Update of the Use of NH3 in the National Maritime Transport

Universidad Austral de Chile
Conocimiento y Naturaleza

2nd LATAM MEETING ON GREEN AMMONIA AND POWER-to-X

THEMS
Test-bench for Hybrid Electric Marine System

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Contenido…

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- When to Start Using NH_3
- From Conventional Fuel to NH_3
- THEMS and the Integration of NH_3
- Conclusions
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Introduction

Introduction – Decarbonization

2021 – Fossil Fuels

- MDO – MGO
- HFO – IFO
- LS – VLS – ULS Fuels
- LPG (Propane/Butane)
- LNG – CNG
- Methane
- Methanol
- Ethanol
- Butanol
- Biodiesel - WDO
- Ammonia "NH_3"
- Green Hydrogen "GH_2"

2018 – Initial IMO Strategy on Reduction of GHG Emissions from Ships

- Short-term measures by 2023
- Mid-term measures
- Long-term measures

2030 – Alternative Fuels

- e-Fuels
- e-Methanol
- Biofuels
- eNH$_3$
- GH$_2$

2030 – Mid-Term Measures

- Alternative Fuels
- EEXI and CII Strengthens… 2024

2050 – Zero Carbon Fuels

- NH_3
- GH_2

2050 – Long-Term Measures

- Zero Carbon Fuels

Zero GHG Emissions…. As soon as possible in this century.

Introduction – Update

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- From the IMO is the consideration of NH3 as a fuel, therefore the International Code of Safety for Ships Using Gases or Other Low –Flashpoint Fuels “IGF Code” can be used to assessed the safety and conditions to storage, manipulate and use on board vessels.
- From the Classification Societies… New Standards.
  - For the design & construction of vessel above 400 GT.
  - For the design & construction of tanks.
  - For the safety considering HAZID/HAZOP.
- From the Governments
  - NH3 as a fuel not as a dangerous substance.

Table 1. Summary of the IMO’s short-, mid-, and long-term measures.

Measure	Timeline	Technologies and Energy Source
Short-term	2018–2023	Improvements in EEDI, EEXI, CII, and SEEMP Address emissions other than CO_2 Shoreside power supply from RESs Research and development of the propulsion system Research into alternative fuels (AFs)
Mid-term	2023–2030	Implement alternative low-carbon and zero-carbon fuels Improve the efficiency of new and existing ships A selection of GHG reduction measures that compromise a goal-based marine fuel standard and economic element Informed policy-making Incentives for first movers Port development
Long-term	Beyond 2030	Development and provision of zero-carbon fuels Adoption of new emissions reduction mechanism

Introduction – Update

- From the Chilean Government
  - Specifically, from the Ministry of Energy
    - The Green Hydrogen Action Plan 2023-2030
  - From the Chilean Navy
    - National Continuous Naval Construction Plan
    - General Strategy of the Maritime Administration of Chile related to how to effectively implement the IMO instruments.
    - Three tenders related to:
      - The Technology Innovation Center for the Maritime Industry and Green Hydrogen.
      - The Study for the Development of the Business Case for the Retrofit of a General Service Boat for the Use of Carbon Neutral Fuels… MeOH, DME and Synthetic MDO.
      - The Maritime Energy Transition 2050, Roadmap Towards Net Zero.

Table 3. Alternative fuels.

AF						
Gaseous	**Liquid**	**Low-Carbon**	**Zero-Carbon**	**Carbon Factor (CF) g_CO_2/g_Fuel**	**Low Heat Value (LHV) MJ/kg**	**Density kg/m^3 kg/L**
LNG		x		2.755	47.1	0.777
LPG		x		3.030	45.5	0.537
CH_4		x			50.0	0.716
	C_2H_6O	x		1.913	26.7	0.789
	CH_3OH	x		1.375	19.9	0.791
	C_4H_9OH	x			34.4	0.810
	Biofuels	x			37.8	0.920
	Waste-derived oil	x				
	Emulsified fuel		x			
H_2			x	-	120.0	0.090
NH_3			x	-	22.5	
Electricity		x	x			

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Table 4. Baseline of available technology and AFs.

