FreeCo2ast project

SFI Smart Maritime Final Conference – June 20th

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HAV GROUP ASA: Enabling the green transition at sea

- International provider of green technology and services for maritime industries
- Vision: A sustainable future at sea
- Comprises four subsidiaries with several decades of combined industry experience
- Special expertise in guiding the marine and maritime industries towards zero emissions

HAV hydrogen

FreeCO2ast Project and Partners

HAV Group ASA and consortium partners was awarded a **Pilot E** development project for **large scale maritime hydrogen** application in 2018

The project has been running for 4,5 years with focus on **knowledge building, system design and approval** of a scalable maritime hydrogen solution.

Cooperation agreements with Powercell and Linde

Havyard Group ASA | HAV design | HAV hydrogen | norwegian electric systems | HAVILA Kystruten | Clara Venture Labs | SINTEF

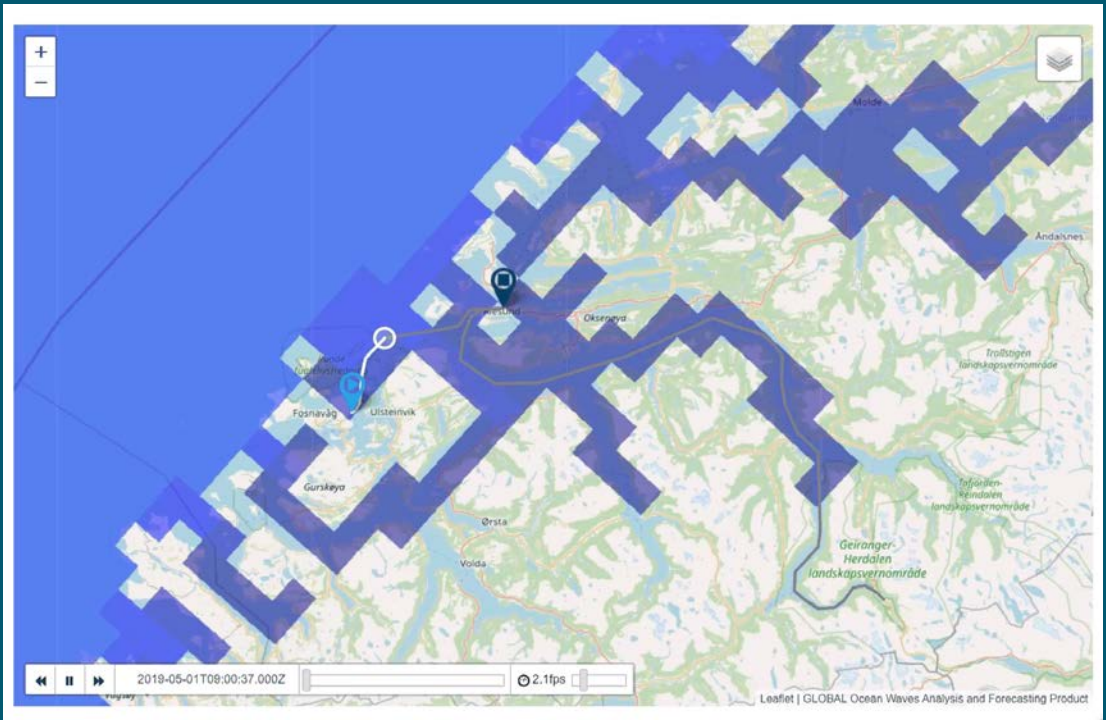
HAVhydrogen

Project Work Packages

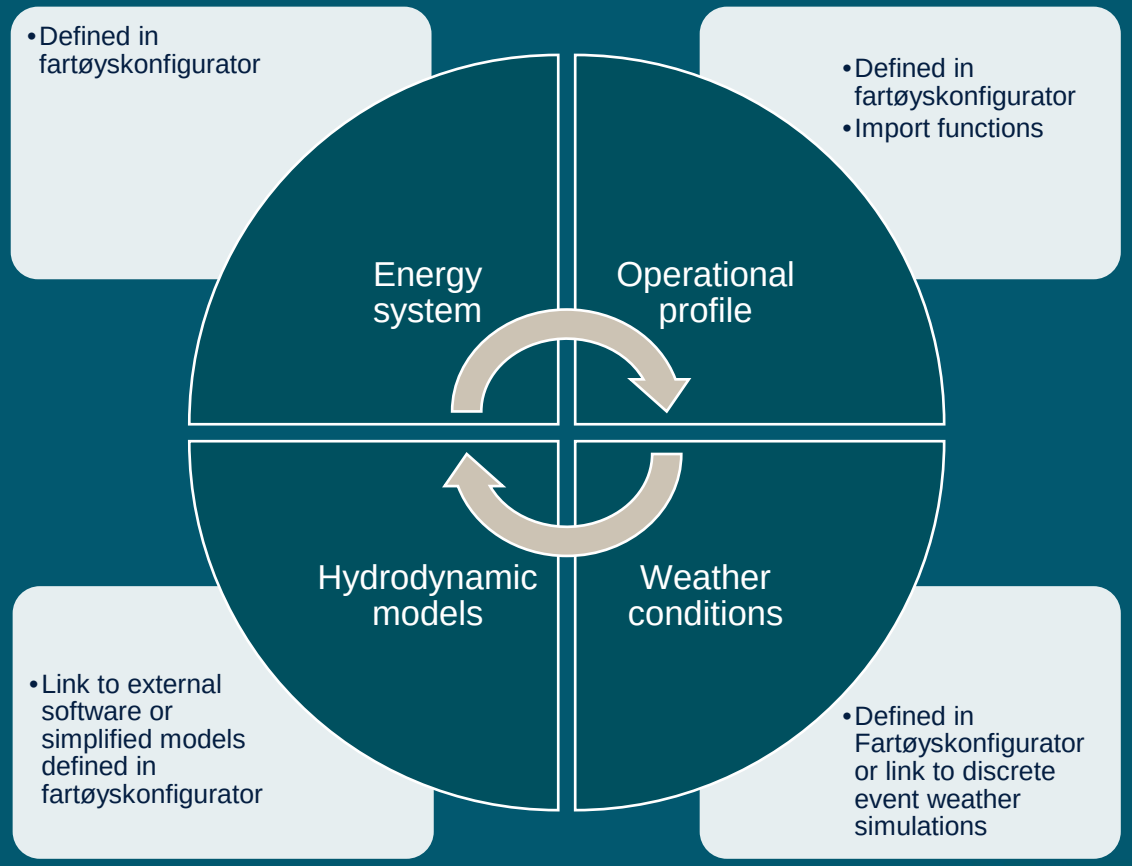
WP1	Efficient system design	• Development of Vessel configurator and simulation models for advanced propulsion systems with fuel cells, batteries and internal combustion engines
WP2	Reliable hydrogen technologies	• Evaluation of fuel cell technologies and suppliers and development of fuel cell model
WP3	Verification and validation methodology	• Development of time domain simulations based on Integrated Simulation Sandbox • Test and validate models and components by the X-in-the-loop method
WP4	Feasibility study of bunkering logistics and energy harvesting technologies	• Evaluate potential in bunkering opportunities for the Coastal Route • Evaluate energy harvesting and potential to maximize zero-emission operation
WP5	Vessel and system design	• Design of retrofit hydrogen energy system • Alternative Design approval process with NMA and DNV
WP6	Realization; installation, commissioning and testing	• Implement, install and commissioning of energy system on board.
WP7	Market analysis of zero-emission solutions	• Market analysis to map future market potential for the technologies developed in the project. • Big data analysis for maritime yearly reports to investigate investment sentiment
WP8	Project management	• Project Management

Vessel Configurator

Configuration tool that enables to quickly simulate and test several configurations for a complete ship operation in a relevant environment:



Important tool for HAV in all of our ship segments in order to validate energy reducing measures in relevant conditions



