

SOx
NOx
SECA
LNG

Don't we all Love an Acronym?

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Piraeus - Istanbul - Montenegro - Houston - Split - Shanghai - Dubai - Singapore - India



The **2020**
Emission Control
Regulations
Financial
& Technical **Impact**
Alternatives and Solutions



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Is this
the beginning
of a
New era in Fuels?
Is "LNG as a fuel" prevailing
and becoming a
standard?

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Is greener shipping threatening Operators & Underwriters' "greener" pockets?

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Are we Facing a milestone?



- Early 20th Century Coal to Diesel
- 1983 Segregated ballast tanks MARPOL Annex I
- 1992 Double Hull Tanker Vessels MARPOL Annex I
- 1997 Regulations for the **Prevention of Air Pollution from Ships** MARPOL Annex VI



Low Sulphur Fuels ?



- The 2020 Regulations are all about reducing Sulphur (SO_x)
- The whole process commenced about a decade ago
- But it peaks in 2020

Can anyone recall, what happened when SO_x were initially reduced, some 10 years ago?



Question No.1

What were the consequences in the Marine H&M Market of the initial (mild) reduction of the Sulphur content in Marine fuels, that initiated some 10 years ago?

1. H&M Underwriters and Claims people were able to breath better because the air was cleaner and made wiser decisions!
2. H&M Underwriters made big profits, as the reduction of sulphur in fuels greatly reduced machinery claims
3. H&M Underwriters got stuck with CATALYTIC FINES and started paying millions of \$ in claims

The Outline



- The MARGETIS MARITIME Opinion Survey
- What is it all about – The punch line
- Compliant fuel oils – Primary Solution
- Scrubbers – Secondary Solution
- Marine Claims Consequences
- LNG as Fuel
- Conclusions

The Outline



The MARGETIS MARITIME Opinion Survey

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The MARGETIS MARITIME CONSULTING Opinion Survey



- Questionnaire to various Greek Ship Management Companies
- Received responses from:
 - Abt. 48 Companies
- Representing a fleet of:
 - Abt. 1,143 Ships

The Outline

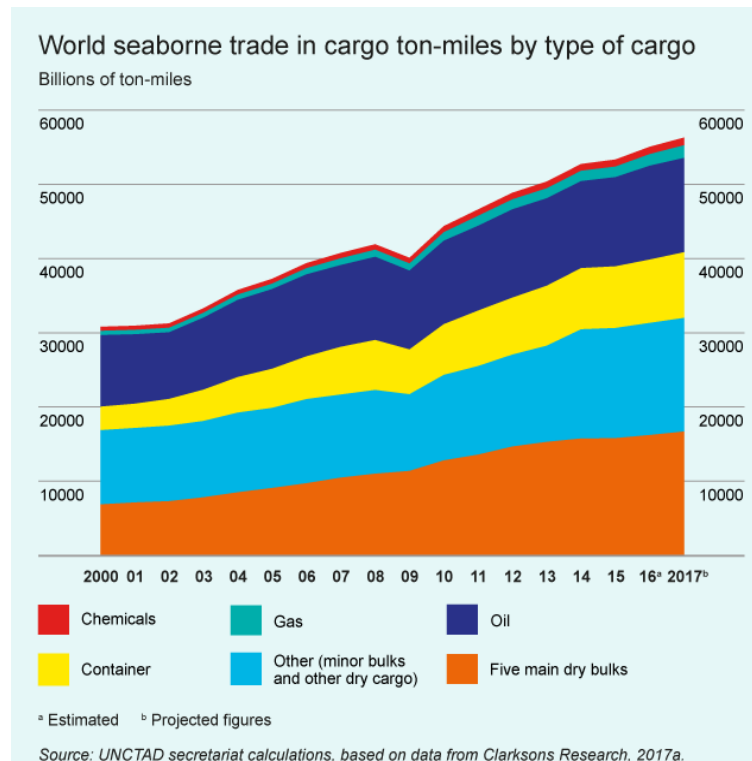


- The MARGETIS MARITIME Opinion Survey

What is it all about – The punch line

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Why Shipborne Air Emissions were adopted?



- Diesel engines 90% of the world's ocean going ships

→ heavy fuel oils practical and cheap

BUT contain

- sulphur oxides (SO_x)
 - nitrogen oxides (NO_x)
 - carbon dioxide (CO₂)
 - particulate matter (PM)
-
- Chemical reactions in the atmosphere → SO_x and NO_x converted into fine particles (sulphate and nitrate aerosols) with significant health impacts

Some statistics...

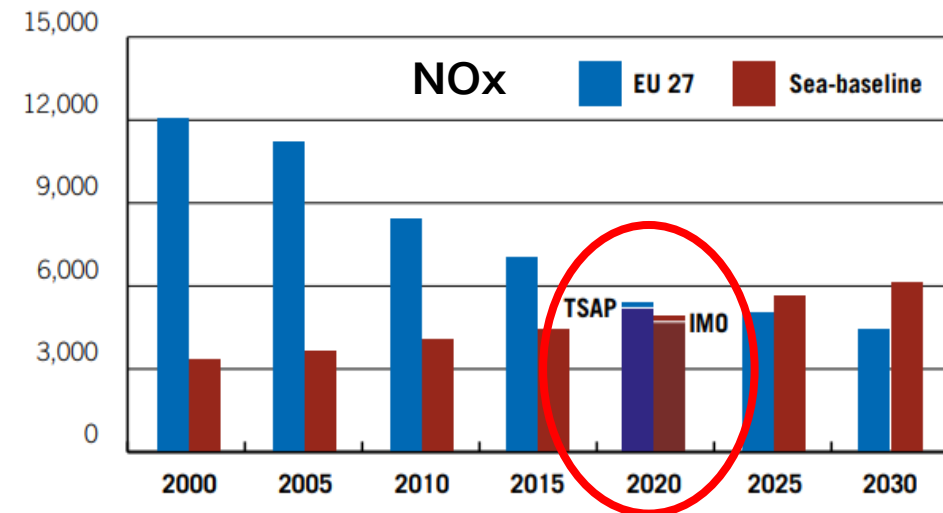
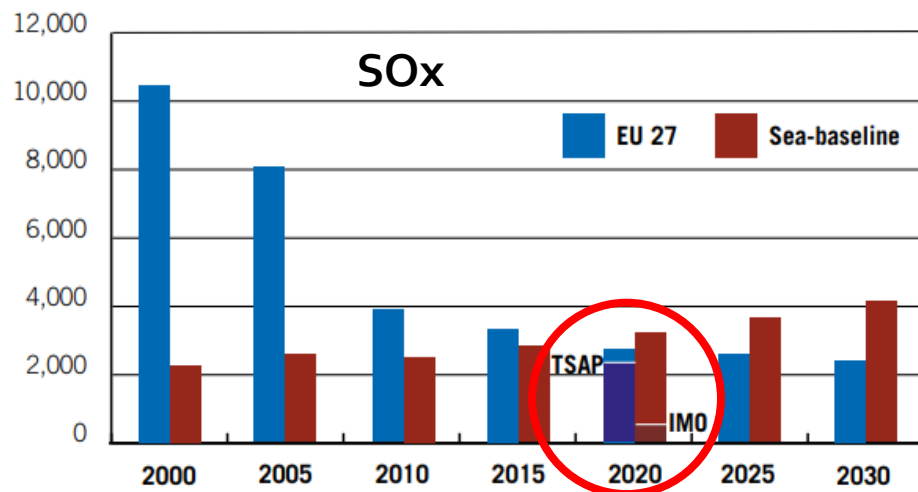


Air pollution from international shipping accounts approximately for **50,000 premature deaths per year** in Europe, at an annual cost to society of more than **€58 billion**

International ship traffic is responsible for an estimated 7% of the total health effects in Europe due to air pollution in the year 2000, increasing to **12% in the year 2020**

How are shipping emissions compared to land based emissions?

Pollutant emissions from land-based sources gradually coming down **BUT** those from shipping show a continuous increase



EU27 = Emissions from land-based sources (incl. domestic shipping)
Sea = Emissions from international shipping in European sea areas
TSAP = Target in line with the EU's Thematic Strategy on Air Pollution
IMO = Expected outcome from implementing the revised IMO MARPOL Annex VI

Source: Air Pollution & Climate Secretariat

Question No.2



Do you consider that the new regulations will indeed have a positive impact to the environment and human health?

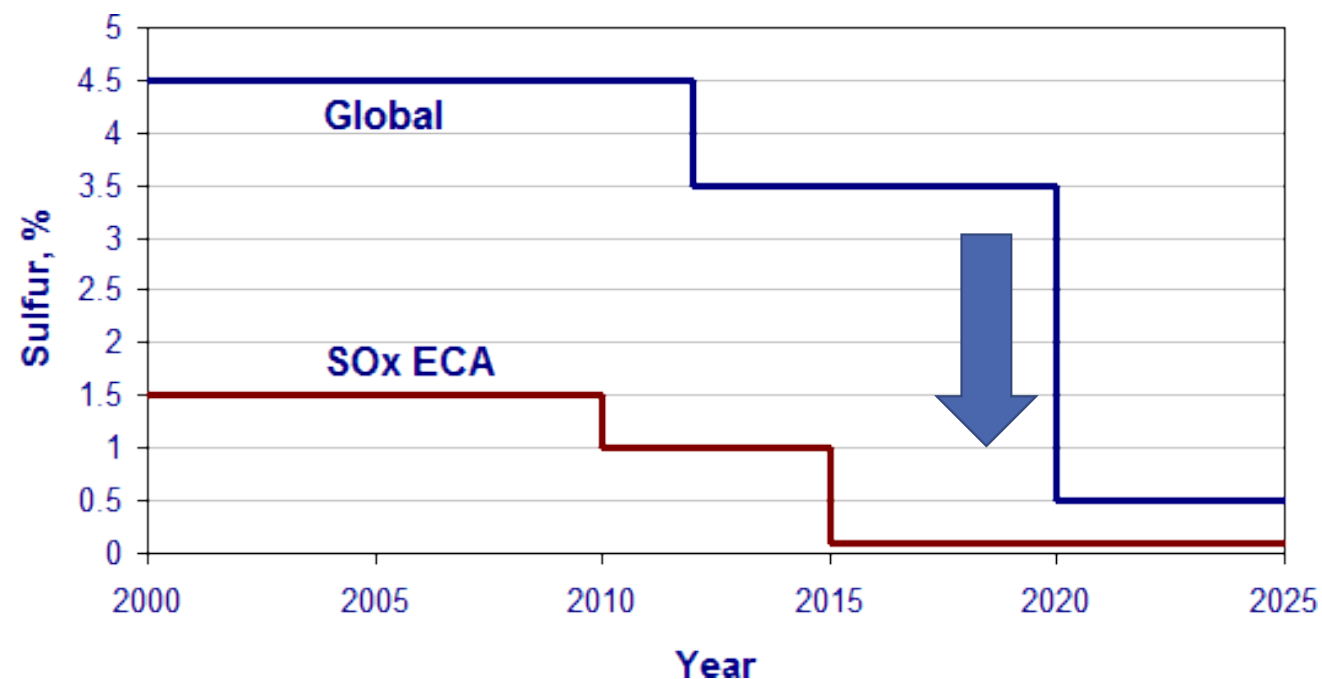
1. Yes
2. No
3. I do not know

Which are these regulations?

