
Professor Marcus Haward
Institute of Marine and Antarctic Studies, University of Tasmania

The Sustainable Offshore Developments program is profiling and advocating for the regulatory frameworks that provide the confidence for aquaculture and renewable energy industry to invest, while also giving the public confidence that offshore developments operate to the highest environmental standards for sustainability and ecosystem integrity.

Ethics, Values and Social Licence in the Blue Economy (5.20.005)

What are the key ethical values that the Blue Economy should respect and support? How best can we understand terms like the 'Social Licence to Operate'? These are questions explored by the Blue Economy CRC project Ethics, values and social license in the Blue Economy (5.20.005), running from November 2020 to October 2023.

The project, led by Professor Charles Sampford, Director of Griffith University's Institute for Ethics, Governance and Law, includes researchers Dr Hugh Breakey, Dr Katja Cooper, Rebecca Marshallsay and PhD student Shay O'Hara-Smith (Griffith University)) and Dr Graham Wood (University of Tasmania).

The project work (building on an earlier Blue Economy CRC Scoping Project) involved two literature reviews, fifteen interviews with national and international stakeholders, conference presentations, webinars, Practitioner Summaries, a PhD project, and a range of scholarly publications. A Practitioners Summary I has now been published.

Key Findings | Blue Economy Values and Ethical Risk

The research reviewed 238 scholarly articles to determine what values were informing Blue Economy decisions, discussions, and practices. A subset analysis of 150 of these articles, on 'Aquaculture ethics', in 2023 was published in Fish & Fisheries.

Combining this research with our independent ethical analysis (published by De Gruyter), the team's analysis (in Practitioner Summary I) derived six key Blue Economy ethical principles:

1. **Environmental Protection:** Blue Economy activities should protect sustainability, biodiversity, and ecosystem function
2. **Stakeholder Participation:** Community knowledge and engagement should play a role in Blue Economy decision-making.
3. **Fairness:** Opportunities, risks, impacts, costs, and benefits should be fairly distributed across stakeholders.
4. **Harm Prevention:** Human rights and animal welfare should be protected and respected.
5. **Beneficence:** Blue Economy activities should deliver good outcomes, including food, safety, prosperity, and employment.
6. **Trustworthiness & Accountability:** Blue Economy activities and systems must demonstrate their trustworthiness.

These Blue Economy ethical principles can be applied to different stakeholder groups. This creates a list of ethical risks, such as: interference with rival users, unfair disruption of industry operations, inadequate consultation with local communities, and animal welfare concerns for both farmed (e.g., finfish) and wild animals (e.g., seals).

Our further research (available as a Blue Economy CRC Webinar) explored how moving Blue Economy operations further offshore, and into exposed waters, can change their ethical risk Professorile, such as by limiting ecological risks, but elevating safety concerns.

The 'Social licence to operate'

The 'Social licence to operate' **(SLO)** often arises in the context of Blue Economy ethics. The term typically refers to key stakeholders' (such as a local community's) social acceptance of industry operations.

This award-winning research considers the term's complexity and ambiguity. For example, stakeholder sentiment will fall on a spectrum, from active resistance, vocal rejection, ignorance and apathy, to grudging acquiescence, toleration, acceptance, support, and even to feelings of ownership and identification.

Because of these ambiguities, the SLO can be used as:

- **An activist weapon:** The SLO can be invoked to subject industry operations to 'mob rule', where operational legitimacy hinges on potentially fickle and inconsistent community sentiment.
- **An industry shield:** Industry might insist they have an SLO, perhaps because they are independently certified, even as their operations breach key ethical standards.
- **A vital lever for ethical action:** Industry may genuinely buy-in to achieving an SLO, engaging with the community and raising standards to achieve best-practice.
- **An empty buzzword:** Appeal to the SLO might prove vacuous, unable to justify, critique, or morally improve industry operations.

Key Takeaways

Blue Economy industries are dynamic and innovative, offering great promise of benefits (healthy food, renewable energy), and operating on public resources in an emerging governance environment. As such, ongoing ethical risks and social license concerns are inevitable. However, this is a space that can be sensibly navigated, with sensitivity, forethought, and transparency.

Ocean Accounting, Disclosures and Social Capital in the Blue Economy (5.21.001)

The Ocean Accounting, Disclosures and Social Capital in the Blue Economy (5.21.001) project is working with industry and government partners (Tassal, Oysters Tasmania, NRET, DCCEEW) to develop innovative tools and metrics to support corporate disclosure across climate, natural and social capitals, and develop ocean accounts at regional and local scales.

The research team has been working with industry partners to co-design guidelines and potential metrics for climate, nature and potential society-related disclosure reporting through consultation workshops and discussions. This has been taking place alongside a global and national push for increased disclosure and new methodologies.

The project team members are actively engaged in discussions with the Australian government's DCCEEW regarding synergies between the ocean accounting component of the project and the Australian government's $3 million commitment to support the nation roll-out of ocean accounting.

Cultural Licence to Operate in the Blue Economy (5.20.006)

With the emerging concept of the cultural licence to operate (CLO) it is imperative to consider the rights, equity, and livelihood opportunities for First Nations Peoples.

The Cultural licence to operate in the Blue Economy (5.20.006) project is addressing this challenge. Poor inclusion into economic agendas leads to a greater chance of First Nations People "losing-out"– rather than gaining – from blue growth. This brings the potential legal and cultural license challenges if their voices are not properly considered.

The project team held an online Australian Indigenous Forum, a workshop with Blue Economy CRC participants and meetings with Australian government departments to build CLO literacy while also understanding current opportunities and challenges.

Pre-conditions for the Development of Offshore Wind Energy in Australia (5.22.001)

With suitable sites located across all Australian states and the passage of recent legislation, Australia's offshore wind energy industry is poised to grow over the coming years. To realise the industry's promise and avoid costly social and legal disruptions and environmental challenges that have accompanied other offshore industries, planning and development in key knowledge areas is critical.

The Pre-conditions for the Development of Offshore Wind Energy in Australia (5.22.001 project is providing the Blue Economy CRC and industry partners to seize the opportunity provided by recent legislation to build efficacy, integrity and good governance into Australia's burgeoning offshore wind power industry.

Across four work packages, this project addresses industry needs regarding social acceptability, law and policy settings, and supply chain operations.

Achievements have included: (i) capturing snapshots of overseas policy and regulatory frameworks and (ii) developing an initial work plan for assessing the demand and capabilities of Australia's offshore wind supply chain, with services and components (Tier 1- Tier 4) for the entire lifecycle of offshore wind farms identified.

Ocean Accounting, Disclosures and Social Capital in the Blue Economy (5.21.001)

Alana Knight (Griffith University) commenced her PhD in July 2022 in association with the Ocean Accounting, Disclosures and Social Capital in the Blue Economy (5.21.001) project.

Alana's PhD research looks at how social capital is conceptualised and presented in academic literature and corporate reports. Her research explores how effective measurement and reporting of the impacts, dependencies, risks and opportunities surrounding corporate interactions with and investments in social capital can enhance corporate resilience and social licence for blue corporations.

Chandima Jeewanthi Hapu Achchige (Griffith University) commenced her PhD in February 2022 in association with the Ocean Accounting, Disclosures and Social Capital in the Blue Economy (5.21.001).

Jeewanthi's PhD research examines adoption of sustainability control systems within blue corporations' management accounts. Her research will explore whether the underlying intention for adopting sustainability controls influences how effective they are in achieving truly sustainable business operations.

Jeewanthi's research could help demonstrate the benefits of embedding sustainability controls within everyday decision making by blue corporations.

Research Projects: Current

1.20.006: Developing a robust collar-tie

Lead Organisation: The University of Queensland

Project Leader: Michael Heitzmann

Blue Economy CRC Participant Organisations Involved:
The University of Queensland, Tassal Group

Project Duration: 36 Months

Start Date: June 2020

1.21.001: Moorpower™ – Scaled demonstrator

Lead Organisation: Carnegie Clean Energy

Project Leader: Alexandre Pichard

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: Advanced Composite Structures Australia, Carnegie Clean Energy, Climate KIC Australia, DNV Australia, Huon Aquaculture, Tassal Group, University of Queensland, University of Tasmania

Third Party Participant: AMC Search

Project Duration: 39 months

Start Date: September 2021

1.21.002: Novel offshore fish pen design: phase 1 (conceptual development)

Lead Organisation: Griffith University

Project Leader: Joerg Baumeister

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: Auckland University of Technology, Cawthron, DNV Australia, Griffith University, Huon Aquaculture, SINTEF, Tassal Group, TCOMS, University of Chile, University of Queensland, University of Tasmania

Project Duration: 24 months

Start Date: January 2022

1.21.003: Robust salmon feed delivery systems

Lead Organisation: Advanced Composite Structures Australia

Project Leader: Rowan Paton

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: Advanced Composite Structures Australia, Griffith University, Pacific Engineering Systems International, Tassal Group, University of Tasmania

Project Duration: 42 months

Start Date: February 2022

1.21.004: Enabling autonomous technologies for aquaculture in challenging environments

Lead Organisation: University of Queensland

Project Leader: Simon Albert

Blue Economy CRC Participant Organisations Involved: Griffith University, Oysters TAS, Southern Ocean Carbon Company, Tassal Group, University of Queensland, University of Tasmania

Project Duration: 42 months

Start Date: April 2022

1.21.005: Code of practice for aquaculture vessels

Lead Organisation: BMT

Project Leader: Chris Shearer

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: BMT, DNV Australia Pty Limited, Oysters TAS, Tassal Group, University of Queensland, University of Tasmania

Third Party Participants: AEX Group, AMC Search, Australian Maritime Safety Authority, Green Aqua

Project Duration: 24 months

Start Date: March 2022

1.21.007: Hydrogen powering of vessels

Lead Organisation: BMT

Project Leader: Andrew Harris

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: BMT, University of Tasmania, Auckland University of Technology, DNV Australia, Griffith University, Huon Aquaculture Company, Department of State Growth.

Third Party Participants: Australian Maritime Safety Authority, Flanders Investment & Trade, Revolution Design, Riverside Marine, Tasmanian Ports Corporation,

Project Duration: 24 Months

Start Date: February 2023

2.21.001: Opportunities and challenges for the oyster industry in the blue economy

Lead Organisation: Tasmanian Oyster Research Council Limited

Project Leader: Frances Huddlestone

Project Type: Scoping Project

Blue Economy CRC Participant Organisations Involved: Advanced Composite Structures Australia, Blue Economy CRC, Oysters TAS, University of Tasmania, Cawthron Institute, BMT, University of Queensland, Griffith University

Project Duration: 9 Months

Start Date: October 2022

2.21.002: Experimental platform for aquaculture production

Lead Organisation: University of Tasmania

Project Leader: Chris Carter

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: University of Tasmania, Huon Aquaculture, Gibson's Limited trading as Skretting Australia, Tassal, Blue Economy CRC

Third Party Participant: Salmon Enterprises of Tasmania (SALTAS)

Project Duration: 45 months

Start Date: December 2022

2.21.003: Creating opportunities for bull kelp aquaculture

Lead Organisation: University of Tasmania

Project Leader: Jeff Wright

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: Auckland University, Cawthron Institute, Seasol International, a division of Dulux Group (Australia), Southern Blue Reef, University of Tasmania

Project Duration: 24 months

Start Date: April 2022

2.21.005: Developing production systems for offshore kelp mariculture

Lead Organisation: University of Tasmania

Project Leader: Craig Johnson

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: Blue Economy CRC, BMT, Climate Foundation Australia, CSIRO, Department of Natural Resources and Environment Tasmania, Huon Aquaculture, Southern Ocean Carbon Company, University of Queensland, University of Tasmania

Third Party Participant: Deloitte Australia

Project Duration: 24 months

Start Date: November 2022

3.20.004: DC microgrids for offshore applications

Lead Organisation: Griffith University

Project Leader: Evan Gray

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: Griffith University, Optimal Group Australia, Pitt & Sherry, University of Tasmania

Project Duration: 46 Months

Start Date: June 2020

3.20.006: Mooring tensioner for WECs - MoTWEC

Lead Organisation: Carnegie Clean Energy Limited

Project Leader: Alexandre Pichard

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: Carnegie Clean Energy, Advanced Composite Structures Australia, Climate-KIC Australia, The University of Queensland

Project Duration: 36 Months

Project **Start Date:** October 2020

3.21.004: Seeding marine innovation in SW WA with a WEC deployment in Albany

Lead Organisation: University of Western Australia

Project Leaders: Christophe Gaudin and Hugh Wolgamot

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: BMT, Climate KIC Australia, Huon Aquaculture, University of WA, University of Queensland, University of Tasmania

