Germanischer Lloyd

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Costs and benefits of LNG-fuelled container vessels

Christian Freiherr von Oldershausen, Senior Vice President Global Sales, GL SE

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Outlook

Attractions for using LNG as ship fuel

1. 90%-95% reduction of Sulphur-oxide emissions

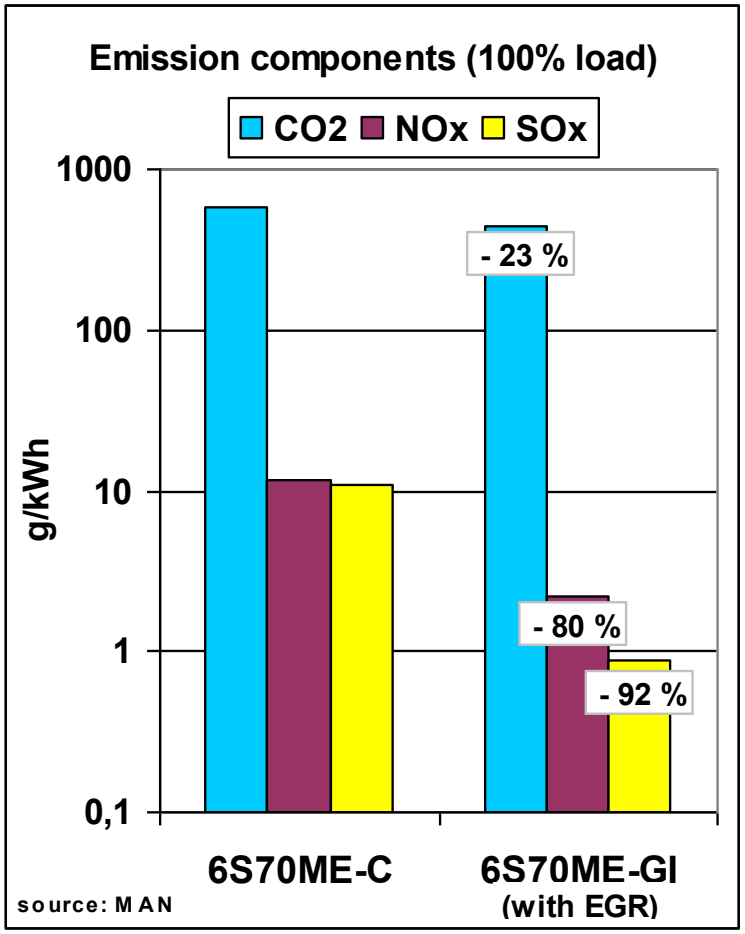
   required within Emission Control Areas (ECAs) by 2015

   required globally by 2020, pending a review at IMO by 2025
2. reduction of Nitrogen-oxide emissions to IMO Tier III levels

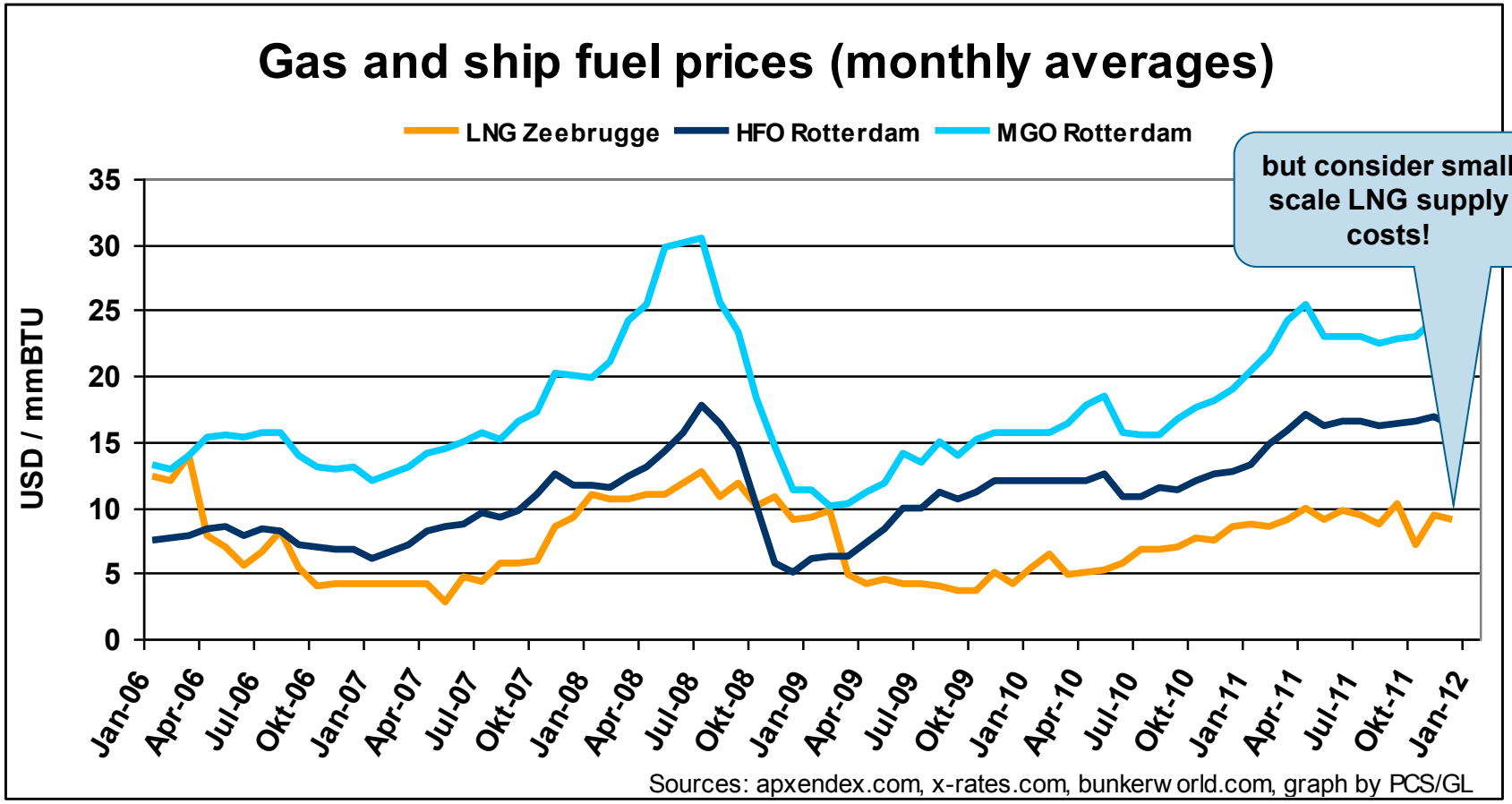
   only for pure gas engines and dual-fuel four stroke engines

