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CLEAN EMISSIONS 2020

Pinelopi Rapti

Giuseppe Tringali

"IN SEA AFFAIRS NOTHING IS IMPOSSIBLE AND NOTHING IS IMPROBABLE"

ADMIRAL LORD NELSON, 1804, HMS VICTORY

OUR FOCUS

«THE MISSION OF LEADSHIP IS TO PROVIDE BESPOKE SOLUTIONS TO THE MARITIME INDUSTRY WITH FOCUS ON INNOVATION»

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ABOUT LEADSHIP

DESIGN ACTIVITIES

from concept design development to coordination of detail and production design.

CONSULTANCY ACTIVITIES

Preparation of specifications, selection of shipyards, techno-economical evaluation of projects.

ONSITE SUPPORT & REP

Provide dedicated on-site teams, technical and financial reporting to Owner

OUR SERVICES GO BEYOND DESIGN TO OFFER TOTAL SUPPORT FROM OUR CONSULTANTS AND ON-SITE TEAM, ENSURING THE SMOOTHEST OUTCOME FOR EVEN THE MOST DEMANDING PROJECTS AND PARTNERS

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EMISSIONS IN SHIPPING ...

GREEN SHIP – MINIMUM IMPACT ON THE ENVIRONMENT

- Cleaner fuels for power production
- Application of technologies that mitigate side effects of emissions
- Reduction in fuel consumption through combined application of energy saving measures

SOx

PM

NOx

CO2

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FOCUS ON « GLOBAL SULPHUR LIMIT »

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SOx EMISSION LIMITS

Average Sulphur Content (2015) in fuels:

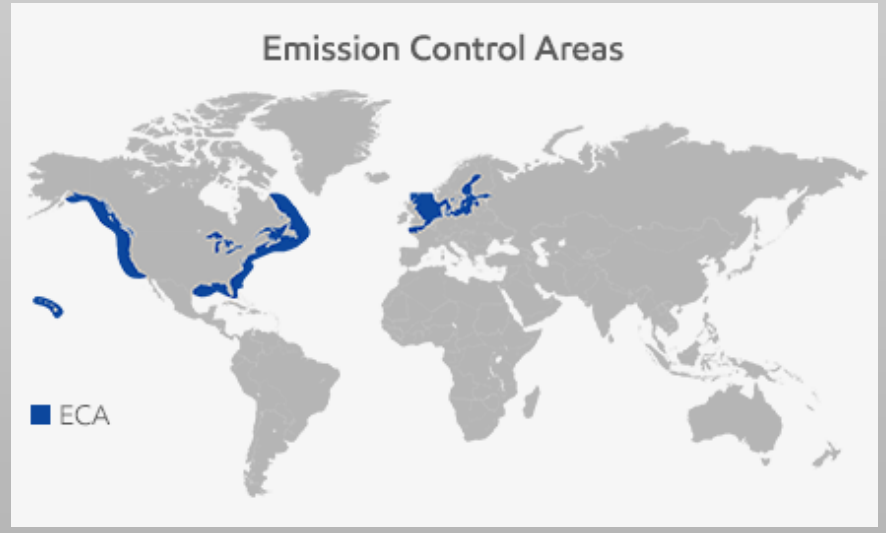
- ❖ Residual Fuel oil: 2.45%
- ❖ Distillate Fuel: 0.11 %

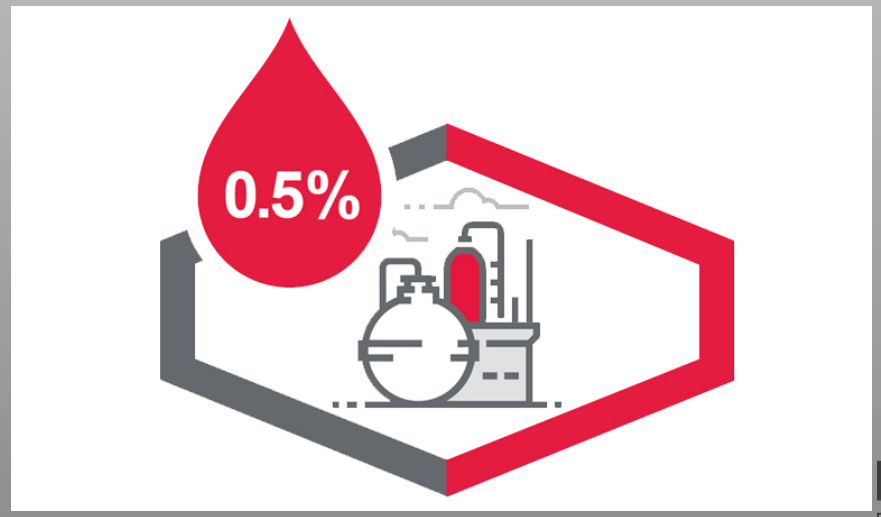
Global Sulphur limits (mass to mass m/m):

- ❖ Emission Control Areas (Jan 2015): 0.10 %
- ❖ Globally (Jan 2012): 3.5 %

October 2016 : Marine Environment Protection Committee - MEPC 70 decided:

- ❖ Globally (Jan 2020): 0.5 %





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WHAT TO DO WHEN IN PORT ?

