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LNG FREIGHT RATE ESTIMATES – Methodology

A study commissioned by ACCC

EXPERTS WITH IMPACT™

FTI CONSULTING

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1. Introduction and executive summary

1.1. Context and purpose of this report

1. The Australian Competition and Consumer Commission (ACCC) publishes LNG netback prices to help Australian market players assess the indifference price of gas for consumption in the East Coast Gas Market in comparison to the price that producers would get if they exported this gas to Asia, which is the main export market for Australian LNG.[1]

2. In 2021, the ACCC reviewed the LNG netback price series, partly in response to recent developments in LNG export markets, including an increase in export capacity from US LNG exporters and the forthcoming expansion of LNG liquefaction capacity in Qatar. The ACCC decided to continue the release of forward LNG netback prices with an extended period of up to 5 years. As such, the ACCC requires estimates of LNG freight rates up to 5 years to calculate these longer-term forward LNG netback prices.

3. Economic consultancy FTI Consulting (FTI) was selected by ACCC to provide LNG freight rates estimates based on a modelling of the LNG shipping market.

4. This report to the ACCC, describes FTI's detailed methodology for estimating LNG freight rates and to calculate the cost of a shipment from Gladstone, Australia to Tokyo, Japan.

5. Instead of adopting an approach assuming that prices will converge to the Long-Run Marginal Cost (LRMC) of new ships, FTI has chosen to use a fundamental market model to forecast LNG freight rates. Looking at past charter rates, there is no clear convergence between charter rates and the LRMC of vessels. This discrepancy can be explained by dynamic factors including the evolution of demand, which due to investment lead-time does not always match the supply of ships, as well as strict contractual commitments, speculative orders, and other similar factors. While in a static world we would expect prices to converge with LRMC, FTI considers that these various dynamic elements can best be integrated using the fundamental supply and demand model.

1.2. Methodology

6. Our central approach to estimate LNG freight rates consists in the use of a fundamental LNG shipping market model to simulate future LNG shipping supply and demand and hence future freight rates. Through this modelling we provide an estimate of the opportunity cost of LNG freight.

7. Our fundamental model relies on the equilibrium of shipping supply and demand for LNG transport. We separately model (i) the LNG shipping demand based on origins, destinations,

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[1] Source: ACCC, Gas inquiry 2017-2025, https://www.accc.gov.au/regulated-infrastructure/energy/gas-inquiry-2017-2025/lng-netback-price-series

and volumes of LNG to be transported, and (ii) the LNG shipping supply through a simulation of investment in new vessel builds and exit of older vessels.

8. In a secondary approach, we also provide freight rates based on direct, but less comprehensive, opportunity cost estimates. Namely, we provide estimates based on:

    i. the latest medium-term transactions for LNG carrier charters, for a duration of 3 to 5 years

    ii. charter rate forward analysis by ICIS, a Price Reporting agency

    iii. the estimated revenues that would allow a reasonable payback period for new builds based on their cost of acquisition.

    This aims at providing transparent partial references to cross check the results from the fundamental model.

1.3. Required data

9. FTI gathers data from publicly available sources on LNG shipping, including LNG trade reports, LNG trades forecasts and LNG shipping reports, to support its modelling and estimates of LNG shipping freight rates. In addition, we have partnered with shipbroker Howe Robinson Partners (HRP) to provide comprehensive, up-to-date information on the global LNG shipping industry. HRP offers a full range of shipbroking services including newbuilding contracts, sale and purchase, demolition, and chartering, as well as market research and valuations. HRP data will be sent every six months to FTI Consulting to keep the model up to date with the latest developments in the LNG shipping market.

10. By convention, all model outputs will be expressed in real terms in the year in which we provide the results.

1.4. Structure of the report

11. This report is structured as follows:

    Section 0 presents the functioning of the LNG shipping market with a focus on the freight rates market;

    Section 3 presents our approach for a fundamental LNG shipping model to determine freight rates forecasts;

    Section 4 presents the demand side of the LNG shipping model, i.e., the approach selected for the forecasting of LNG to be transported;

    Section 5 presents the supply side of the LNG shipping model, i.e., the approach selected for the forecasting of the LNG carriers' transport capacity offered;

Section 6 presents the model optimization to determine the LNG shipping supply/demand equilibrium; and finally

Section 7 presents the direct partial references, that will be presented as cross-checks on the model outputs.

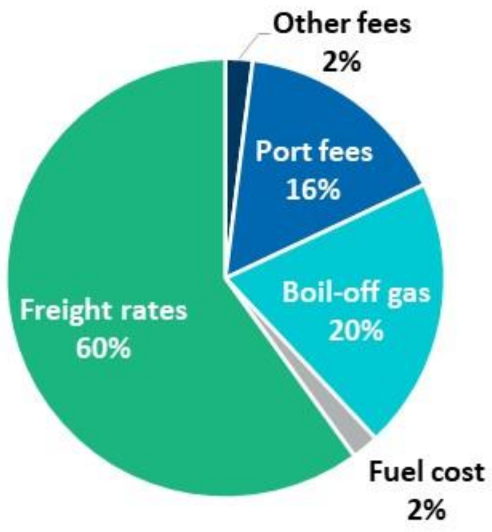
2. The LNG shipping market and cost structure

12. The total cost of shipping LNG from an origin to a destination in an LNG carrier vessel includes the following elements:

- **Freight rates:** This corresponds to the price to charter a vessel. It is also known as charter rate. It covers the shipowner's costs which are made of the operations and maintenance costs, and the recovery of the sunk costs and of the purchase costs of the vessel, plus a profit margin.
- **Fuel cost:** The fuel cost corresponds to the fuel consumption multiplied by the cost of fuel. After freight rates, it is usually the second largest cost element. The fuel cost differs according to the propulsion technology. Most LNG ships can burn fuel oil, boil-off gas, or a combination of both in their boilers. As a result, the cost of fuel usually encompasses the cost of the boil-off gas and is therefore linked to the opportunity cost of gas.
- **Boil-off gas:** The boil-off gas is the evaporated or boiled gas formed due to the heat entering the cryogenic tank during storage and transportation, regardless of whether it is used as a fuel.
- **Port fees:** At loading and unloading ports, fees must be paid to port authorities and service providers**.** Depending on the port location, the components and level of expense associated with loading and unloading can vary.
- **Other fees:** Other expenditures include a variety of fees based on the cargo route as well as internal shipping costs. For example, canal fees, must be paid to use the transcontinental Suez and Panama canals, as well as ship and cargo insurance must generally be paid to be able to operate the LNG vessel.

13. Most of the above-mentioned charges depend on the type of the ship, the propulsion technology, and the LNG cargo capacity. Below, is an illustration of the typical breakdown of charges.

Figure 1: Illustrative – Typical breakdown of costs of a shipping voyage for an XDF vessel, in %



14. All the above-mentioned charges must be borne ultimately by the charterer of the vessel, who is transporting LNG from an origin to a destination. The propulsion type and size of the LNG vessel is an essential determinant of these costs, impacting the fuel costs, boil-off gas costs, and other fees by unit of LNG transported.

15. To compute the values for each one of these cost elements, FTI Consulting relies on the data provide by HRP for the percentage of boil-off gas by technology, the average port fees and other fees. The fuel cost is determined based on natural gas, MDO (Marine Diesel Oil) and HFO (Heavy Fuel Oil) quotations from industry publications.[2] The freight rates are determined using FTI's LNG shipping market model.

3. Approach to LNG shipping fundamental modelling

3.1. Overview of supply and demand model

16. FTI Consulting's fundamental LNG shipping model is based on the simulation of the equilibrium between supply and demand of LNG transport. It estimates:

   i. the demand for LNG transport, that is the quantity of LNG transported by unit of distance

   ii. (ii) the supply of LNG transport, that is the capacity of LNG carrier vessels to transport LNG quantities over the water.

[2] Natural gas prices are taken from ICIS, MDO prices come from Energy Market Price and HFO prices come from the European Commission. For the forecasts, we use the World Energy Outlook of the IEA

17. Both demand and supply are estimated over a period of one year, using a measurement of the volume of LNG being carried (ton), and the distance sailed (nautical mile) for the shipment. The product of these dimensions (ton.mile) is the scale of shipping services effectively provided.

