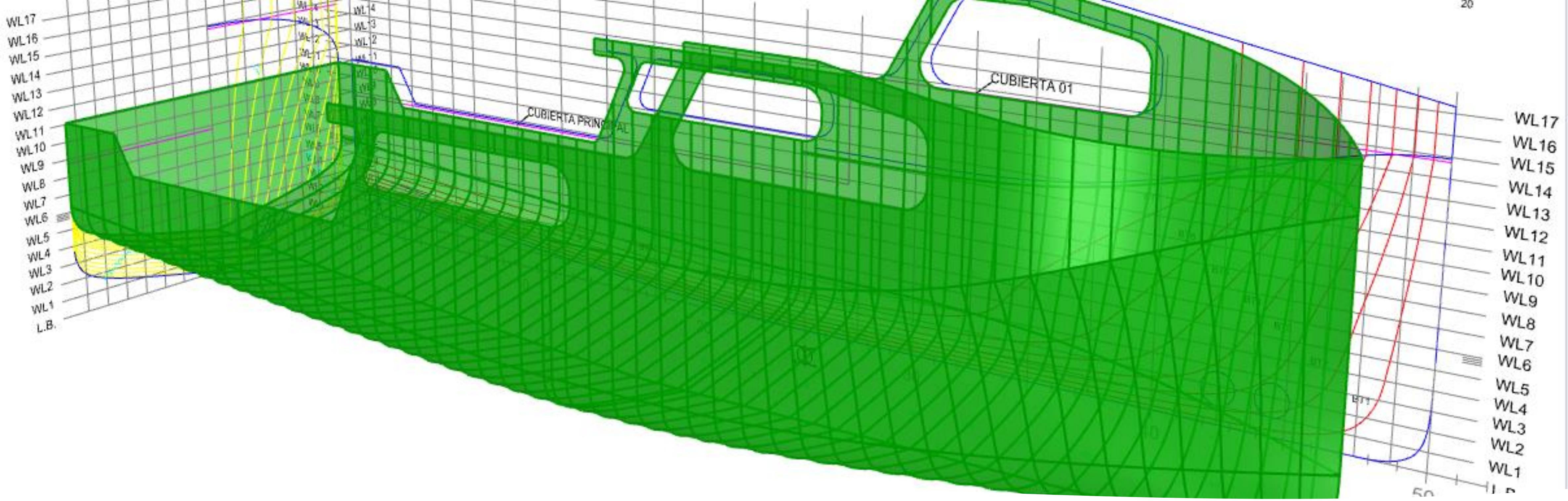
26th ERVO Annual Meeting
10th - 13th of June 2024

# SEAPLACE




# SHIP DESIGN

## Concept & Initial design

- New concept design
- Feasibility assessment
- Tender documentation packages
- Third party pre-contract review

## Basic Design

- General design
- Hydrodynamics & model testing
- Class documentation for approval
  - Naval Architecture
  - Structural Design
  - Mechanical Systems
  - Outfitting Design
- Final documentation
  - Trials, Stability booklet & Manuals

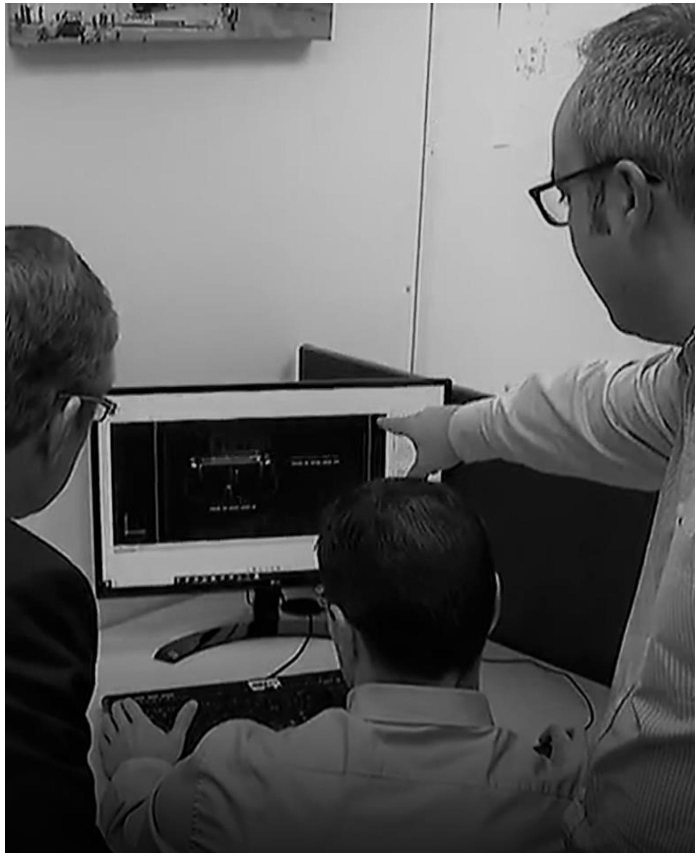
## Detail Design

- Structural Detail Design
- Outfitting Detail Design
- 3D model
- Workshop documentation
- Shipyard construction support

# CONSULTANCY

**High qualified engineers** working together in each project to **support client needs** and project **requirements**

| | | | | |
|---|---|---|---|---|
| Design basis & specifications | Third verification party | Risk analyses, FMEA, FMECA, HAZID, HAZOP | Logistic analyses | Due dilligence |
| Safety | Rules and Regulations | Naval Architecture | Structural assessment | Hydrodynamic performance |
| Main Systems | Energy Efficiency | Emissions reduction | Alternative fuels | Technical support to procurement team |
| Shipyard assessment and selection | Tender technical evaluation, RFPs, RFIs, RFQs | Hazardous materials | Life cycle | Cost estimation |



26th ERVO Annual Meeting
10th - 13th of June 2024

*R/V Emma Bardan*

*R/V Miguel Oliver*

*R/V Ramon Margalef*

*R/V Angeles Alvariño*

*R/V Sarmiento Gamboa*

Requirements definition
**Concept Design**
Basic Engineering
Detail Design
Shipyard support
Life cycle support
Conversions
Owner representative
Construction survey