Post Bunkering Delivery Note:

- ❖ Statement of Fuel Oil Sulphur Content
- ❖ Samples for Verification

International Air Pollution Prevention Certificate (IAPP):

- ❖ To be issued by Flag State

Port State Control :

- ❖ Verify the compliance of the vessel

Sanctions:

- ❖ Up to Individual State Parties

Expected Reduction in SO2 emissions by **85%** compared to today's levels

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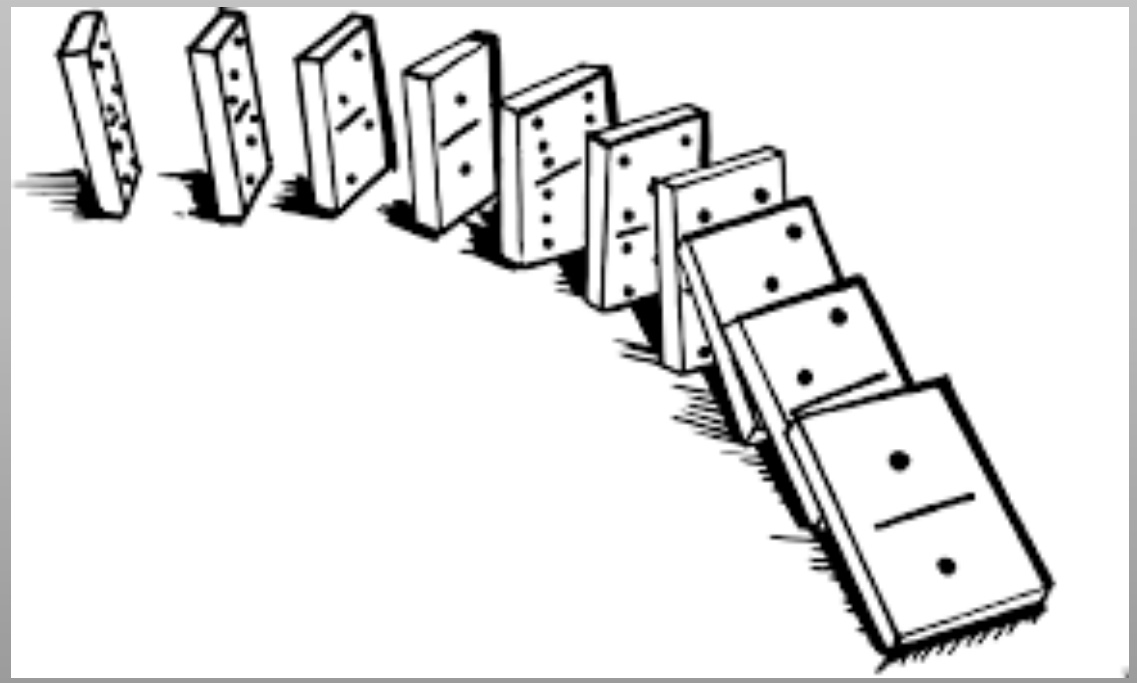
MARITIME INDUSTRY REACTION?



Option 1: Low S compliant Fuel Oils

Option 2: Scrubbers

Option 3: Liquified Natural Gas as fuel

Option 4: Hybrid Propulsion Designs

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OPTION 1: LOW S COMPLIANT FUELS

Fuel Oil Blends - Low S content :

- Low Sulphur Distillate fuels – MGO
- Low Sulphur Heavy Fuel Oil – to achieve 0.5% S
- Low Sulphur Fuel Oil Blended – to achieve 0.1% S

Points to Consider:

- Cost: Higher compared to HFO
- Availability: Sufficient

VIEW EXPRESSED BY BP:

(Source: MARPOL 2020 and beyond)

Until 2020: - HSFO Dominating
- MGO– in ECAS

After 2020: - Combined HSFO & Scrubber Technology
Significant Decline in Quantities
- Increased MGO consumption - <u>First Period of implementation</u>
- Very Low Sulphur Fuel Oil – will supply more than 50% of the Market

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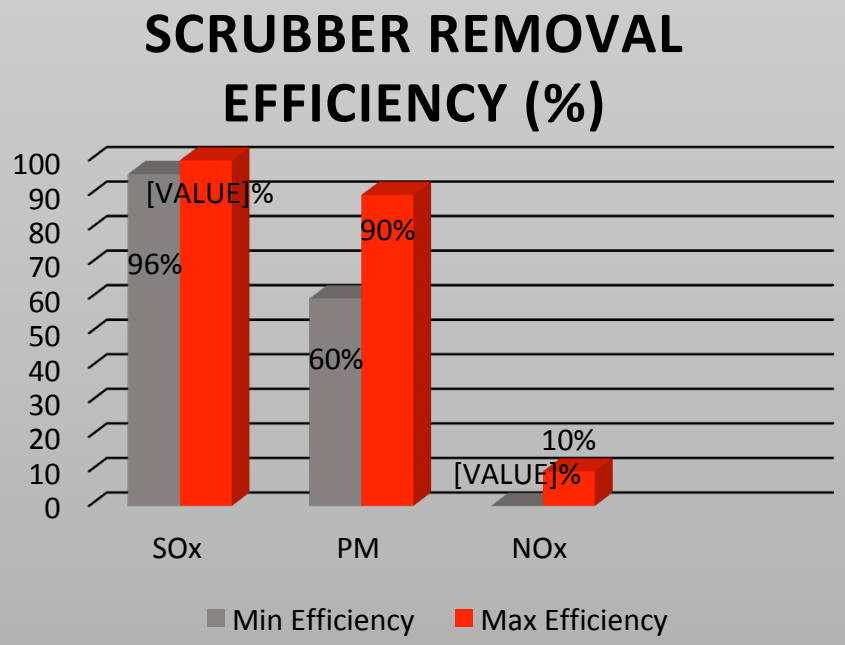
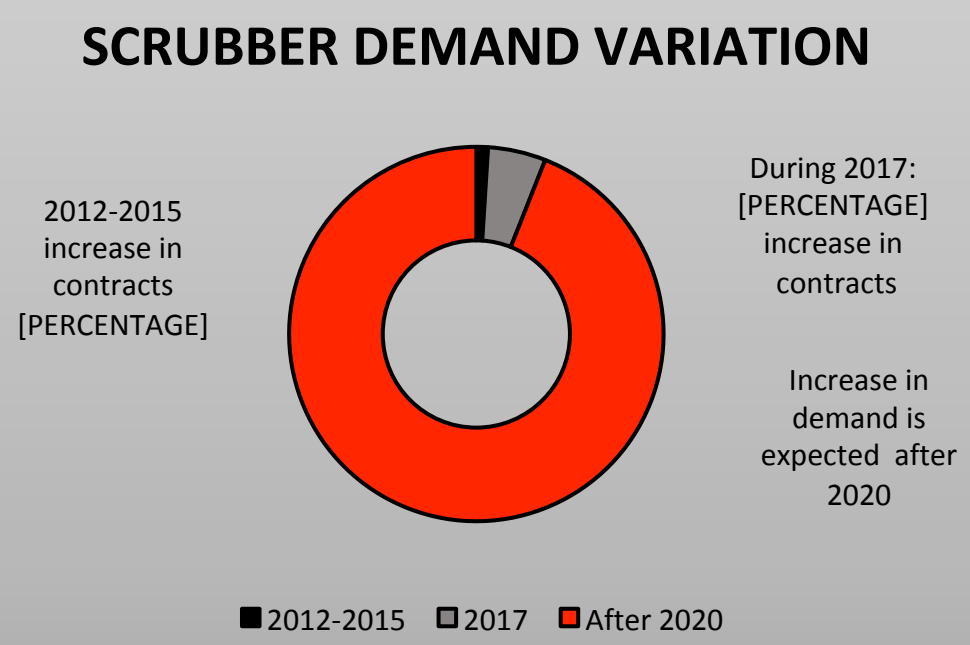
OPTION 2: SCRUBBERS





