AMOGY

Ammonia-to-Electricity for the Maritime Industry

Svein Erik Oeiestad

Head of BD & Sales, Singapore

Company Profile

130+ Employees

Founded: Nov. 2020

Funding to date: $220M

Headquarters: Brooklyn, NY

Locations: Houston Norway Singapore Korea

Our Investors

aramco ventures · Climate Pledge Fund · amazon · TEMASEK · SK

MOL Mitsui O.S.K. Lines · APVentures Advance & Pioneer · Mitsubishi Corporation · YANMAR · DCVC Data Collective

ZEON · Korea Zinc · Mitsubishi Heavy Industries · Marunouchi Innovation Partners

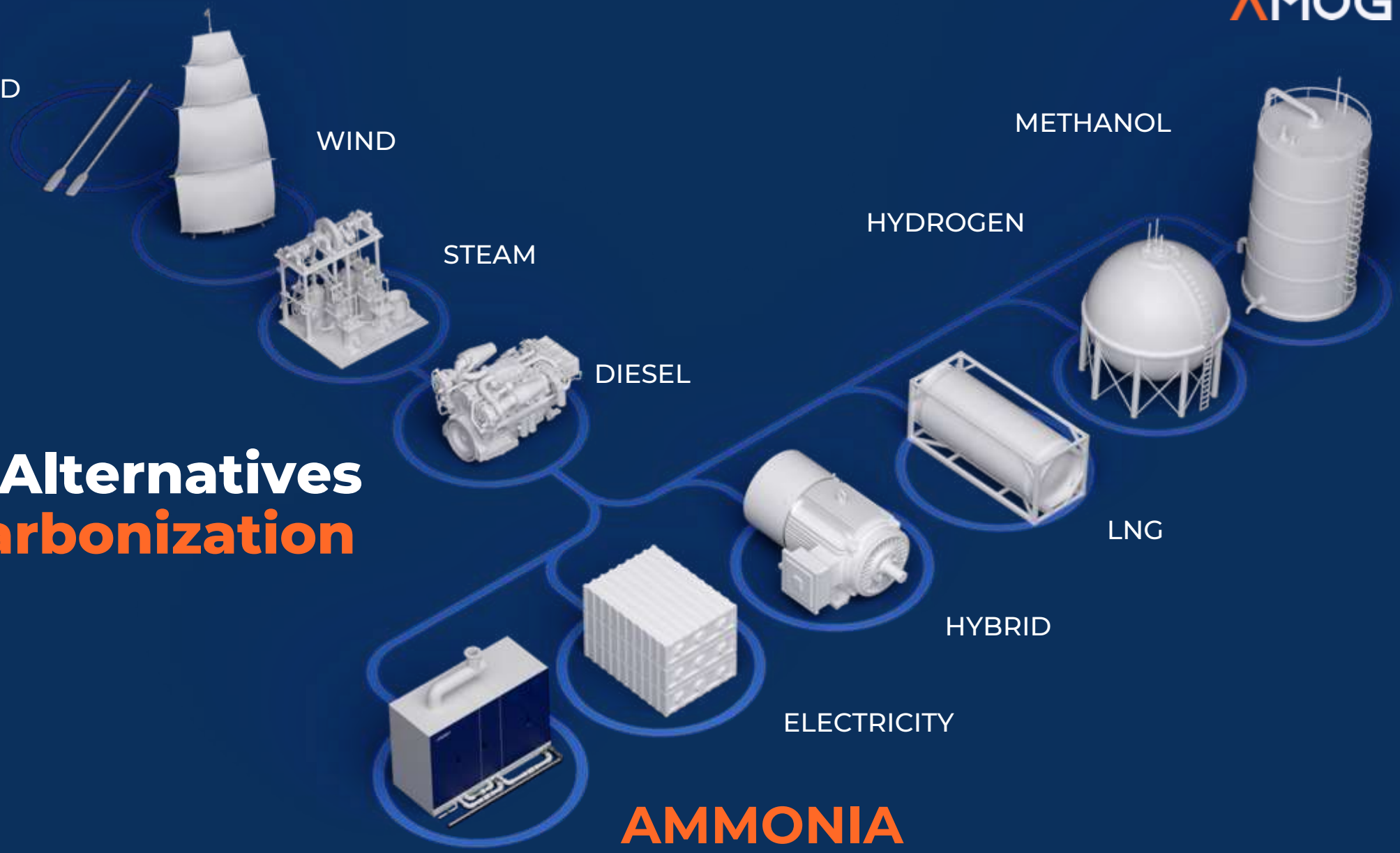
Global Footprint

AMOGY

Why Ammonia?

