

# FORUM – CENPES – 2022

## Decarbonizing Offshore Operations

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SENIOR MANAGER, LATIN AMERICA

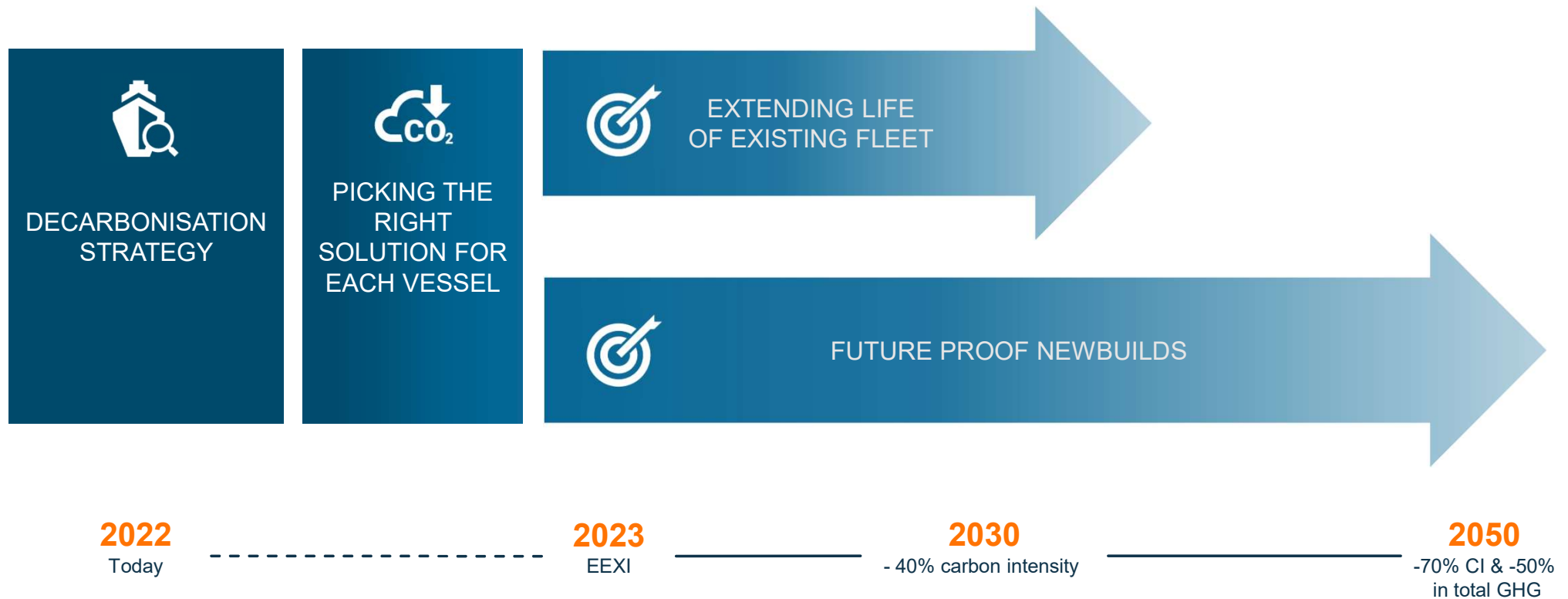
*THOUGHT LEADER LUMINARIE*



# OWNERS FACE A CRITICAL DECISION



30,000 VESSELS WILL REQUIRE RECERTIFICATION\*



# Há décadas, pesquisadores alertam que desastres naturais seriam mais frequentes no Brasil

Pelo menos 450 mortes em enchentes e deslizamentos em sete meses. Uma sequência de tragédias: na Bahia, em Minas Gerais, em cidades do estado de São Paulo. No Rio, a chuva castigou Petrópolis, Angra dos Reis e Paraty. Agora, o Grande Recife sofre com as perdas.

Por Jornal Nacional

04/06/2022 21h14 · Atualizado há 5 meses



## Global Warming Turned 2022 Into a 'Chronicle of Climate Chaos'

This year is likely to be the 5th or 6th hottest on record, according to the UN's provisional State of the Climate Report.



Smoke from the Creek Fire settles over Glacier Point in Yosemite National Park, California, U.S., on Saturday, Sept. 5, 2020. *Photographer: Naureen Malik/Bloomberg*

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Why act now on climate change? Look at the disasters around you

This year's crop of extreme weather events has brought home the urgency of tackling climate change

EUROPE

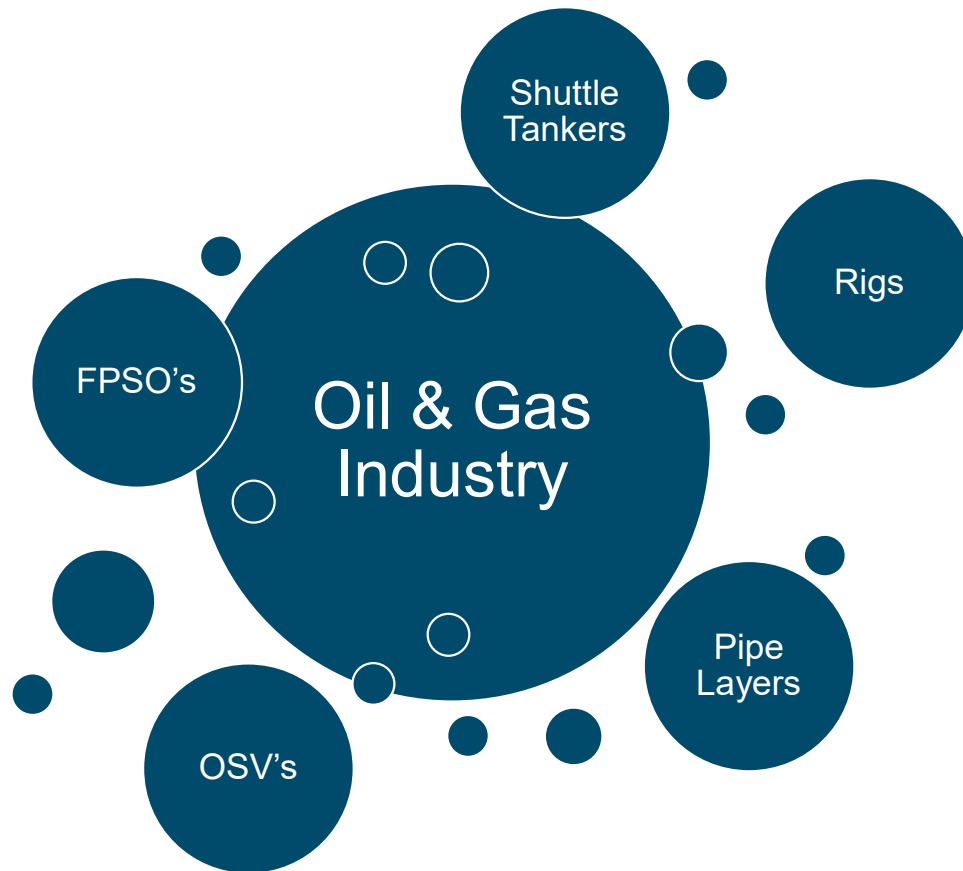
## Global warming twice as fast in Europe as in rest of world, study says

By Victoria Bisset

November 3, 2022 at 8:12 a.m. EDT

WHAT IS REALLY IMPORTANT TO US?

# HOW TO DECARBONIZE THE OPERATIONS?



Offshore activities (Upstream, Midstream and Downstream) can be accessed and there are different technologies to support the reduction on GHG Emissions, such as:

- Hybrid Systems with Batteries
- Digitalization
- Future Fuels conversion
- Electrification
- VOC Recovering



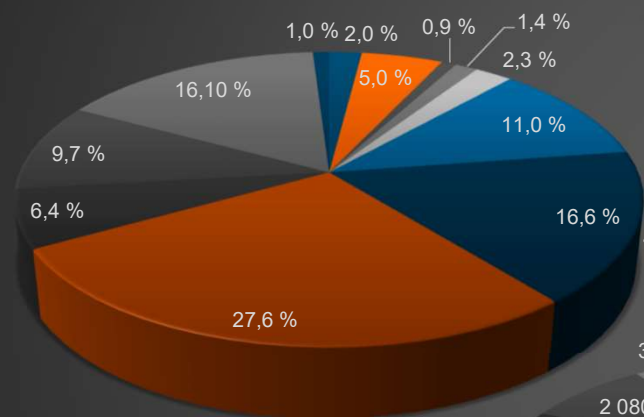
# HYBRID SOLUTIONS – CASE STUDY: RETROFIT

Technology is Ready !

