

MAN Energy Solutions

RoPax Case Study: Liquid fuel versus LNG

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Head of Sales Four-Stroke Marine

MAN Energy Solutions

Business areas



Engines & Marine Systems



Power Plants



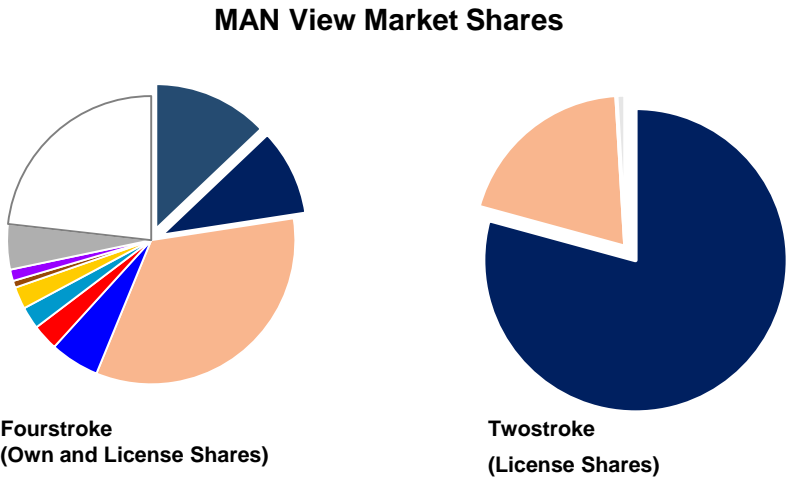
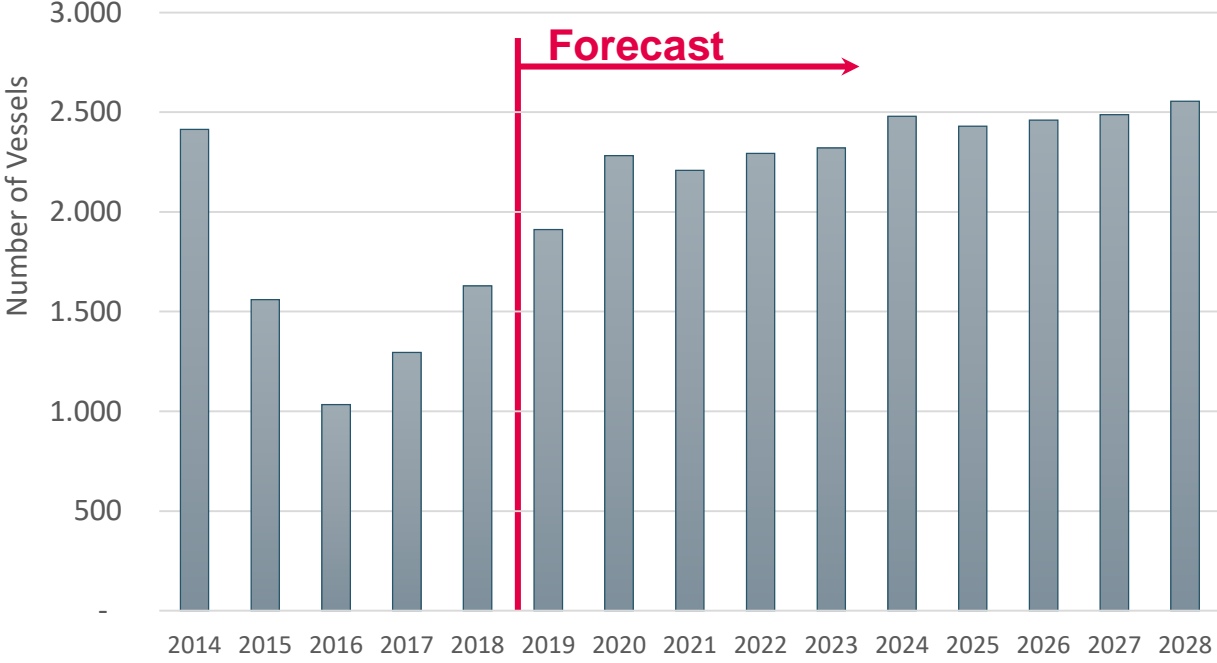
Turbomachinery



Aftersales MAN PrimeServ



Market Development Marine 2010-2027



Market Situation Order Year

- Record low in 2016 with ~ 1000 ships built globally in total
- Recovery expected in practically all market segments (especially commercial and Oil&Gas)

Market for ocean going vessels is recovering after a record low

Where do we stand today?

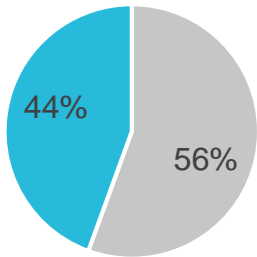
RoPax Case study: HFO vs LNG



Ropax-Ferry-Sales-Projects we are working on....Sea trials 2021-2023...

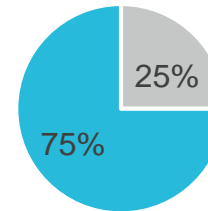
Europe

■ Liquid fuel ■ LNG Dual Fuel



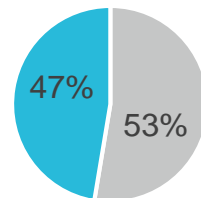
Americas

■ Liquefied Fuel ■ LNG Dual Fuel



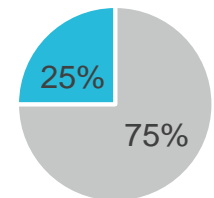
Worldwide

■ Liquid Fuel ■ LNG Dual Fuel



Asia

■ Liquid Fuel ■ LNG Dual Fuel



1 Case Study

Which road to take?

RoPax Case study: Liquid fuel vs LNG



“Which fuel shall I choose for my new vessel?”



