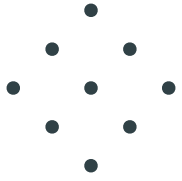


LATERAL

NAVAL ARCHITECTS

ENERGY
TRANSITION
PLATFORM

LATERAL

Lateral Naval Architects provide complete engineering expertise to the superyacht industry, from project conception to delivery.

Our core competence is engineering, but our unique focus is on meaningful innovation, to enable superyachts that meet the demands of today's owners and those of the future.

We believe that meaningful innovation starts with asking new questions.

LATERAL

How do you future-proof a superyacht?

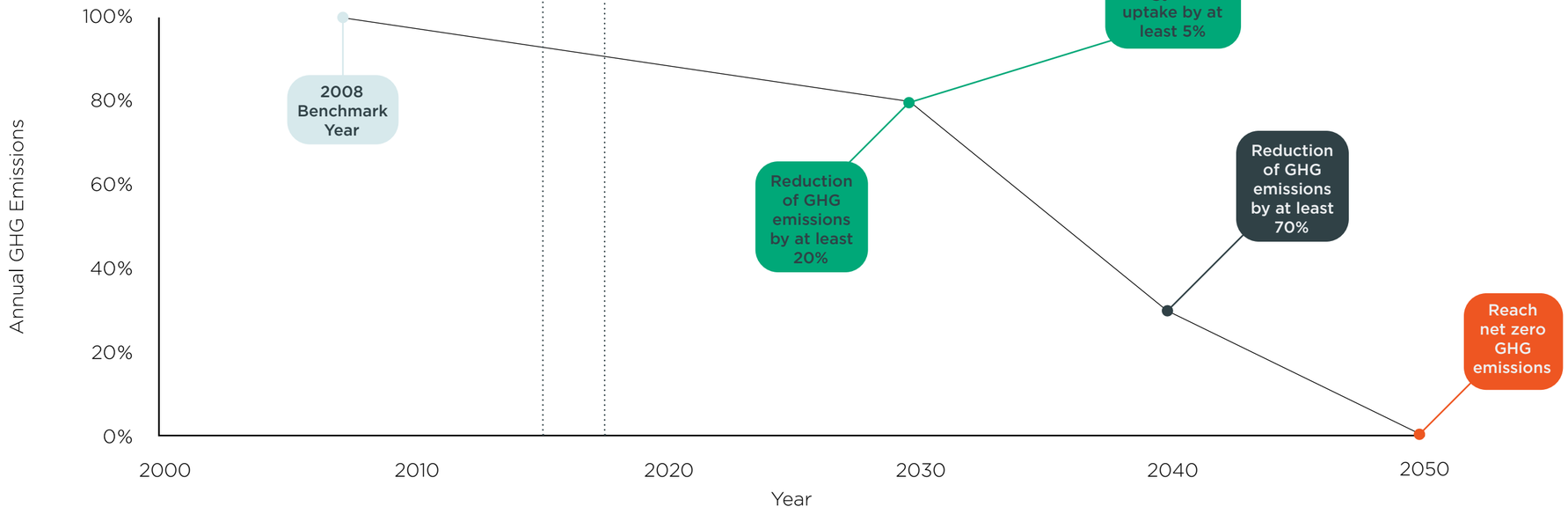
'TOMORROWLAND' BY SYD MEAD

LATERAL

FUTURE MARITIME TARGETS

2015 Paris Agreement:
Set in motion a renewed global effort to minimise the efforts of climate change.

2018 IMO Agreement:
Implement measures to reduce the emission of greenhouse gases (GHG) by shipping.



What tools drive these targets?
Interim IMO Tools:
EEDI – Sets minimum design efficiency per transport mile for new builds. Presents a pass/fail reference that gets harder for newer ships.
EEXI – As EEDI but for existing ship.
CII – Operational recorded fuel use against transport mile requires year-on-year fuel reduction/improvement to achieve good ratings.

EU Tools:
ETS - Carbon cap and trade system, imposing costs for excessive carbon pollution.

Are Yachts Set to Comply?
Current regulations do not have a meaningful impact in the design and operation of large yachts. There is a great deal of uncertainty about the direction of future regulations, and its possible in the near future that yachts will need to adapt to mandatory energy efficiency.

There isn't a meaningful incentive for the yachting fleet to change its practices, but should we maintain business as usual whilst the rest of the maritime fleet is moving towards net zero?