*R/V Falkor Too*

*R/V Victor Angelescu*

*R/V Mar Argentino*

*R/V Vizconde de Eza*

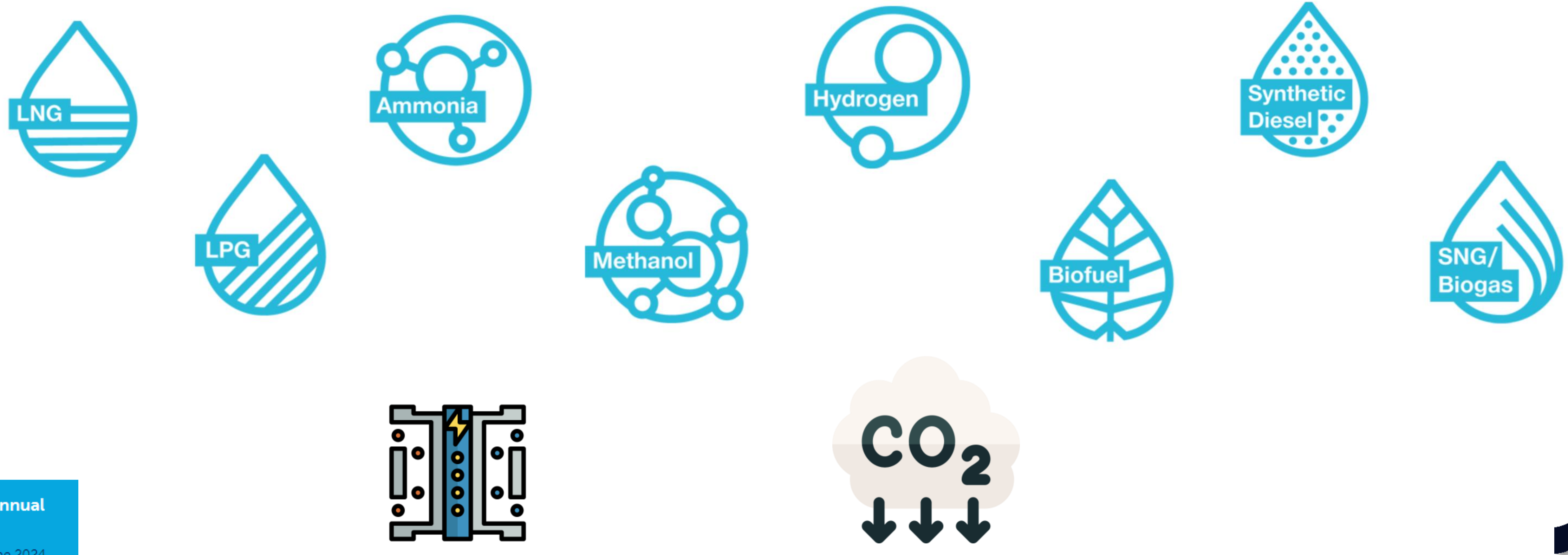
*R/V David Packard*



# REFERENCE RESEARCH VESSELS

# IMPLEMENTATION OF ALTERNATIVE FUELS AND DECARBONISATION TECHNOLOGIES IN RESEARCH VESSELS

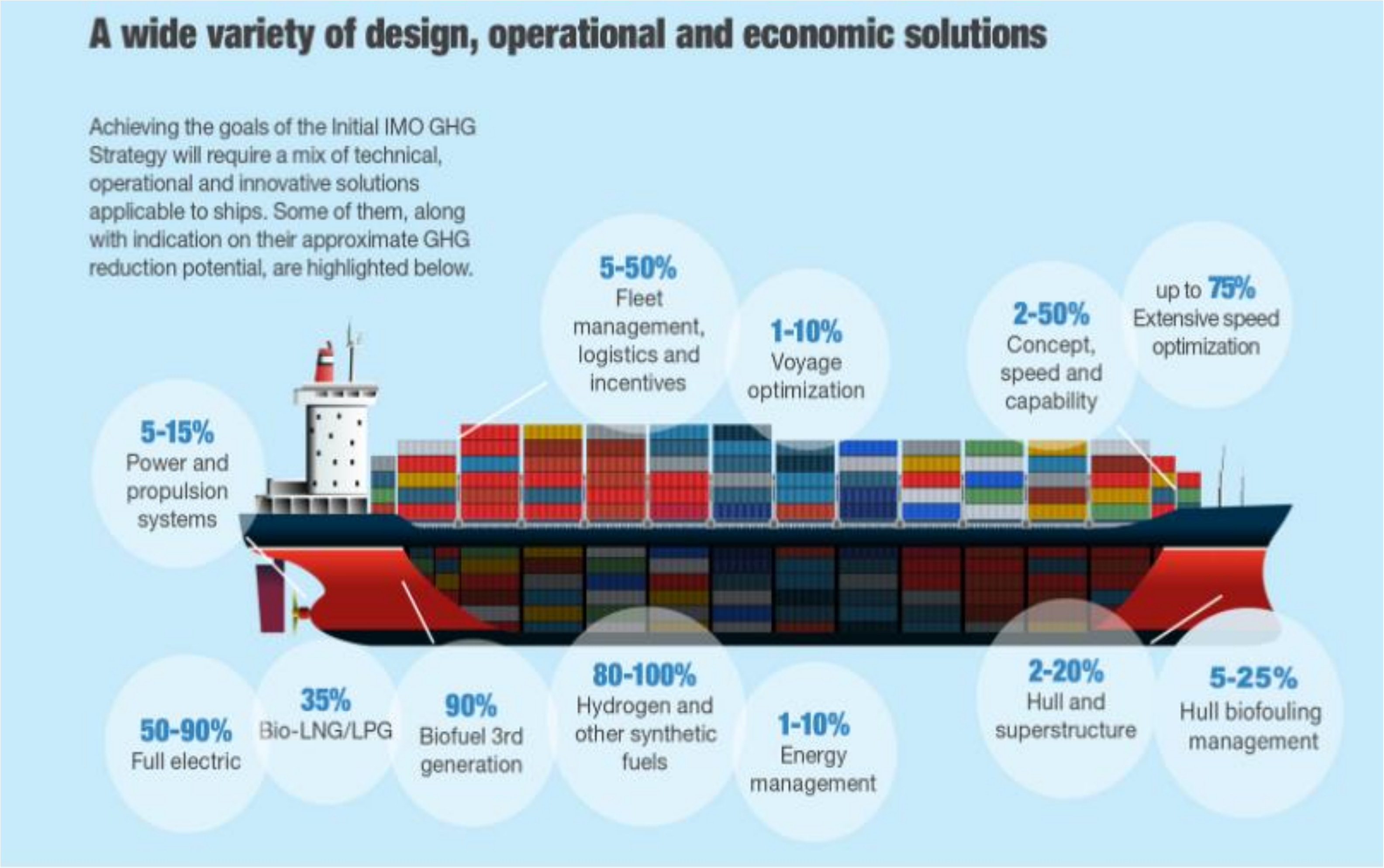
***FROM REQUIREMENTS DEFINITION TO SHIP DELIVERY***