AMOGY

Several Alternatives for Decarbonization



Ammonia Infrastructure Today

190 MTA of production

200 ports store ammonia

4,000 km+ of pipelines in U.S

20 MTA of waterborne trading

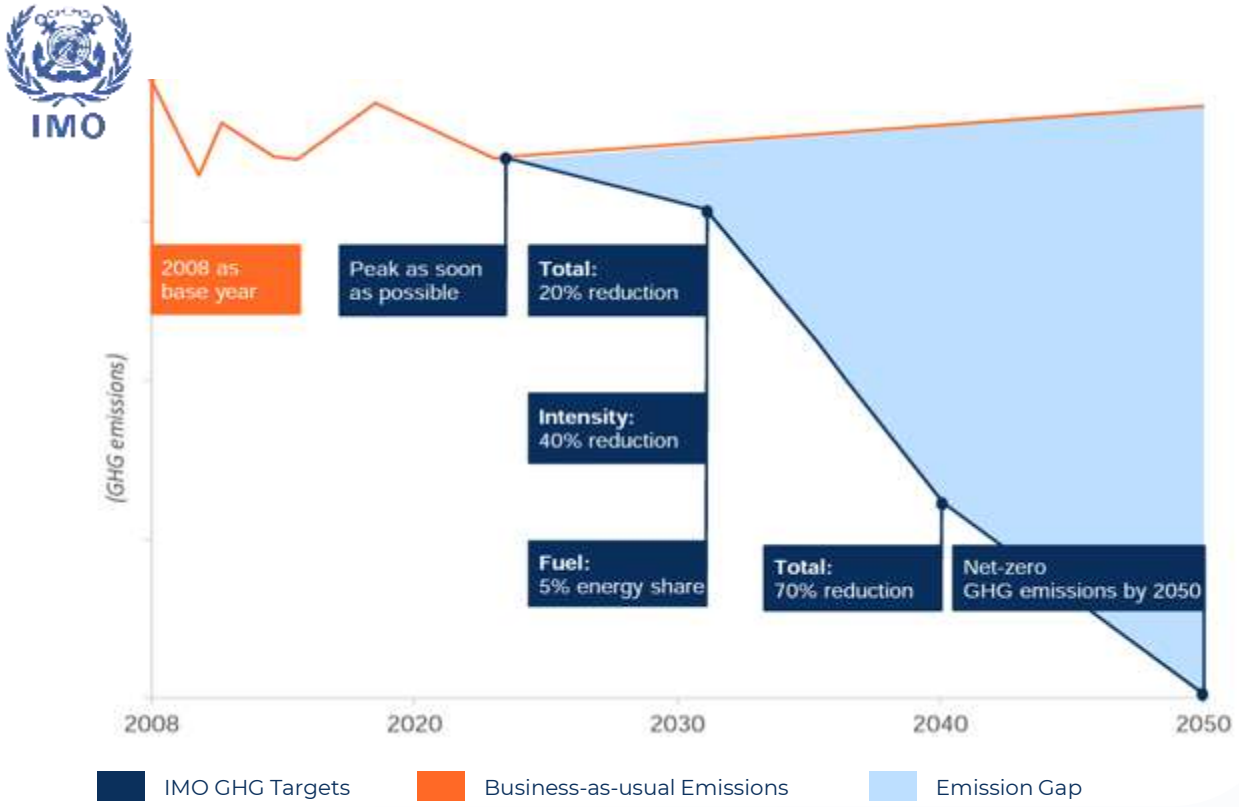
500 vessels capable of carrying ammonia

100+ years of scaled industrial use, however,

no ammonia-to-power technology available yet

Strong Regulatory Tailwinds

Maritime Decarbonization Target: Zero Greenhouse Gas Emissions by 2050



Strong Regional Ammonia Incentives

European H_2 Bank: $700/ton tax credit for green ammonia

US IRA: up to $500/ton tax credit for green ammonia

>3 MTA ammonia for power gen by 2030

~3.6% power gen using ammonia by 2030

>50 MW power gen using ammonia by 2027

IMO: International Maritime Organization; **Source** for business-as-usual emission projection: DNV
European H_2 Bank: $4.50/kg Green H_2 tax credit; **US IRA**: up to $3/kg H_2 tax credit. Green Ammonia has 177 kg of H_2, impact of $3/kg of H_2 tax credit is ($3*177= $531).

Ammonia Chosen by Major Shipowners

2023

MOL receives AiP for ammonia FSRU design from ClassNK

2024

First Ammonia-Ready Containership Delivered to CMB

Moving the Maritime Industry Closer to Clean Energy, Amogy is Building the World's First Ammonia-Powered, Zero-Emission Ship

AMOGY

2025

EXMAR Selects Ammonia-Dual Fuel Engines for First Ocean-Going Ammonia Ships

Yara announces world's first clean ammonia-powered container ship

NYK Proceeds with Designs for Ammonia Bunker Vessel

NYK LINE

YARA INTERNATIONAL PRE-ORDERS 15 AMMONIA BUNKERING BARGES FROM AZANE FUEL SOLUTIONS TO LAUNCH WORLD'S FIRST CARBON-FREE BUNKERING NETWORK