LATERAL

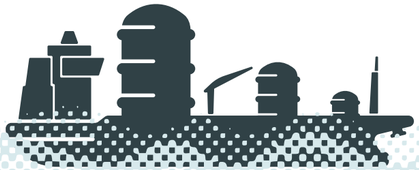
WHICH ENERGY CARRIER?

The concept of fuel energy carrier refers to various substances that can store and transport energy. There are numerous types of fuel energy carriers, each with its own set of advantages and disadvantages. In the context of setting a net zero path, two primary metrics will have major impact on the design of a yacht; the well to wake and the energy density.

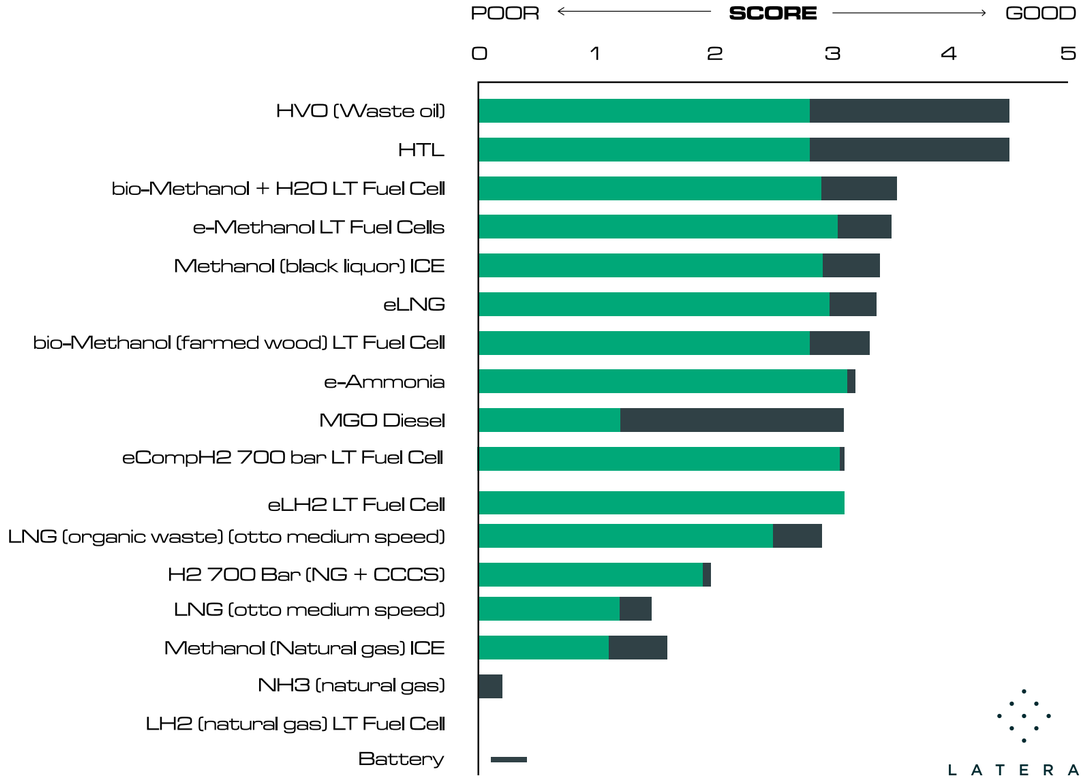
The first key metric to consider is the **well-to-wake,** which is all emissions in the fuel lifecycle and their relative greenhouse gas effects to establish an equivalent amount of CO2 released per onboard energy.

In yacht design, the second key performance indicator is the ratio of luxury space to Gross Tonnage with the higher ratio giving a strong commercial advantage. In the case of a yacht primarily intended for leisure with no useful “transport work”, this ratio essentially determines the value delivered per unit of volume of the yacht, in effect it is a measure of density.

Therefore, the **energy density** of any alternative fuel is an important design criteria.



SCORE = WELL-TO-WAKE + ENERGY DENSITY



LATERAL

VIABLE FUEL SOLUTIONS?

Ammonia based solutions

- Zero carbon
- Some compelling arguments regarding energy density
- Extremely toxic

Toxicity is considered not compatible with a yacht application.

Battery – Energy storage charged from shore power

- Very low energy density
- Constant improving energy density
- Dependant upon shore charging carbon intensity

Not considered currently viable as a primary energy source with current technology and market requirements.

Gaseous fuels – Including compressed hydrogen

- Energy density too low for large power applications.
- High TRL in some cases

Not compatible with a large yacht application.

