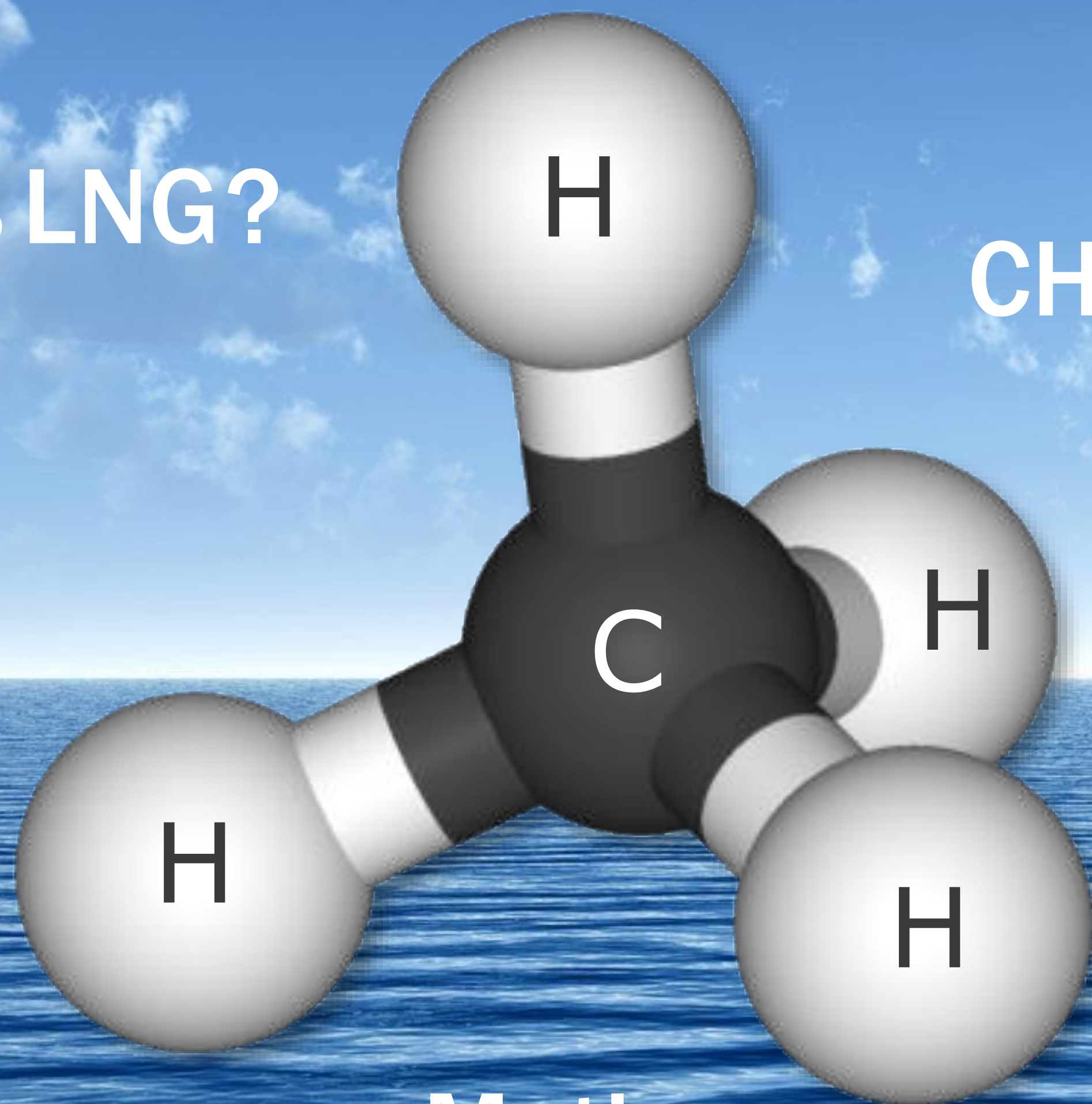


Methanol as marine fuel

IMSF Annual Meeting 2015

Per Stefenson, Stena Teknik

What is LNG?