MARPOL Annex VI Regulations for the Prevention of Air Pollution from Ships

- Sulphur oxide (SOX) from **3.5% to 0.5%** in 2020 globally
- Emission Control Areas (ECAs) from **1% to 0.1%** in 2015
- ❑ Crude oil sulphur ranging from **0.1% to 4.1%**
- ❑ As per IMO MEPC 72 committee, annual average in 2017 around **2.6%** → well above

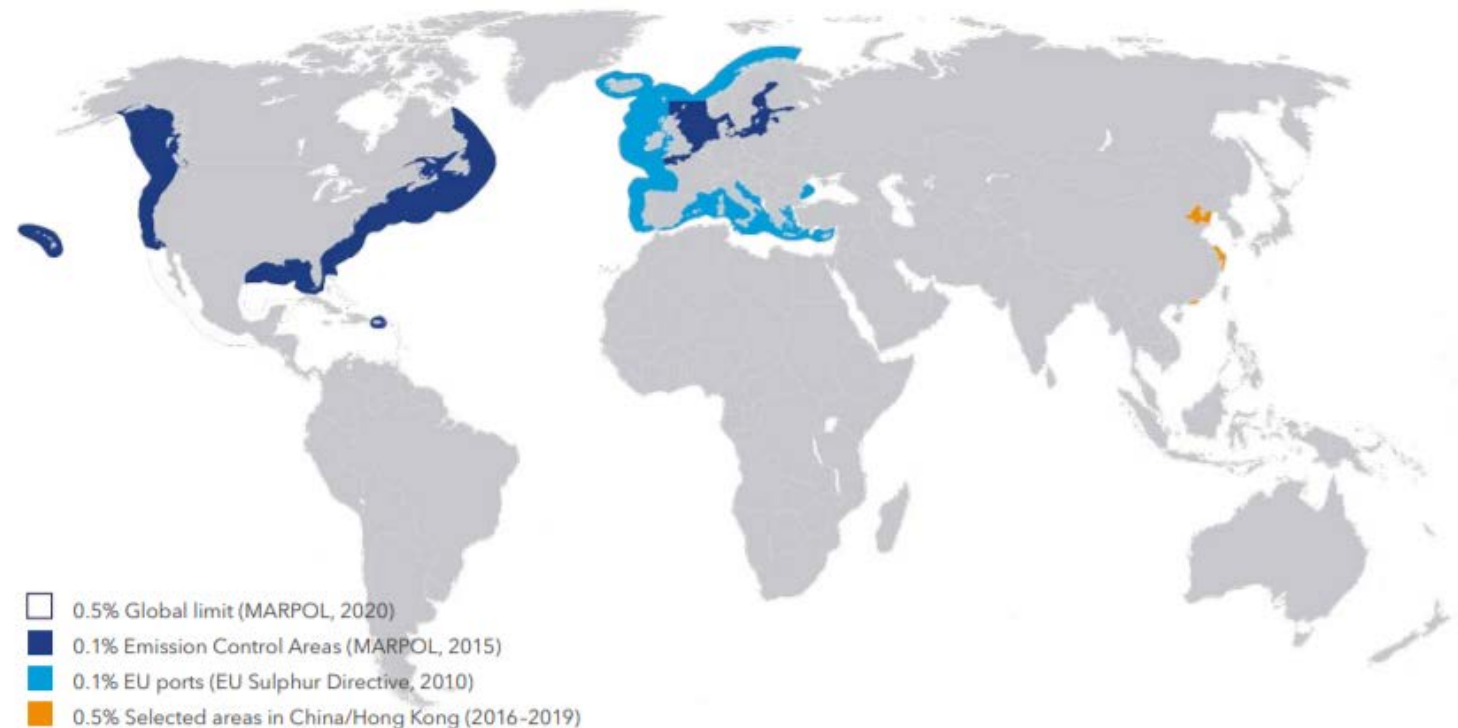
2020 limits



ECAs

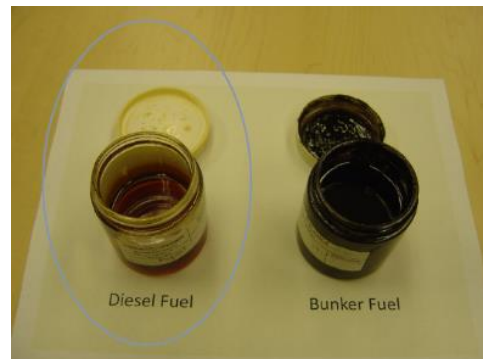
MARPOL Annex VI Regulations for the Prevention of Air Pollution from Ships

- **Baltic Sea area (SO_x only);**
- **North Sea area (SO_x only);**
- **North American area (entered into effect 1 August 2012 SO_x, NO_x and PM);**
- **United States Caribbean Sea area (entered into effect 1 January 2014 SO_x, NO_x and PM)**



Fueling the solution: there is no one-size-fits-all!

Primary Methods



Low-sulphur fuels

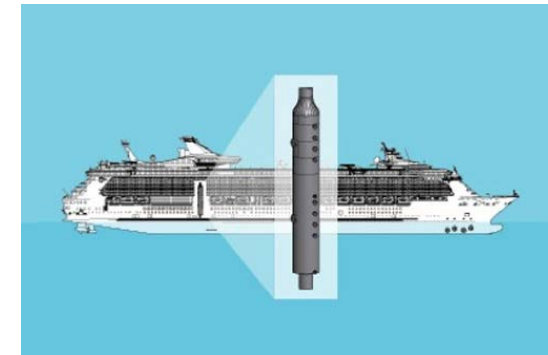
- Using low-sulphur FO or MGO (max 0.5%) globally and ultra-low-sulphur FO or low sulphur MGO (max 0.1%) in ECAs



Gas or dual-fuel engines

- Using Liquefied Natural Gas (LNG) as fuel

Secondary Method



Exhaust Gas Cleaning Systems

- Burning HFO (3.5%) with scrubber installed

Question No.3



Which solution do you think that will eventually prevail?

1. Widespread usage of **LNG** as fuel
2. Widespread usage of **Compliant Fuels**
3. Widespread usage of **Scrubbers**
4. I don't have enough information to decide

But there is something in common... high cost!

Cost of Measures about
50 billion USA dollars / per year



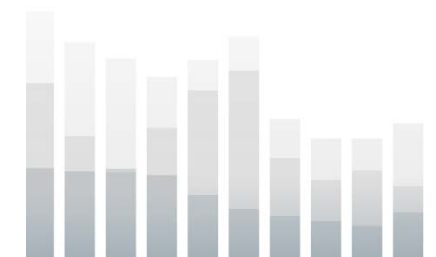
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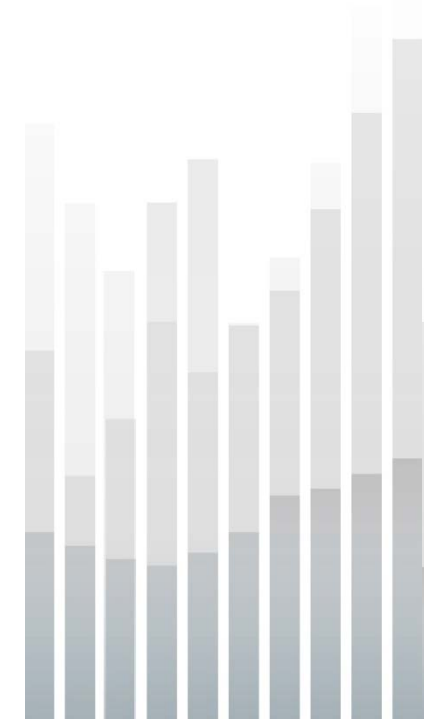
Refineries are adopting and evolving...

Fuel Types	Category	Viscosity Range (cSt)	Sulphur Content Range (%)	Price Range (\$)
IFO 180	Residual	180	1.0 – 3.5	470
HFO 380	Residual	380	1.0 – 3.5	435



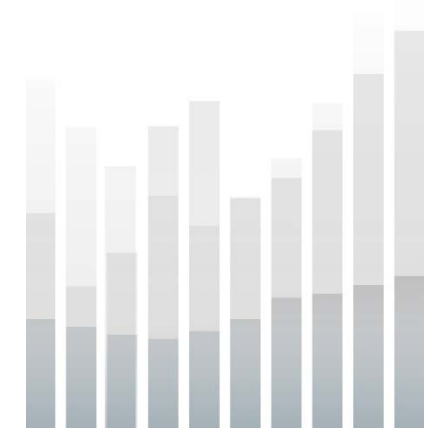
Refineries are adopting and evolving...

Fuel Types	Category	Viscosity Range (cSt)	Sulphur Content Range (%)	Price Range (\$)
MDO	Distillate	10	0.1 – 1.5	630
MGO	Distillate	5	0.1 – 1	630
IFO 180	Residual	180	1.0 – 3.5	470
HFO 380	Residual	380	1.0 – 3.5	435



Refineries are adopting and evolving...

Fuel Types	Category	Viscosity Range (cSt)	Sulphur Content Range (%)	Price Range (\$)
MDO	Distillate	10	0.1 – 1.5	630
MGO	Distillate	5	0.1 – 1	630
0.1% HFO	Not standardized	70	< 0.1	5??
0.5% HFO	Not standardized	70	< 0.5	5??
IFO 180	Residual	180	1.0 – 3.5	470
HFO 380	Residual	380	1.0 – 3.5	435



Beware...

Higher Cost of Fuel!

Beware...



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What is a scrubber?

- Main principle → **washing** the exhausts prior releasing to the atmosphere
- Converts SO_x to harmless sodium sulphate

3 Main Types:

- ❖ Open Loop
- ❖ Close Loop
- ❖ Hybrid

✓ Regulated by:
Annex 1 Resolution MEPC.259(68) adopted on 15 May 2015:
Guidelines For Exhaust Gas Cleaning Systems

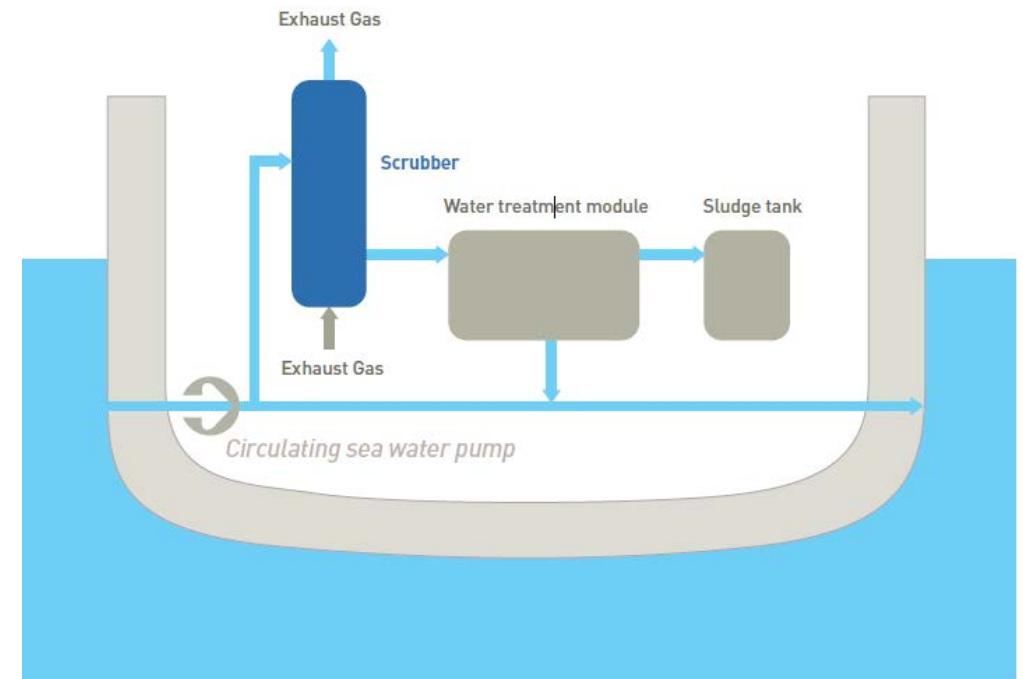


Open Loop: Uses untreated seawater and washwater is discharged at sea

- ✓ Untreated seawater of natural alkalinity (no need for chemical additives)
- ✓ Quite high pumping capability required
- ✓ Efficiency increases in higher alkalinity waters
- ✓ Washwater discharged into the sea after being treated

BUT

- ❖ Greater energy consumption compared to a close loop system
- ❖ Not permitted to discharge washwater everywhere