   required within Emission Control Areas by 2015
3. 20% to 25% reduction of Carbon-dioxide emissions

   Methane slip needs to be avoided during bunkering and usage



Historic records of fuel prices



LNG: Liquefied Natural Gas, HFO: heavy fuel oil (IFO 380), MGO: marine gas oil, BTU: British thermal Unit = 1,06 kJ

Regulatory development

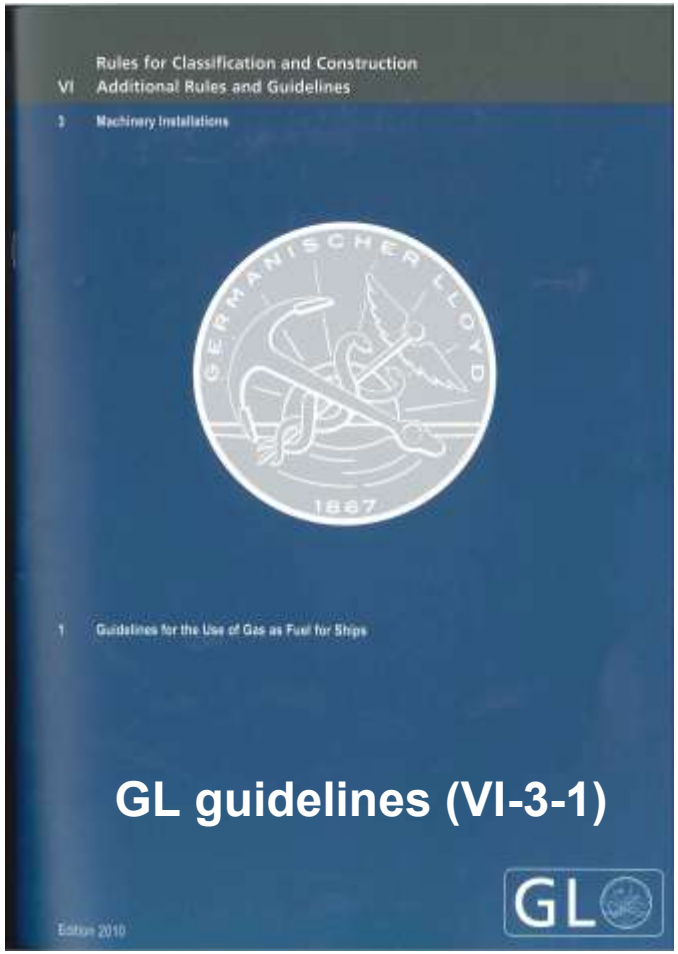
IMO issued interim guidelines in 2010. These are not mandatory for flag states.

GL (and also other class societies) have issued their own guidelines. GL guidelines offer additional interpretations.

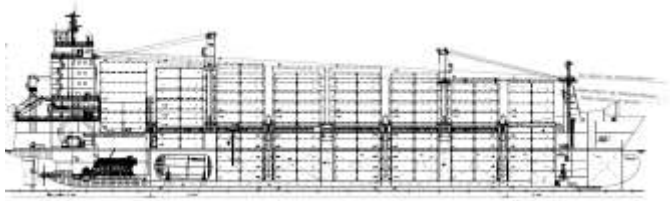
IMO subcommittee BLG currently works on the IGF-code, finalisation before Jan. 2013 planned. The IGF code should be published with the next SOLAS revision in 2014.

Harmonisation of the IGC-code with the future IGF-code is required to ensure consistent regulation.

ISO TC 67 started on LNG bunkering standard.

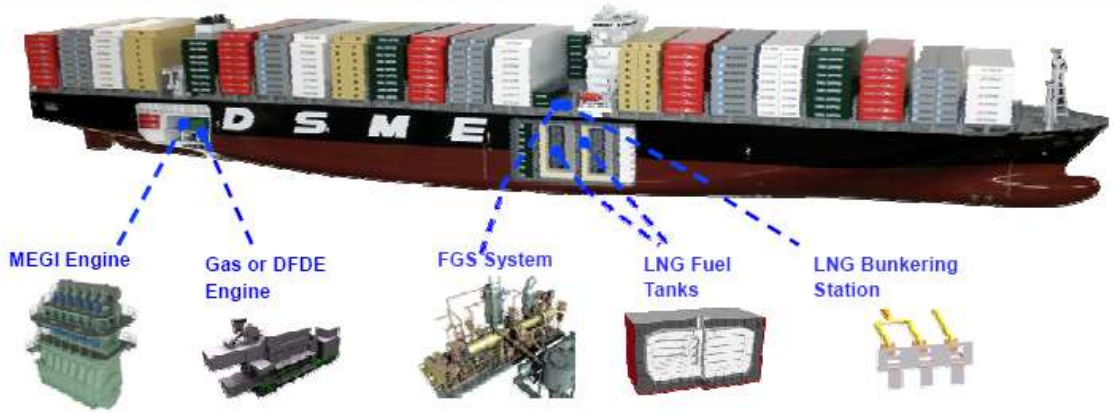


Projects exploring LNG as ship fuel for container vessels



GL 1200 TEU feeder (2009)

IPP 4200 TEU (2011), AiP* by GL



DSME 14000 TEU (2011), AiP* by GL

*) Approval in Principle

LNG as ship fuel for container vessels – a new joint study by GL and MAN

GL and MAN teamed up in late 2010 to jointly develop a roadmap for container vessel advanced propulsion solutions, with the aim to support decision making.

