Università di Genova

Clean energy solutions towards zero emissions for maritime applications

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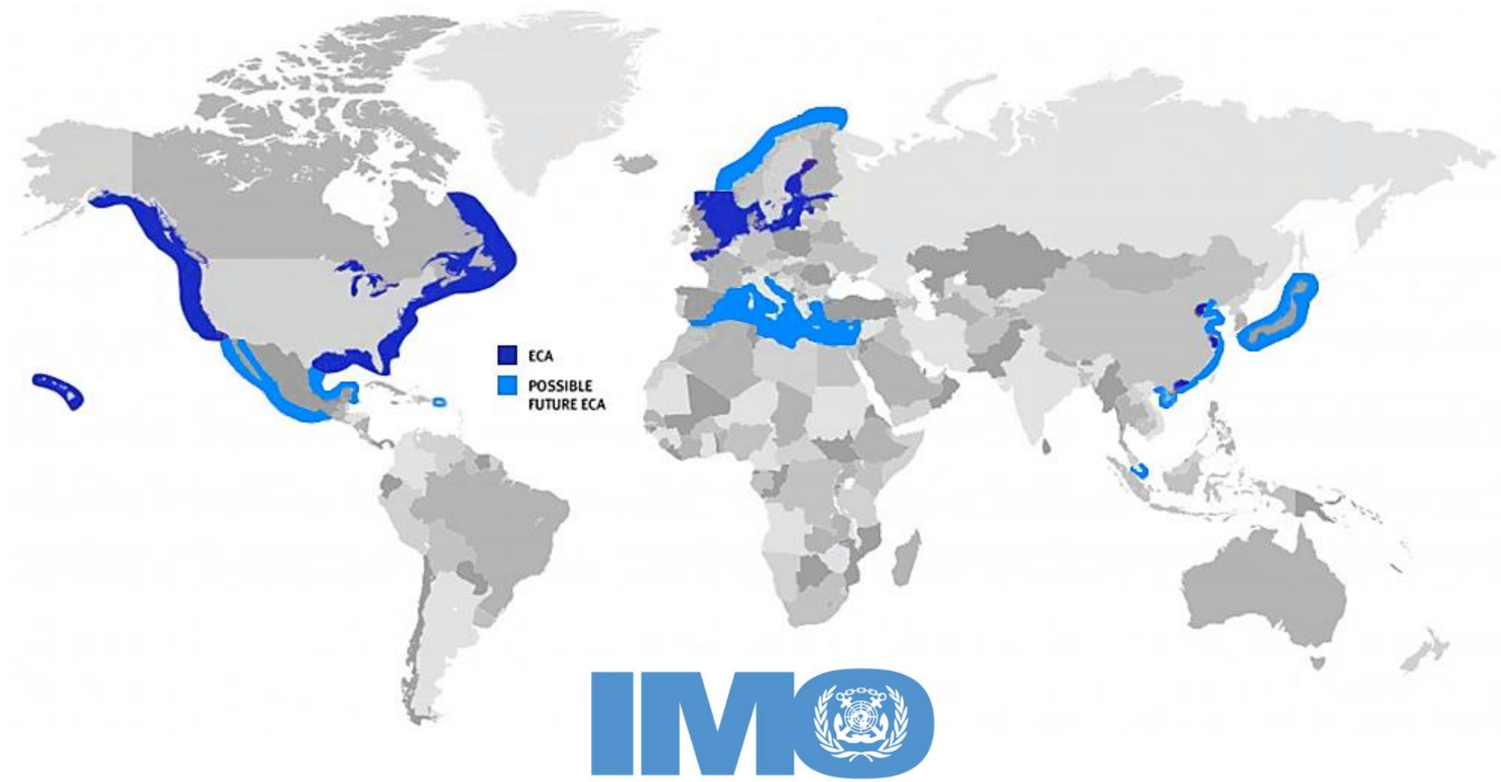
Eng. Massimo Rivarolo, PhD massimo.rivarolo@unige.it