3.2. LNG shipping demand

18. In order to estimate the LNG shipping demand, we establish the LNG transport origins and destinations.

19. To geographically distribute LNG molecule supply and demand, we rely on planned liquefaction and regasification capacities and historical patterns of utilisation. Once LNG molecule origins and destinations have been defined, we run a dispatch optimization model to determine the flows of LNG from origins to destinations minimizing the total cost to transport LNG. This determines the total annual LNG shipping demand, in ton.mile.

20. This provides us with an LNG shipping demand curve that we can match to an LNG shipping supply curve.

3.3. LNG shipping supply

21. Based on the existing fleet of LNG vessel carriers, and the confirmed order book of future LNG vessels, we determine for each vessel the capacity (ton.mile) to transport LNG and the associated variable costs to provide such services. The variable costs of service for every LNG carrier vessel is the sum of the fuel costs, port fees, boil-off gas costs, other costs, and the part of the freight rate that is not sunk, i.e. the operations and maintenance costs.

22. The technical characteristics of every vessel (speed, OPEX, fuel consumption, size etc.) are considered to establish each vessel's capacity and associated variable cost to operate, and from that, determine a merit order of LNG carriers' vessels that form our LNG shipping supply curve.

3.4. Equilibrium between supply and demand determining freight rates

23. FTI Consulting's model quantifies the annual equilibrium price, in US$/ton.mile, that results from the intersection of the LNG shipping demand and supply curves, as determined above. From this price of LNG transport in US$/ton.mile, we determine for different type of LNG vessels the residual LNG freight rate, as the difference between the equilibrium LNG transport price and the other variable charges of the LNG transport price (fuel costs, boil-off costs, port fees, other costs…).

24. We hereafter further detail the quantification of our demand and supply curves that underpins the estimate of the LNG transport price and resulting freight rates.

4. Model methodology - Demand side

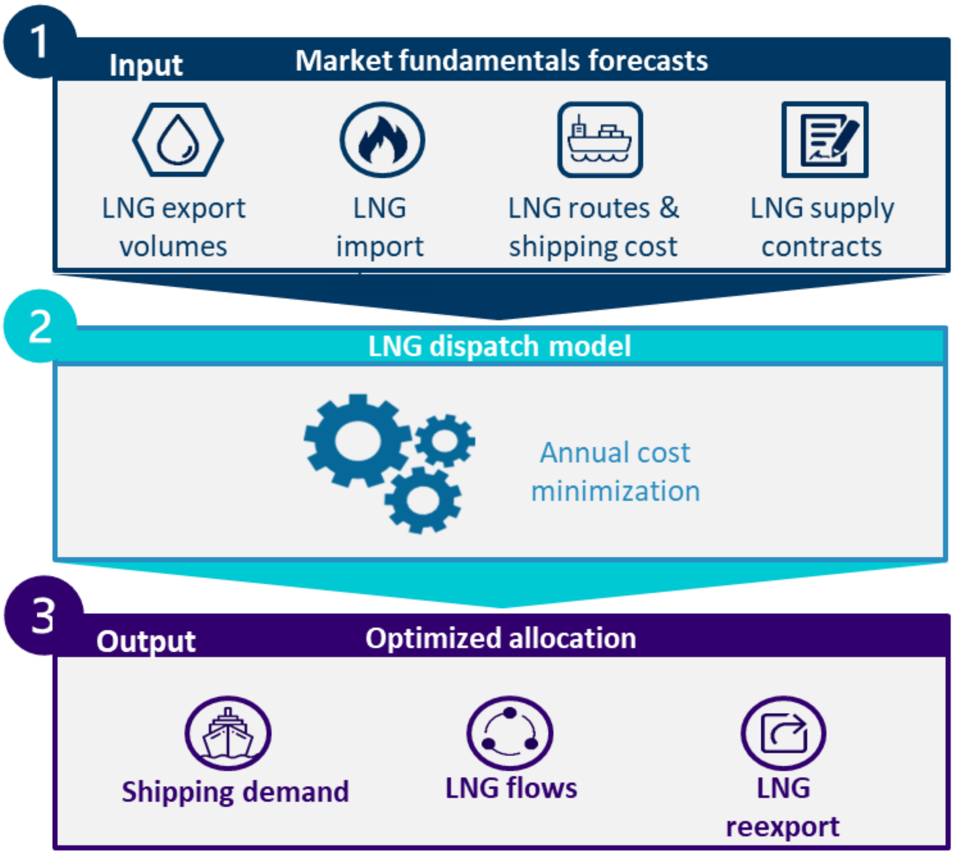
25. As summarized below, to quantify the LNG shipping demand, we

    i. select a forecast of the global LNG molecule demand, and from that

    ii. determine the volume of imports and exports per region.

Then, using a dispatch optimisation model, we compute the LNG shipping demand, in ton.mile, by minimising the global LNG shipping distances sailed the import and export zones.

Figure 2: Schematic explanation of the LNG shipping demand model

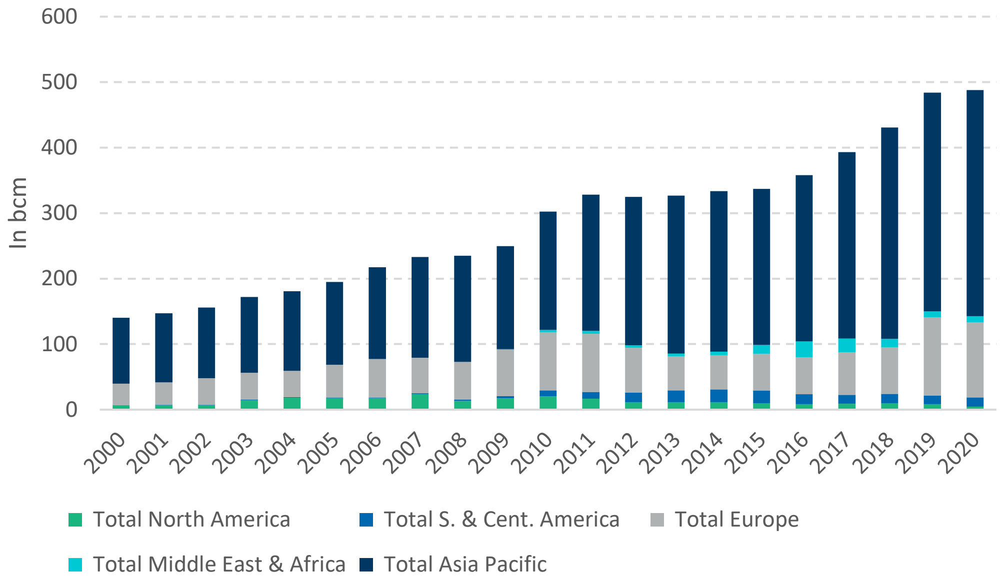


4.1. Forecast of the LNG trade

Historical trade volumes

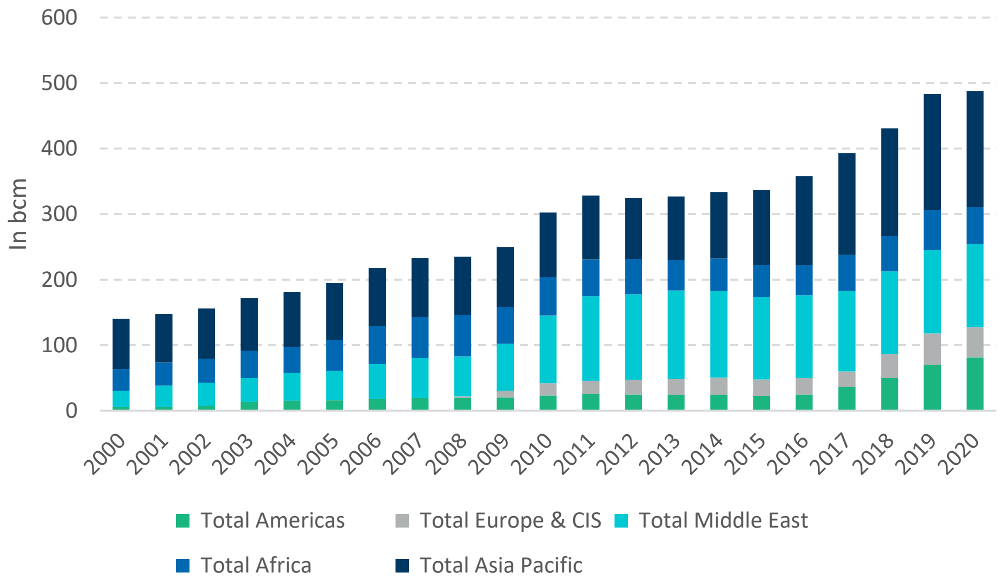
26. Over the past two decades, the global LNG trade has evolved with significant growth and diversification of importing and exporting countries. New gas discoveries and the construction of new infrastructures have had an important impact in the volume and the distribution of trade between countries, as shown in the Figure 3**Error! Reference source not found.** and Figure 4 below.