The study compares a standard container vessel with advanced vessels using LNG as ship fuel, scrubber systems and waste heat recovery systems.

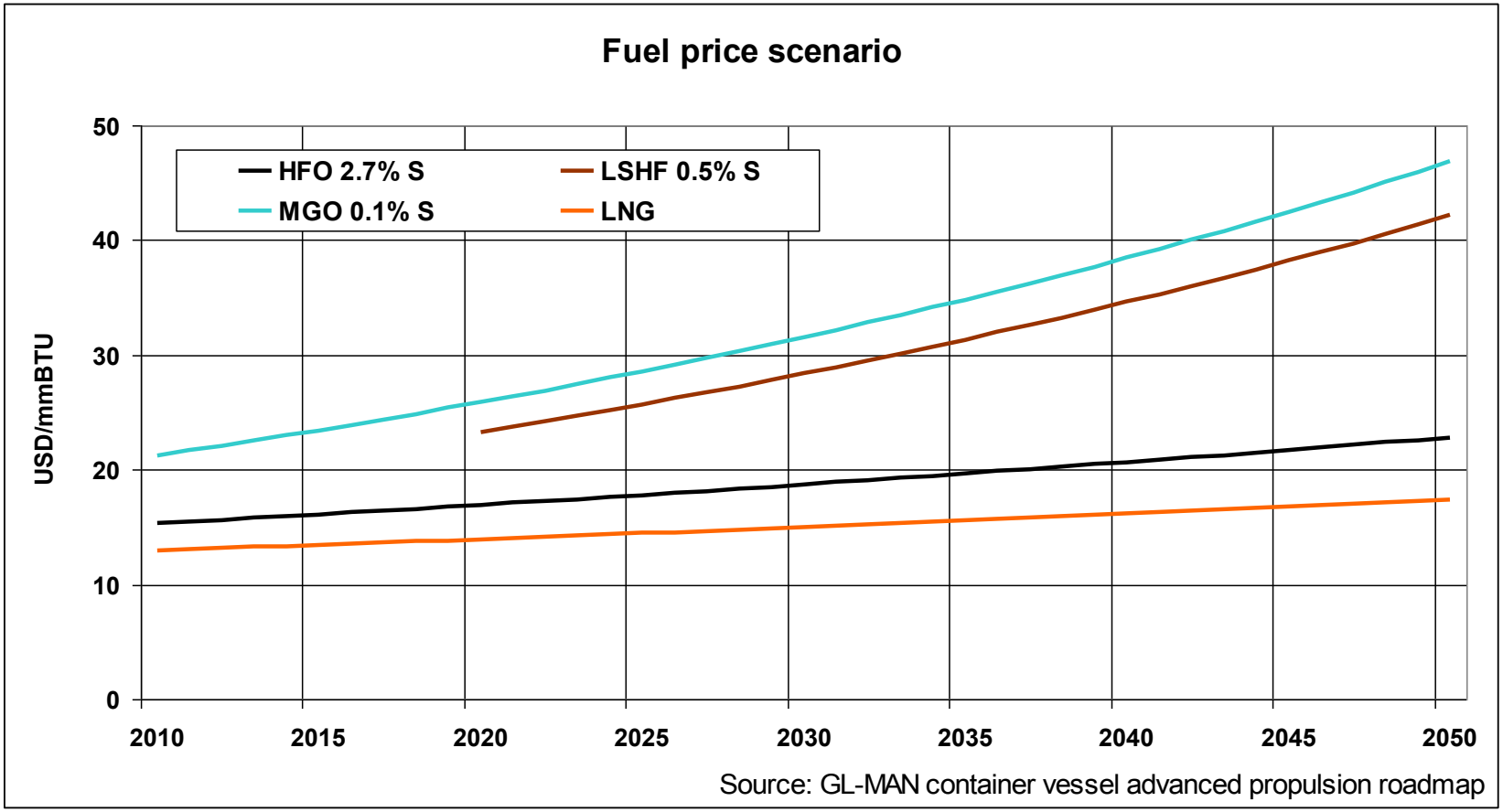
The standard vessel uses required fuels depending on time and location of its operation.

The same TIER III-related measures are assumed for all variants and, therefore, these have no effect on the cost differences between the standard vessel and the variants.

Lower earning due to space for LNG tanks, scrubbers and WHR is accounted for.

