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SVITZER'S FUTURE FUEL STRATEGY...

A fuel transition pathway

There is no single, true replacement for MGO that matches the energy density, ease of use, availability of supply or low cost. Therefore, we need to explore our options and prepare for a future where there are multiple fuel choices in the short term whilst, globally, fuel choices mature and the 'best' fuel is established. Alternative fuel technologies continue to develop with methanol, ammonia, and hydrogen as leading options. In the near-term drop-in fuels can provide a critical route to decarbonize as they offer carbon neutral tank-to-wake emissions, but demand, cost and well-to-wake impacts remain a concern. Mitigating the risk regarding availability and cost issues around fuel is critical for our future fleet operation. Whilst newer fuels are in the early stages of development, we risk not being able to benefit from them when they are available at scale if we don't prepare to use them. Designing and building 'future fuel' ready vessels and understanding how to retrofit our existing vessels will help to do this. Dual fuel engines and early adoption of new technology will be critical to help us de-risk the fleet to avoid being 'stuck with' expensive fuels in limited supply and avoid stranded assets – vessels we have built but can no longer operate. We need to determine which fuel is right for Svitzer and how widely we use it across our fleet. Methanol and Ammonia show promise as future marine fuels with methanol easiest to work with, and Ammonia challenging from a safety and supply perspective. We cannot exclude solutions that support electrification. Green electric is the most efficient 'carbon neutral' fuel, but also the hardest in terms of operation and energy density, front runner advantage will be key if we are to use these wisely in our fleet. Until such time as the storage requirements, equipment availability, and overall system costs of carbon free fuels improve, they will remain challenging to implement. We will need to explore our options in the near term as we transition to progressively lower carbon fuels as technology matures.

HVO

- Drop in fuel
- 1:1 Energy Density compared to MGO
- Easy handling and bunkering
- Availability Issues related to land use and first-generation food crops
- Volume security linked to biomass availability and competition for fuel
- WTW 90% CO2 reduction

FAME

- (almost) Drop in fuel
- Lower cost than HVO
- Engine considerations (acidity etc.)

Methanol

- (almost) Drop in fuel
- 1:2,5 Energy Density compared to MGO
- Handling and bunkering requires scaling
- Engine development needed for 100% MeOH
- WTW 95% CO2 reduction

Battery Power (Hybrid)

- Very low energy density
- Shore charging infrastructure an issue
- Essential to work with Fuel Cell technology

Battery Power (low operational profile)

- Charging and battery capacity critical to operational profile
- Limited utility for harbour towage

Ammonia

- New engine and fuel management system
- 1:3 Energy Density compared to MGO
- Revised vessel design needed
- Bunkering infrastructure needs to be scaled
- Safety and training issues needs to be resolved
- WTW 100% CO2 reduction

Battery Power (All OP profiles)

- Battery longevity a key issue (10yr limit now)
- Rare earth mineral concerns for production
- Likely "end state" future fuel for maritime sector

Electrification

- Ammonia, Hydrogen, Battery
- Fuel Cells will play a vital role

METHANOL (MEOH)

Production

'Green' methanol (MeOH) can be produced from 3 pathways today:

- Bio-Methanol from gasification of biomass or biowaste
- Bio-Methanol from reforming biogas made from biomass or biowaste
- E-Methanol from electricity and CO2

CO2 for E-methanol can be obtained either by capturing CO2 from a point source like factory emissions (Carbon capture) or directly from the air (Direct Air capture – DAC). This technology is not yet mature – most green methanol is from biomass or biowaste

Advantages

Methanol is liquid at ambient temperature and does not need to be stored in cryogenic or high-pressure containment systems.