Figure 3: Evolution of LNG imports by regions 2000-2020, in bcm



Sources: bp "Statistical review of World Energy 2021"

Figure 4: Evolution of LNG exports by regions 2000-2020, in bcm



Sources: bp "Statistical review of World Energy 2021"

Forecast trade volumes

27. To forecast future supply and demand for each country, we first assess the historical trade data, i.e. LNG import and export volumes data per country, as made available by ICIS and use

the ratio between countries to breakdown regional historical data of LNG demand and supply.[3]

28. To forecast, we then rely on an analysis of planned new liquefaction infrastructure, increasing export historical volumes as a proportion of the new capacity to be commissioned. Having set a total forecasted LNG supply based on liquefaction capacity evolution, we distribute this supply to demand countries based on expected new regasification capacity and historical regasification utilisation per country. For new LNG countries, we rely on available relevant neighbouring country reference. We thus obtain annual forecasts of LNG production and consumption for every country for every forecasted year.

29. Through this approach, we assume that LNG infrastructure is representative of medium-term future flows of LNG trade, and that country-specific utilisation rates remain stable in the future.

Supply and demand zones

30. To support faster dispatch optimization, we group the country production and consumption into 20 geographical zones, which have been determined using historical data on imports and exports per country and region to identify the most important zones of production and consumption of LNG.

31. In the model, for the 20 geographical areas shown in Figure 5 we allocate an import and / or export volume. For countries that appear in more than one zone (e.g. Mexico which is part of North America Pacific and North America Atlantic), the breakdown is made using the annual country's operating liquefaction capacity for exports and the annual country's operating regasification capacity for imports from ICIS.

[3] We rely on the total import and export values as published by bp and then we distribute this total by country using the import and export data per country from ICIS. We use the total data from bp and the distribution from ICIS because it allows us to better reproduce the LNG historical demand.

Figure 5: Geographic zones considered in the LNG shipping model

Sources: FTI Consulting

32. We therefore obtained a production and consumption on a global level broken down in 20 zones, whose connections can be optimised.

4.2. Calculation of the LNG Shipping Demand

33. The LNG shipping demand is assessed by minimizing the total global LNG shipping costs to transport LNG from production areas to consumption areas, relying on an estimate of the cost of each LNG route, while also taking into account of forced routes stemming from long-term fixed-destination LNG trade contracts.

34. The 20 zones defined above are mapped in our model to create routes from a departure zone to an arrival zone. The mapping results in 400 different routes for which the costs of shipping are estimated for each year of the simulation.

35. To calculate the cost of each route, we compute the total cost of the voyage for the average LNG carrier vessel of the fleet on the relevant year. We estimate:

    i. the number of voyage days for each route

    ii. the total shipping costs of the route in US$/MMBtu.

36. For each route, we calculate the duration of shipping in number of days, as the sum of:

- **The number of days in transit**: the division of the length of the route from the departure zone to the arrival zone (nautical miles) to the speed of the vessel (knots); and

- **The number of days resting in a port**: the number of days during the voyage spent in a port (in days).

37. For each route, we then compute the five different elements of costs of a shipping voyage[4]:

- **Freight rates:** Freight costs (US$) represent the daily charter rates (US$/day) multiplied by the number of days of the voyage (day);
- **Fuel costs:** Fuel costs (US$) are the product of fuel consumption (ton/day) and the price of fuel (US$/ton), multiplied by the number of days of the route (days);[5]
- **Boil-off costs:** Boil-off costs (US$) are calculated as the difference between the volume of LNG at the origin port and the volume of LNG at the destination port (m^3 LNG) considering boil-off rates, multiplied by a reference price of natural gas (US$/$m^3$ LNG);
- **Port fees:** Fees of loading and discharging LNG (US$), respectively in the port of departure and arrival, calculated as the average global port fees of 2021 received by HRP; and
- **Other fees**: Cost of the Panama or Suez Canal crossing (US$), if it is part of the itinerary, and inspection fees for loading and unloading (US$).[6]

38. The cost of each route thus determined is then apportioned to the standard capacity of the average LNG carrier vessel to obtain a cost in US$/MMBtu for each route.

39. After accounting of the fixed origins and destinations requested by some long-term contracts, the LNG shipping demand model optimises the residual LNG trade that is flexible through minimizing the global total cost of LNG routes that would move LNG from production zone to consumption zone, with the aim of obtaining the lowest overall cost. This defines the optimized origins and destinations of LNG trade, considering long-term contracts constraints.

40. This optimization model operates on an annual time step, with the output being the total annual shipping demand (ton.mile), corresponding to the sum of all the volumes shipped through a route (mtpa) multiplied by the length of the route (nautical mile).

5. Model methodology - Supply side

41. The supply modelling relies on the current shipping fleet and its estimated evolution based on:

    i. the exits of vessels, when they pass a certain age or when their competitiveness is too low

[4] Each one of these five elements will evolve in each update of the estimated freight rates, every six months.

[5] The fuel costs are based on published quotations of natural gas, MDO and HFO;

[6] Boil-off gas by technology, port fees and other fees are determined by HRP based on their own experience and on data collect by HRP.

ii. the additions of vessels, through different types of investments.

Different vessels' technologies as well as age are considered in the model to calculate the variable costs of operation that determine the supply curve merit order.

5.1. Structure of the vessels' fleet by propulsion technologies

42. To estimate the evolution of the LNG fleet, we need to consider vessel-specific factors that influence expenditures and thus the competitiveness of each vessel and of new builds. The performance of a vessel is primarily driven by its propulsion technology, with six distinct technologies present in the current active fleet of LNG carrier vessels, as described below in Figure 6.

Figure 6: Presentation of the propulsion technologies present in the LNG 2022 fleet

Propulsion technology	Period of commissioning	Fuel efficiency[7]
Steam (ST)	1970-2000	~30%
Duel-Fuel Diesel-Electric / Tri-Fuel Diesel-Electric (DFDE/TFDE)	2000-2020	~40%
Slow-Speed Diesel (SSD)	2005-2010	~40%
Steam Turbine and Gas Engines (STaGE)	2015+	N/A
Electronically Controlled Gas Injection (MEGI)	2017+	~50%
XDF	2017+	~50%

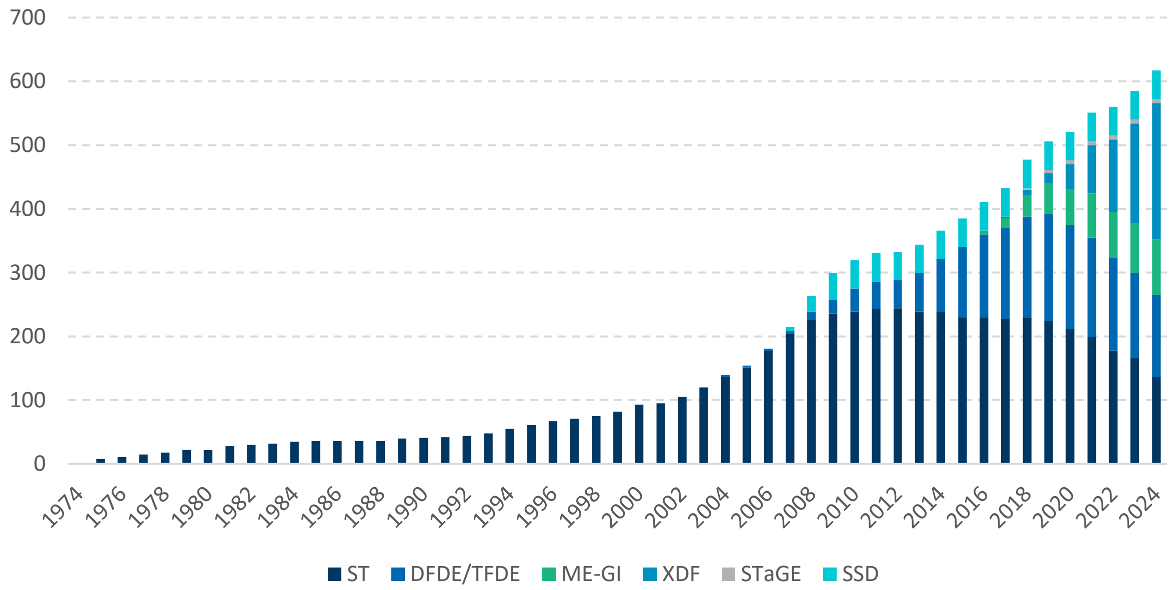
43. The market share of LNG propulsion types has changed, with the development of ME-GI and XDF technologies, while steam systems are gradually disappearing.[8] In 2021, the largest share of vessels is still based on steam propulsion, representing 36% of the total fleet, however, it is expected that by 2024[9], XDF technology will be the most prevalent in the charter fleet, with 35% XDF and only 22% of steam vessels.