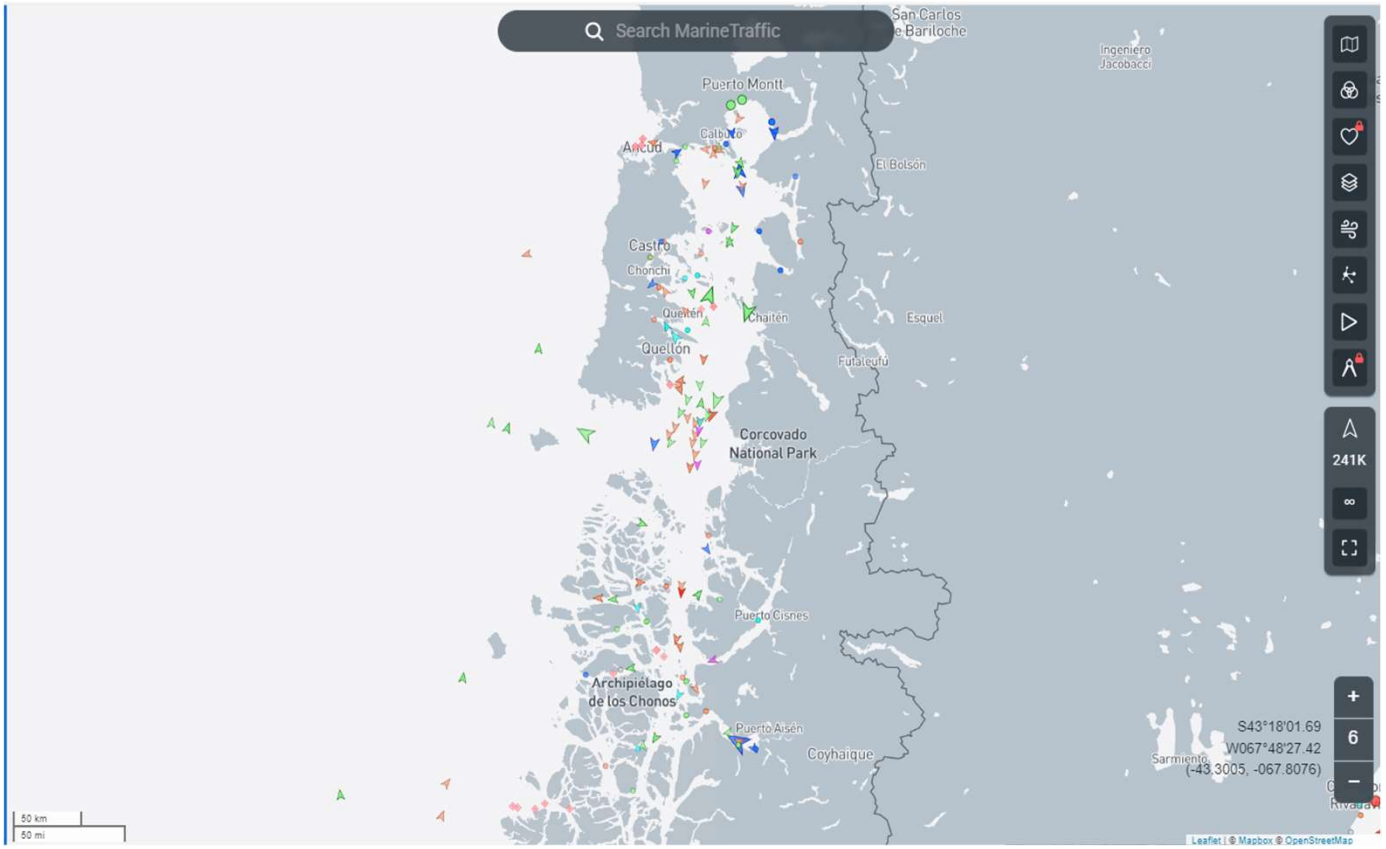
Technology and AF	Availability	AF		Chilean Merchant Fleet: 250	Applicability for Cabotage: 26,000
		H_2	NH_3		
2S DFE	2026	x	yes	yes	yes
4S DFE	yes	yes	yes	yes	yes
FC		yes	yes	yes	yes
H_2		-	-	yes	yes
NH_3				yes	yes
Regulations	progressing	yes	no	no	no

When to Start Using NH_3

From Conventional Fuels to NH3

- ~105.000 vessels in the World Merchant Fleet.
  - Bulk carriers, tankers, containerships, cruise ships, car carriers, to name a few.
  - Burning fossil fuels such as IFO and MDO/MGO.
  - & alternative low carbon fuels such as LNG, LPG, MeOH, Ethanol, Biofuel, NH3, H2, Electricity.
- 5.000 GT but now is 400 GT to be considered to apply the IMO regulations about Emissions.
- ~250 in the National Merchant Fleet and ~200 in the Cabotage Fleet from more than 88.000 registered vessels.
  - Burning fossil fuels such as IFO and MDO/MGO and in some cases having scrubbers to abate emissions.
- ~28.000 small vessels in service… less than 400 GT from the IMO and less than 100 GT from the Chilean Maritime Authority.