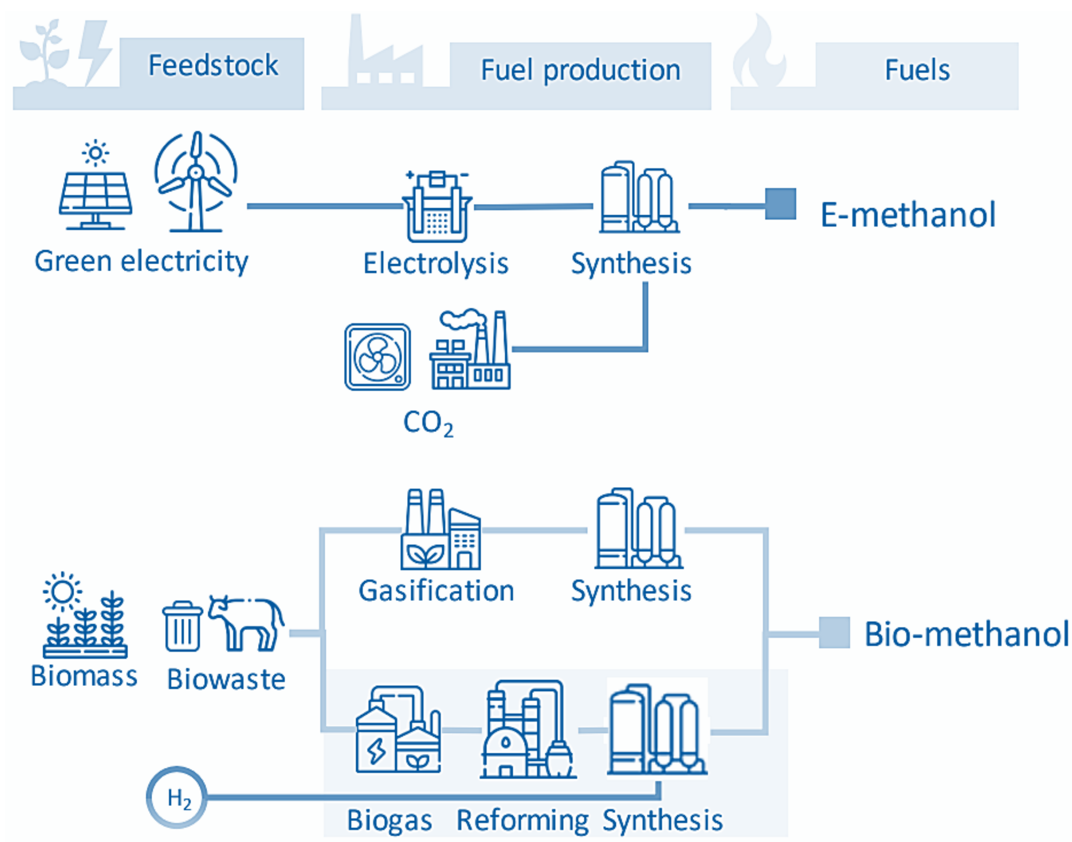
- Methanol is bio-degradable and water soluble
- Offers a reduction in 'well to wake' (WTW) emissions compared to conventional fuels: circa. 65% reduction for Bio-Methanol and 99% for E-Methanol
- Harmful combustion emissions like Sulphur oxides (SOx), Nitrogen oxides (NOx), and Particulates are reduced resulting in cleaner air
- MeOH powered two-stroke main engines and four-stroke auxiliary engines are commercially available now and are being scaled up
- Grey methanol (not CO2 neutral) widely available now in key ports

Challenges

Methanol has lower volumetric energy content relative to MGO (see below). To match the energy content of MGO, tugs would require 2,3 times more fuel. Tank design requirements add additional volume increasing this to 13 times the tank capacity when vessel design is considered. Other issues:

- The fuel burns with a flame that is nearly invisible, so special fire detectors must be installed onboard the tugs.
- Competition for renewable feedstock (biomass, CO2, renewable power, green hydrogen) with other renewable alternatives
- Methanol contains a carbon molecule (CH3OH), so renewable CO2 feedstocks are critical
- Renewable methanol requires investment support, technology-neutral public policy, and removal of barriers to access affordable renewable electricity, CO2 and biomass feedstocks
- Investment and significant scale up of CO2 capture necessary for E-Methanol production