YARA

2026

Hanwha Ocean bags $498 million order for world's largest ammonia carriers

Hanwha Ocean, Amogy, and Hanwha Aerospace Forge Partnership

Singapore's MPA Expects Ammonia Bunkering From 2026: Report

MPA SINGAPORE

2027

Maersk Tankers orders up to ten very large ammonia carriers

Capital Gas Ship Management Orders Two Very Large Ammonia Carriers

Höegh Autoliners and Sumitomo Corporation forge alliance on ammonia bunkering in Singapore and Jacksonville ports

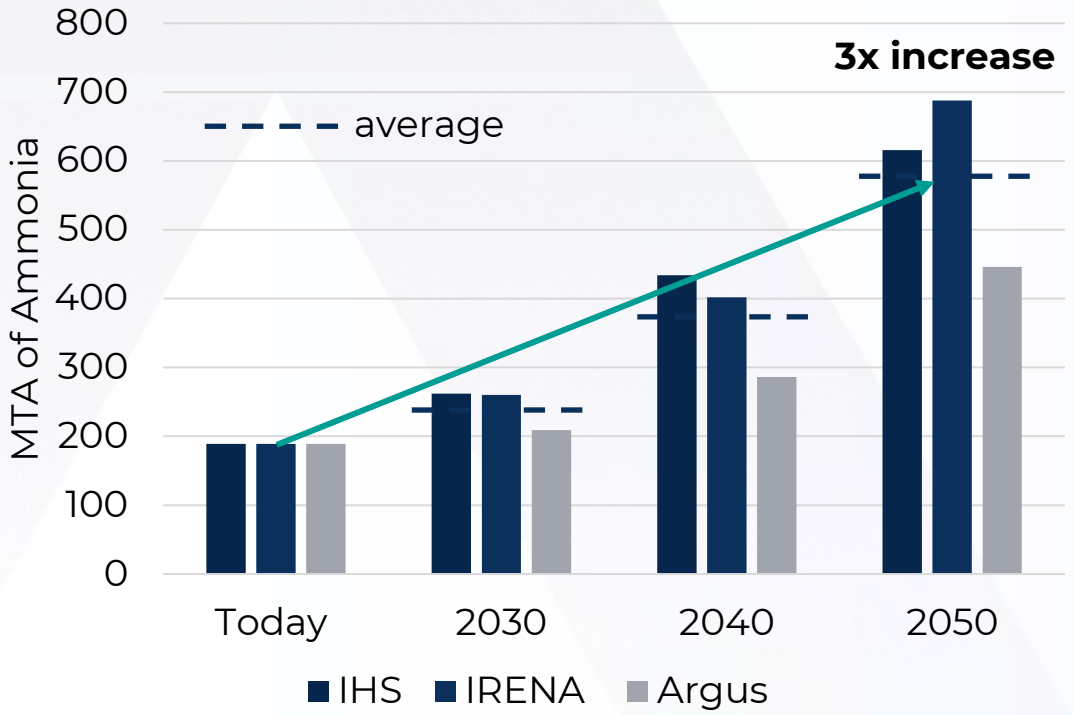
Sumitomo

Sources: The Maritime Executive, Ammonia Energy Association, Company-specific websites.

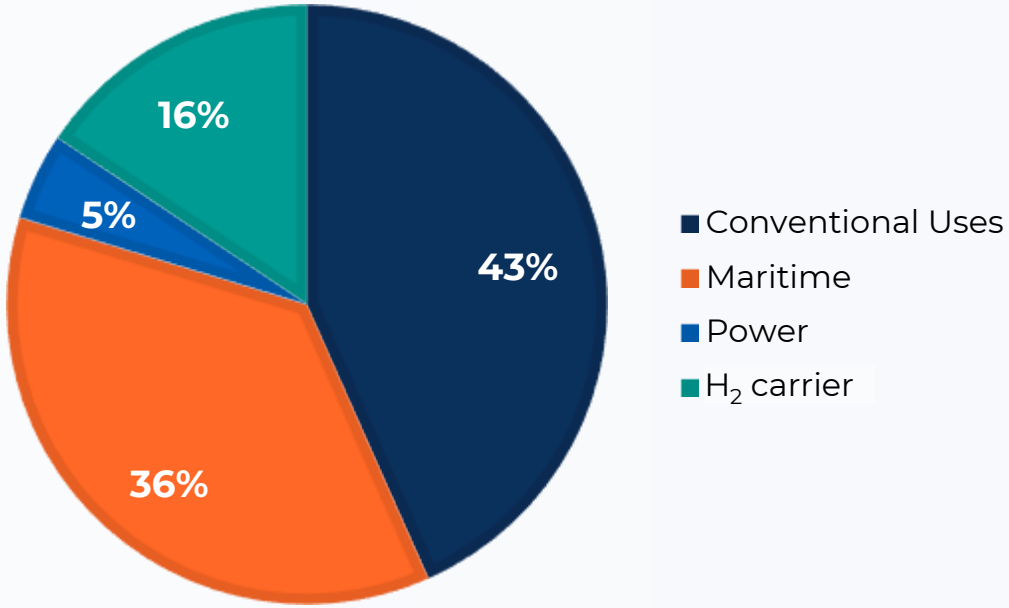
Future Clean Ammonia Demand

90% of ammonia production will be clean by 2050, nearly 60% of ammonia will be used as a fuel