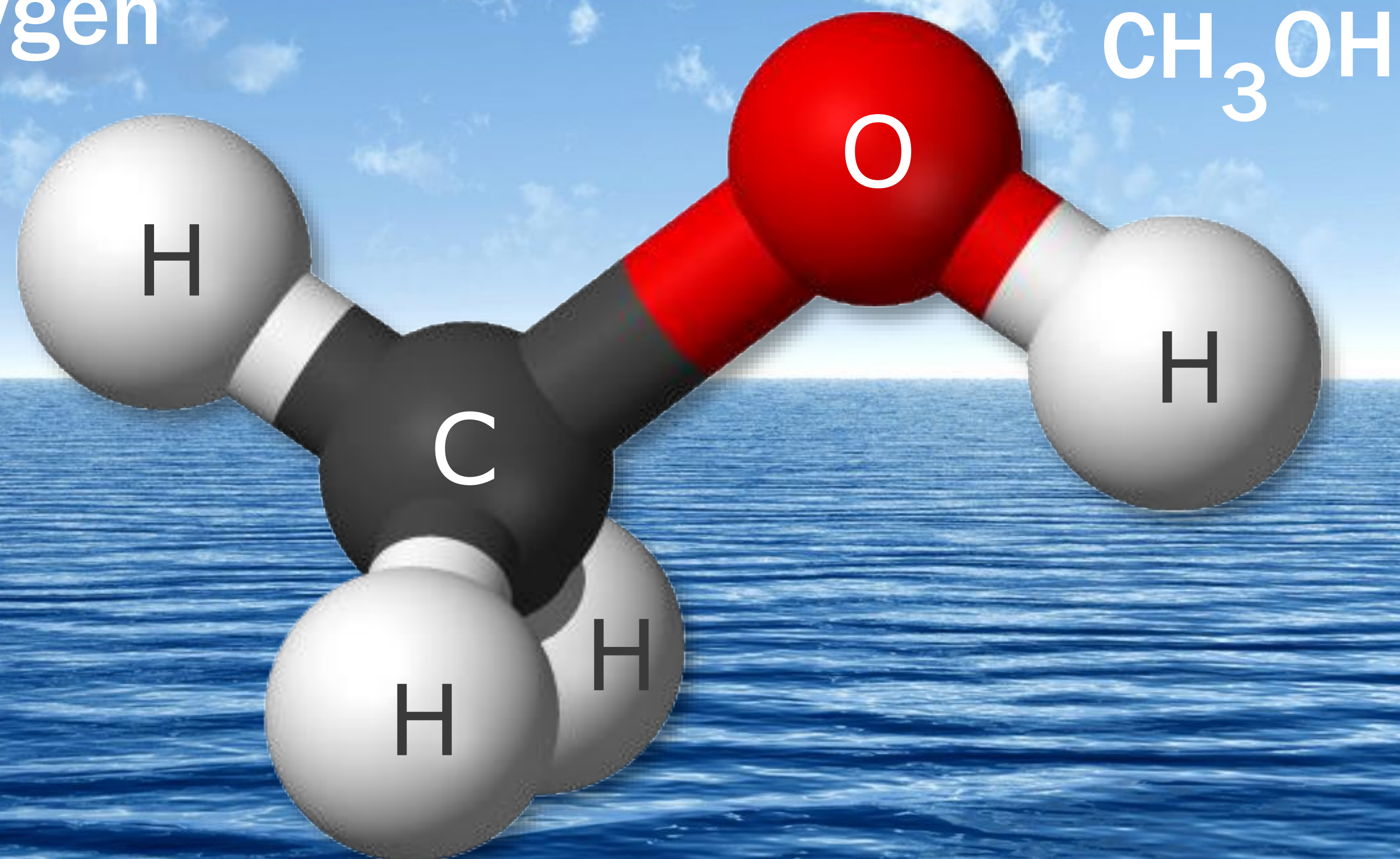


CH_4 -163°C

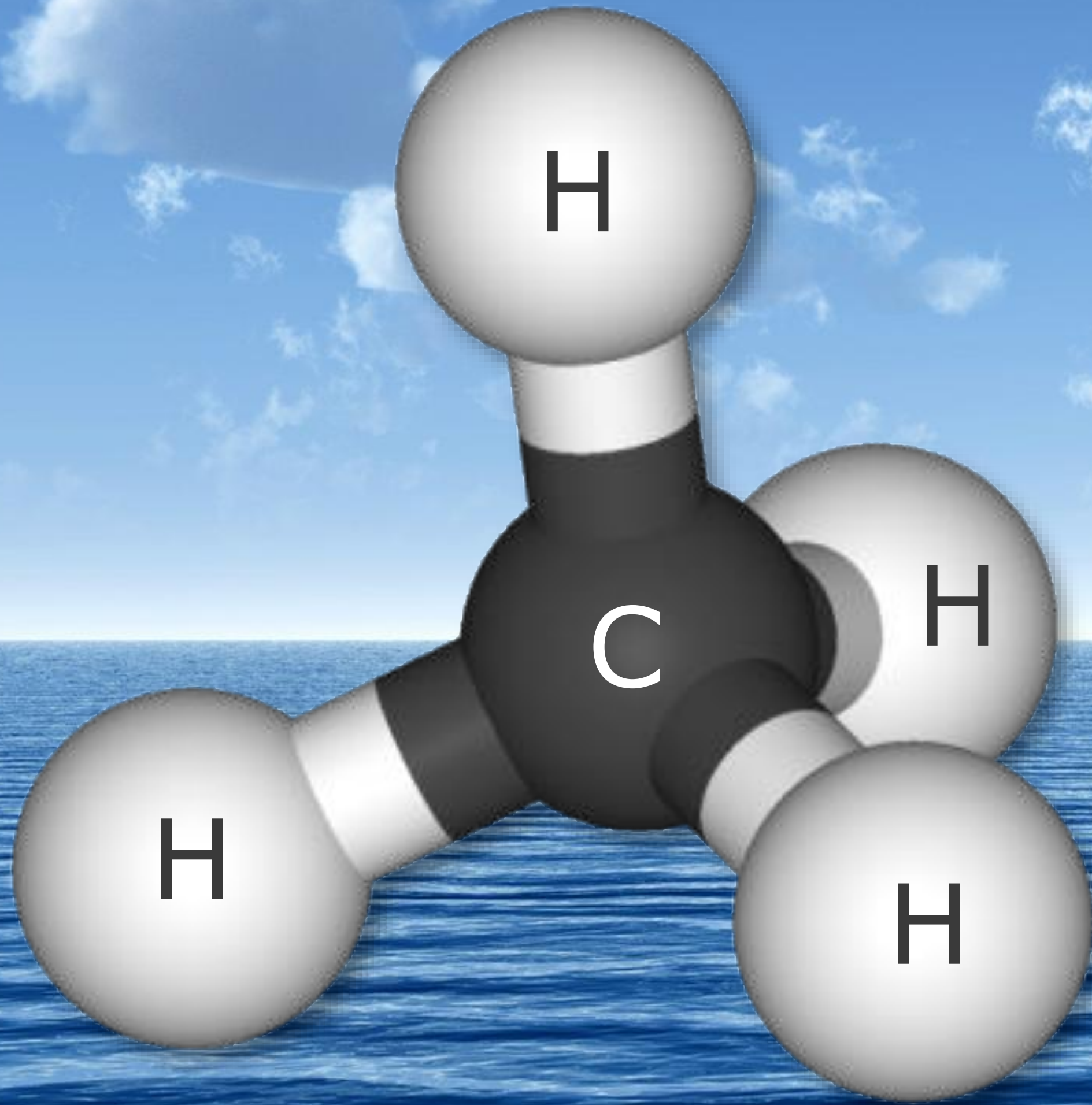
Methane
(Natural Gas)