Third Party Participants: Albany Shellfish Hatchery, M4 WavePower, WA State Government Department of Primary Industries and Regional Development

Project Duration: 36 months

Start Date: December 2021

3.21.005: Risk-based procedures for safe and reliable ORES

Lead Organisation: Macquarie University

Project Leaders: Rouzbeh Abbassi

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: Macquarie University, University of Tasmania, Carnegie Clean Energy, DNV Australia, Auckland University of Technology, Optimal Group, Pitt&Sherry, University of WA

Project Duration: 24 months

Start Date: December 2022

3.22.002: System level modelling to improve the performance of offshore sustainable power

Lead Organisation: Auckland University of Technology

Project Leaders: Ramon Zamora

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: Auckland University of Technology, BMT, University of WA, University of Tasmania, Pitt & Sherry, Optimal Group Australia, The New Zealand King Salmon, Griffith University, HENSOLDT Australia, OceanPixel, Carnegie Clean Energy Limited, Macquarie University

Project Duration: 42 months

Start Date: November 2022

4.20.004: A novel approach to measuring the depositional footprint of the blue economy

Lead Organisation: Project Leader: Kay Vopel

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: Auckland University of Technology, CSIRO, Department of Natural Resources and Environment Tasmania, East China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Griffith University, Tassal Group, NZ King Salmon, University of Tasmania

Project Duration: 48 Months

Start Date: January 2021

4.21.001: Advanced monitoring to maximise fish welfare in offshore aquaculture

Lead Organisation: Griffith University

Project Leader: Kylie Pitt

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: Griffith University, Huon Aquaculture, Petuna Aquaculture, Tassal Group, University of Tasmania

Project Duration: 42 months

Start Date: April 2022

4.21.002: Marine spatial planning for a blue economy

Lead Organisation: Griffith University

Project Leader: Chris Frid

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: BMT, Brookvale Energy (trading as Nexsphere), CSIRO, Department of Natural Resources and Environment Tasmania, Ghent University, Griffith University, Huon Aquaculture, Petuna Aquaculture, Southern Ocean Carbon Company, State Government - Renewables, Climate and Future Industries Tasmania, Tassal, University of Queensland, University of Tasmania

Third Party Project Participant: Western Australian Marine Science Institution

Project Duration: 42 months

Start Date: March 2022

4.22.001: Data infrastructure design for the blue economy

Lead Organisation: BMT

Project Leader: Louise Bruce

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: BMT, Griffith University, OceanPixel, University of Tasmania, University of Western Australia

Third Party Participant: Geoscience Australia - Australian Government

Project Duration: 12 months

Start Date: March 2023

5.20.005: Ethics, values and social licence in the blue economy

Lead Organisation: Griffith University

Project Leader: Charles Sampford

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: Griffith University, BMT, University of Tasmania, Carnegie Clean Energy, The New Zealand King Salmon, Tassal Group,

Department of Natural Resources and Environment Tasmania

Project Duration: 36 Months

Start Date: November 2020

5.20.006: Cultural licence to operate in the blue economy

Lead Organisation: Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Project Leader: Cass Hunter

Project Type: General Project

Blue Economy CRC Participant Organisations Involved: CSIRO, Plant & Food Research NZ

Third Party Participants: Wai Communications, Swinburne University of Technology

Project Duration: 18 months

Start Date: February 2022

5.21.001: Ocean accounting, disclosures and social capital in the blue economy

Lead Organisation: Griffith University

Project Type: General Project

Project Leader: Jim Smart

Blue Economy CRC Participant Organisations Involved: CSIRO, Department of Natural Resources and Environment Tasmania, Griffith University, Oysters Tasmania, Tassal Group

Project Duration: 47 months

Start Date: November 2021

5.22.001: Pre-conditions for the development of offshore wind energy in Australia

Lead Organisation: University of Tasmania

Project Leader: Marcus Haward

Blue Economy CRC Participant Organisations Involved: University of Tasmania, University of Queensland, Griffith University, SAITEC SA, SINTEF Ocean AS, Universidad Austral de Chile, BMT, DNV Australia, State Growth Tasmania.

Third Party Participant: Copenhagen Energy Australia Pty Ltd, Brookvale Energy (trading as Nexsphere), Flotation Energy, Tasmanian Ports Corporation, Star of the South Wind Farm at Star of the South Trust.

Project Duration: 36 months

Start Date: January 2023

Exploring opportunities for regenerative aquaculture on the NSW south coast

Lead Organisation: University of Wollongong

Project Leader: Michelle Voyer and Tillmann Boehme

Blue Economy CRC Participant Organisations Involved: Blue Economy CRC

Third Party Participant: University of Wollongong, Blue futures, AusKelp, Sea Health Products Australia, South Coast Mariculture

Project Duration: 6 months

Start Date: April 2023

Research Projects: Completed in 2022-2023

5.21.002: Identifying the potential of floating artificial benthic ecosystems to underpin offshore development

Lead Organisation: University of Tasmania

Project Leader: Marcus Haward

Project Type: Scoping Project

Blue Economy CRC Participant Organisations Involved: University of Tasmania, Southern Blue Reef, Macquarie University, Oysters TAS, Tasmanian Government, SmartCrete CRC, Climate Foundation Australia, Southern Ocean Carbon Company, Auckland University of Technology

Third Party Participant: De Blauwe Cluster VZW

Project Duration: 8 months

Completed Date: December 2022

CRC.21.002: Baseline survey of the blue economy zone (phase II)

Lead Organisation: University of Queensland and Griffith University

Project Leader: Remo Cossu and Chris Frid

Project Type: General

Blue Economy CRC Participant Organisations Involved: CSIRO, Griffith University, Tassal Group, University of Queensland, University of Tasmania, Xylem

Project Duration: 17 Months

Completed Date: July 2022

CRC.22.001: 2022 Tasmanian salmon project

Lead Organisation: Blue Economy CRC

Project Leader: John Whittington

Project Type: Corporate

Blue Economy CRC Participant Organisations Involved: Blue Economy CRC, Department of Natural Resources and Environment Tasmania

Project Duration: 5 Months

Completed Date: August 2022

Feasibility study into floating artificial reefs using smart concrete

Lead Organisation: Macquarie University and SmartCrete CRC

Project Leader: Rouzbeh Abbassi

Blue Economy CRC Participant Organisations Involved: Macquarie University and SmartCrete CRC, University of Tasmania and Blue Economy CRC

Project Duration: 6 Months

Completed Date: July 2022

EDUCATION AND TRAINING

Developing a workforce for the future Blue Economy is an integral part of the Blue Economy CRC strategy.

The Blue Economy CRC's education and training program provides a range of research opportunities, with fully and co-funded Higher Degree by Research (HDR) PhD and MPhil scholarships across its five Research Programs. The Blue Economy CRC is an ideal work environment for talented graduates to conduct commercially relevant research to tackle the technical challenges facing blue economy industries and develop detailed cross disciplinary knowledge.

HDR Scholars Program

The HDR Scholars Program aims to develop and commercialise leading-edge research and produce graduates with hands-on industry experience to create a highly skilled workforce. Our PhD and MPhil Scholars have opportunities to develop their industry knowledge and relevance, through additional training and international networking opportunities associated with the Blue Economy CRC.

The Blue Economy CRC aims to deliver approximately 50 HDR graduates over its lifetime. The past year saw a dramatic increase in the size of our HDR group, with the number of commenced students almost doubling. At the end of the 2022-23, 14 additional PhDs students, and one additional MPhil student, had begun their research. A further two are confirmed to start in the first half 2023-24.

As at 30 June 2023, the Blue Economy CRC had 30 PhD Scholars and 1 MPhil Scholar currently engaged in research and 1 PhD completion.

Congratulations Migyuan Ma – Blue Economy CRC PhD Graduate

A significant milestone for the Education and Training program was achieved in June when the first Blue Economy CRC Scholar Dr Mingyuan Ma from Griffith University was awarded his PhD. Mingyuan's research investigated the hydroelastic interaction between ocean waves and open-net fish pens in order to design effective systems to operate in high-energy offshore environments with significant wave loads.

Mingyuan's Primary Supervisor was Professor Hong Zhang from Griffith University.

I would like to express my most heartfelt appreciation to my principal supervisor, Professor Hong Zhang. Thanks to her for introducing me to academia, and with her continuous encouragement and support, I was able to persevere in the long research journey. I am lucky and proud to have such an academically excellent, responsible and kind mentor.

Special and sincere thanks to Griffith University and Blue Economy CRC for giving me the opportunity to join a big family with other excellent scholars." said Dr Ma.

Inaugural 2023 PhD Summer School

The first Blue Economy CRC PhD Summer School was held in Albany, Western Australia in the week of 23rd to 27th January 2023.

All PhD Scholars were invited to attend a week-long Summer School with opportunities to present their work, learn from keynote lectures, participate in workshop/group activities, and expand their professional networks. Attending were UWA academic staff and fellow PhD students, Program Leaders from AUT and Griffith University and early career engineers and scientists from BMT and Carnegie Clean Energy. In addition to traditional learning in a classroom environment, each day included an interactive outdoors component with fieldwork and site visits.

PhD Scholars Present their Research at the 2023 Participants Workshop

Nineteen of the Blue Economy CRC's PhD Scholars attended the 2023 Participants Workshop, held in Fremantle, WA from 16-18 May 2023. The PhD Scholars were asked to submit a presentation or poster regarding their research, with a particular focus on 'impact' – this being the overall theme of the Workshop.

Jessica Roach was awarded the leading submission as voted on by attendees. She presented a fascinating and informative video about her PhD research on developing technology for seaweed aquaculture that highlights its cultural significance. In addition, four of these students participated in discussion panels that were held on particular themes across the two days of the Workshop proper.

BMT hosted a networking event, Careers in the Blue Economy, for PhD Scholars, industry and research organisations. A number of speakers from industry including BMT, Flotation Energy, Nexsphere, Oceanex Energy, Carnegie Clean Energy, and Austral Fisheries, described their career path and aspirations from studies to their current positions.

Dr Jana Orszaghova from UWA and the Summer School Coordinator said,

The summer school was a unique opportunity for our PhD Scholars and young engineers and scientists from our industry partner organisations to immerse themselves in blue economy themes.

The event was very successful with testimonials from Scholars and attendees:

Every hands-on immersion uniquely worked its magic – from the funky wave converter demo, to sifting sands for microplastics, to tossing in rolly seas to retrieve sensors, to building model turbines – brilliant, and we got to see the breath-taking beauty of the area at the same time.

Overall I thought it was a fantastic week!

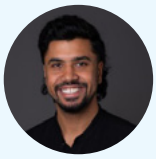
I learned a lot and had a lot of fun. I loved meeting all the other students and had some really nice discussions and experiences with them.

Totally amazing and gained so much valuable information out of the sessions.

The Summer School is to be a biennial event with the next edition to be held in 2025.