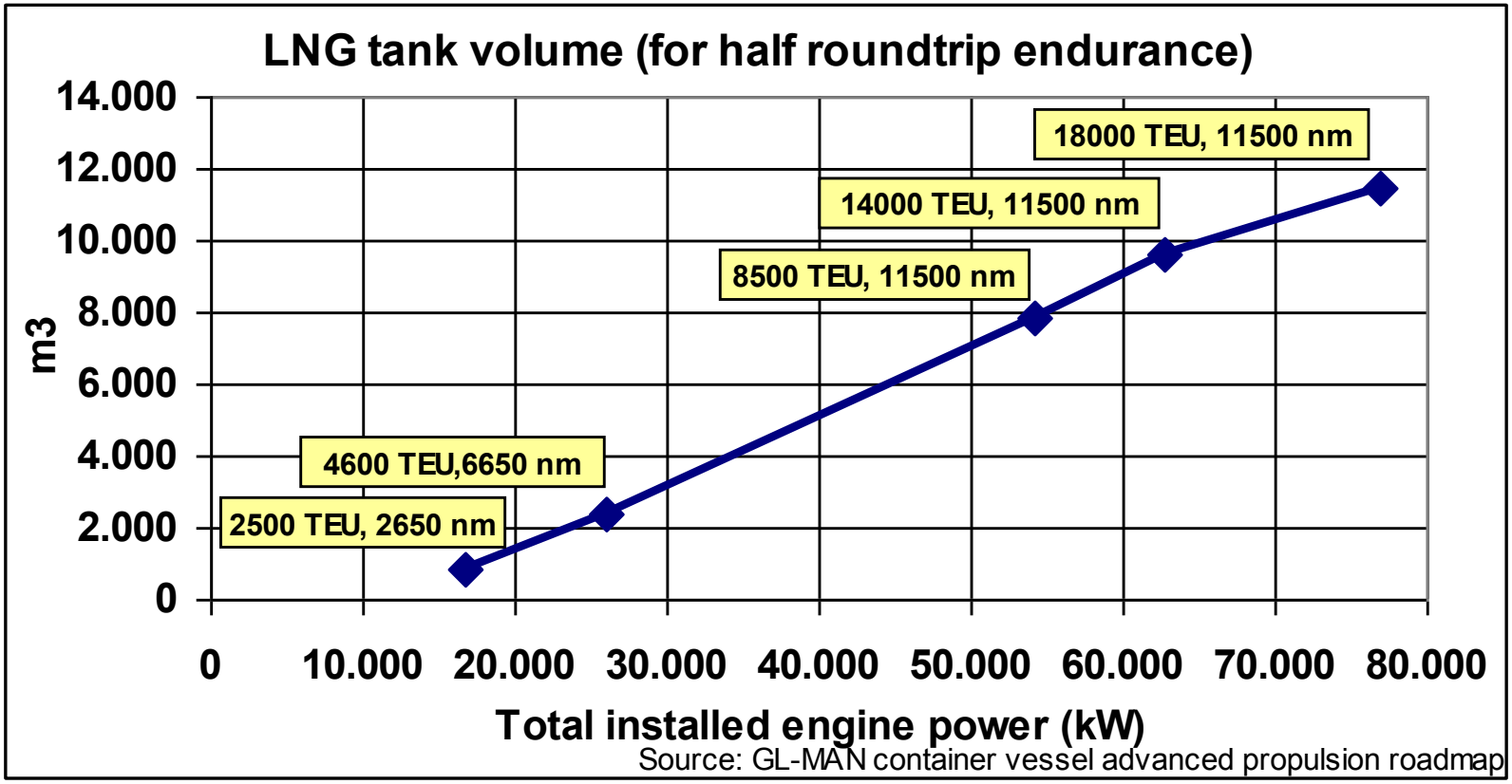
	Speed (knots)	ME power (kW)	Roundtrip (nm)	ECA share
2.500 TEU	20	14.500	5.300	65,1%
4.600 TEU	21	25.000	13.300	11,0%
8.500 TEU	23	47.500	23.000	6,3%
14.000 TEU	23	53.500	23.000	6,3%
18.000 TEU	23	65.000	23.000	6,3%

Fuel price scenario – delivered to the ship



LNG delivery costs of 4 USD/mmBTU have been added to the LNG wholesale price.