Hydrogen carriers – Including LOHC, LIHC, metal hydrides etc

- Liquid/inert fuels
- Energy density lower than other options
- Equipment solutions difficult and at lower TRL

Interesting for some applications possibly in the future not priority for large yacht design.

Bio-derived fuels – Including Bio-methanol, HVO

- Good well to wake, net zero capability
- Liquid fuels at ambient pressure and temperature
- Good energy density
- Average power density
- Questions regarding long term sustainability

Feasible for further consideration.

Cryogenic Fuels – Including Liquid Hydrogen, LNG variants etc

- Challenging energy density and storage.
- Good power density
- Can be a zero carbon solution with low well to wake
- Technology TRL is relatively high

Feasible for further consideration.

E- Fuels – Synthetic fuels derived from renewable sources including e-methanol, e-diesel

- Good well to wake, net zero capability
- Liquid fuels at ambient pressure and temperature
- Good energy density
- Average power density
- Questions regarding authenticity of net zero, economic feasibility and maturity of technology

Feasible for further consideration.

LATERAL

DROP IN BIO-FUEL.
THE WAY FORWARD?

Reduction of 80-95% in CO2 emissions compared to diesel but will emit carbon and other local pollutants, not suitable whilst strict environmental limits are in place.

Superyacht running on bio-fuel could be future-proofed to some extent by providing a significant storage energy capacity for a local zero mode.

Future of these bio-fuels may not be reliably available to superyachts.

Ability to demonstrate the authenticity of the biomass feedstock and avoid greenwashing.

Availability of feedstock may become limiting factor, dependent on the growth and uptake by other industries.

The viability of bio-diesel to meet all future marine shipping requirements **is uncertain** due to supply competition and the development of a suitable marine distribution network. This may also impact the economic feasibility of the use of bio-diesel.

LATERAL

THE **MARKET DIRECTION**

Recent reports* show that **24%** of the newly awarded contracts within the maritime market involved the utilisation of alternative fuels, with a predominant focus on **Methanol.**

*Source DNV report

IN THE NEWS

Containership

- Maersk has 12 dual fuel methanol ships on order and 7 global partnerships to 790,000t of bio or e-methanol by 2025.
- CMA-CGM has 6 dual fuel methanol ships on order.
- Container ship industry is a suitable indicator to follow when it comes to infrastructure and its location.

Cruise

- Construction of Mein Schiff 7 as a methanol ready underway at Turku for TUI.
- Type approval of fuel cells at Meyer Werft for use of AIDA.

Ferry

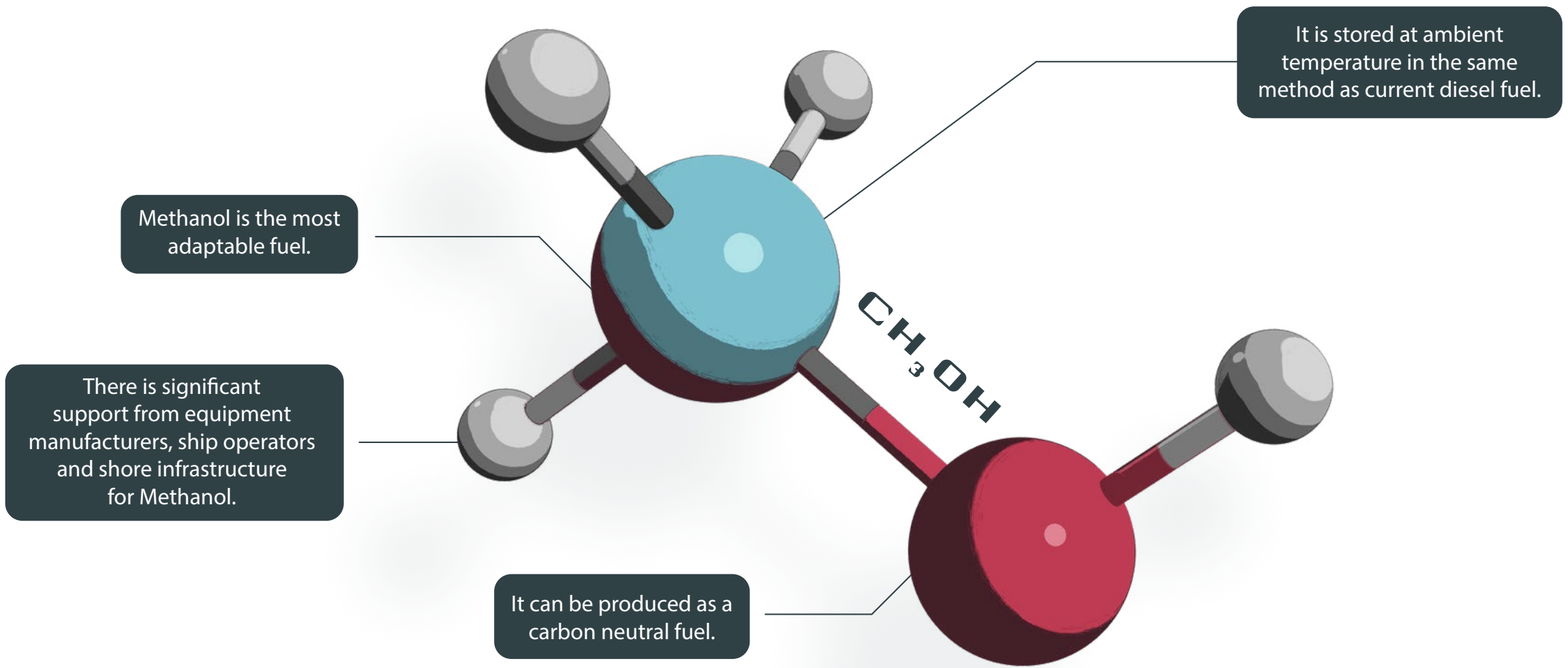
- Stena Germanica converted to methanol 2015.
- Running “Blue” Methanol in 2021.