# DECARBONIZATION PATHWAYS

Energy saving measures

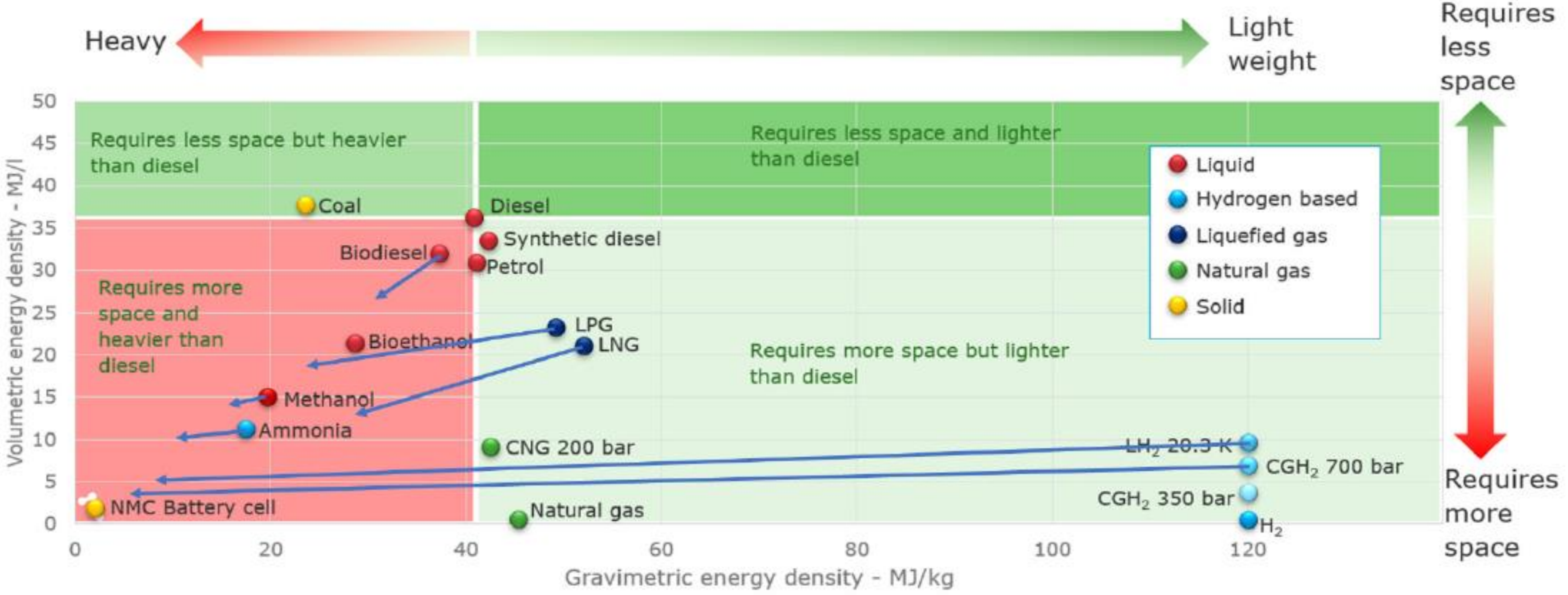
New energy sources
Carbon Capture




26th ERVO Annual Meeting
10th - 13th of June 2024

# STORAGE REQUIREMENTS

## FUELS




26th ERVO Annual Meeting
10th - 13th of June 2024

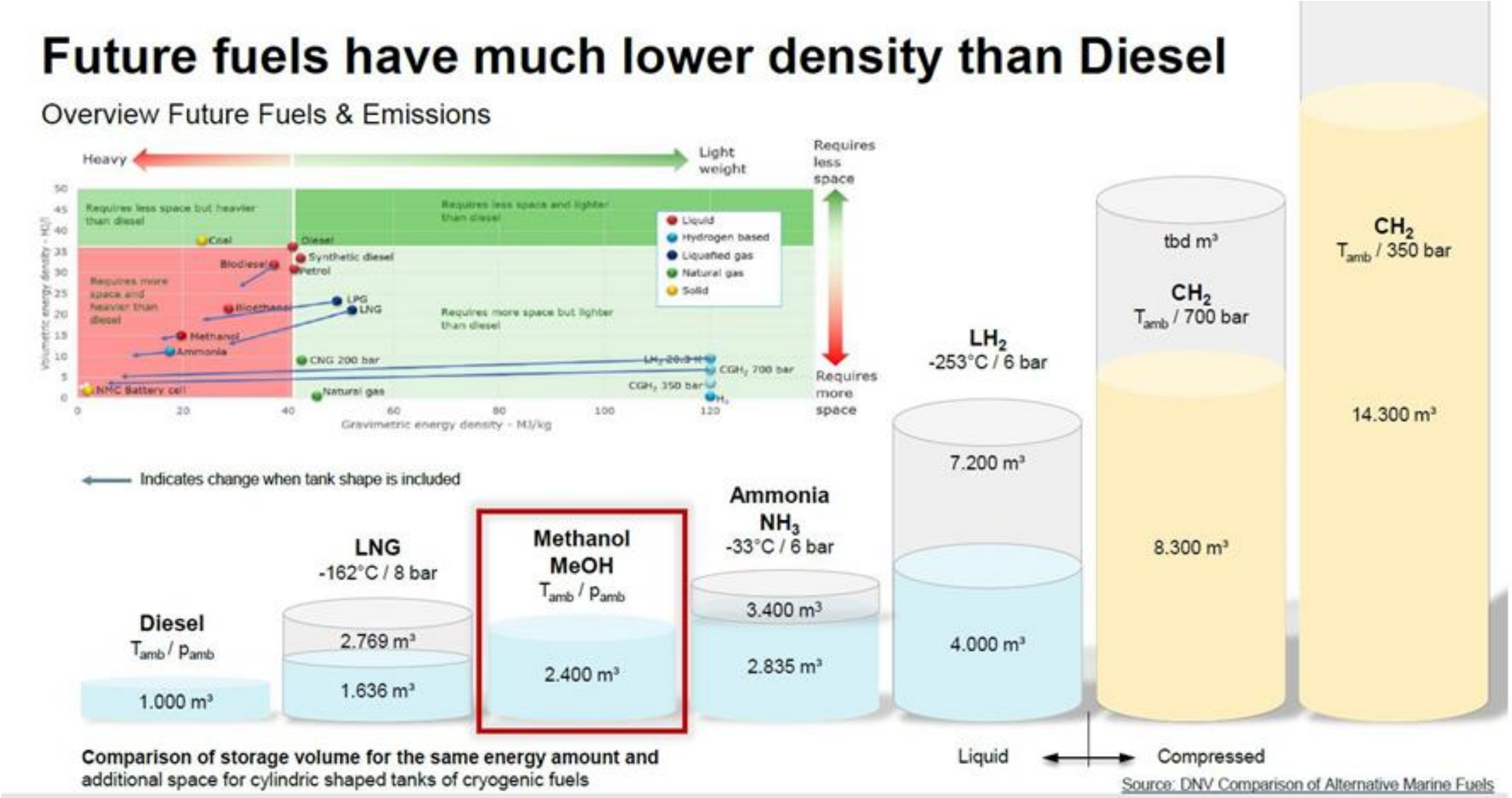
# STORAGE REQUIREMENTS

## *FUELS*

Methanol can achieve better storage volumes than LNG

Additional space for cylindrical tanks

These characteristics will not improve in the future

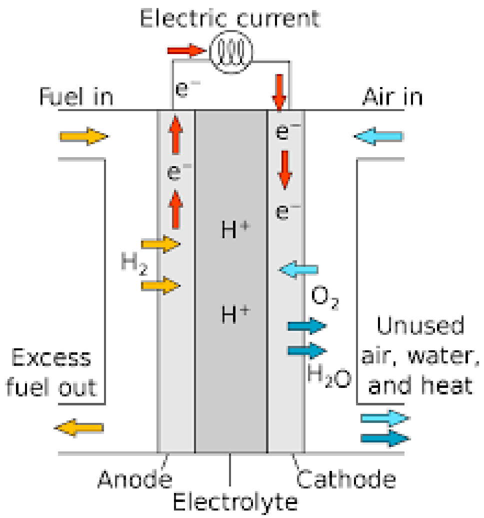



26th ERVO Annual Meeting
10th - 13th of June 2024

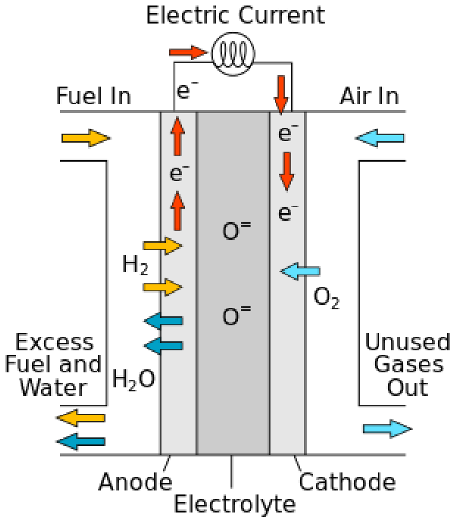
# ALTERNATIVE POWER GENERATION

## *FUEL CELLS*

| | PEMFC | SOFC |