[7] Source: Maran Gas Maritime Inc. An update on LNG propulsion and peripheral systems. 2016

[8] Source: ICIS

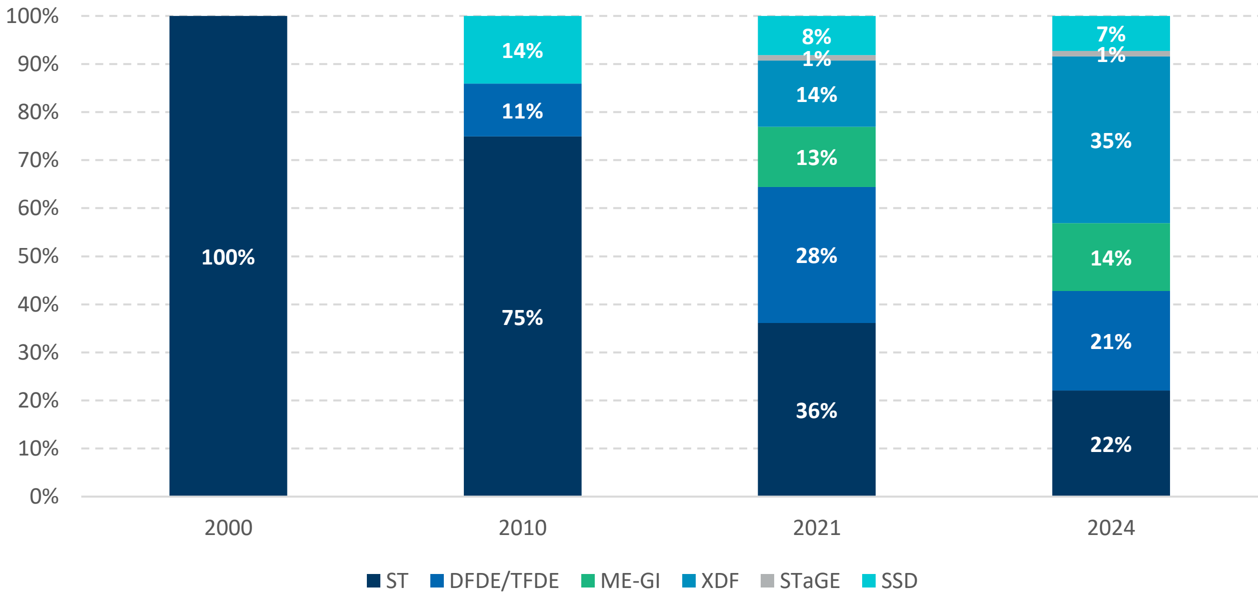
[9] Source: ICIS order book, 2022

Figure 7: Evolution of the number of charters in the charter fleet by propulsion technology, 1974-2024



Sources: ICIS, FTI analysis

Figure 8: Evolution of the breakdown of each propulsion technology, 2000-2024, in %



Sources: ICIS, FTI analysis
Forecasts for 2022-2024 based on ICIS order books

44. The different propulsion technologies determine different transport capacity and cost parameters that have been modelled for each LNG carrier.

45. Regarding transport capacity, while all technologies have been assumed to offer a similar maximum filling rate (98%) and required LNG heel (4%), each propulsion technology is given

a technology-specific transport average speed. Relying on ICIS historical data we obtained an average speed by technology by dividing the duration of each voyage by the distance travelled. The average speed for all technologies combined is 14.71 knots.

46. Regarding cost parameters, the boil-off rates, the fuel consumption, the CAPEX and the OPEX have been determined specifically for each propulsion technology. The source of these parameters is HRP[10] and they reflect the current operational costs LNG ship owners must bear. As an example of the value of one of these parameters, the average boil-off rate given by HRP is 0.080%.

5.2. Calculation of the annual vessels' fleet

47. On top of actual LNG vessels active in the market and LNG vessel orders registered by shipyards (known fleet), our model endogenously balances supply and demand for shipping by investing in new ships (modelled investment) and removing old and uncompetitive ships (modelled disinvestment).

Known fleet

48. The historical charter fleet data from 1974 and the current orderbook are taken from ICIS and GIIGNL data. The order book reported is adjusted using the actual global shipyard construction capacities for each year, to reflect the construction constraints.

49. The model only includes ships with a capacity of more than 65,000 m^3 of LNG.

Modelled investment

50. We model currently unannounced LNG vessel investment by shipowners in the future through an approximation of the decisions expected to be taken by shipowners in reaction to market conditions.

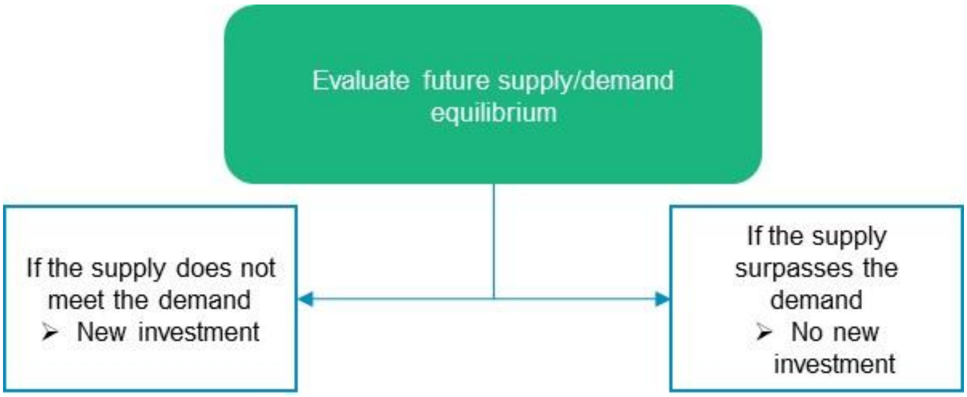
51. The investment algorithm is divided in the following two types of investment:

- **Adequacy investment:** Adequacy investments are based on the balancing of supply and demand ahead of time. The investment decision is made when there is not enough vessel capacity to meet the future shipping demand. As it takes an average of three years to build a ship, we compare:
    - i. the expected supply of year Y+4, made of the supply of year Y and the committed orderbook until Y+4
    - ii. the expected LNG shipping demand of year Y+4.

[10] We adjust the OPEX based on the publication of The Oxford Institute for Energy Studies published on March 2018 and named "The LNG Shipping Forecast: Costs rebounding, outlook uncertain" which states that operating costs can be estimated at around 5% of the CAPEX of an LNG vessel.

When the ratio of supply over demand (the reserve margin) is bellow a given value, determined by historical observation, the construction of vessels is unleashed to meet the reserve margin.