Current PhD and MPhil Scholars

Akshay Harikumar (PhD)



Start: 2020

Expected Completion: 2024

Project Title: Developing a robust collar tie

Host Institution: The University of Queensland (UQ)

Primary Supervisor & Industry Research Advisor: Dr Michael Heitzmann, UQ, Dr Brad Evans, Tassal Group

Neil Salam (PhD)

Start: 2020

Expected Completion: 2024

Project Title: DC Microgrids for offshore applications

Host Institution: Griffith University (GU)

Primary Supervisor & Industry Research Advisor: Professor Evan Gray, GU, Craig Dugan, Optimal Group Australia

Yuan Zhen (Richard) Cai (PhD)

Start: 2021

Expected Completion: 2024

Project Title: Mooring Tensioner for WECs - MoTWEC

Host Institution: The University of Queensland (UQ)

Primary Supervisor & Industry Research Advisor: Dr Michael Heitzman, UQ, Rodney Thomson, ACS-A

Aaron Hibberd (PhD)

Start: 2021

Expected Completion: 2024

Project Title: Investigating Thresholds in the Metabolic Response of Sediment to Organic Enrichment

Host Institution: University of Tasmania (UTAS)

Primary Supervisor & Industry Research Advisor: Dr Scott Hadley, UTAS, Joel Cooper, Tassal Group

Avik Nandy (PhD)

Start: 2021

Expected Completion: 2024

Project Title: Use of multispectral imagery to enhance aquaculture operations

Host Institution: The University of Queensland (UQ)

Primary Supervisor & Industry Research Advisor: Dr Simon Albert, UQ, Frances Huddlestone, Oysters Tasmania

Leteisha Prescott (PhD)

Start: 2021

Expected Completion: 2025

Project Title: The effects of sustained swimming on long-term changes to Chinook salmon form and composition

Host Institution: University of Tasmania (UTAS)

Primary Supervisor & Industry Research Advisor: Professor Chris Carter, UTAS, Dr Jane Symonds, Cawthron Institute

Amara Steven (PhD)

Start: 2021

Expected Completion: 2025

Project Title: Responses to risk: Blue Economy explorations using behavioural economics

Host Institution: University of Tasmania (UTAS)

Primary Supervisor & Industry Research Advisor: Darla Hatton-MacDonald, UTAS, Stephanie Thornton, AOEG

Shujian Ma (PhD)

Start: 2021

Expected Completion: 2024

Project Title: Wave Driven Compressed Air Energy Storage

Host Institution: University of Tasmania (UTAS)

Primary Supervisor & Industry Research Advisor: Professor. Xiaolin Wang, UTAS, Dr Alex Pichard, Carnegie Clean Energy

Kelly Hoareau (PhD)

Start: 2021

Expected Completion: 2025

Project Title: Science, Technology, and Decision-making in the Blue Economy: Addressing knowledge gaps

Host Institution: University of Tasmania (UTAS)

Primary Supervisor & Industry Research Advisor: Professor. Marcus Haward, UTAS, Dr David Rissik, BMT

Brett Bolte (PhD)

Start: 2021

Expected Completion: 2025

Project Title: Exploiting filter feeding bivalves as a natural sampling platform

Host Institution: Griffith University (GU)

Primary Supervisor & Industry Research Advisor: Dr. Carmel McDougall, GU, Dr Pascal Craw, Dr Andrew Bissett, Dr James Wynne, CSIRO

Thien Than Tun (PhD)

Start: 2021

Expected Completion: 2025

Project Title: Energy-optimal control scheme for mobile robotic platforms in offshore aquaculture

Host Institution: Auckland University of Technology (AUT)

Primary Supervisor & Industry Research Advisor: A/Professor. Loulin Huang, AUT, Grant Rosewarne, New Zealand King Salmon

Nazhmiddin Nasyrlayev (PhD)

Start: 2021

Expected Completion: 2025

Project Title: Integrated Numerical Modelling Approach for Design of Offshore Aquaculture Structures

Host Institution: University of Tasmania (UTAS)

Primary Supervisor & Industry Research Advisor: Dr Ali Tolooiyan, UTAS, Zac Couper, BMT

Chandima Jeewanthi Hapu Achchige (PhD)

Start: 2022

Expected Completion: 2025

Project Title: Integrating sustainability strategy within Environmental Management Accounting and Control

Host Institution: Griffith University (GU)

Primary Supervisor & Industry Research Advisor: Associate Professor Robert Hales, GU, Dr Leo Dutra, CSIRO

Robin Cappaert (PhD)

Start: 2022

Expected Completion: 2025

Project Title: Influences on composition and ecology of biofouling communities associated with salmon aquaculture

Host Institution: University of Tasmania (UTAS)

Primary Supervisor & Industry Research Advisor: Dr. Camille White, UTAS, Dr Brad Evans, Tassal Group

Alana Knight (PhD)

Start: 2022

Expected Completion: 2026

Project Title: Social licence reporting to support Blue Economy development and expansion in Australia

Host Institution: Griffith University (GU)

Primary Supervisor & Industry Research Advisor: Professor Christopher Fleming, GU, Dr Leo Dutra, CSIRO

Alamgir Hossain (PhD)

Start: 2022

Expected Completion: 2026

Project Title: DC Microgrids for Offshore Applications

Host Institution: University of Tasmania (UTAS)

Primary Supervisor: Professor Michael Negnevitsky, UTAS

Bawantha Indrajith (PhD)

Start: 2022

Expected Completion: 2026

Project Title: Optimum control strategy for the energy management in Low-Voltage Hydrogen based DC Micro-grids

Host Institution: University of Technology Sydney (UTS)

Primary Supervisor: Dr. Kosala Gunawardane, UTS

Brianne Lyall (PhD)

Start: 2022

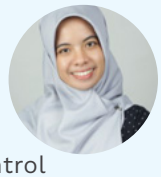
Expected Completion: 2026

Project Title: Skeletal development in Chinook salmon, with an emphasis on intermuscular (pin) bones abnormalities

Host Institution: University of Tasmania (UTAS)

Primary Supervisor & Industry Research Advisor: Dr Gianluca Amoroso, UTAS, Dr Zac Waddington, New Zealand King Salmon

Avy Sheina (PhD)



Start: 2022

Expected Completion: 2026

Project Title: Fault Protection and Control Mechanisms of DC Microgrid

Host Institution: Auckland University of Technology (AUT)

Primary Supervisor & Industry Research Advisor: Dr. Ramon Zamora, AUT, Dr. Gary White, Optimal Group

Hasith Jayasinghe (PhD)

Start: 2022

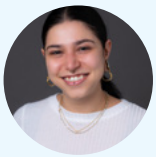
Expected Completion: 2026

Project Title: Energy storage and Demand Side management in offshore Hydrogen based DC microgrids with controllable loads

Host Institution: University of Technology Sydney (UTS)

Primary Supervisor:
Dr. Kosala Gunawardane, UTS

Elianna Zoura (PhD)



Start: 2022

Expected Completion: 2026

Project Title: The effect of organic enrichment on animal–sediment interactions

Host Institution: Auckland University of Technology (AUT)

Primary Supervisor:
Associate/Professor Kay Vopel, AUT

Jillian Conrad (PhD)

Start: 2022

Expected Completion: 2026

Project Title: An ecosystem-based blue economy on Sea Country

Host Institution: Griffith University (GU)

Primary Supervisor: Professor. Chris Frid, GU

Shay O'Hara-Smith (PhD)

Start: 2022

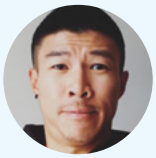
Expected Completion: 2026

Project Title: Ocean Ethics: Making the Case. Aesthetics, intrinsic value, and naturalistic intuitions

Host Institution: Griffith University (GU)

Primary Supervisor: Professor Charles Sampford, GU

Huan Sheng (Vincent) Yap (PhD)



Start: 2022

Expected Completion: 2026

Project Title: Creating opportunities for Bull Kelp aquaculture

Host Institution: University of Tasmania (UTAS)

Primary Supervisor: Associate. Professor. Jeffrey Wright, UTAS

Quynh Vo (PhD)

Start: 2022

Expected Completion: 2026

Project Title: Advanced monitoring of salmon welfare in offshore aquaculture in Tasmania

Host Institution: Griffith University (GU)

Primary Supervisor: Professor. Kylie Pitt, GU

Benhur Joseph Raju (PhD)

Start: 2022

Expected Completion: 2026

Project Title: Assessing the scale effects on the performance of a multi-body floating wave energy converter

Host Institution: University of Tasmania (UTAS)

Primary Supervisor:
Dr Jean-Roch Nader, UTAS

Minghan (Tony) Bao (MPhil)

Start: 2023

Expected Completion: 2027

Project Title: Developing risk-based methodology for co-locating offshore aquaculture and renewable energy systems

Host Institution: Macquarie University (Macq U)

Primary Supervisor & Industry Research Advisor: A/ Professor Rouzbeh Abbassi, Macquarie University, Kevin Heasman, Cawthron Institute

Trudi Hogg (PhD)

Start: 2023

Expected Completion: 2026

Project Title: Enabling autonomous technologies for aquaculture in challenging environments

Host Institution: University of Tasmania (UTAS)

Primary Supervisor: Dr Andrew Fischer, UTAS

Jessica Roach (PhD)

Start: 2023

Expected Completion: 2026

Project Title: Creating opportunities for Bull Kelp aquaculture

Host Institution: Auckland University of Technology (AUT)

Primary Supervisor:
Professor Lindsey White, AUT

Atshaya Sundararajan (PhD)

Start: 2023

Expected Completion: 2026

Project Title: Translational Research on Atlantic Salmon Performance Using OMICS Technologies

Host Institution: University of Tasmania (UTAS)

Primary Supervisor: Professor Chris Carter, UTAS

Christine Lynggard Hansen (PhD)

Start: 2021

Expected Completion: 2025

Project Title: Design Wave Analysis on floating structures: Identifying extreme response drivers for complex structures

Host Institution: The University of Western Australia (UWA)

Primary Supervisor: Dr. Hugh Wolgamot, UWA

Robert Tullberg (MPhil) *

Start: 2022

Expected Completion: 2023

Project Title: Offshore Seaweed and R-E Farms: Solutions for Integration and Co-location

Host Institution: The University of Queensland (UQ)

Primary Supervisor: Professor. Chien Ming Wang, UQ
(Withdrew from HDR program).

Completed PhD and MPhil Scholars as at 30 June 2023

Mingyuan Ma (PhD)

Start: 2019

Expected Completion: 2023

Project Title: Hydroelastic analysis of offshore fish net cages under wave action

Host Institution: Griffith University (GU)

Primary Supervisor & Industry Research Advisor: Professor Hong Zhang, GU, Lex Mulchay, Pacific ESI

COMMUNICATIONS

28K WEBSITE VISITORS

100K PAGE VIEWS

25%↑ SUBSCRIBERS

19%↑ CLICKS TO WEBSITE

Over the 22/23, the Blue Economy CRC has continued to grow awareness of work and achievements through our website, newsletters, media releases and social media channels. The website continues to evolve through continual upgrades to demonstrate the connection between projects, themes and partner activity that combined are working towards the overall goals of the Blue Economy CRC.

The website attracted 28,000 visitors over the last 12 months and over 100,000 page views and our mailing database continues to grow with over 7,000 contacts (growth of 25% from previous year). Four quarterly newsletters were distributed across the year with good readership rates providing updates on project activities and milestones, events, education, publications and more. Traffic to the website from emails increased by 18.9%, demonstrating our audience clicking through to the website from the newsletters for further information.

This year saw the addition of key new major research pages including the Blue Economy Zone, the Hydrogen Microgrid Project and Marine Spatial Planning which act as key theme research areas with associated project portfolios.

Our socials channels continue to grow with the scheduling of consistent, branded content on commencing and completed project outcomes, events, media mentions, PhDs and current research. LinkedIn continues to be the predominant channel with 4,351 followers (growth of 24% from previous year) and a total of 546 posts across the year (an average of 2 posts per week per channel).

We continue to release relevant and newsworthy items via our media releases and articles on the website. There were 184 media mentions over the year increased with a reach of 138M with articles based on renewable energy and seaweeds generating the most mentions. When incorporating social media mentions from these publishers this increased to a total of 713 mentions. Articles can be found at https://blueeconomycrc.com.au/news/

24%↑ LINKEDIN FOLLOWERS

184 MEDIA MENTIONS

138 MILLION REACH

Leading Project Statistics 2022-23

4,327 WEBSITE VIEWS

The Offshore Wind in Australia report

1,348 WEBSITE VIEWS

Developing Production Systems for Offshore Kelp Mariculture

763 WEBSITE VIEWS

Marine Spatial Planning for a Blue Economy

The Offshore Wind in Australia report

4,327
Website views

136
Media mentions

* lifetime stats ~ July2021 - June2023

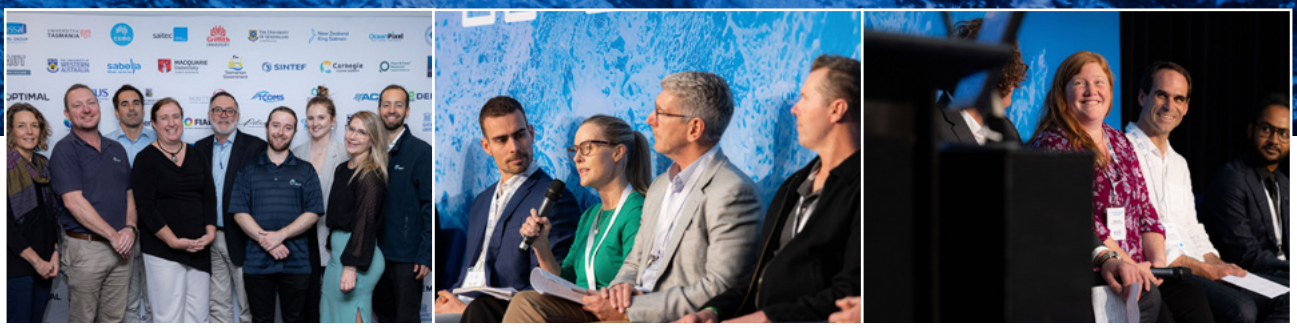
Webinars

We have continued delivering our well-recognised webinar series to support engagement and collaboration across the blue economy sectors and community. Participants and external organisations from industry, research and government are invited to share their blue economy R&D activities and knowledge of the sector. Several of the webinars are built around key Blue Economy CRC themes and highlight our engagement activities and research outcomes.