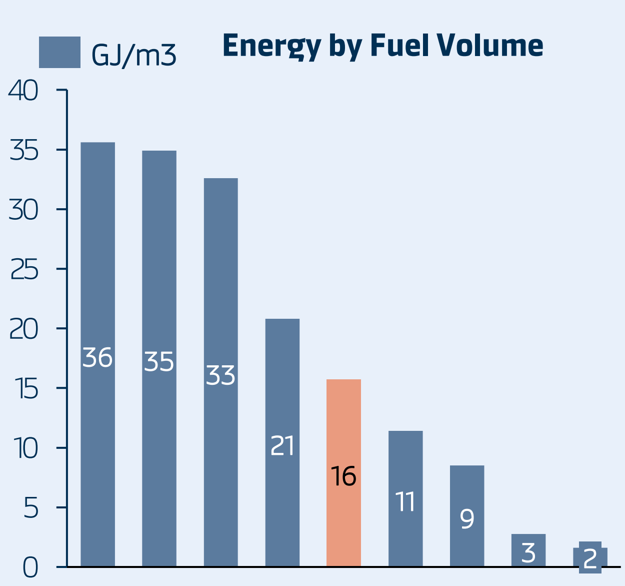
Well-to-Wake Process

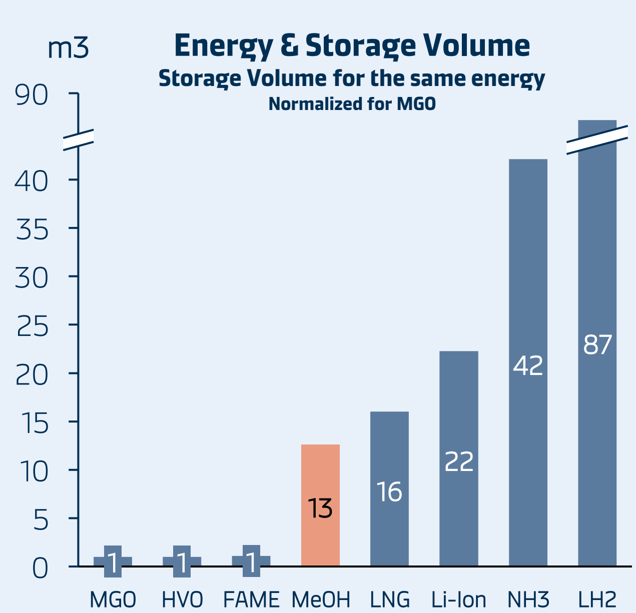


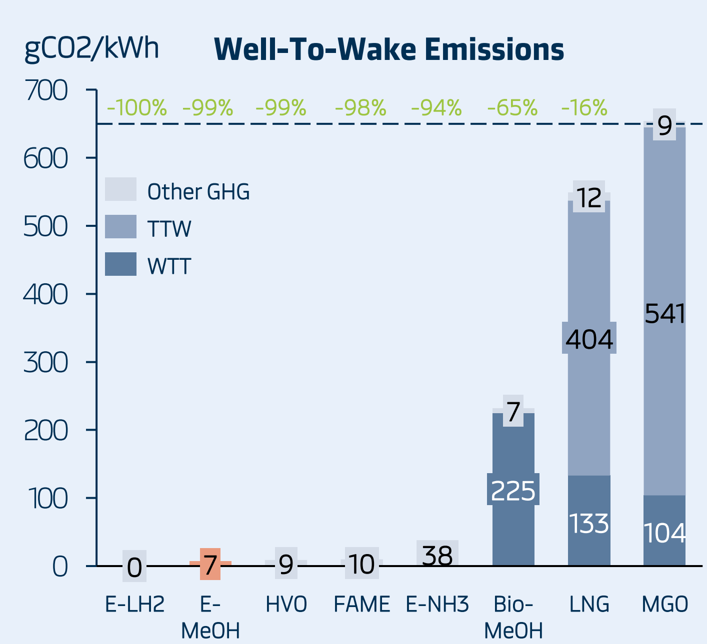
Source: MMMCZCS

Key Points

Technological Maturity - Production	Production Process and Grey MeOH Available widely. Bio & e-methanol volumes growing
Technological Maturity - Use	Dual Fuel ICE & Fuel Cells available.. 100% MeOH Main Engine > 2024
Energy Density	2.3x the volume of MGO equivalent needed
Safety considerations	Low flashpoint fuel, hazardous to humans and environment depending on exposure
Global availability of fuel	Existing infrastructures for HFO and MGO can be adapted to methanol
Sustainability ESG	Depending on production pathway
CAPEX	Medium – Fuel management and engine cost
OPEX	Medium - compared to fossil fuels







AMMONIA (NH3)

Production

Low Emission ammonia (NH3) is produced from hydrogen that is generated in two ways:

1. Blue Ammonia: Methane reforming to generate hydrogen for Haber-Bosch process to form NH3. CO2 released is captured and stored
2. Electro-ammonia: electrolysis of water, powered by renewable sources

GHG reduction can only be achieved using blue or 'e' ammonia. The choice between them will depend on the cost and availability of renewable electricity and the carbon taxation level, as producing blue ammonia emits some CO2

Advantages

Ammonia is a promising option for shipping, as a zero emission CO2 fuel source. Ammonia is a widely traded commodity today, as a crop fertilizer and a refrigerant. It is also globally traded by sea with robust safety handling and loading and offloading procedures.

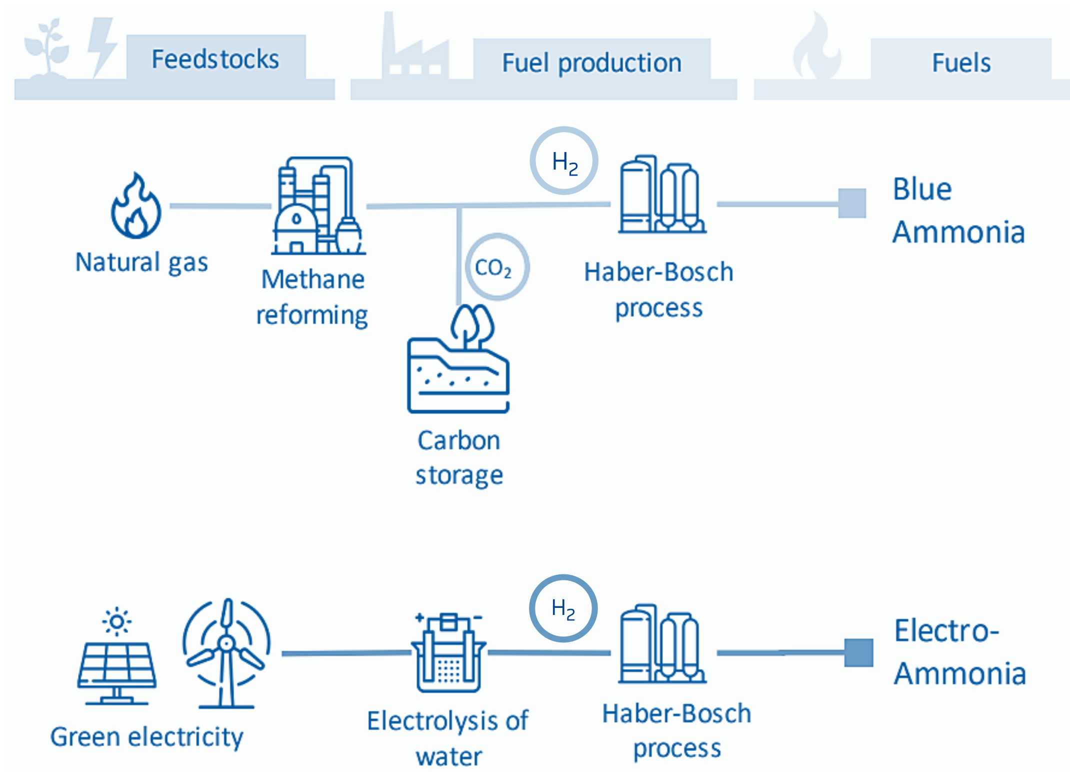
- Two-stroke internal combustion main engines are expected to be prototyped in 2024
- Fuel Cells (SOFC technology) are in early development to be directly fed with ammonia (and thus not generating any N2O emissions), producing no vibration, no combustion, less noise and higher efficiency compared to ICE.
- Offers circa. 94% reduction reduction in 'well to wake' (WTW) emissions for E-Ammonia compared to conventional fuels:

Challenges

As a marine fuel, ammonia has potential to significantly decrease emissions, but its use is held back by:

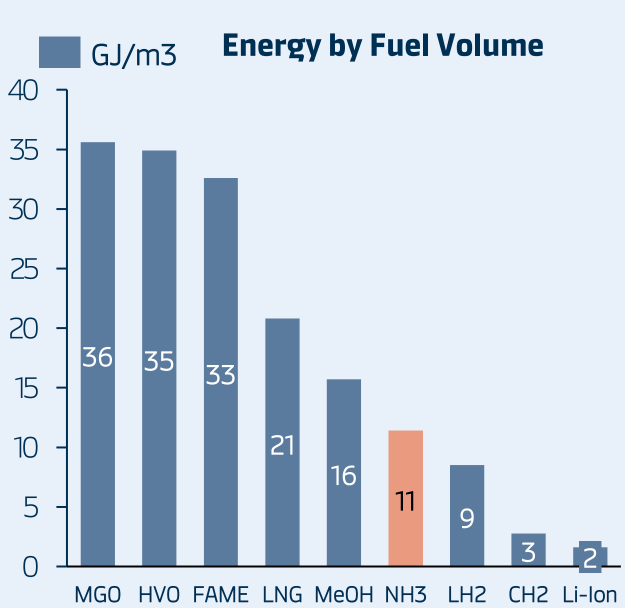
- Supply: infrastructure scale-up needed, for production and distribution
- Onboard: Volume and weight considerations, low technology readiness, needs fossil pilot fuel for combustion in engine.
- Safety concerns: Ammonia is corrosive and toxic, making it essential to protect crews and passengers from exposure during all operations, including maintenance and bunkering.
- Liquid ammonia has a lower energy density than MGO by about one third. Substantially more ammonia fuel is needed on board relative to MGO, unless operational profile can allow for frequent bunkering.

