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FreeCo2ast project

SFI Smart Maritime Final Conference – June 20th Kristian Osnes, HAV Hydrogen

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

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



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🔗 Kystruten





Project Work Packages

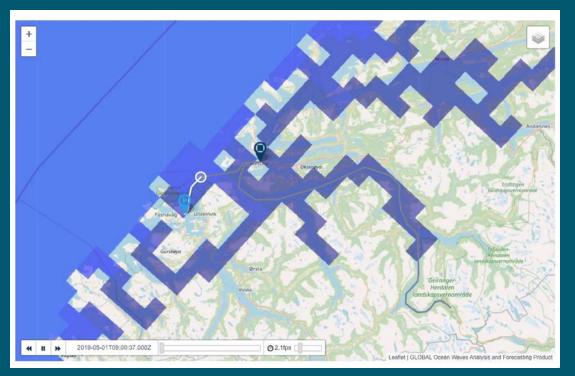
WP1	Efficient system design	 Development of Vessel configurator and simulation models for advanced propulsion systems with fuel cells, batteries and internal combustion engines
WP2	Reliable hydrogen technologies	Evaluation of fuel cell technologies and suppliers and development of fuel cell model
WP3	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

Project management WP8

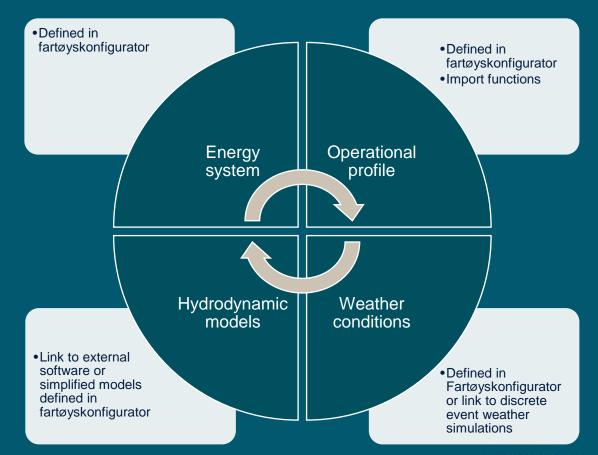
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Vessel Configurator

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

Particula HAV Group ASA Customer Concept Liquefied hydrogen fael system for Havyard 923 design This is to verify that the gas fuel system has been assessed by DNV an the Society and applicable statutory regula Sjøfartsdirektoratet Our date 05.05.203 Our reference 2021/20944-20 Basis for Preliminary Approval File no 57/029477 he documentation specified in letter M-SA-CL/MOAL/P compliance with the safety principles of DNVGL Rules PL6 Ch.2 Sec.5 'Gas Fueled Ship Is AVVARD GROUP AS Holmefjordvegen 1 6090 FOSNAVÅG DNUCE Rules Pt 6 Ch 2 Sec 3 Fuel cell installator MO IGF Code The approval process has followed the IMO guidelines guired by IOF Code 2 3/SOLAS Regulation II-1/55. FREECO2AST - Sta of preliminary assessment of an alternative design using Conditions for Preliminary Approval hydrogen as fuel The acceptance of the liquelled hydrogen gas · The conditions for preliminary approval are give assenger ships operated by "HAVILA KYSTRUTEN AS". Since hydrogen as fuel is not specifically addressed by Gif code, this system shall be subject to an alternative design process according to IGF Code Part A Reg. 2.3.3 Before construction and installation onboard and (Alternative design) set of documentation minuted for the particula The Norwegian Maritime Authority (NMA) confirms that the alternative design is consider MSC.1/Circ.1455 paragraph 4.10.1 with a set of conditions listed in appendix 1 to this stat Legal Basis The preliminary Place: Oslo Date: 2022-05-13 Regulations of 27 December 2016 No. 1883 on shi IGF code IMO Res. MSC.391(95) Part A

using fuel with a flashpoint of less than 60 SOLAS II-1 regulation 55 MSC 1/Circ. 1455 Guidelines for the approval of all

e NMA has reviewed the hydrogen fuel system according to MSI ary design docu

The issue of a statement of preliminary assessment by the NMA does not imply that final approval will and it is issued along with a set of confitions (see appendix 1 for details). These conditions outline the requirements and necessary tasps that will be required in order to achieve a final approval.

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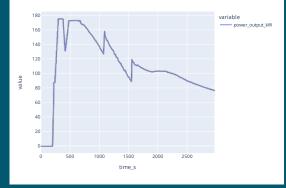
Vessel and System Design

- Retrofit module added to the aft of the ship ٠
- Integration, Barriers and Safety Concept and Approval, HAV •
- 3,5 Ton LH2 under deck, Linde \bullet
- 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 Alternative 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