|---|---|---|
| Working Temperature | <120 °C | 500-1000 °C |
| Typical Stack Size | 1 kW – 100 kW | 1 kW – 2 MW |
| Electrical efficiency | 50-60 % | 50-65 % |
| Power density volume | 100-600 kW/$m^3$ | 3-10 kW/$m^3$ |
| Power density weight | 200-400 kW/t | <90 kW/t |
| Advantages | Low Temperature<br>Quick start-up and loading | High efficiency<br>Fuel flexibility<br>Hybrid/gas turbine |
| Challenges | Sensitive to fuel impurities<br>Expensive catalysts | High temperature<br>Long start-up time<br>Slow load variations |




Proton Exchange Membrane Fuel Cell




Solid Oxide Fuel Cell

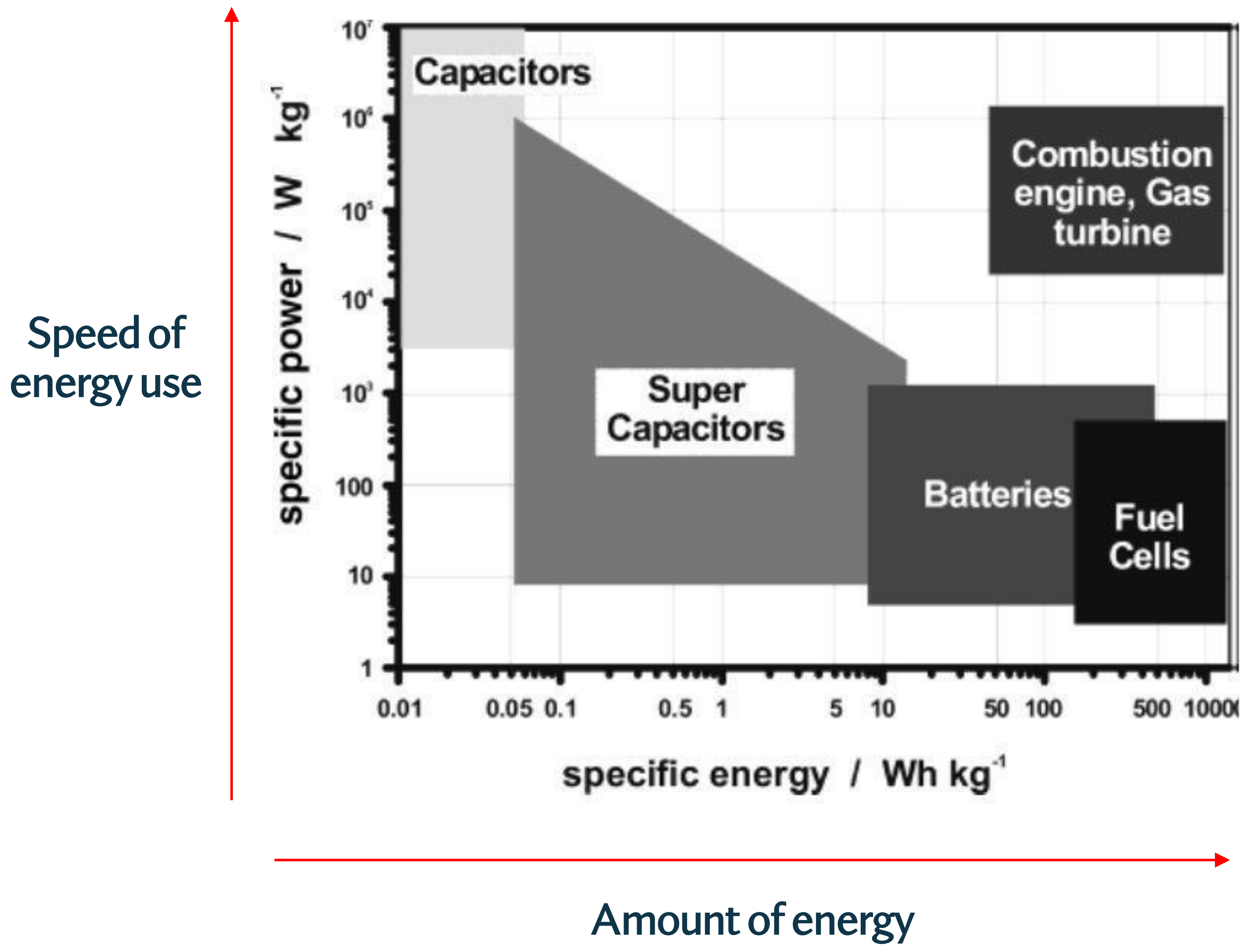
26th ERVO Annual Meeting
10th - 13th of June 2024