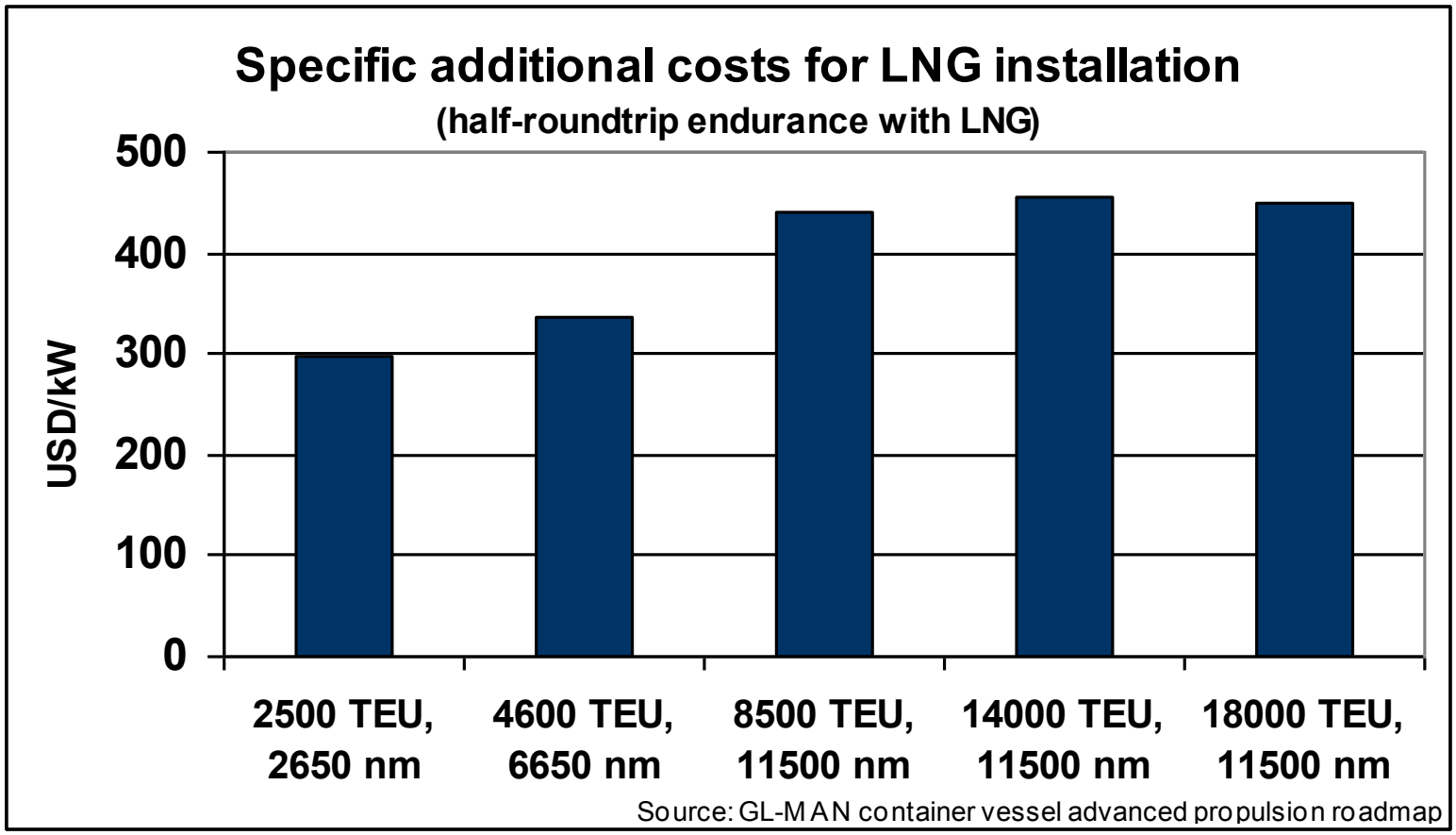
LNG tank volume depends on endurance



Source: GL-MAN container vessel advanced propulsion roadmap

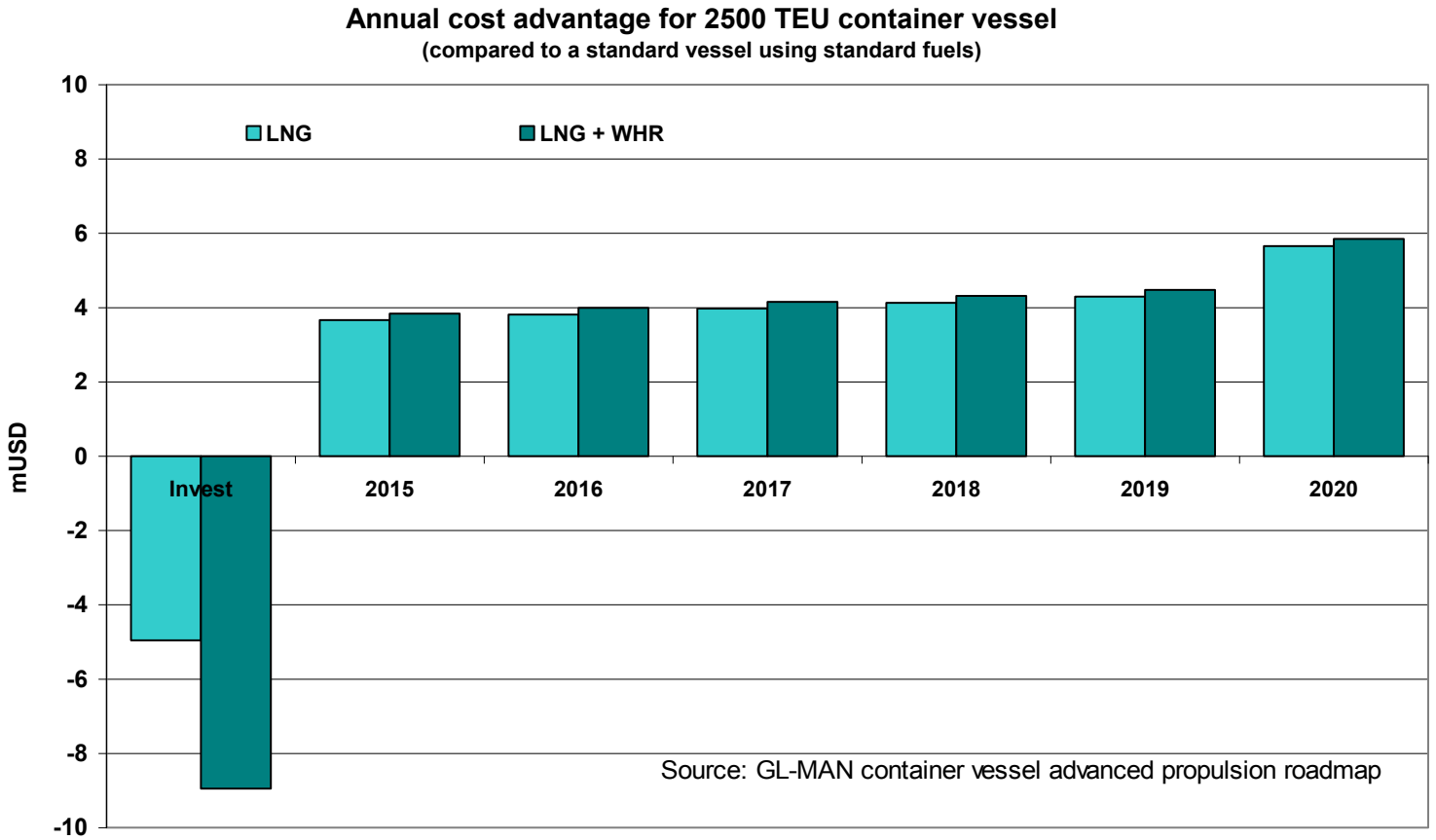
Total installed power comprises main engine and auxiliary engines (incl. reefer loads). Two bunker actions per roundtrip were assumed.