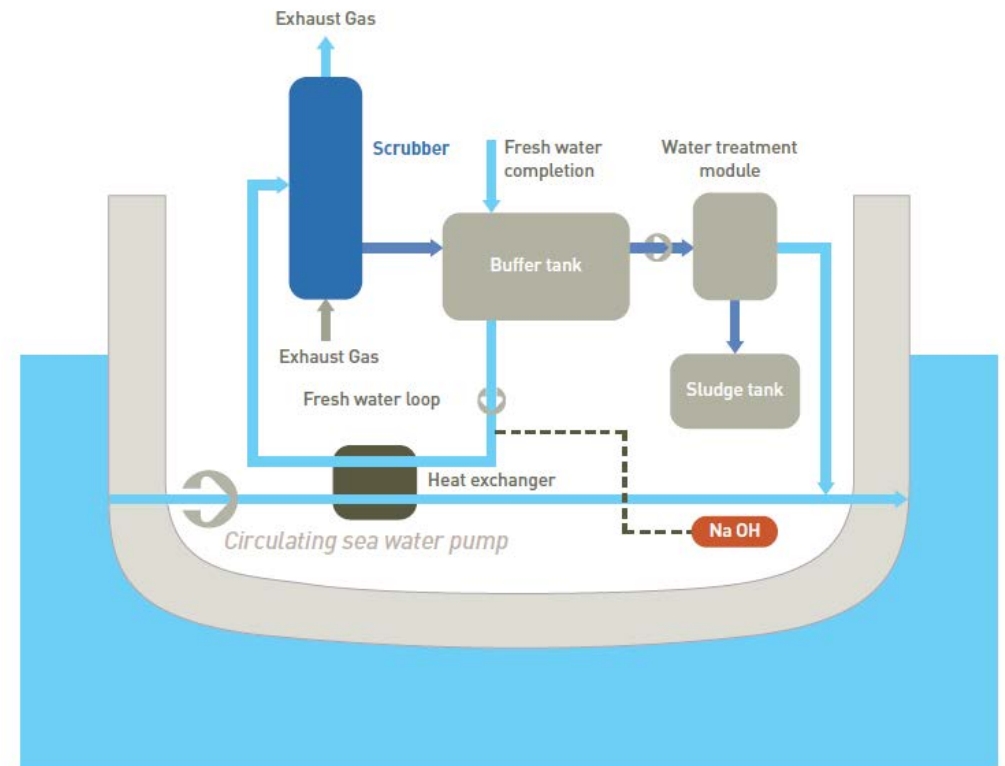


Closed Loop: Uses caustic soda and washwater is not discharged at sea

- ✓ Caustic soda added to fresh or sea water in a closed system (not dependent on the type of the water/alkalinity levels)
- ✓ Wash water passes into a process tank where it is cleaned before being recirculated with a small discharge overboard
- ✓ The amount of the water needed is about half of the flow in an open loop system

BUT

- ❖ More tanks are required and system is more complex than open

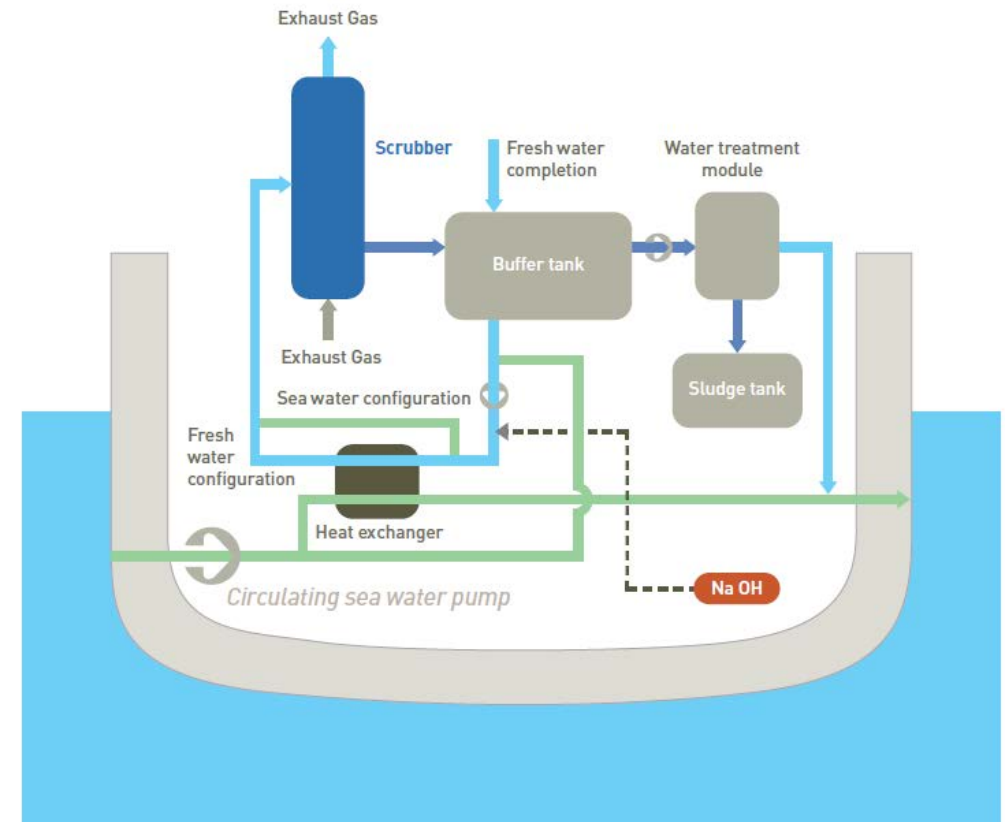


Hybrid: Combined open and closed loop

- ✓ Flexibility to either use closed loop or open loop technology
- ✓ Used as an open loop system when in open sea and as a closed loop system when in harbour
- ✓ Increasingly preferred given its flexibility

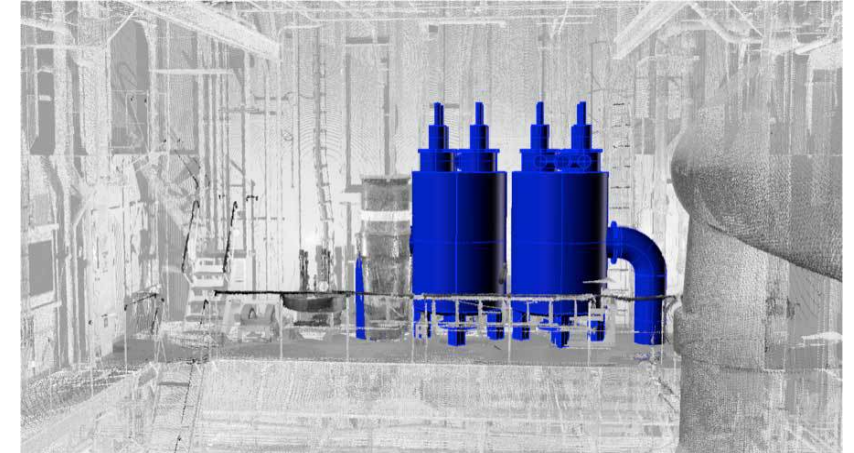
BUT

- ❖ Increased cost and more complex system than open & closed loop

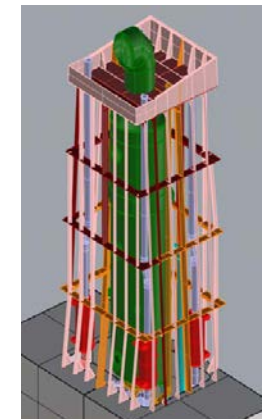


Which are the main parameters to consider when choosing system?

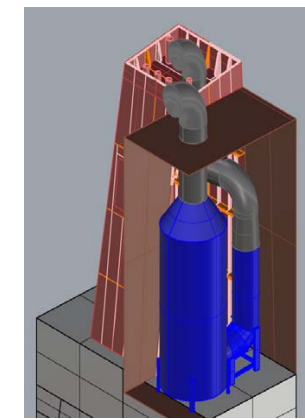
- ✓ Newbuilding vs retrofit
- ✓ Operating route
- ✓ Space availability onboard
- ✓ Capital vs operational costs
- ✓ Price differential between low sulphur and heavy fuel
- ✓ Sludge handling and disposal
- ✓ Availability of heavy fuel oil



In Line



U type



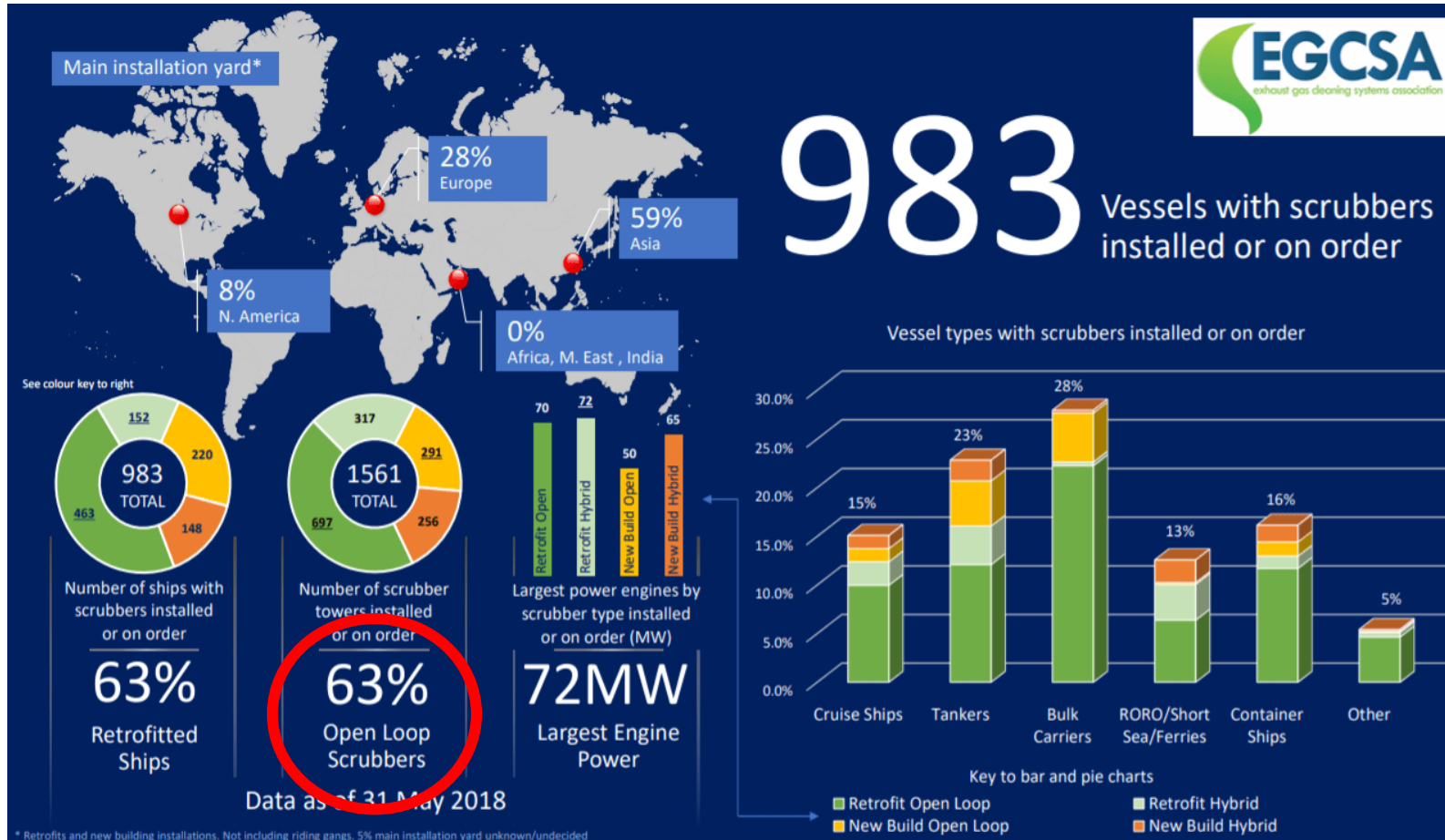
Question No.4



What percentage of the world fleet is EXPECTED to be fitted with scrubbers by the 2020 deadline?