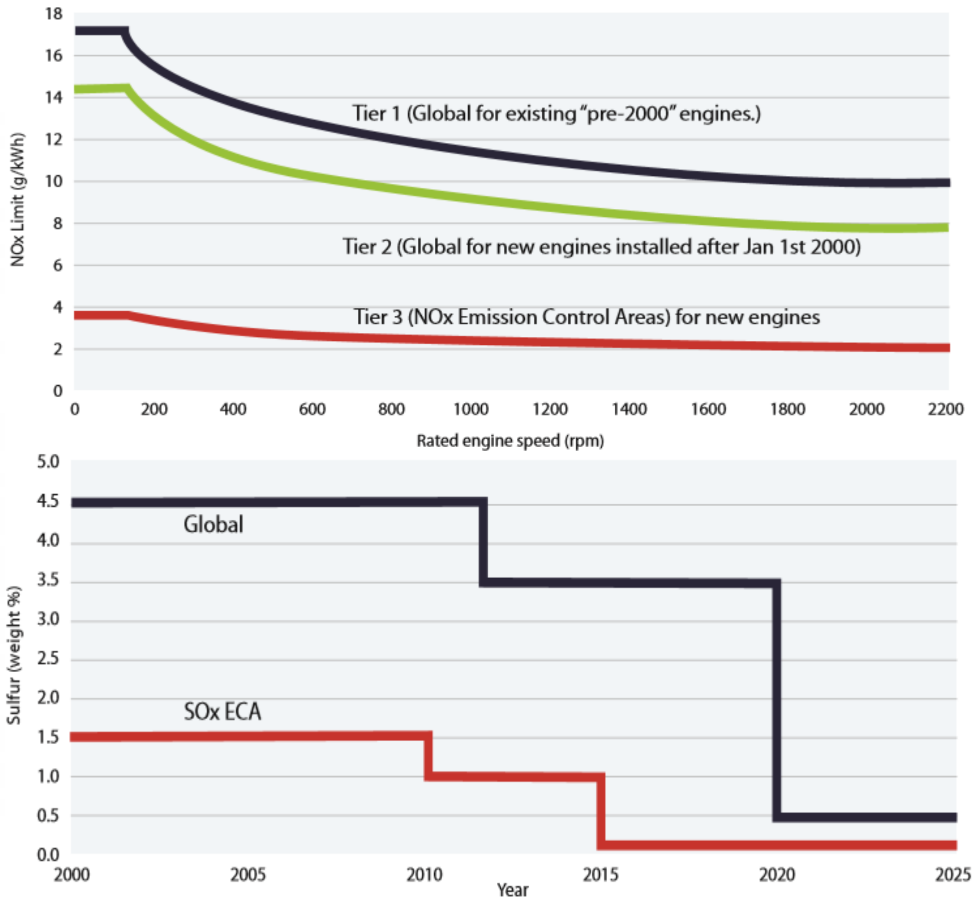
THERMOCHEMICAL POWER GROUP
UNIVERSITY OF GENOA (ITALY)
tpg.unige.it

Introduction

IMO Regulation

The International Maritime Organization (**IMO**) in **1997** introduced the Emission Control Areas (ECAs) to control pollutant emissions from ships (**NOx, SOx, PM**) but not CO_2. In **2018** IMO launched a strategy that aims to **reduce CO_2 emissions by at least 50% by 2050 compared to 2008**.