From Conventional Fuels to NH3



- 3.365 operating in the southern area of Chile but 1.576 supporting the operation and service of the aquaculture industry.
- 342 supporting the aquaculture in general… mostly barges and 86 supporting the salmon industry specifically.
- The rest of the fleet considers: 213 fishing vessels, 67 wellboats, 650 registered naval artifacts, and 73 tugboats.

From Conventional Fuels to NH3

Nuestras Barcazas - Naviera Austral (navieraustral.cl)

Don Sebastian - Frasal

PATAGON X - ASENAV (webdemos.cl)

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From Conventional Fuels to NH3

Dra Barbieri… Research Vessel

Tugboat in Puerto Chacabuco

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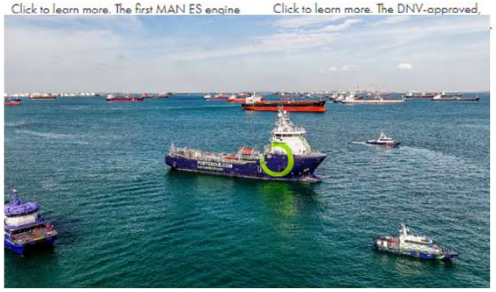
When to Start Using NH3?

Click to learn more. The first MAN ES engine

Click to learn more. The DNV-approved,



PSV bunkers and trials ammonia as fuel in Singapore

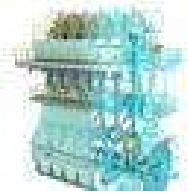
Click to learn r
transfers fuel
USA. Sumitom
explore the sup
for Höegh's
Jacksonville an

Click to learn more. H2SITE has validated its ammonia cracking technology onboard the
ed along the
uring the tests.

world-first ammonia PCTC newbuilds

Design of the A-Tug ammonia powered tugboat set to operate in Japan (source: NYK)

Successful ammonia STS trial in South Africa



WinGD
X-DF-P
NH3/LPG

Japanese Consortium Targets 2026 For First NH3-Fuelled Gas Carrier

The Kraken tugboat 1957

Tests completed on world's first four-stroke ammonia engine

When to Start Using NH3?

PURUS COMPLETES SHIP-TO-SHIP AMMONIA TRANSFER

NYK takes delivery of latest dual-fuel LPG carrier

Hyunday Heavy Industries Class approval granted for dual fuel, four stroke engine

When to Start Using NH3?

- From the International Fleet… already using it because government with their own roadmaps and national strategies considering NH3 as fuel.
- Available and applicable to merchant vessels and to small vessels.
- How to decide when and how to use NH3 in the shipping industry?
  - Availability?
  - TRL?
  - Energy Matrix?
  - Bunkering Infrastructure?
  - Safety?
  - Reduce the CO_2 footprint?

Viking Energy 2003
World's first LNG cargo vessel
2016: First BATTERY POWER hybrid
2018: Shore Power
2020-2024:ShipFC Ammonia project

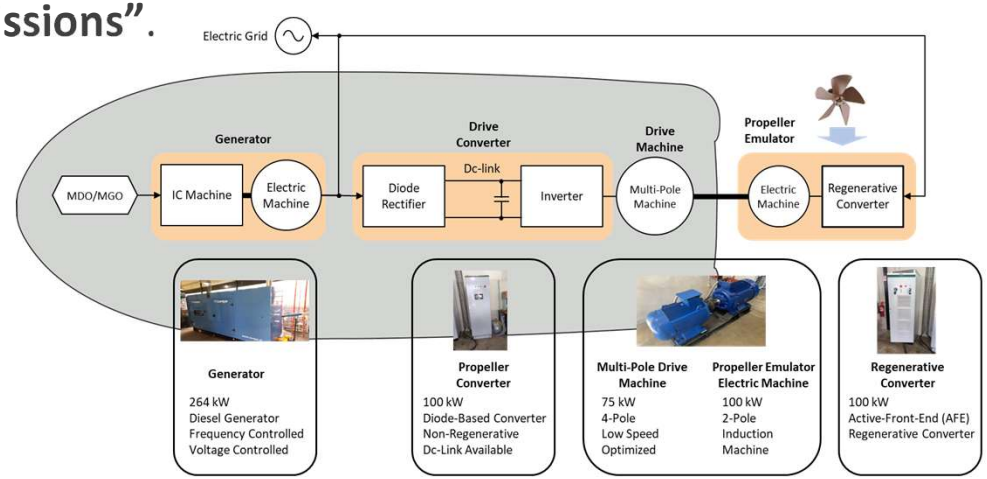
Viking Energy with ammonia-driven fuel cell – Eidesvik

THEMS and the Integration of NH_3

THEMS and the Integration of NH3

THEMS
Test-bench for Hybrid Electric Marine System

- What's THEMS… **Test-Bench for Hybrid and Electric Marine System.**
- Is the results of a Fondef Project called **"Development of a Scalable Hybrid Propulsion Plant that enables the Maritime Electromobility and the Control and Reduction of Emissions"**.