No	Webinar Topic	Date	Registered
1	Risks & Opportunities for the Blue Economy	17-Aug-22	379
2	Trends, Challenges, and Future Perspectives for Floating Offshore Wind Turbine Development	1-Sep-22	747
3	Carbon Accounting in Oceans	15-Mar-23	598
4	Transforming the Offshore Industry Using Digital Twin Technology	9-Nov-22	350
5	Tasmania's Oceans of Opportunity	8-Dec-22	355
6	Flow interactions with seaweed: implications for offshore aquaculture	26-Apr-23	403
7	Understanding and improving salmon performance	21-Jun-23	218
		Total registered	**3050**

2023 PARTICIPANTS WORKSHOP

IMPACT



Participants Workshop 2023

Tuesday 16th – Thursday 18th May, 2023
The Esplanade Hotel, Fremantle

This year's workshop showcased the impact of our research and training as we continue the conversation on growing a sustainable blue economy that is underpinned by our innovative industries and the trusted stewardship of our oceans and the services they provide.

We invited project leaders, participants and our Blue Economy CRC friends' network to share their aspirations, experiences, what they have learned and what is ahead as together, we continue to play our part in growing the blue economy.

The event consisted of two full days of sessions, discussions, panels and networking with a third day offsite visiting our local partner facilities. Feedback from the event was overwhelmingly positive with over 160 Participants registered for the event.

> **It was just such a wonderful and comprehensive synthesis of opinions and voices. The groundwork, the planning, the considered commentary, the generosity of all participants, the commitment - everyone was so well prepared and well equipped. And it was warm and relaxed.**

> **Whole event had an excitement vibe from the participants, people were well engaged during the breaks and evening sessions.**

> **Such a privilege and beneficial experience.**

OES OCEAN ENERGY SYSTEMS

International Energy Agency Ocean Energy Systems (IEA OES) – 2022 Annual Report Published

The OES Annual Report showcases the 2022 key achievements and recent outcomes of the IEA-OES in collaborative efforts on a global scale, as well as updates on ocean energy policy, research, and deployment advancements in all participating countries.

As the Australian Delegates to the IEA-OES, Professor Irene Penesis and Professor Christophe Gaudin, University of Western Australia and with contributions from AOEG, industry and research partners, provided the chapter on Australia's activities.

The Executive Committee (Ex-Co) of the IEA-OES held its in-person meeting 17-18 October 2022 in Spain alongside the International Conference on Ocean Energy (ICOE) 2022. The following meeting was held online 22-23 March 2023. During these meetings the Blue Economy CRC was announced as host of the 2024 International Conference on Ocean Energy.

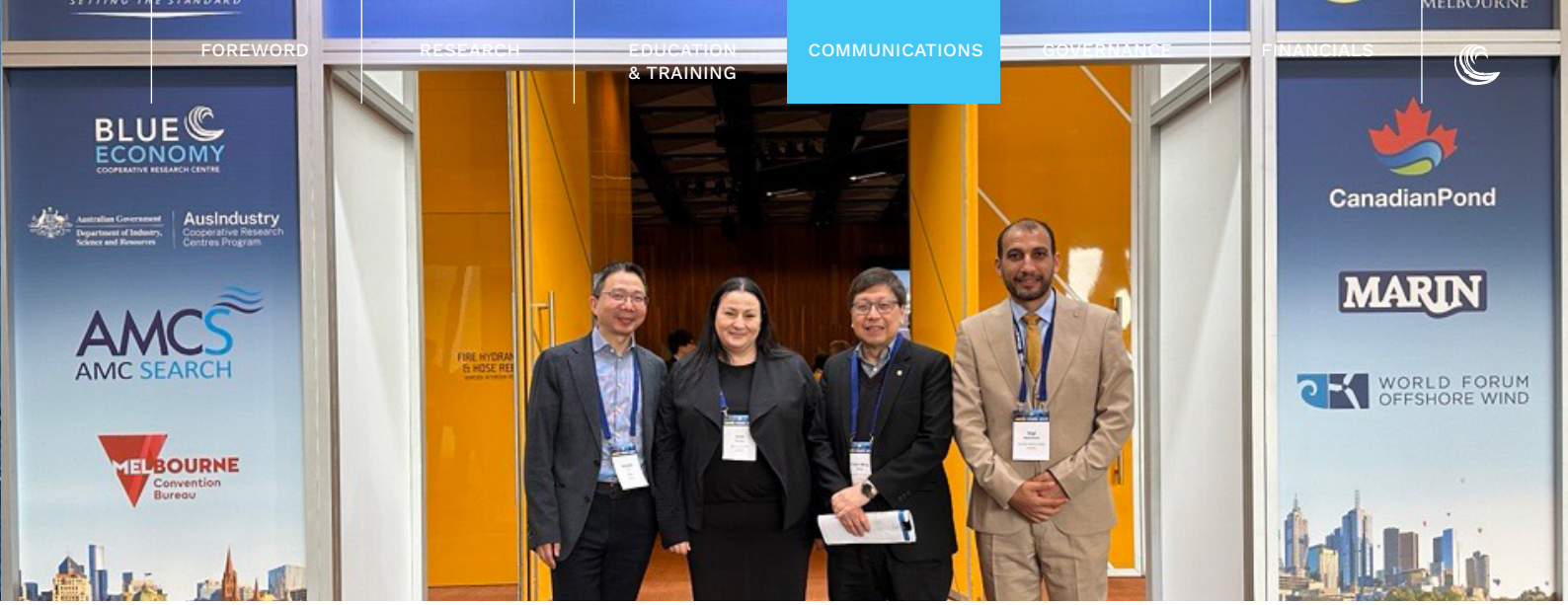
Dr Matthijs Soede (European Commission) was announced as the new Chair of the Ex-Co with three Vice-Chairs, Dr Purnima Jalihal (National Institute of Ocean Technology, India), Professor Christophe Gaudin (The University of Western Australia) and Dr Tim Ramsey (US Department of Energy).

About Ocean Energy Systems

Ocean Energy Systems (OES) is the short name for the Technology Collaboration Programme on Ocean Energy Systems, an intergovernmental collaboration between countries, founded in 2001, which operates under a framework established by the International Energy Agency (IEA) in Paris.

Established in 1974, the International Energy Agency (IEA) carries out a comprehensive programme of energy co-operation for its 29 member countries and beyond by examining the full spectrum of energy issues and advocating policies that will enhance energy security, economic development, environmental awareness and engagement worldwide.

The IEA OES brings together countries to advance research, development and demonstration of conversion technologies to harness energy from all forms of ocean renewable resources, such as tides, waves, currents, temperature gradient (ocean thermal energy conversion and submarine geothermal energy) and salinity gradient for electricity generation, as well as for other uses, such as desalination, through international cooperation and information exchange. The Blue Economy CRC is the member representing Australia.



Conferences / Outreach

42nd Ocean, Offshore and Arctic Engineering Conference (OMAE 2023) Conference - Melbourne

The Blue Economy Symposium was held for the first time within the 42nd OMAE 2023 conference held in Melbourne, Australia in 11-16 June 2023, by Program Leaders Professor Chien Ming Wang (UQ) and Dr Nagi Abdussamie (AMC-UTAS).

OMAE is the key international conference in offshore and arctic engineering and held by the American Society of Mechanical Engineers (ASME), and first time in Southern Hemisphere. OMAE combines Academia with Industry to adapt scientific achievements into practical applications for a smart, sustainable, and safe use of our oceans.

Research Director Professor Irene Penesis presented a keynote lecture on the Challenges of the Blue Economy for Sustainable Offshore Development to over 800 attendees, followed by 32 lively presentations from Blue Economy CRC participants covering many aspects of the Blue Economy CRC research activities including aquaculture farm infrastructure, seafood production, hydrogen powering vessels, offshore renewable energy devices, remote and autonomous technologies, offshore development policies, legislations and ethics. Eighteen peer reviewed technical papers were also published on Blue Economy CRC research activities in the OMAE 2023 conference proceedings.

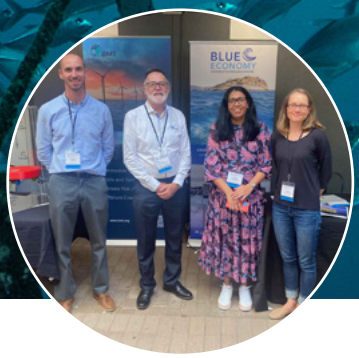
World Aquaculture Society 2023 - Darwin

The World Aquaculture Society held its annual meeting in Darwin from 29 May to 1 June 2023 and was attended by many Blue Economy CRC participants with Program Leader Professor Chris Carter presenting an update on the Blue Economy CRC R&D building blocks including the Blue Economy Zone, case studies on aquaculture development and social license.

Dr Sarah Ugalde (IMAS-UTAS), Professor Chris Carter (Blue Economy CRC and IMAS-UTAS) and Professor Lindsey White (Blue Economy CRC and AUT) presented on future aquaculture systems for Australia and NZ and Leteisha Prescott (IMAS-UTAS) presented her PhD research on Chinook salmon swimming.

Oceans Decade Ocean Business Leaders Summit – Sydney

Greg Johannes, Maia Schweizer, John Whittington, Irene Penesis, Angela Williamson and Partners Carnegie Clean Energy, Huon Aquaculture, Tassal and Saitec represented at the Oceans Decade Ocean Business Leaders Summit 1-2 March 2023 with Greg on the Summit Advisory Board and Angela as co-Chair for the Oceans Food panel along with SIA CEO Veronica Papacosta.



AOG Energy Knowledge Forum in Perth, WA

Research Director Professor Irene Penesis presented the keynote at the AOG Energy Knowledge Forum in Perth, WA with Partners Carnegie Clean Energy, BMT, Marine Energy Research Australia (MERA) and the University of Western Australia, bringing together specialised industry sectors to discuss the latest techniques, technology and opportunities in offshore renewable energy.

World Renewable Energy Conference (WREC2022)

Deputy Leaders of the Offshore Renewable Energy Systems Program, Dr Jana Orszaghova and Associate Professor Kosala Gunawardane joined delegates from Partners Carnegie Clean Energy and BMT at the World Renewable Energy Conference (WREC2022) in Perth from the 4th - 9th December.

The event, themed Renewable Energy: A pathway to economic recovery and climate change mitigation featured speakers from across the globe with both Dr Orszaghova and Associate Professor Gunawardane presenting and representing the Blue Economy CRC as sponsors of the event.

ICOE
INTERNATIONAL CONFERENCE ON OCEAN ENERGY

MELBOURNE **2024**

The Blue Economy CRC will be hosting the leading global ocean energy event, the 2024 International Conference on Ocean Energy (ICOE) to be held in the Southern Hemisphere for the first time in Melbourne on the 17 – 19 September 2024.

ICOE 2024 will bring together ocean energy leaders, decision-makers and researchers from every corner of the globe for a rich and exciting program of sessions, workshops, networking, technical site visits and an insight into Australasia's rapidly evolving ocean energy activities.

As Australia moves towards a 43% reduction in C emissions by 2030 and net zero by 2050 ocean energy will have an important role. The Blue Economy CRC is one of the major centres supporting sustainable offshore renewable energy developments and the hosting of ICOE 2024 provides an opportunity for attendees to see first-hand the industry and expertise that exists in Australia, New Zealand and the Pacific region and support global ocean energy connections.

This global marine energy event, expecting to attract up to 1000 delegates from across Europe, North and South America and Australasia, will share recent experiences from research and demonstration efforts in ocean energy. Funding to support the event has been provided by the Victorian State Government, Federal Government and Business Events Australia.