Volume -600 times
=
Liquefied

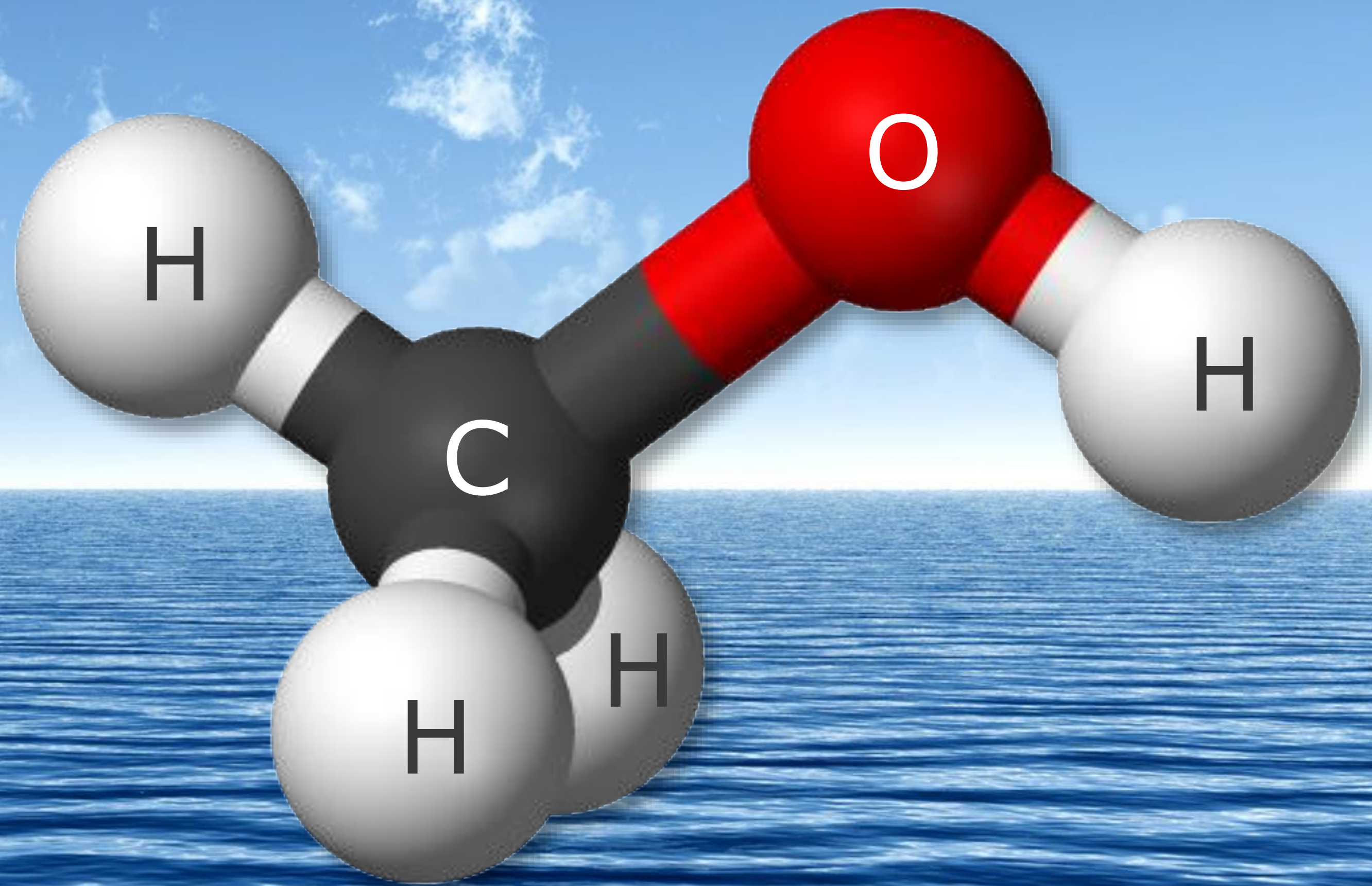
Methanol
Add one oxygen



Methanol is liquefied gas



Methane CH_4



Methanol CH_3OH

Methanol is used as a fuel already today – but in limited areas



Natural gas well head price

0.010	€/kWh	
183	\$/ton	Crude eqv.

Methanol cost ex works

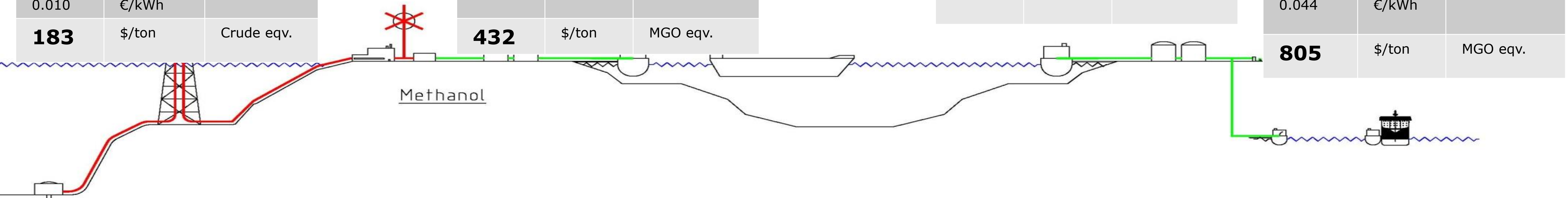
0.025	€/kWh	
432	\$/ton	MGO eqv.

Methanol produced from forest products

0.072	€/kWh	
1244	\$/ton	MGO eqv.

Methanol along side Göteborg

0.044	€/kWh	
805	\$/ton	MGO eqv.



Natural gas well head price

0.010	€/kWh	
183	\$/ton	Crude eqv.

LNG cost ex works

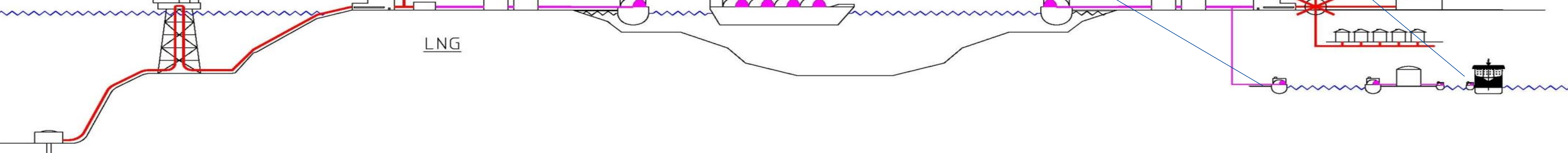
0.02	€/kWh	
345	\$/ton	MGO eqv.

LNG FOB Zeebrugge

0.03	€/kWh	
518	\$/ton	MGO eqv.

LNG along side Göteborg

0.046	€/kWh	
845	\$/ton	MGO eqv.



Crude oil well head price

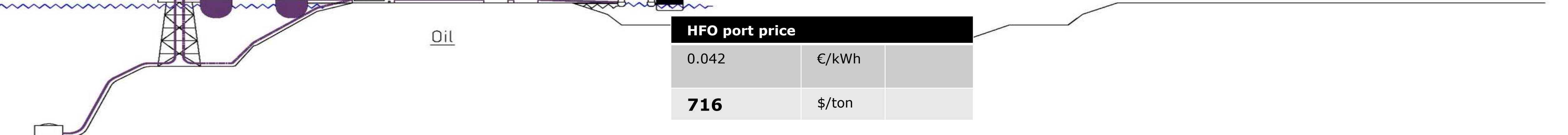
115	\$/bbl	
843	\$/ton	

Crude landed (WTI/Brent approx)