Ammonia Market Set to Triple by 2050



Uses of Clean Ammonia in 2050



MTA: Million metric tons annually. **Sources**: Left hand side - IHS, IRENA Ammonia Innovation Outlook 2022, Argus Ammonia Analytics Long-Term Ammonia Outlook 2023. Right Hand Size: IRENA Ammonia Innovation Outlook 2022

Our **Technology**

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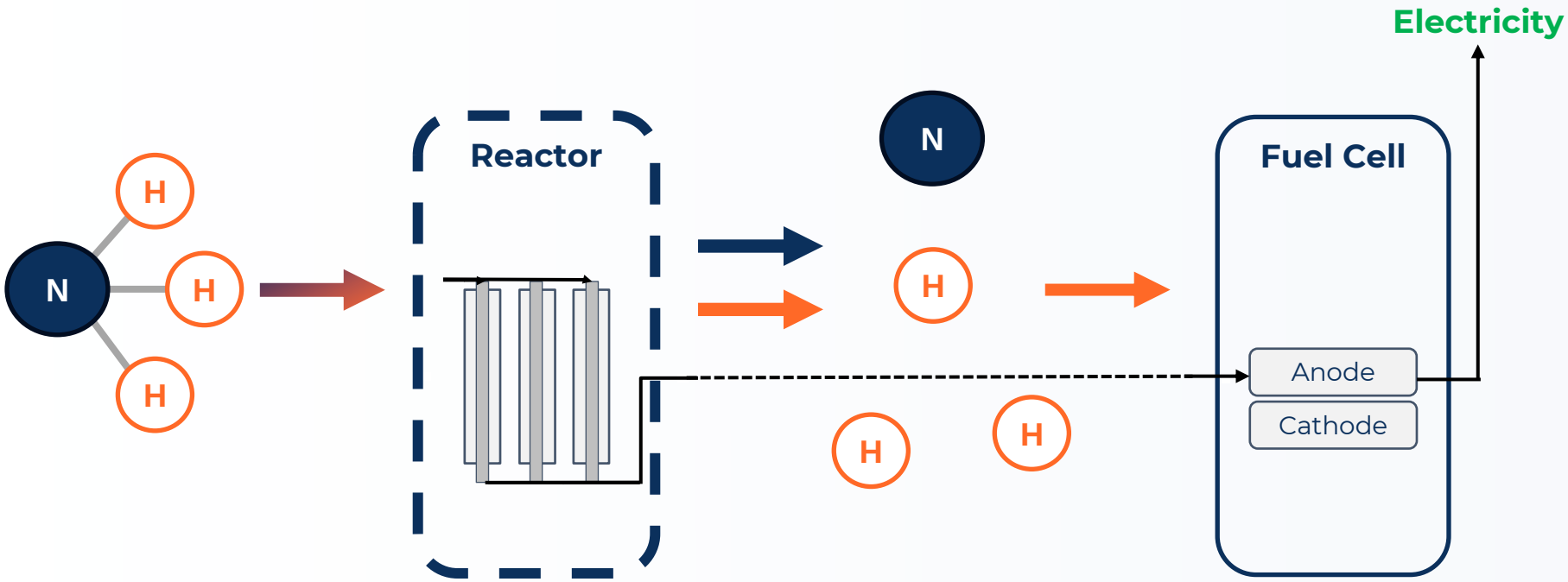
Two stages: NH3 Cracking / Fuel Cell



Most Advanced Ammonia Cracking

Technology

- Most efficient ammonia cracker on the market
- High energy density
- Zero carbon emissions

Demonstrated Ability

- Scale up via successful demonstrations
- Extensive and expanding IP
- Strong industry partnerships