1. Less than 5%
2. Around 15%
3. Around 25%
4. Around 35%
5. I have no idea

Current trends on scrubbers



Open Loop Scrubber and switching to ultra low Sulphur fuels in ports where discharge is prohibited...

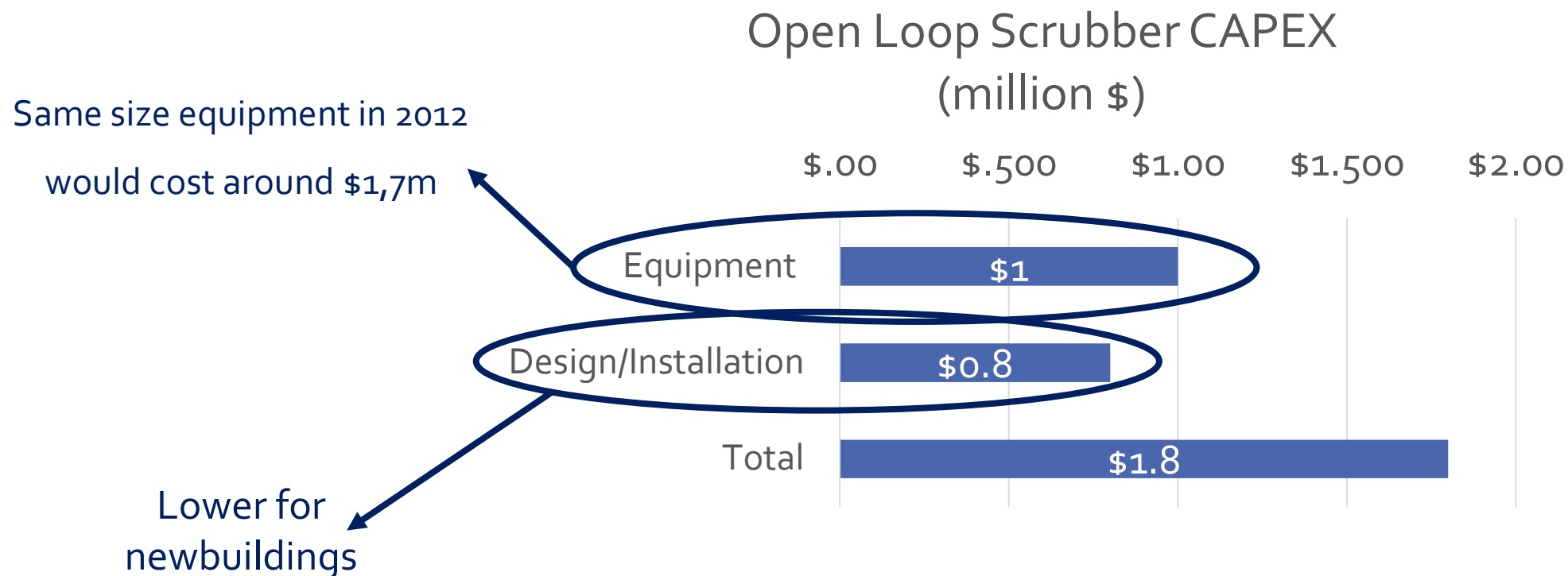
As per Wood MacKenzie, by 2020 only 2-3% of total fleet will have installed scrubbers...

Food for thought...

- If only 2-3% of vessels will have scrubbers, **will there be HFO readily available worldwide?**
 - ✓ Imagine a terminal having to maintain a bunkering barge only for such a small amount of clients for HFO
 - ✓ Big players with scrubbers will have contracts with terminals for HFO at a pre-agreed price
- If majority of scrubbers are open loop how can we ensure that **disposal will not be prohibited in the future** in areas, such as the Baltic, North Sea etc. ?

Scrubbers Installation Costs

- ❖ Equipment prices have dropped significantly from the previous years
- ❖ Example for a Panamax Bulk Carrier **retrofit**



Case Study for MGO and Scrubbers

Reference vessel	Panamax Bulk Carrier		
Average Percentage Spent in SECA	20%		
Average Percentage Spent outside SECA	80%		
Fuel Cost Differential	\$150.00	\$200.00	\$250.00
Additional Yearly Costs if NO technology installed	\$759,000	\$1,012,000	\$1,265,000
Yearly Savings if Scrubber installed	\$938,750	\$1,255,000	\$1,571,250
Return period (years)	2	1.4	1

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Impact to the insurance market

Scrubbers

- **New machinery**
- **Water** in engine combustion chamber
- **LOH** for complex damages

- overheating damages similar to boilers
- machinery malfunction/damages
- idle vs expensive low sulphur fuels

Impact to the insurance market

MGO/MDO Advantages:

- ❖ Convenient and widely available
- ❖ Operational experience in industry
- ❖ Cleaner fuel – less machinery related malfunctions

vs

Compliant fuel oil blends:

- ❖ Low quality/out of spec bunker
- ❖ May contain cat fines as products of refinery streams
- ❖ Compatibility and stability issues
- ❖ Lubricity issues

Compliant low sulphur fuels

- Cat fines
- New blend of fuels / uncertainties
- Fuel incompatibility
- Different properties (viscosity, pour point etc.)

- main cause of machinery failures
- combustion issues
- sludge accumulation, dedicated tanks
- overheating, delicate changeover procedures

Beware...

More Combustion Related Claims!

The Outline

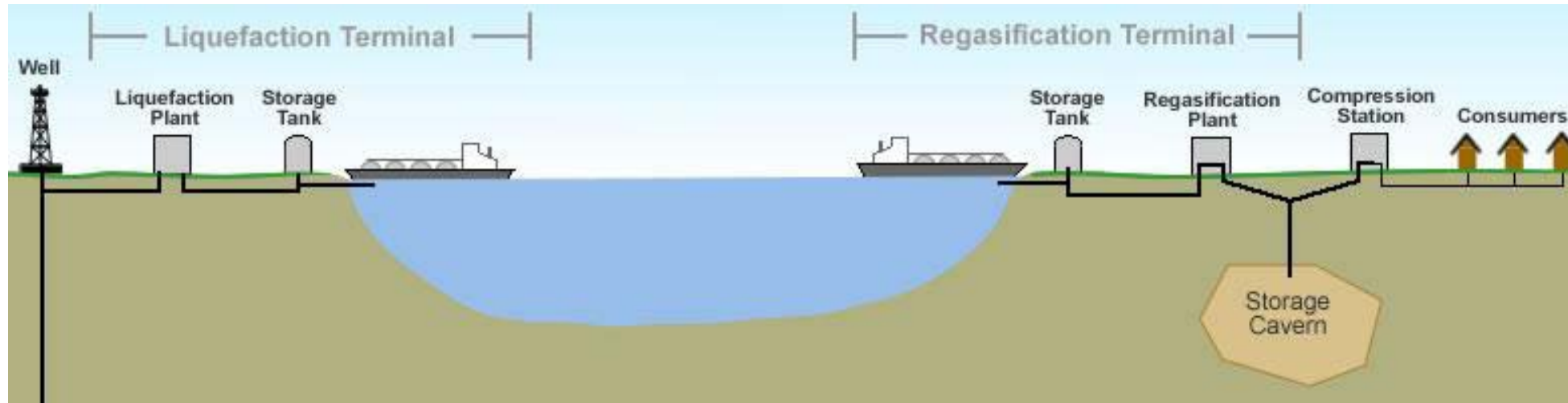


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What is LNG?

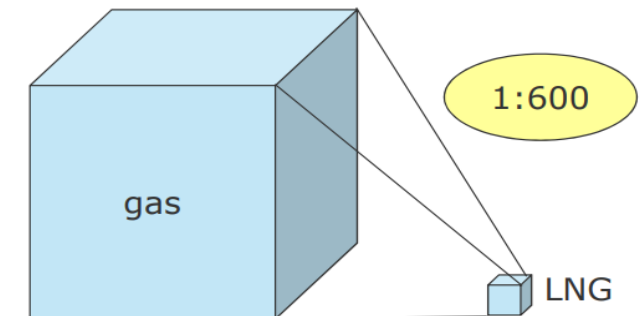


- ✓ Natural Gas transported in **liquefied form** onboard specialized ships in well-insulated tanks

Why?

Liquefied gas occupies **1/600** of the volume of been vapour

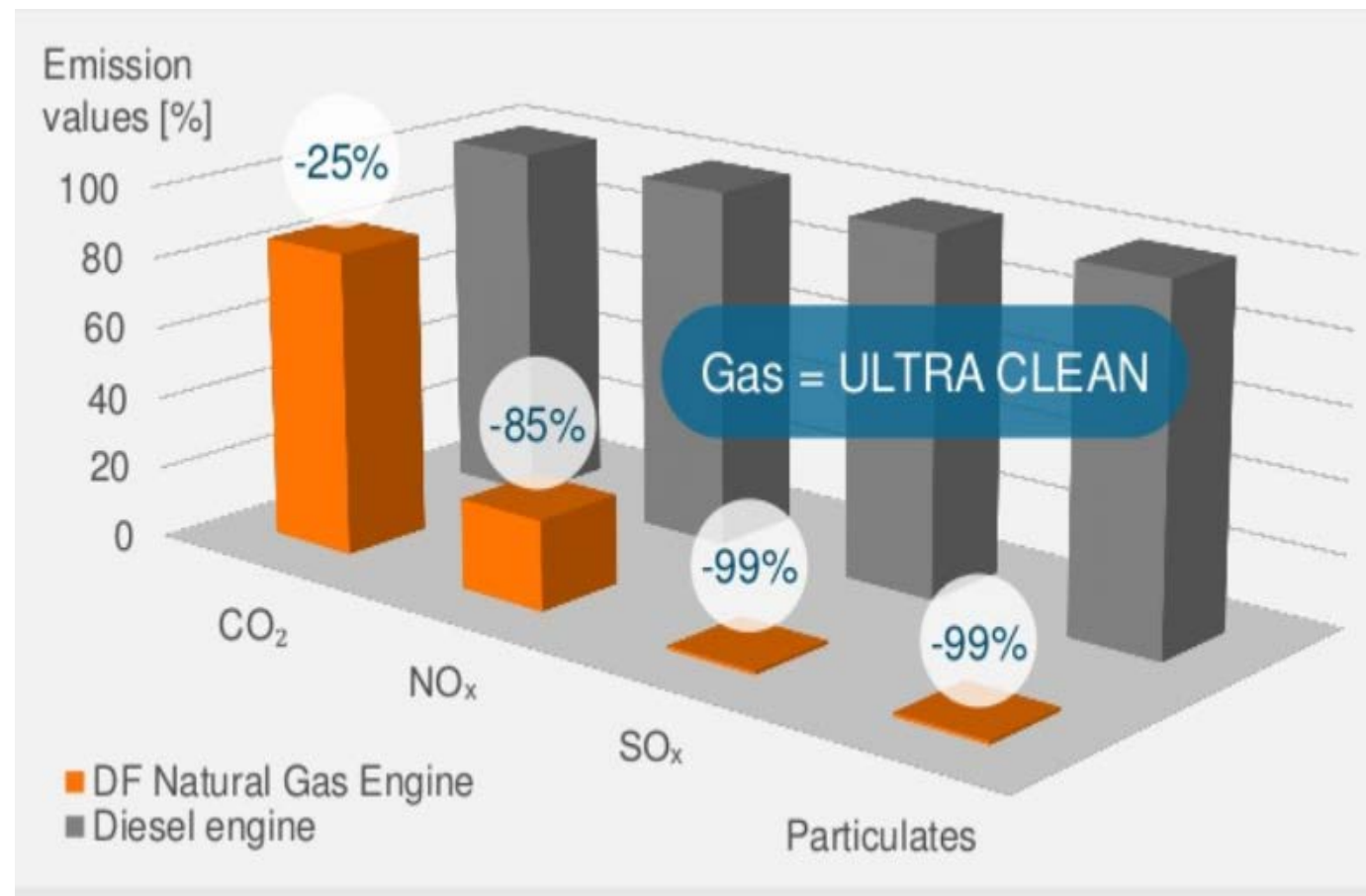
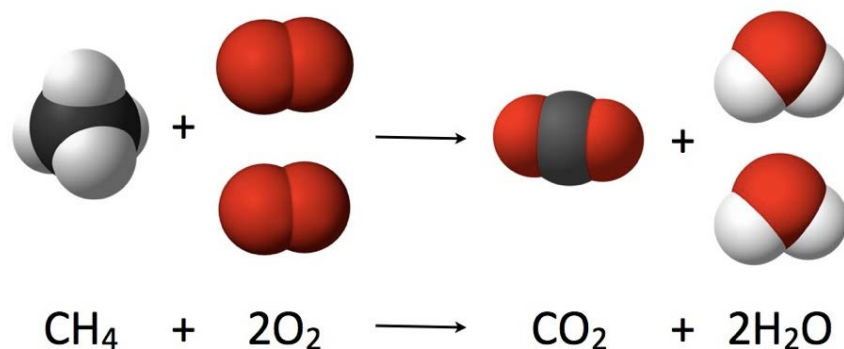
→ So easier to be stored and transported