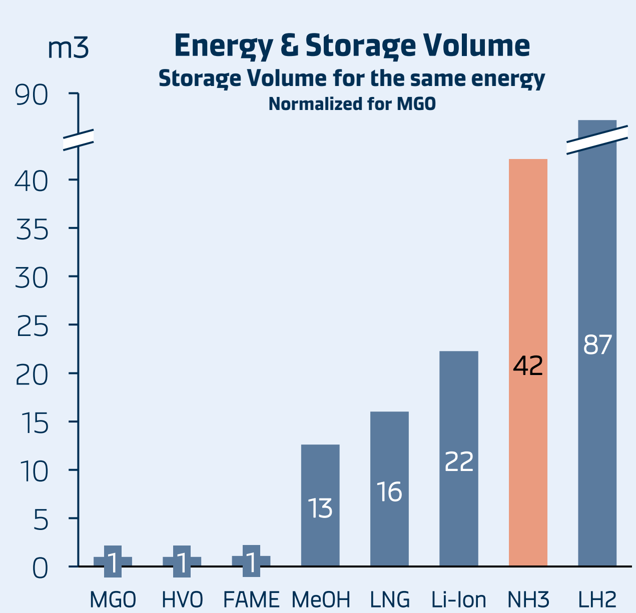
Well-to-Wake Process

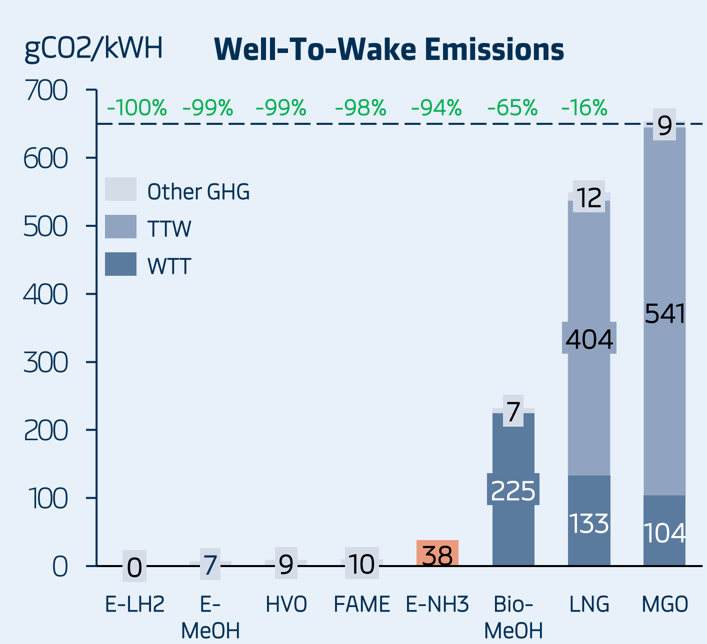


Source: MMMCZCS

Key Points	
Technological Maturity - Production	Production available but supply at scale still needs to be ramped up for e-ammonia
Technological Maturity - Use	ICE engines in development for 2024
Energy Density	3x the volume of MGO equivalent needed
Safety considerations	Low flashpoint fuel, hazardous to humans and environment depending on exposure
Global availability of fuel	Widely traded commodity, existing terminal network. Uses existing infrastructure for storage. Bunkering process required.
Sustainability ESG	Depending on production pathway
CAPEX	Medium – Fuel management and engine cost
OPEX	High - compared to fossil fuels







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HVO & FAME

Production

Biodiesel: Commonly known as fatty-acid methyl ester (FAME) and is produced from various oils or animal fat.

HVO: Hydrotreated Vegetable Oil (HVO). Uses same feedstock as biodiesel, but production is different, hydrotreating and refining instead of esterification in FAME.

These fuels can be used as drop-in fuel or blended with conventional fuels.

Advantages

HVO and **FAME** are an immediately actionable solution as a more sustainable fuel source. The decarbonisation efforts are applied upstream during production and in the supply chain.. They are already compatible with modern ship engines, and require little to no modification of our engines to use them

- Offers a circa. 98% reduction in 'well to wake' (WTW) emissions compared to conventional fuels

Challenges

Availability: forecasts for biofuels predict that only 30% of fuel will be available for the global fleet. The maritime industry may lose out competitively to harder-to-abate sectors such as aviation. All vessel types – large or small, gas-fueled or traditionally liquid fueled – could burn biofuels increasing potential competition in the market for these fuels

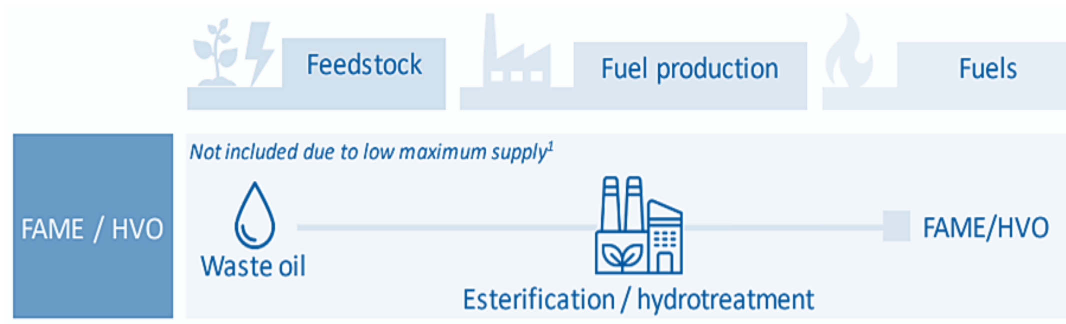
Land use: increasing demand for biofuels can have indirect detrimental effects on the environment by driving a change in land use from food production to fuel production, creating undesirable competition with food markets. Extra biofuel demand could also spur additional land to be converted for feedstock cultivation, driving habitat loss.

Certification: Biofuels made from first generation feedstock (e.g. soy and palm oils) can have greater GHG emissions than MGO. We can only use second-generation biofuels which have been certified from Second-generation feedstock from waste biomass (e.g. farm and food waste) which provide 90% GHG reduction compared to MGO.

Specific for FAME

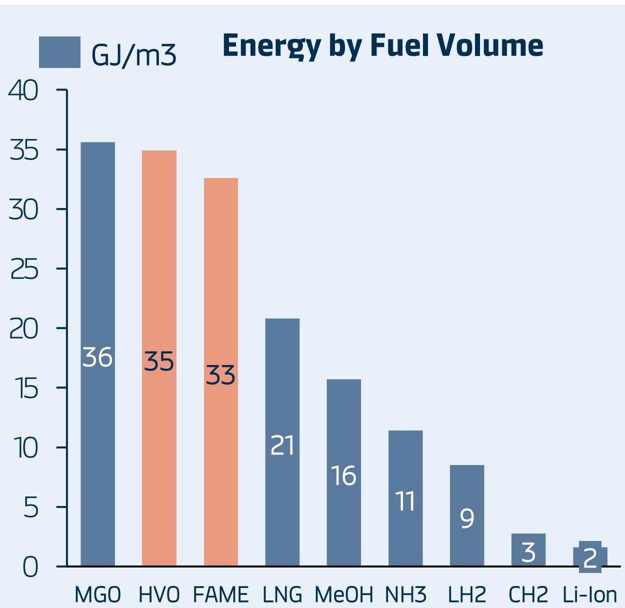
Unlike HVO, FAME should not be stored for longer than six months as it is susceptible to oxidation, which can leave deposits that will eventually block filters. FAME can also affect seals and gaskets, so more controls and monitoring of the engine and fuel system is needed compared to HVO.