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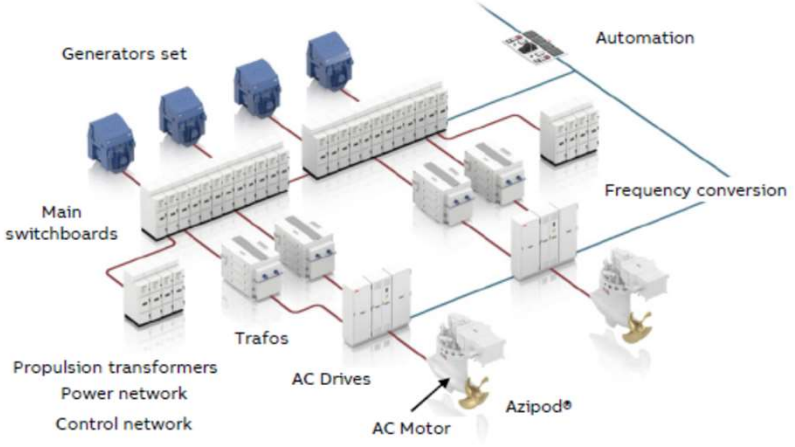
THEMS and the Integration of NH3

- General Objective is to **Decarbonize the Chilean Shipping Industry through Applied R&D**.
- Moving from **EE measurements** as the baseline to improve the efficiency of **existing ships** to achieve emissions reductions.
- Moving from **Conventional Propulsion Systems** consuming fossil fuels to **Non-Conventional Propulsion Systems** consuming alternative low-carbon and zero-carbon fuels. **NEW & EXISTING SHIPS.**

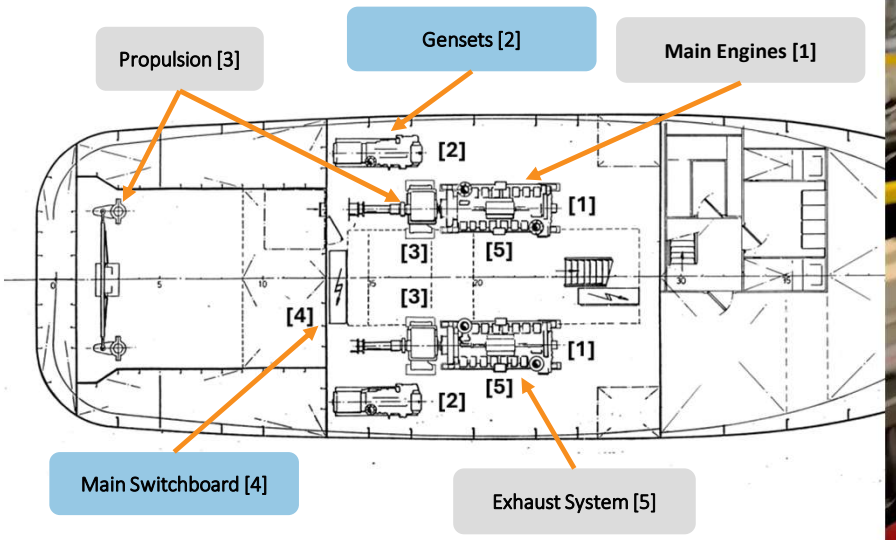
Electric, Automated and Digital solutions for the marine industry | ABB

