BLUE ECONOMY
COOPERATIVE RESEARCH CENTRE

Australian Government
Department of Industry, Science, Energy and Resources

AusIndustry
Cooperative Research Centres Program

SHORT SUMMARY

3.20.002 Offshore/High Energy Sustainable Hybrid Power Systems

KEY POINTS

- More market-oriented research and closer collaboration between the Blue Economy CRC and relevant industries, organisations and government are required to support the progress of offshore renewable energy in Australia.
- The flagship demonstration project to build a hydrogen microgrid offshore is a vehicle for drawing together the wide-ranging capabilities within the BE CRC relating to offshore engineering, renewable energy, markets, analysis, risk and modelling.
- In view of the early stage of development of offshore renewable energy systems, careful consideration of risk is needed to support the successful completion of the demonstration project.
- In seeking to reduce complexity, cost and risk, adoption of commercialised technologies is advised, where possible.
- Realistic modelling is essential for risk mitigation at every stage of such a project from concept to implementation.
- A team of 29 researchers from ten BE CRC partner organisations contributed to this project.

THE CHALLENGE

Energy is fundamental to the growing blue economy, for powering industries located offshore, for shipping, for supply to onshore energy grids, and for export. At present most of the blue economy relies on fossil fuels. The need to limit emissions within and improve the sustainability of the blue economy is increasingly being recognised.

This recognition is seeding activity internationally to identify optimal solutions to meet the resource needs of offshore industries and harness the available energy resources sustainably, with technological readiness, reliability, survivability and economics all posing significant challenges.

According to the Department of Industry, Science, Energy and Resources, there are currently no offshore renewable energy projects in Australia, and there is no legislation in place to support their development, although the Offshore Clean Energy Bill was due to be introduced in 2020, and The Star of the South project to build the world's biggest wind farm in Bass Strait has received an exploration licence. Offshore energy is at the very beginning of its development in Australia.

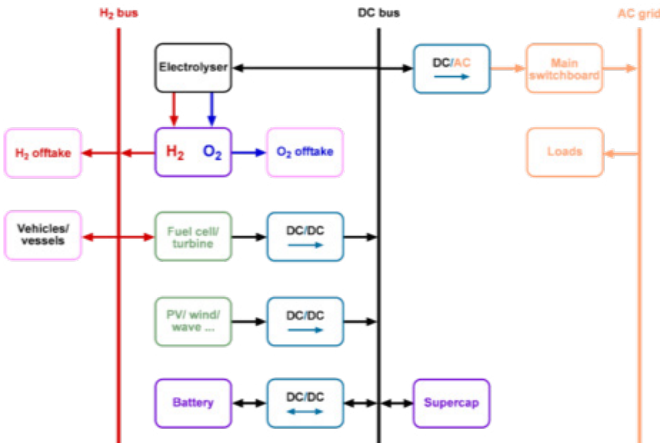

Figure 1. Hydrogen microgrid.
Figure courtesy of Evan Gray.

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

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THE OPPORTUNITY

Abundant renewable energy resources are available in the offshore environment: solar, wind, wave, currents, tidal flows, thermal gradients and salinity gradients. Electricity generation by offshore wind is the most advanced technology in terms of availability and cost of energy supplied.

According to the International Energy Agency (IEA), the potential for offshore wind is 36,000 TWh of electricity per year for installations in water less than 60 metres deep and within 60 km from shore, which is more than 150% of the present global annual electricity demand.

IEA analysis predicts that in Australia, based on near-term costs, 1000 GW of generating capacity is available at less than about AUD0.13 per kWh, compared to Australia's average electricity consumption of about 24 GW. The potential for export is huge, particularly when conversion to hydrogen is included. Because other energy capture and conversion technologies for the offshore environment lag behind wind, opportunity exists for the development and manufacture of novel devices to harness other resources, such as wave energy, that are abundant around the Australian coast.

OUR RESEARCH

The underlying theme of the project was the linking of devices for energy capture, storage and end use by means of electricity and hydrogen into a hydrogen microgrid. This is an electricity microgrid with a second energy carrier - hydrogen - embedded. An electrical architecture and control system are employed to integrate the sources of electricity with storage and other generation devices,

providing reliable electricity to the load and hydrogen (and as appropriate oxygen and fresh water) for associated end uses. The concept is scalable from a small off-grid system to support telecommunications, for instance, to an entire hydrogen export enterprise.

Objectives

The objectives of the scoping project were:

1. To clarify the numerous challenges associated with
   - employing renewable energy conversion technologies offshore;
   - building hydrogen microgrids that are robust in this environment;
   - modelling the components of a hydrogen microgrid and the entire energy system.
2. To identify clearly the strategic strengths of the CRC capability aligned with Research Program 3, capture lessons learned from prior national and international projects, provide guidance as to how to tackle the challenges and thereby identify strategic priorities over the first several years of the CRC.

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Methodology

The study focused on four main tasks:

1. Review offshore renewable energy conversion technologies, providing perspective on current status, concentrating on technologies at Technology Readiness Level 6 and higher.
2. Review microgrid architectures suitable for offshore deployment, encompassing control system, storage (other than hydrogen storage, which is covered by Scoping Project P.3.20.002: Hydrogen Storage and Distribution), and other end-product requirements.
3. Review software models for the components of offshore renewable energy systems, including in addition to the standard devices for energy capture, electrolysers, oxygen and hydrogen storage, fuel cells, microturbines and desalination plant.
4. Identify priority opportunities that play to the strengths of the Blue Economy CRC, and capture lessons learned from similar international programs.

OUTCOMES

The review of technologies for offshore renewable energy pointed to the need for more research to better understand where the market opportunities for offshore renewable energy developers lie in Australia; identify end user requirements and which technologies best meet these requirements; identify the technical, commercial and legislative gaps hindering these opportunities from developing; and towards closer collaboration with ORE-related industries, organisations and government to investigate market opportunities and support development.

Risks associated with designing and building offshore renewable energy systems based on microgrids were identified and recommendations for mitigating these risks were made.

The need for realistic modelling at every stage of a project was identified.

Significant relevant capability across nearly the entire CRC was identified. The flagship demonstration project to build an offshore hydrogen microgrid is a vehicle for drawing together this capability to develop and demonstrate solutions to the challenges associated with offshore renewable energy technology.

NEXT STEPS

The outcomes of this scoping study are to be synthesised, along with the results of all initial scoping studies, to support the establishment of a phase 1 research plan for the Blue Economy CRC. There are several areas of ongoing research recommended in the study and captured in the final report.

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PROJECT REPORTS/PUBLICATIONS

Gray, E.MacA. et al. (2020). Offshore/High Energy Sustainable Hybrid Power Systems, P.3.20.002 – Final Scoping Project Report. Launceston: Blue Economy Cooperative Research Centre. 36 pp plus technical appendices.

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