Owner's Consideration:

- Regulatory Implications
- Fuel S content to achieve 0.1% fuel equivalence
- Operational Implications
- Stability of the Vessel
- 1-1.5% Additional fuel consumption

Facts:

- December 2017 : 240 Scrubber Installations.
- 2030: 1/3 of Shipping Industry will have Scrubbers Installed
- Financially viable option for Newbuilds

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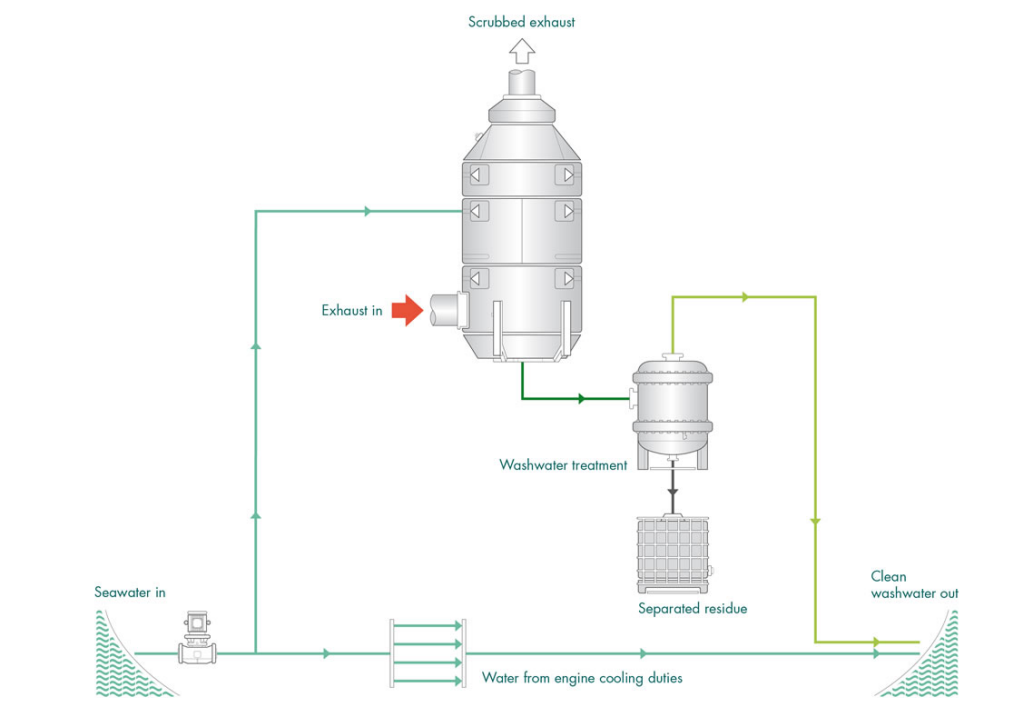
WET SCRUBBERS