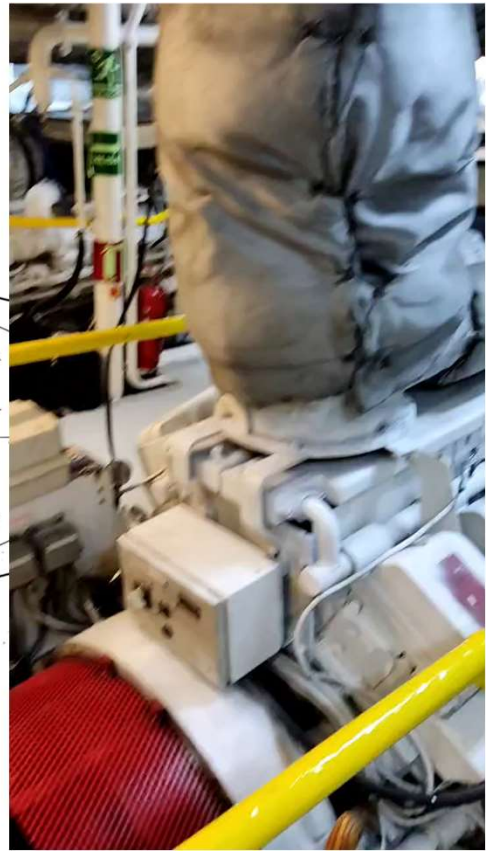


THEMS and the Integration of NH3

- Works as an Integrator of Technology. **Batteries, PEM FC, SOFC, Supercapacitors, PV, Luminescence Concentrators…**
- Integrator of Alternative Fuels. **Biofuels, Emulsified Fuels, MeOH, DME, Pyrolysis Fuels, H2, LNG, LPG, NH3…**
- A baseline from where to start to Decarbonize the National Shipping Industry. **Tugboats Fleet, Barges, Ro-Ro Ferries…**
- A laboratory to teach and train the present and future marine engineers and naval architects. **3 MSc, 3 Undergrads, 16 Current Undergrads.**