Professor Irene Penesis
CHAIR

Primary Delegate for Australia, IEA Technology Collaboraation Programme for Ocean Energy Systems & Research Director, Blue Economy CRC

Professor Christophe Gaudin
CO-CHAIR

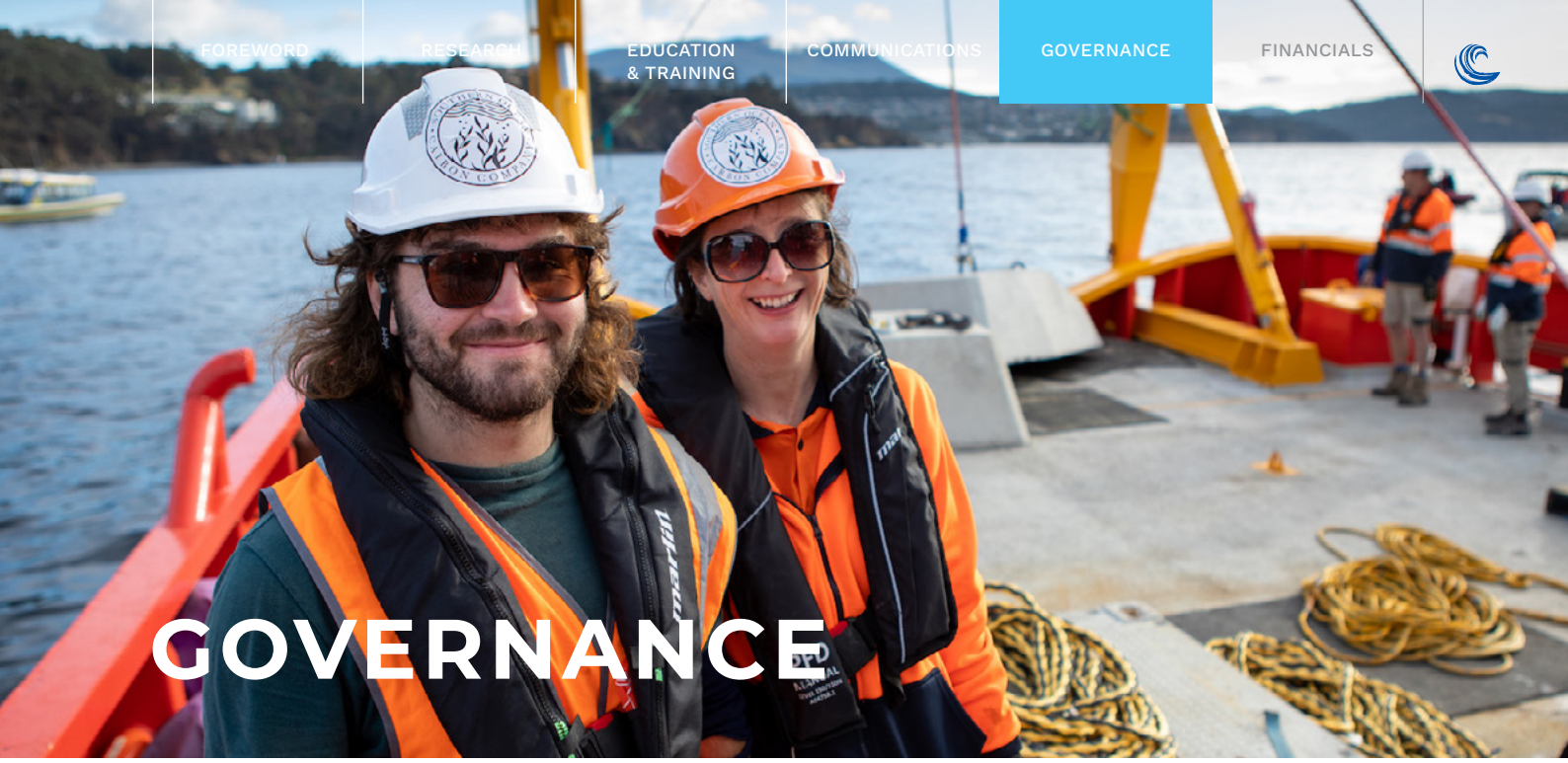
Vice-Chair of IEA Technology Collaboration Programme for Ocean Energy Systems & Director of the UWA Oceans Institute

Publications

The Blue Economy CRC continues to publish its findings in high-quality publications. As well as Blue Economy CRC final project reports, as at 30 June 2023, the Blue Economy CRC has published:

- 1 book
- 6 book chapters
- 50 journal papers & 12 additional submitted and under review
- 30 refereed conference abstracts and papers
- 1 external report.
- 4 magazine articles.

The full list of publications, chapters and articles is available on our website.



GOVERNANCE

The Blue Economy CRC-Co Ltd (ABN 64 634 684 549) is an independent organisation that manages the Blue Economy CRC and is a Company Limited by Guarantee, incorporated in July 2019. Participants in the CRC are eligible to become company members.

At the end of the reporting period the Blue Economy CRC-Co Ltd had six members. The Blue Economy CRC is registered with the Australian Charities and not-for-profit Commission (ACNC) and is income tax exempt.

The key legal agreements establishing the Blue Economy CRC-Co Ltd are:

- Blue Economy CRC Constitution
- CRC Grant agreement between the Australian Government CRC Program and Blue Economy CRC-Co Ltd
- Participants agreement between all participants and Blue Economy CRC-Co Ltd.

Blue Economy CRC-Co Ltd is governed by an independent skills-based board which is made up of six independent directors, one of whom acts as Chair. There are four sub-committees which are listed below

Directors

Name	Role	Since	Number of Meetings Eligible to Attend	Number of Meetings Attended
Greg Johannes	Chair	5 July 2019	6	6
Dr Gunilla Burrowes	Director	5 July 2019	6	6
Greg Vickery	Director	5 July 2019	6	6
Rhys Edwards	Director	5 July 2019	6	6
Dr Nick Elliott	Director	5 July 2019	6	5
Dr Maia Schweizer	Director	28 February 2023	3	3

Finance, Audit and Risk Management Committee (FARM)

The purpose of the Finance, Audit and Risk Management (FARM) Committee is to provide advice to the Board on issues to do with financial management and performance, risk management and audit.

Name	Role	Organisation
Rhys Edwards	Chair of FARM	Director
Greg Vickery	Director, Member	Director
Alicia Leis	Member	WLF Advisory & Accounting

Scientific Advisory Committee (SAC)

The purpose of the Scientific Advisory Committee (SAC) is to provide advice to the Board in relation to the relevance, scientific rigour, funding and performance of the R&D projects to be undertaken under the auspices of the Blue Economy CRC.

Name	Role	Organisation
Dr Nick Elliott	Chair of SAC	Director
Dr Raymond Bannister	Member	EPA Tasmania
Dr Brad Evans	Member (until Nov 2022)	Tassal
Sean Riley	Member (appointed Dec 2022)	Tassal
Dr David Rissik	Member (until Nov 2022)	BMT
Dr Maren Wellenreuther	Member	The New Zealand Institute for Plant and Food Research
Professor Stewart Frusher	Independent Member	University of Tasmania
Dr Martin Renilson	Independent Member (until Nov 2022)	Renilson Marine Consulting
Associate Professor Fatemeh Salehi	Member	Macquarie University
Dr Helen Fitton	Independent Member	Phycosolutions Pty Ltd
Dr Allan Magee	Independent Member (appointed Dec 2022)	Consultant
Rob De Roach	Member (appointed March 2023)	BMT

Participants Advisory Committee (PAC)

The Participants Advisory Committee (PAC) provides advice to the Board on the Blue Economy CRC's overall strategic direction and priorities for participant engagement. The PAC's role includes helping the Blue Economy CRC increase participant engagement and providing market intelligence through networks and industry engagement.

Name	Role	Organisation
Greg Johannes	Chair	Director
Terry Bailey	Member	University of Tasmania
Dr ir Margriet Drouillon	Member	Ghent University
Stephanie Thornton	Member	Climate-KIC Australia
Dr Ian Dutton	Member	The Department of Natural Resources and Environment Tasmania
Professor Udaya K. Madawala	Member	The University of Auckland
Phillipa Ormandy	Member	CSIRO
Jonathan Fiévez	Member	Carnegie Clean Energy Limited
Justin O'Connor	Member (appointed Sep 2022)	Tassal Group Limited

Communications Advisory Committee (CAC)

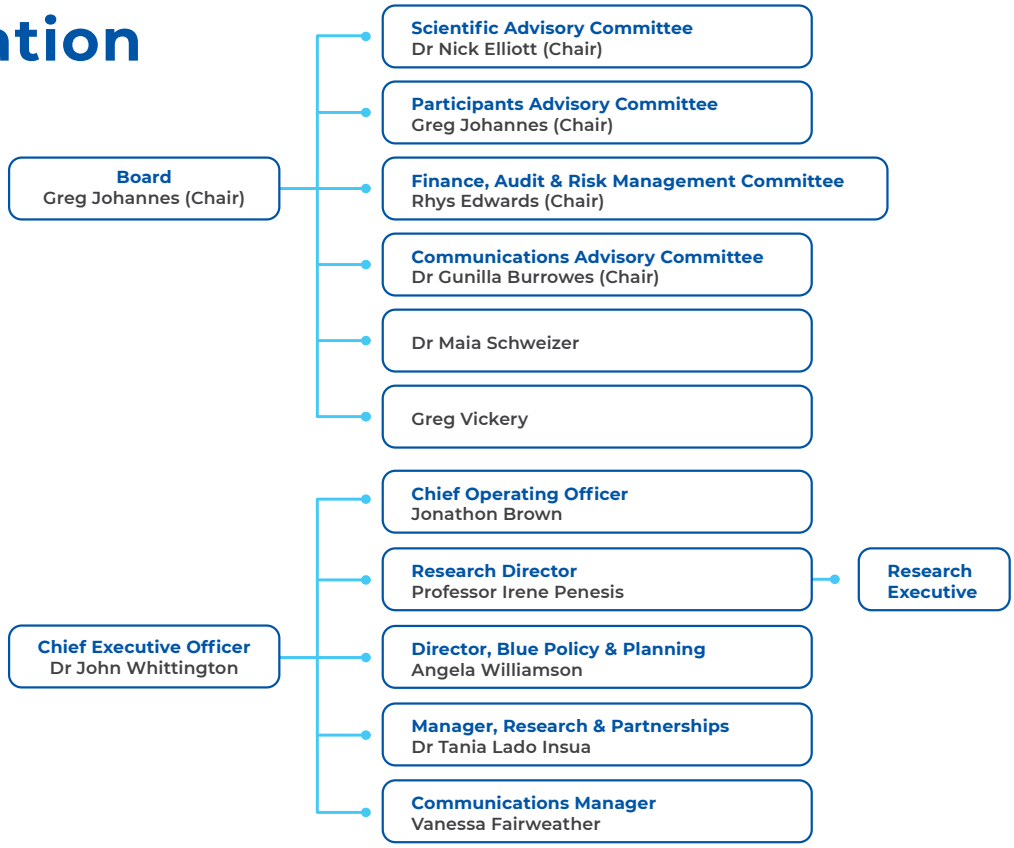
The purpose of the Communication Advisory Committee (CAC) is to provide advice to the Board of Blue Economy CRC-Co Ltd (the Board) on issues to do with internal and external communication-related matters to support the effective operation of Blue Economy CRC-Co.

Name	Role	Organisation
Dr Gunilla Burrowes	Chair of CAC	Director
Pene Snashall	Member (until Feb 2023)	Huon Aquaculture
Matthew Whittle	Member (appointed Feb 2023)	Huon Aquaculture
Nathalie Almonacid	Member	MERIC
Jacquie Ray	Member	Petuna Aquaculture
Tom Middleton	Member (appointed May 2023)	Tassal
Brighid Jay	Member (appointed Feb 2023)	Carnegie Clean Energy

Research Executive

Name	Organisation	Role	Time Commitment
Professor Chien Ming Wang	University of Queensland	Program 1 Leader	60%
Dr Nagi Abdussamie	University of Tasmania	Program 1 Deputy Leader	40%
Professor Chris Carter	University of Tasmania	Program 2 Leader	60%
Professor Lindsey White	Auckland University of Technology	Program 2 Deputy Leader	40%
Professor Evan Gray	Griffith University	Program 3 Leader	60%
Dr Kosala Gunawardane	Auckland University of Technology (until Jan 2023)	Program 3 Deputy Leader	20%
Dr Jana Orszaghova	University of Western Australia	Program 3 Deputy Leader	20%
Professor Chris Frid	Griffith University	Program 4 Leader	60%
Dr Remo Cossu	The University of Queensland	Research 4 Deputy Leader	20%
Professor Marcus Haward	University of Tasmania	Research 5 Leader	60%
Associate Professor Ki-Hoon Lee	Griffith University (until Oct 2022)	Research 5 Deputy Leader	20%

Organisation Chart



BLUE ECONOMY
COOPERATIVE RESEARCH CENTRE

FINANCIAL REPORT FOR THE PERIOD 1 JULY 2022 TO 30 JUNE 2023

BLUE ECONOMY CRC-CO LTD | ACN 634 684 549

Australian Government
Department of Industry, Science and Resources

AusIndustry
Cooperative Research Centres Program

FINANCIALS

Contents

Directors Report

Blue Economy CRC-Co Ltd
For the year ended 30 June 2023

The Directors of Blue Economy CRC-Co Limited ("the Company") present their report, together with the financial statements of the entity for the period 1 July 2022 to 30 June 2023 and the Independent Audit Report.