# STORAGE REQUIREMENTS

## *ENERGY CONVERTERS*

RAGONE CHART

- Relates power, energy density for different power plants
- Takes into account energy storage (fuel, battery) and energy conversion devices
- Combustion engines in ideal region

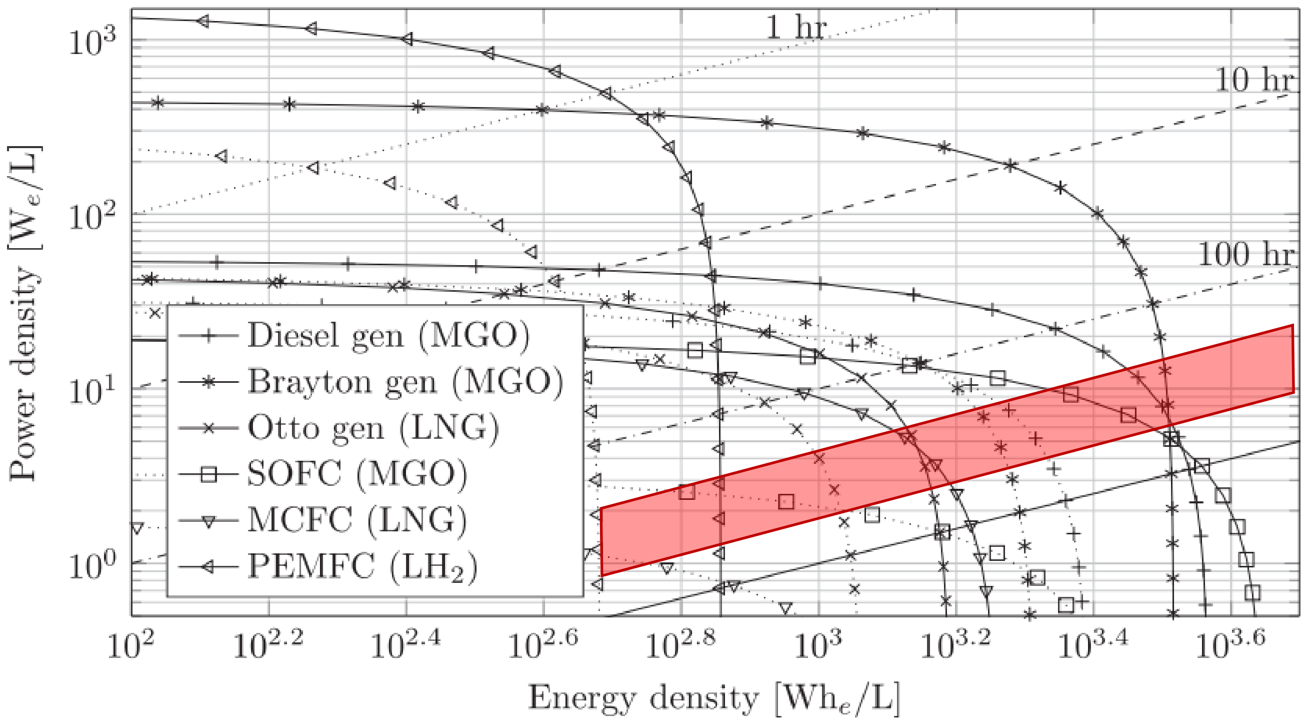


# STORAGE REQUIREMENTS

## *ENERGY CONVERTERS*

### Ragone Chart – Volumetric

- Similar tendency as gravimetric
- Typical ship autonomy 200-500 h
- SOFC (using MGO) competitive with combustion engines in this range




(a) Volumetric density of various maritime power plants.

26th ERVO Annual Meeting
10th - 13th of June 2024

# CARBON CAPTURE AND STORAGE METHODS

Carbon Capture methods:

- Chemical Absorption
- Membrane Separation
- Adsorption
- Cryogenic Separation
- Oxy-Fuel Separation