119	\$/bbl	
872	\$/ton	

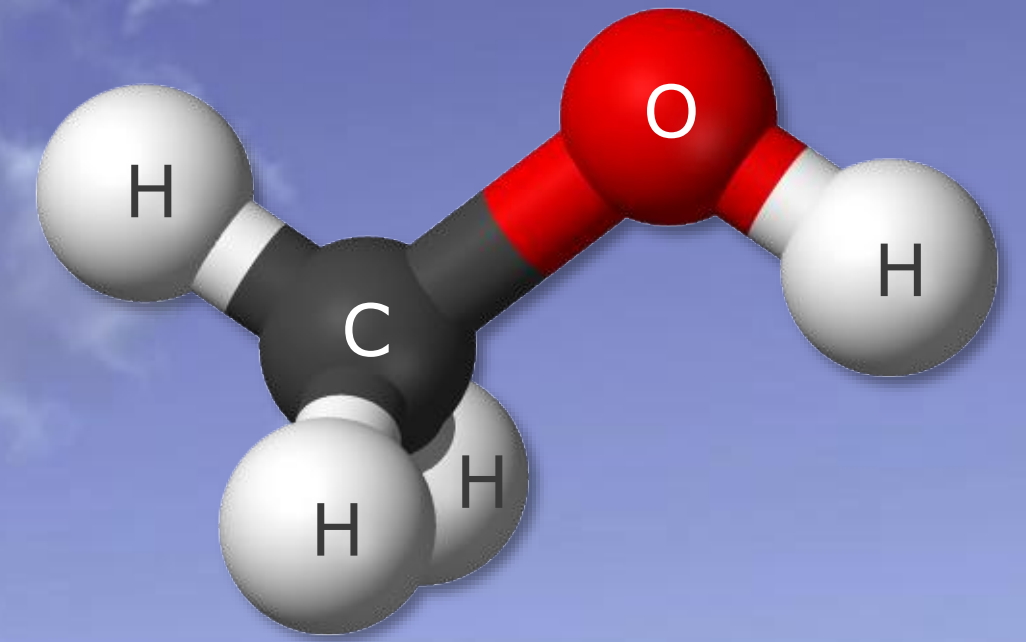
MGO port price

0.062	€/kWh	
1070	\$/ton	



HFO port price

0.042	€/kWh	
716	\$/ton	



Methanol

The marine fuel of the future



Conversion of Stena Germanica, Gothenburg - Kiel

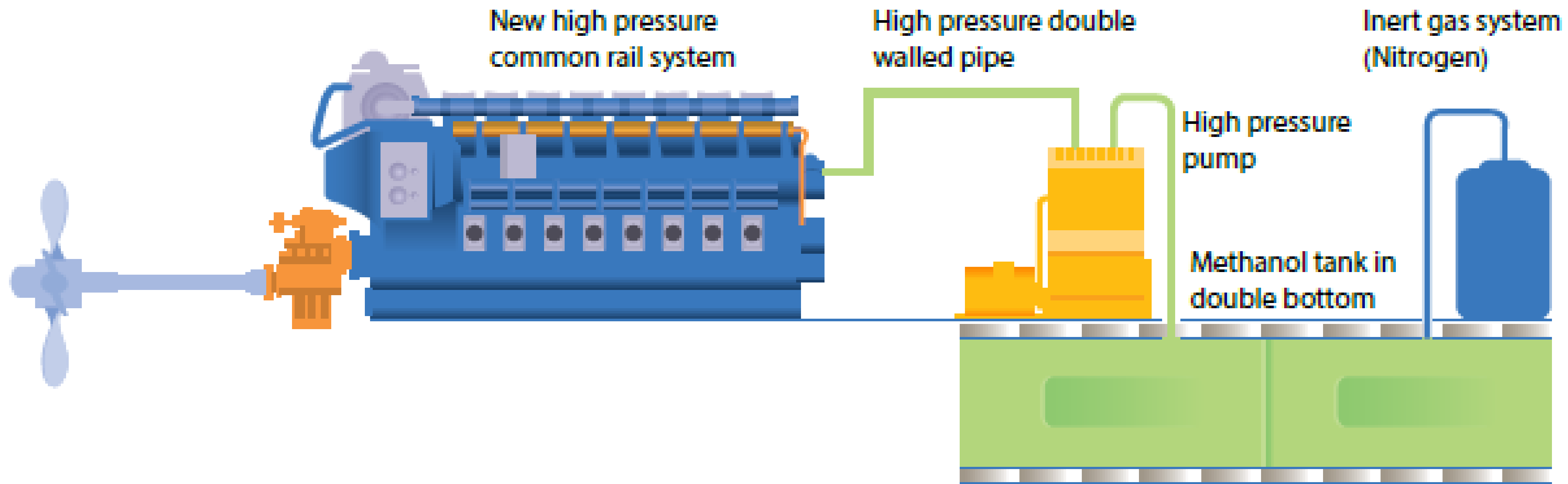