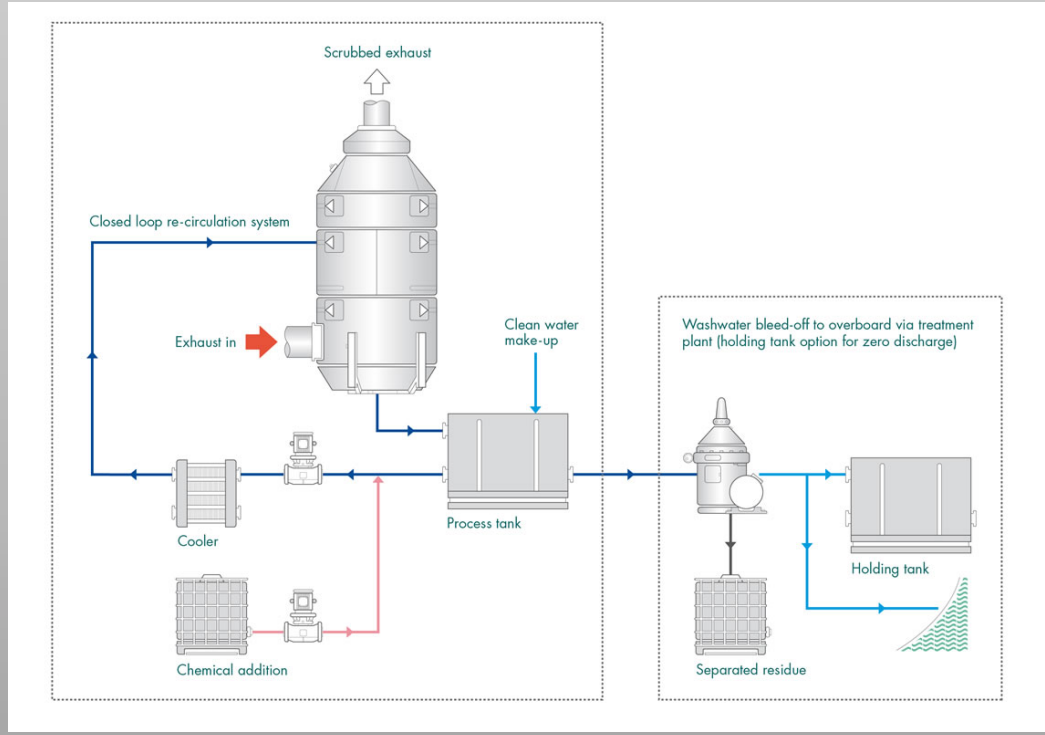
Open Loop System Working Principle:



Source : EGCSA

- SOx+H2O → H2SO4, Highly Corrosive
- H2SO4 Neutralized when diluted in Alkaline Seawater
- Scrubbing Medium : Seawater
- After Treatment for Sea Water

Closed Loop System Working Principle:



Source : EGCSA

- Scrubbing Medium: Fresh Water & Chemicals
- SOx → Na2SO4 - Harmless
- Water flows to a process/buffer tank
- Cleaned and then Re-Circulated

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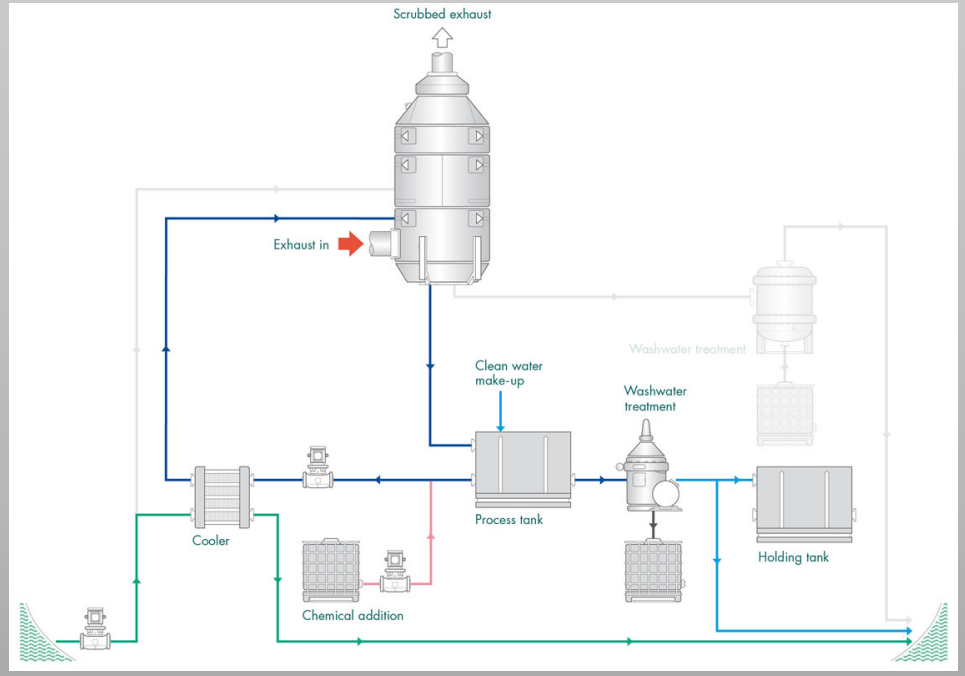
OTHER TYPES OF SCRUBBERS

Hybrid Scrubber:



Source : EGCSA

- ❖ Combined Use of Open & Close Loop System
- ❖ Employs the most appropriate technology:
  - to cope with all possible conditions.
  - to achieve the required efficiency
- ❖ Popular Technology

Open vs Closed Loop System

+ Closed Loop requires half the water quantity of the Open Loop

- Closed Loop requires additional tanks on board

Drawbacks of Wet Scrubbers:

- ❖ Lower Exhaust Gas Temperature
- ❖ Selective Catalytic Reduction Systems – located before the Scrubbers
- ❖ Complex Fitting of all Equipment

Other Types of Scrubbers:

- ❖ Dry Scrubbers – Membrane Scrubbers
- ❖ Not popular technologies: Operational and space allocation cost
- ❖ Limited number of suppliers

