

LNG AS A MARINE FUEL: THE RETROFIT INVESTMENT OPPORTUNITY



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SEA/LNG STUDY: RETROFIT 300K DWT VERY LARGE CRUDE CARRIER (VLCC) SAILING FROM THE ARABIAN GULF TO CHINA

KEY FINDINGS

The threat of stranded assets for the maritime fleet has become a reality under the pressure of increasingly stringent environmental regulations. The long lifespan of VLCC vessels, representing significant investments and high operating costs, requires their owners to constantly seek innovation to improve existing ships so they can operate at optimal energy efficiency and with reduced emissions. Hence, it is critical to evaluate LNG (Liquefied Natural Gas) retrofit options that not only contribute to significant energy savings but offer cleaner fuel-burning technology to comply with EEXI (Energy Efficiency Existing Ship Index) and CII (Carbon Intensity Indicator) regulations while protecting commerciality during the remaining asset life.

LNG is a safe, mature, commercially viable marine fuel offering superior local emissions performance, significant Greenhouse Gas (GHG) reduction benefits and a pragmatic pathway to a zero-emissions shipping industry. With drop-in bioLNG or synthetic LNG (e-LNG), the LNG-fuelled vessels are future-proofed, enabling compliance with GHG reduction targets as the shipping industry moves toward a zero emissions goal by mid-century. Hence, LNG retrofit offers the potential to extend a vessel's environmental compliance (CII runway) by several years while restoring financial viability.

Business Case

The business case compares a 300K DWT VLCC trading from the Arabian Gulf to China. The 11,700 nautical mile round trip from Ras Tanura to Ningbo was chosen to represent the major energy trade corridor from the Middle East to China.

The relative investment performances of three 2-stroke environmentally compliant propulsion alternatives are evaluated to compare the most cost-effective options available to the ship owners:

- a conventional VLCC currently sailing on Very Low Sulphur Fuel Oil (VLSFO),
- a retrofit VLCC equipped with scrubbers sailing on Heavy Fuel Oil (HFO), and
- a retrofitted LNG-powered VLCC

This analysis concludes that retrofitting LNG as a marine fuel potentially delivers strong investment returns over the remaining 10-year trading life of the VLCC, with returns dependent upon the relative fuel prices of LNG, HFO, and VLSFO. With the recent extreme volatility in energy prices, SEA-LNG has introduced a "Readers' Choice" plot, allowing the reader freedom to select their own preferred future fuel price forecasts. Simply use the "Readers' Choice" chart, selecting a preferred fuel price and the chart displays the equivalent prices for the other fuels to generate the same investment outcome on a Net Present Value basis over a 10-year period. The plot assumes a time value of money discount for the Weighted Average Cost of Capital "WACC" of 9.2%¹ where inflation² adjustments retain nominal values and a conservative zero terminal value.

CAPEX Values

Items	Units	2-stroke LNG Retrofit	2-stroke HFO & Open Loop Scrubber	2-stroke VLSFO Conventional
Retrofit CAPEX	Million \$US	\$27.2	\$4.0	\$0.0
Opportunity Cost	Million \$US	\$3.1	\$0.7	\$0.0
CAPEX	Million \$US	\$30.3	\$4.7	\$0.0

Table 1: Three competing CAPEX alternatives; retrofit LNG, retrofit open loop scrubber, and reference VLSFO plus recognition for opportunity costs i.e. lost charter revenue for out of service project days.