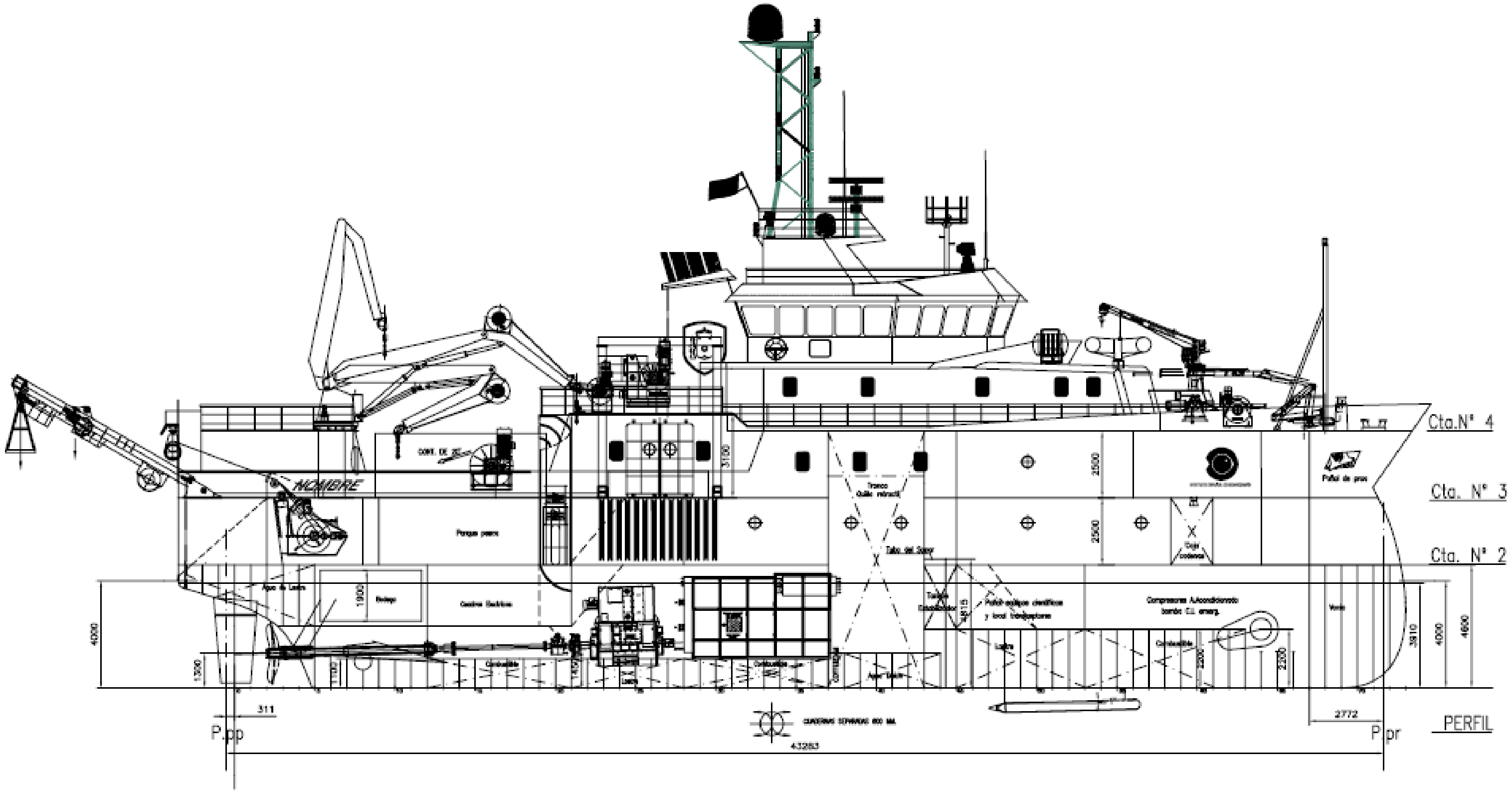
| | Temperature | Pressure | Density |
|---|---|---|---|
| Compressed and Refrigerated Liquid | -20 °F (-28.9 °C) | 300 psi (20.4 bar) | 67 $lb/ft^3$ (1,073 $kg/m^3$) |
| Compressed Gas at Ambient Temperature | 110 °F (43.3 °C)<br>40 °F (4.4 °C)<br>-10 °F (-23.3 °C) | 800 psi (54.4 bar)<br>800 psi (54.4 bar)<br>800 psi (54.4 bar) | 7.91 $lb/ft^3$ (128 $kg/m^3$)<br>57.2 $lb/ft^3$ (916 $kg/m^3$)<br>66.3 $lb/ft^3$ (1,062 $kg/m^3$) |
| Compressed Fluid at Ambient Temperature | 110 °F (43.3 °C)<br>40 °F (4.4 °C)<br>-10 °F (-23.3 °C) | 3000 psi (204 bar)<br>3000 psi (204 bar)<br>3000 psi (204 bar) | 51.7 $lb/ft^3$ (828 $kg/m^3$)<br>62.8 $lb/ft^3$ 1,006 $kg/m^3$)<br>69.2 $lb/ft^3$ (1,108 $kg/m^3$) |
| Dry Ice Storage at Ambient Pressure | -120 °F(-84.4 °C) | 14.7 psia (1 bar absolute) | 97.5 $lb/ft^3$ (1,562 $kg/m^3$) |

Requires additional Power

# R/V RAMÓN MARGALEF

## *CASE STUDY*

| Vessel specifications | |
|---|---|
| Length Overall | 46,7 m |
| Beam (max) | 10,5 m |
| Design Draught | 4,0 m |
| Depth (working deck) | 4,6 m |
| Installed Power (generators) | 2150 kWe |
| Service speed | 12 kn |
| Max speed | 13 kn |
| Endurance | 10 days / 3000 nm |
| Class Notation BV | I + HULL + MACH, SPECIAL SERVICE, UNRESTRICTED NAVIGATION, +AUT-UMS, +ALM, +ALS SYS-IBS, CLEANSHIP, CONF+, DINAPOS-AW/AT |
| Underwater Radiated Noise | ICES 209 |