Workboat

- MV Hydrogen one utilizing fuel cells in build for 2023 launch.
- Pilot project for port of Antwerp tugboat conversion.

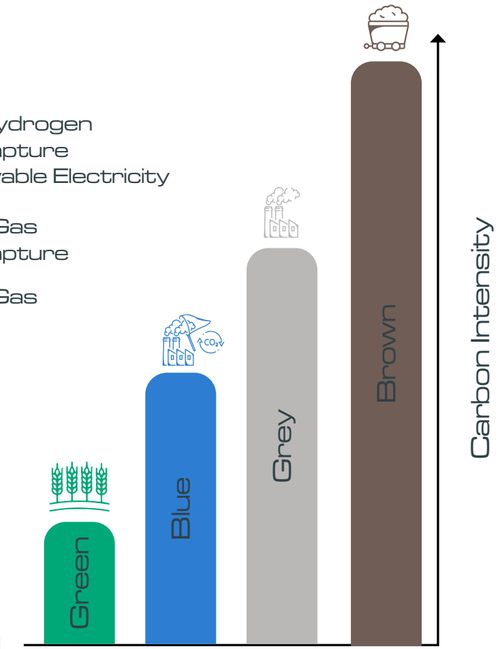
LATERAL

WHY **METHANOL?**



Key

Methanol	**Source**
Green	Green Hydrogen & CO^2 capture & Renewable Electricity
Blue	Natural Gas & CO^2 capture
Grey	Natural Gas
Brown	Coal



Green Methanol is the **yacht fuel** for the **energy transition.**

LATERAL

FUTURE-PROOFING

Future-proofing a superyacht is the process of anticipating the future to enable informed choices of layout, configuration, technology and specification that will avoid obsolescence within the intended lifespan of the yacht. We believe there are four key pillars to future-proofing a superyacht.

Any yacht built today, will have to span the energy transition, a period of significant change in available fuel types and associated technologies.

This demands an adaptable technical architecture that can accommodate the alterations to layout, configuration and specifications needed to integrate future technologies and alternative fuels in the least invasive way possible.

PILLAR 1

A highly optimised platform that operates in a fundamentally efficient solution space and operational parameters.

PILLAR 2

An all electric advanced architecture that can adapt to different types of energy sources.

PILLAR 3

Consider sufficient technical space and in-built flexibility to adapt to future fuels and technologies.