Source: IMO

Introduction

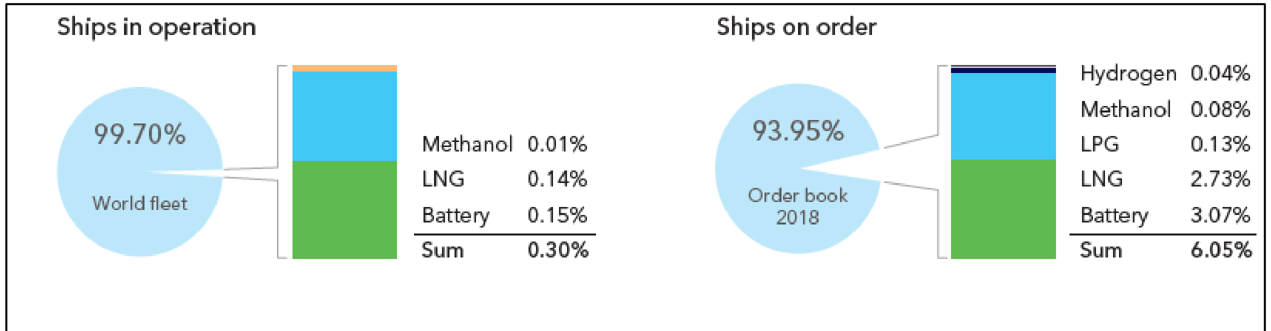
Current Scenario

Need for **alternative fuels** and **innovative technologies**

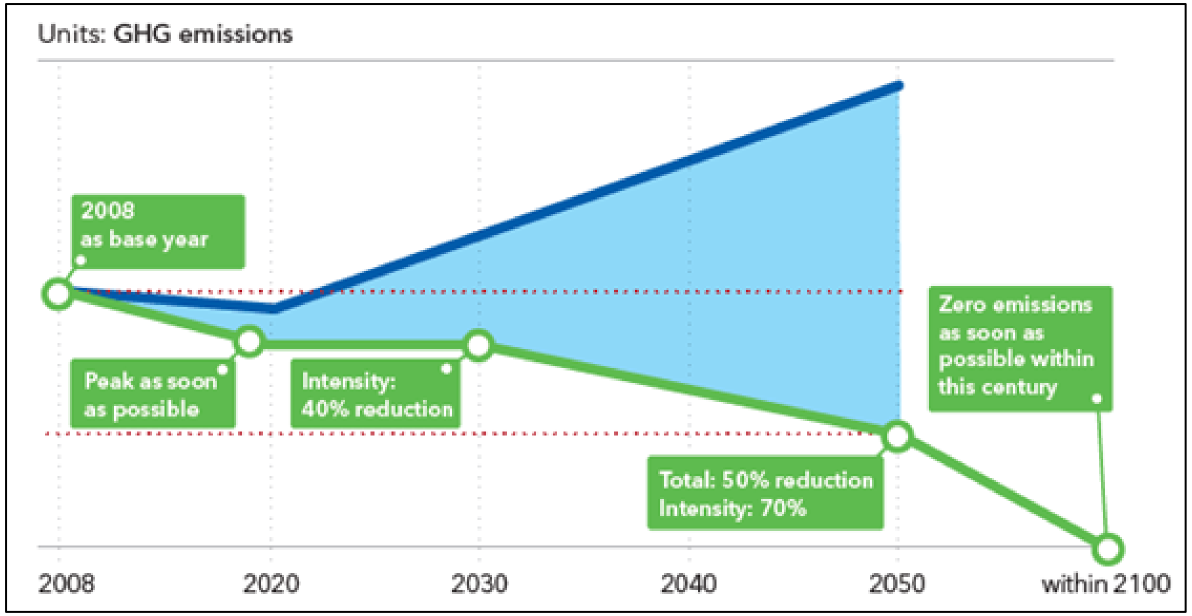
90% of world transportation in weight terms (11,000 Mtons) by vessels

2.8% of global CO_2 emissions due to maritime sector (in 2018 about 870 million tons of CO_2)

