December 2023

LNG FREIGHT RATE ESTIMATES – Results

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, the main export market for Australian LNG.[1]

2. In response to changes in LNG export markets, such as an increase in global LNG liquefaction capacity, the ACCC reassessed the LNG netback price series in 2021. The ACCC made the decision to supplement its netback reporting by publishing forward LNG netback prices for a period of up to five years in the future. Therefore, to determine these longer-term forward LNG netback prices, the ACCC requires estimates of LNG freight rates up to five years in the future.

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

4. The objective of this report to the ACCC is to provide the estimated medium-term LNG freight rates and the full costs of shipping of LNG from Gladstone, Australia, to Tokyo, Japan, for the next five years.

5. The computation of these results is based on an FTI Consulting methodology report dated 9th of August 2022 provided to the ACCC.

1.2. Executive summary

6. In this report, we present estimates of LNG freight rates for the period 2024-2029 for four different propulsion engine technologies: ST, DFDE/TFDE, ME-GI/ME-GA[2], and XDF, and the results of the LNG shipping prices from Gladstone to Tokyo based on medium-term freight contracting. The estimates are based on an LNG shipping supply/demand model that computes an annual LNG shipping equilibrium price, providing an opportunity cost estimate for 2024 to 2029 (see box 1 below). This report is an update of the Results Report [3] delivered to the ACCC on 27th of June 2023 (which relied on computations as of June 2023).

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

[2] ME-GA is a new propulsion technology made by the same manufacturer as ME-GI (MAN) that operates on lower pressure fuel supply compared to its ME-GI counterpart. ME-GI and ME-GA are grouped together for the purposes of modelling. https://www.man-es.com/marine/products/two-stroke-engines/megi-mega

[3] FTI Consulting (June 2023) LNG Freight Rate Estimates – Results, https://www.accc.gov.au/system/files/June%202023%20-%20FTI%20-%20Freight%20Rates%20Results_FINAL.pdf

Box 1. Methodology to estimate medium-term LNG freight rates[4]

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

1) the demand for LNG transport, that is the quantity of LNG transported by unit of distance, and

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

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

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

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 optimisation 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 tonne-mile.

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

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 (tonne-mile) to transport LNG and the associated variable costs to provide such services. The variable cost 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. As of December 2023, we have added carbon costs where applicable after the European Union (EU) finalised the inclusion of the maritime sector in its Emissions Trading System (ETS) with a progressive phase-in starting in January 2024. [5] [6]

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.

FTI Consulting's model quantifies the annual equilibrium price, in USD/tonne-mile, that results from the intersection of the LNG shipping demand and supply curves, as determined above. From this price of LNG transport in USD/tonne-mile, we determine for different types of LNG vessels the residual LNG freight rate, as the difference

[4] See the ACCC website for a full explanation of FTI's methodology, FTI Consulting methodology report – LNG freight rate estimates, 1 September 2022, available via https://www.accc.gov.au/inquiries-and-consultations/gas-inquiry-2017-30/lng-netback-price-series

[5] Inclusion of maritime emissions in the EU Emissions Trading System (ETS) starting January 2024. The policy targets a base of 100% of intra-EU voyages emissions and a base of 50% of extra-EU voyage emissions to be accounted for by 2027. This target will be phased in progressively with 40% of that base accounted for in 2024, then 70% in 2025 and finally 100% in 2027. Source: European Commission, Reducing emissions in the shipping sector, last accessed 7 December 2023. https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-shipping-sector_en

[6] In the model, carbon prices are set at the level of carbon price for the European region forecasted by the IEA in the Stated Policies Scenario. Source: IEA WEO 2023, page 297. https://www.iea.org/reports/world-energy-outlook-2023

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, carbon cost inclusion etc.).