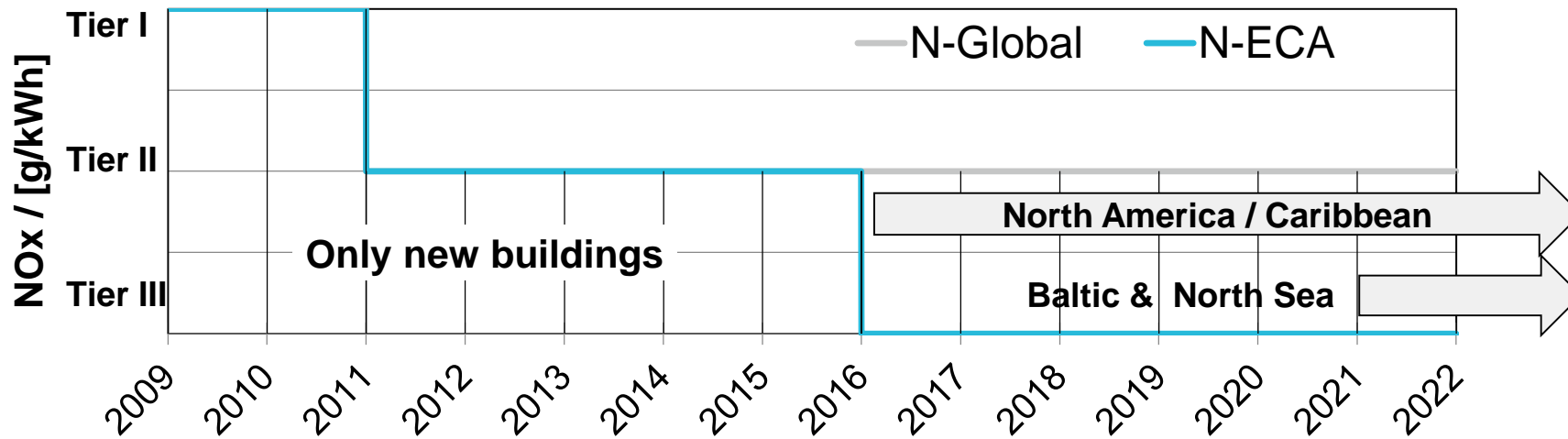
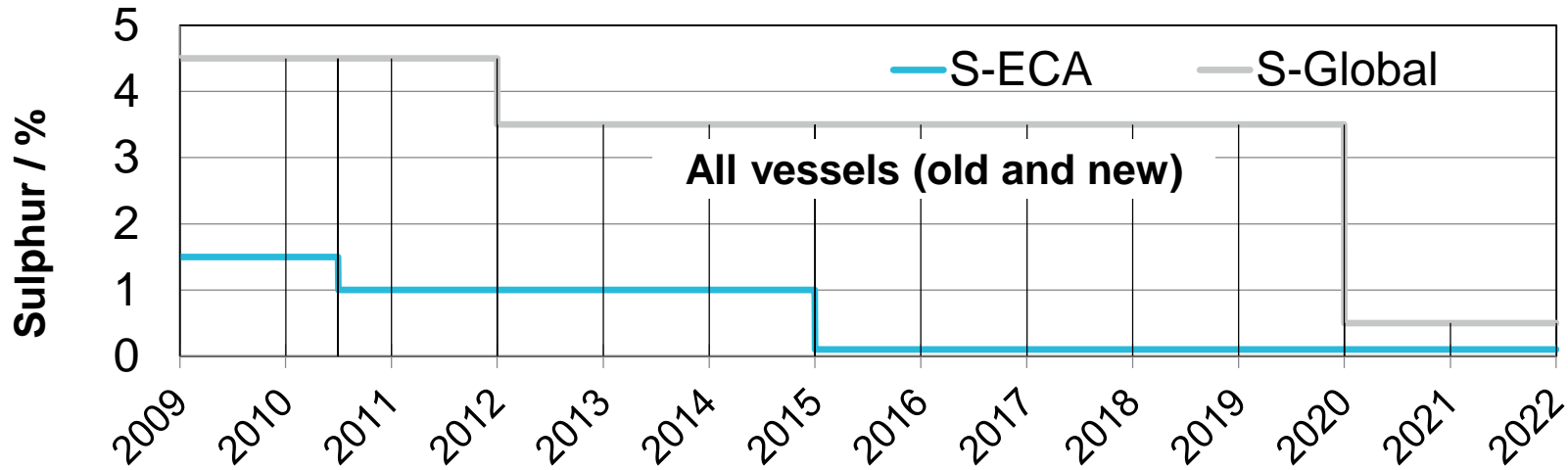
“It all depends on the fuel prices, nothing else”



“There are many more things to consider: green image, fuel availability, ...”

Legislation

Legally Effective IMO Limits



Technologies for Emission Compliance

RoPax Case study: Liquid fuel vs LNG



Countermeasures for
NO_x

SCR (MGO, HFO)

SO_x

Scrubber (HFO)