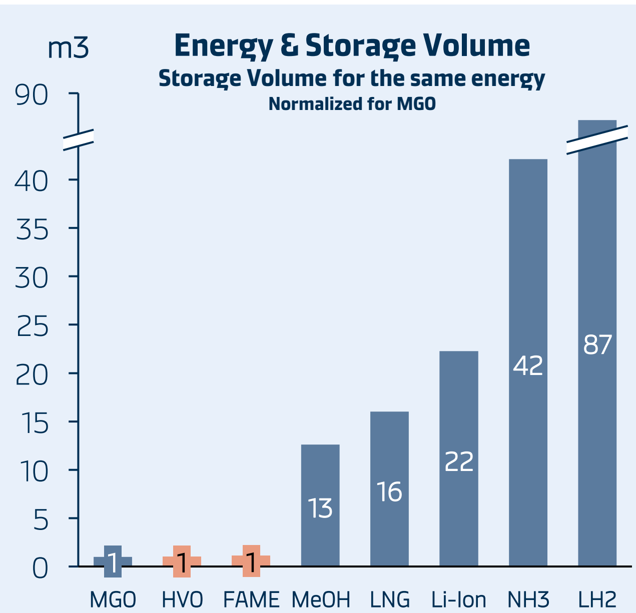
Well-to-Wake Process

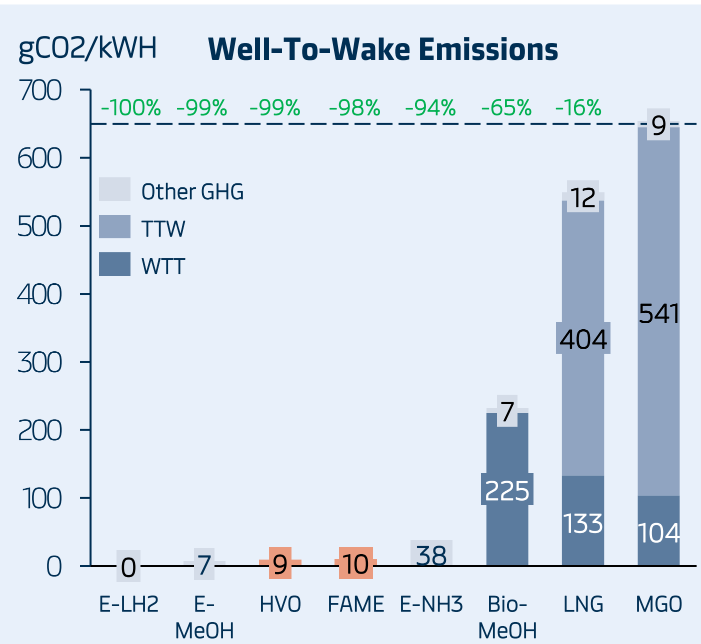


Source: MMMCZCS

Key Points	
Technological Maturity - Production	Production available but supply at scale may be challenging for second and third generation biofuels
Technological Maturity - Use	Conventional ICE engines
Energy Density	Similar to conventional fuel oil
Safety considerations	Similar to conventional fuel oil
Global availability of fuel	Medium scarcity – competition from other sectors
Sustainability ESG	Depending on generation of biofuel
CAPEX	Conventional
OPEX	High fuel cost compared to fossil fuels







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HYDROGEN (H2)

Production

Depending on the production pathway, hydrogen can be either black, brown, blue or green. For renewable hydrogen, only green is considered. Green Hydrogen is produced by electrolyzing water using renewable electricity. The resulting H2 can then be used directly as a fuel or to manufacture other products like ammonia and methanol. Green Hydrogen is an e-fuel on its own, but the highly energy-intensive production uses vast amounts of renewable power currently not available in the current energy mix. Significant growth in renewable electricity is therefore needed to support its use.

Advantages

Hydrogen is a promising potentially zero-carbon fuel when sourced from renewable electricity via electrolysis. It offers an efficient fuel for fuel cells and can be used in traditional ICE with modification. It is best suited to vessels with access to frequent bunkering or large volume fuel tanks.

Fuel cell technology is developing rapidly and are expected to be used in lower power applications like auxiliary systems up to around 1MW. As costs and efficiency improves, they will be scaled up to fully power ships' primary propulsion systems, likely combined with battery power to improve the response time of the system