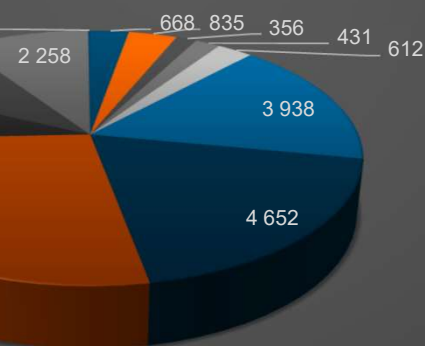
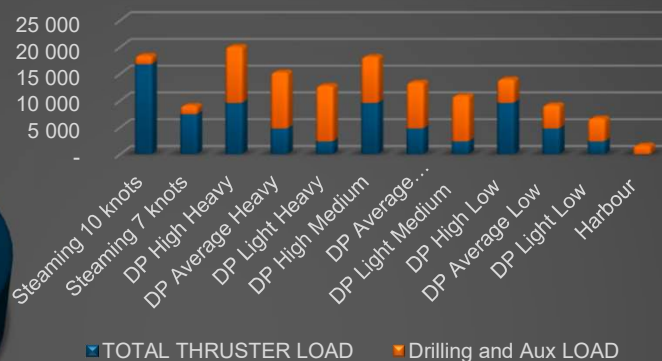
# OPERATIONAL PROFILE

## Operational Modes

Operational Modes [%]



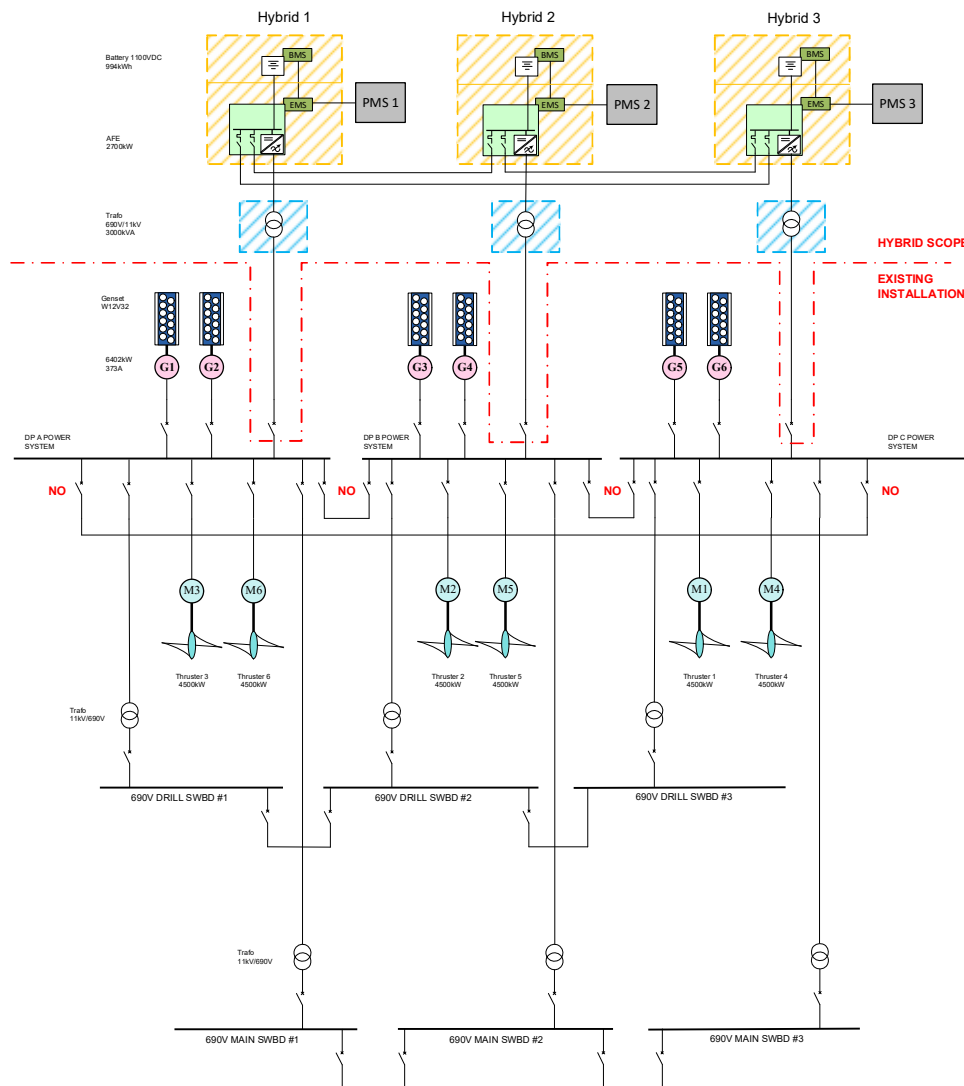
Electrical Loads [kW]



Fuel Consumption [t/y]

- Steaming 10 knots
- Steaming 7 knots
- DP High Heavy
- DP Average Heavy
- DP Light Heavy
- DP High Medium
- DP Average Medium
- DP Light Medium
- DP High Low
- DP Average Low
- DP Light Low
- Harbour

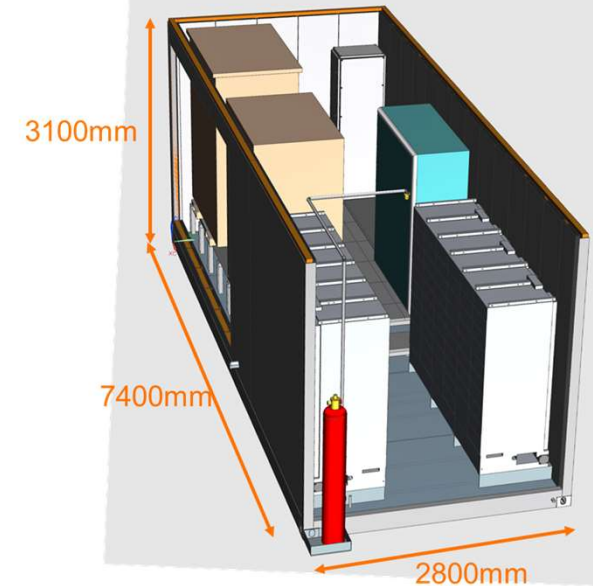
# DRILLING RIGS



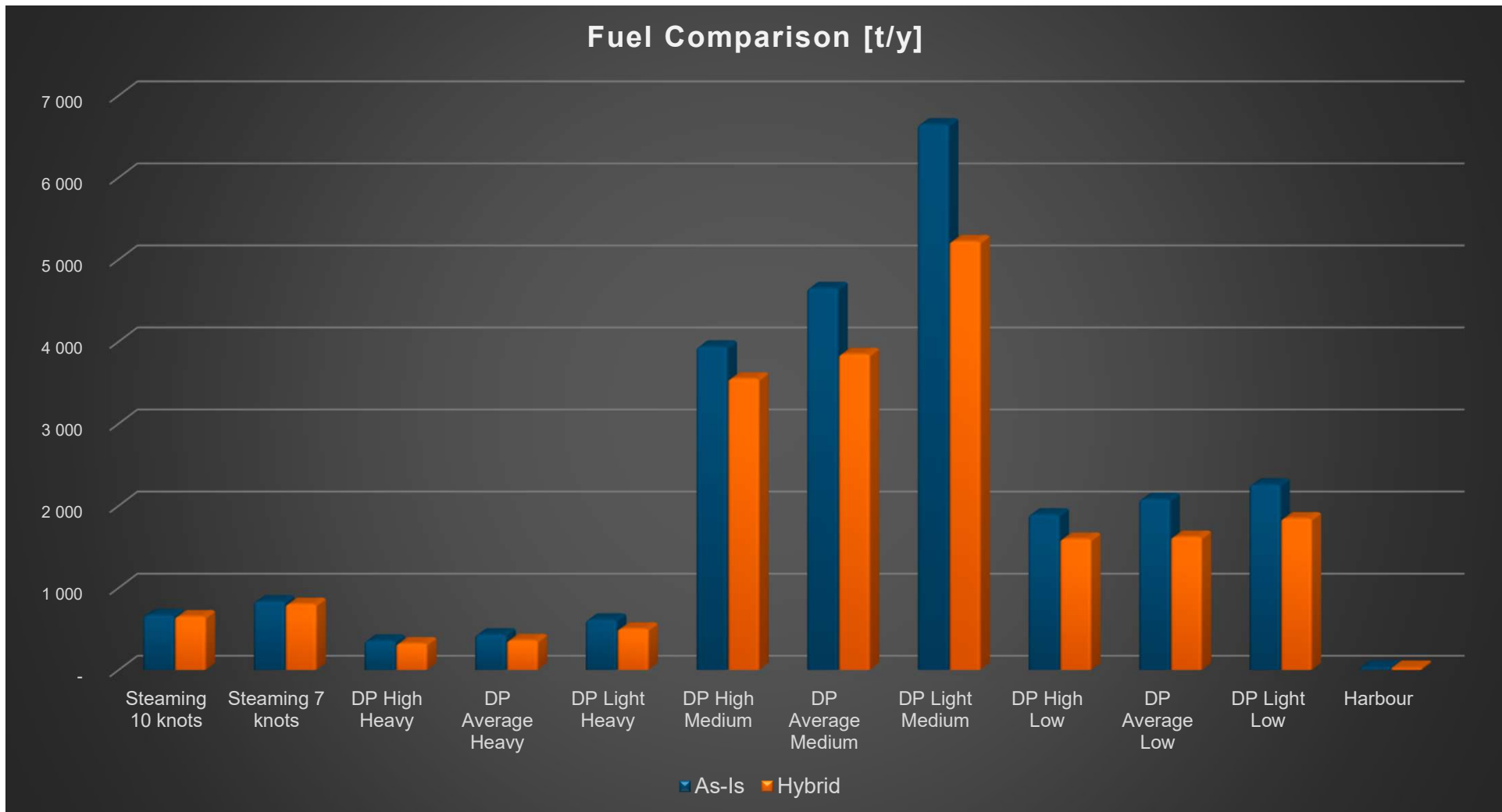
## • Alternative

- 3 hybrid system,
  - 1500kW drive
  - 722kWh battery
- Peak shaving
- Spinning reserve
- Load optimization