Estimates for total additional invest vs. total installed power



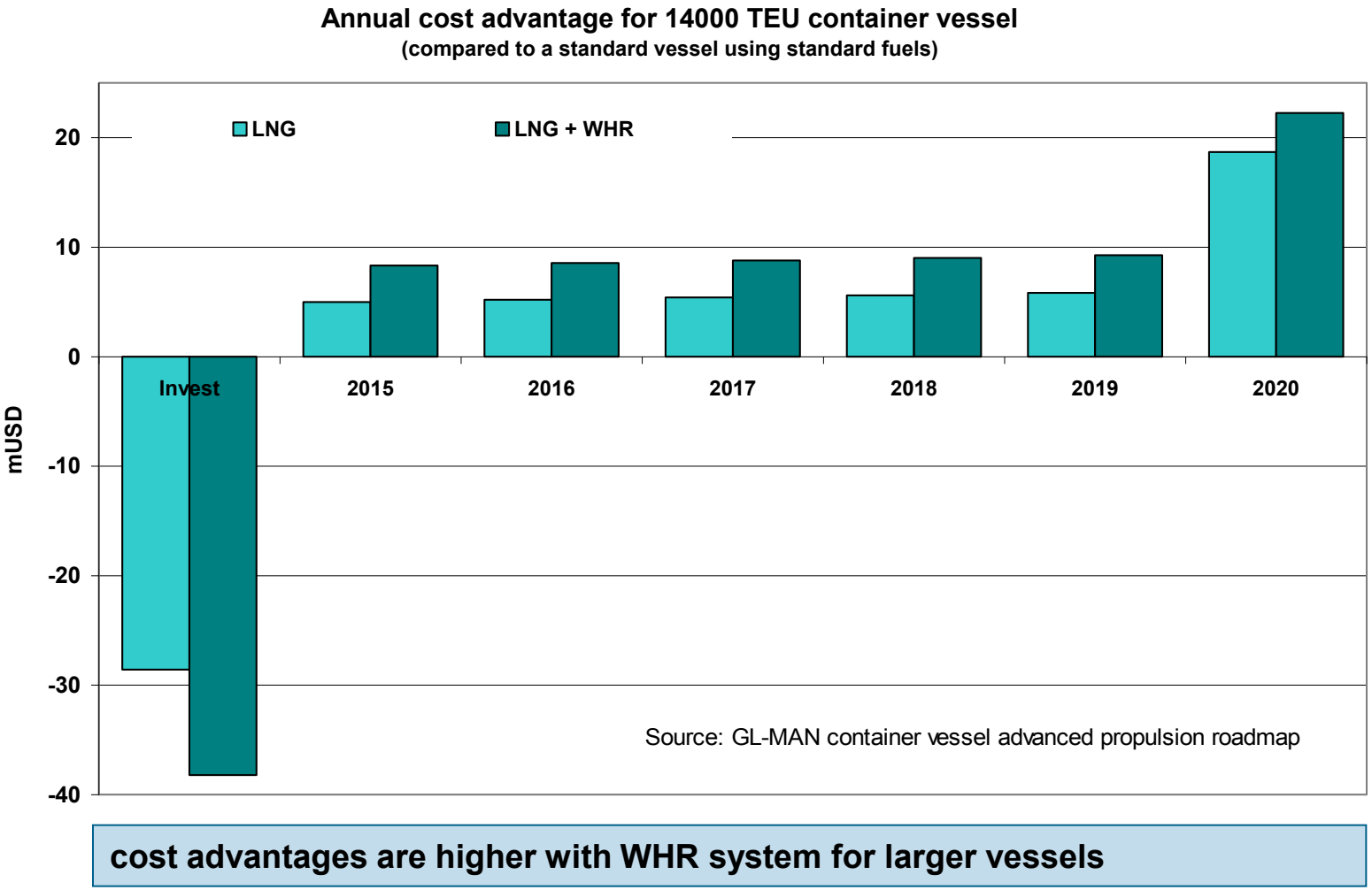
Type C LNG tank assumed for 2500 TEU vessel, type B LNG tanks for larger vessels

Results for 2500 TEU vessel (65% ECA operation share)