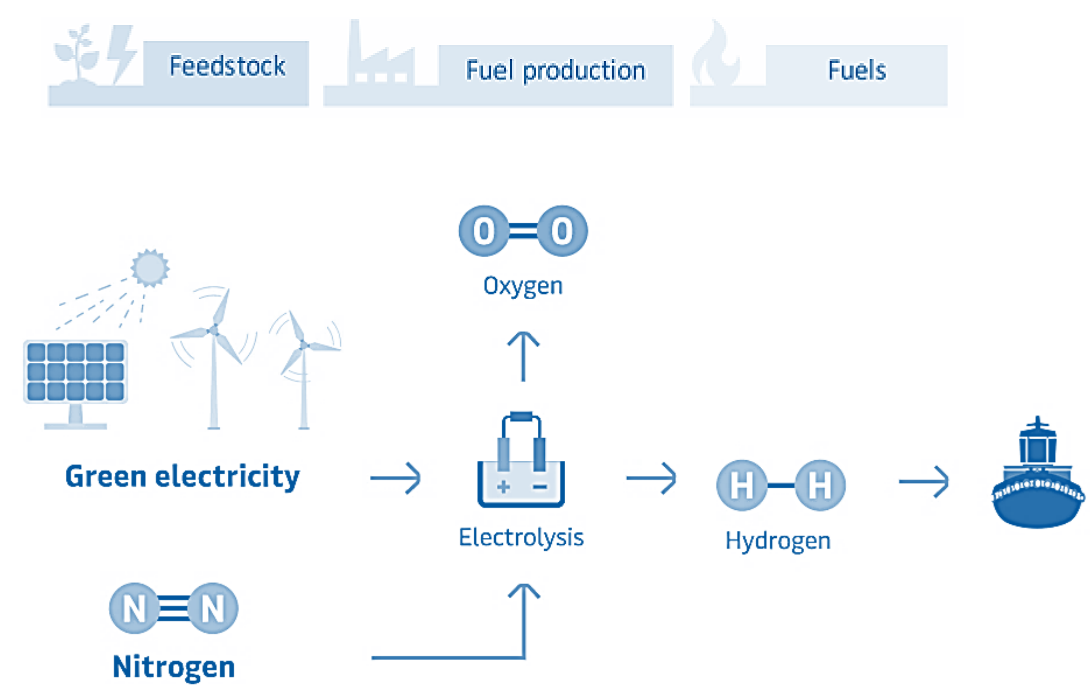
- Offers 100% reduction in 'well to wake' (WTW) emissions compared to conventional fuels

Challenges

For hydrogen to become an alternative fuel of choice, the industry needs to overcome safety and storage issues :

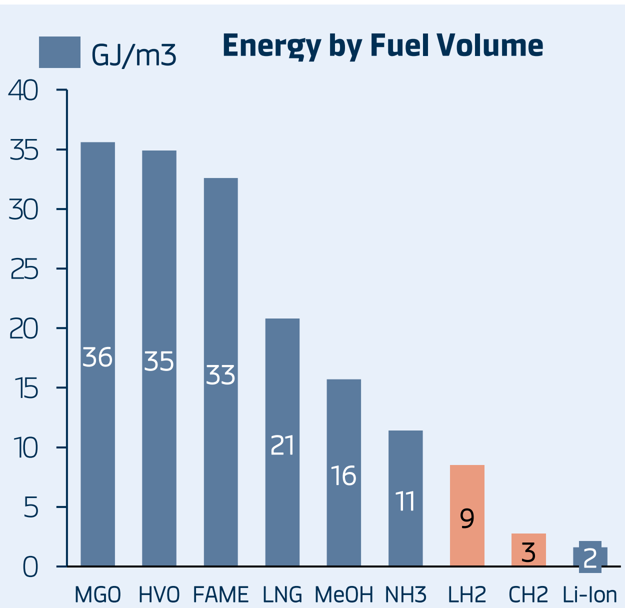
- Hydrogen has major safety risks it is explosive and highly flammable.
- Hydrogen has logistical challenges: it has low volumetric density, requiring significantly more onboard storage capacity compared to MGO. It can be compressed (CH2), or liquified (LH2)
- To maximise storage volume LH2 is best, but must be stored using cryogenic technology at temperatures of -253C
- Fuel Cell technology is new to the maritime sector and will take time to mature (circa 5-10yr)