## TYPICAL 1500KW CONTAINER SOLUTION



# REDUCTION ON FUEL CONSUMPTION





## EMISSIONS REDUCTION IN DIFFERENT TYPES OF VESSEL – ESTIMATED BASED ON REFERENCE CASES.



Drilling  
Rigs

- About 30% on Emission.
- 25% on Fuel Savings



Floatels  
and Pipe  
Layers

- About 30% on Emission.
- 25% on Fuel Savings



PSV's

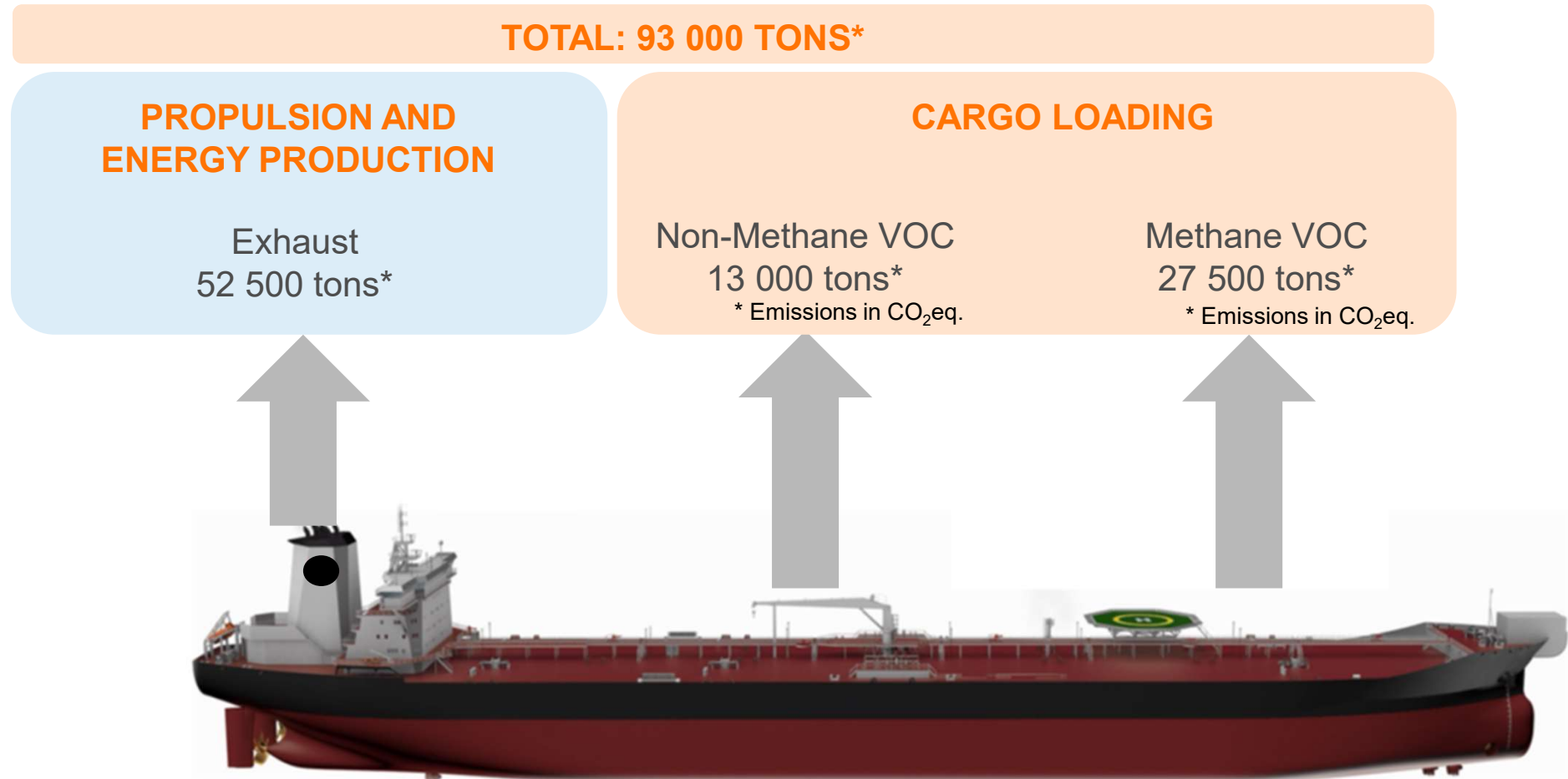
- About 25% on Emissions
- 20% on Fuel savings

# **Volatile Organic Compounds - VOC**

## **VOC Recovering Vessel**

**Technology is Ready !**

# TRADITIONAL SHUTTLE TANKER OPERATION (BRAZIL) ANNUAL EMISSIONS





Eliminates the Pollution and Extracts its Value

VAHOLMEN VOC RECOVERY AS  
PRESENTATION TO PETROBRAS

9<sup>TH</sup> NOVEMBER 2022

STRICTLY PRIVATE & CONFIDENTIAL!

POLLUTION IS VALUE GONE ASTRAY!





## THE CHALLENGE – VALUES ARE GOING ASTRAY WHEN LOADING CRUDE OIL CARRIERS

- During loading of crude oil tankers huge volumes of valuable Volatile Organic Compounds (“VOC”) are emitted to the atmosphere – 150-450 tons per VLCC<sup>1)</sup> per Loading. **This should be avoided for several reasons**
- Limited Space on **FSO/FPSO’s** and **sea islands** for compressors etc. and costly subsea pipes to shore
- No space for VOC handling equipment when loading from **buoys**
- Logistical Issues when loading from **remote quays**
- Extensive and expensive shore based, and FSO/FPSO and sea island facilities required for VOC handling and disposal
- IMO is focusing on VOC emissions limitations from crude oil cargoes
  - Canada and Norway taking initiative
  - Emphasis on emissions during loading – 70-80 % of total emissions
  - Vaholmen and Wärtsilä are contributing to solve the VOC issues





# VAHOLMEN HAS A UNIQUE AND PROTECTED GREEN SOLUTION BASED ON PROVEN TECHNOLOGY

1

Collection of  
Petroleum  
Gases

2

Monetizing  
the collected  
Material

3

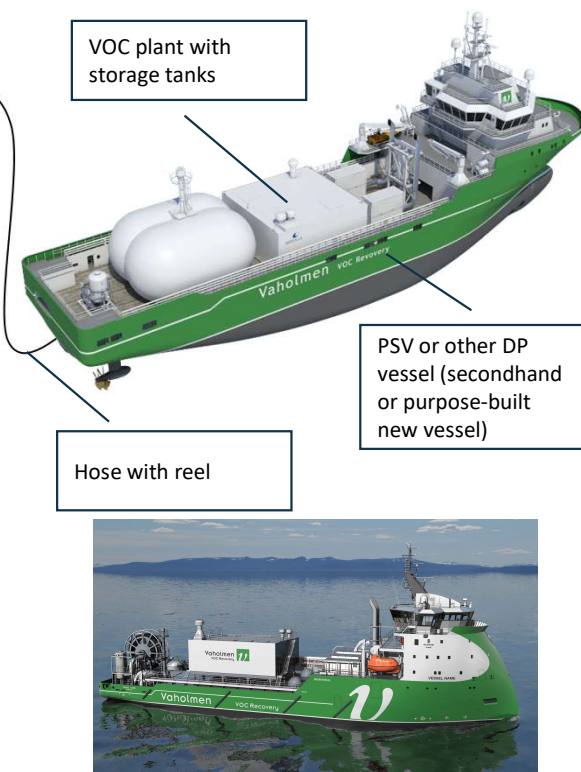
Proven  
Technology –  
simple to  
deploy

4

Protected  
solution

- Solves severe global warming, local pollution and safety issues for the customers, as well as helps “rescue” valuable resources gone astray
- Allows OilCos solve environmental issue and earn money simultaneously
- Collects, processes and recirculates petroleum gases emitted to air from loading of crude oil carriers at loading buoys, sea islands and berths
- Liquefies and re-injects petroleum gases to crude oil in export pipeline or other hydrocarbon flow
- Uses value of the petroleum gases “rescued” to cover costs and (in many cases) generate a net profit – and CO<sub>2</sub> emission fees saved, where applicable
- Builds on proven Norwegian technology applied in North Sea for decades
- Has no requirements at loading site – a self-contained plug and play concept, only offloading facilities required
- Vaholmen’s solution has patent protection in Norway and Vaholmen has taken steps to ensure international protection

**THE VAHOLMEN UNIT: HIGHLY EFFICIENT  
RECOVERY OF HYDROCARBONS FOR MONETISATION  
& SOLVING KEY ENVIRONMENTAL ISSUES**



# OVERVIEW OF THE VAHOLMEN UNIT



Hose/hook-up

VOC recovery plant delivered by Wärtsilä (20 years track Record)