LATERAL

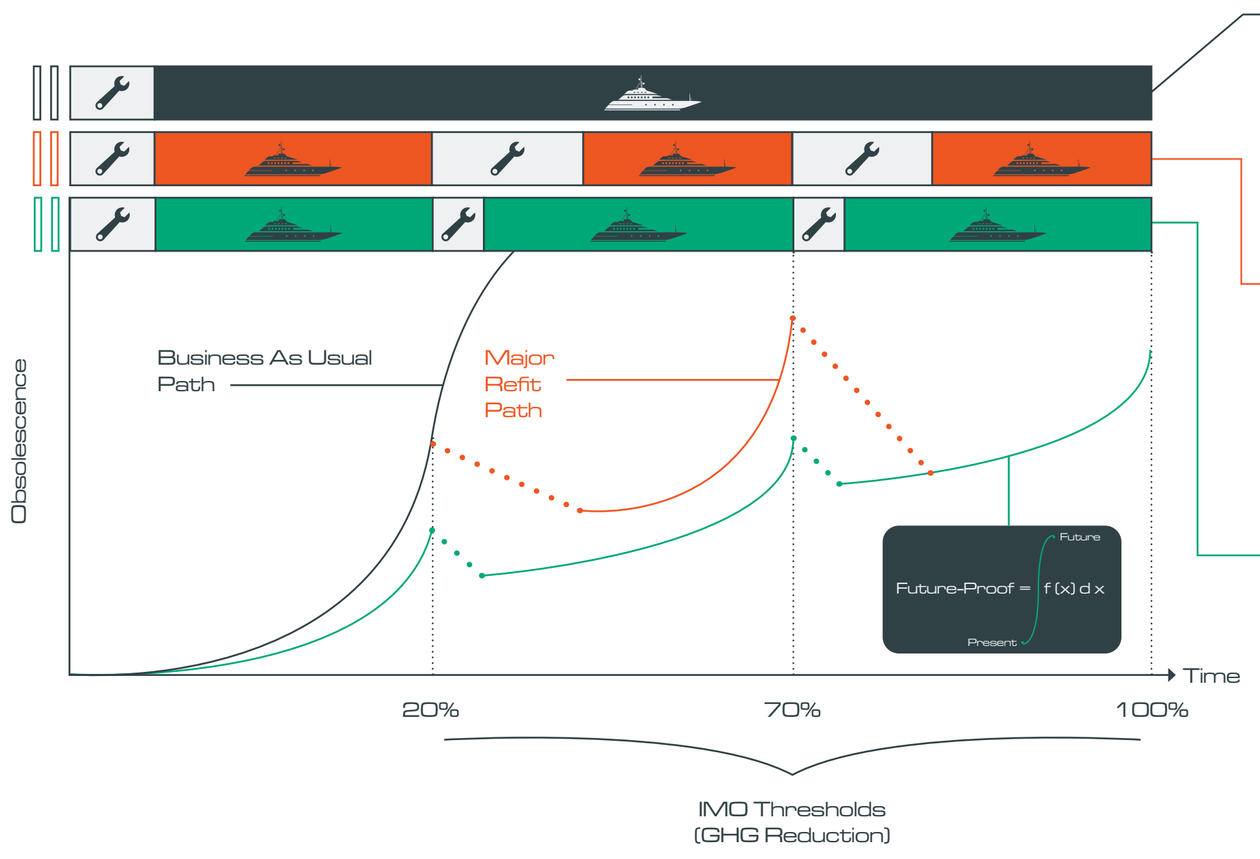
COST EFFECTIVE SOLUTION?

Considering a limited availability of HVO, and a desire to align with the IMO goals, Lateral has explored various scenarios highlighting the importance of investment and the retention of asset value over the entire yacht's lifespan.

How does the **Energy Transition Platform** compare against different pathways when evaluating both yacht obsolescence and the usability?

In Shipyard

At Sea



Business As Usual (BAU)

BAU + Major Refit Path

Future-Proof Path

LATERAL

ENERGY TRANSITION PLATFORM

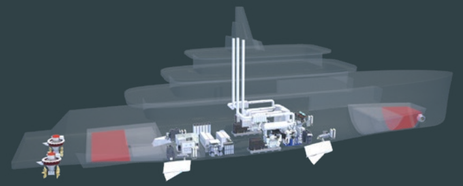
Lateral have developed the Energy Transition Platform (ETP) to ensure multiple technical pathways can be pursued as technologies mature during the energy transition time line.

This project is configured in her initial configuration to be state of the art today; fully procurable and warrantable as an advanced diesel electric architecture. In her final ‘end state’ the project would be upgraded to a 100% alternative fuel hybrid of fuel cells and internal combustion power generation. Critically, during her lifespan, a pre-strategised and intermediate upgrade can be implemented, dependent upon the advancement and commercial availability of technology.