Amogy 200 kW Cracking Module

40-70%
more efficient ammonia cracking catalyst*

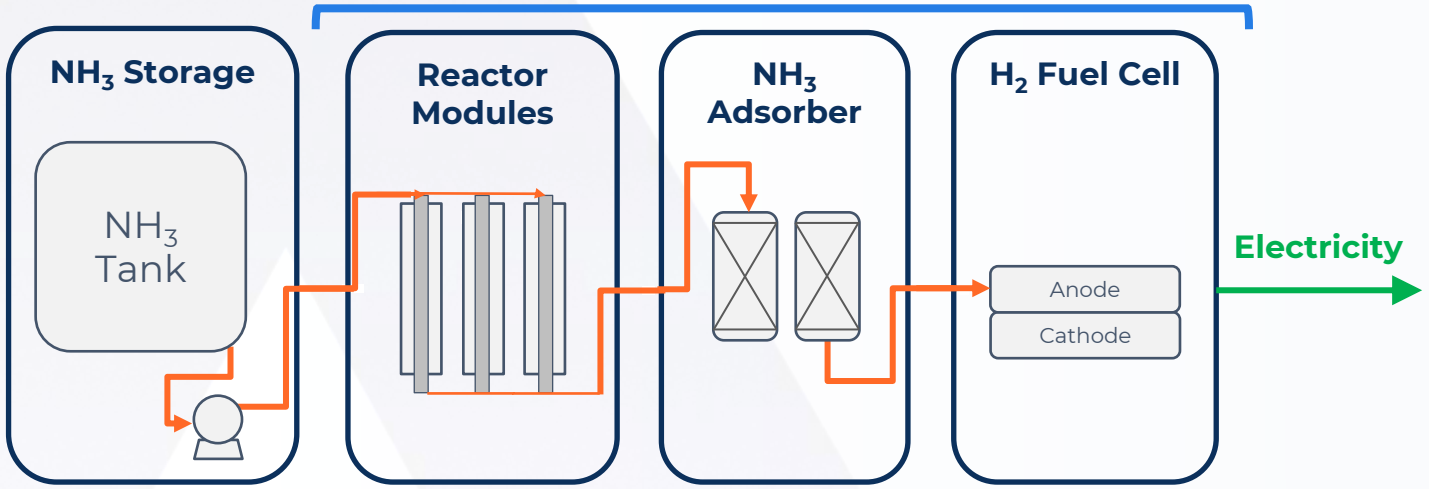
Up to 35%
higher reforming efficiency**

>80%
higher reformer power density***

*At typical operating temperatures.
**Compared to other reforming technologies (SMR, NH_3 cracking, photocatalytic reactors); ***Compared to Steam Methane Reforming (SMR) technologies.

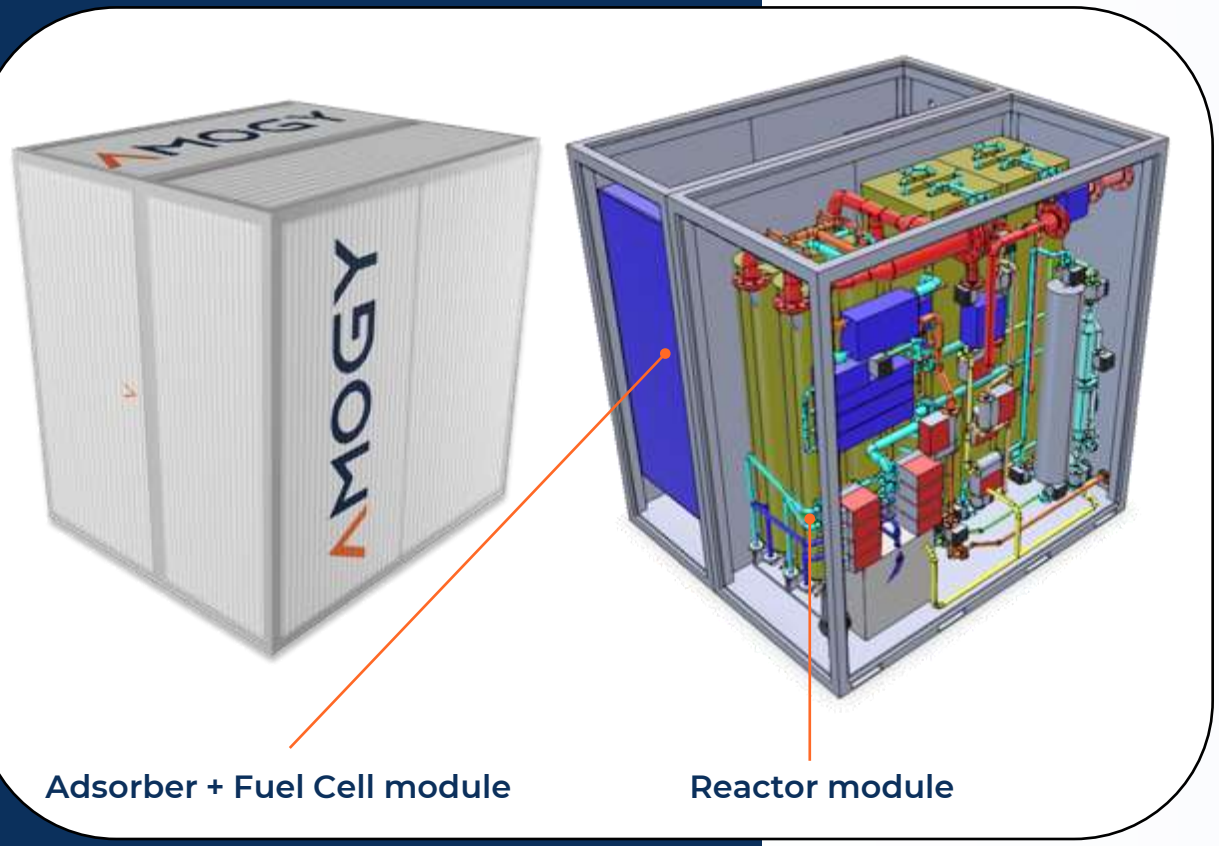
Amogy's Technology

Ammonia-to-power: Fuel Cell Solution



Fuel Cell Solution

Powerpack Safety Features



- Hardwired signals for safety-critical components
- Separate Basic Process Control (BPCS) and Safety Instrumented Systems (SIS)
- Gas detection system (H_2, NH_3, O_2) interlocked with the SIS
- Fire-fighting system
- Comprehensive emergency stop device (ESD) philosophy including both manual & automatic devices
- Ventilation to prevent explosive or toxic vapor clouds
- Pressure relief valves
- Inter-module double-walled pipe
- Alarm & monitoring system
- Remote interlocks
- “Fail-Safe” equipment