MGO

Dual Fuel Technology

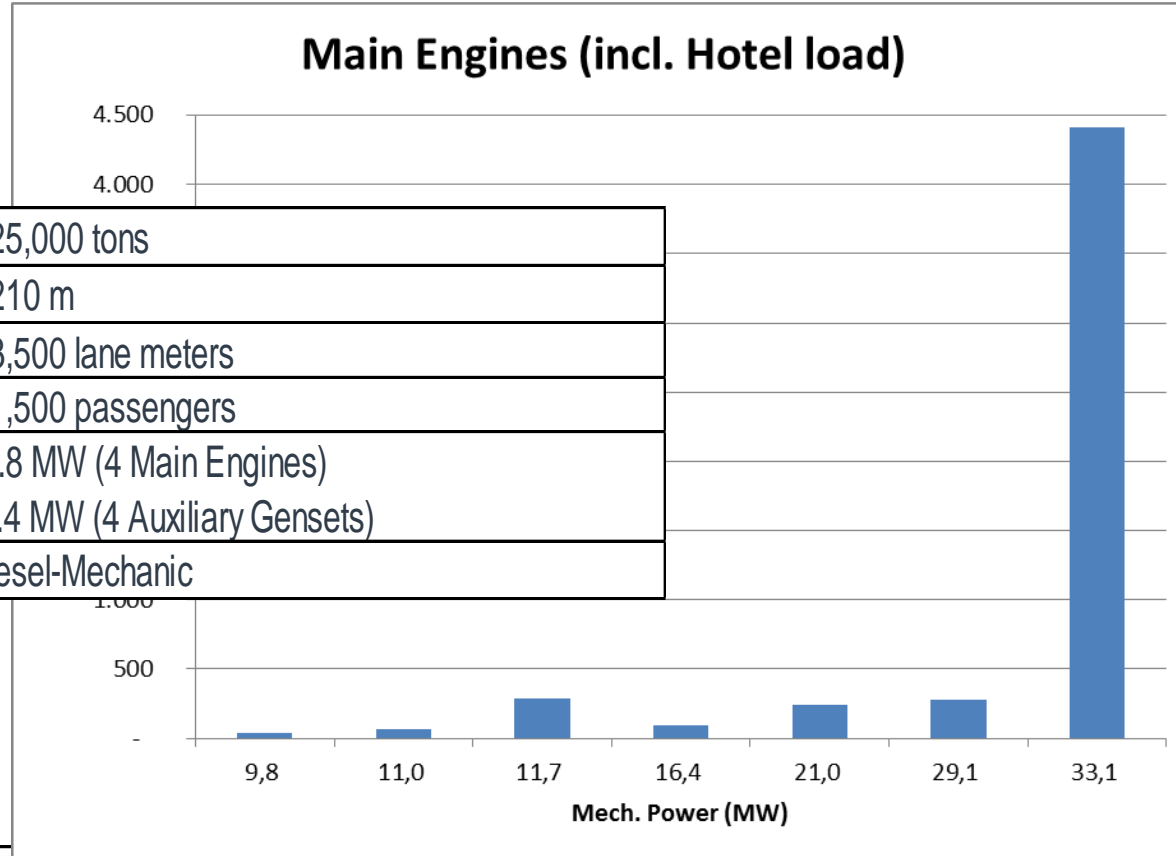


RoPax Ferry Data

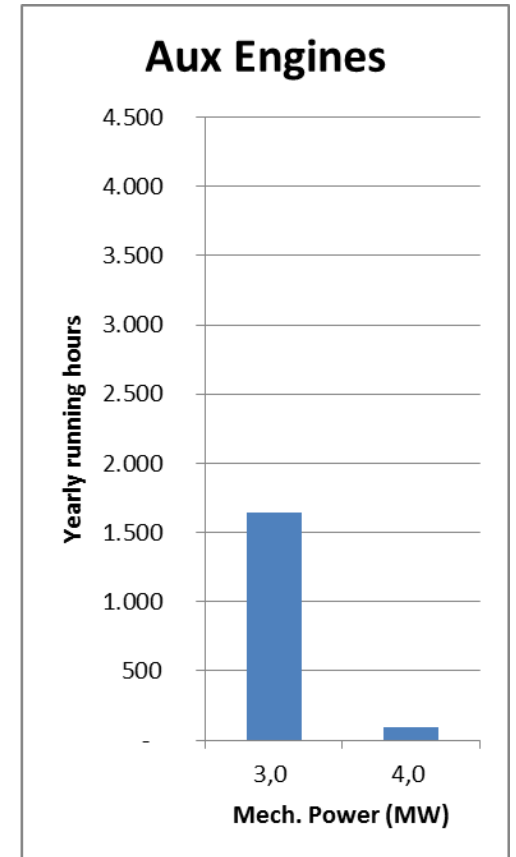
RoPax Case study: Liquid fuel vs LNG



Main Vessel Data	Displacement	~ 25,000 tons
	Length	~ 210 m
	Capacity	~ 3,500 lane meters
		~ 1,500 passengers
	Installed Power	38.8 MW (4 Main Engines) 6.4 MW (4 Auxiliary Gensets)
Propulsion system	Diesel-Mechanic	



Route Profile	Length of Round Trip	1,370 n.m.
	Duration of Round trip	76 hours (thereof at ports: 12 hours)
	LNG Refueling	Once per round trip
	LNG tank capacity	2 x 450 m ³ (C-type)



RoPax Case Study – Emissions



RoPax Case study: Liquid fuel vs LNG

**IMO Tier III +
S-ECA (0,1%S)**

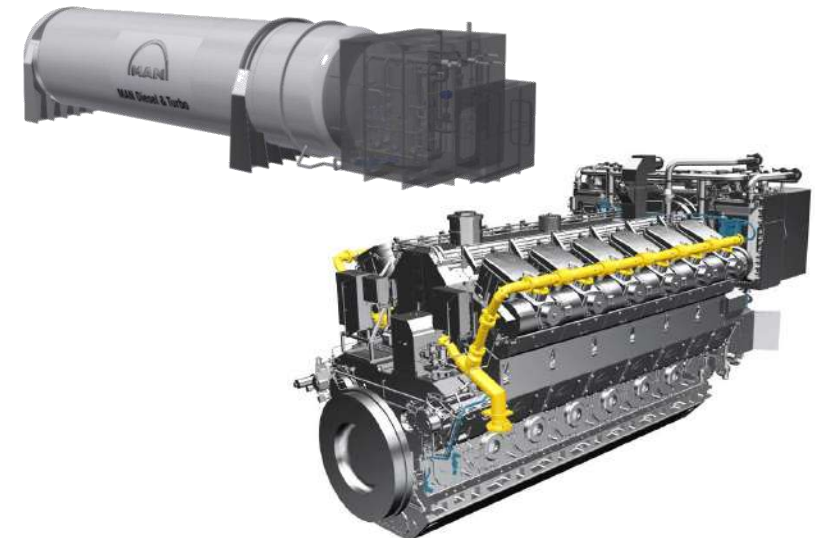
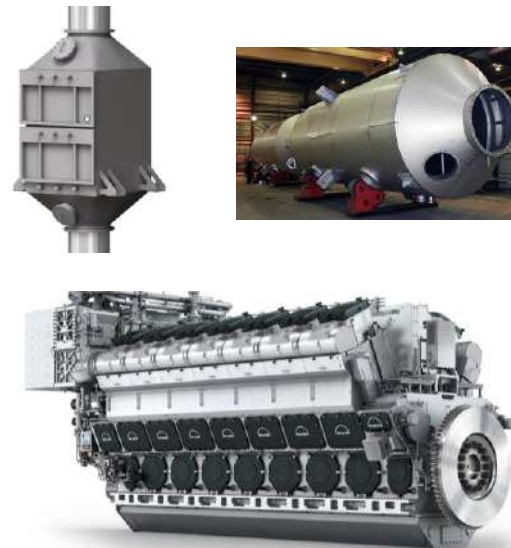
**Baltic and North Sea
North American ECA**

48/60CR

1. 4x8L 48/60CR
100% MGO
SCR
2. 4x8L 48/60CR
100% HFO
Scrubber + SCR

51/60DF

3. 2x8L + 2x9L 51/60DF
100% LNG
MGO as pilot oil only
(no after treatment)