100% PERFORMANCE CAPABILITY
Top Speed & Range Maintained Throughout

DIESEL OR **HVO**

METHANOL
OR OTHER ALTERNATIVE
LOW FLASH POINT FUEL



CURRENT STATE-OF-THE-ART

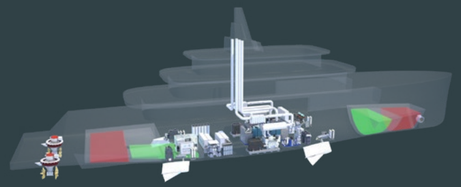
Stage 1
DIESEL ELECTRIC HYBRID

Present

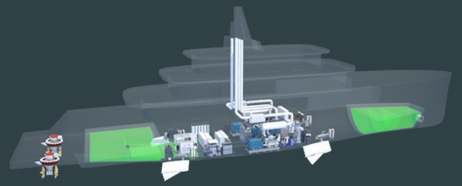
Period for further development of fuel cells, machinery and fuel infrastructure

MID-LIFE UPGRADE

Stage 2
DUAL FUEL METHANOL/DIESEL



Full diesel operation maintained in case of lack of fuel availability or sytem reliability



Stage 3
100% METHANOL

END STATE

Future

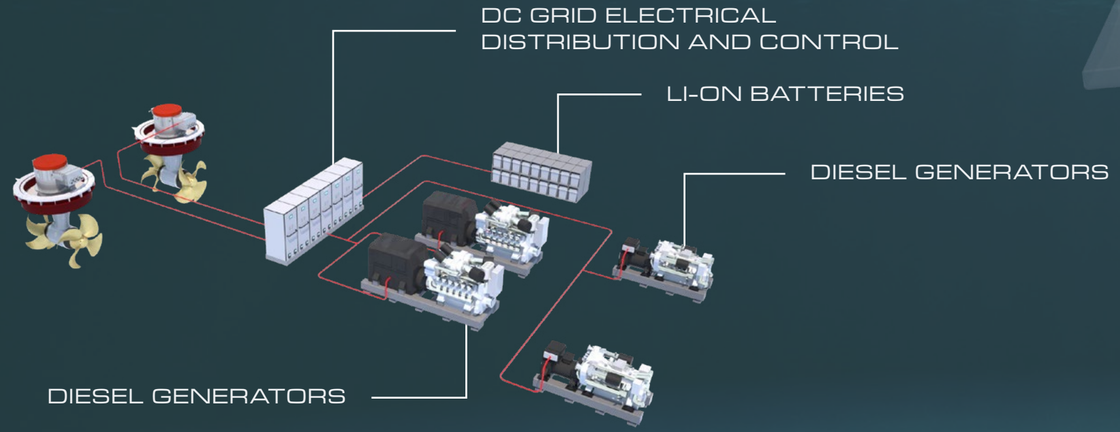
100% Net Zero

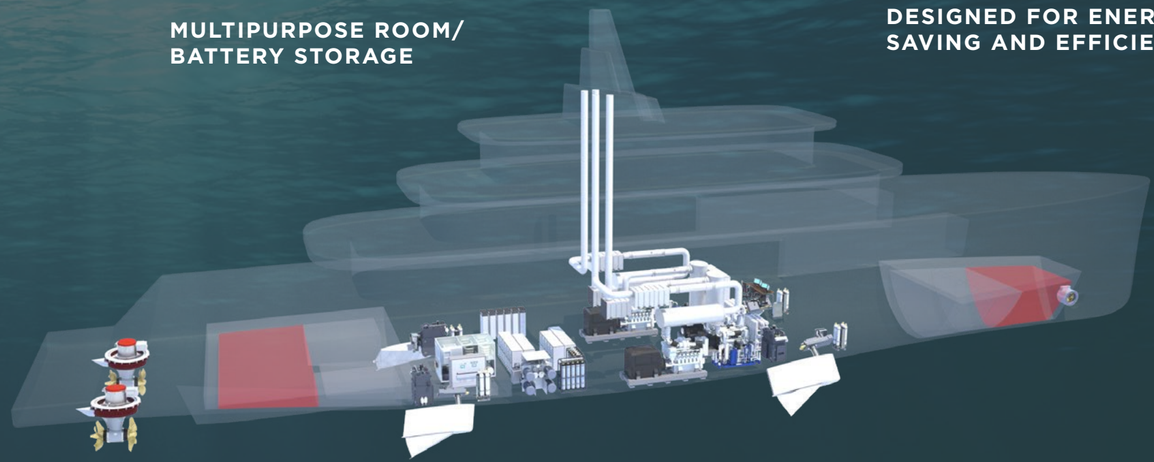
LATERAL

THE ENERGY TRANSITION PLATFORM

STAGE 1

100% ADVANCED DIESEL ELECTRIC SYSTEM (WITH BATTERIES). ENGINEERED WITH A FUTURE FUEL STORAGE ARCHITECTURE.