**26th ERVO Annual Meeting**
10th - 13th of June 2024

# R/V RAMÓN MARGALEF

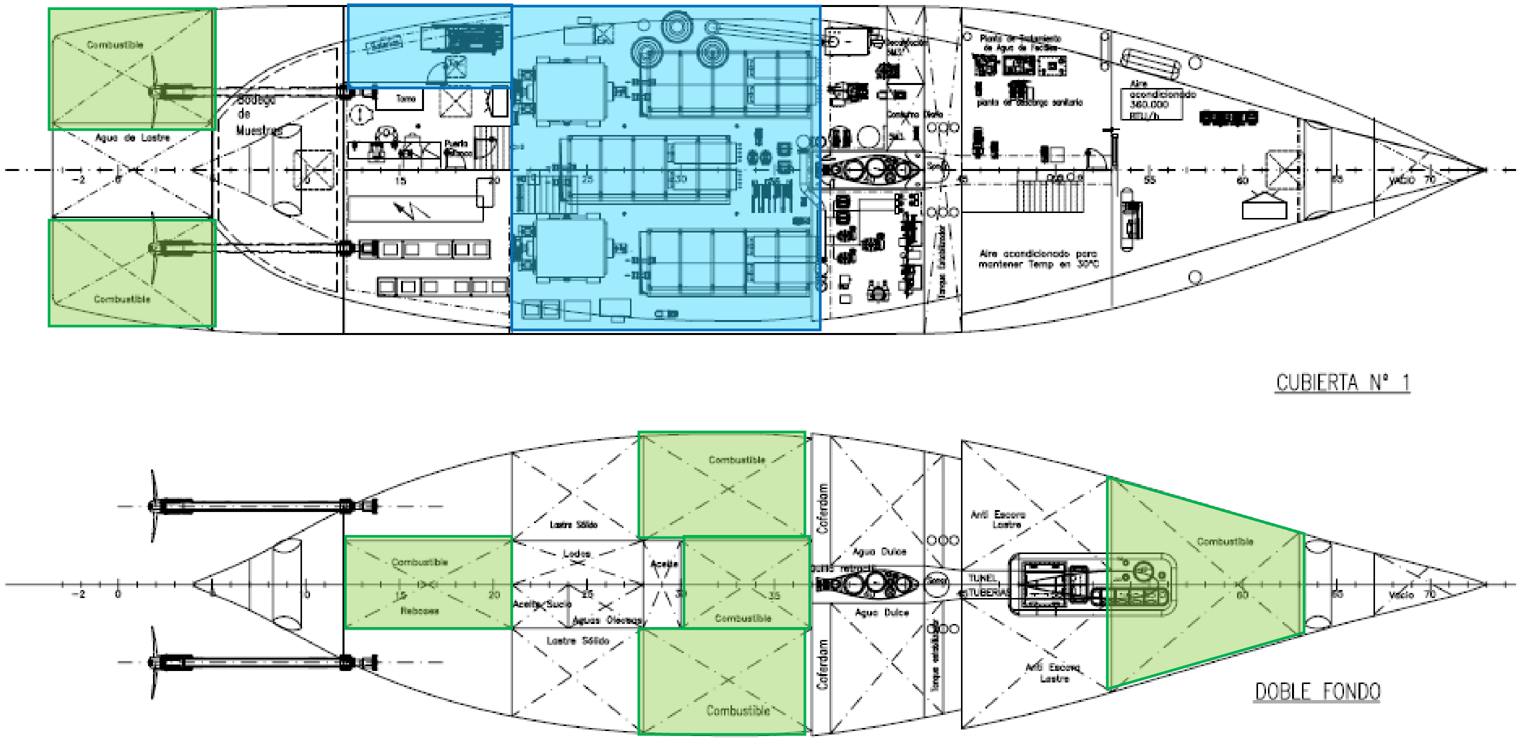
*CASE STUDY*

**Power Plant**

- 3x 850 kW Gensets
- 1x200 kW Harbour generator
- 2x 900 kW Propulsion motors

**Total FO Capacity:**

- 158 m3
- 134 t



# R/V RAMÓN MARGALEF

FO: 42,7 MJ/kg & 850 kg/m3

ME: 19,9 MJ/kg & 800 kg/m3

Total FO Capacity: 134 t

- 158 m3

Equivalent Methanol Capacity:

- 288 t
- 359 m3

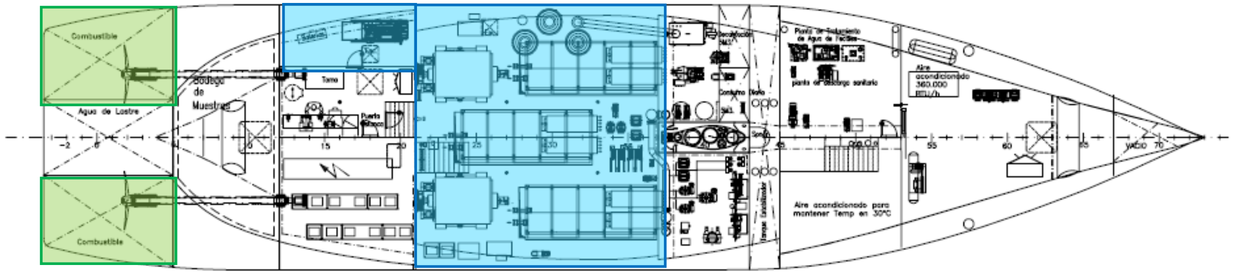
Available 4-stroke dual fuel engines of 850 kW?

- Option of MCR>3000 kW + Batteries?

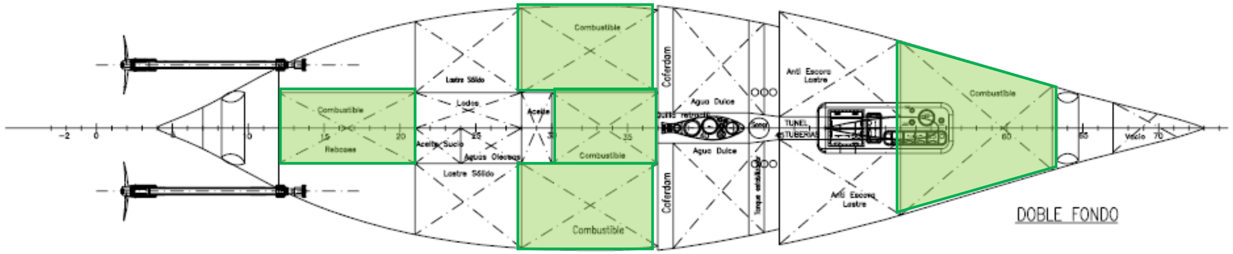
2,4 times more space for fuel storage

2-4 times more space for power plant if hybridization with batteries

## *METHANOL PLANT*



CUBIERTA Nº 1



DOBLE FONDO

Impact analysis main dimensions of the research vessel → Requirements definition

# R/V RAMÓN MARGALEF

## *$CO_2$ CAPTURE & STORAGE*

Total FO Capacity:

- 134 t
- 158 m3

CF,FO=3,206 (t-$CO_2$/t-Fuel)

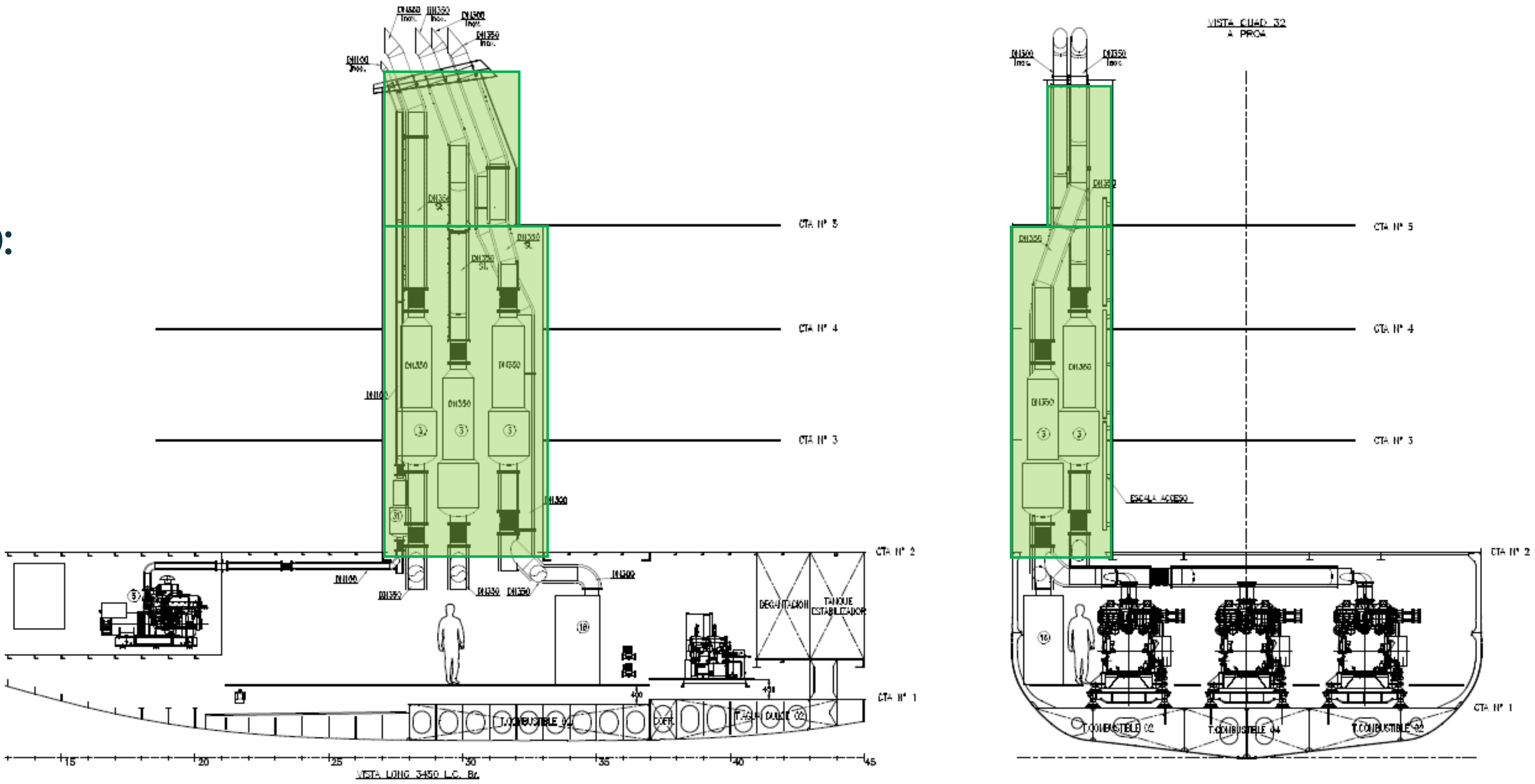
$CO_2$ generated (assuming 90% of FO use):