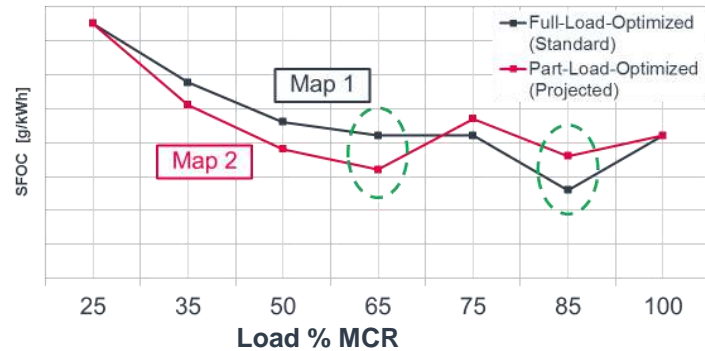


CR & EcoSCR: Ecology & Economy

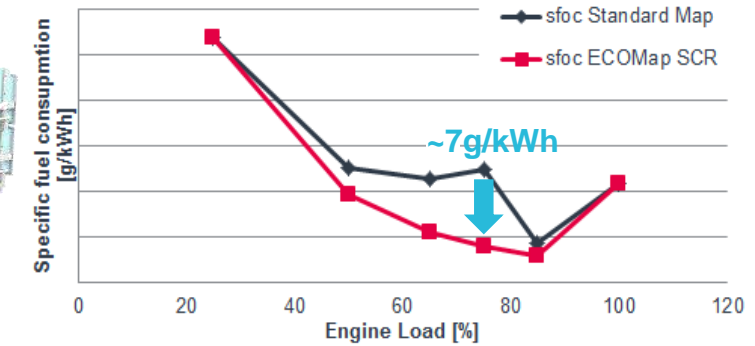
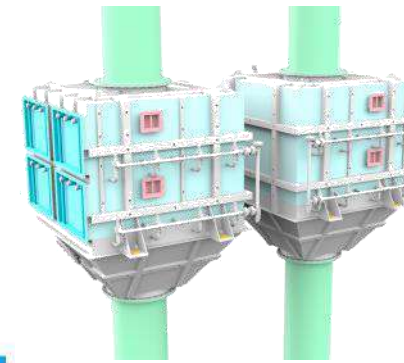


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MAN Common Rail System



MAN SCR-LP System



ECOMAP 1.0 – Map Selection Concept

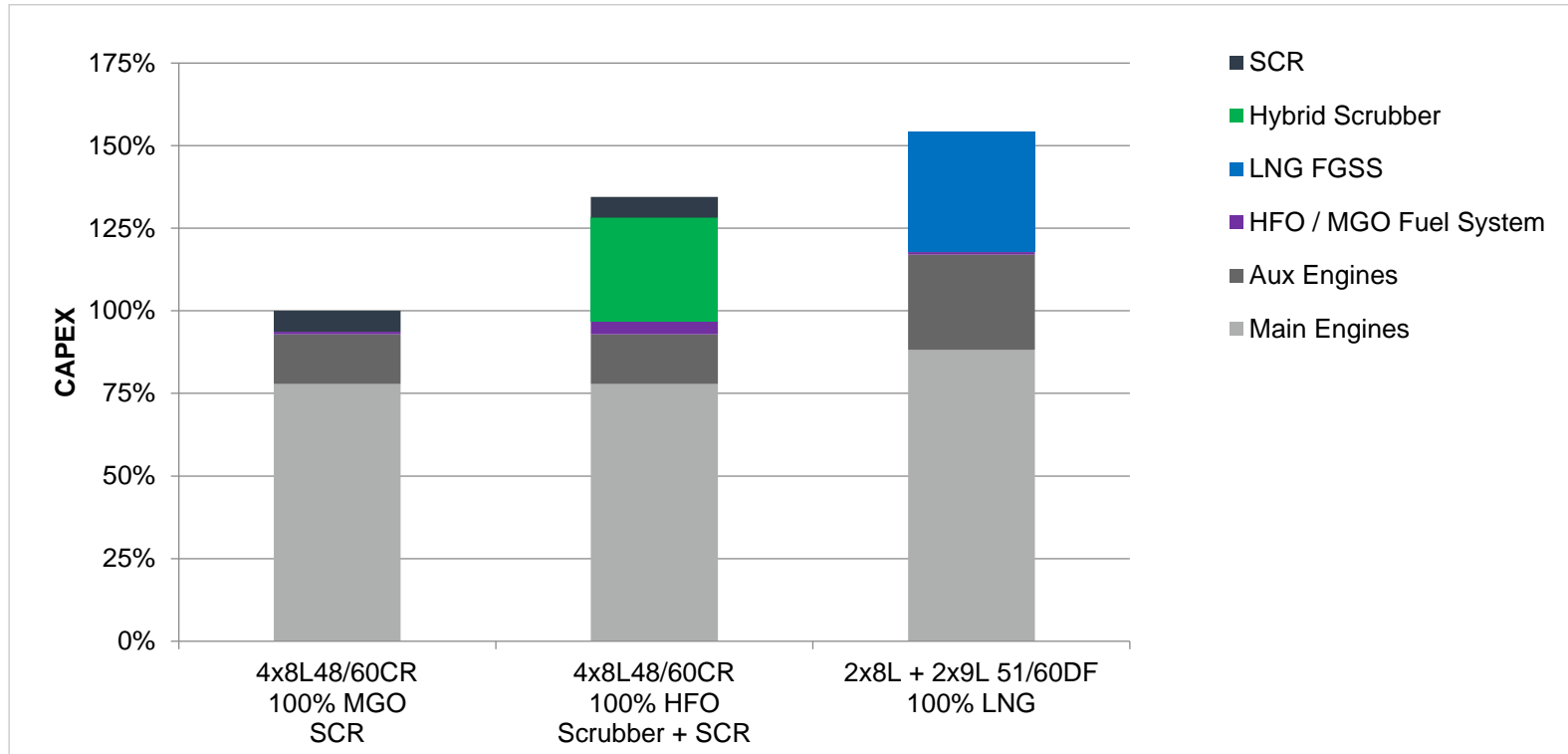
- Engine can be equipped with more than one injection map
- Each of the engine maps is IMO Tier II compliant
- Acc. to map selection rules (no random switching)
- Improvement of 3 to 5 g/kWh

EcoSCR – System Optimization with SCR

- Set engine to lowest fuel oil consumption but high NOx emission
- SCR operation mandatory to reach IMO Tier II / III
- Up to 7 g/kWh fuel consumption savings
- Up to 3 % CO2 emission reduction