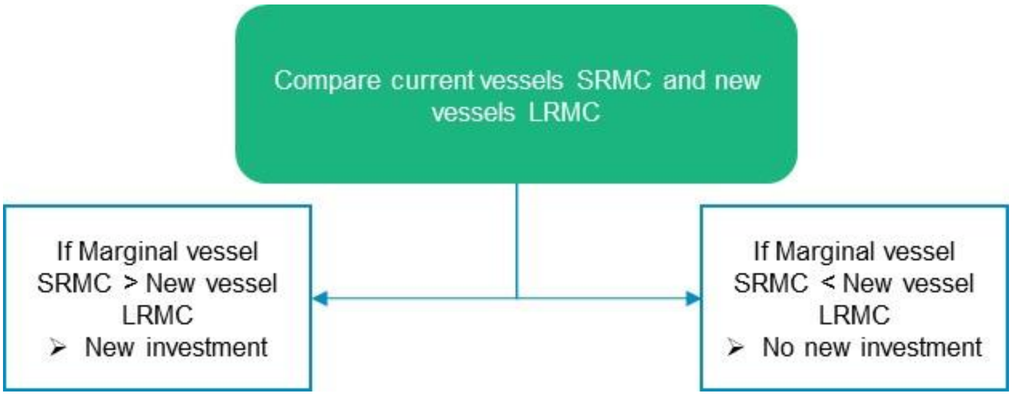
Figure 9: Functioning of the adequacy investments algorithm in the model



Sources: FTI analysis

- **Competition investment:** Competition investments are based on a current comparison between the Short Run Marginal Cost (SRMC) of the existing vessels with the Long Run Marginal Cost (LRMC) of the new vessels' investment. SRMC includes the sum of OPEX and fuel costs, while LRMC includes OPEX, fuel costs and CAPEX[11]. New investment happens whenever the SRMC of an existing ship required to meet current demand is higher than the LRMC of the new investment, indicating that the new investment is more competitive than the existing vessel. Investments are triggered at the beginning of each year Y, considering the use of the fleet in the year Y-1.

Figure 10: Functioning of the competition investments algorithm in the model



Sources: FTI analysis

[11] Historical CAPEX data (US$/m3) are provided by HRP, for each propulsion technology and according to the capacity of the vessel. The annual forecast data is based on the average value of the previous 4 years.

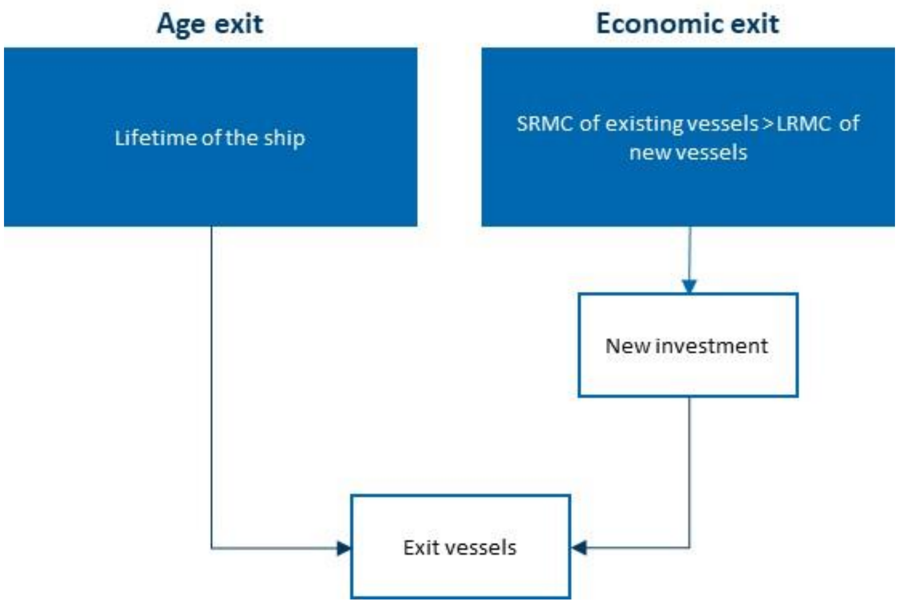
52. New vessels built using the modelled investments have the average properties of the vessels expected to be commissioned in the forecasted period, based on the order book. The construction of new vessels is also limited to the estimated maximum global shipyard capacity.

Modelled disinvestment

53. We model two different mechanisms for vessels to exit the market:

- **Age exit:** Age exit refers to the removing of a ship that has been in service for as long as the average exit age of vessels.
- **Economic exit:** Economic exit refers to the scrapping of a vessel because it is economically preferable to invest in new vessels with new technology, rather than to continue operating with these vessels. A vessel is not used if its SRMC is not competitive enough, and it is economically more favorable to invest in new charters. The exit of the vessel occurs when the vessel has not been used a certain amount of time, as it is considered that it will not return to the market and will be scrapped.

Figure 11: Exit of charters



54. Finally, we consider two limitations to exit of vessels:

- Vessels with ongoing long-term charter cannot exit the market regardless of their SRMC or age until the end of their long-term charter; and
- To reflect conservatism in the shipping industry mentioned by shipbrokers to FTI Consulting, we consider a maximum proportion of exits per year (%) acting as a ceiling to the number of exits per year.

6. Model methodology – Determination of the equilibrium

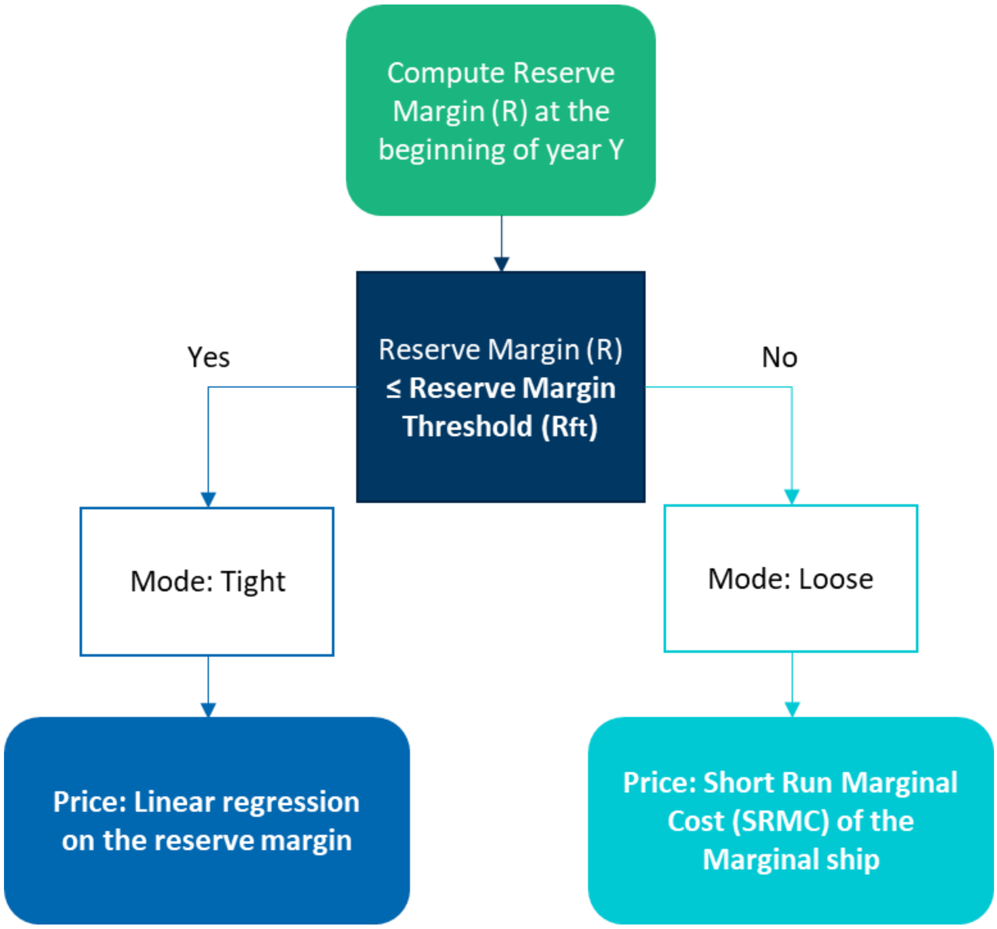
6.1. The model is based on an optimization of the costs to achieve the lowest freight rates

55. The confrontation of the demand curve and the supply curve is done using an optimisation algorithm to obtain the lowest global shipping cost (US$) that meets the overall transport demand (ton.mile), by selecting the appropriate least cost fleet ordered by SRMC. The equilibrium is calculated on an annual basis, with a comparison of demand and supply at the beginning of each year.