Directors details

The following persons were Directors of the company during the whole period since incorporation up to the date of this report:

Greg Johannes	(Appointed 5 July 2019)
Gunilla Burrowes	(Appointed 5 July 2019)
Greg Vickery	(Appointed 5 July 2019)
Rhys Edwards	(Appointed 5 July 2019)
Nick Elliott	(Appointed 5 July 2019)

The individual listed below served as a Director of the company from their appointment date up to the current date of this report:

Maia Schweizer	(Appointed 28 February 2023)

Objectives

To undertake the principal activities the Company draws together the knowledge, skills and experience of 44 Participant organisations from industry, research and government, based around Australia and internationally.
The Company's short-term objectives are to:

- Develop an industry led research portfolio with a network of Participants, from research, industry, and government;
- Coordinate Participant cash and in-kind contributions together with funding from the Australian Government to undertake the research and training activities and commercialise the outcomes of research;
- Implement the Blue Economy CRC's Higher Degree by Research Education Program to support the development of trained workforce for the future.

The Company's long-term objective is to perform world class, collaborative, industry focused research and training that underpins the growth of Australia's Blue Economy through increased offshore sustainable seafood production and renewable energy.

Strategy for achieving the objectives

To achieve these objectives, the Company is undertaking research and training across five research programs consistent with our Research Road Maps:

Program 1: Offshore Engineering & Technology

Provides engineering solutions that create healthy aquaculture growing conditions that use the latest technologies for construction, installation, automation, monitoring and maintenance of offshore infrastructure.

Program 2: Seafood & Marine Products

Developing innovative offshore aquaculture systems to provide solutions in animal and plant husbandry and feed design.

Program 3: Offshore Renewable Energy Systems

Developing and testing marine renewable energy devices suited to offshore conditions that support energy export and storage to support aquaculture and other sectors, remote islands and communities and on-grid generation.

Program 4: Environment & Ecosystems

Delivering innovative solutions for modelling and monitoring to understand the environmental impacts of new offshore developments.

Program 5: Sustainable Offshore Developments

Creating new fit for purpose policies and regulatory instruments and sustainable business development and commercialisation models.

Principal activities

The principal activity of the Company during the course of the financial year was the administration of the Blue Economy Cooperative Research Centre.

There were no significant changes in the nature of the activities for the Blue Economy CRC-Co during the year.

Performance measures

The company's principal obligations arise from CRC Grant Agreement 20180101 between the Blue Economy CRC and the Commonwealth Government. The Blue Economy CRC delivers these obligations by developing and undertaking projects whose outputs contribute to meeting the contracted milestones. The company has developed software-based systems to track progress towards meeting milestones.

Meetings of Directors

During the financial year, 6 meetings of directors were held. Attendances by each director were as follows:

Directors Meetings

	Number eligible to attend	Number attended
Greg Johannes	6	6
Gregory Vickery	6	6
Gunilla Burrowes	6	6
Maia Schweizer	3	3
Nicholas Elliott	6	5
Rhys Edwards	6	6

Information on Directors

Name: Greg Johannes

Title: Chair of the Board

Qualifications: BA (Hons)

Experience and Expertise: Greg Johannes has more than 20 years of leadership experience in the Australian public, private, not-for-profit and research sectors. His roles have included being Head of the State Service and Secretary of the Department of Premier and Cabinet in Tasmania.

In 2015 he was made a National Fellow of the Institute of Public Administration Australia for his outstanding contribution to the public sector in Australia over many years. Greg has a deep interest in the marine science community and has previously been on the boards of both the Antarctic Climate and Ecosystems CRC and the Institute for Marine and Antarctic Studies.

He now runs his own consulting company, helping boards, CEOs and senior managers and leaders address complex development and organisational issues.

Special Responsibilities: Chair of the Participants Advisory Committee

Name: Gunilla Burrowes

Title: Board Director

Qualifications: BE (Elec), MPhil, PhD & GAICD

Experience and Expertise: An electrical engineer with a broad range of industry and academic experience, Gunilla is passionate about innovation, entrepreneurship, technology commercialisation and improving diversity and inclusion in the workplace. She has a Master of Philosophy in Engineering Education and a Doctorate in Underwater Swarm Sensor Networks.

In 2000, she founded an underwater tech company, BlueZone Group with her husband which now has two offices in Newcastle and Perth. Gunilla is also co-founder of a consultancy, Gender Matters that advises organisations on gender equity and has a unique approach to mitigating cognitive bias in decision-making.

Gunilla is the inaugural Chair of Eighteen04 (an inspirational co-working and incubator space for companies scaling in the clean tech and smart city area) and inaugural board

member of Hunter iF project (an open consortium of leading organisations in the Hunter to support the growing startup ecosystem in the region). She is a member of the Hunter Angels and has been an Angel investor for over 10 years. Gunilla is also a member of the SmartCrete CRC Board. She has been a National Vice President of Engineers Australia, awarded an Honorary Fellow of Engineers Australia in 2017 and invited as a Fellow of the Australian Academy of Technology and Engineering in 2019.

Special Responsibilities: Chair of the Communications Advisory Committee

Name: Greg Vickery AO

Title: Board Director

Qualifications: BA/LLB (UQ), Grad Dip Dispute Resolution (Bond Uni) and FAICD

Experience and Expertise: Greg Vickery is an experienced company and commercial lawyer and company director based in Brisbane. Graduating in Law from the University of Queensland he was for 40 years a partner of the firm now known as Norton Rose Fullbright at which he is now a part time consultant. He is a Fellow of the Australian Institute of Company Directors and is currently a director of several companies including Burrells Stockbroking P/L and Australia & International Holdings Ltd. He chairs the Law Council of Australia's Business & Human Rights Committee and was appointed as a member of the Federal Government's Expert Advisory Committee on Modern Slavery in 202. He has previously been a director of several companies including Ergon Energy Retail, Queensland Energy Resources and Russo Higher Education P/L. He has previously been President of the Qld Law Society and chaired its Legal Education Committee as well as being a member of its Integrity Committee. He was for many years a member of Federal Treasury's Companies and Markets Advisory Committee (CAMAC). He was for 7 years the Honorary Consul in Queensland for the Republic of Indonesia and he remains an active member of the Australian Indonesia Business Council. He is a qualified and experienced commercial mediator. He has for over 40 years been an active Red Cross volunteer, working mainly in the areas of fund raising and governance. He was for 8 years the national President of Australia Red Cross, for 6 years a member of the Governing Board of the International Red Cross & Red Crescent Societies and for 8 years an elected member of the prestigious International Standing Commission of Red Cross & Red Crescent Societies (including 4 years as its Chair). In 2001 he became a member of the Order of Australia (AO) for his governance and leadership of international humanitarian organisations.

Special Responsibilities: Member of the Finance, Audit & Risk Management Committee

Name: Dr Nick Elliot

Title: Board Director

Qualifications: BSc (Hons), PhD

Experience and Expertise: Dr Nick Elliott has extensive marine and aquaculture research and industry knowledge, experience and achievements built through his 33-year career at CSIRO. He is internationally recognised for his research leadership, education and management. A PhD graduate from the University of Tasmania, his research experience has included biomonitoring of heavy metals, genetics applied to fisheries, and the application of genetics, physiology, and innovative technologies to advance aquaculture production. His vision and leadership resulted in the internationally recognised selective breeding team at CSIRO, as well as collaborative innovative research in biotags and opportunities for industry expansion offshore. Nick has co-supervised over 15 post-graduate students and mentored many careers. His mission is to continue to see the transformation of the Australian aquaculture sector through collaborative research and education and is committed to the use and

integration of rapidly advancing technologies. Nick brings abundant knowledge of aquaculture and research management to the Board, including over 10 years on the Tasmanian Fisheries Research Advisory Board.

Special Responsibilities: Chair of the Scientific Advisory Committee

Name: Rhys Edwards

Title: Board Director

Qualifications: B.Ec (Hons), MSc. Comparative Social Research

Experience and Expertise: Rhys Edwards is the principal of RDME Consulting a boutique consulting firm working with governments, universities, and the private sector. Rhys is an experienced organisational leader and has a strong background in governance, leadership, economic development, innovation, and major project facilitation.

Rhys is Rhodes Scholar, an honorary senior research fellow at Melbourne University, a moderator for the Cranlana Centre for Ethical Leadership, a fellow of the Australian Institute of Company Directors and a Salzburg Global Fellow. He sits on the board of Aurora Energy, the Foyer Foundation, Swisherr Pty Ltd and is Chair of InVent, a university owned commercialisation company.

Rhys enjoys working with clients at the intersection of government, education, social enterprise, and the private sector to create new models for change and growth.

Special Responsibilities: Chair of the Finance, Audit & Risk Management Committee

Name: Maia Schweizer

Title: Board Director

Qualifications: BA (Hons), MSc, DPhil

Experience and Expertise: Dr Maia Schweizer has worked in energy and infrastructure for 15 years, moving from oil and gas to renewable electricity and fuels.

Maia trained as a geobiologist, including as a Marshall Scholar at the University of Oxford working with NASA scientists and engineers on detection of life in extreme environments. She spent several years at McKinsey and Company serving leading companies in capital-intensive industries across six continents on strategy, organisation and operational performance.

In Australia, she has held senior executive roles in project development and operations at Origin Energy and Fortescue Future Industries, and served as chief executive of CleanCo Queensland, a low-emissions electricity generator and retailer. In these roles, Maia led development of new resources and renewables projects from inception to commissioning. Maia's mission is tackling climate change challenges while ensuring communities benefit from solving them.

Company Secretary

Jonathon Brown BBus

Jonathon Brown has held the role of Company Secretary since 29 January 2020. Jonathon also acts as the Chief Operating Officer for the Company. Jonathon has held several senior executive positions across various industries in both Australia and New Zealand. Prior to joining Blue Economy CRC Co Ltd, Jonathon held the position of General Manager & previously Financial Controller & Company Secretary with co-operative hospitality company, Edgewater Resort in New Zealand.

Jonathon holds a Bachelor of Business from the University of Tasmania and has over 10 years' experience in business management, finance and advisory, having worked for KPMG and a number of global hospitality & vacation exchange companies across Australia and New Zealand.

Contributions on winding up

In the event of the company being wound up, ordinary members are required to contribute a maximum of $10 each. At 30 June 2023, the total amount that members of the Company are liable to contribute if the Company is wound up is $10.

Auditor's Independence Declaration

A copy of the Auditor's Independence Declaration for the period ended 30 June 2023 is included in this financial report and forms part of the Directors' Report.

Signed in accordance with a resolution of the Board of Directors.

Chair, Blue Economy CRC-Co Ltd

Director, Blue Economy CRC-Co Ltd

Dated this 24th day of October 2023

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Fax: +61 3 6234 2392
www.bdo.com.au

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Hobart TAS 7000
GPO Box 1681 Hobart TAS 7001
Australia

DECLARATION OF INDEPENDENCE BY DAVID E PALMER TO THE MEMBERS OF BLUE ECONOMY CRC-C0 LTD

As lead auditor of Blue Economy CRC-Co Ltd for the year ended 30 June 2023, I declare that, to the best of my knowledge and belief, there have been:

1. No contraventions of the auditor independence requirements of section 60-40 of the *Australian Charities and Not-for-profits Commission Act 2012* in relation to the audit; and
2. No contraventions of any applicable code of professional conduct in relation to the audit.

This declaration is in respect of Blue Economy CRC-Co Ltd.