Our **Demonstrations**

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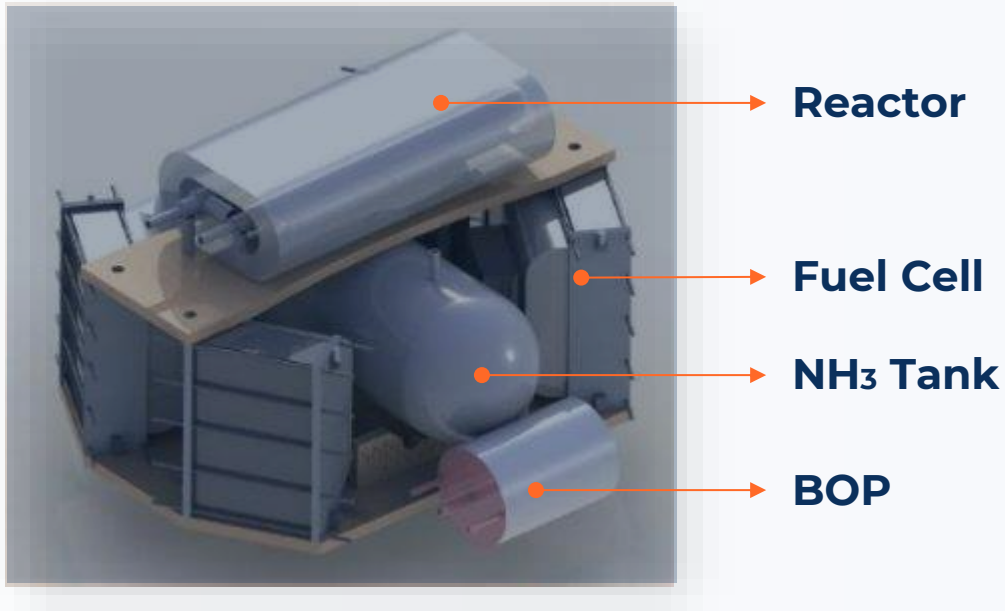
DEMONSTRATIONS

Ammonia Powered Drone

World's first carbon-free, ammonia-powered drone:

- Power: 5 kW
- Ammonia-to-power efficiency: 38%
- Demo date: July 2021

Watch Demo



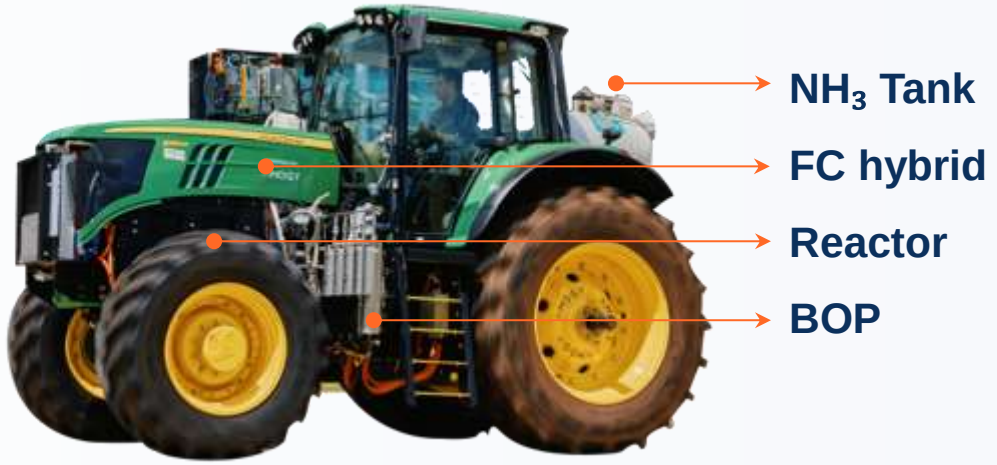
DEMONSTRATIONS

Ammonia Powered Tractor

World’s first carbon-free, ammonia-powered tractor:

- Power: 100 kW
- Ammonia-to-power efficiency: 40%
- Demo date: May 2022

Watch Demo



DEMONSTRATIONS

Ammonia Powered Truck

World's first carbon-free, ammonia-powered class 8 semi-truck:

- Power: 300 kW
- Ammonia-to-power efficiency: 40%
- Demo date: January 2023

Watch Demo

DEMONSTRATIONS

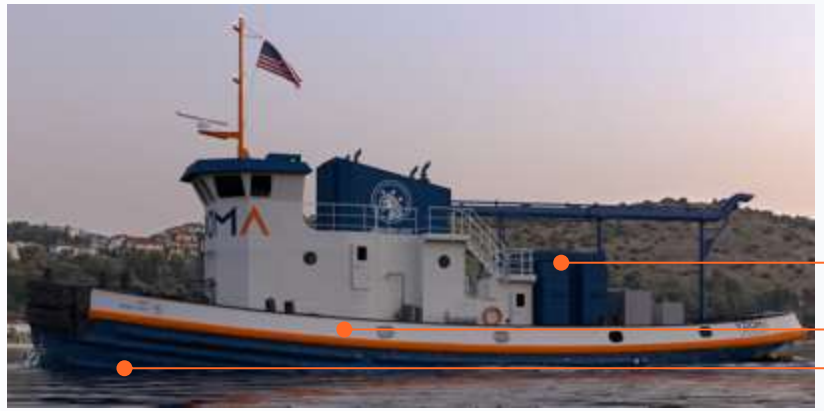
Ammonia Powered Tugboat

World's first carbon-free, ammonia-powered vessel:

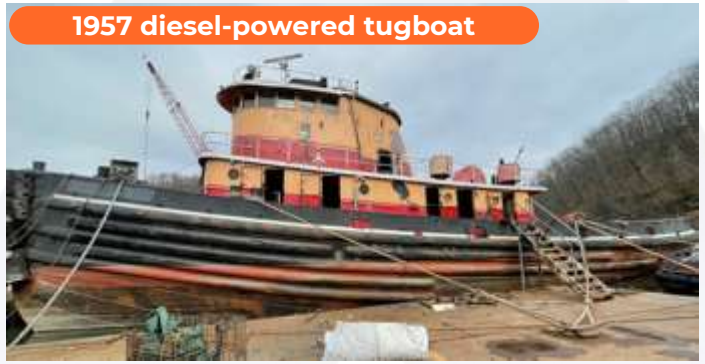
- Vetted design from regulatory bodies to ensure full safety compliance
- Demo date: September 2024

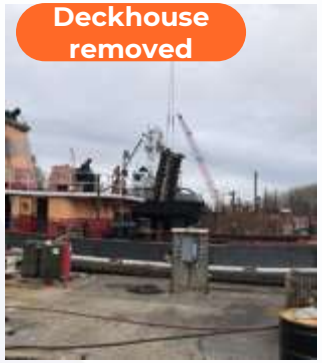
Watch Demo

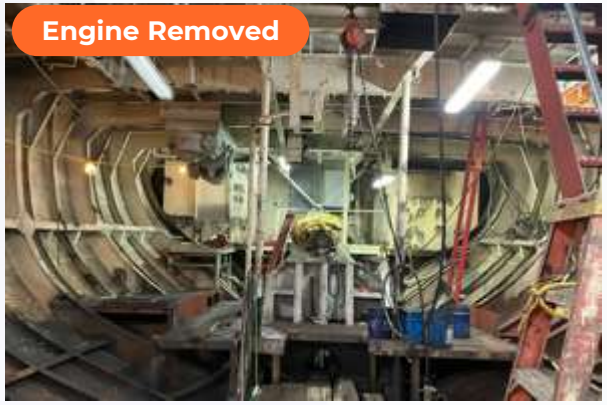
Partners:



Construction Process







Initial Design & Demolition

Legacy Equipment Removal

Drydock & Initial Construction

Construction Process

Heat recovery & bilge

NH_3 tank & feed

Motor

Scrub

Powerpack modules in skids

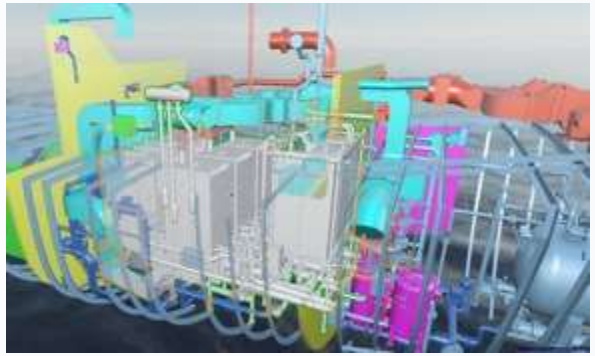
Above deck completion & commissioning

Module transport

Wheelhouse/deckhouse

Sewage tank

Switchboards



Vessel layout

Completed Vessel

NH_3 Kraken in Photos

1957 diesel-powered tugboat

NH_3 Kraken, May 2024

NH_3 Kraken, Sept. 2024

Target **Applications**

AMOGY

Target Applications

Maritime Shipping

- Propulsion: offshore supply, short-sea cargo, other hybrid vessels
- Auxiliary power: deep sea cargo, inland and bunker barges

Power Generation

- **Shore power in Ports**
- **Off-grid charging**
- **Harbourcraft EV**
- Diesel generator displacement