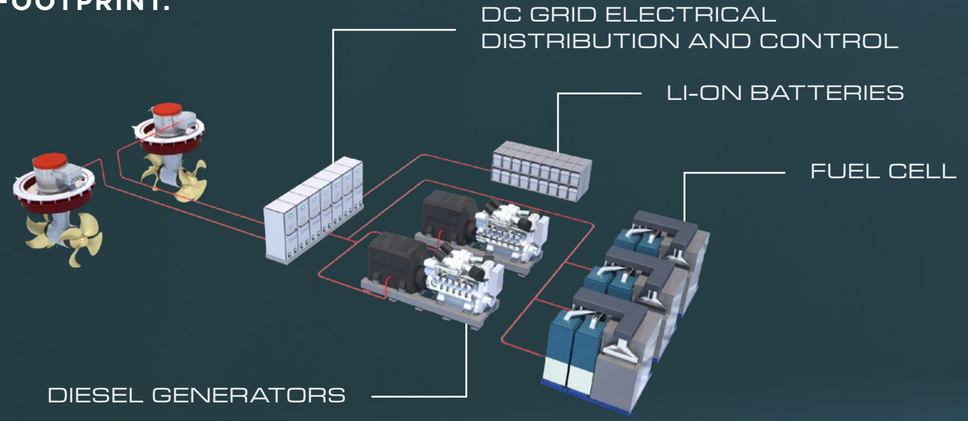
LATERAL

THE ENERGY TRANSITION PLATFORM

STAGE 2

UPGRADEABLE IN LINE WITH AVAILABLE FUEL CELL TECHNOLOGY DEVELOPMENTS. DUAL FUEL CAPABLE WITH REDUCED CARBON FOOTPRINT.

CAN CARRY ENOUGH METHANOL TO OPERATE 2 WEEKS AT ANCHOR



METHANOL FUEL CELLS WITH SUFFICIENT POWER TO MEET REQUIREMENTS WHILST AT ANCHOR

IN THE EVENT OF LACK OF METHANOL AVAILABILITY OR EQUIPMENT RELIABILITY CAN OPERATE IN ALL CONDITIONS ON DIESEL ONLY

REDUCED GHG EMISSIONS BY 40-50%*

CONVERSION TO STAGE 2 IN A REFIT. CONVERSION IS PRE-ENGINEERED AND CONSIDERED IN INITIAL DESIGN.

CAN CARRY ENOUGH DIESEL TO MAINTAIN FULL RANGE OF 4500NM

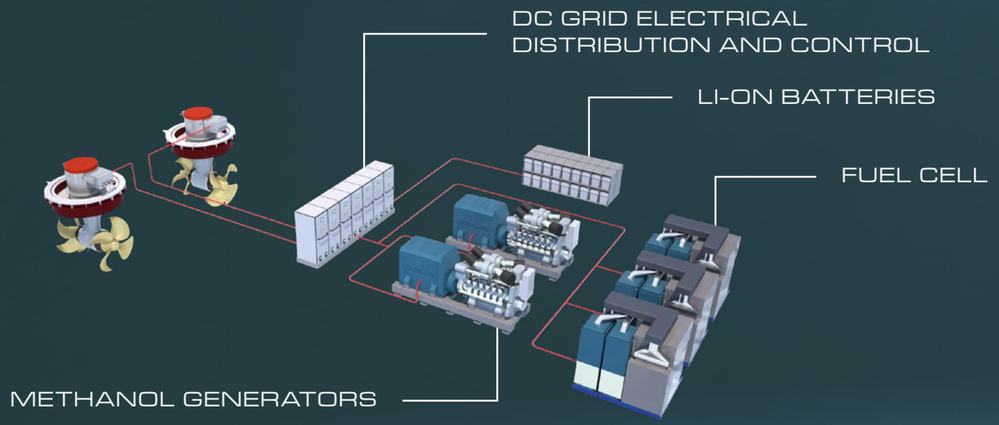
*GHG EMISSIONS REDUCTION DEPENDENT ON OPERATIONAL PROFILE AND FUEL PRODUCTION METHOD