CAPEX

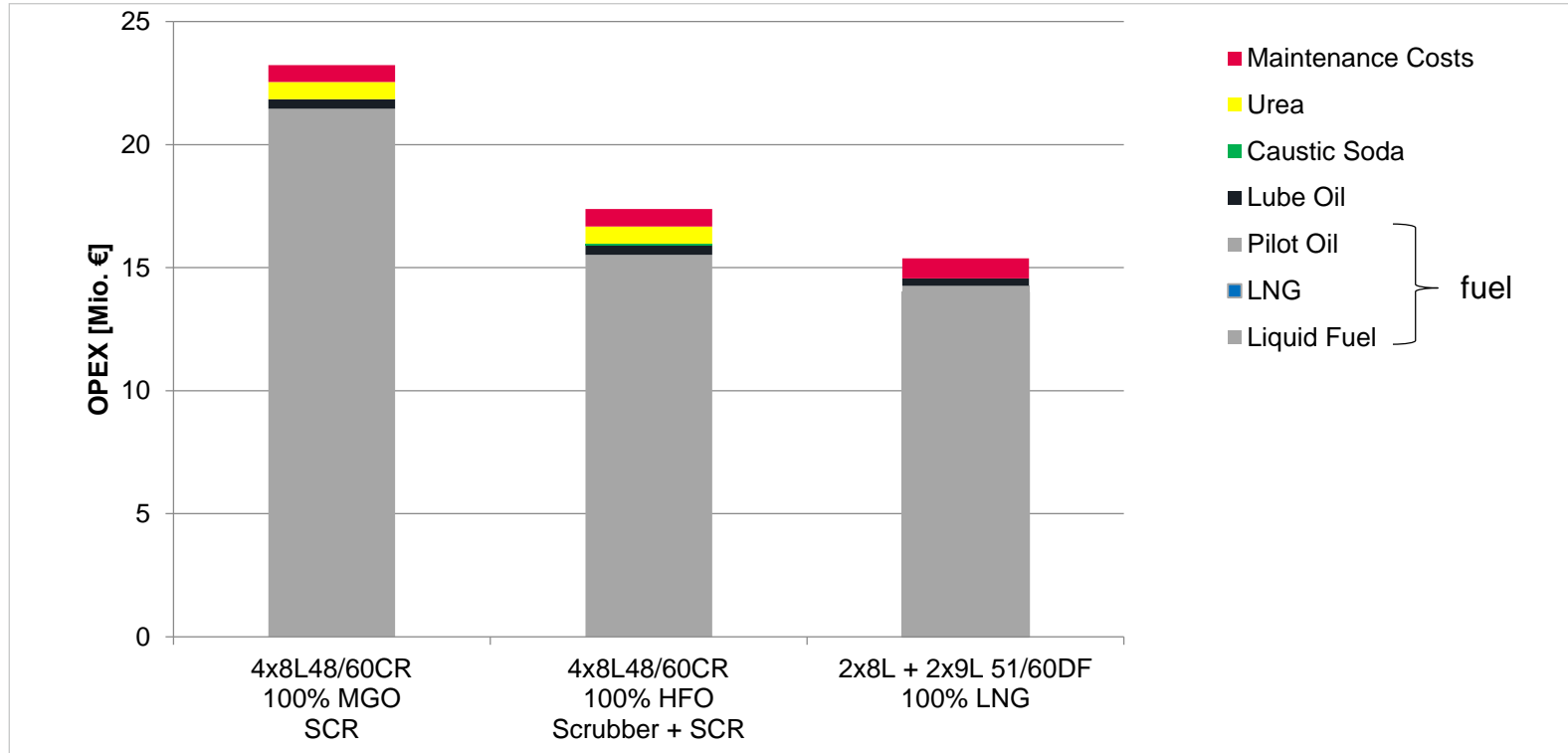
RoPax Case study: HFO vs LNG



- Highest CAPEX for LNG fuelled vessel due to extra expenses for fuel gas storage and supply system (FGSS) as well as higher engine first costs.
- Size of the LNG tank is main driver for the FGSS cost, which is mainly depending on voyage time (respectively intervals between refuelling)

OPEX

RoPax Case study: Liquid fuel vs LNG



PRICES [USD/t]:

HFO (3.5%S): 412¹

MGO (0.1%S): 582¹

LNG: 440² (= 9.4 USD/mmBTU)

Urea: 250 USD/t

Caustic Soda (50%): 250 USD/t

Lube Oil: 3,200 USD/t

¹ Source: shipandbunker.com
(March 2019)

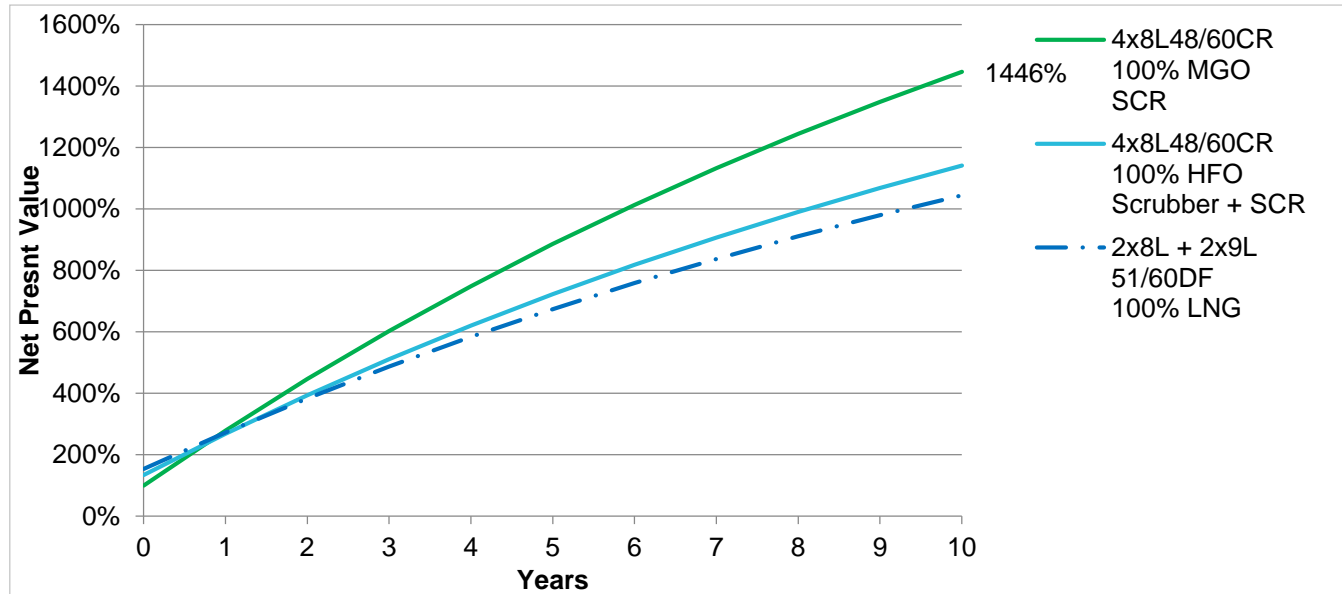
² Source: see separate slide attached in Backup