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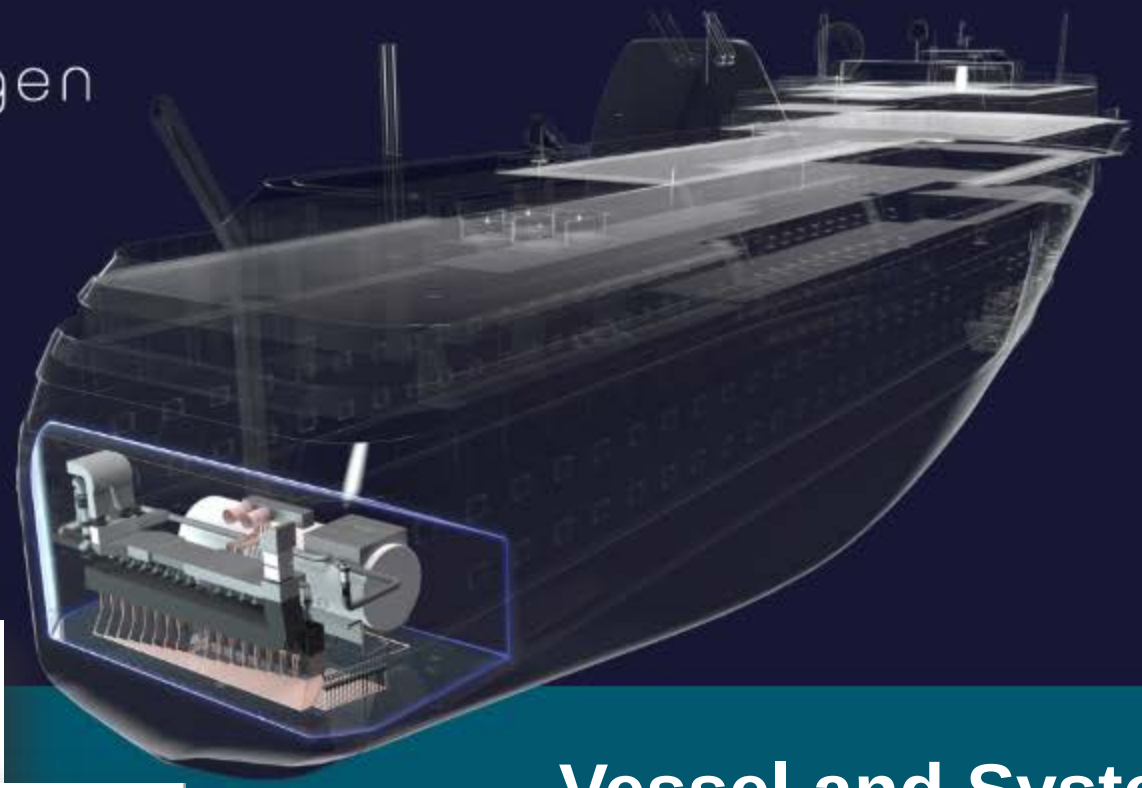


DNV

STATEMENT OF PRELIMINARY APPROVAL

Particulars of Product

Customer: HAV Group ASA

Concept: Liquefied hydrogen fuel system for Havyard 923 design

This is to verify:

Basis for Preliminary Approval

Conditions for Preliminary Approval

Sjøfartsdirektoratet
Norwegian Maritime Authority

HAVYARD GROUP ASA
Holmefjordvegen 1
6090 FOSNAVÅG
Norway

FREECO2AST - Statement of preliminary assessment of an alternative design using hydrogen as fuel

Introduction

Statement

Legal Basis

Basis for the statement

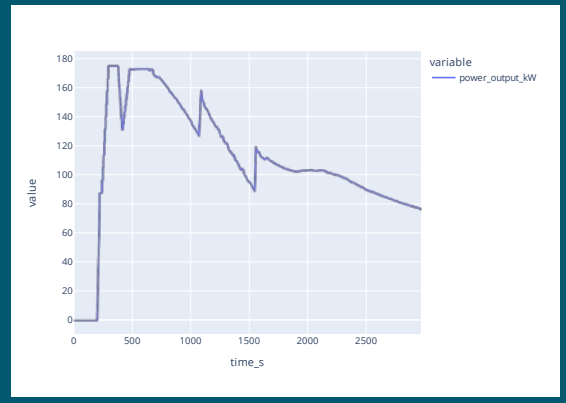
NISNOR

Vessel and System Design

- Retrofit module added to the aft of the ship
- Integration, Barriers and Safety Concept and Approval, HAV
- 3,5 Ton LH2 under deck, Linde
- 3,2 MW Fuelcells, Powercell

Validation of fuelcell model and X in the loop

- Test run of NES electrical drives and control system against the Powercell fuelcell installed at Sustainable Energy NCC in Stord.
- Produce data for validation of data in fuel cell simulation model
- Run fuel cell according to relevant loads simulated by WP3 tool. (X in the loop)



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Project effects and further work

- Broad knowledge development throughout the Project Consortium on hydrogen technology and **design of ships for alternative fuels**
- Expanded toolbox for **simulation driven ship design** to evaluate technologies and systems in a realistic environment.
- Obtained approval and knowledge development for the A**lternative design process** and risk analysis methodology
- Contribution in raising of **Technology readiness level** for maritime fuelcell, storage tanks, control systems
- Elaboration of pressurized H2 logistics, live testing and validation of simulation models