THEMS and the Integration of NH3





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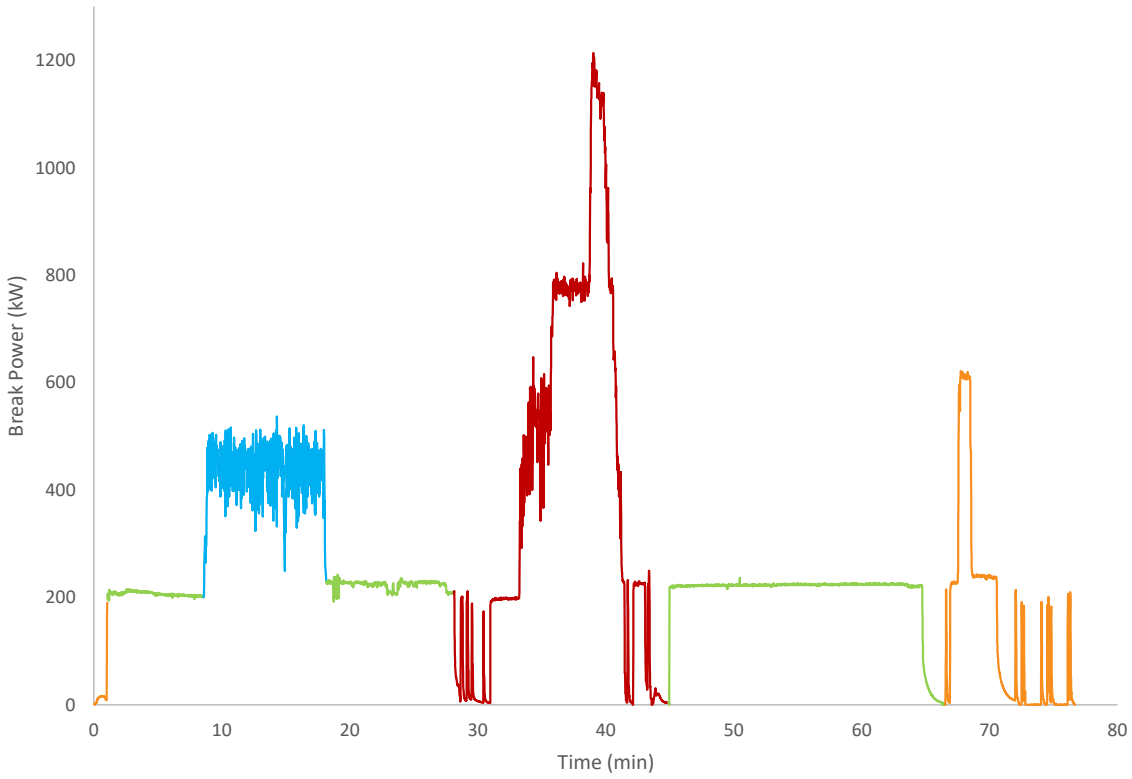
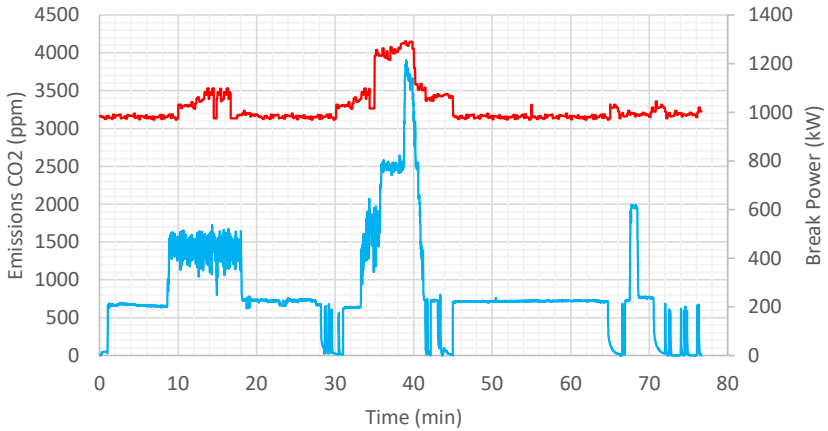
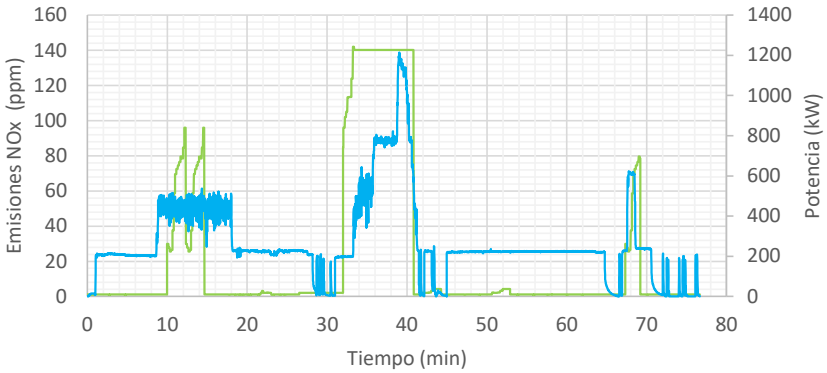
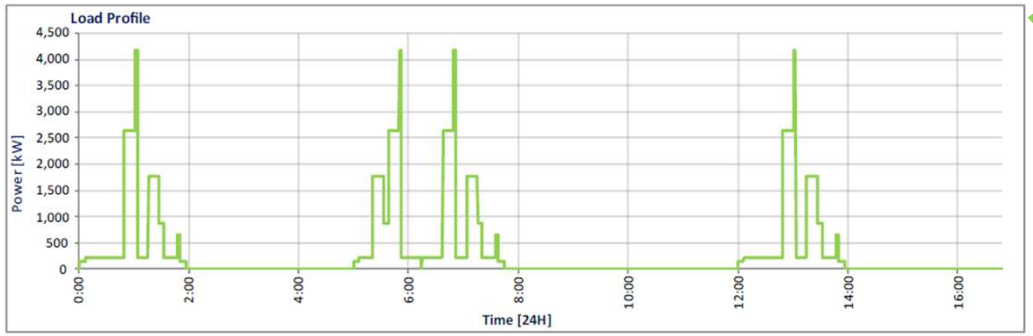