DP2 PSV (or purpose built Vessel)

Vaholmen  
VOC Recovery

ISO 9001:2015  
CERTIFIED

**VAHOLMEN UNIT**

patent trademark design  
Norwegian Industrial  
Property Office  
GCC/PCT





**PATENT  
PROTECTED**

Sjøfartsdirektoratet  
Norwegian Maritime Authority

**APPROVAL IN  
PRINCIPLE**

**APPROVAL IN  
PRINCIPLE**

# GLOBAL SUSTAINABILITY ISSUE: PRESERVING THE RESOURCES GONE ASTRAY AND ELIMINATES THE ENVIRONMENTAL ISSUES

<p><b>1</b></p> <p><b>Valuable Hydrocarbons Lost</b></p>  <ul style="list-style-type: none"> <li>During loading of crude oil tankers, huge volumes of VOC are emitted directly to the atmosphere – 150-350 ton per VLCC Loading</li> <li>Around 0.1% of exported crude oil is released to the Atmosphere as VOC</li> <li>A fleet of 50 Vaholmen Units may contribute to up to USD ~2.6 bn worth of VOC per year being gathered and sent back into the loop ensuring a sustainable circular economy</li> </ul>	<p><b>2</b></p> <p><b>Global Warming (CO<sub>2</sub> Emissions)</b></p>  <ul style="list-style-type: none"> <li>Avoiding emission of VOC to the atmosphere during loading is important</li> <li>A fleet of 50 Vaholmen Units would capture up to ~12.5 million tons of CO<sub>2</sub> equivalents emission per year (corresponds to ~1/3 of mainland Norway CO<sub>2</sub> emissions)<sup>1)</sup></li> </ul>	<p><b>3</b></p> <p><b>Health Problems (O<sub>3</sub> Emissions)<sup>2)</sup></b></p>  <ul style="list-style-type: none"> <li>VOC exposed to sunshine creates ground level Ozone, harmful to humans</li> <li>Concentration of VOC around the VLCC is a hazard to crews' health</li> <li>VOC may also cause damages to population in general (more difficult to breathe deeply and vigorously, etc.)</li> <li>Vaholmen contributes to avoidance of ground level Ozone (O<sub>3</sub>) – a major local health problem</li> </ul>	<p><b>4</b></p> <p><b>Safety Issue – Risk of Explosions</b></p>  <ul style="list-style-type: none"> <li>Safe and uninterrupted loading of crude oil tankers is imperative</li> <li>High concentration of VOC around the tankers causes risk for explosions and disruption of operations</li> <li>If high densities of hydrocarbons around a tanker, the vessel must be evacuated</li> <li>Vaholmen contributes to safe and uninterrupted loading operations</li> </ul>
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# MONETIZATION OF THE LIQUID VOC (LVOC) - DISTRIBUTION & TRADING OF THE HYDROCARBONS

## Monetizing of LVOC

- Injection of LVOC into a relevant hydrocarbon flow:
  - Crude oil,
  - Gas processing plant,
  - Petrochemical plant or power plant
  - Separation unit (propane, butane, pentane, condensate)
- Transfer of LVOC to a smaller LPC carrier near the loading facility, for export as Y-grade product
- **Active international market for trading of CO<sub>2</sub> equivalent emission quotas**

## Oil Company's Economics

Value Creation for Customer per Vaholmen Unit (3 Loadings)	
	150T per loading
Liquefied petroleum gases / loading (tons)	150
Loadings per week	3
Bbls/Ton	10,55
Liquefied petroleum gases / year (Mbbls)	0,25
USD/bbl	90
<b>Value liquefied petroleum gases / year (USDm)</b>	<b>22,3</b>
<i>USD per day</i>	<i>61 031</i>
Tons liquefied petroleum gases / year	23 464
Tons CO <sub>2</sub> equivalents / year	106 802
CO <sub>2</sub> price (USD/ton)	80
<b>Value CO<sub>2</sub> savings (USDm)</b>	<b>8,5</b>
<i>USD per day</i>	<i>23 409</i>
<b>Total Value (USDm)</b>	<b>30,8</b>
<b>Revenue per Vaholmen Unit (USD per day)</b>	<b>84 439</b>

- The VOC volume of 150 tons is based on loading from FSO/FOSO to Suezmax crude oil carrier with capacity 1.2 mill BBLS of crude oil
- Utilisation of the Vaholmen Unit is essential to the economy of the operations

## VAHOLMEN'S PRODUCT LINE FOR BRAZIL

### Product line

#### 1. Feasibility Studies

- a) Analysing the oil field particulars including production volumes, logistics etc.
- b) Measure actual emissions during loading and estimating total emission volumes, composition and VOC plant output
- c) Propose Vaholmen solution for the actual field(s)

#### 2. Long Term Time Charter through local shipowner and –operator: Grupo CBO???

#### 3. EPC

- a) Ship building
- b) Ship management with local ship manager
- c) VOC plant management

### Add-ons

- Vaholmen has gained considerable VOC expertise in addition to a solid competence regarding ships in general and OSV's with DP in particular.
- The integration of VOC plants and relevant DP vessels into Vaholmen Units has been studied and planned over 5 years.
- New design for IGC classed DP2 Vaholmen Unit worked out together with Ulstein Ship Design.
- Together with its partners Vaholmen is offering all relevant services for the projects.





# FUTURE FUELS

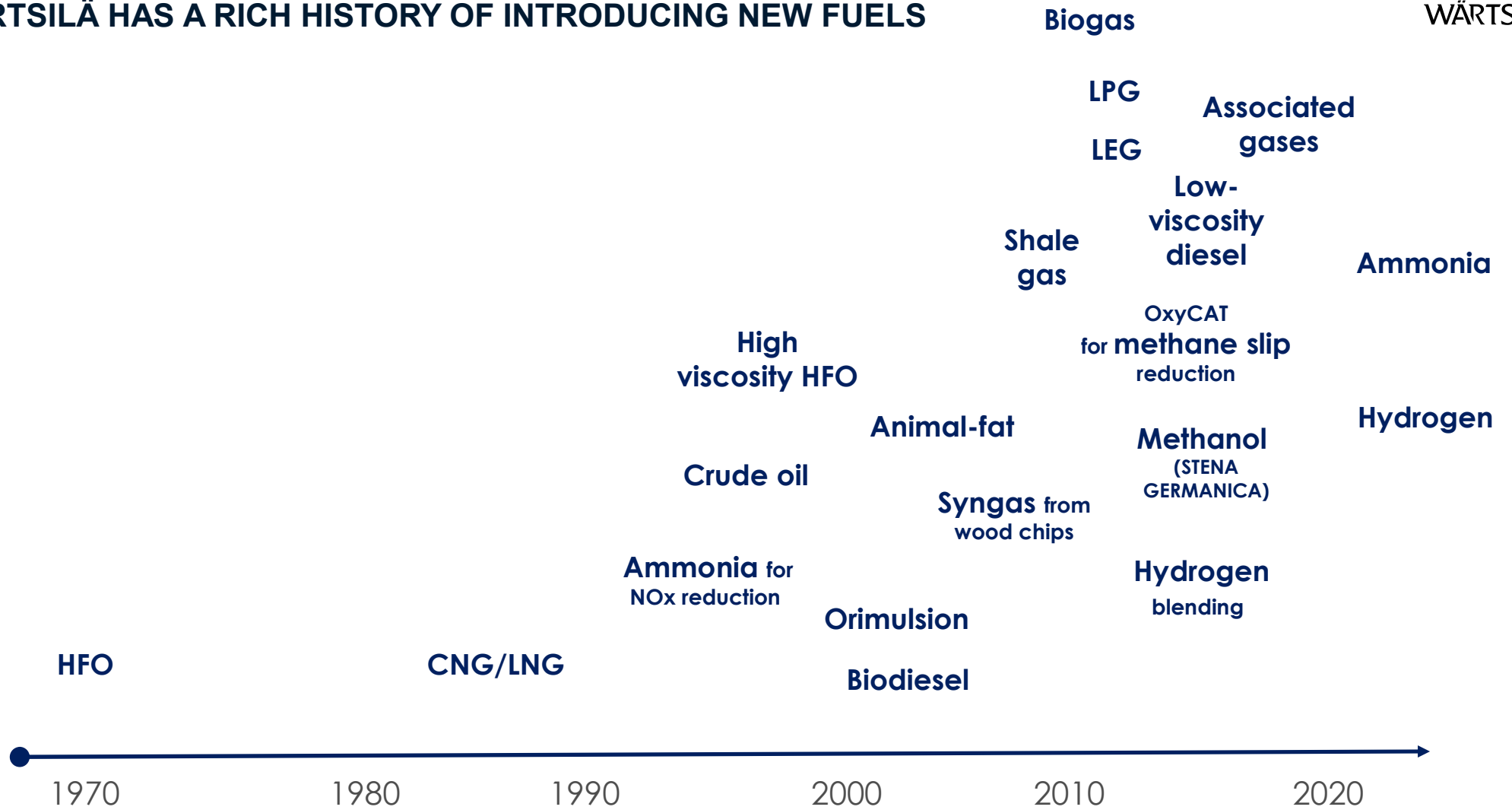
## WÄRTSILÄ'S SUSTAINABLE FUELS & INDUSTRIALISATION PLANS