> APRIL 23, 2024

Hanwha Ocean, Amogy and Hanwha Aerospace Forge Partnership to Decarbonize Maritime Sector with Ammonia as a Zero-Emission Fuel

Hanwha

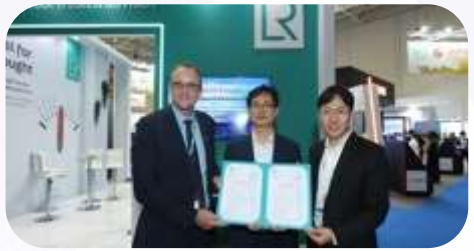
> APRIL 17, 2024

Amogy Receives Order from Terox to Enable Carbon-free Charging on Construction Sites

TEROX

Example Contracts

Shipyard Collaborations



COMPANIES	SHORT DESCRIPTION
Hanwha Ocean	Pilot project for the deployment of **Powerpacks on new VLAC** built, owned, and operated by Hanwha. Integration of Hanwha Aerospace (HAS) FCs into Powerpack. A JDP signing ceremony took place at Posidonia 2024. Collaboration with Korean Register for project certification.
Hyundai Heavy Industries	Obtaining AiP for deployment of Amogy Powerpacks aboard **newbuild VLAC**, owned by Capital Gas Ship Management to be constructed by Hyundai Heavy Industries (HHI). AiP awarded during Posidonia 2024 by class ABS and Liberian Flag Registry.
Samsung Heavy Industries	Obtaining AiP for Samsung Heavy Industries (SHI) conceptual design incorporating Amogy Powerpacks as the **main propulsion system for VLACs**. AiP awarded during Posidonia 2024 by Lloyd's Register.
Hyundai Mipo Dockyard	Obtaining AiP for Hyundai Mipo Dockyard's conceptual vessel design of a **Feeder Container Vessel** utilizing Amogy Powerpacks as the **main propulsion system**. AiP awarded during Posidonia 2024 by Lloyd's Register.

AiP – Approval in Principle; VLAC - Very Large Ammonia Carrier; JDP - Joint Development Project

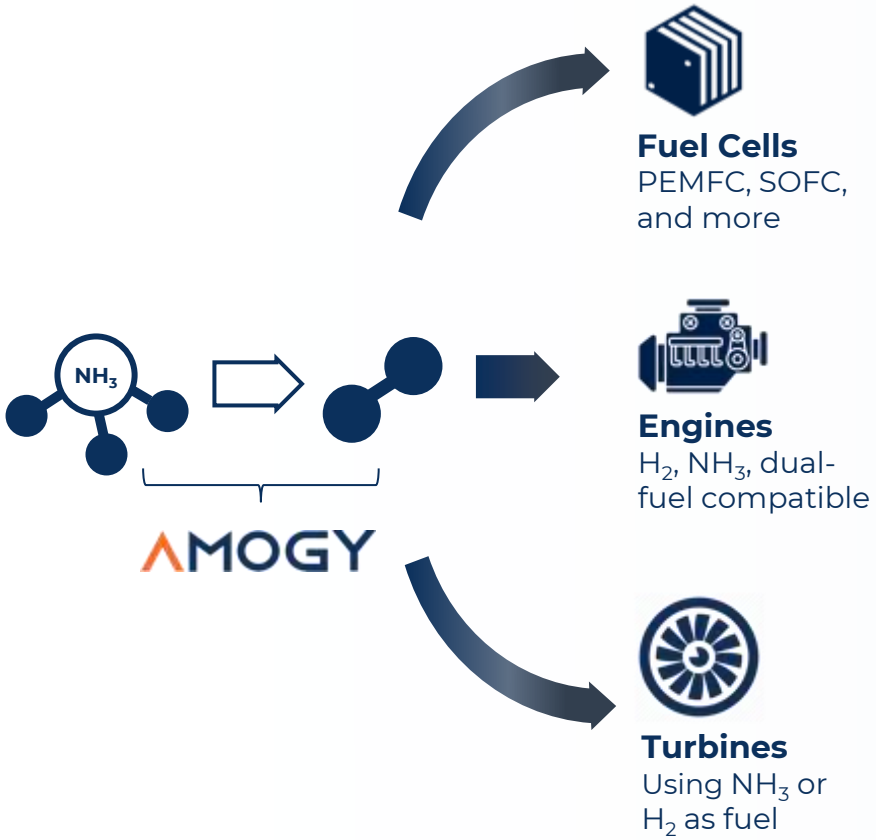
Floating Cracking Solution

FSRU (Floating Storage and Regasification Unit)

Status: Five-party consortium (HD KSOE, POSCO, SNU, ABS, AMOGY) established

Scope: Joint Dev Program (JDP) for ammonia-to-hydrogen FSRU design; 2028 deployment

Enabling NH3 as a Clean Fuel Source



Fuel Cells
PEMFC, SOFC, and more

Engines
H_2, NH_3, dual-fuel compatible

Turbines
Using NH_3 or H_2 as fuel

White paper:
Ammonia as a Clean Energy Solution for Maritime Use