99% of ships is currently powered by ICE with conventional fuels

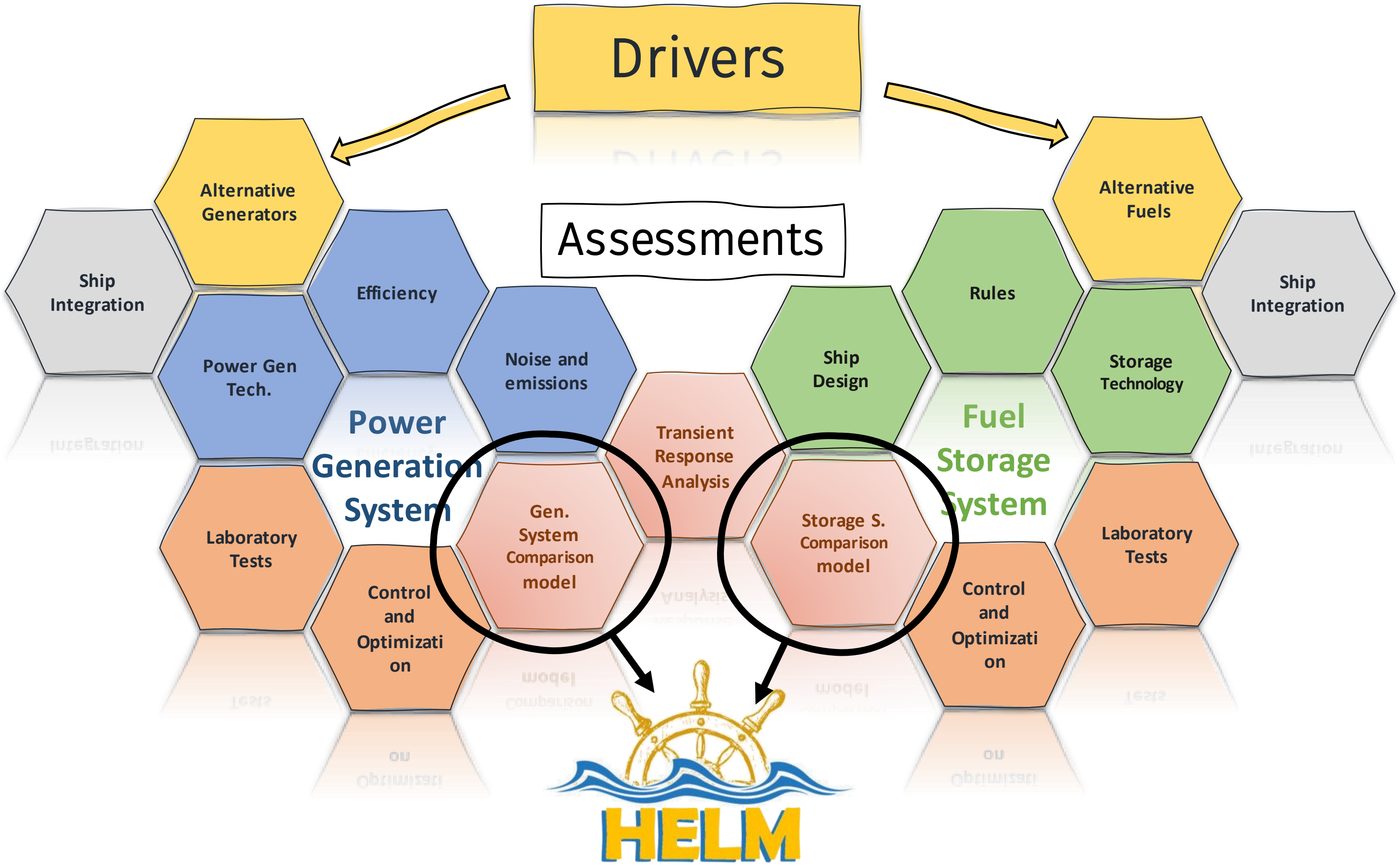


[a] Source: DNV GL's Alternative Fuels Insight (AFI) portal, https://www.dnvgl.com/services/alternative-fuels-insight-128171



Introduction

Alternative Fuels and innovative technologies



HELM Tool Description

HELM (Helper for Energy Layouts in Maritime applications)

Developed by TPG Research Group

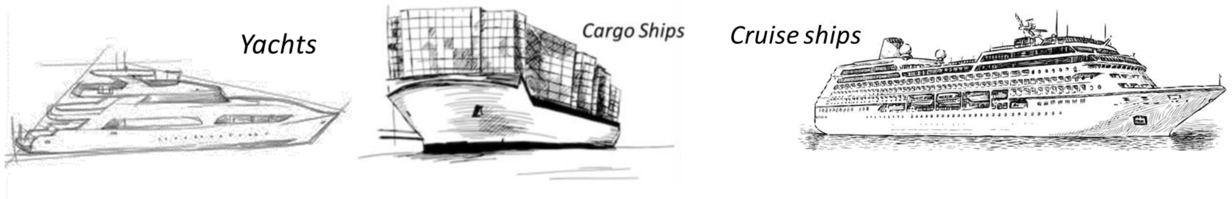
HELM compares different solutions for energy production in maritime applications considering the **relevance** of:

Weights   Volumes   Costs   Emissions

$$X = \frac{V_i}{V_{best}}$$

Value	Score	Value	Score
$1 < X \leq 1.1$	10	$3 < X \leq 4$	5
$1.1 < X \leq 1.3$	9	$4 < X \leq 5$	4
$1.3 < X \leq 1.6$	8	$5 < X \leq 6$	3
$1.6 < X \leq 2$	7	$6 < X \leq 8$	2
$2 < X \leq 3$	6	$X > 8$	1

In relation to a **specific scenario and application**



Technologies implemented in HELM

Energy generation	PEMFC		SOFC	micro GT	Internal Combustion Engine			
Fuel storage	CH2	LH2	LNG	LNG	Methanol	LNG	MDO	Ammonia

Case study (small ferry boat) and results

Installed power: 500 kW

Autonomy: 8 hours

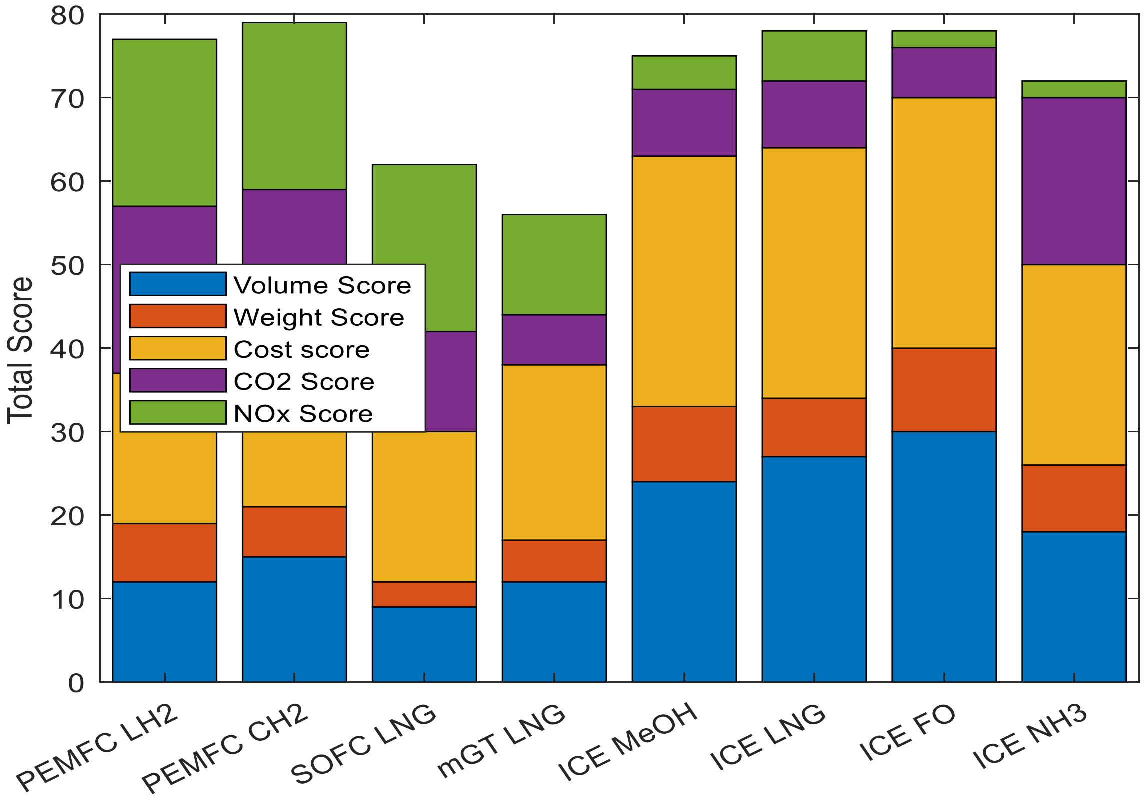
Volumes 3/5

Weights 1/5

Costs 3/5

4/5

Emissions



Technology	Total Volume [m^3]	Total Weight [tons]	Total Cost [k$]	CO2 [kg]	NOx [kg]
PEMFC LH2	40.8	6.6	682	0	0
PEMFC CH2	33.3	9.4	664	0	0
SOFC LNG	58.9	31.5	655	1685	0
mGT LNG	49.7	15.2	468	3186	1.0
ICE MeOH	12.7	5.2	272	2839	16.5
ICE LNG	10.2	7.1	283	2407	7.4
ICE FO	9.2	4.1	261	3298	38.9
ICE NH3	18.8	6.1	342	0	38.6