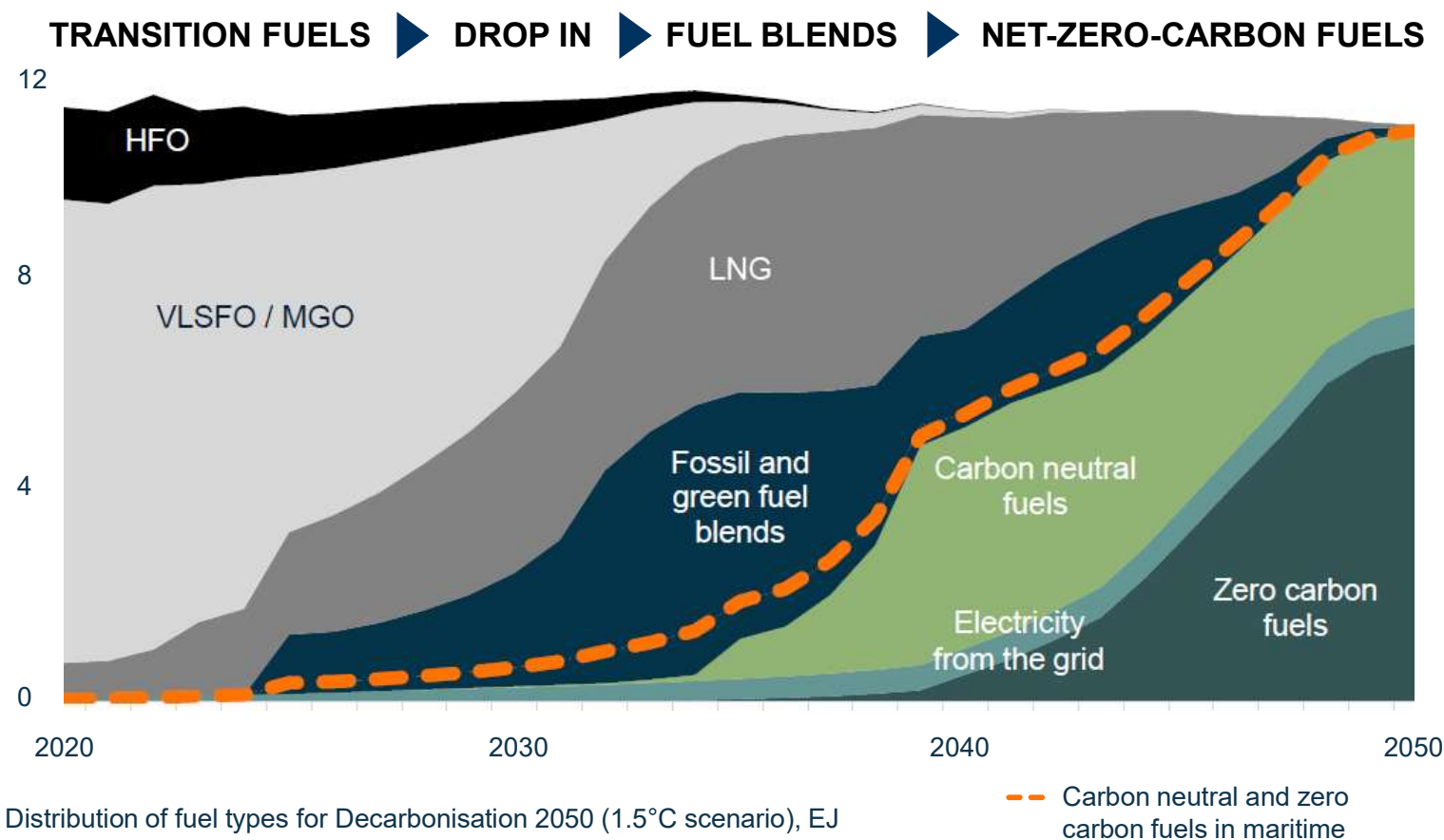


WÄRTSILÄ

## WÄRTSILÄ HAS A RICH HISTORY OF INTRODUCING NEW FUELS



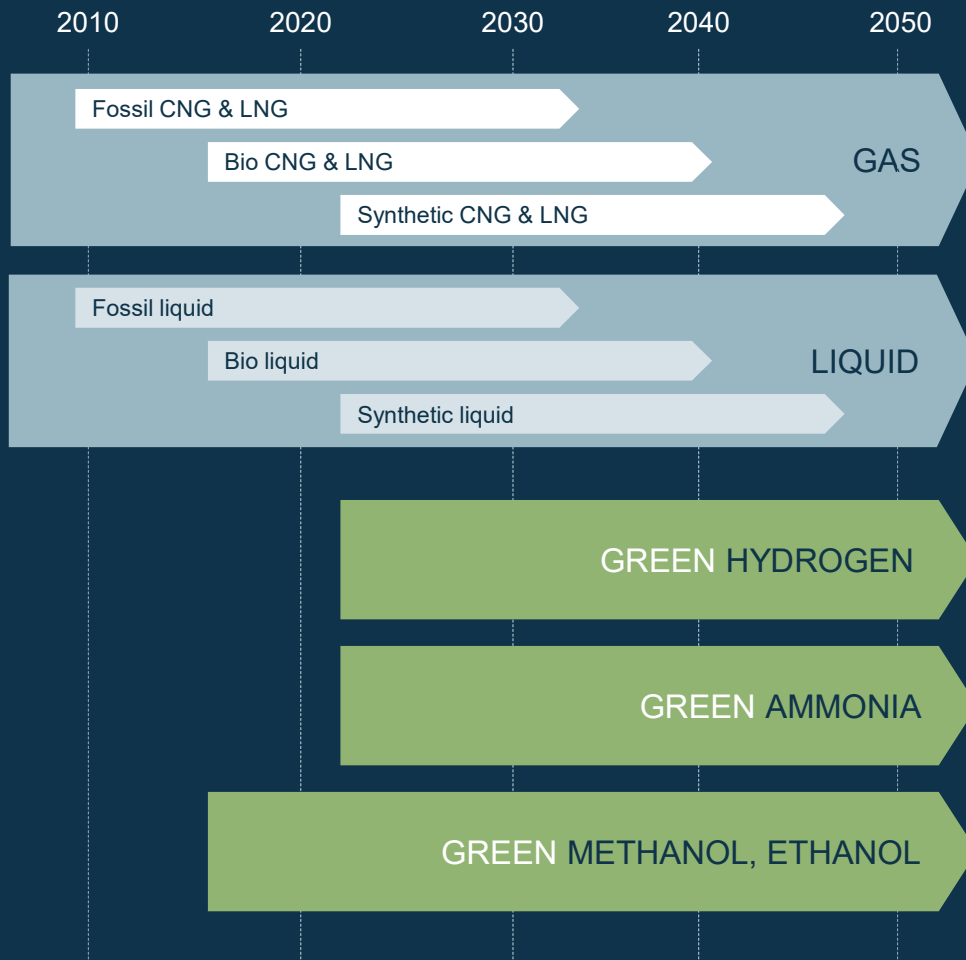
## MOVING FROM SINGLE-FUEL INDUSTRY TO MULTI-FUEL INVESTMENT IN FUEL FLEXIBILITY SECURES YOUR ASSETS



### Owners set to determine technology partners now

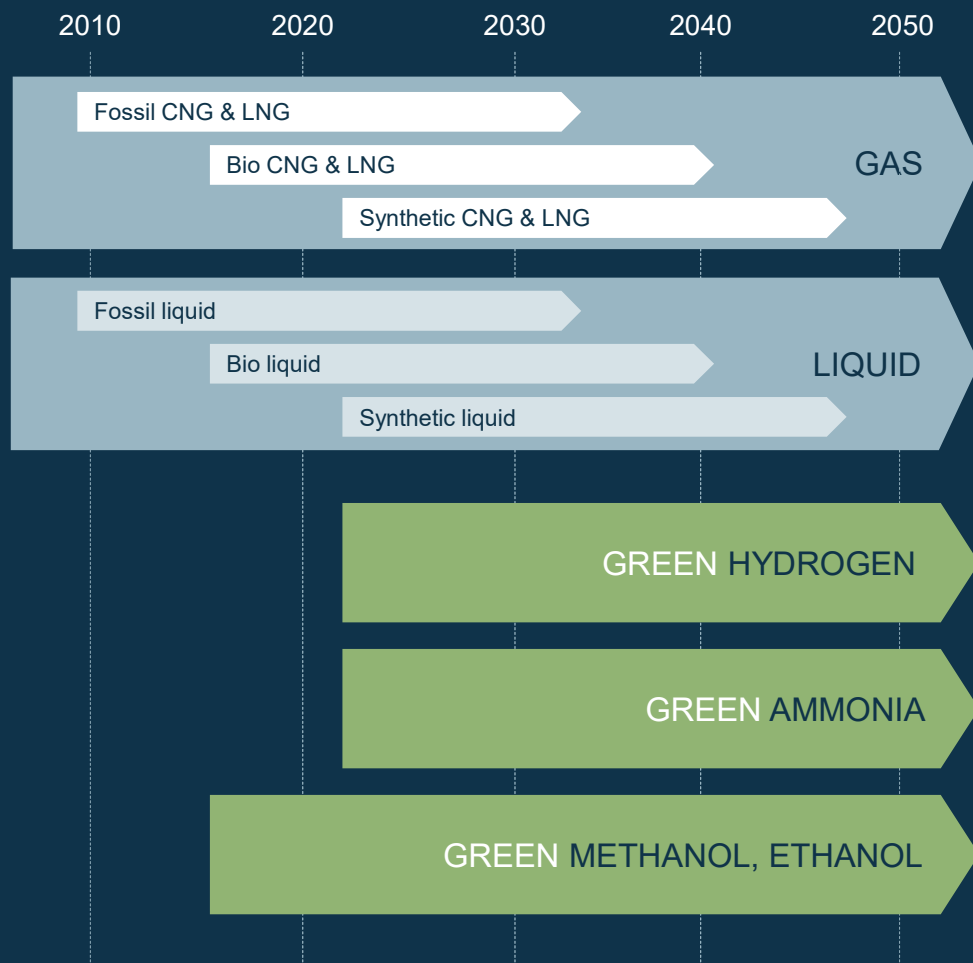
- Vessel lifetime: 25-30 years
- Criteria:
  - Multi-fuel capability, blending green fuels
  - Conversion capability accommodating future fuels