56. The equilibrium price (US$/ton.mile) is set differently according to the mode in which the market is found each year. There are two different modes assessed in our model depending on the value of the ratio of the supply over the demand in the evaluated year. The tight mode corresponds to a scenario in which the reserve margin is under a given value determined according to observed historical data. In the opposite case the market is in loose mode:

- **In tight mode:** Historically, in tight periods price does not match the SRMC of the marginal vessel but increases inversely with the reserve margin, reflecting increasing remuneration of vessel scarcity. We use a linear regression of historical annual prices and reserve margins to model future prices in tight mode; and
- **In loose mode:** The price is set by the most expensive unit satisfying the demand, i.e. the variable costs (SRMC) of the least efficient vessel required to meet LNG shipping demand.

Figure 12: Schematic explanation of the determination of the shipping price

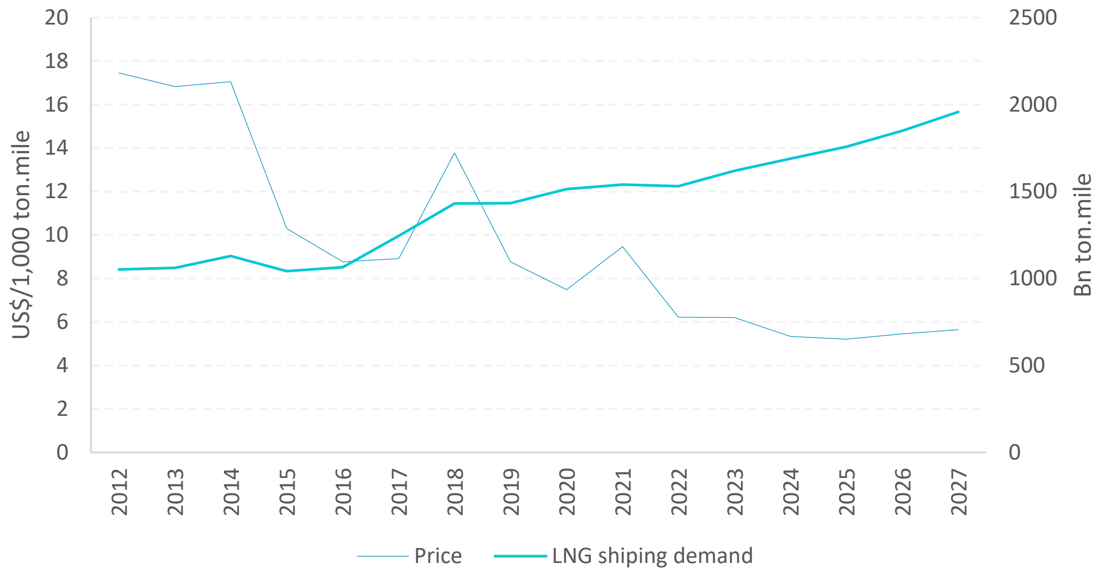


6.2. Expected results of the model

57. The model simulates an equilibrium between supply and demand, on an annual step. The result of a model is the equilibrium shipping price (US$/ton.mile), which allows to calculate the average freight rate (US$) for each type of propulsion technology.

58. The equilibrium price (US$/ton.mile) is provided, and is set differently in tight mode or in loose mode as explained above in paragraph 56.

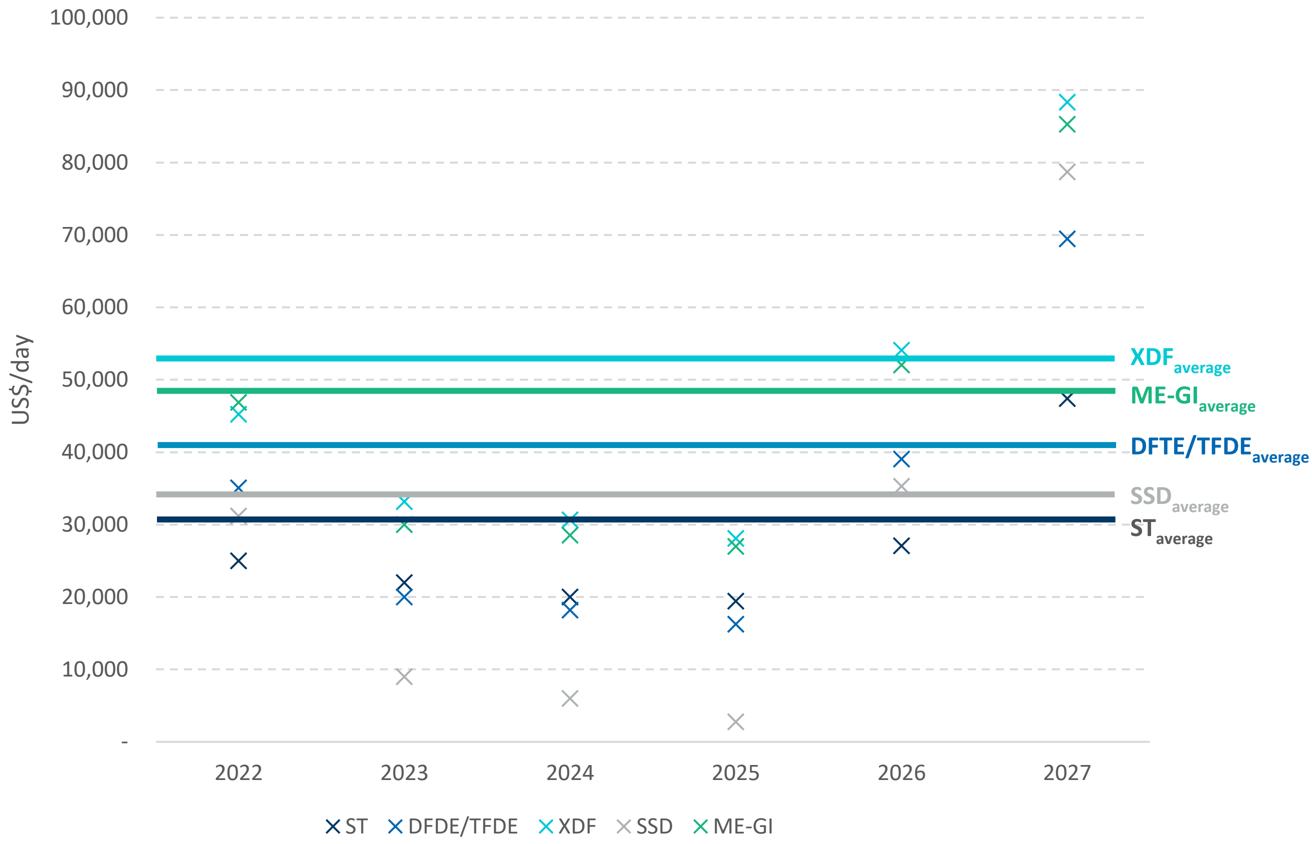
Figure 13: Illustrative – LNG shipping demand, in Bn ton.mile, and shipping price, in US$/1,000 ton.mile, from 2012-2027



Sources: FTI analysis

59. The freight rate per day (US$/day) is calculated as the average freight rate by propulsion technology of the existing fleet of year Y.