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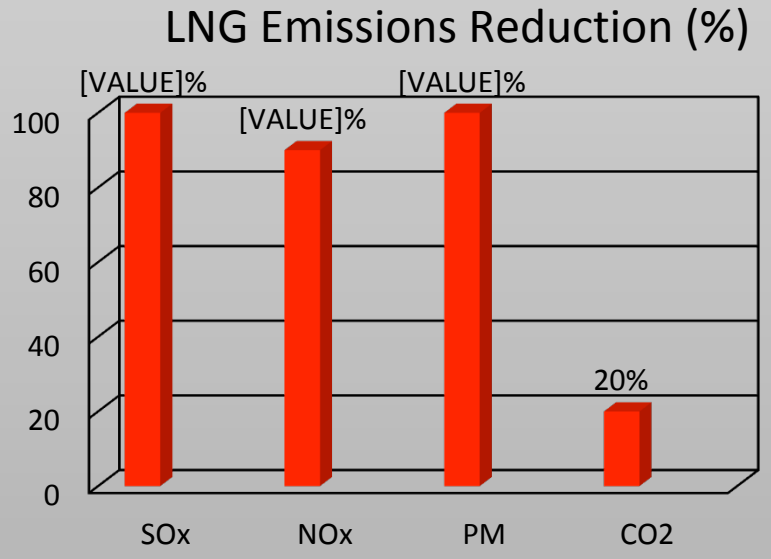
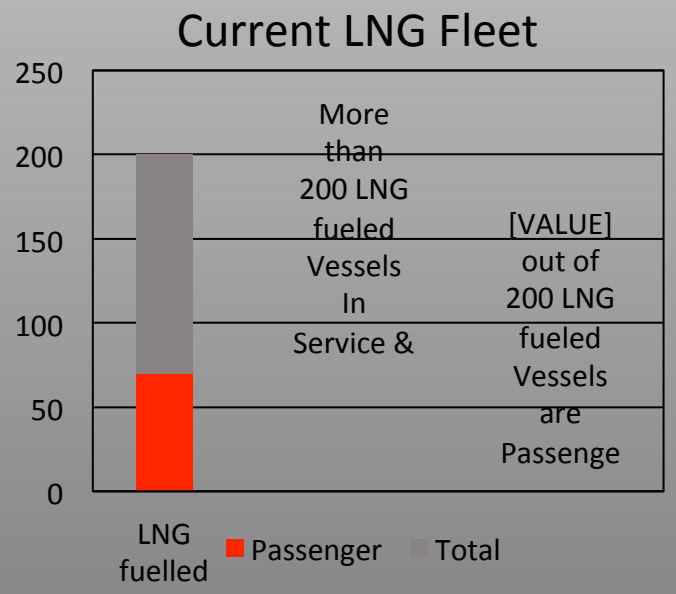
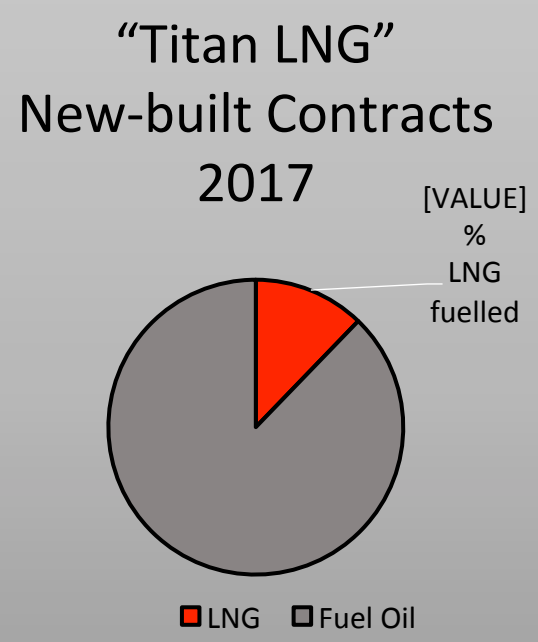
OPTION 3: LNG AS FUEL





Up to November 2017 :

- 2/3 of the 117 LNG fuelled vessels in operation, were in Europe.
- 114 vessels were classed as LNG ready
- Confirmed orderbook of 111 vessels
- 1/4 of the global Cruise Ship orderbook will be LNG fuelled
- LNG Fuelled Tankers & Bulk Carriers: Orderbook topped up by a few Newbuilding Contracts
- LNG Fuelled Containers and Dry Cargo: have the Smallest Orderbook



However…

- MAERSK – Opts for Fuel Oil Blends Solution
- MSC Containers, Opts for Scrubber Solution.

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STORAGE OF LNG

According to IGF Code the types of LNG Containment Systems are the following:

Type	Design Criteria	Shape of Tank	Design Vapour Pressure Po	Secondary Barrier
A	Classic Ship Structural Procedures	For Plane Surfaces	< 0.07MPa	Complete
B	Model Tests Analytical Tools & Methods	For Plane Surfaces	< 0.07MPa	Partial
C	Pressure Vessel Criteria	Spherical	Ensure low dynamic stress	No
Membrane	Thermal Expansion or Contraction is not affecting tightness of the membrane	Plane Surfaces	< 0.025 Mpa but no more than < 0.07 MPa	Complete

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AVAILABILITY OF LNG

How can LNG as a fuel take a part of the Marine Market without Established Bunkering Network?

European Maritime Safety Agency
Issued guidelines to establish a European LNG bunkering Network – January 2018

SEA/LNG coalition:
Standardization of LNG bunker vessels/barges will be the outcome of growth in demand.

Shell downstream LNG General Manager, Wetemans:
Significance of cross collaboration between various sectors, to establish LNG as a marine fuel in a market of 230 LNG fuelled vessels.