## FUEL ROADMAP



- CNG & LNG are the cleanest fossil fuels
  - -5 to -20% GHG reduction (well to wake/power)
  - local emissions virtually eliminated with LNG
- Unburned fuel release high on agenda, great reduction achieved and further reduction on-going
- Bio & synthetic fuels reduce GHG -70 to -100% (well to wake/power)
  
- Zero carbon, no CO<sub>2</sub> emissions
- Can be blended with gaseous fuels
- Liquid storing possible, at -253 °C
  
- Zero carbon, no CO<sub>2</sub> emissions
- Can be blended with liquid fuels or gases
- Toxic, safety concepts and regulation being developed
  
- Carbon neutral
- Can be blended with liquid fuels
- Toxic, safety regulations exist

## TECHNOLOGY ENABLING A FUEL TRANSITION IS AVAILABLE ALREADY TODAY



### Gaseous and liquid fuels

- Possible already today, infra, rules and regulations exist and supply infrastructure adaptation has started

### Hydrogen

- Wärtsilä gas engines blend up to 25%-vol hydrogen in natural gas, combustion concepts aim for 100% hydrogen
- Pure Hydrogen operation achieved, focus on improving performance
- Technical concept ready 2025

### Ammonia

- Combustion concepts maximising engine performance, developing safety technologies
- 70% Ammonia blend achieved
- Technical concept ready 2023

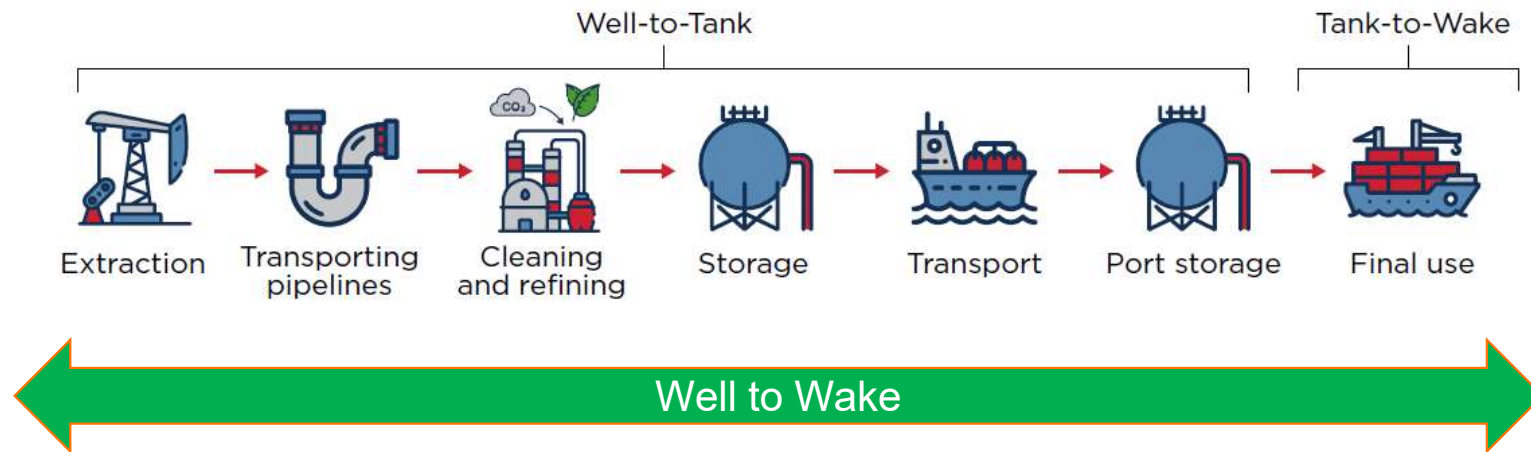
### Methanol

- March 2015, ZA40 retrofitted for Methanol operation
- January 2022, W32 Methanol launch
- Serial production 2023



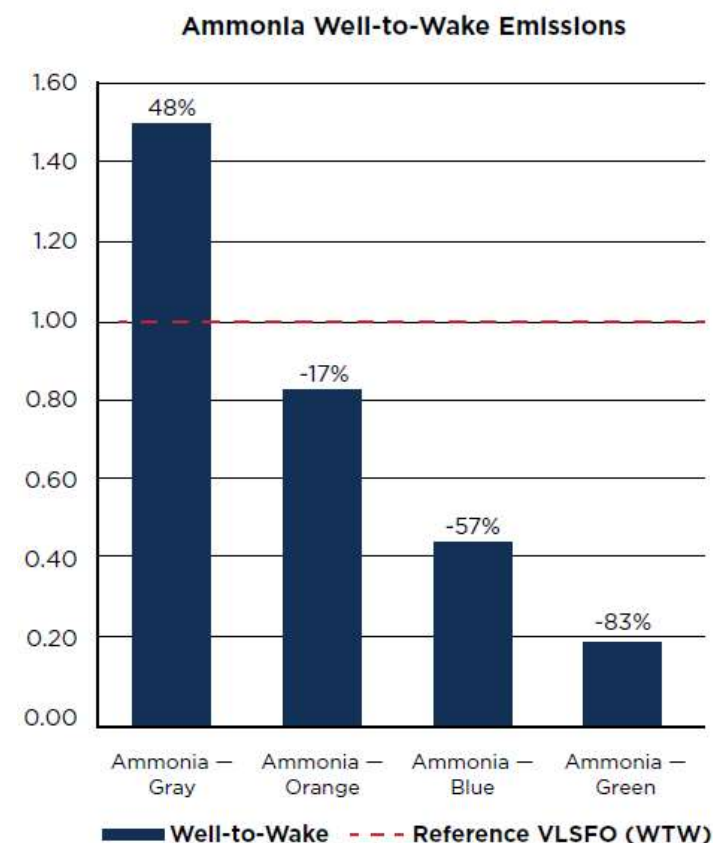
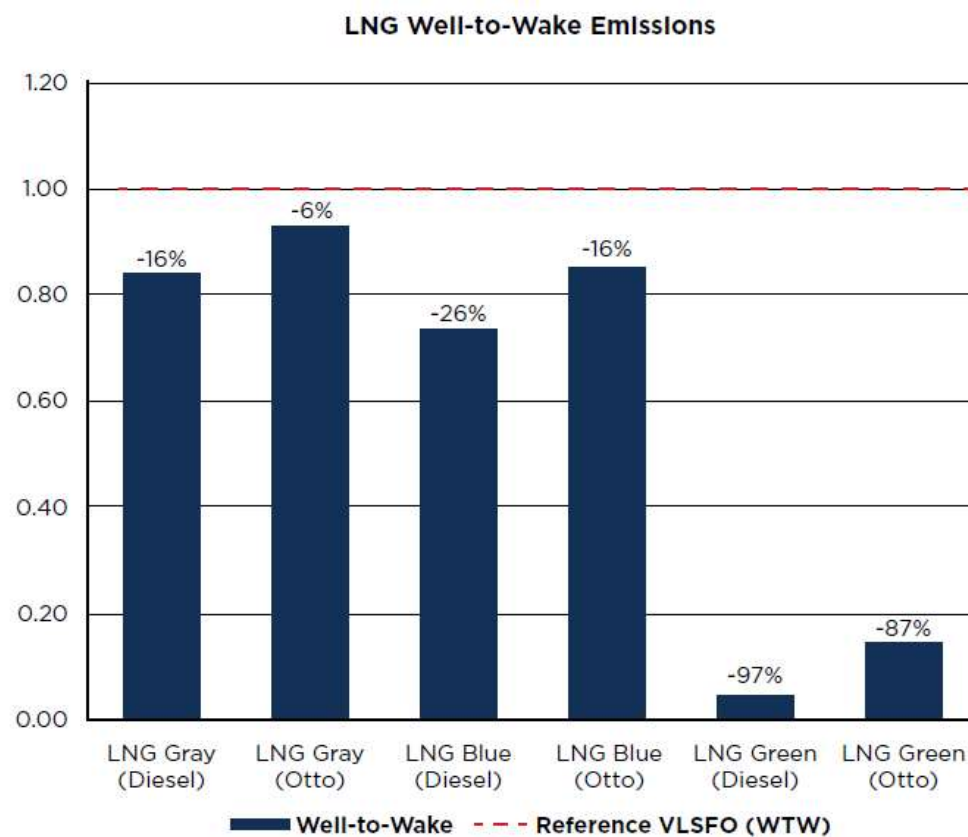
# LIFECYCLE CARBON EMISSIONS