LATERAL

THE ENERGY TRANSITION PLATFORM

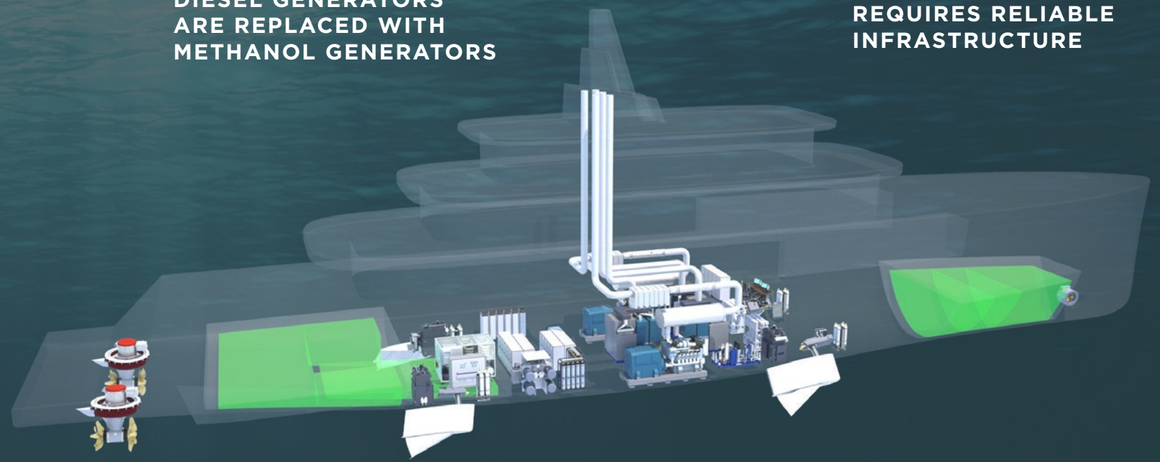
STAGE 3

**NO DIESEL ONBOARD
FULL RANGE AND SPEED
CAPABILITIES MAINTAINED
VIA FUEL CELL/COMBUSTION
ENGINE HYBRID.**



**DIESEL GENERATORS
ARE REPLACED WITH
METHANOL GENERATORS**

**100% METHANOL FUEL
REQUIRES RELIABLE
INFRASTRUCTURE**



**REDUCED GHG EMISSIONS
BY 96%***

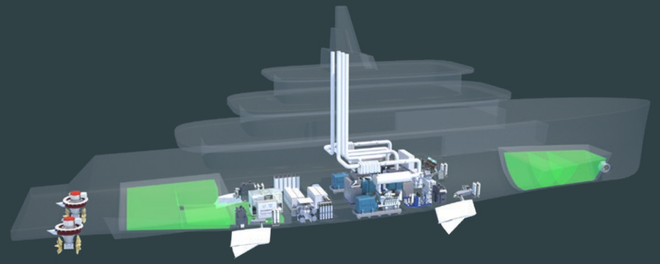
**CONVERSION TO STAGE 3
IN A REFIT. CONVERSION
IS PRE-ENGINEERED AND
CONSIDERED IN INITIAL
DESIGN.**

**CAN CARRY ENOUGH
METHANOL TO MAINTAIN
FULL RANGE OF 4500NM**

*GHG EMISSIONS REDUCTION DEPENDENT ON OPERATIONAL PROFILE AND FUEL PRODUCTION METHOD

LATERAL

ENERGY TRANSITION PLATFORM



Principal particulars

Length Overall	70.0 m
Length Waterline	70.0 m
Beam	12.2 m
Draught (Full Load)	3.5 m
Gross Tonnage	1700
Top Speed	16.0 knots
Cruise Speed	13.0 knots
Range Speed	12.0 knots
Range	4500nm

ASK FURTHER QUESTIONS

Adrien Thoumazeau

Principal Naval Architect / R&D Coordinator

athoumazeau@lateral.engineering

T +44 (0)23 8022 8855

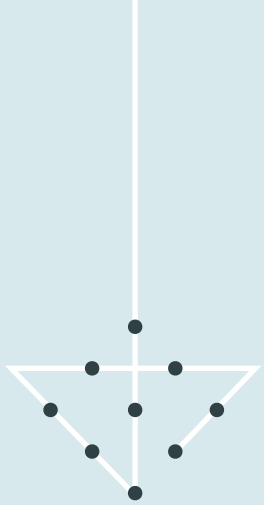
Simon Brealey

Chief Mechanical Engineer

sbrealey@lateral.engineering

T +44 (0)23 8022 8855

LATERAL



BUILDING 13,
SHAMROCK QUAY,
WILLIAM STREET, SOUTHAMPTON,
SO14 5QL, UK

T +44 (0)23 8022 8855

WWW.LATERAL.ENGINEERING