45.000 Cars
45.000 Lorries



Lifted from the road
every year





New high pressure common rail system

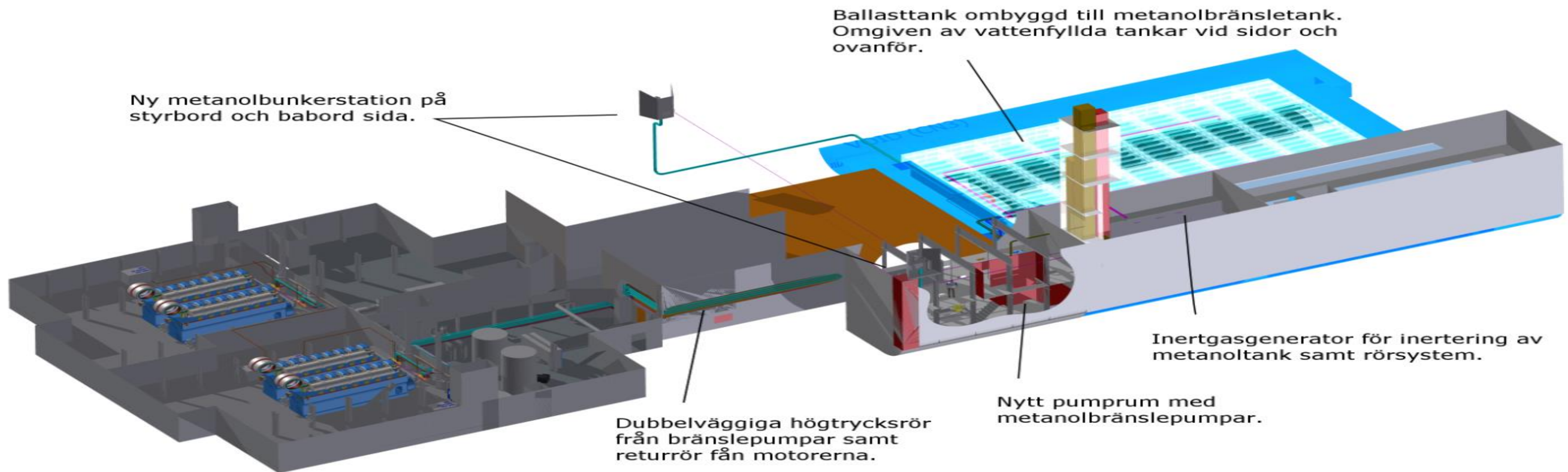
High pressure double walled pipe

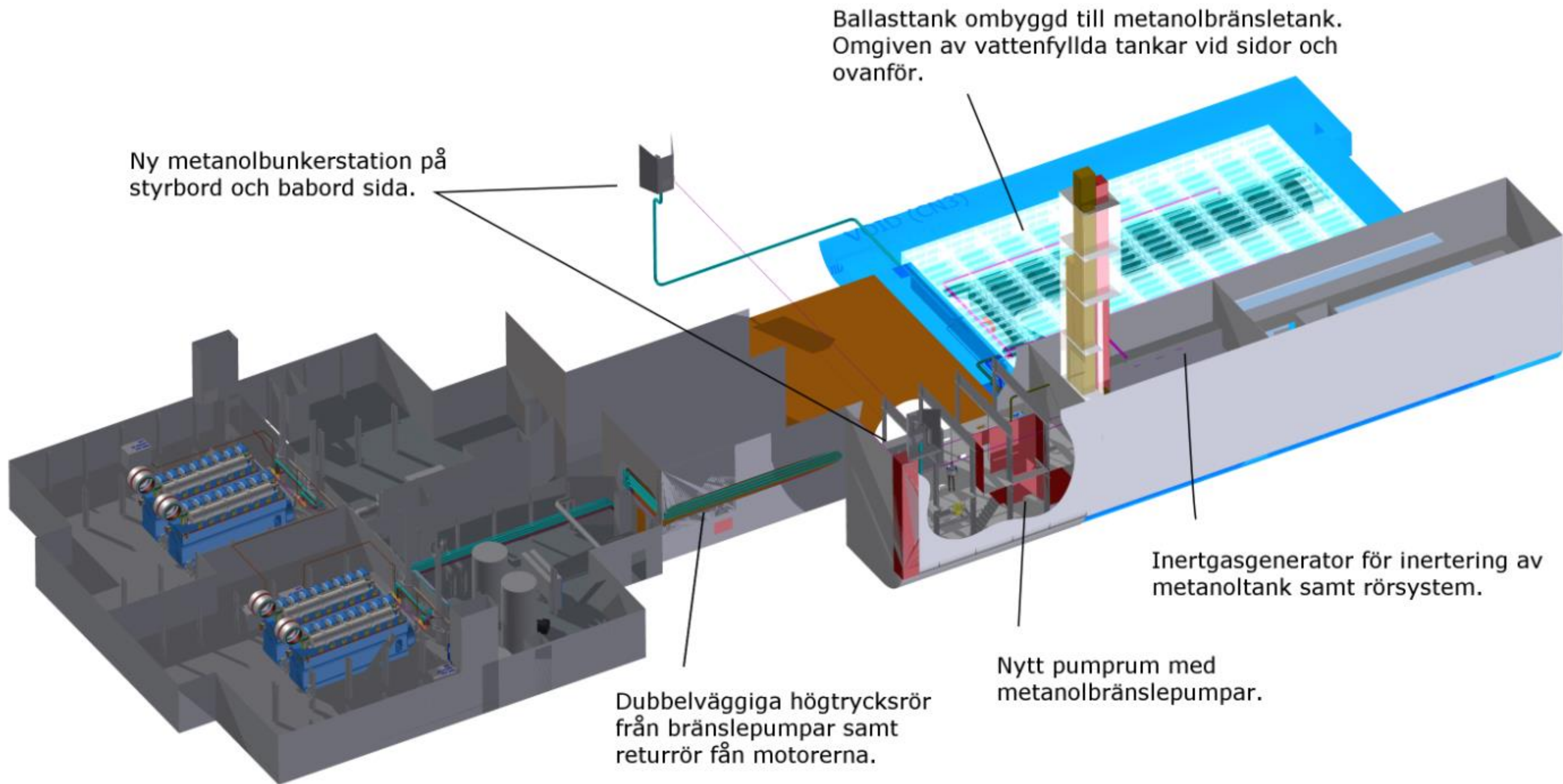
Inert gas system (Nitrogen)