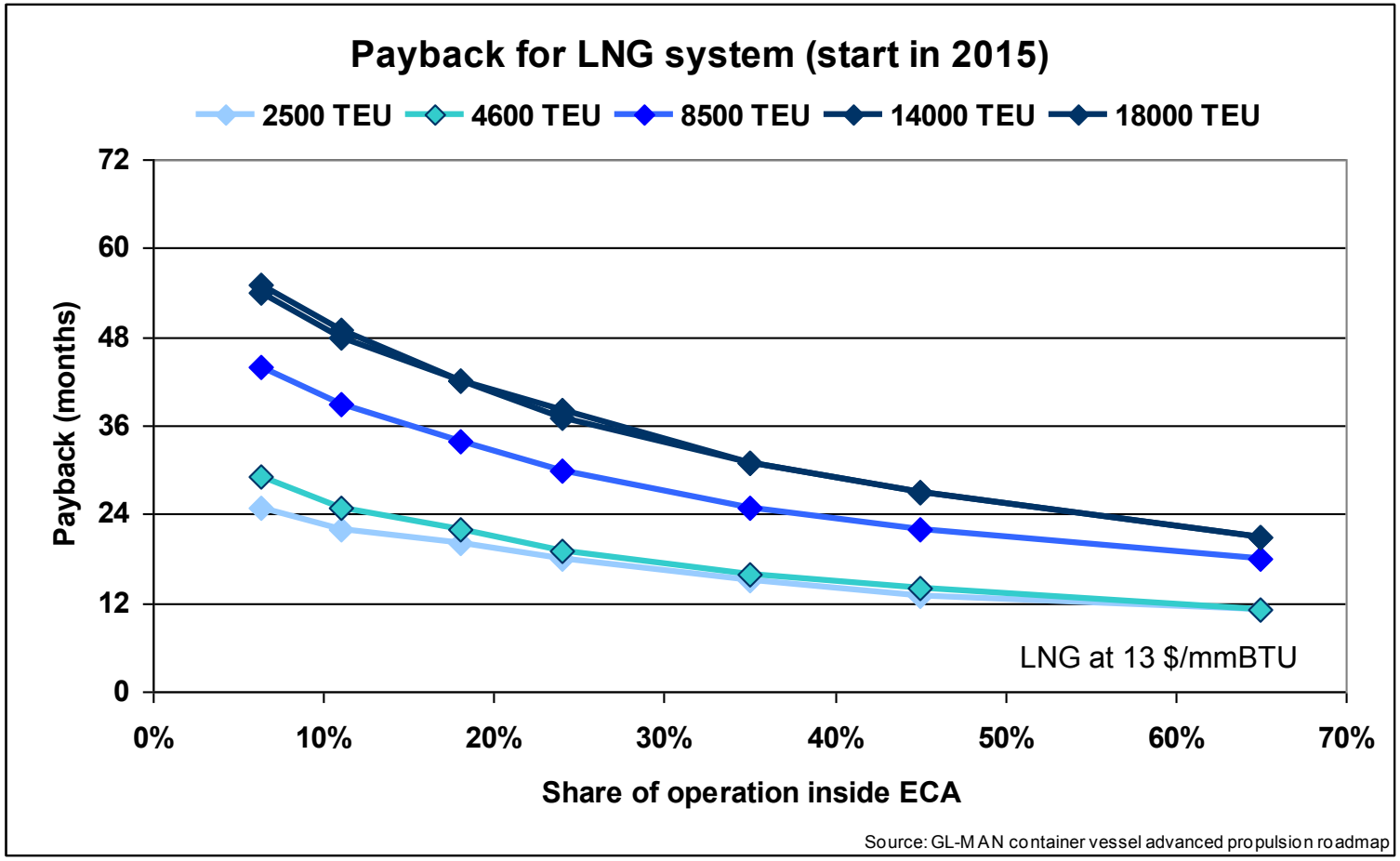
Annual cost advantage compared to the standard vessel is significant once strict fuel-quality regulations are in place and/or the vessel is sailing mostly within ECAs.

Results for 14000 TEU vessel (6.3% ECA operation share)



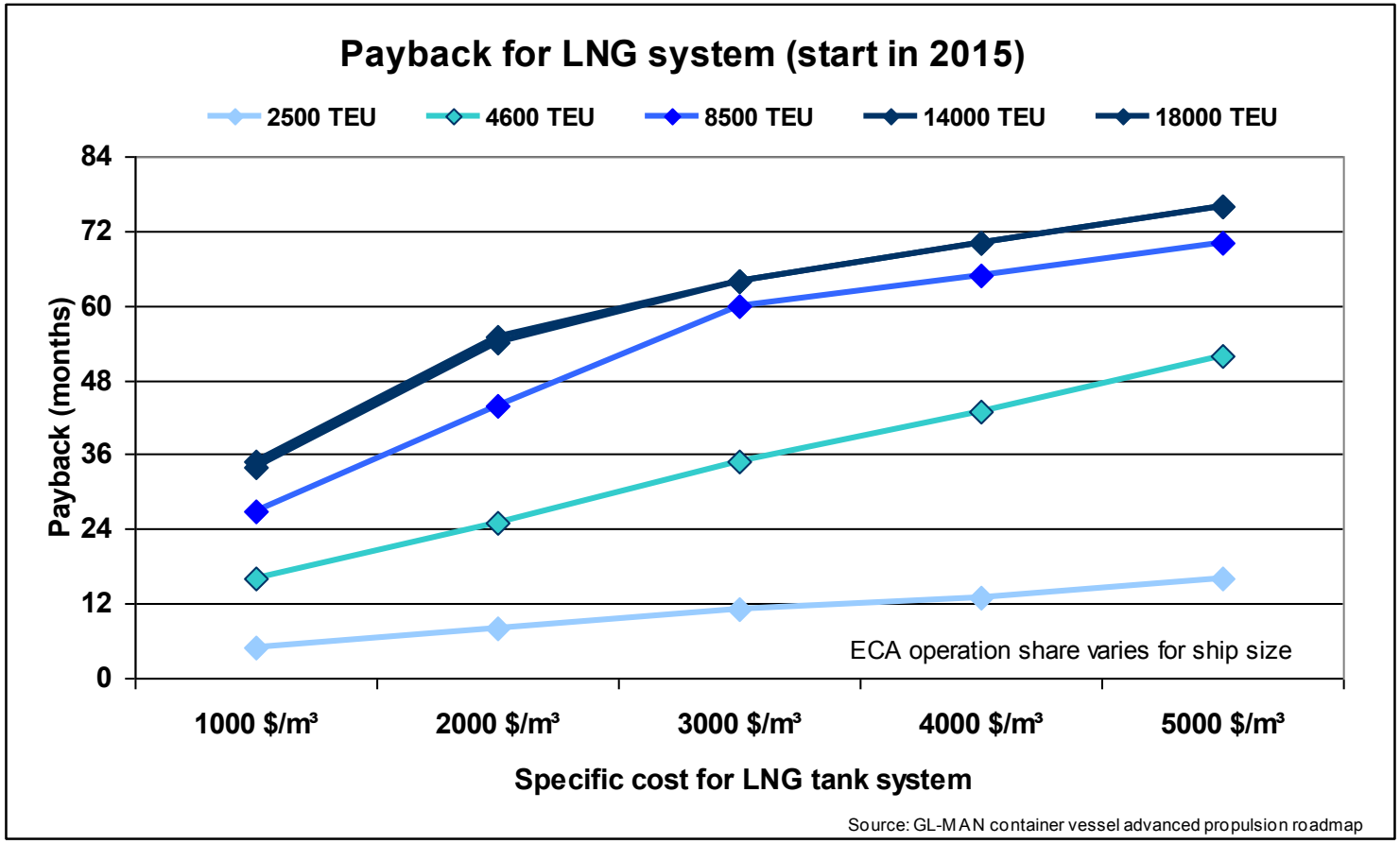
cost advantages are higher with WHR system for larger vessels