Main fuels being discussed in the market



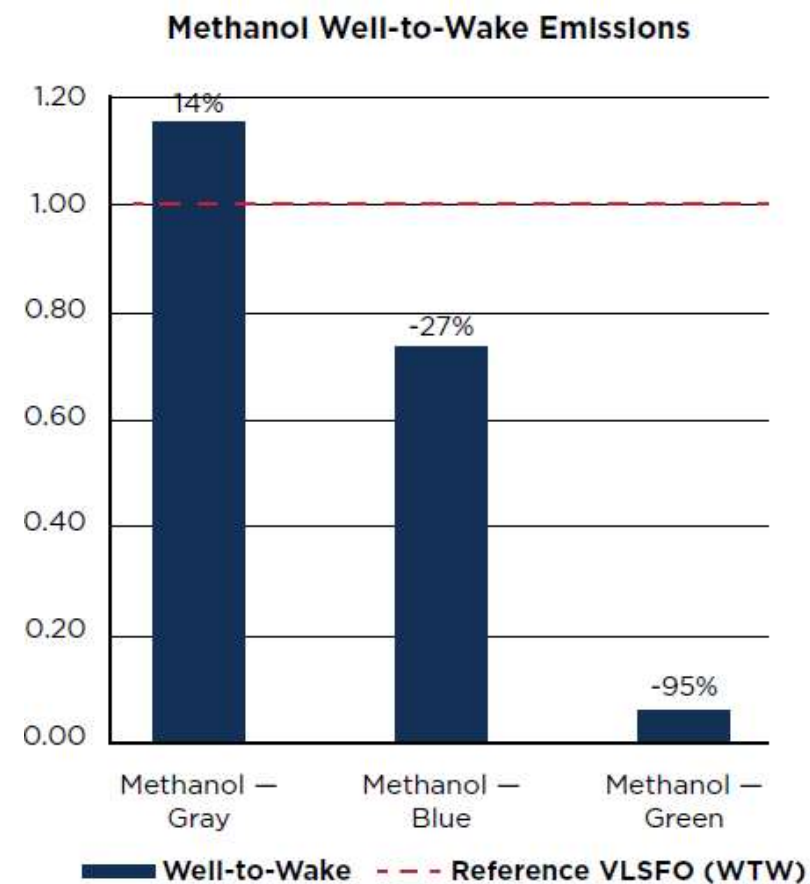
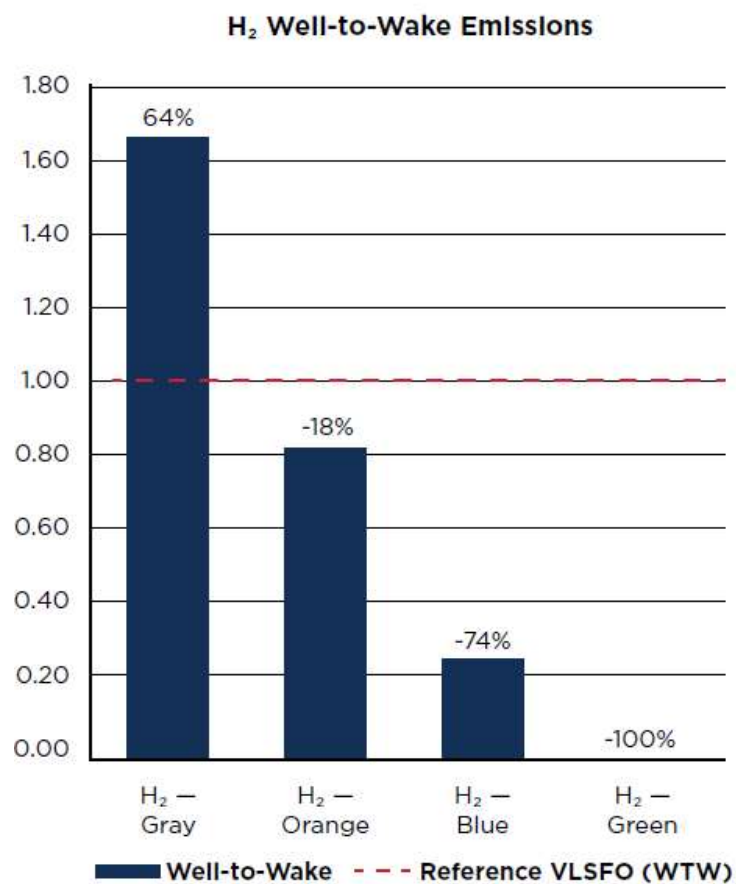
If we need to change the GHG emissions in the World we have to consider the lifecycle of the fuels – “Well-to-Wake” should be the real emission factor to be considered.

## EMISSIONS OF DIFFERENT FUELS: WELL-TO-WAKE



Source: SETTING THE COURSE TO LOW CARBON SHIPPING - ABS

## EMISSIONS OF DIFFERENT FUELS: WELL-TO-WAKE



Source: SETTING THE COURSE TO LOW CARBON SHIPPING - ABS

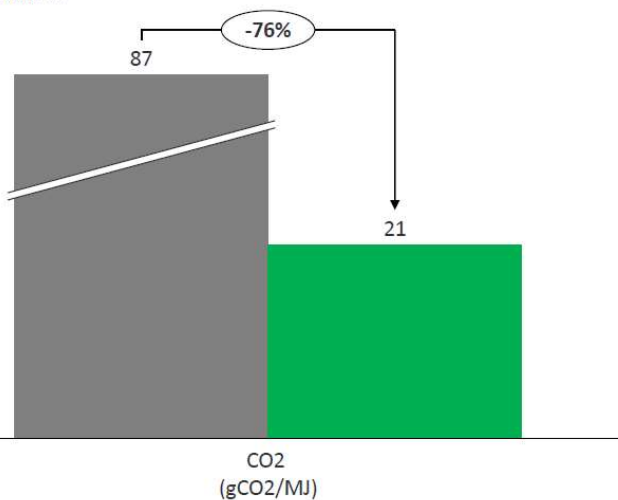
# EMISSIONS OF DIFFERENT FUELS: WELL-TO-WAKE

## Life Cycle ANALYSIS

raízen

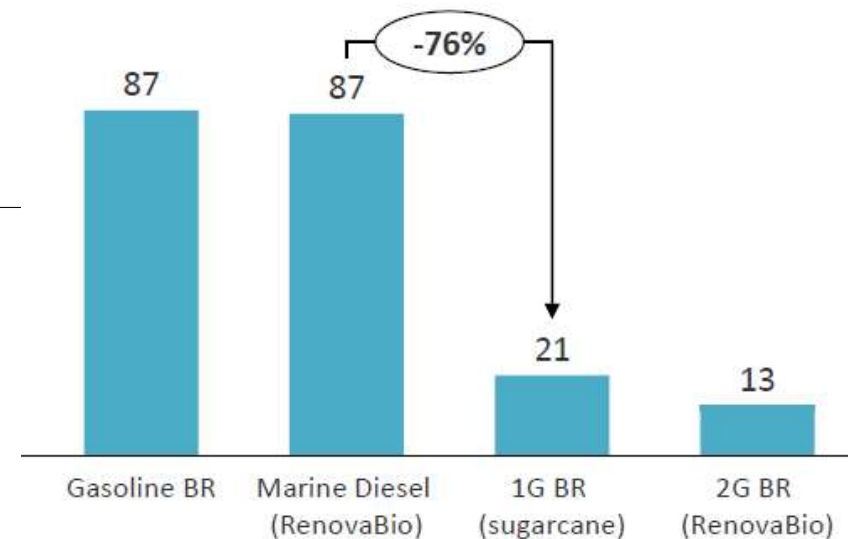
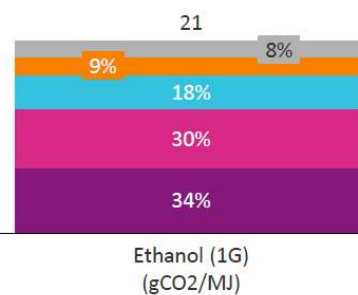
### Life Cycle Emissions<sup>1</sup>

Marine Diesel  
1G Ethanol



### 1G Ethanol Break-down (2019/2020 Harvest)

Industry Limestone  
Others Nitrogen Fertilizer  
Diesel (agricultural stage)