- Fuel bill is the biggest part of OPEX by far.
- Hence, fuel prices will have **the** decisive impact on the OPEX ranking.
- For the reflected price situation (03/2019), the LNG solution yields lowest OPEX (approximately 2 Mio. EUR lower annual OPEX compared to the HFO solution)

Life Cycle Costs

RoPax Case study: Liquid fuel vs LNG



PRICES [USD/t]:

HFO (3.5%S):

- 412 US\$ton¹
 - 40 000 MJ/ton
 - 11 111 kWh/ton
 - 37,8 mmBTU

MGO (0.1%S): 582¹

LNG:

- 49 300MJ/ton
- 440² (= 9.4\$/mmBTU)

Urea: 250 USD/t

Caustic Soda (50%): 250 USD/t

Lube Oil: 3,200 USD/t

¹ Source: shipandbunker.com (March 2019)

² Source: see separate slide attached in Backup

- With today's fuel price scenario, after 10 years, the LNG solution provides an accumulated LCC benefit of 8% against the HFO and 27% against the MGO solution
- Amortization time of LNG System compared to the HFO solution is about 1 year (Price Differential 1 ton LNG to 1 ton HFO = 30 US\$ but 16% higher energy content)

NPV based on costs today and in 2017



RoPax Case study: Liquid fuel vs LNG

Fuel prices as of today : 03/2019

HFO (3.5%S): 412

MGO (0.1%S): 582

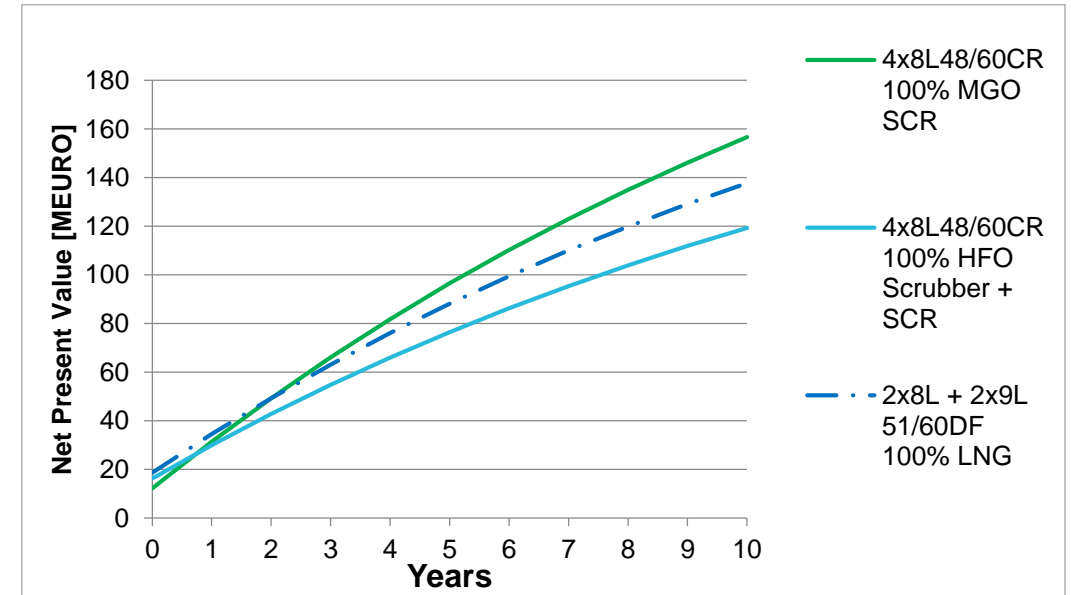
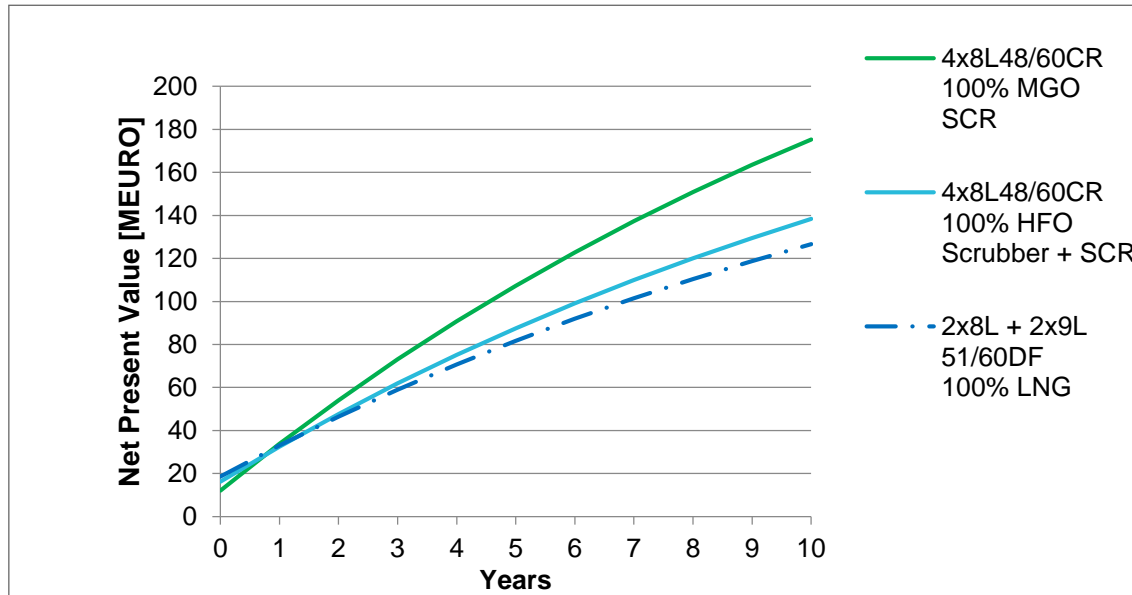
LNG: 440 (= 9.5 \$/mmBTU)

Fuel prices as 03/2017

HFO (3.5%S): 340

MGO (0.1%S): 510

LNG: 490 (= 10.5 \$/mmBTU)