Figure 14: Illustrative – Average freight rates by propulsion technologies by year and 5-year average, in US$/day from 2022-2027

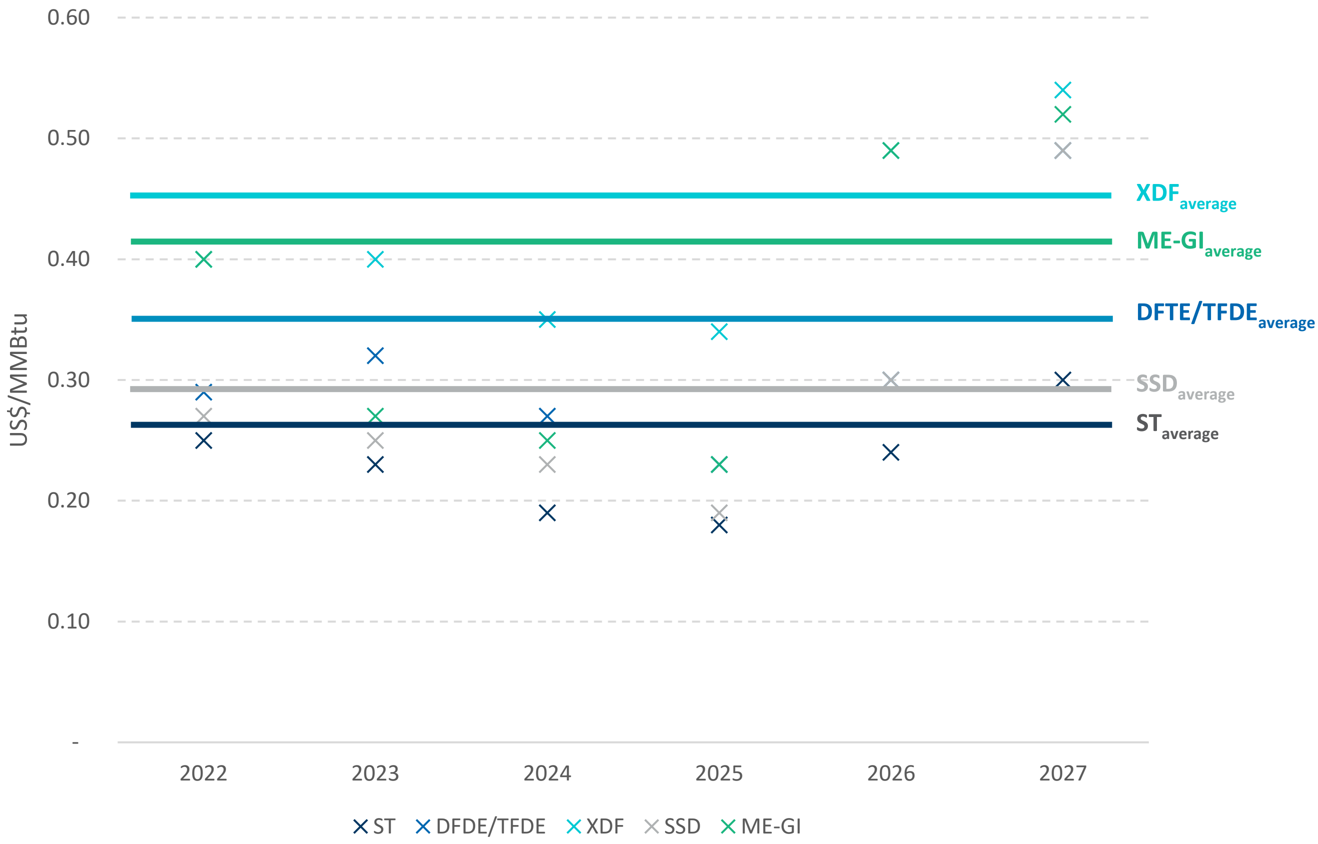


Sources: FTI analysis

Note: 2022 & 2027 are weighted as half-years in the average

60. The cost of the LNG shipping voyage from Gladstone, Australia to Tokyo, Japan is calculated using the shipping price (US$/MMBtu) for the Gladstone-Tokyo route distance (nautical mile). The voyage costs are distinguished according to the propulsion technologies.

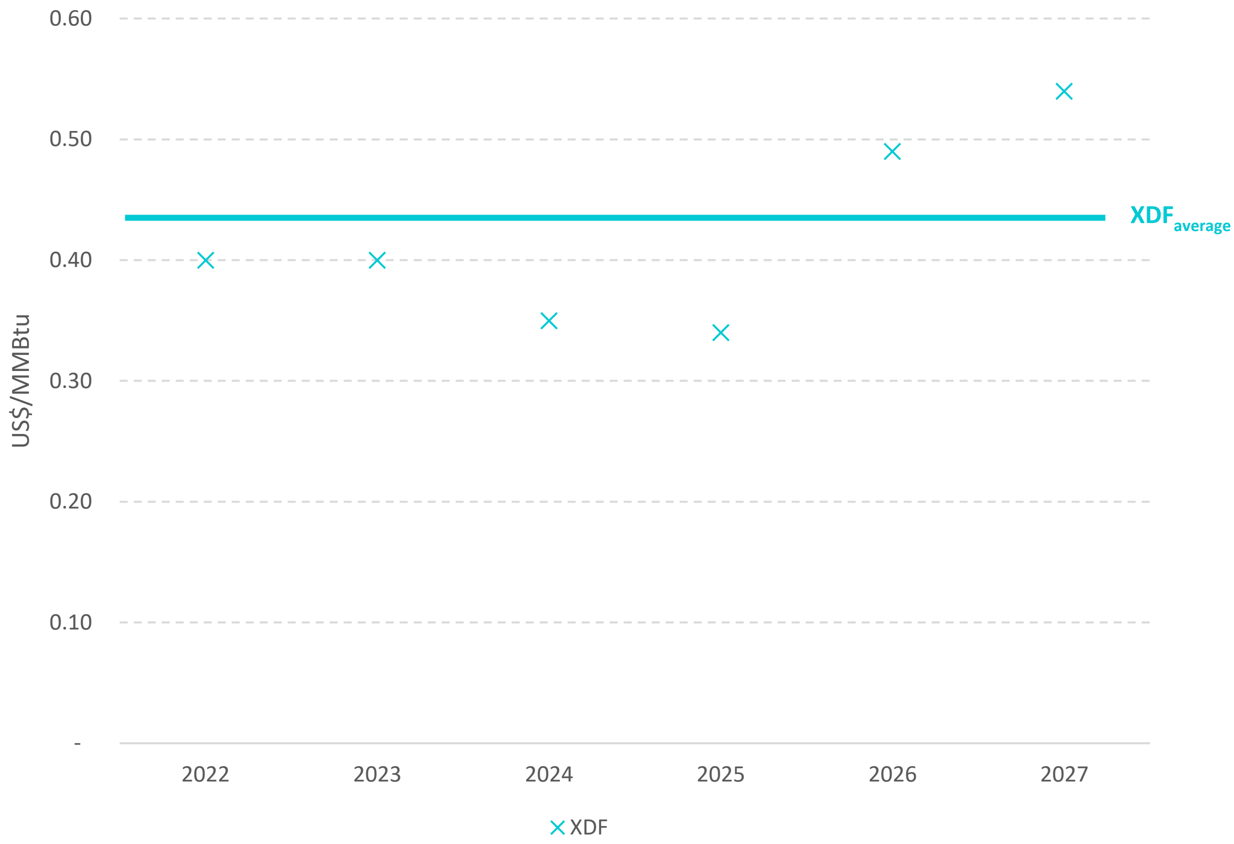
Figure 15 - Illustrative – Average cost of shipping Gladstone-Tokyo by propulsion technologies by year and 5-year average, in US$/MMBtu from 2022-2027



Sources: FTI analysis

Note: 2022 & 2027 are weighted as half-years in the average

Figure 16: Illustrative – Average cost of shipping Gladstone-Tokyo for the most representative propulsion technologies by year and 5-year average, in US$/MMBtu from 2022-2027



Sources: FTI analysis
Note: 2022 & 2027 are weighted as half-years in the average

61. The results presented are updated every six months, with the most recent data for all model parameters, in order to be as close as possible to the reality of the LNG transport market, and to consider recent events exogenous to the model. This update will involve rolling forward the model by six to twelve months to ensure a full five-year forecast period at each update.

6.3. Model limitations

62. The LNG shipping model relies on demand and supply forecasts extending to 5-6 years, and forecasts of this duration are inherently uncertain and subject to significant change as market information is progressively made available closer to the targeted date.

63. Additionally, the LNG shipping market is also impacted by non-economic factors such as diverse geopolitical events or technical issues that can modify the LNG demand and/or supply, and hence the equilibrium.

64. Our model does not consider such factors as we rely on the planned evolution of LNG liquefaction and regasification infrastructures as well as on long-term LNG contracts (for LNG molecules and for LNG carriers chartering). Nevertheless, the bi-annual update of the model planned by ACCC offers the possibility to implement the different evolutions as they appear through time.

65. Besides, as our model estimates the LNG shipping price and the charter rates on an annual basis, it does not provide information on more granular, infra-annual, variations.

66. Moreover, to build our supply and demand equilibrium, we rely on LNG infrastructure evolution data and forecasts extending to 5 years. This data is inherently uncertain and subject to change which limits the accuracy of the model.