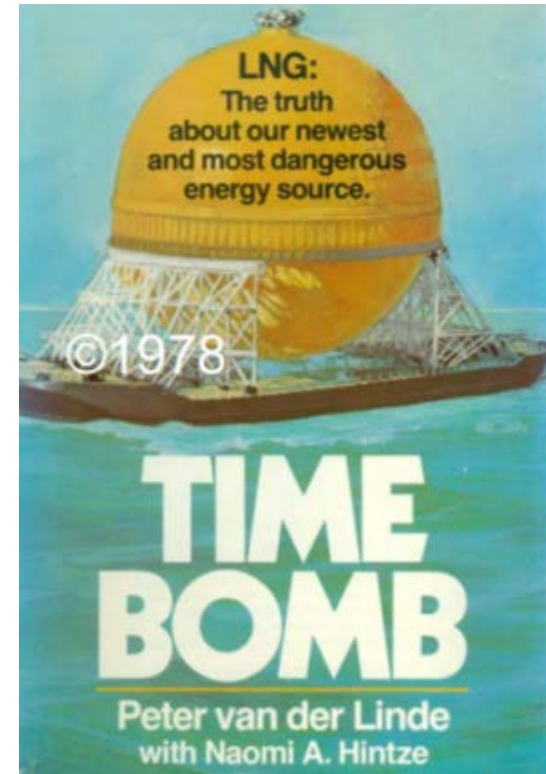
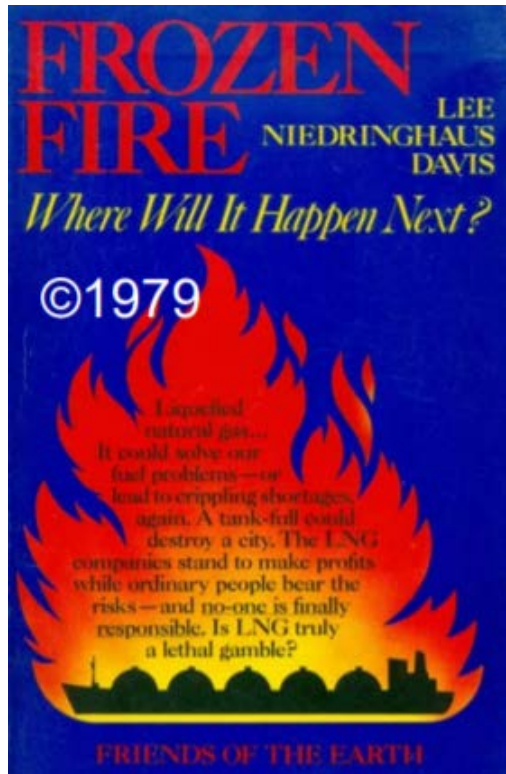
Why does it constitute a solution for compliance?

✓ Typical composition:

**Methane 94.0% Ethane 4.7% Propane
0.8% Butane 0.2% and Nitrogen 0.3%**



But is it safe to use?



Question No.5

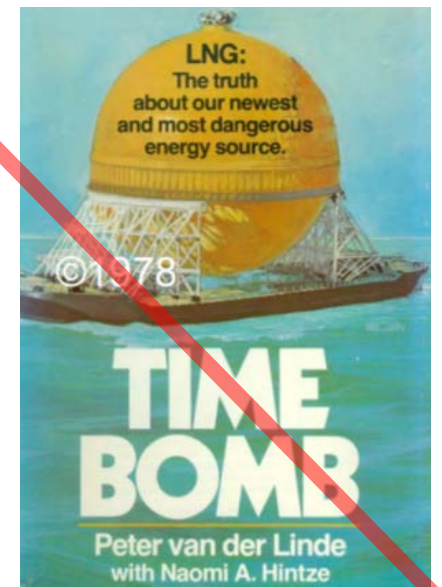


Over the last 55 years how many serious Marine Casualties / Explosions / Fires have been directly caused due to the LNG?

1. Zero
2. 1 to 5
3. 5 to 10
4. More than 10
5. I do not know

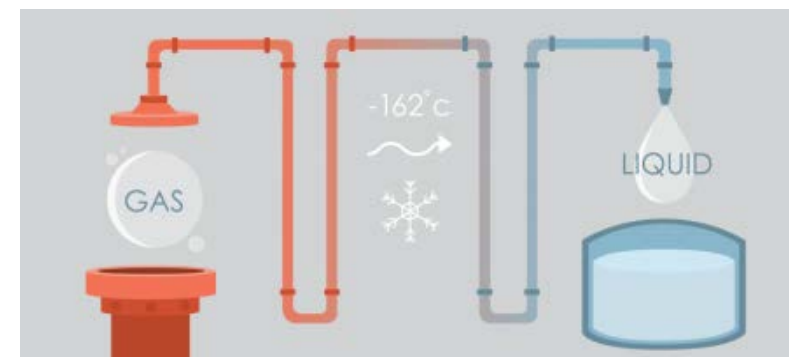
But is it safe to use?

- ❑ General misconception
- ❑ Since **1960s on LNG carriers** – almost 60 years of marine experience
- ❑ On **non-gas carriers since 2002**
- ❑ As per DNV GL, **no reported major events**, e.g. fire, explosion, grounding etc. caused by LNG fueled engines or ancillaries
- ❑ No reported incidents with significant LNG release in more than 50,000 bunkering operations



Which are its main properties?

- ✓ Temperatures between **-159 to -162°C** at atmospheric pressure – **Cryogenic nature**
- ✓ Clear, colourless, non-toxic and non-corrosive



- ✓ Lighter than water – if spilled, floats and vaporizes quickly causing no harm



Which are its main properties?

- ✓ If released in air, **visible vapor cloud created**, becomes progressively lighter, rises and dissipates
- ✓ LNG is **not explosive** - not pressurized and contains no oxygen
- ✓ LNG does not burn on its own → if mixed with air in a **mixture that contains between 5-15% of methane** and finds an **ignition source**



Which are the main CHALLENGES to address?

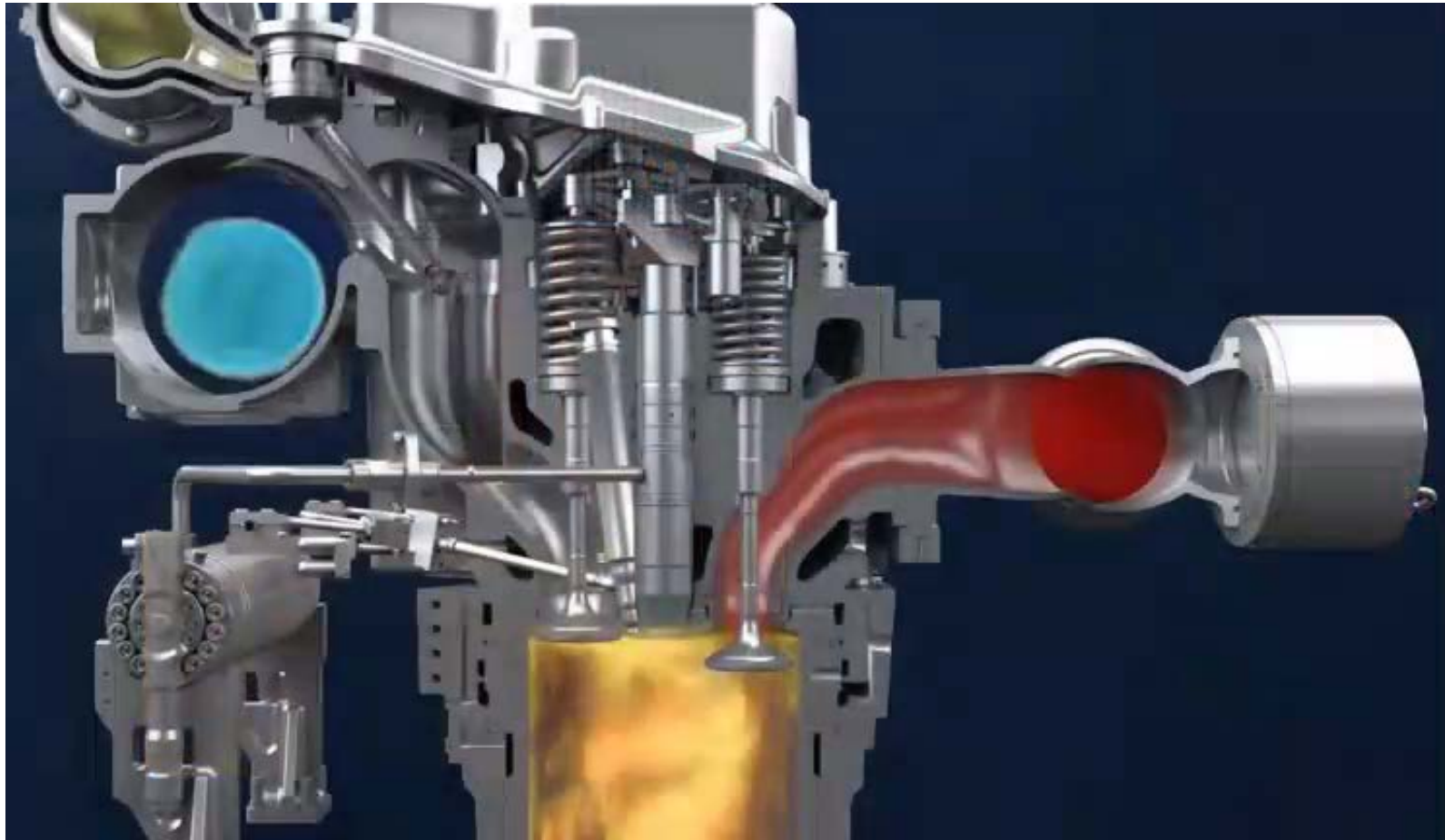
So equipment, piping, materials, handling and safety **much different** than for an **oil fuel system!**

- ❖ Gas-fuelled marine engines and associated machineries
- ❖ Onboard storage
- ❖ Onboard handling
- ❖ Bunkering
- ❖ Infrastructure
- ❖ Financial aspects
- ❖ Regulatory framework