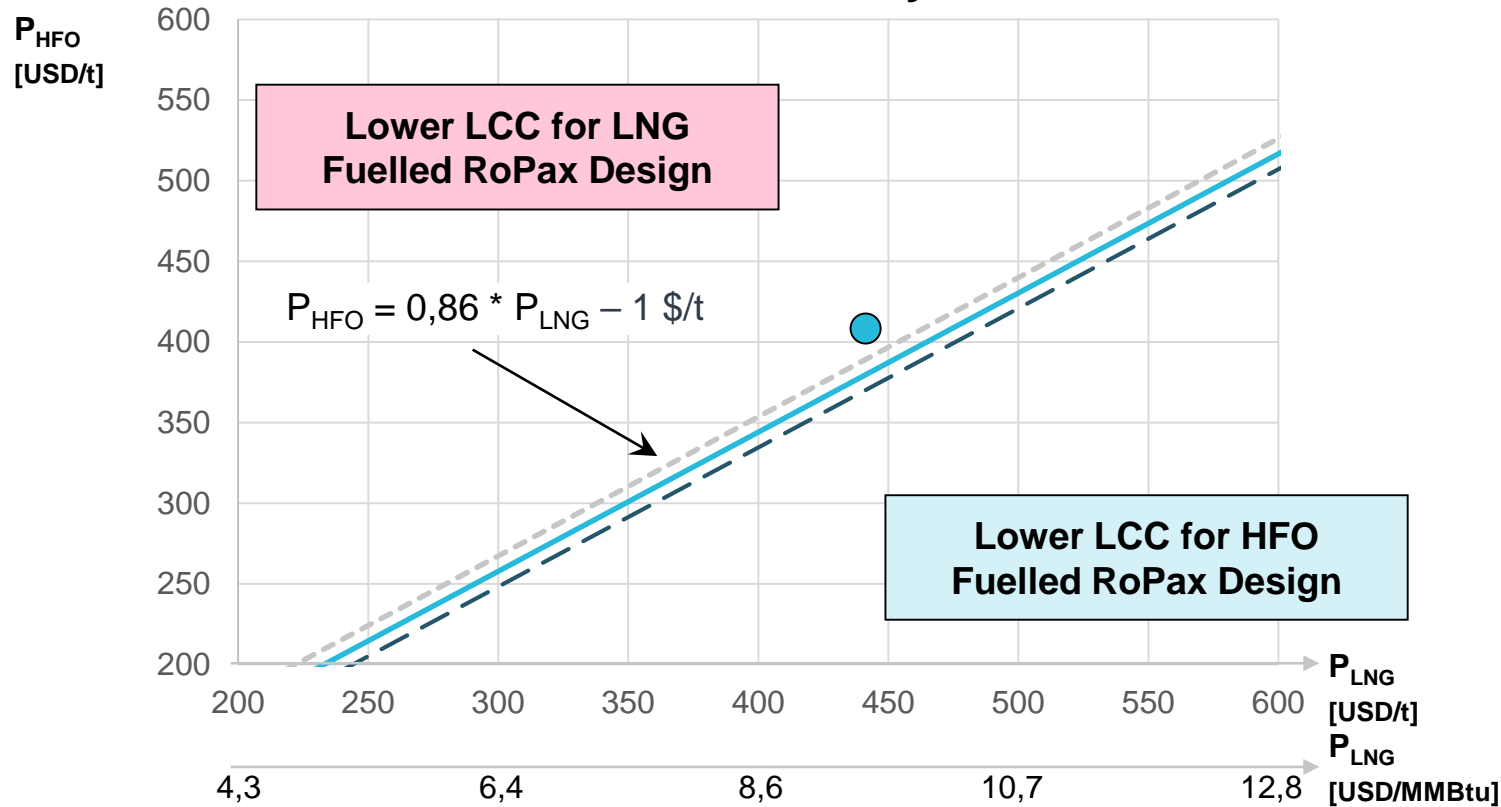


Fuel selection diagram



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NPV Calculation of Life Cycle Costs



PRICES [USD/t]:

Urea Price:

- 125 USD/t
- 250 USD/t
- - - 375 USD/t

Neglectable influence:

- MGO (0.1%S):** 582¹
- Caustic Soda (50%):** 250 USD/t
- Lube Oil:** 3,200 USD/t

¹ Source: shipandbunker.com (March 2019)

Assumptions

- Time Period: 10 years
- Net Interest Rate: 7%

● **HFO / LNG Price Situation in 03-2019**
(used for case study LCC calculation)

CONCLUSIONS

Expected Trends and Major Aspects for Fuel Type Solution



**Main Marine Market: SCR + HYBRID SCRUBBER *versus* DUAL-FUEL
(especially after 2020 with 0.5%S limit on global level)**

MAIN FACTORS

- Initial Costs (CAPEX)
- Small Scale LNG Price vs. HFO Price (OPEX) → LCC Key Driver!
- Impact of Equipment Size & Weight on Revenue *
(Green image, Loss of Cargo, Loss of Cabins / Public Spaces)

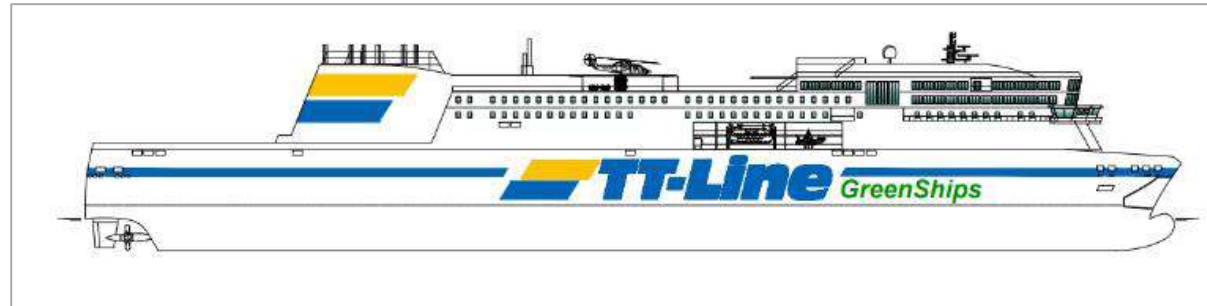
** not considered in previous RoPax case study*

OTHER

- Fuel Availability & Safe Bunkering Procedure
- Reliability of Technology in the Field
- Potential Scenario of Emission Legislation on Particulate Matters, THC
- CO2 reduction target

If you go DF, check on engine performance

51/60DF and 35/44DF USPs



TT Line:

2 x 6L + 2 x 8L MAN 51/60DF +
Cryo LNG FGSS +
AKA system +
MAN Alpha CCP system

Heerema:

12 x MAN 8L51/60DF



Dredger Samuel de Champlain:

3 x 6L 35/44 DF Diesel-electric



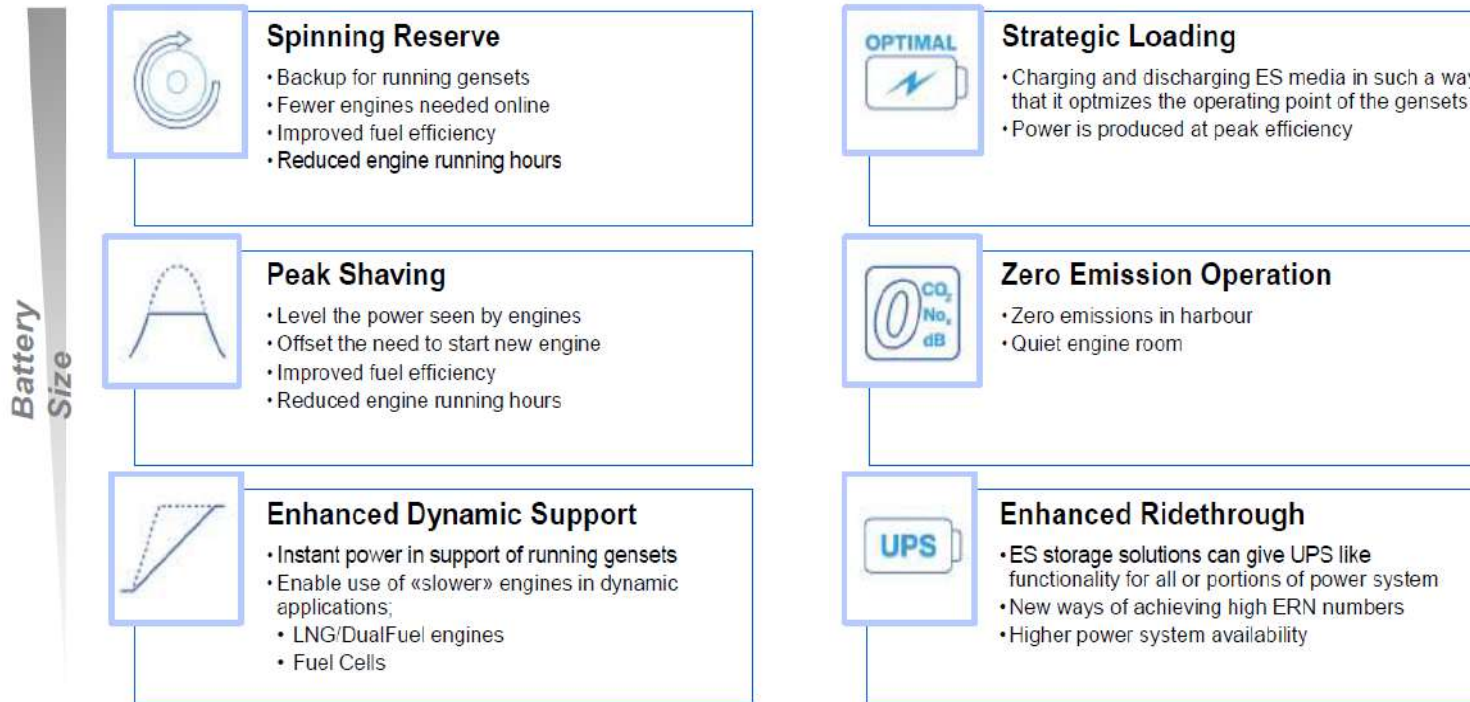
Seaspan RoRo Battery hybrid:

2 x 9L 35/44 DF Diesel-electric plus AKA Hybrid Battery + Cryo LNG FGSS

If you go for new, consider Battery-Hybrid



LNG driven Battery-Hybrid RoRo Ferry



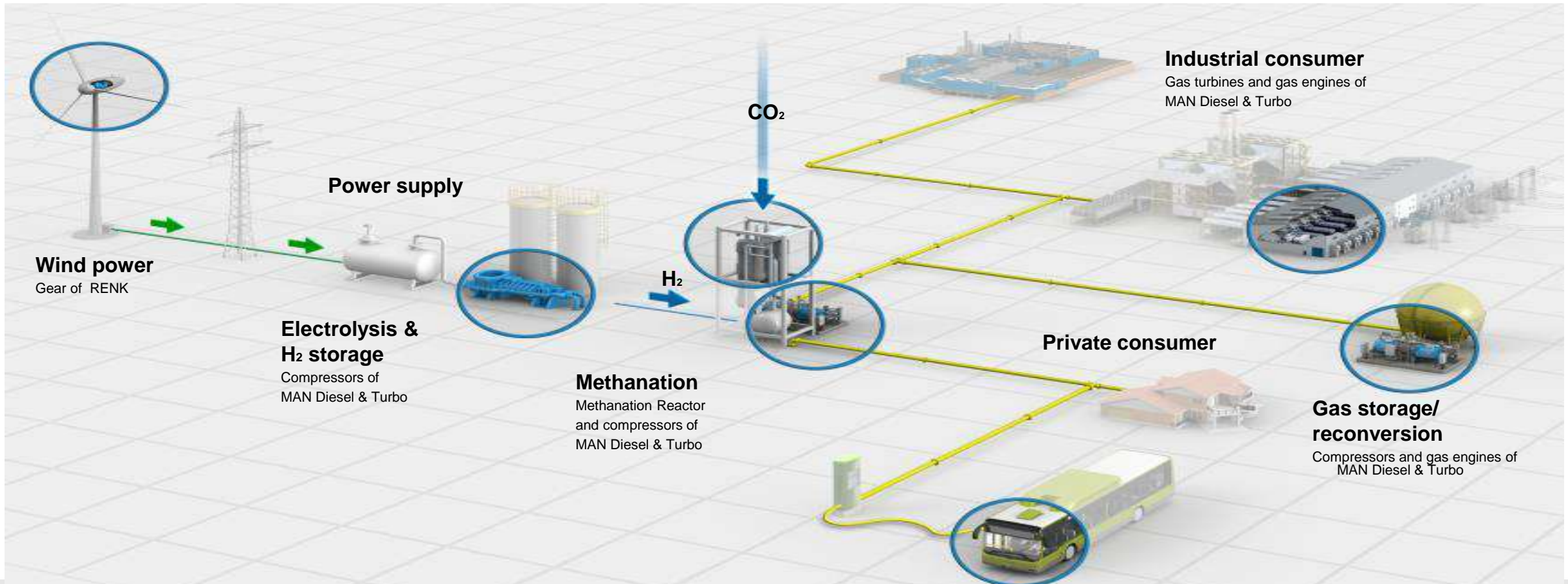
Broadest operational flexibility – onboard. More details will be introduced in a separate presentation.

Stay flexible to meet decarbonisation target



Ferry shipping Summit 2019

Power to Gas, a new energy supply concept



Disclaimer



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Thank you very much!

**Strictly
confidential**