67. Also, to get or model as close as possible to reality, we must draw some assumptions on dimensioning parameters, for example the impact of the shipping reserve margin on shipping prices. Our assumptions are based on historical data, and, as such, might not be fully adapted for a future LNG market that is expected to continue to grow significantly within the forecasted horizon.

68. Another limitation of our model is an absence of inertia. In practice, changes in demand and supply occurring in one year may not be reflected in that same year in the shipping investment/disinvestment but more progressively.

7. Discussion of results - Cross-checks

69. Once the results are generated, they will be compared to additional data on freight rate forecasts and CAPEX forecasts from ICIS and HRP.

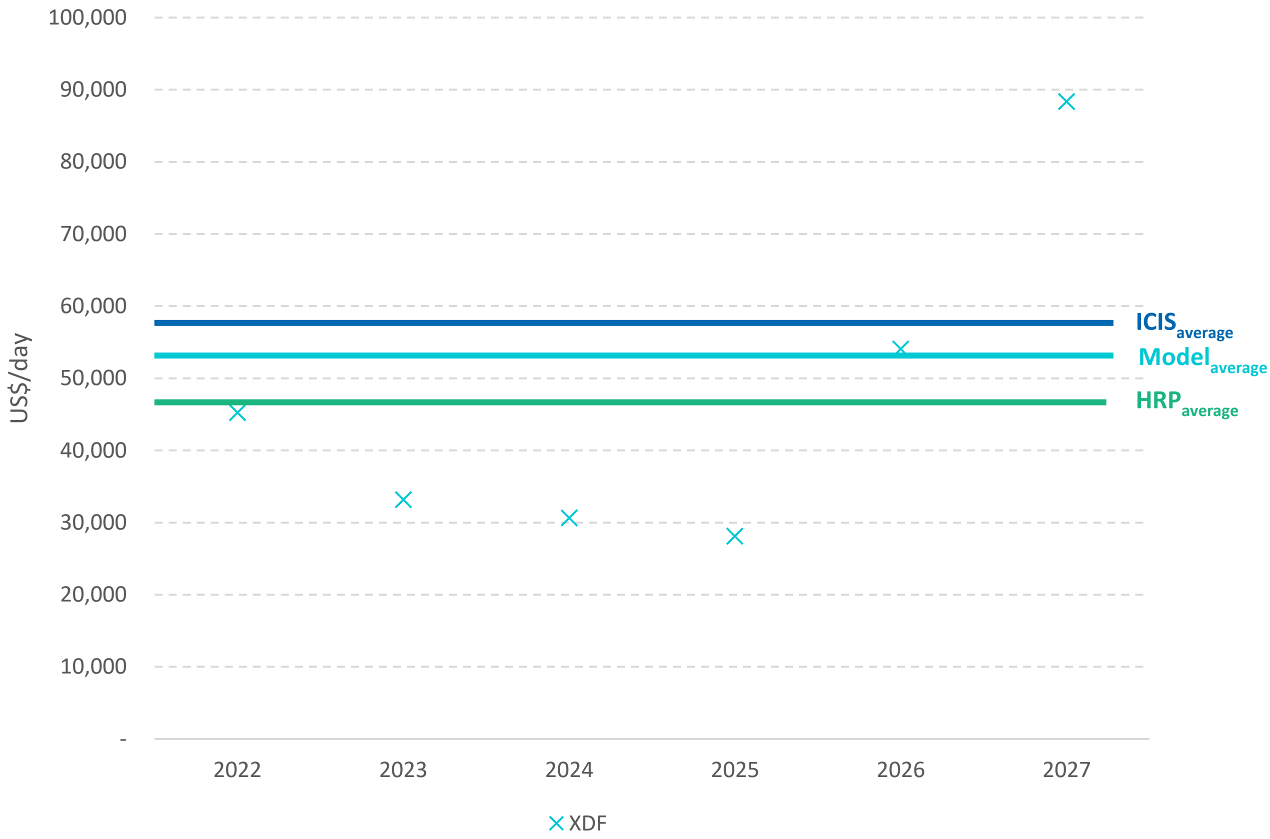
7.1. Freight rates cross-checks

70. We will perform a comparison of the freight rate outputs obtained with the model with the following data sources:

- **HRP data:** Average Medium-term charter fixtures, observed in the past 6 months;
- **ICIS data:** Long-term freight rate, as estimated by ICIS; and
- **HRP CAPEX:** Analysis of typical CAPEX provided by HRP alongside with the current expected payback period to compute a yearly expected revenue for vessel owners.

71. The comparison will be done with the freight rates of the most representative propulsion technology of the orderbook and the most present in the fleet over the next years: the XDF propulsion technology.

Figure 17: Illustrative - Model prevision results and cross-checks for freight rates, in US$/day from 2022-2027



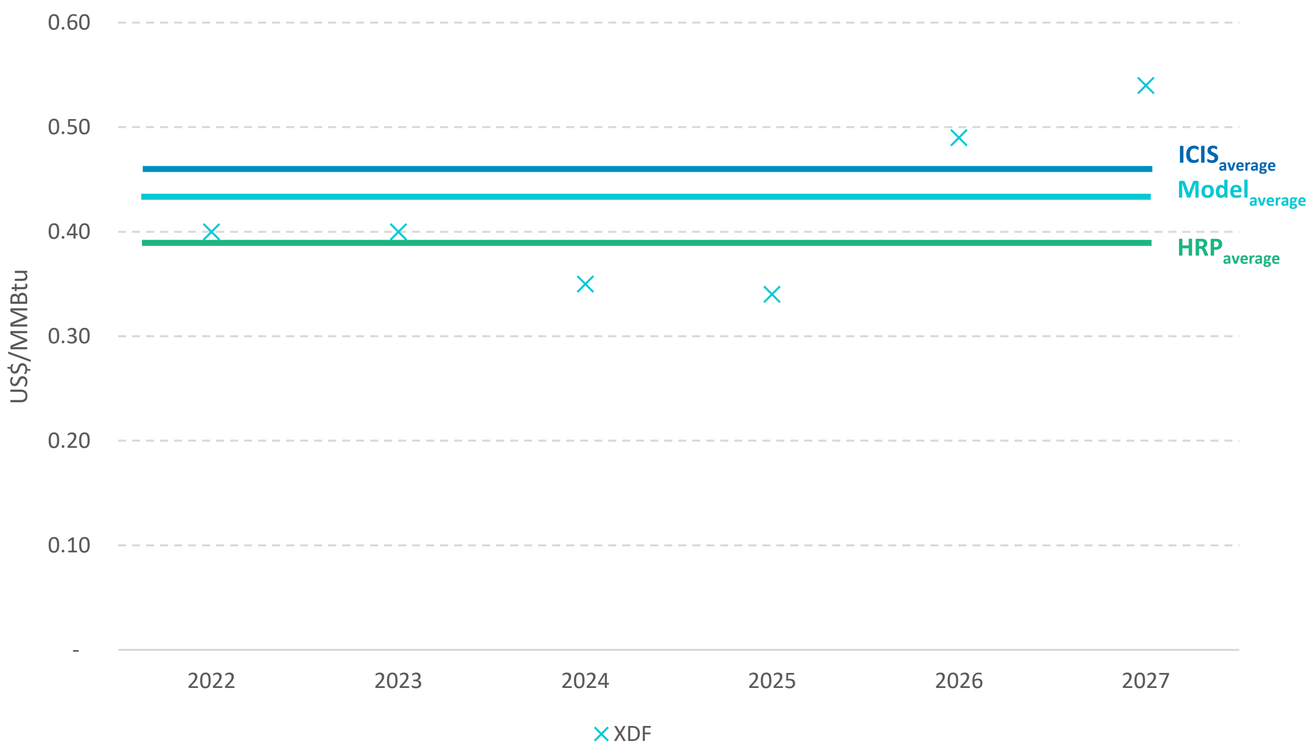
Sources: ICIS, HRP, FTI analysis

7.2. Gladstone-Tokyo route cost cross-checks

72. A comparison cost of travel from Gladstone, Australia to Tokyo, Japan obtained with the model will be done with the ICIS and HRP data.

73. The update of these cross-checks will be done every six months, with the most recent data available.

Figure 18: Illustrative - Model prevision results and cross-checks for cost of travel Gladstone-Tokyo, in US$/MMBtu from 2022-2027



Sources: ICIS, HRP, FTI analysis