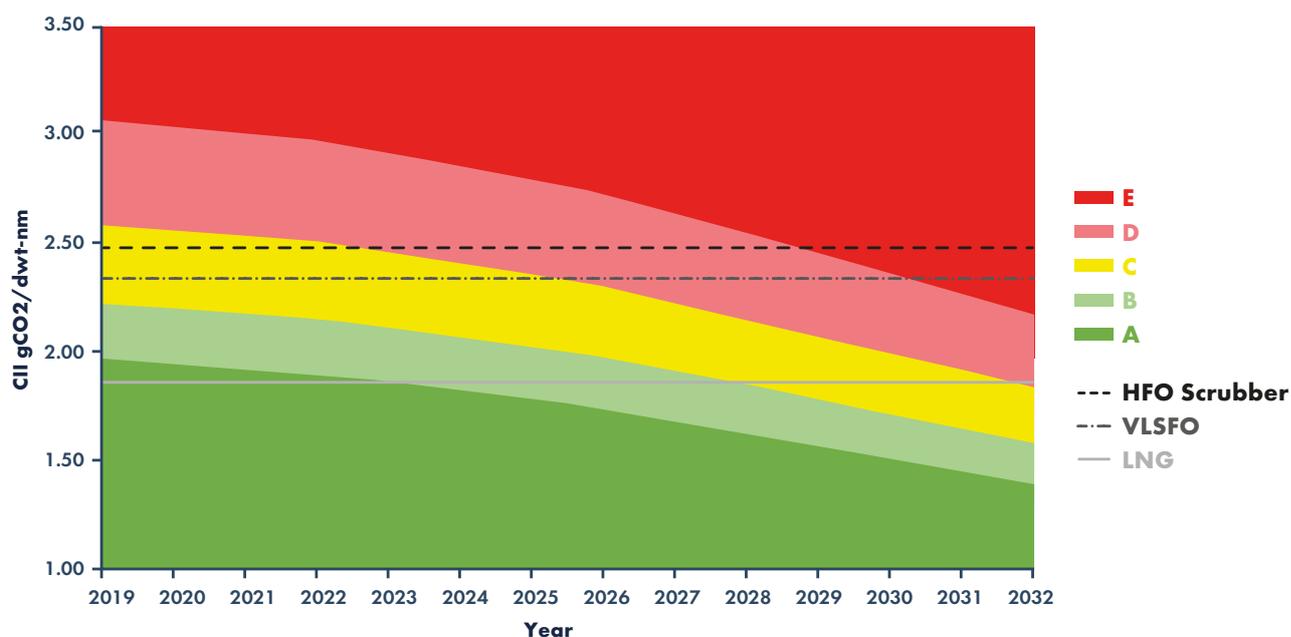
CAPEX for a turnkey project to retrofit a 2-stroke LNG engine totals US\$30.3 Million, a significant premium above the reference 2-stroke VLSFO Conventional ship and assumes delivery one year after contract signing. The scope of work includes modifications to the 2-stroke engine for LNG fuel, necessary LNG delivery systems, and incorporates a 4,600m³ LNG tank to provide 14,000 nm range at 15% sea margin for market ballast/laden speeds.

The LNG retrofit CAPEX value in Table 1 provides a conservative investment approach for the business case. Project optimisation and market conditions are expected to significantly reduce the LNG retrofit CAPEX.

The opportunity cost for the retrofit LNG project estimate includes a conservative \$3.1 million charge reflecting lost charter hire during the 91-day conversion. Total CAPEX for the Open Loop Scrubber retrofit for the 2-stroke HFO engine is \$4.7 million, comprising a \$4.0 million project cost³, plus a charter hire opportunity cost of 30 working days. These out-of-service lost revenue charges are reduced if the retrofit work is undertaken concurrently with a scheduled dry-docking.

Compliance: Carbon Intensity Index

The IMO "CII" and rating scores pose a threat to many VLCC ships of becoming a stranded asset. Retrofitting to LNG fuel provides an opportunity to future-proof the vessel. The LNG fuel VLCC CII ratings improve substantially, beginning and maintaining a range of 1 - 2 full grade improvements over the alternatives throughout the remaining lifetime of the vessel.



The chart displays the IMO CII grade ratings for VLCC retrofit alternatives: HFO scrubber, VLSFO and LNG fuel. HFO Scrubber falls from C to D year 2023 and into E mid-year 2028. Compliant VLSFO falls from C to D year 2025 and into E in the year 2030. LNG maintains superior rating B until it slides into C mid-2027 before finally slipping to D in 2032.