## FUEL COMPARISON

Comparative analysis

# FUELS TECHNICAL CARACTERISTICS



### Marine Fuels - Key Properties

Key properties	Oil Derivatives			Biodiesel		Liquid Gas		Potential Biofuel			Available Biofuel
	HFO	MDO	MGO	FAME	HVO	LPG	LNG	Methanol	Ammonia	Hydrogen	Ethanol
Heating value (MJ/kg)	40.5 - 43	42 - 48	44 - 45	37 - 40	44 - 47	46	50	21	18.6	120	27
Density at 15°C (kg/m3)	<991	<900	<890	880 - 920	770 - 790	500-620	450	792	609	0.08375	805
Flashpoint (°C)	>60	>60	>60	110 - 195	>61	-144	-188	11	NA	< -253	15
Sulfur (mass %)	<3.5	0.3 - 2.0	0.1 - 1.5	0	0	<0,004	<0,004	0	0	0	0

Confidencial Source: 1. IEA Bioenergy, ANP and team analysis



# FUEL COMPARISON

Comparative analysis

## CI vs. FUEL COMPETITIVENESS

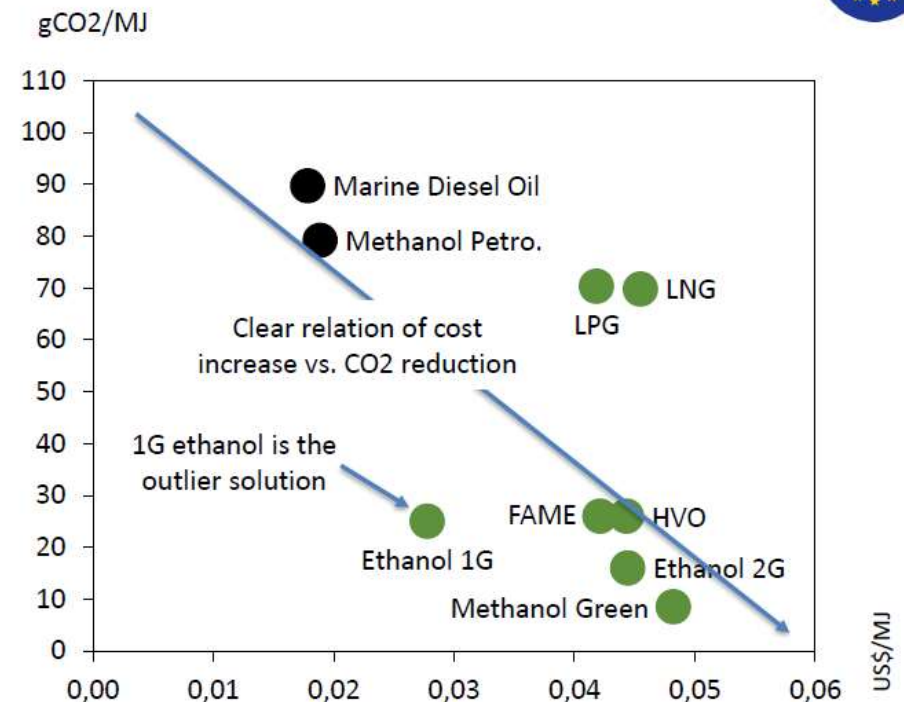
Fuels comparison 2022: USD/MJ vs. gCO<sub>2</sub>/MJ

● Fossil fuels ● Green fuels



Indicator	USD/MJ			gCO <sub>2</sub> /MJ
Fuels	Price avg.	Mass (g/cm <sup>3</sup> )	PCI (MJ/kg)	CI
Marine Diesel Oil	750 USD/ton <sup>1</sup>	0,900	42	89,7 gCO <sub>2</sub> e/MJ <sup>7</sup>
Methanol Petro.	397 USD/ton <sup>2</sup>	0,792	21	79,2 gCO <sub>2</sub> e/MJ <sup>8</sup>
Methanol Green	1013USD/ton <sup>3</sup>	0,792	21	8,5 gCO <sub>2</sub> e/MJ <sup>9</sup>
Ethanol 1G	750 USD/ton <sup>4</sup>	0,805	27	25,0 gCO <sub>2</sub> e/MJ <sup>10</sup>
Ethanol 2G	1200 USD/ton <sup>4</sup>	0,805	27	16,0 gCO <sub>2</sub> e/MJ <sup>10</sup>
HVO	1951 USD/ton <sup>5</sup>	0,770	44	26,0 gCO <sub>2</sub> e/MJ <sup>7</sup>
FAME	1559 USD/ton <sup>5</sup>	0,880	37	26,0 gCO <sub>2</sub> e/MJ <sup>7</sup>
LNG	2275 USD/ton <sup>1</sup>	0,450	50	69,8 gCO <sub>2</sub> e/MJ <sup>11</sup>
LPG	1925 USD/ton <sup>6</sup>	0,560	46	70,3 gCO <sub>2</sub> e/MJ <sup>11</sup>

Notes: Fuel prices: (1) Shipping and bunker website/Europe data (2) IHS/Europe data (3) Irena publication/Europe data (4) Raizen/Europe data (5) Argus/ Europe Data (6) Petrobras/Brazil data  
CI: (7) Renovabio/Brazil data (8) IPCC Methanol Petrochemical/Europe data (9) European Methanol Policy Forum/Europe data (10) Raizen/Europe data (11) Froinvent/Europe data

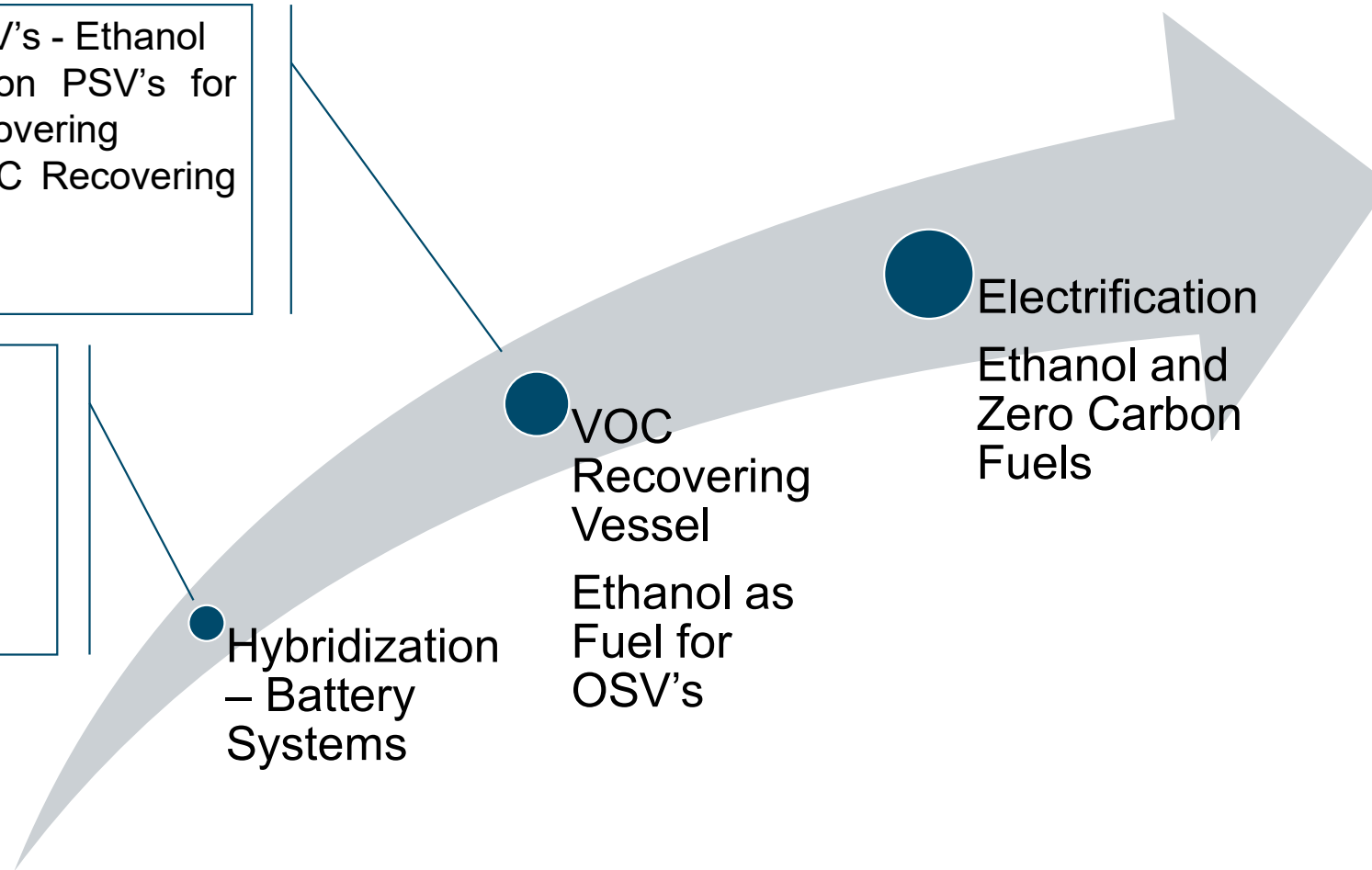


# DECARBONIZATION ROAD MAP

- New OSV's - Ethanol
- Retrofit on PSV's for VOC recovering
- New VOC Recovering Vessels.
- Etc.

## Hybrid Retrofit:

- OSV's
- Drilling Rigs
- Floatels
- Pipe Layers
- Etc.





**Mário Barbosa**

Senior Sales Manager – Latin America



**STAY IN TOUCH**