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BUNKERING VESSELS

Shell's highly flexible bunker vessel - "Cardissa" :

- Designed to adopt to all possible port specific regulations for bunkering operations.
- Capacity 6500 m3 capacity
- Large CAPEX

LSH Suggestion – adoption of an alternative strategy :

- Tailor made / port specific bunkering vessel
- Port Authority, Flag and Designers should collaborate on Regulations and Design production .
- Simple Design
- Smaller Vessel Dimensions
- Low Power Requirements – Low Speed & Low Fuel Consumption
- Low manning requirements
- High Cargo efficiency
- Estimated CAPEX between 20 - 25 mil.$

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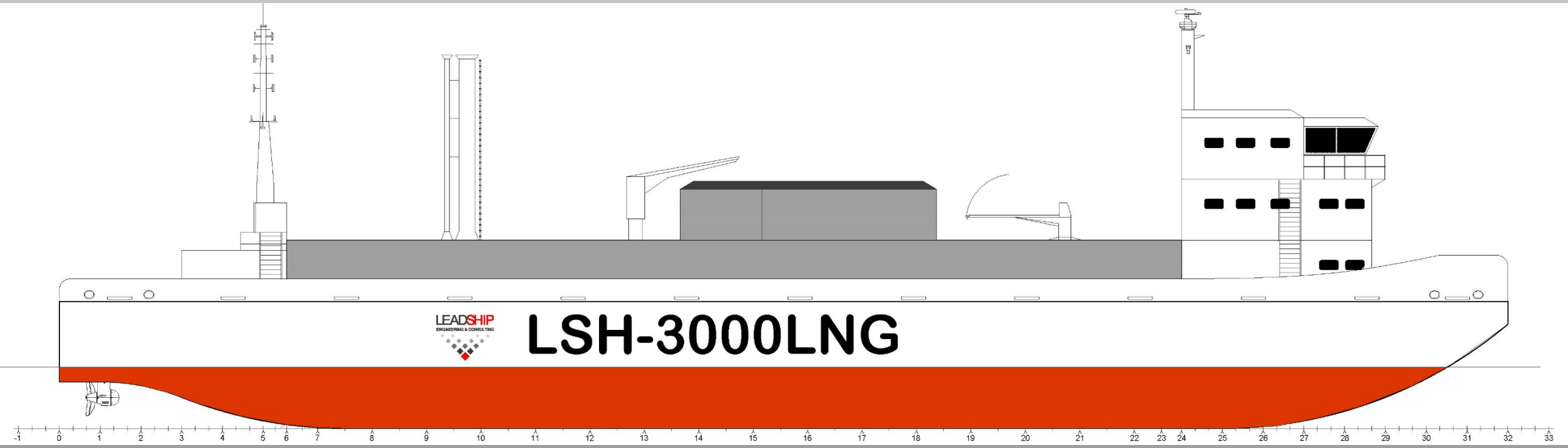
LSH CASE STUDY



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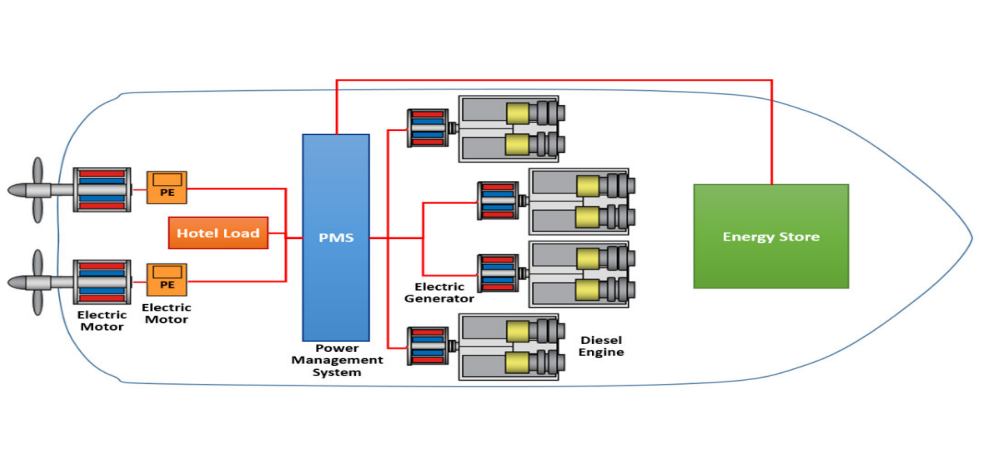
OPTION 4: HYBRID DESIGNS

"System that comprises of various means for power production"

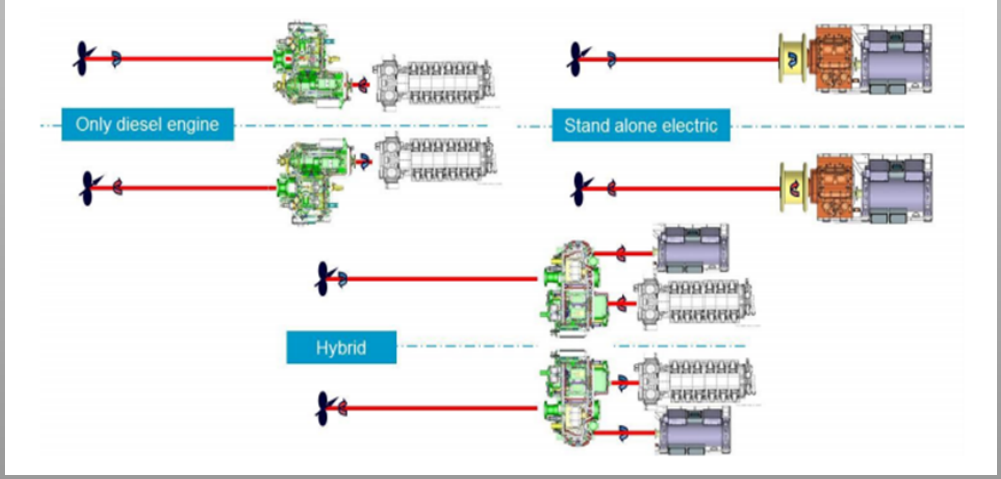
- ❖ Can partially mitigate the issues related to Emission Limits
- ❖ Main Drawback → Increased CAPEX