Example of Low Pressure Four Stroke Dual Fuel MAN L35/44DF

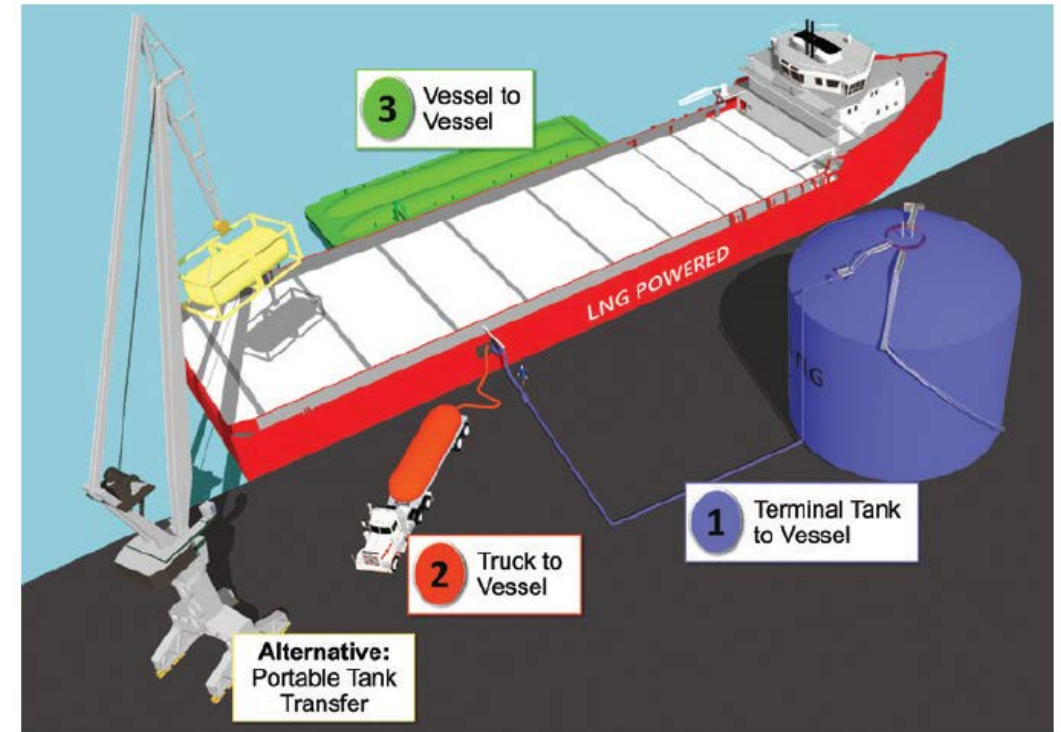


Example of Low Pressure Four Stroke Dual Fuel MAN L35/44DF



Which are the main LNG bunkering options?

1. Ship to Ship transfer (STS)
 2. Truck to Ship transfer (TTS)
 3. Terminal/Pipeline to Ship transfer (PTS)
 4. The use of portable tanks
- Today, small number of LNG fuelled vessels, so mainly bunkering using **LNG tank trucks**
 - **Bunker vessels** and **barges** – first one about 5 years ago



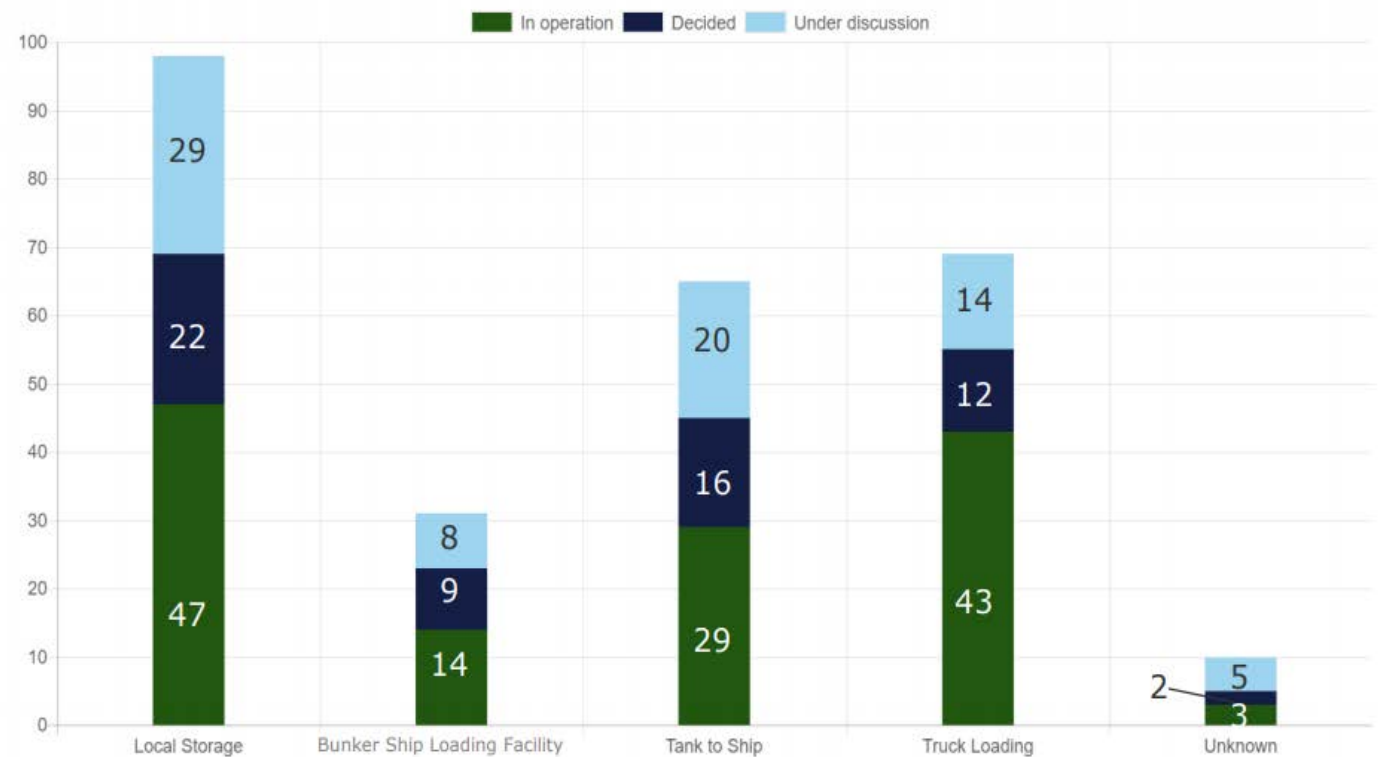
→ As of August 2018, **six (6)** LNG bunker vessels in service and **twelve (12)** on order

Bunkering infrastructure is a work in progress..

➤ Is the “chicken-and-egg” problem solved?

☐ **Cooperation** between the ports and ship owners → financially beneficial for both sides and promote the use of LNG as a marine fuel

Facilities worldwide by type



Some 2018 updates on bunkering

NYK memorandum of understanding with three compatriots for supplying LNG as fuel in western **Japan**

Yokohama-Kawasaki study for LNG bunkering hub in **Tokyo** bay

By the end of 2018, Port of **Amsterdam** to have an LNG bunkering pontoon in operation

Port of **Amsterdam** to increase the port dues discounts for vessels using LNG as fuel

Ship-to-Ship bunkering at **Rotterdam** from June 2018. Short-haul sea vessels first followed by LNG fuelled cruise ships in November 2018 and deep sea vessels by end of 2019.

The Maritime and Port Authority of **Singapore** (MPA) injected S\$12 million to boost LNG bunkering in the Port of Singapore. Half of this S\$12 million to co-fund the building of new LNG bunker vessels (LBVs).

Poseidon Med II LNG bunkering project in **East Med** - Greece, Italy & Cyprus



Conversion is technically feasible but is it economically viable?

YES if additional **space** for LNG system and storage exists

Important factor to consider → **age of ship** - too expensive investment and may not give its money back!

- As per DNV GL, LNG fuelled **newbuilding** may be around **20-25% more expensive** than a conventional design
- A **retrofit** may require about **30-40% of the newbuilding price**

Costs	
2 x 4,000 cbm Type C Tanks	\$8 Million
Engine Parts	\$5 Million
Docking & Off-Hire	\$5 Million
Installation & Piping	\$10 Million
TOTAL CAPEX	\$28 Million

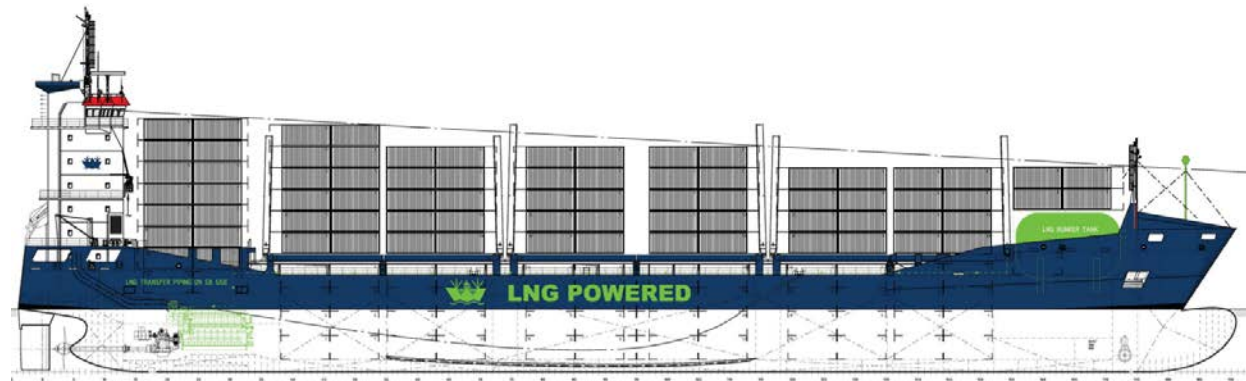
Retrofitting costs for a
8,500 TEU Container Ship

EXTRA cost for a newbuilding
8,500 TEU Container Ship

Costs	
2 x 4,000 cbm Type C Tanks	\$8 Million
Engine Parts	\$2 Million
Piping	\$3 Million
TOTAL CAPEX	\$13 Million

Have any conversions taken place?

- The "**Bit Viking**" owned by Tarbit Shipping became the **world's first merchant ship** to undergo a LNG conversion
- Started Summer 2010 and completed Autumn 2011



- The "**Wes Amelie**" 1,000 TEU was the **first containership** to undergo DF conversion by German Dry Docks in Bremerhaven in 2017.
- Backed by the German Federal Ministry of Transport and Digital Infrastructure (BMVI)

LNG fueled ships scaling up..

- ❑ 2 LNG fueled car carriers for Volkswagen
- ❑ Construction of LNG ROPax vessel “Honfleur”
- ❑ Launch of first of 5 LNG hybrid ferries for Norway
- ❑ Carnival building 9 LNG fueled cruise liners
- ❑ TOTE to complete 2 LNG retrofits by Q1 2021
- ❑ 1st LNG fueled Supramax Bulk Carrier delivered

CMA CGM to Power Its 22,000 TEU Giants with LNG

French shipping major CMA CGM Group has unveiled the decision to equip its nine future ships of 22,000 TEUs with engines using liquefied natural gas.

MSC and Moby order LNG-ready ro-pax newbuild vessels from GSI

MSC and Moby have ordered four LNG-ready ro-pax ferry/cruise vessels, plus options for up four for more, from GSI Shipyard in China.

World's first LNG-fuelled bulk carrier delivered.

Rotterdam: Less fuel oil and more LNG bunkered in 2017

In 2017, the sale of bunker oil – fuel for shipping – in the Rotterdam bunker port diminished from 10.1 million m³ to 9.9 million m³. Bunkers contain fuel oil, in 2017, 8.3 million m³. The throughput bunkered liquefied natural gas (LNG) – liquefied natural gas – from less than 100 tonnes to 1500 tonnes.

TOTE Completes First Phase of Vessel Conversion to LNG-Fuelled Propulsion

TOTE Maritime Alaska (TOTE) says it has completed the first of four conversion periods for its Circa class vessels, which will enable the ships to use liquefied natural gas (LNG) as fuel.

Carnival Orders Third LNG-Fuelled Ship for Its AIDA Brand

Carnival Corporation & plc has signed a shipbuilding contract for a third next-generation cruise ship for its Germany-based AIDA Cruises brand.

EMSA – New guidance on the use of LNG as a ship fuel

Guidance on LNG Bunkering European Maritime Safety

In the Press

MOL orders LNG-fueled tugboat

Japan's Mitsui O.S. ordered a liquefied fuelled tugboat at Dockyard.

China Boasts a Gas-Fueled Fleet of 275 as Bullish Outlook for LNG Bunkering Continues

2018's bullish outlook for liquefied natural gas (LNG) bunkering continues the week courtesy of several recent reports highlighting increased interest and adoption for the emerging marine fuel.