DAVID E PALMER
Partner

BDO Audit (TAS)

Hobart

27 October 2023

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Statement of Profit or Loss

Blue Economy CRC-Co Ltd
For the year ended 30 June 2023

	NOTES	2023	2022
Funding & Program Revenue			
Funding & Program Revenue	12	11,966,922	10,307,580
Total Funding & Program Revenue		**11,966,922**	**10,307,580**
Other Revenue			
FBT Employee Contribution		1,164	2,779
Interest Income		13,025	3,501
Other Income		20,490	-
Total Other Revenue		**34,679**	**6,281**
Total Revenue		**12,001,601**	**10,313,861**
Expenditure			
Consulting & Legal Fees		159,114	170,491
Depreciation & Amortisation Expense		33,485	16,649
Directors Fees		196,215	177,233
Employee Benefit Expense		1,060,416	730,096
Finance Fees		121,308	111,891
General Administration		316,338	158,655
Marketing & Communications		199,877	119,794
Research & Development Expenditure		9,441,287	8,637,325
Travel		440,046	188,225
Total Expenditure		**11,968,086**	**10,310,360**
Net Surplus / (Deficit) for the year		**33,515**	**3,501**

The accompanying notes form part of these financial statements. These statements should be read in conjunction with the attached compilation report.

Statement of Financial Position

Blue Economy CRC-Co Ltd
As at 30 June 2023

	NOTES	30 JUN 2023	30 JUN 2022
Assets			
Current Assets			
Cash and Cash Equivalents	3	1,939,045	3,016,404
Financial Assets	5	2,000,000	2,000,000
GST Receivable		121,913	53,880
Other Current Assets	7	1,307,625	1,287,521
Trade and Other Receivables	4	1,033,663	1,532,289
Total Current Assets		**6,402,246**	**7,890,094**
Non-Current Assets			
Property, Plant & Equipment	6	3,248,034	2,468,091
Total Non-Current Assets		**3,248,034**	**2,468,091**
Total Assets		**9,650,280**	**10,358,185**
Liabilities			
Current Liabilities			
Deferred Revenue	11	5,503,898	7,033,728
Lease Liability	10	505,986	150,857
Provisions	8	74,562	42,068
Trade and Other Payables	9	1,702,580	1,144,099
Total Current Liabilities		**7,787,026**	**8,370,752**
Non-Current Liabilities			
Lease Liability	10	1,719,023	1,876,718
Total Non-Current Liabilities		**1,719,023**	**1,876,718**
Total Liabilities		**9,506,049**	**10,247,470**
Net Assets		**144,231**	**110,715**
Accumulated Funds			
Surplus / (Deficit) for the year		144,231	110,715
Balance at end of year		**144,231**	**110,715**

The accompanying notes form part of these financial statements. These statements should be read in conjunction with the attached compilation report.

Statement of Cash Flows

Blue Economy CRC-Co Ltd
For the year ended 30 June 2023

	NOTES	2023	2022
Operating Activities			
Receipts from grants and participants		12,029,290	10,053,814
Payments to suppliers and employees		(12,416,017)	(10,674,152)
GST refunds/(payments) on operating items		35,157	56,394
Interest received		13,025	3,501
Net Cash Flows from Operating Activities	20	**(338,545)**	**(560,443)**
Investing Activities			
Payment for property, plant and equipment		(642,677)	(485,144)
GST refunds/(payments) on capital items		58,425	44,104
Net Cash Flows from Investing Activities		**(584,252)**	**(441,040)**
Financing Activities			
Payment of lease liability		(154,561)	(108,767)
Net Cash Flows from Financing Activities		**(154,561)**	**(108,767)**
Net Cash Flows		(1,077,358)	(1,110,250)
Cash and Cash Equivalents			
Cash and cash equivalents at beginning of period		3,016,404	4,126,654
Net change in cash for period		(1,077,358)	(1,110,250)
Cash and cash equivalents at end of period		1,939,046	3,016,404

Statement of Movements in Equity

Blue Economy CRC-Co Ltd
For the year ended 30 June 2023

	2023	2022
Equity		
Opening Balance - Accumulated Funds	110,715	107,214
Increases		
Surplus for the Period	33,515	3,501
Total Increases	**33,515**	**3,501**
Closing Balance - Accumulated Funds	**144,230**	**110,715**

Notes to the Financial Statements

Blue Economy CRC-Co Ltd
For the year ended 30 June 2023

1. General Information

(i) Basis of Preparation

Blue Economy CRC-Co Ltd is a not-for-profit company limited by guarantee, incorporated and domiciled in Australia. These general purpose financial statements have been prepared in accordance with the Corporations Act 2001 and Australian Accounting Standards Simplified Disclosures.

The presentation currency used in these financial statement is Australian dollars ($). Amounts in these financial statements are stated in Australian dollars unless otherwise noted.

2. Summary of Significant Accounting Policies

(a) Cash and Cash Equivalents

Cash and Cash Equivalents in the Statement of Financial Position comprise cash at bank and in hand and short-term deposits with an original maturity of three months or less. For the purposes of the statement of Cash Flows, cash and cash equivalents consist of cash and cash equivalents as defined above, net of outstanding bank overdrafts.

(b) Receivables

Trade receivables are initially recognised at fair value and subsequently measured at amortised cost using the effective interest method, less any allowance for expected credit losses. Trade receivables are generally due for settlement within 30 days.

The company has applied the simplified approach to measuring expected credit losses, which uses a lifetime expected loss allowance. To measure the expected credit losses, trade receivables have been grouped based on days overdue.

Other receivables are recognised at amortised cost, less any allowance for expected credit losses.

(c) Property, Plant & Equipment

All classes of property, plant and equipment are measured on the cost basis and are therefore carried at cost less accumulated depreciation and any accumulated impairment losses. Cost includes expenditure that is directly attributable to the acquisition of the item.

The method of depreciation and the depreciation rate is used a follows:

Furniture and Computer Equipment - Straight Line Method at 30% - 50%

Computer Software - Diminishing Value 67%

Fitout - Straight Line Method over the remaining life of the lease

Right of Use Asset - Hydrogen Equipment - Diminishing Value Method over a self-assessed 20-year effective life

Gains and losses on disposals are determined by comparing proceeds with the carrying amount. These gains or losses are recognised in profit or loss in the period in which they arise.

) Revenue Recognition

venue comprises revenue from government grants, cash and in-kind contributions from Participants. Revenue from major oducts and services is shown in Note 12.

venue is measured by reference to the fair value of consideration received or receivable by the Company for goods supplied d services provided, excluding sales taxes, rebates and trade discounts.

venue is recognised when the amount of revenue can be measured reliably collection is probable, the costs incurred or to be curred can be measured reliably, and when the criteria for each for the Company's different activities have been met. Details of e activity-specific recognition criteria are described below.

Government Grants

e Company's operations are supported by federal government grant funding.

ufficiently specific conditions are attached to a grant which must be satisfied before the Company is eligible to receive the ntribution, recognition of the grant as revenue is deferred until those conditions are satisfied.

here a grant is received on the condition that specific services are performed, revenue is recognised as services are performed d at period end a liability is recognised until the service is delivered.

venue that is not subject to conditions is recognised when the Company obtains control of the funds, economic benefits are obable and the amount can be measured reliably. Where a grant may be required to be repaid if certain conditions are not tisfied, a liability is recognised at period end to the extent that conditions remain unsatisfied.

here the Company receives a contribution of an asset from a government or other part for no or nominal consideration, the set is recognised at fair value and a corresponding amount of revenue is recognised.

) Cash Contributions Received from Participants

come arising from participant cash contributions received is recognised as deferred revenue on receipt and revenue is cognised as services are performed in accordance with the project agreements. At period end a liability is recognised to the tent that conditions remain unsatisfied.

) In-Kind Contributions

e Company has not elected to bring in-kind contributions to account in the financial statements, which is allowed as a policy oice under AASB 1058. Additional disclosures in relation to in-kind contributions received during the financial year are cluded at note 18.

) Gifts and Donations

ts and donations received that do not create enforceable rights and performance obligations are recognised as revenue on ceipts.

Interest Revenue

erest revenue is recognised using the effective interest rate method. It includes the amortisation of any discount or premium.

Trade and Other Payables

ade and other payables are recognised when the company becomes obliged to make future payments resulting from the rchase of goods and services. The amounts are unsecured and paid within 30 days of recognition.

Impairment

each reporting date the company reviews the carrying amounts of assets to determine whether there is any indication that ose assets have suffered an impairment loss. If any such impairment exists, the recoverable amount of the asset is estimated order to determine the extent of the impairment loss if any. The recoverable amount is assessed as the higher of the value less sts to sell or the assets value in use being the depreciated replacement cost.

) Goods and Services Tax

venue, expenses and assets are recognised net of the amount of goods and services tax GST) except:

Where the amount of GST incurred is not recoverable from the taxation authority, it is recognised as a part of the cost of acquisition of an asset of as part of an item of expense, or
For receivables and payables which are recognised inclusive of GST, the net amount of GST recoverable from, or payable to the taxation authority is included as part of receivables or payables in the Statement of Financial Position. Receivables and payables are stated with the amount of GST included.

) Leases

e company recognises a right-of-use asset and a lease liability at the lease commencement date excluding short term leases d lease for which the underlying asset is of low value. An asset is considered low-value when it is expected to cost less than 0,000. The right-of-use asset is initially measured at cost, which comprises the initial amount of the lease liability adjusted for y lease payments made at or before the commencement date, plus any initial direct costs incurred and an estimate of costs to ;mantle and remove the underlying asset or to restore the underlying asset or the site on which it is located, less any lease :entives received.

e right-of-use asset is subsequently depreciated using the straight-line method from the date the asset becomes available for e to the earlier of the end of the useful life of the right-of-use asset or the end of the lease term. The estimated useful lives of ht-of-use assets are determined on the same basis as those of property and equipment. In addition, the right-of-use asset is riodically reduced by impairment losses, if any, and adjusted or certain re-measurements of the lease liability.

e lease liability is initially measured at the present value of the lease payments that are not paid at the commencement date, ;counted using the interest rate implicit in the lease or if that rate cannot be readily determines, the company's incremental rrowing rate. Generally, the company uses its incremental borrowing rate as the discount rate.

e lease liability is measured at amortised cost using the effective interest method. It is remeasured when there is a change in :ure lease payments arising from a change in an index or rate, if there is a change in the company's estimate of the amount pected to be payable under a residual value guarantee, or if the company changes its assessment of whether it will exercise a rchase, extension or termination option.

ıen the lease liability is remeasured this way, a corresponding adjustment is made to the carrying amount of the right-of-use set or is recorded in profit or loss if the carrying amount of the right-of-use asset has been reduced to zero.

Income Taxes

e company is charitable organisation under Subdivision 50-B of the Income Tax Assessment Act 1997, Division 176 of a New x System (Goods and Services Tax) Act 1999 and section 123E of the Fringe Benefits Tax Assessment Act 1986.

e company is exempt from the income tax and therefore no provision for income tax is made in these financial statements.

Financial Assets and Liabilities

ıancial assets and financial liabilities are recognised in the Statement of Financial Position when the company becomes party the contractual provisions of the financial instrument.

ıancial instruments are subsequently measured at fair value, amortised cost using the effective interest method, or cost.

inancial asset is derecognised when the contractual rights to the cash flows from the financial assets expire or are transferred d no longer controlled by the company.

inancial liability is removed from the Statement of Financial Position when the obligation specified in the contract is ;charged or cancelled or expires.

Financial assets and financial liabilities classified as held for trading are measured at fair value though profit or loss.

Financial assets not measured at fair value comprise, held-to-maturity investments being non-derivative financial assets with fixed or determinable payments and fixed maturity that will be held to maturity. These are measured at amortised cost using the effective interest method.

(k) Research and Development Expenditure

Research and development expenditure is recognised as an expense in the period incurred. At the financial year end, the research and development costs will be reviewed and any costs eligible for asset recognition under AASB 138 Intangible Assets will be capitalised.

Intangible assets arising from the development activities are recognised when the resources are available to complete the assets and future economic benefits from the use or sale of assets is probable. In assessing whether Intellectual Property falls within the scope of AASB 138, it will be assessed against a set of criteria and then allocated into one of two phases, the research phase or the development phase.

An intangible asset arising from the development will be recognised if, and only if, the recognition criteria is met. The cost of an internally generated intangible asset is the sum of expenditure from the date when the intangible asset first meets the recognition criteria, expenses previously recognised will not be able to be reinstated to this cost base.

(l) Employee Benefits

Short term employee benefits are employee benefits (other than termination benefits and equity compensation benefits) which fall due wholly within 12 months after the end of the period in which the employee services are rendered. They comprise wages, salaries, social security obligations, short-term compensation absences, profit sharing and bonuses payable within 12 months and non-mandatory benefits such as medical care, housing and car and service goods.

Short term employee benefits are measured at the (undiscounted) amounts expected to be paid when the obligation is settled.

Other long-term employee benefits include long-service leave, long-term disability benefits, deferred compensation and profit sharing and bonuses payable 12 months or more after the end of the period in which the employee service are rendered.