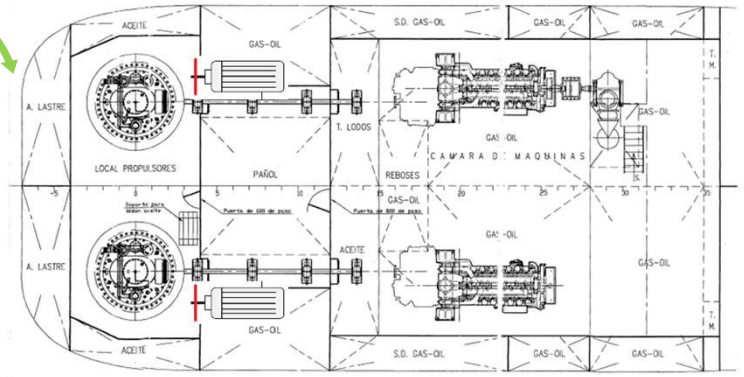


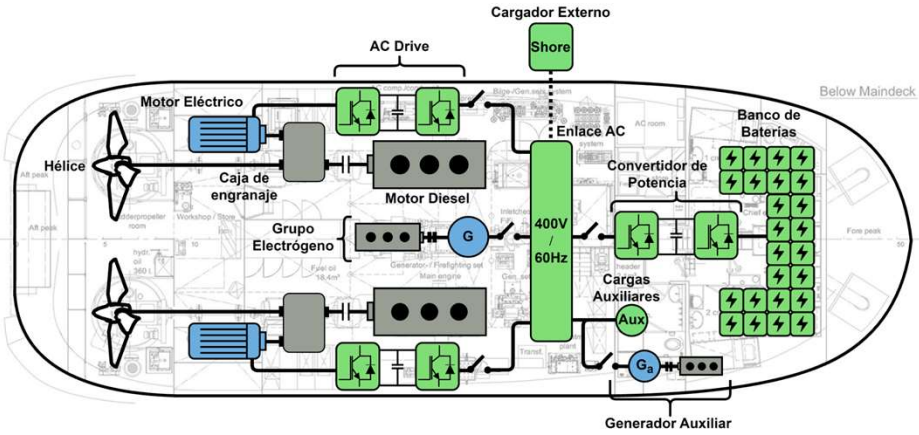


THEMS and the Integration of NH3

THEMS
Test-bench for Hybrid Electric Marine System







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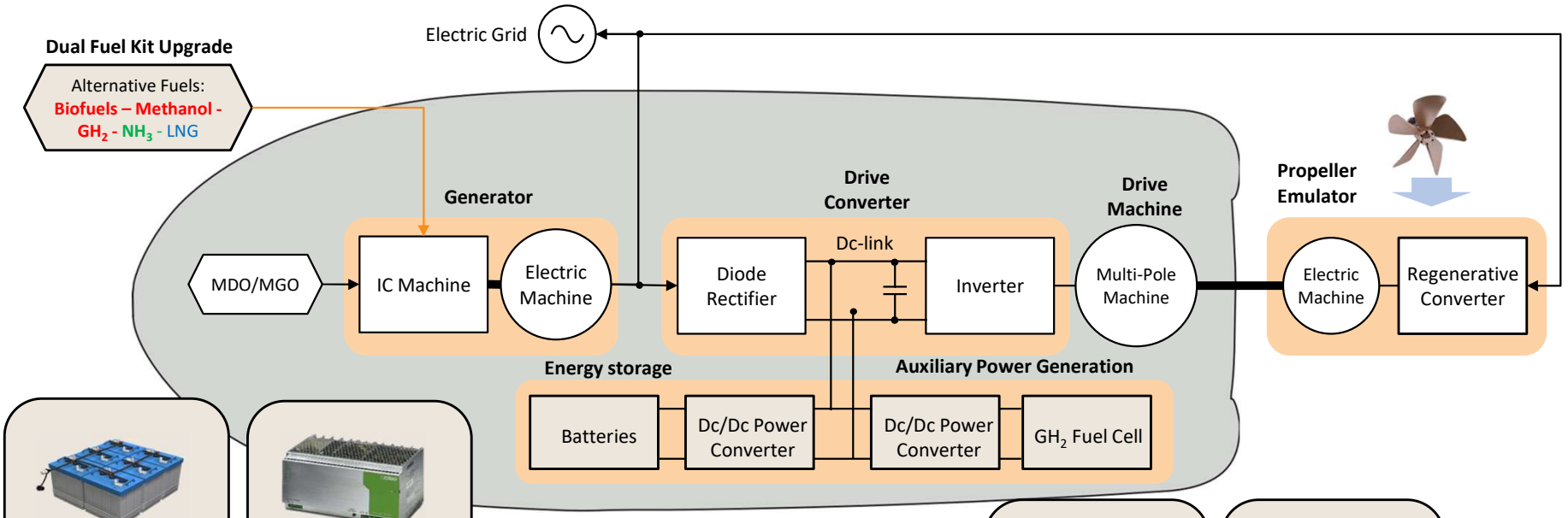

Batteries

20 kWh
20% power shaving
60 min port operation

Dc/Dc Power Converter

20 kW
Dc/Dc Converter
BMS Capability

Dc/Dc Power Converter

20 kW
Dc/Dc Converter
BMS Capability

Fuel cell

20 kWh
For Auxiliary Service
feed with GH_2

Ammonia Cracker

Storage
Heat Exchanger
Furnace

THEMS and the Integration of NH3

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Test-bench for Hybrid Electric Marine System