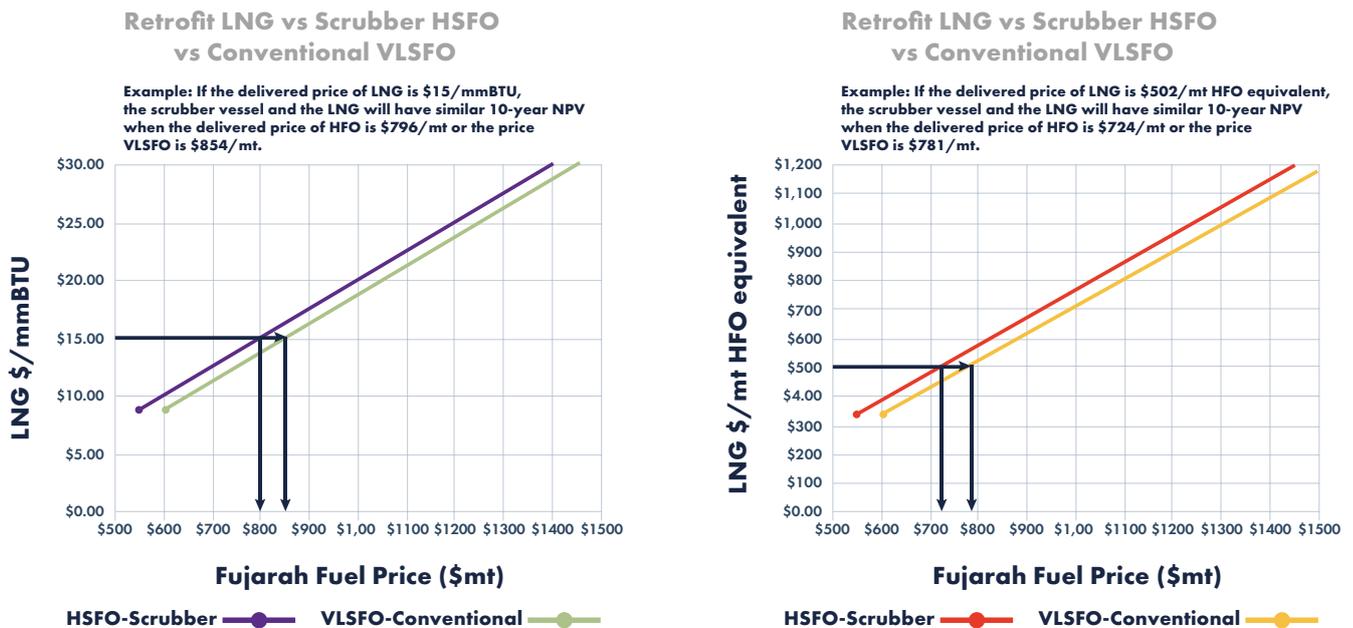
The HFO scrubber faces imminent danger of becoming obsolete due to the environmental regulations with an existing CII grade of C sliding into D in 2023. Stranding for the VLSFO compliant vessel is delayed by two years with a drop from C to D grade in 2025.

The LNG retrofit VLCC is future-proofed as the CII scoring fares much better than other alternatives considered in the study. The LNG retrofit enjoys the commercial chartering financial advantages of one or more grade ratings above HFO scrubber or compliant VLSFO options. The LNG vessel retains a superior B grade until mid-2027, then a passing C grade until year 2032 until it slips into D matching the tanker historical retirement age of 20 years. The potential use of bioLNG as a drop-in blend could increase compliance further.

Slow steaming strategy for addressing CII targets will be discussed in a separate publication.

Fuel prices: Readers' Choice

The recent extreme volatility in fuel prices results from multiple market forces including COVID-19 disruptions, conflict in Europe, and other macro business factors. To avoid choosing fuel prices, SEA-LNG offers the readers of this report a choice, allowing readers to select fuel prices aligned with their estimates of fuel pricing across the 10-year investment horizon.



The charts above enable users to understand the relative fuel prices that will provide the same returns for different investment choices in the absence of a carbon levy. The left-hand chart shows LNG priced in energy units \$/mmBTU, and the right-hand chart provides LNG in \$/mt HFO equivalent based on lower heating value (LHV).⁴

Fuel is traditionally purchased on a dollar per ton basis and the transaction focuses on buying energy. LNG offers a lower energy cost per ton. When priced against HFO, the differential is nearly 22% because LNG contains more energy for a given mass. LNG as a marine fuel provides 49.32GJ of energy per ton, whereas HFO only provides 40.5GJ/ton on a Lower Heating Value (LHV) basis.

For a given vessel on a trade route and using their chosen fuel forecast price, the user can get the answer to the question “if the price of one fuel type is X, at what price point for the other alternative fuels is the business case neutral on Net Present Value “NPV?”. The Readers’ Choice provides the user with valuable guidance, using their interpretation of future fuel prices to evaluate business return opportunities on a go /no go basis. The anticipation of future CO2 prices of \$100 per tonne, (near the level of prices in the EU ETS in July 2022) enhances the LNG business case as the HFO and VLSFO price points tighten downward about \$70 /tonne of fuel further weakening the economics for these alternatives.

To summarise, the Readers’ Choice provides business case comparisons of LNG fuelled vessel with the HSFO scrubber and VLSFO compliant fuel alternatives over the remaining 10 year trading life of the vessel. The plot assumes an investment return on capital of 9.2% as demonstrated across a range of readers’ expectations on fuel prices.

CONCLUSION

LNG retrofits future-proof assets against both planned environmental regulations and new climate-related measures, such as carbon pricing for shipping, that may be introduced in the coming years. The implementation of CII means that existing vessels in the VLCC fleet face imminent danger of becoming stranded assets with millions of dollars of value lost for the owners as lowering of CII grades will erode charterers' preferences and reduce the Time Charter Equivalent (TCE) for VLCCs.