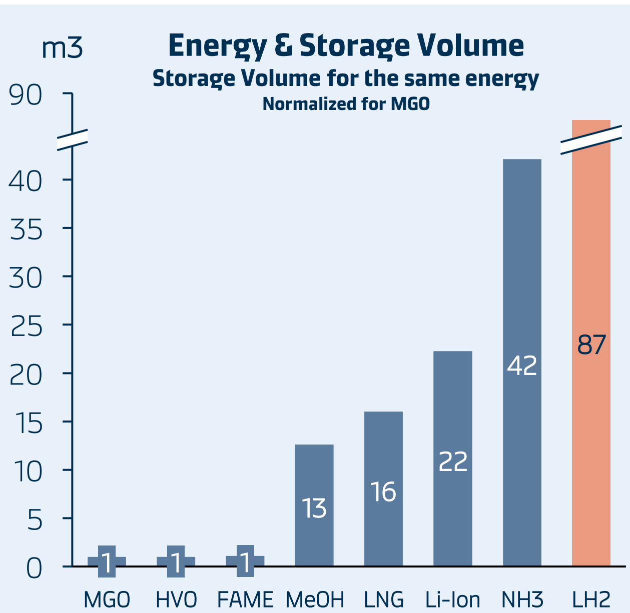
Well-to-Wake Process

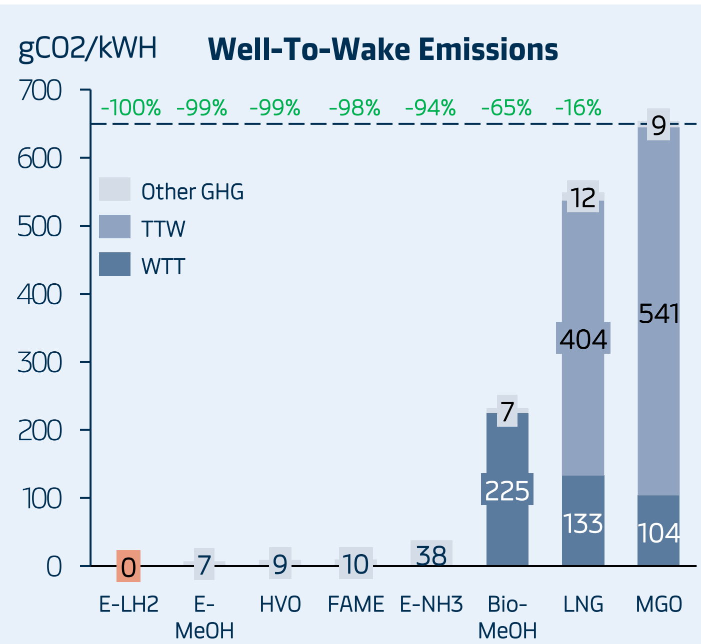


Source: APMM

Key Points	
Technological Maturity - Production	Production available but supply at scale is currently ramping up for green hydrogen
Technological Maturity - Use	ICE under development – Fuel Cells technology maturing
Energy Density	4,5x the volume of MGO equivalent needed
Safety considerations	High flammability and explosivity
Global availability of fuel	To be developed
Sustainability ESG	Green hydrogen is a zero-carbon fuel
CAPEX	High – Storage and power conversion costs to date vs. conventional systems
OPEX	High - compared to fossil fuels







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LITHIUM ION BATTERY POWER (LI-ION)

Production

Battery production is very energy intensive and has higher material requirements than traditional combustion engines. Currently, most lithium is extracted from hard rock mines and much of the energy used to extract and process it comes from CO2- emitting fossil fuels. Hence, understanding the Life Cycle of the battery, from production to disposal and the CO2 emission throughout the entire life span of the battery components is crucial to determine the true carbon cost of batteries.

Advantages

As battery technology and energy density has improved, the cost per kilowatt-hour (kWh) has decreased to the point that tugs powered primarily (or solely) by batteries have become viable, particularly for tugboats less than 500 GT.

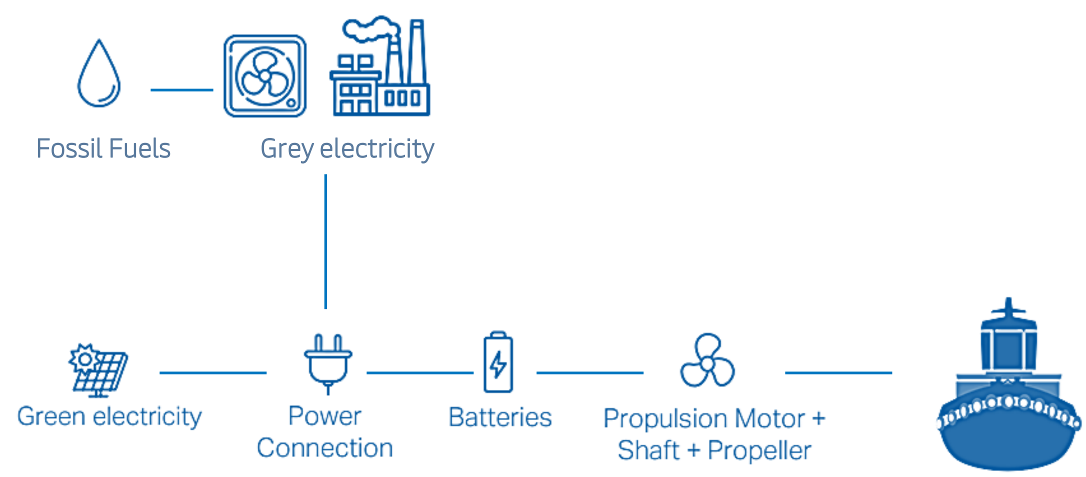
These vessels can perform all their operations from batteries and charge from shore power. Battery tugs provide a clear pathway to net zero emissions, provided sources of electrical shore power are also green and charging infrastructure is available. To obtain close to zero lifecycle emissions, the electricity itself must be produced by a zero-emission energy source, or by using Carbon Capture and Storage (CCS).

Challenges

While battery-electric tugs can result in zero or near zero GHG emissions, they are not suitable in every tug application due to the limited operational time between charging:

- Harbour towage with predictable operational profiles are needed
- Fleet mix needs to cover frequent recharging
- Shoreside charging infrastructure must be available
- Charging infrastructure expensive to install if at all (e.g., remote locations, away from established power grids)
- Larger tugs (e.g., escort duty) with more demanding power and endurance requirements, may lack space to fit batteries with sufficient capacity
- Battery size, weight and cost limits utility for all tug types

Well-to-Wake Process



Key Points	
Technological Maturity - Production	Production already widely available
Technological Maturity - Use	Mature but not for all applications
Energy Density	22x the volume of MGO equivalent needed
Safety considerations	High safety in use. Battery fires a concern
Global availability of fuel	Strong competition for batteries in the EV industry
Sustainability ESG	Batteries are zero carbon emitting, but the LCA of batteries have emissions in the production phase
CAPEX	High – compared to fossil fuels
OPEX	Medium – compared to fossil fuels