Payback for LNG technology



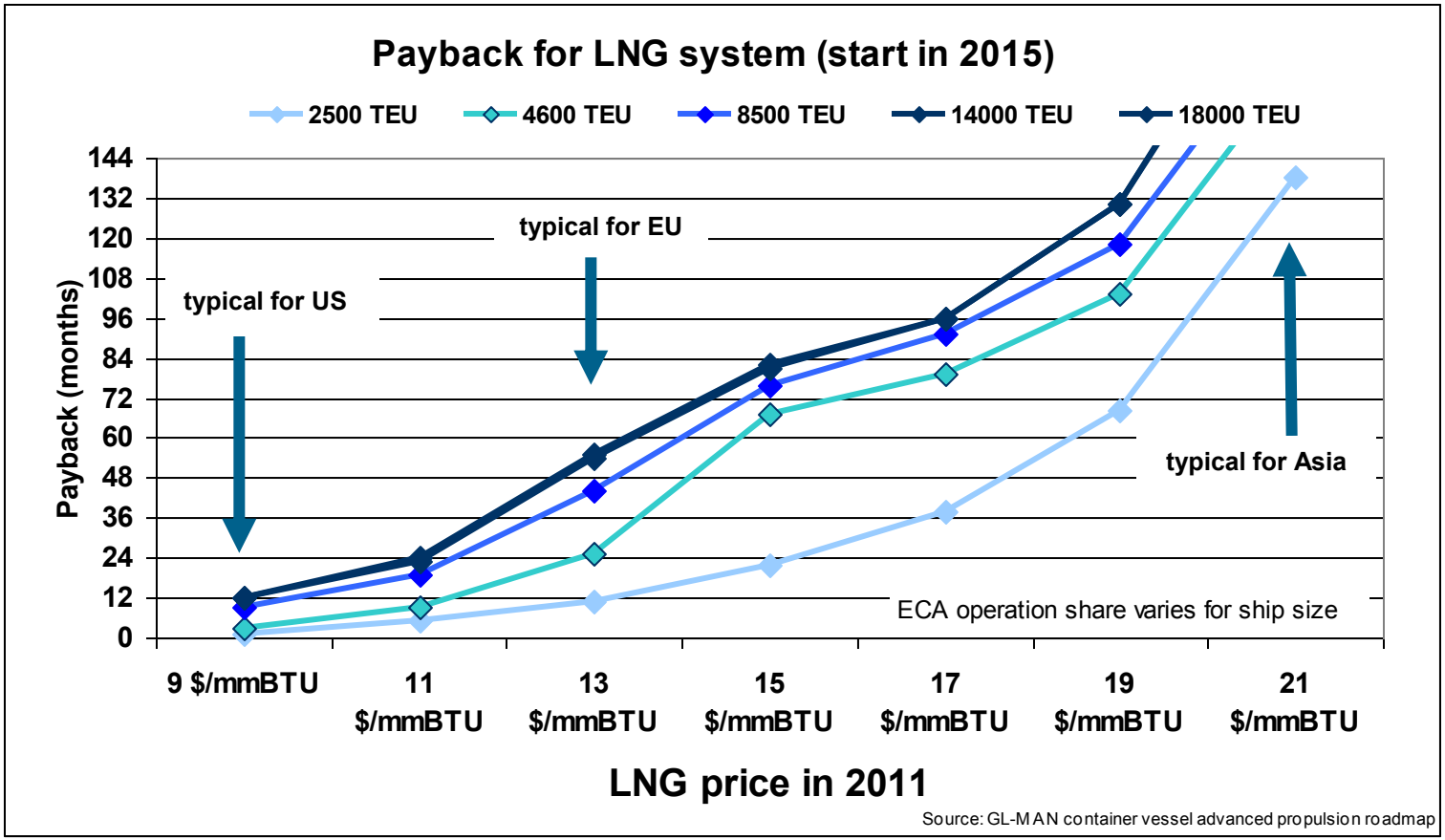
payback for smaller vessels is faster due to relatively smaller additional invest

Payback for LNG technology



LNG tank prices affect payback time.
Higher specific LNG tank price values are assumed for smaller tanks.

Payback for LNG technology



LNG prices strongly affect payback time

Payback (months) for a 2500 TEU vessel

LNG price LNG spec. tank price	13 $/mmBTU	15 $/mmBTU	17 $/mmBTU
2000 $/m3	8	18	33
3000 $/m3	11	22	38
4000 $/m3	13	26	43

LNG specific tank price has a lower effect on payback than the price of LNG.
Doubling LNG spec. tank price increases payback by 30 to 60%.
Increasing LNG price (from 13 to 17 $/mmBTU) increases payback by a factor of 3 to 4.

Conclusions

Using LNG as ship fuel is attractive due to lower air emissions than for standard fuels.

A joint GL-MAN study looked into LNG and scrubber solutions for several container vessel sizes operating partly inside ECAs.

The study shows that operating share inside ECA, LNG-HFO price difference and LNG tank costs are the dominant parameters to be considered for future LNG-fuelled propulsion solutions.

Similar conclusions are valid for for other ship types, eg, tanker.

Editors:

- Dr. Pierre C. Sames, Senior Vice President, Research and Rule Development GL SE
- Niels B. Clausen, Senior Manager Low Speed, Engine and System Application, MAN Diesel & Turbo

The first LNG-fuelled vessel with class GL

Thank you for your kind attention.

Pierre.Sames@GL-Group.com
Christian.von-Oldershausen@GL-Group.com