1. Diesel Electric Propulsion & Batteries / Fuel Cells



Source : MFAME Team

2. Diesel Mechanic & Diesel Electric Propulsion



3. Diesel Mechanic, Diesel Electric Propulsion & Batteries / Fuel Cells (Combination of cases 1 and 2)

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DE & BATTERIES / FUEL CELL POWER PRODUCTION

Power is produced by a combined operation of **Gensets** and **Batteries and/or Fuel Cells.**
Advantages: Clean Source of energy can be used exclusively for power production in certain areas

Batteries

- Electrochemical Process
- Charge of Batteries → Excess Electricity, "Peak Shaving"
- Battery Size/Space allocation
- Hard to Classify Battery Performance
- Fast developing Battery Chemistries

Applications

- Corvus ESS : Claims application of Lithium Ion System on 17 newbuilds
- Hurtigruten: Battery powered auxiliary engine, for sailing of 15-30 mins – Rolls Royce Hybrid design
- First Asian E-ferry in Taiwan has a hybrid system with batteries -Finnish " VISEDO" design

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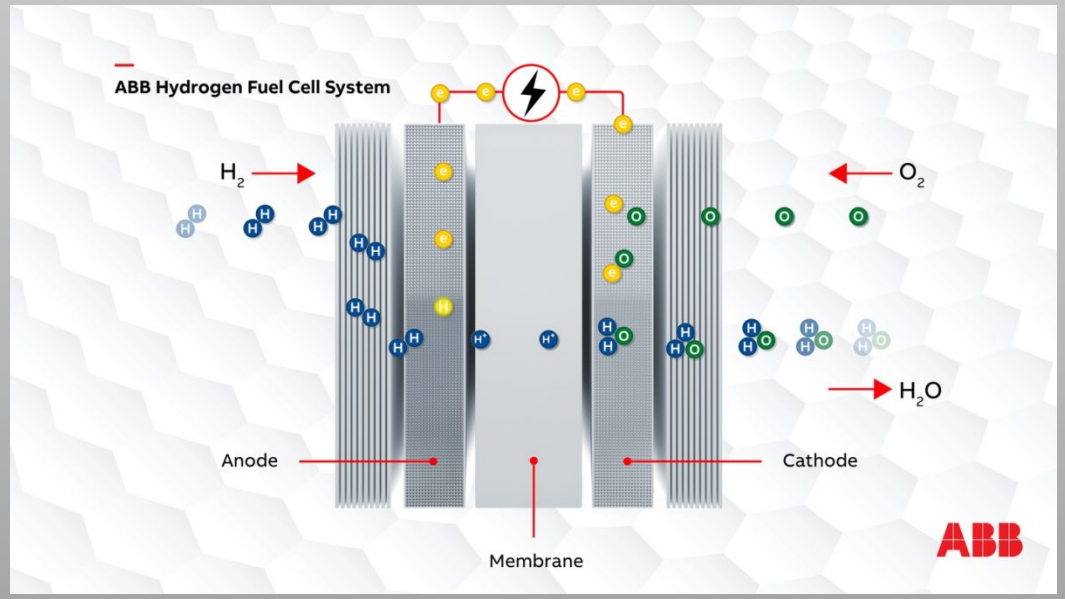
DE & BATTERIES / FUEL CELL POWER PRODUCTION

Fuel Cells

- Electrochemical Process
- Products: Water, Electrical Power and Thermal Power
- Consume their reactants
- Pros: Efficiency – Part Load Application
  Low Emissions
  Easy to Operate and Maintain - Modularity
- Cons: High CAPEX
  Fuel Supply
  Fuel Cell Life
  Compatibility with Sea Environment
  Ability to withstand Ship Motions & Vibrations
  High power demand → Increased Volumes



Applications:

- Royal Caribbean on Icon Class Vessels: Hydrogen Fuel Cell Technology to boost the LNG power production
- Viking is planning to build the first cruise ship fuelled by liquid hydrogen.

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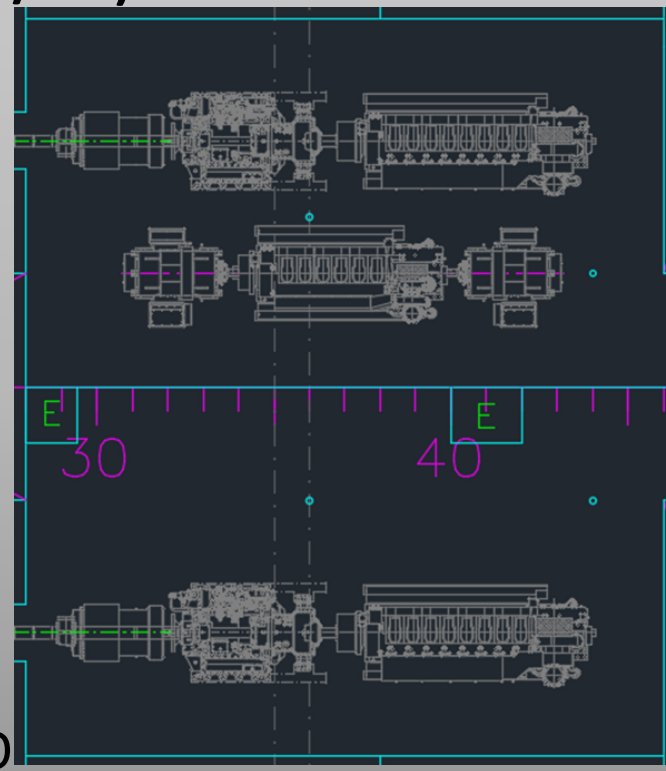
WHEN ON LSFO... MINIMISE FUEL CONSUMPTION DM /DE POWER PRODUCTION