High pressure pump

Methanol tank in double bottom

Stena Germanica Methanol conversion

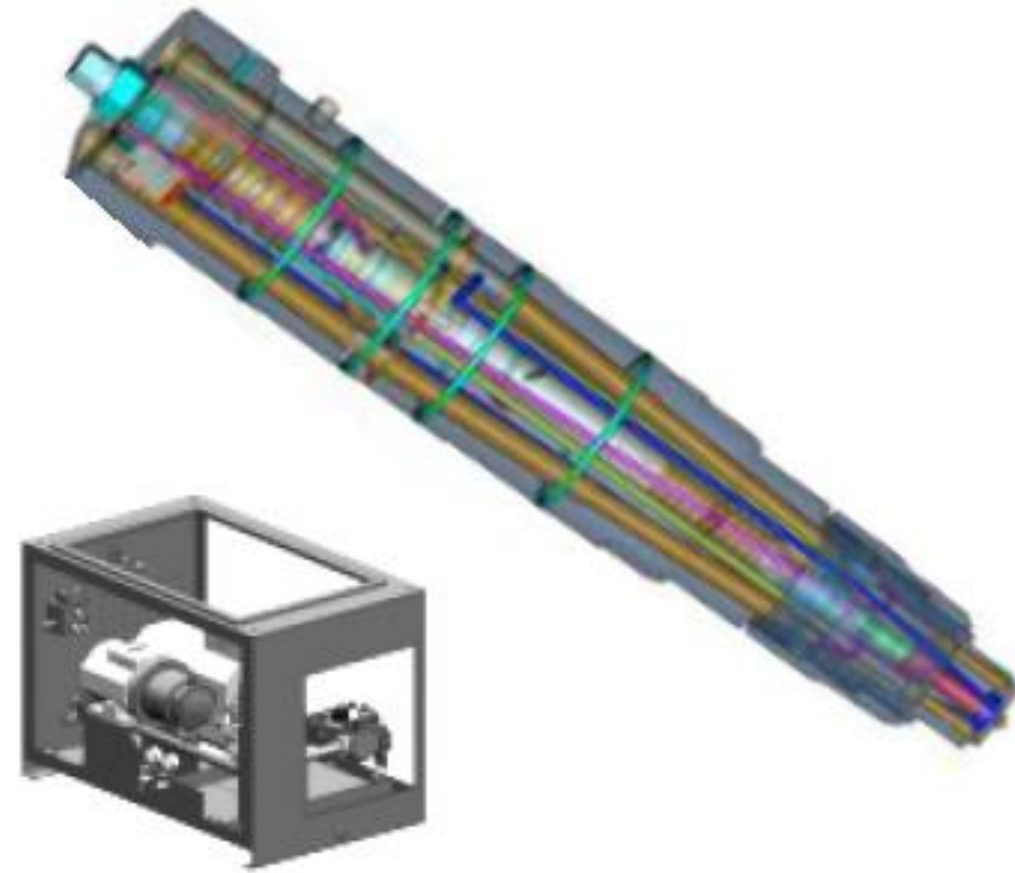






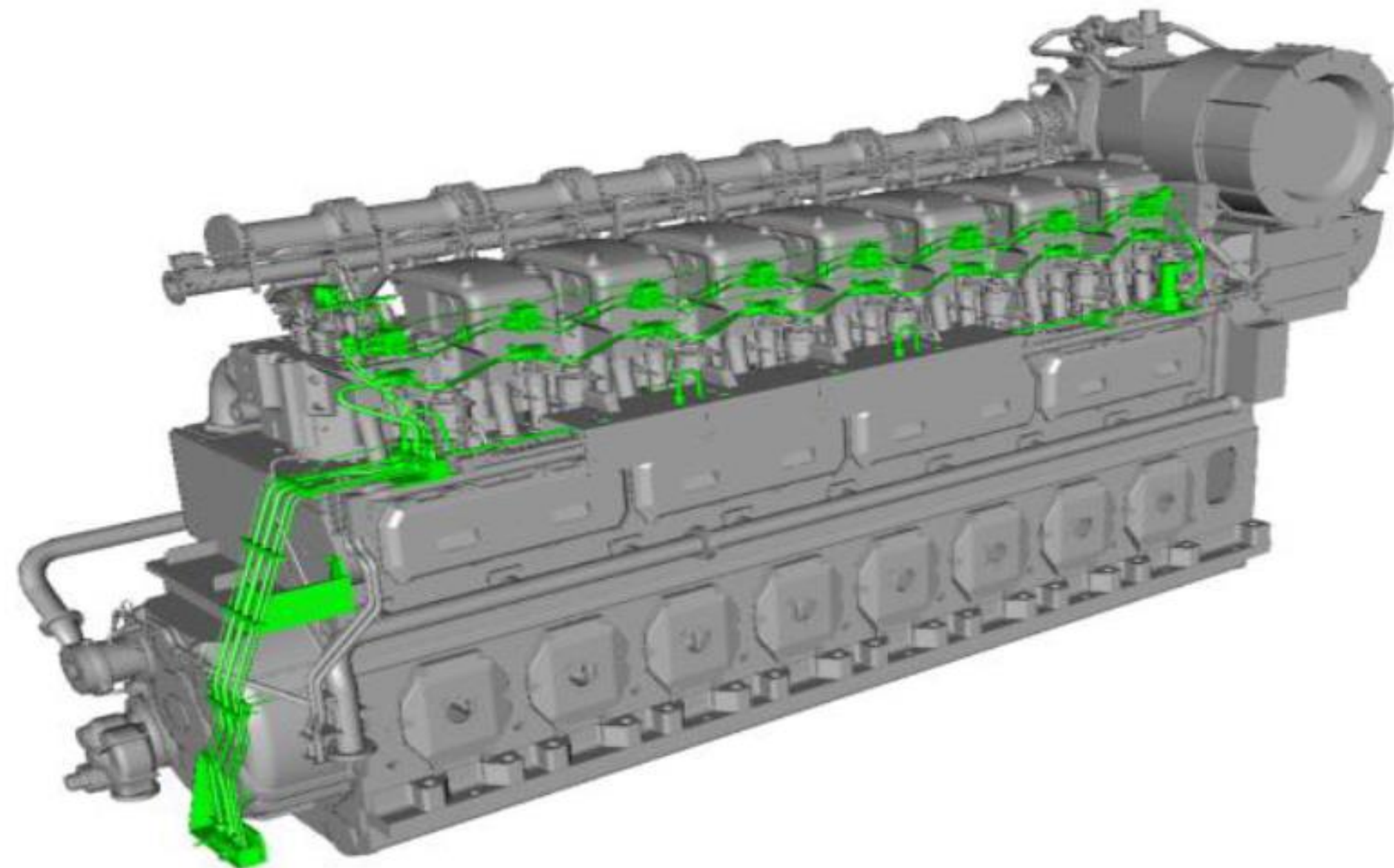
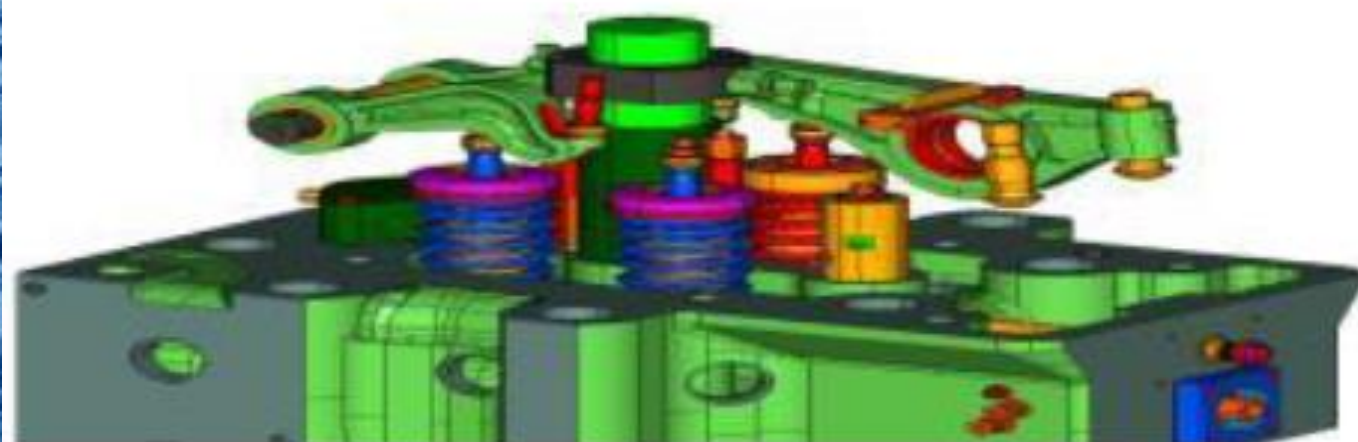
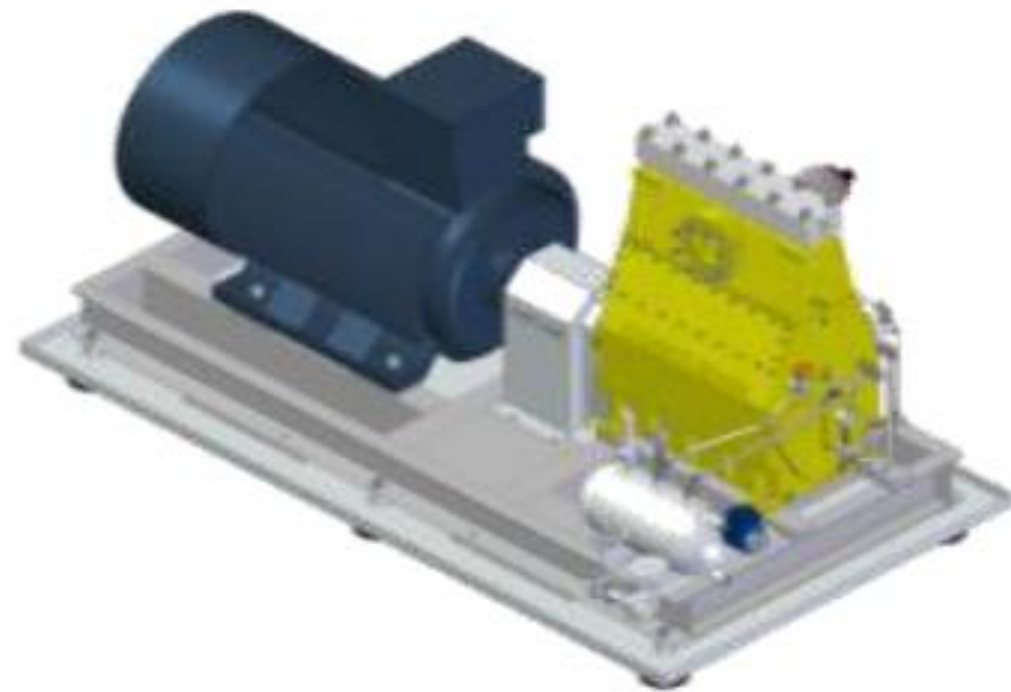
tena