How many LNG fueled vessels operate today?

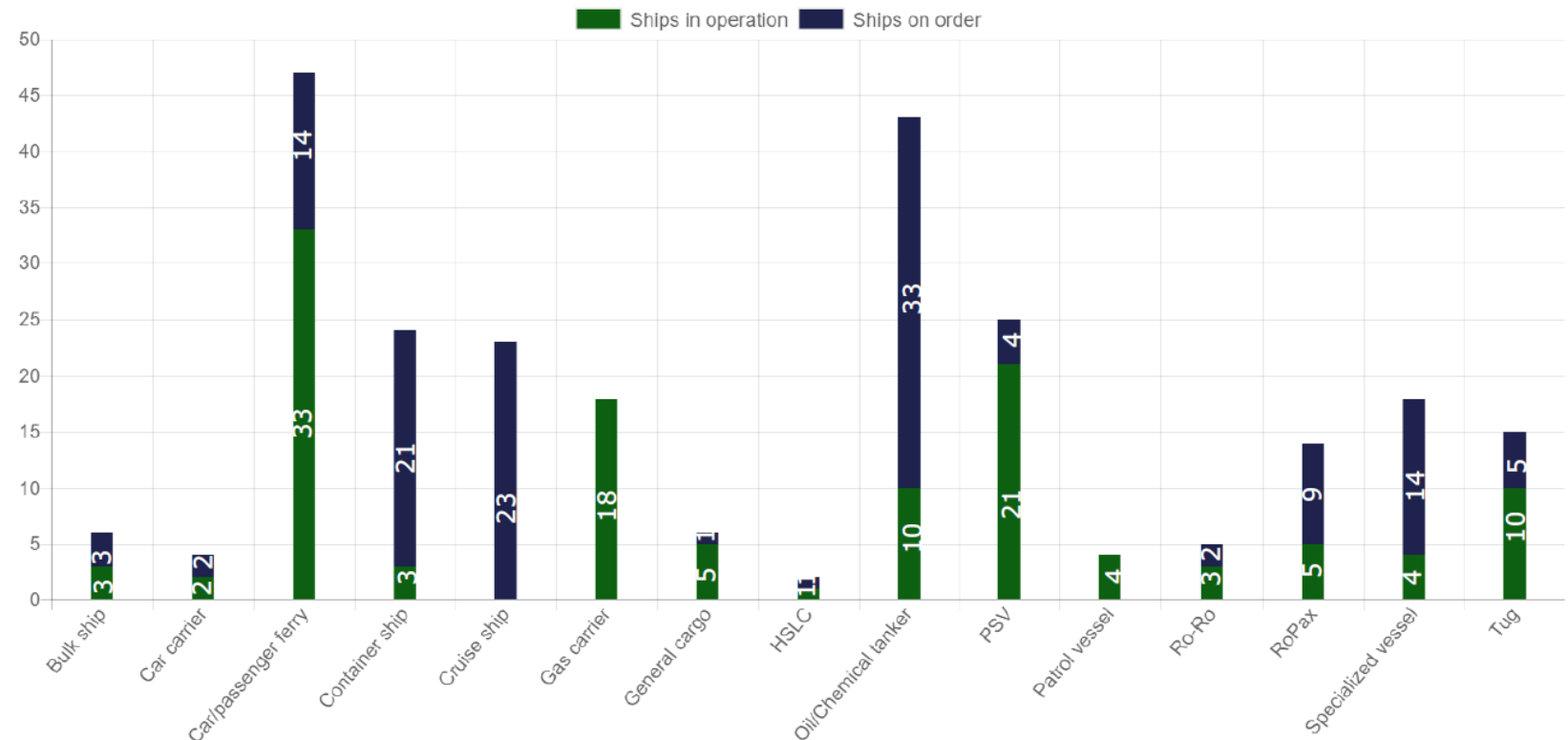
❖ Shift from short-sea shipping to deep-sea shipping space

✓ **121 in operation**

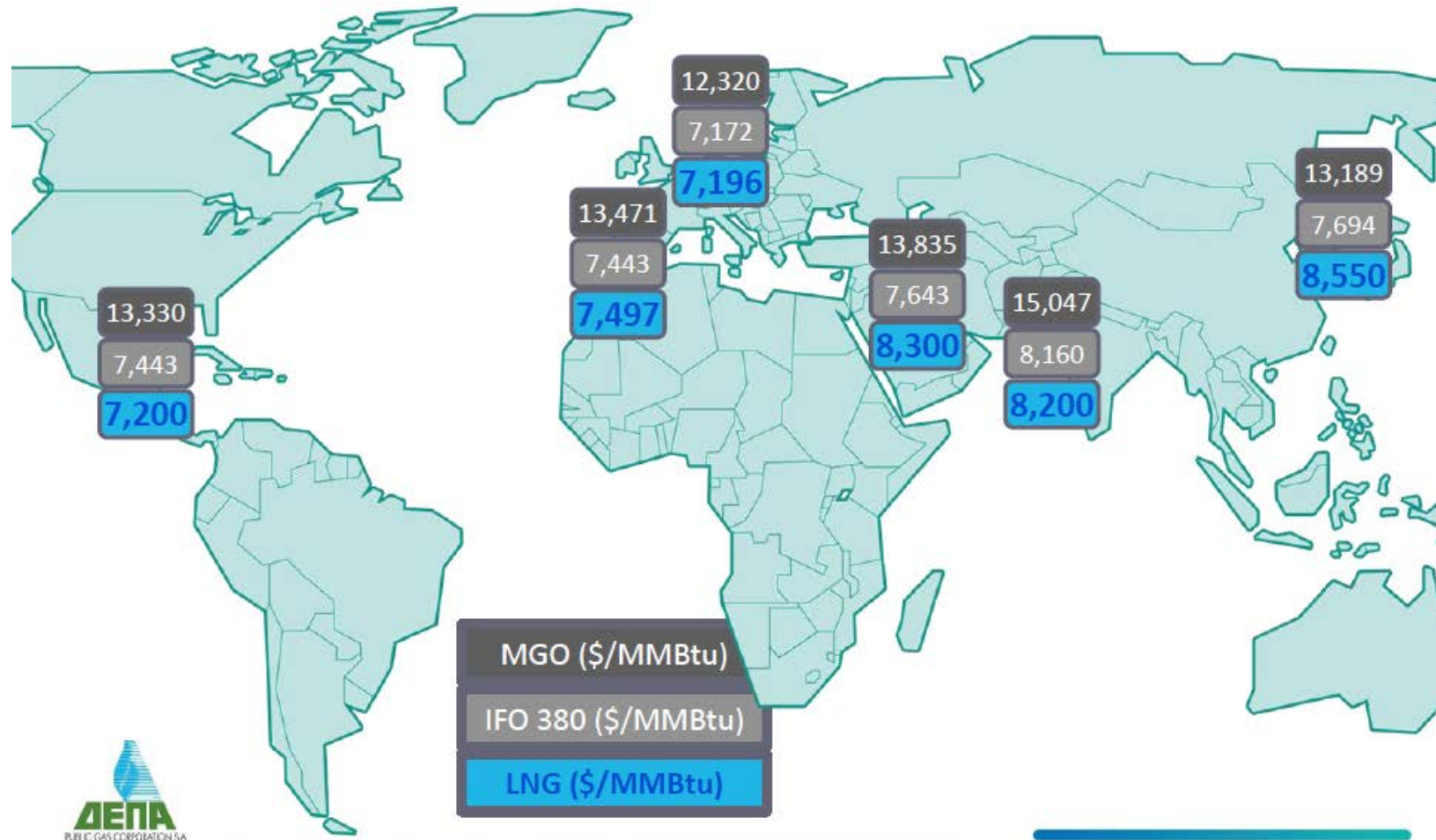
✓ **127 on order**

(As per DNV GL 1st March 2018)

Fleet by vessel type



But how much does LNG fuel cost?



Case Study for LNG Newbuilding

Begin of July 2018:

- ✓ LNG = 390 \$/MT
- ✓ MGO = 640 \$/MT

Round Trip in SECA / Vysotsk-Bremen

- Panamax Bulk Carrier
- Distance: abt. 2,230 nm
- Duration of trip: abt. 13 days



Compliance Option	<u>0.1% MGO</u>	<u>LNG</u>
Approx. Yearly Fuel Costs	\$4,000,000	\$2,300,000
Yearly Savings with LNG		\$1,700,000
Investment for Installation	-	\$6,000,000
Return Period of Investment (years)		3 1/2



