

# HySeas III

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## INSIDE THIS ISSUE

1. Introduction
2. Ship Design
3. Webinars
4. Final Workshop

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## Consortium Partners



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## Introduction

After the launch of the string test, the actual testing of the system went ahead at a frenetic pace and was completed by February 2022. At the same time work was also proceeding on the ship design with the design having progressed sufficiently to carry out a hazard identification workshop (HAZID) in January 2022 after which modifications needed to be made to the design in order to address or mitigate some of the hazards that had been identified.

Two further webinars were held, one in April on the whole lifecycle analysis work that had been carried out in Work Package 6, and a hybrid one in May held at Ballard's premises in Hobro, Denmark, on the topic of safety.

The final workshop of the project was held in Edinburgh in June 2022, with good in-person attendance from a wide variety of stakeholders, and lots of discussions and questions.

As we look back over the project, there have been several important achievements to highlight:

1. First scalable marine DC-DC system architecture for fuel cells, batteries, and generators with customised power management
2. First demonstration and detailed testing of 6 fuel cells and 4 battery strings working together in a marine configuration, and including implementation of extensive safety systems
3. Detailed whole lifecycle analysis comparing fuel cell battery ferry with other fuel/propulsion solutions

## Ship Design

CMAL worked with ABL (AqualisBraemar LOC Group) to develop the ship design in order to obtain Approval-in-principle certification.

Prescriptive regulations for hydrogen and fuel cell powered ships are either missing, or still in their infancy, however a risk based design and approval framework is used by the regulatory authorities in such cases. The burden of proof to demonstrate adequate safety is of course much higher, and therefore more time consuming and costly.

A key part of a risk based design process is the hazard identification workshop, where a workshop facilitator and group of experts examine the ship design and specific subsystems and try to identify and then quantify the risks of possible hazards. Once this is done, mitigations are proposed to reduce the risks of the worst hazards, to bring them to a tolerable level.

One of the more tangible results of this process was the move of the hydrogen storage from below deck, adjacent to the wheelhouse. In order to accommodate this, the wheelhouse was offset to one side.

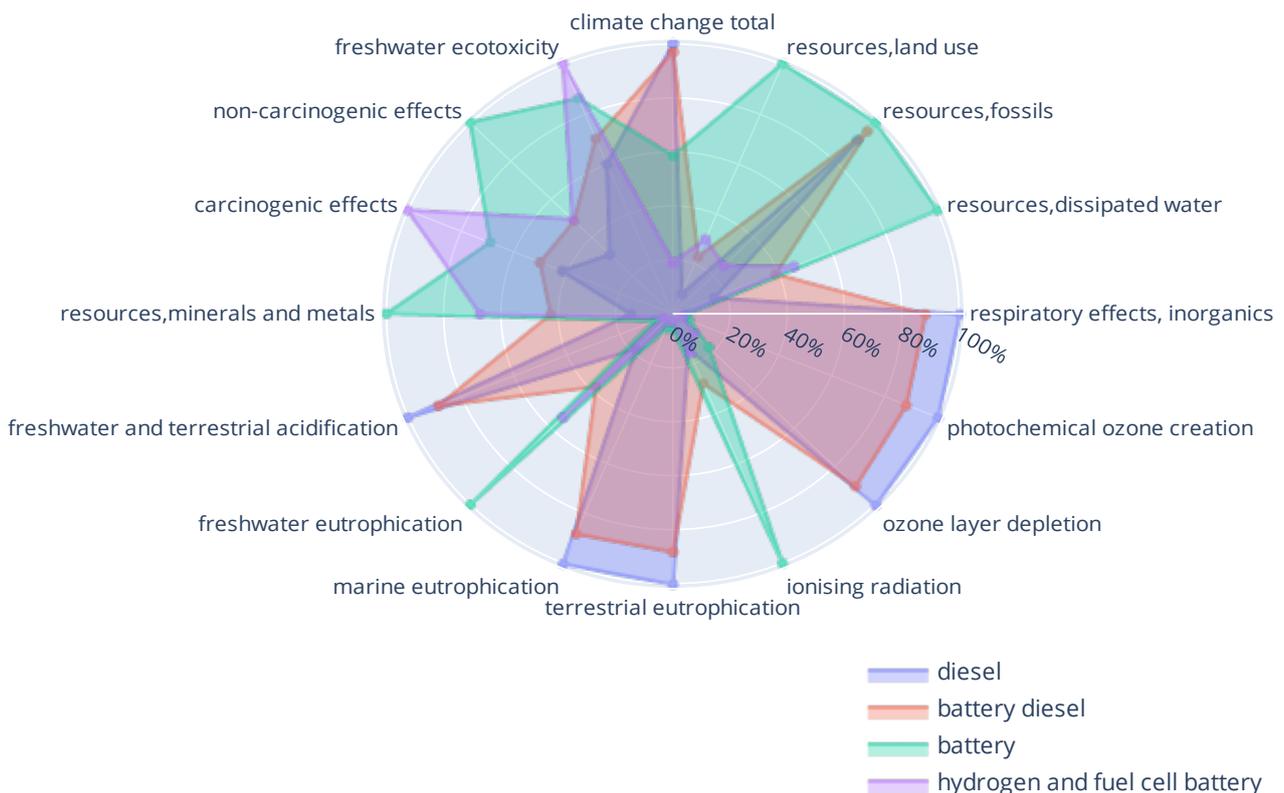
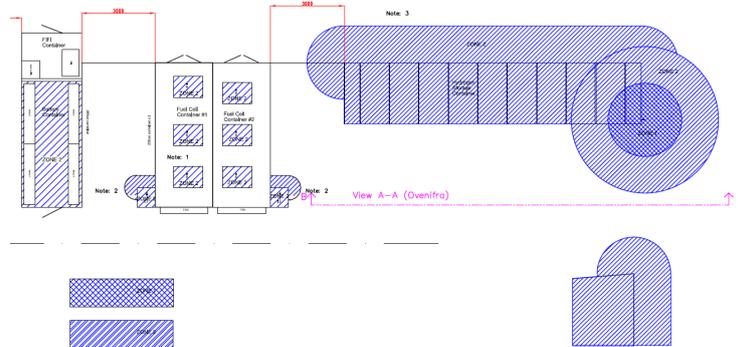
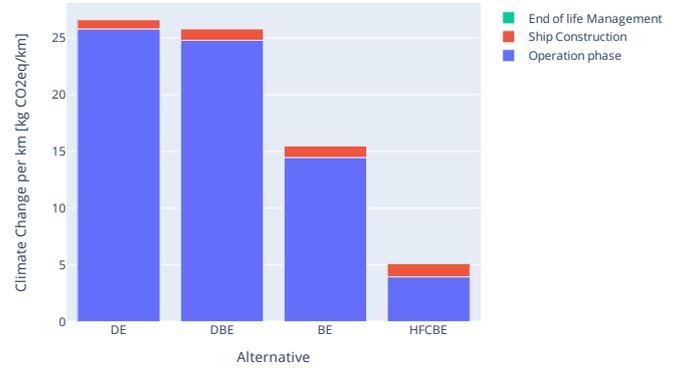