- 387 t
- 350 - 500 m3 for storage

The casing has less than 85 m3

Space requirements to allocate carbon capture equipment

~330 kW extra power for carbon capture process



# R/V RAMÓN MARGALEF

## *IMPACT ASSESSMENT*

Approximate existing total enclosed volume 3.600 m3

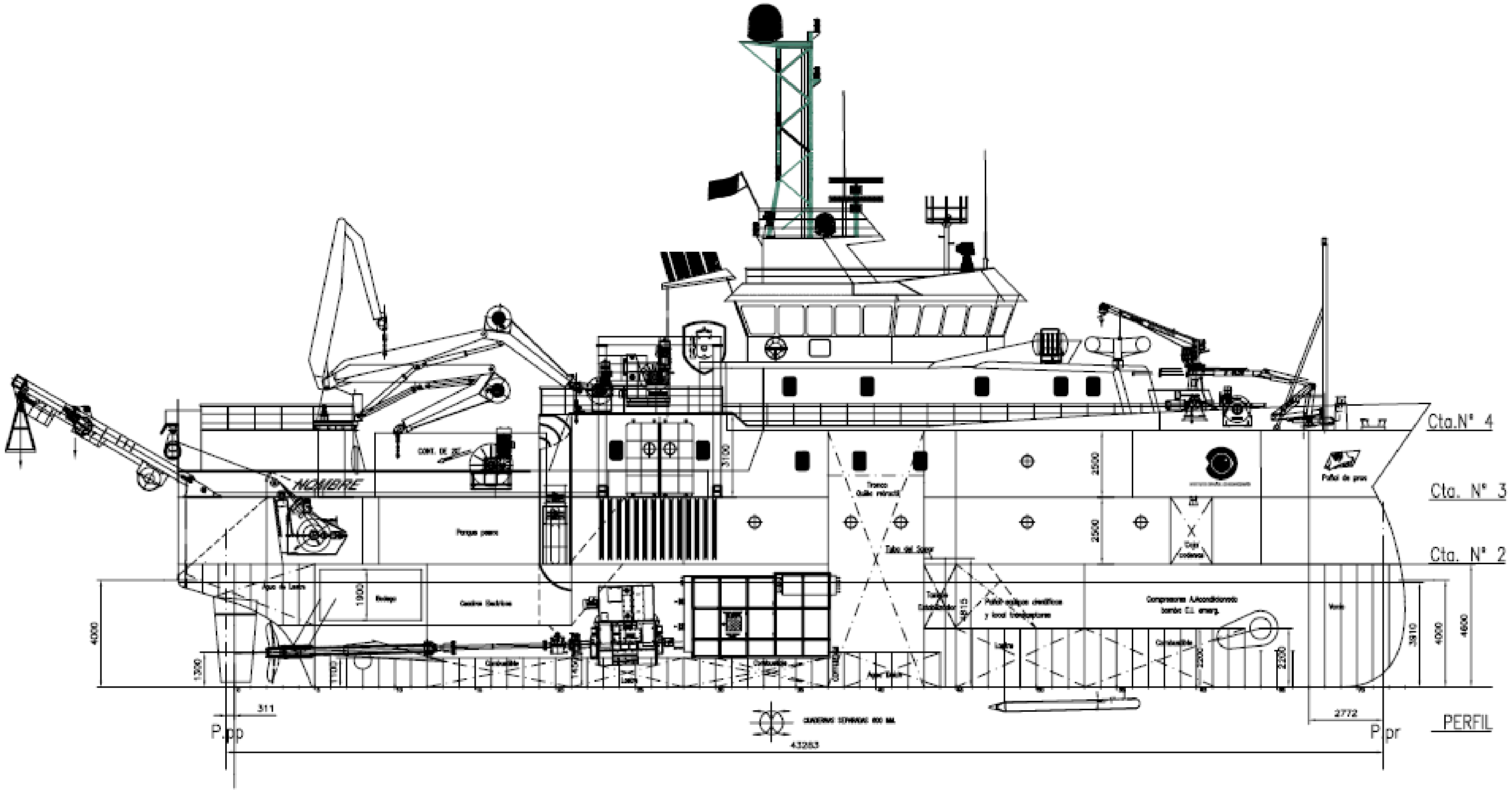
Methanol power plant and batteries

900 – 1.250 m3 extra

$CO_2$ capture & storage

350-500 m3 $CO_2$ storage extra

330 kW power requirement extra




26th ERVO Annual Meeting
10th - 13th of June 2024

# CONCLUSIONS

The implementation of alternative fuels requires a proper initial assessment based on:

- Physic-chemical characteristics of fuels
- Logistics
- Technology development status. Known available technology
- R/V operational profile

The impact on newbuildings to be considered from the initial requirements definition:

- Operation
- Main dimensions & power demand
- Economics

Opportunity to operate in full electric mode in specific operation profile

Oscar Perez
Ship Technical Manager
operez@seaplace.es

www.seaplace.es
Seaplace
seaplace@seaplace.es