The Aquaculture Green Corridor Approach - PFA as the Energy Hub of the Region

THEMS and the Integration of NH3

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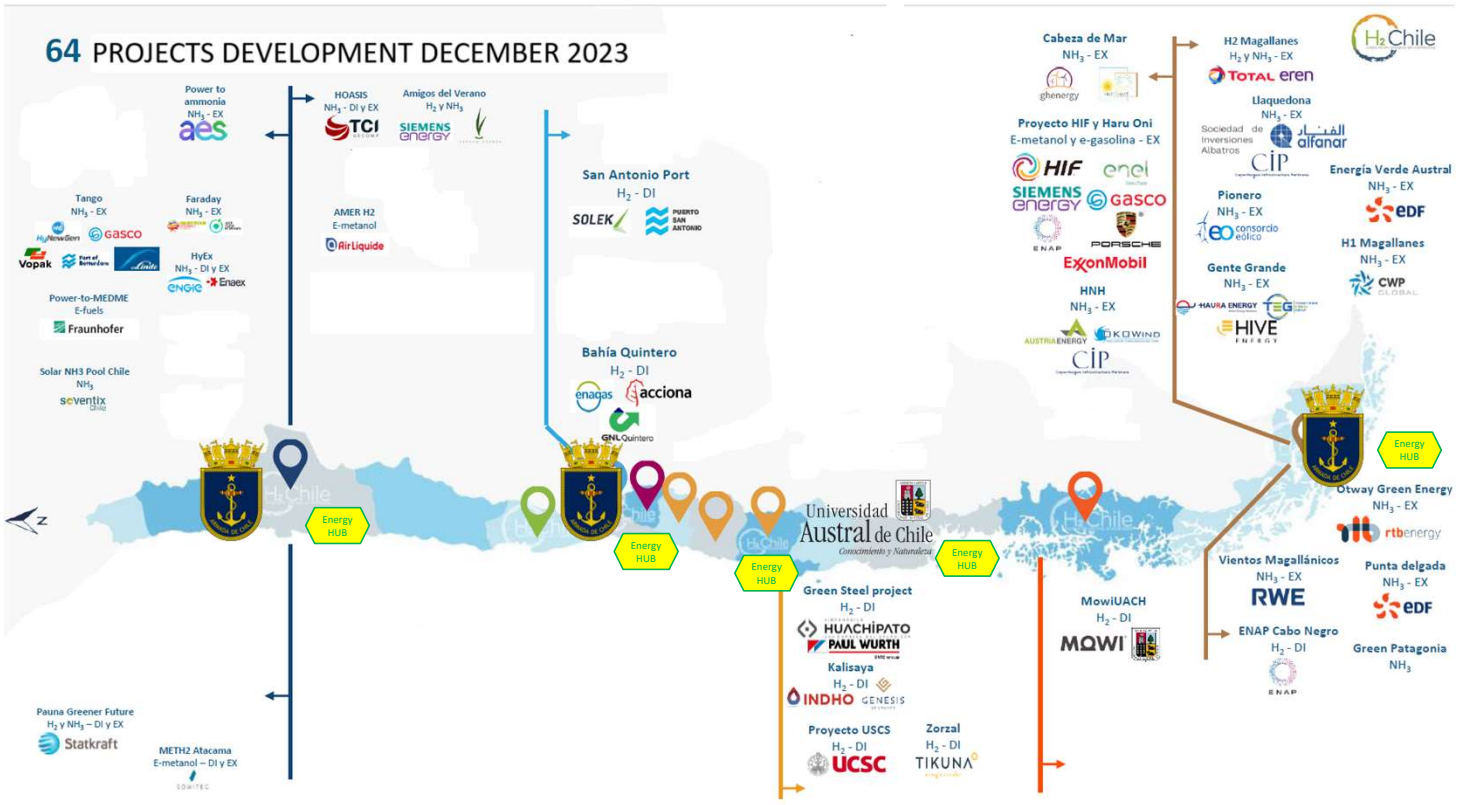

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Conclusions

- With all the experience around, what would be right path to follow to apply NH3 in the National Fleet… go deep into R&D?
- Introspective analysis of our own capabilities but not only at UACh level but as country level looking for the right partners and not clients. LIKEMINDED PARTNERS.
- Power to GH_2 and GNH3
- What's the efficiency that we want to achieve to start to considering other alternatives? Availability?
  - TRL? - Energy Matrix? - Bunkering Infrastructure? - Safety? - Reduce the CO_2 footprint?
- NH3 for small projects but nothing related to passengers' vessels quite yet…
- The toxicity and the necessity to conduct hazard identification studies “HAZID” to reduce the risks when considering the design of NH3 vessels. Even going deep into the consideration of specific preventive measures and countermeasures against NH3 leaks.

Q&A
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