Combined DM/DE Power Production → Achieved via **Shaft Generators (PTO/PTI)**



<u>Mechanical drive configuration:</u>

Engine's Rotary Motion → via PTO → Generates Electricity
Generated Electricity → via PTI → Rotary Motion

<u>Twin Shaft Configurations:</u>

1 Engine/ 1 Shaft: Excess Propulsion Power → via PTO → Electricity
Optimised Main Engine Load
Reduced Aux. Genset Installed Power

1 Engine/ 2 Shafts: Operating Main Engine → Shaft Generator acts like a PTO
Standing Main Engine → Shaft Generator acts like a PTI
Optimised Main Engine Load

Great savings for variable operational profiles

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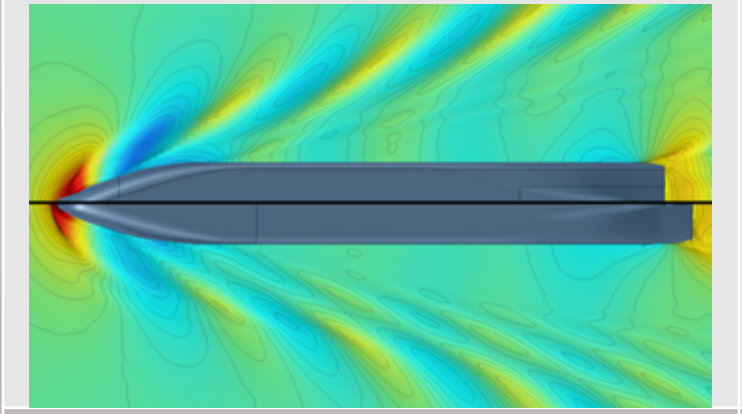
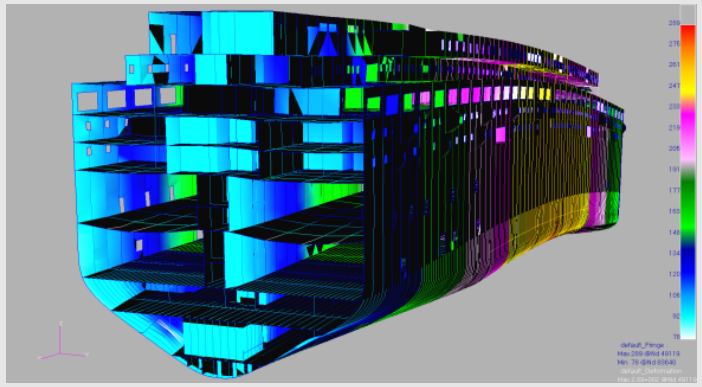
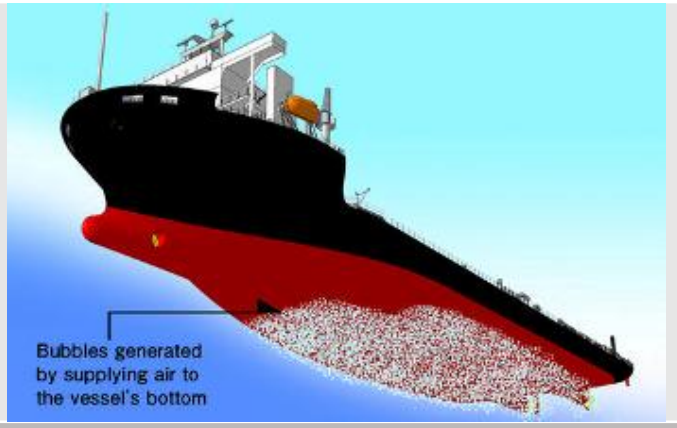
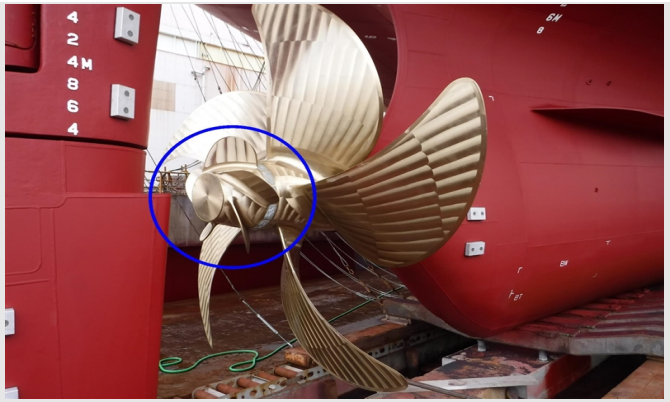
LSH Hybrid Explorer vessel

WHEN ON LSFO... MINIMISE FUEL CONSUMPTION

Hull Hydro Optimization	Lightweight Construction	Air Lubrication
		
Anti fouling Coating	**Sails and Rotors**	**Energy saving technologies**
		

LSH POINT OF VIEW

NO UNIFORM SOLUTIONS

CASE BY CASE - TAILOR MADE - MARKET SPECIFIC – OPTIMISED DESIGNS/SOLUTIONS – LIMIT COSTS – AHEAD OF THE MARKET

THANK YOU FOR YOUR TIME