Methanol Engine Conversion Scope



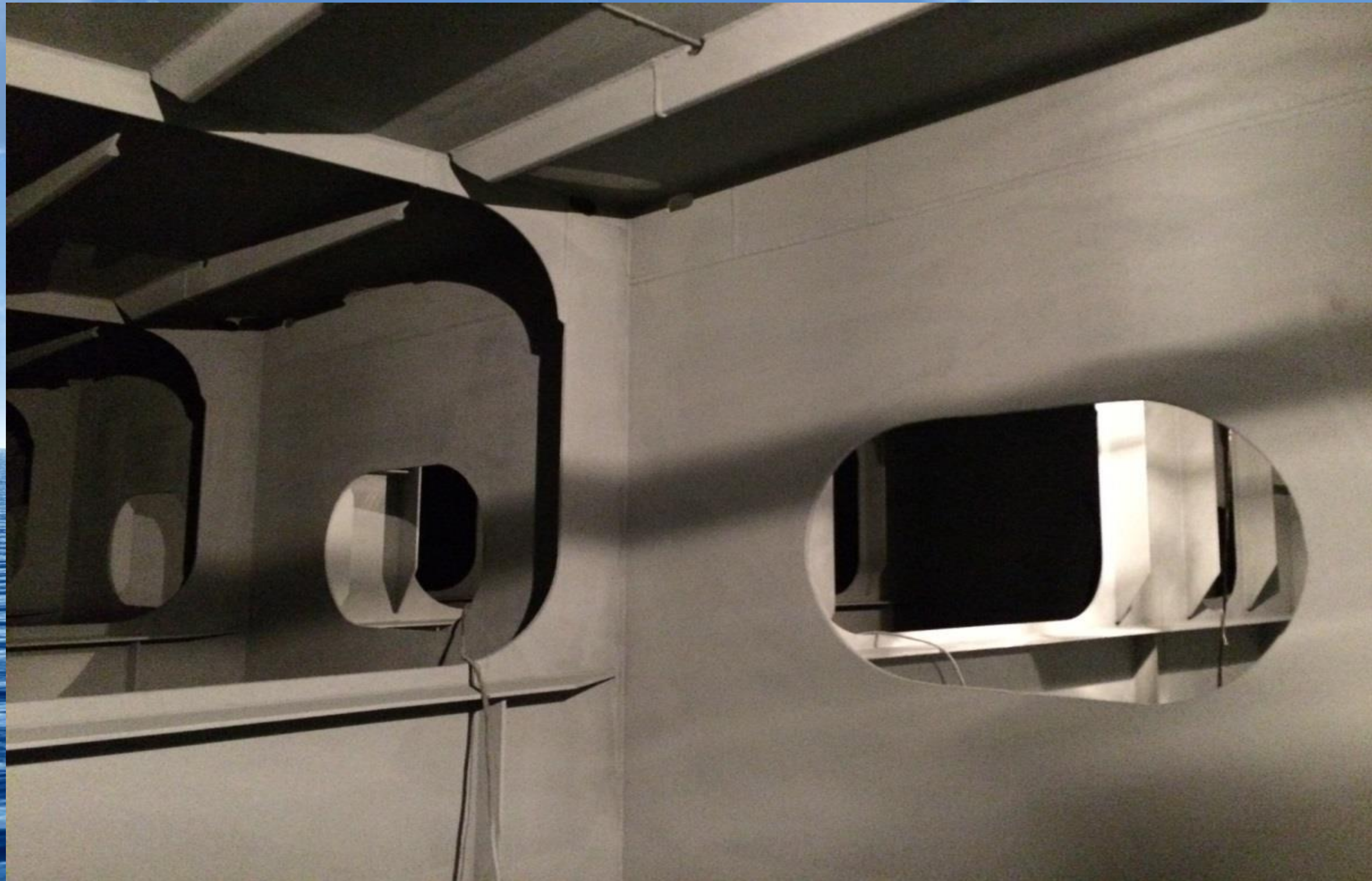
On-engine scope is limited to exchange of cylinder heads, fuel injectors and fuel plungers in existing fuel pumps. A common rail system for methanol injection will be added on the engine.

In addition to the Engine related conversion includes the conversion kit a stand-alone high pressure methanol pump with belonging oil unit for supply of sealing oil and control oil to the fuel injectors. A UNIC C3 solution will be used for engine control.