Other long-term employee benefits are measured at the present value of the expected future payments to be made to other employees.

Defined Contribution superannuation benefits

All employees of the company receive defined contribution superannuation entitlements, for which the company pays the fixed superannuation guarantee contribution (currently 11% of the employee's average ordinary salary) to the employee's superannuation fund of choice. All contributions are recognised as an expense when they become payable.

	2023	2022
3. Cash and Cash Equivalents		
Business Transaction Account	1,939,045	3,016,404
Total Cash and Cash Equivalents	**1,939,045**	**3,016,404**

	2023	2022

4. Trade and Other Receivables

Current		
Accounts Receivable	927,663	1,532,289
Accrued Revenue	106,000	-
Total Trade and Other Receivables	**1,033,663**	**1,532,289**

	2023	2022

5. Financial Assets

Current		
CBA Term Deposit	2,000,000	2,000,000
Total Financial Assets	**2,000,000**	**2,000,000**

	2023	2022

6. Property, Plant and Equipment

Capital Works in Progress		
Hydrogen Equipment - Project and Installation Costs	882,520	298,636
Total Capital Works in Progress	**882,520**	**298,636**
Leasehold Improvements		
Leasehold Improvements at Cost	126,865	126,865
Accumulated Depreciation of Leasehold Improvements	(24,243)	(8,385)
Total Leasehold Improvements	**102,622**	**118,480**
Plant and Equipment		
Plant and Equipment at Cost	43,239	42,870
Accumulated Depreciation of Plant and Equipment	(26,535)	(19,470)
Total Plant and Equipment	**16,704**	**23,400**
Right of Use Asset		
Hydrogen Equipment - Right of Use Asset	2,256,750	2,027,575
Hydrogen Equipment - Right of Use Asset - Accumulated Amortisation	(10,562)	-
Total Right of Use Asset	**2,246,188**	**2,027,575**
Total Property, Plant and Equipment	**3,248,034**	**2,468,091**

	2023	2022

7. Other Assets

Current		
Prepayments	1,307,625	1,287,521
Total Other Assets	**1,307,625**	**1,287,521**

	2023	2022

8. Provisions

Annual Leave Liability	74,562	42,068
Total Provisions	**74,562**	**42,068**

	2023	2022

9. Trade and Other Payables

Current		
Accounts Payable	791,341	112,198
Accrued Expenses	822,673	970,024
Accrued Wage	22,298	8,500
Credit Cards	22,929	11,874
FBT Payable	2,031	2,040
PAYG Withholdings Payable	37,273	37,040
Superannuation Payable	4,035	2,422
Total Trade and Other Payables	**1,702,580**	**1,144,099**

	2023	2022

10. Lease Liability

Current		
Hydrogen Equipment < 12 months	550,080	150,857
Hydrogen Equipment Lease Liability - Unexpired Interest	(44,094)	-
Total Current	**505,986**	**150,857**
Non-Current		
Hydrogen Equipment < 5 years	1,794,951	1,698,734
Hydrogen Equipment Lease Liability - Non-current - Unexpired Interest	(75,928)	-
Hydrogen Equipment > 5 years	-	177,984
Total Non-Current	**1,719,023**	**1,876,718**
Total Lease Liability	**2,225,009**	**2,027,575**

	2023	2022

11. Deferred Revenue

Government Contributions		
CRC Program Grant Received in Advance	147,541	3,440,216
Total Government Contributions	**147,541**	**3,440,216**
Participant Contributions		
Participant Contributions Received in Advance	5,356,357	3,593,512
Total Participant Contributions	**5,356,357**	**3,593,512**
Total Deferred Revenue	**5,503,898**	**7,033,728**

	2023	2022
12. Results from Operating Activities		
Funding & Program Revenue		
CRC Program Grant	9,556,525	7,240,405
Participant & Project Contributions	2,410,397	3,067,175
Total Funding & Program Revenue	**11,966,922**	**10,307,580**
Other Revenue		
FBT Employee Contribution	1,164	2,779
Interest Income	13,025	3,501
Other Income	20,490	-
Total Other Revenue	**34,679**	**6,281**
Net Realised Revenue	12,001,601	10,313,861
Reconciliation of Net Result		
Government Contributions Expended	3,594,536	3,147,293
Participant Contributions Expended	8,373,550	7,163,067
Net Result	33,515	3,501

13. Financial Risk Management Objectives and Policies

The company's principal financial instruments comprise receivables, payables, cash and short-term deposits. These activities expose the company to a variety of financial risks: market risk(including interest rate risk), credit risk and liquidity risk.

Surplus funds are invested in short and long-term deposits with the one of the four major Australian banks at the best negotiated rate with maturities selected to match future expenditure needs.

Ageing analyses and monitoring of specific credit allowances are undertaken to manage credit risk, liquidity risk is monitored through regular analysis of cash flows over a variety of periods that draw on the business budgets and forecasts.

The company has implemented a risk management process and a number of operational Key Performance Indicators and provides the Board and Management with an assessment of performance against agreed objectives.

Risk Exposure and Responses

Interest Rate Risk

The company's exposure to market interest rates related primarily to the short and long-term deposits it held.

The company's exposure to interest rate risk is not material as the majority of its interest-bearing financial assets are in the form of fixed rate term deposits.

Liquidity Risk

The company manages liquidity risk by monitoring cash flow and maturity profiles of financial assets and liabilities.

14. Key Management Personnel

Key management personnel comprise executive directors and other persons having authority and responsibility for planning, directing and controlling the activities of Blue Economy CRC-Co Ltd.

Name of Each Key Management Personnel:	Position:
John Whittington	Chief Executive Officer
Greg Johannes	Board Chair
Greg Vickery	Board Director
Gunilla Burrowes	Board Director
Nick Elliott	Board Director
Rhys Edwards	Board Director
Maia Schweizer	Board Director
Irene Penesis	Research Director
Angela Williamson	Director, Blue Policy and Planning
Jonathon Brown	Chief Operating Officer

	2023	2022
Amounts paid or payable to key management personnel are as follows:		
Short-term employee benefits	1,228,346	925,813
Post Employment benefits	-	-

15. In-Kind Contributions

Participants and third parties make contributions to the various CRC projects in accordance with the project agreements through a mix of cash and in-kind contributions. In-kind contributions can comprise both staff in-kind contributions as well as other in-kind contributions. Staff in-kind contributions include the allocation of staff time to the CRC and projects, whereas other in-kind contributions include the allocation of non-staff resources such as access to the use of equipment, property or office space.
As noted in note 1.(d)(iii) the Company has not elected to bring in-kind contributions to account in the financial statements. However, the agreed value of in-kind participant contributions made to the CRC and its projects are as follows:

	2023	2022
In-kind Contributions		
Staff in-kind contributions	10,060,000	7,120,325
Other in-kind contributions	6,806,798	1,585,044
Other in-kind contributions prior year adjustments	4,471,600	-

16. Unrecognised Contractual Commitments

At balance date the entity had the following commitments for expenditure:

- Obligations to make payments under a site access agreement with a participant. The sum of the cash obligations under this agreement is $1,500,000.

	2023	2022
Unrecognised Contractual Commitments		
Payable within 1 year	1,500,000	1,500,000
Payable outside 1 year	-	1,500,000

	2023	2022
17. Remuneration of Auditors for:		
Auditing or reviewing the financial statements	8,250	9,180

18. Subsequent Events

No matter or circumstance has occurred subsequent to year end that has significantly affected, or may significantly affect, the operations of the Company, the results of those operations or the state of affairs of the Company or economic entity in subsequent financial years.

19. Economic Dependency & Continuance of Operations

The Company depends upon continued support from Participants and the Commonwealth of Australia for its ongoing operations. During the period ending 30 June 2023 approximately 39% (2022: 43%) of the Company's cash contributions of $10,331,092 (2022: $10,038,970) was sourced from Participants and 61% (2022: 57%) from the Commonwealth of Australia.

20. Cash Flow Information

Reconciliation of net cash flows from operating activities to operating profit.

	2023	2022
Cash Flow Reconciliation		
Profit for the year	33,515	3,501
Interest on RoU Lease	104,277	108,767
Interest on P&I Loan	18,544	-
Depreciation & Amortisation	33,485	16,649
Changes in Assets & Liabilities		
(Increase)/Decrease in Trade & Other Receivables	498,626	(899,139)
(Increase)/Decrease in Other Current Assets	(19,365)	(29,130)
Increase/(Decrease) in GST Payable	(68,034)	(152,850)
Increase/(Decrease) in Trade & Other Payables	557,742	650,171
Increase/(Decrease) in Provisions	32,494	10,198
Increase/(Decrease) in Other Current Liabilities	-	-
Increase/(Decrease) in Deferred Revenue	(1,529,830)	(268,610)
Cashflows from Operations	**(338,545)**	**(560,443)**

21. Entity Details

The registered office and the principal place of business of the company is:

Building "N"

Maritime Way

Newham, TAS 7248

Directors Declaration

Blue Economy CRC-Co Ltd
For the year ended 30 June 2023

In accordance with the resolution of the directors of Blue Economy CRC-Co Ltd, the directors declare that:

1. The financial statements and notes are in accordance with the Corporations Act 2001 and the Australian Not-for-Profit and Charities Commission Act 2012 and:

1. Comply with Australian Accounting Standards applicable to the Company and Division 60 of the Australian Charities & Not-For-Profits Commission Regulations 2013; and
2. Give a true and fair view of the financial position of the Company as at 2023 and of its performance for the year ended on that date in accordance with the accounting policies described in Note 1 to the financial statements.

2. In the directors' opinion there are reasonable grounds to believe that the Company will be able to pay its debts as and when they become due.

Chairperson - Non-Executive

24 October 2023

Date

Director - Non-Executive

24 October 2023

Date

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INDEPENDENT AUDITOR'S REPORT

To the members of Blue Economy CRC-Co Ltd

Report on the Audit of the Financial Report

Opinion

We have audited the financial report of Blue Economy CRC-Co Ltd (the registered entity), which comprises the statement of financial position as at 30 June 2023, the statement of profit or loss and other comprehensive income, the statement of changes in equity and the statement of cash flows for the year then ended, and notes to the financial report, including a summary of significant accounting policies, and the responsible entities' declaration.

In our opinion the accompanying financial report of Blue Economy CRC-Co Ltd, is in accordance with Division 60 of the *Australian Charities and Not-for-profits Commission Act 2012*, including:

(i) Giving a true and fair view of the registered entity's financial position as at 30 June 2023 and of its financial performance for the year then ended; and

(ii) Complying with Australian Accounting Standards – Simplified Disclosures and Division 60 of the *Australian Charities and Not-for-profits Commission Regulations 2022*.

Basis for opinion

We conducted our audit in accordance with Australian Auditing Standards. Our responsibilities under those standards are further described in the *Auditor's responsibilities for the audit of the Financial Report* section of our report. We are independent of the registered entity in accordance with the auditor independence requirements of the *Australian Charities and Not-for-profits Commission Act 2012* (ACNC Act) and the ethical requirements of the Accounting Professional and Ethical Standards Board's APES 110 *Code of Ethics for Professional Accountants (including Independence Standards)* (the Code) that are relevant to our audit of the financial report in Australia. We have also fulfilled our other ethical responsibilities in accordance with the Code.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Responsibilities of responsible entities for the Financial Report

The responsible entities of the registered entity are responsible for the preparation and fair presentation of the financial report in accordance with Australian Accounting Standards – Simplified Disclosures and the ACNC Act, and for such internal control as the responsible entities determine is necessary to enable the preparation of the financial report that is free from material misstatement, whether due to fraud or error.

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In preparing the financial report, responsible entities are responsible for assessing the registered entity's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the responsible entities either intends to liquidate the registered entity or to cease operations, or has no realistic alternative but to do so.

The responsible entities of the registered entity are responsible for overseeing the registered entity's financial reporting process.

Auditor's responsibilities for the audit of the Financial Report

Our objectives are to obtain reasonable assurance about whether the financial report as a whole is fre from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that ar audit conducted in accordance with the Australian Auditing Standards will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of this financial report.

A further description of our responsibilities for the audit of the financial report is located at the Auditing and Assurance Standards Board website (http://www.auasb.gov.au/Home.aspx) at:

http://www.auasb.gov.au/auditors_responsibilities/ar4.pdf

This description forms part of our auditor's report.

BDO Audit (TAS)

BDO Audit (TAS)

David E Palmer
Partner

Hobart, 27 October 2023

BLUE ECONOMY
COOPERATIVE RESEARCH CENTRE

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