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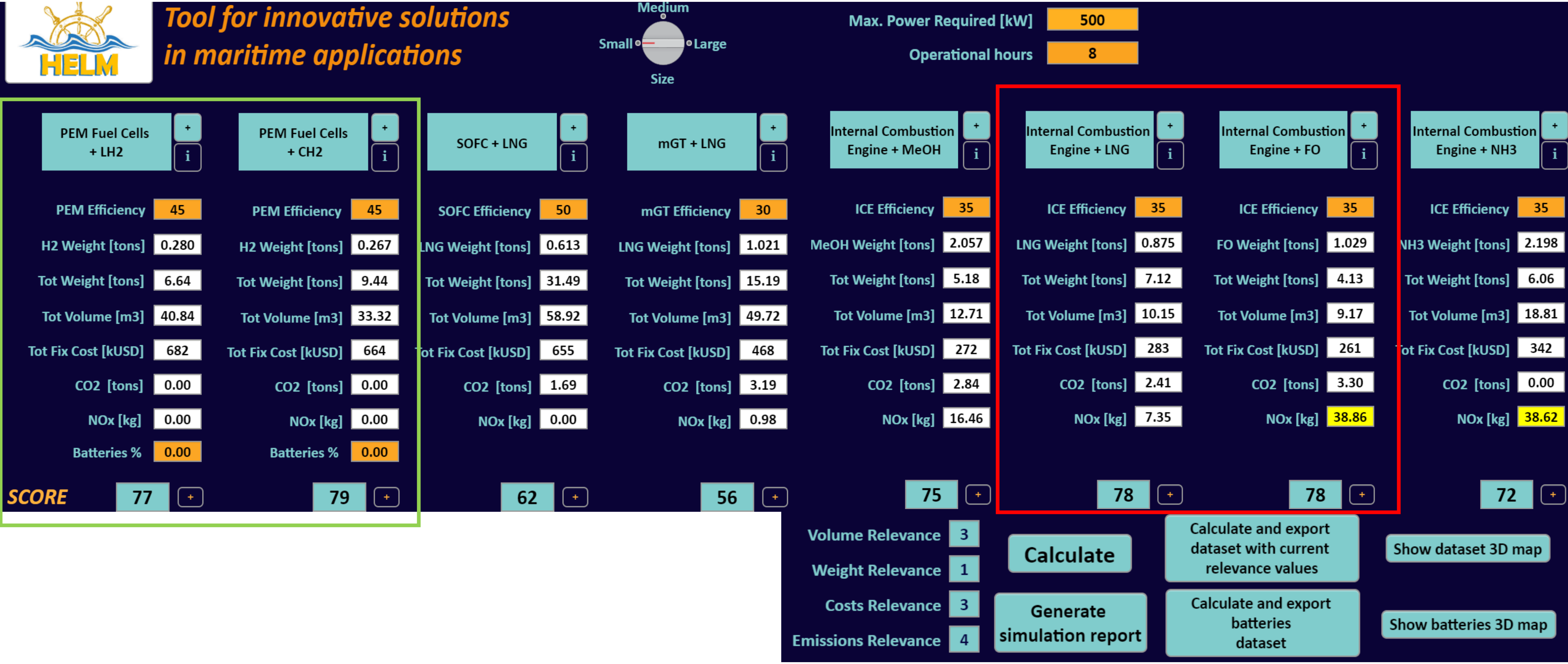
HELM user interface



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Zero Emission Ultimate Ship (ZEUS) - 2022

Developed in the framework of the TECBIA project (financed by Italian Government)

- First Italian Hydrogen Ship (ZEUS), lenght 25 m
- PEM Fuel Cells (140 kW) and electric batteries for propulsion
- H_2 stored in metal hydrides, autonomy 8 hours.

FINCANTIERI The sea ahead

Isotta Fraschini IF MOTORI

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