Additionally, depending on the fuel prices in the future, retrofitting may also offer financial incentives to ship owners. SEA-LNG has provided the Readers' Choice as an aid to allow readers to use their own future fuel price forecast for the business case.

Hence, retrofitting the existing VLCC fleet could be a win-win for the environment and the shipping industry.

Other considerations for the retrofit project.

- Retrofitting costs for an existing trading vessel for LNG fuel will continue to improve and the relatively quick re-entry of the vessel into service, will save about 2 years as compared to newbuilds in today's strong shipbuilding market.
- Newbuilding projects are restricted by limited yard capacity and long lead schedule availability. These are not as critical for retrofit facilities.
- Owners should consider withdrawing vessels for conversion outside of scheduled dry-docking to minimise lost charter opportunity costs in a weak charter market. A secondary, and unintended, benefit of tonnage withdrawal is the reduction in supply that may provide a floor for stabilising low charter rates.
- "LNG Ready" ships should be obvious candidates for retrofits. These ships have addressed critical design issues during the new construction phase allowing for smoother retrofit/upgrade campaign.

For more material, including in-depth newbuilding business cases and further information on LNG as an alternative fuel, visit the SEA-LNG website www.sea-lng.org. The report "LNG As a Marine Fuel – the Investment Opportunity, Newbuild 300K DWT Very Large Crude Carrier (VLCC) Sailing From the Arabian Gulf to China" is available **here**

APPENDIX

User Guide for Readers' Choice Plot: Trifecta Equivalence on Fuel Prices

Option 1: SELECT LNG Fuel Price

Reader seeks the HFO and VLSFO reference prices for the same business case (with 9.2% return on Capital). Steps if the Reader is investigating LNG @ 1,000 \$/mt HFO Equivalent:

1. Enter LNG price @ 1,000 \$/mt HFO Equivalent

run horizontally to right

2. At red line run down and determine HSFO price with scrubber

Same business case outcome for HSFO + scrubber @ 1,244 \$/mt

ANSWER:

IF HSFO > \$1,244 then LNG is superior choice to HSFO + Scrubber option

IF HSFO < \$1,244 then HSFO + Scrubber option is superior choice over LNG

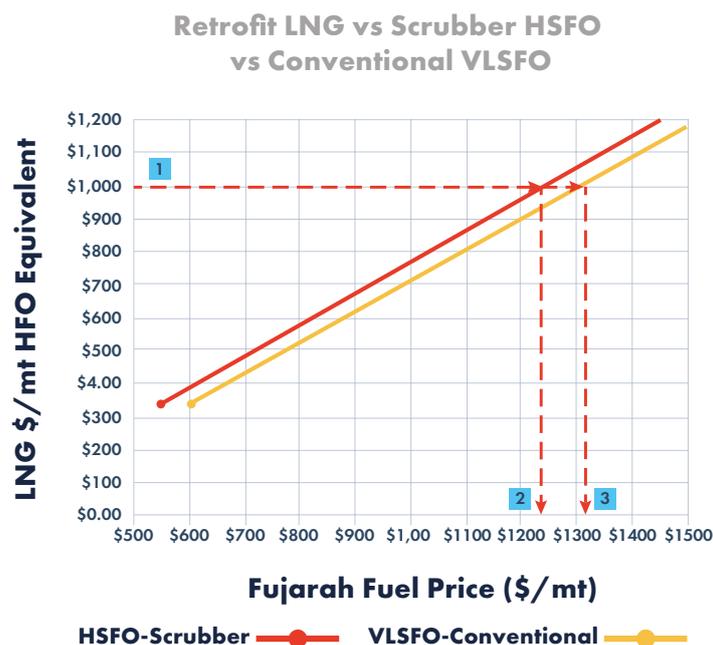
3. At yellow line run down and determine VLSFO conventional rice

Same business case outcome for VLSFO conventional @ 1,312 \$/mt

ANSWER:

IF VLSFO > \$1,312 then LNG is superior choice to VLSFO

IF VLSFO < \$1,312 then VLSFO is superior choice over LNG



APPENDIX

User Guide for Readers' Choice Plot: Trifecta Equivalence on Fuel Prices

Option 2: SELECT HSFO Fuel Price

Reader seeks the LNG and VLSFO reference prices for the same business case (with 9.2% return on Capital). Steps if the Reader is investigating HSFO @ 1,244 \$/mt:

1. Enter HFO price @ 1,244 \$/mt with Scrubber
run vertically up

2. At red line run left towards Y axis and determine LNG price
Same business case outcome for LNG @ 1,000 \$/mt HSFO Equivalent
ANSWER:

IF LNG < \$1,000 \$/mt HFO Equivalent then LNG is superior choice to HSFO + Scrubber option

IF LNG > \$1,000 \$/mt HFO Equivalent then HSFO + Scrubber option is superior choice over LNG

3. Run right to yellow line, run down and determine VLSFO conventional price
Same business case outcome for VLSFO conventional @ 1,312 \$/mt
ANSWER:

IF VLSFO > \$1,312 then HSFO + Scrubber option is superior choice to VLSFO

IF VLSFO < \$1,312 then VLSFO is superior choice over HSFO + Scrubber



APPENDIX

User Guide for Readers' Choice Plot: Trifecta Equivalence on Fuel Prices

Option 3: SELECT VLSFO Fuel Price

Reader seeks the HSFO and LNG reference prices for the same business case (with 9.2% return on Capital).
Steps if the Reader is investigating VLSFO @ 1,312 \$/mt:

1. Enter VLSFO price @ 1,312 \$/mt
run vertically up

2. At yellow line, run left, at red line run down and determine HSFO price
Same business case outcome for HSFO @ 1,244 \$/mt

ANSWER:

IF HSFO < \$1,244 \$/mt then HSFO + Scrubber option is superior choice to VLSFO Conventional

IF HSFO > \$1,244 \$/mt then VLSFO Conventional is superior choice over HSFO + Scrubber option

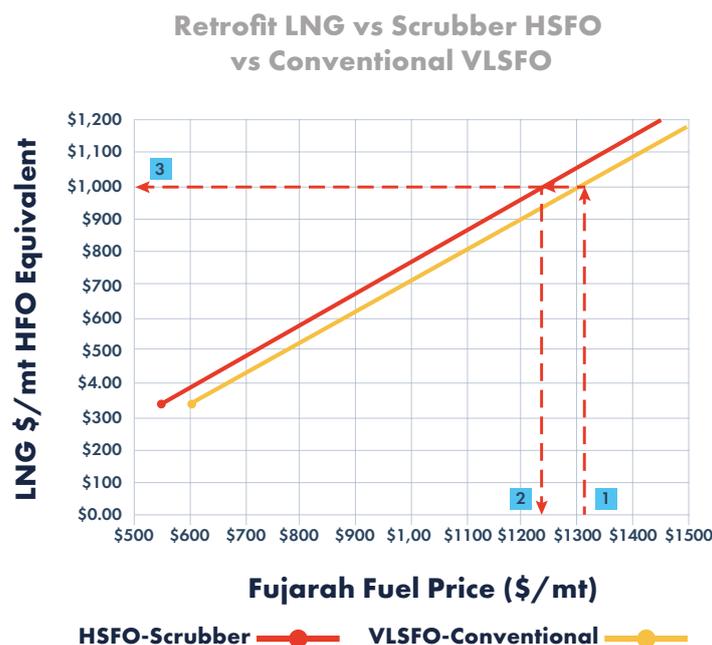
3. Run left to Y Axis and determine LNG price

Same business case outcome for LNG @ 1,000 \$/mt HSFO Equivalent

ANSWER:

IF LNG > \$1,000 then VLSFO Conventional is superior choice to LNG

IF LNG < \$1,000 then LNG is superior choice over VLSFO Conventional



REFERENCES

¹ WACC 9.2% assumes; 6% bank loan on 60% position, 14% equity return on 40%, no tax.

² Inflation assumed 4.5% over the next 10 years to reflect recent upward price pressures.

³ Drewry VLCC Scrubber Cost Insights, MFAME September 24, 2019.

⁴ IMO MEPC 1./Circ 866 30 January 2017 Annex page 3; LHV: LNG 48.0 GJ/mt, HFO 40.2 GJ/mt, VLSFO 41.2 GJ/mt.

About SEA-LNG

SEA-LNG is a UK-registered not-for-profit collaborative industry foundation serving the needs of its member organisations committed to furthering the use of LNG as an important, environmentally superior maritime fuel. SEA-LNG has members across the entire LNG value chain including providers of the product, users, engine and asset suppliers, and class societies. SEA-LNG is already recognised as an international leader in LNG matters. Each member organisation commits mutually agreed human resources, data analysis and knowledge sharing in support of SEA-LNG initiatives and activities and financially contributes via a membership fee. To learn more about the benefits of membership, visit www.SEA-LNG.org.

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