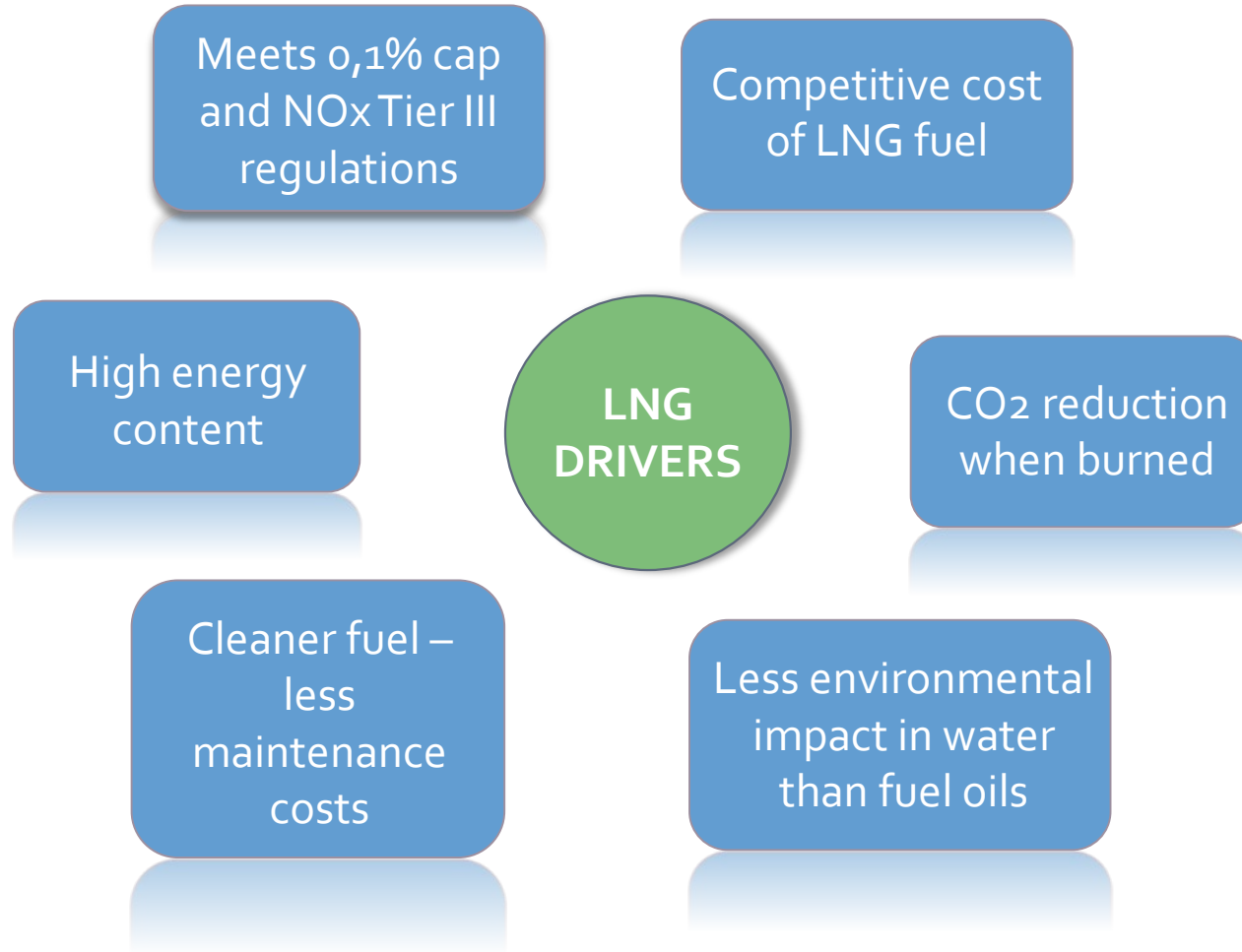
Impact to the insurance market

LNG as fuel

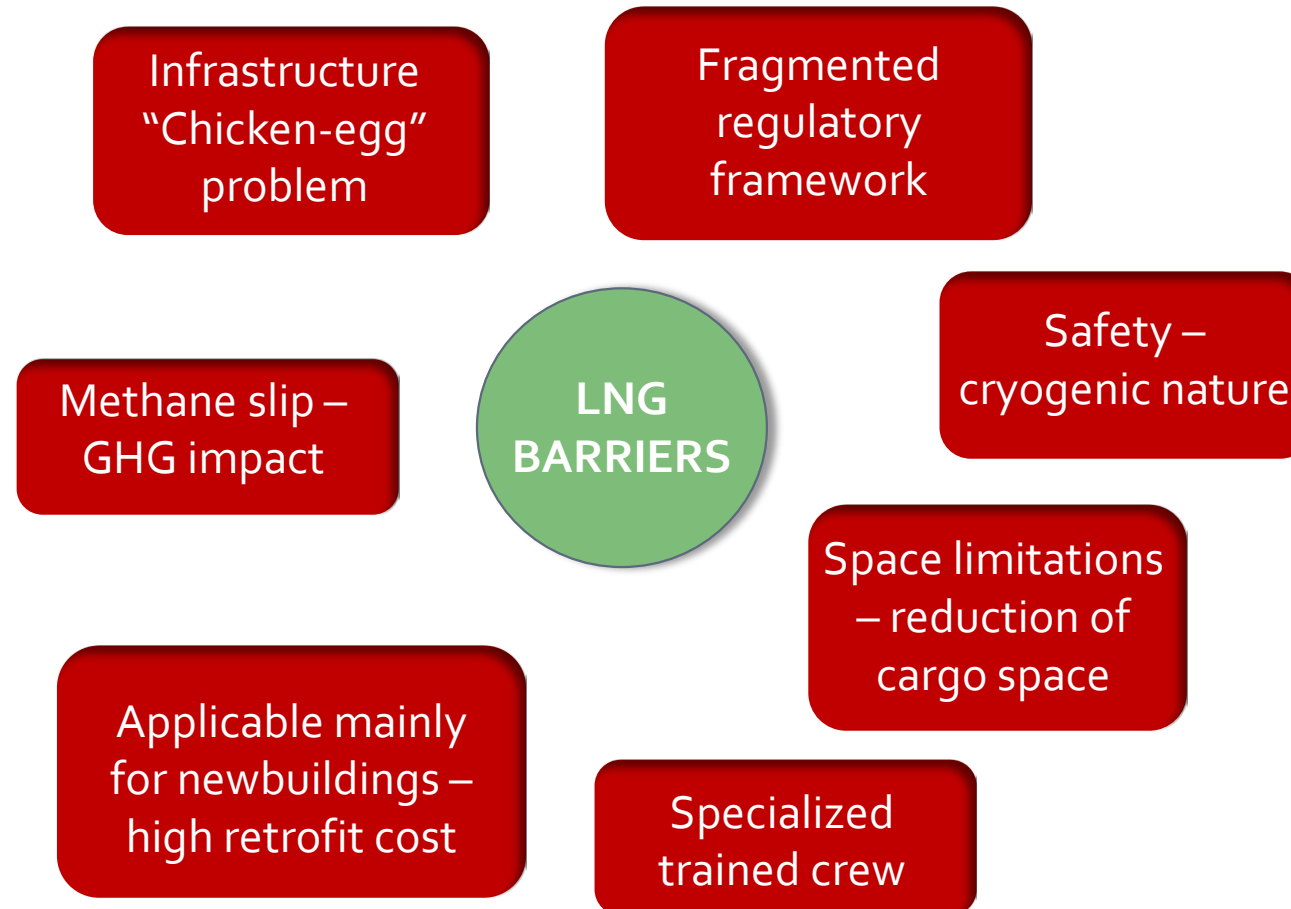
- Cleaner/better combustion
- Safe and environmental friendly
- Modern technology, complex machinery
- Cryogenic nature

- reduce combustion related claims
- low risks for fires, explosions and pollution
- more expensive damage repairs
- hull cracking, personnel injuries etc.

Drivers for LNG as fuel



Barriers for LNG as fuel



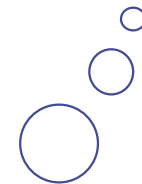
Focus on Methane!

Methane slip –
GHG impact

Methane escapes to the atmosphere in some quantities unburnt during extraction, transportation, bunkering and after combustion.

Over a 20 years period, methane is about **86 times worse than CO₂** in warming the planet!

What will be the outcome for LNG when **IMO roadmap** for **GHG emissions reduction** develops?



LNG to be viewed only as a **SO_x and NO_x compliant fuel** and those who invest to proceed on these grounds, or on its projected future price but **not on reduced GHG effects**

However...

Minor impact by 2020!

The Outline



- The MARGETIS MARITIME Opinion Survey
- What is it all about – The punch line
- Compliant fuel oils – Primary Solution
- Scrubbers – Secondary Solution
- Marine Claims Consequences
- LNG as Fuel

Conclusions

Question No.6 (No.3 Revisited)



Which solution do you think that will eventually prevail?

1. Widespread usage of LNG as fuel
2. Widespread usage of Compliant Fuels
3. Widespread usage of Scrubbers
4. I (Still) don't have enough information to decide

The MARGETIS MARITIME CONSULTING Opinion Survey



Will 2020 regulations result to a historical change period?

58% Yes

Do you believe that the 1/1/2020 deadline should be postponed?

69% Yes

29% due to safety concerns for available fuels

The MARGETIS MARITIME CONSULTING Opinion Survey



Preferred options for meeting the SOx limits?

48% Compliant fuels

33% Scrubbers and Compliant fuels

20% of the surveyed fleet will
have **scrubber** installed

Outcome of the new regulations in the long run?

48% Extensive production of new grades of fuels

The MARGETIS MARITIME CONSULTING Opinion Survey



Will the new regulations indeed have a positive impact to the human health?

42% No

Machinery failures related to catalytic fines would increase?

58% Yes

The MARGETIS MARITIME CONSULTING Opinion Survey



- Full survey results
- Presentation Slides
- Bibliography

VISIT:

<https://margetis.com/downloads/>

Some conclusions and further food for thought...

1. 2020 Regulations

- Is it a **MARITIME** reform **OR** a **REFINERY** reform?
- Fear for **new/altered regulations** which may **compromise compliance** (e.g. open loop scrubbers, LNG as a GHG)
- The “usual” **uncertainty with Policy Makers**

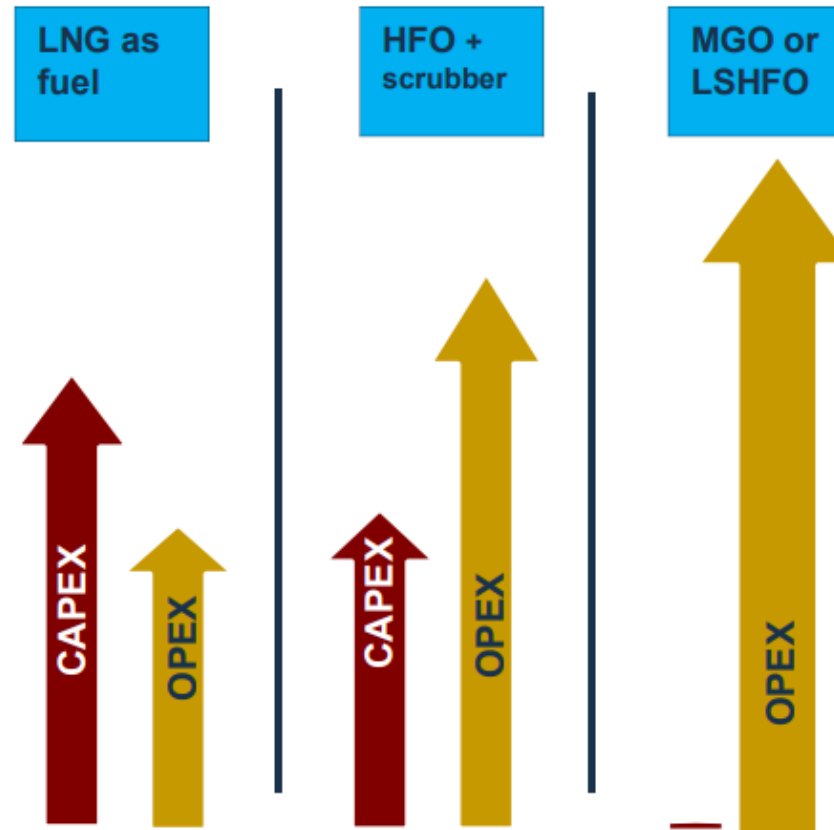
2. Solutions

- **Scrubbers, LNG** or compliant low sulphur **fuels**?

3. LNG as fuel?

- Compliant + competitive fuel price
but
- High investment cost
- Bunkering infrastructure and regulations a work in progress
- GHG effect

Overall Solutions Comparison



Source: Bureau Veritas

Some conclusions and further food for thought...

4. Our predictions...

- Compliant Low Sulphur Fuels will prevail and become standard – MGO or low sulphur fuel oils (ULSFO & VLSFO)
- Expected economical advantage of VLSFO but uncertainty in quality/properties
- LNG as Fuel is being delayed
- Scrubbers for large vessels with high consumption and standard trading routes (e.g. Cruise ships, VLCCs, Containers) – Considerable CAPEX



Our final word...

More Combustion Related Claims!

What did the Ancient Greeks say?

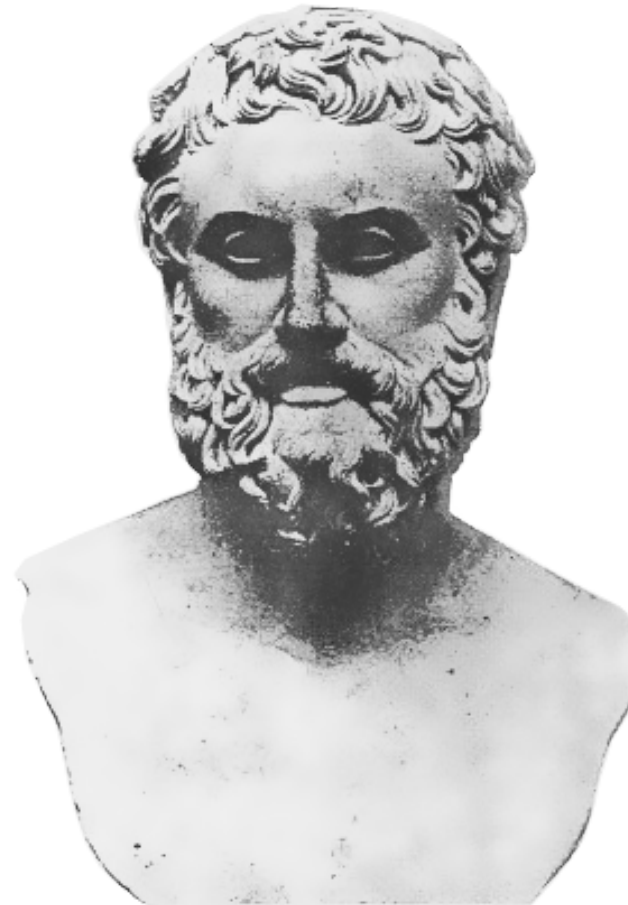
ΠΑΝΤΑ ΡΕΙ

pronounced Panta Re

"There is Nothing Permanent Except Change"

Everything Flows...

2020 Regulations a HOT and FLUID topic -
Further developments during IMCC 2019



HERACLITUS

Greek Philosopher (500 BC)

Are we Living Historical Times ?

Not yet...

Thank you!



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