## Webinars

Two webinars were held in April and May to disseminate specific outcomes of the project – the first covered Lifecycle assessment, providing first an overview of what it is, using ISO 14040 as a basis, how it is applied and why it is useful, and also taking in current discussions at the IMO on LCA for marine fuels. The full LCA work carried out in the project was then presented, comparing a hydrogen fuel cell battery ferry with a battery electric ferry, hybrid battery and diesel ferry and a diesel electric ferry, showing clear benefits for the fuel cell ferry from a climate change perspective, but worse impacts in some other sustainability categories.

The second workshop covered safety issues and safety lessons learnt during the project, particularly in setting up and running the string test, as well as designing the ship to a risk based framework, and ending with the hydrogen training course developed at Orkney College.

Both workshops were recorded and may be accessed on Youtube – [LCA](#) and the 4 segments of the safety workshop, [string test](#), [ship design](#), [fuel cell](#) and [training](#).



## Final Workshop

The final workshop of the project was held on 15 June 2022 in the Wolfson Lecture Theatre at the Royal Society of Edinburgh. Attendees represented a wide range of stakeholders, including UK and Scottish policymakers, oil and gas companies, consultancies, academia, regulators, class societies, ports and shipyards.

There were many questions from the attendees that provoked extensive discussion during the sessions and coffee breaks, lunch and evening networking.

The order of events is as below, together with links to the presentations.

Topic	Speaker
<a href="#">Introduction to Hyseas III</a>	Martin Smith – Uni St Andrews
<a href="#">Hydrogen Territories Platform – Sharing Lessons Learnt</a>	Nigel Holmes - SHFCA
<a href="#">Market Potential</a>	Juan Camillo Gomez - DLR
<a href="#">Cost Implications and Policy Development</a>	Martin Smith – Uni St Andrews
<a href="#">Marine Fuel Cells and Projects</a>	Kristina Juelsgaard - Ballard
<a href="#">Orkney Marine Hydrogen Experience</a>	David Hibbert – Orkney
<a href="#">Hydrogen Fuel Cell-Battery Power String Test Outcomes</a>	Hans Westad/Lars-Petter Nygaard – Kongsberg
<a href="#">Risk Based Vessel Design</a>	Declan MacDonald – CMAL
<a href="#">Fuelling Infrastructure</a>	Klara Vanderkerkhove – McPhy
<a href="#">Lifecycle Analysis</a>	Juan Camillo Gomez - DLR
<a href="#">Training</a>	Mark Shiner – Orkney College