Methanol storage tank painted with zinc silicate



Summary test results



- ❑ **NOx acceptable (-60% to low Tier II values)**
- ❑ **CO acceptable (< 1 g/kWh)**
- ❑ **THC (Total Hydro Carbon) acceptable (< 1 g/kWh) and no "methane slip"**
- ❑ **Very low PM (FSN ~ 0,1 with HFO as pilot)**
- ❑ **Formaldehyde emissions low ~ 10-15 ppm (limit for shore industry 25 ppm)**
- ❑ **Efficiency slightly higher with methanol....compared to diesel**
- ❑ **No Formic acid detected in exhaust gases**

SUPERGREEN

Sustainable Shipping



Methanol
Conversion cost; 350 Euro/kW
Comparable with Scrubber



Conversion from HFO to LNG.



BIT VIKING.

Conversion cost; 1000 EURO/kW



IGF code, International code for gas fuel and other low flashpoint fuels



- **IGF code almost ready for LNG in September -14 at CCC1**
- **Remaining issue about LNG tank size and location**
- **Working group continues with development of guidelines for Methyl- and Ethyl alcohols and Fuel cells, now chaired by Sweden.**
- **Close cooperation between Stena and Swedish Transport Administration supports the development and assures that findings from the risk assessment work performed in the Stena Germanica project is communicated to the working group.**
- **Possible date for new Methyl- and Ethyl alcohols guidelines in September -15 at CCC2**

Annex 1

Draft IGF Code and Methanol

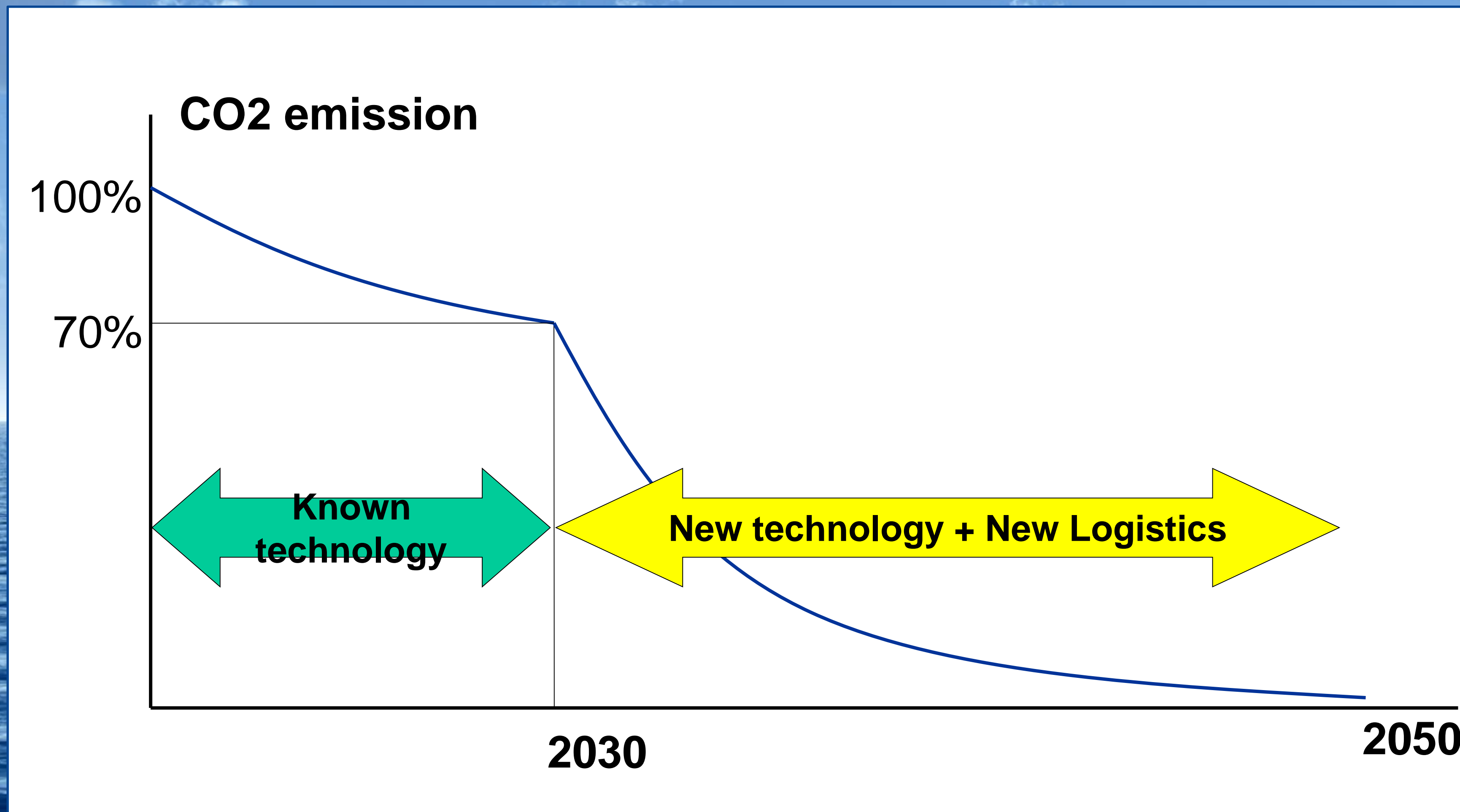
A **A-1**

Preamble	General & Def.	Goal & funct. req.	General requir.	Pipe design	Power generation	Fuel storage	Fuel to consumers	Bunkering	Ship design & arr.	Fire safety	Expl. protection	Ventilation	El installations	Contr & Saf. sys	Personnel safety
1	2	3	4	5.1	6.1	7.1	8.1	9.1	10.1	11.1	12.1	13.1	14.1	15.1	16.1
				5.2	6.2	7.2	8.2	9.2	10.2	11.2	12.2	13.2		15.2	16.2
				5.3	6.3	7.3	8.3	9.3	10.3	11.3	12.3	13.3		15.3	
				5.4	6.4	7.4	8.4	9.4	10.4	11.4	12.4	13.4		15.4	
					6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5		15.5	
					6.6	7.6	8.6	9.6	10.6	11.6		13.6		15.6	
					6.7	7.7	8.7		10.7	11.7		13.7		15.7	
					6.8	7.8	8.8		10.8	11.8		13.8		15.8	
					6.9	7.9	8.9		10.9					15.9	
									10.10						

Legend

	Valid for Methyl & Ethyl Alcohol
	Partly valid for Methyl & Ethyl Alcohol
	Not valid for Methyl & Ethyl Alcohol
	Suggestions given re Methyl & Ethyl Alcohol

Methanol leads towards the zero vision



Methanol – the bridge to a GHG free society



BIO-Methanol



CO2-Electrofuel

Carbon Capture and Recycling, CCR



GHG-neutral Renewable Methanol

** "Methanol provides natural gas an entry point to markets where it is currently underutilize ... By any yardstick, methanol is the most attractive carrier for natural gas."*

Environmental impact from marine fuels