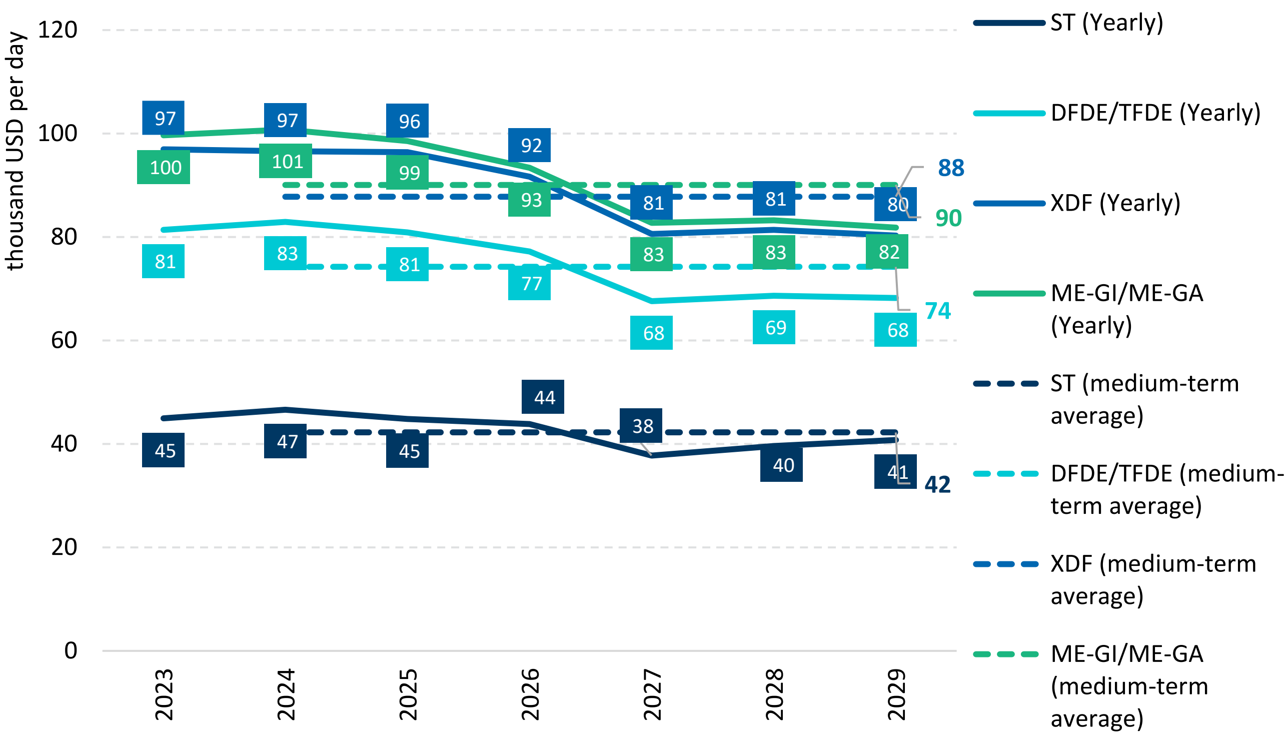
FTI gathers data from publicly available sources on LNG shipping, including LNG trade reports, LNG trades forecasts and LNG shipping reports, to support its modelling and estimates of LNG shipping freight rates. In addition, we have partnered with shipbroker Howe Robinson Partners (HRP) to provide comprehensive, 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.

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

7. The modelled estimates of the annual LNG freight rates are presented in Figure 1 below, along with a medium-term average: the model's outputs are annual freight rates, and an annual average over the period 2024-2029 was calculated as representative of medium-term freight rates.

8. The medium-term average estimates differ by technology, ranging between 42k USD/day for the ST, i.e., the oldest technology with smallest carrier capacities, to 90k and 88k USD/day for ME-GI/ME-GA and the XDF respectively, i.e., the newest propulsion technologies with larger carrier capacities.

Figure 1. Average freight rates by propulsion technologies by year and medium-term average, for the period 2023-2029, in real 2023 USD/day



Sources: FTI analysis

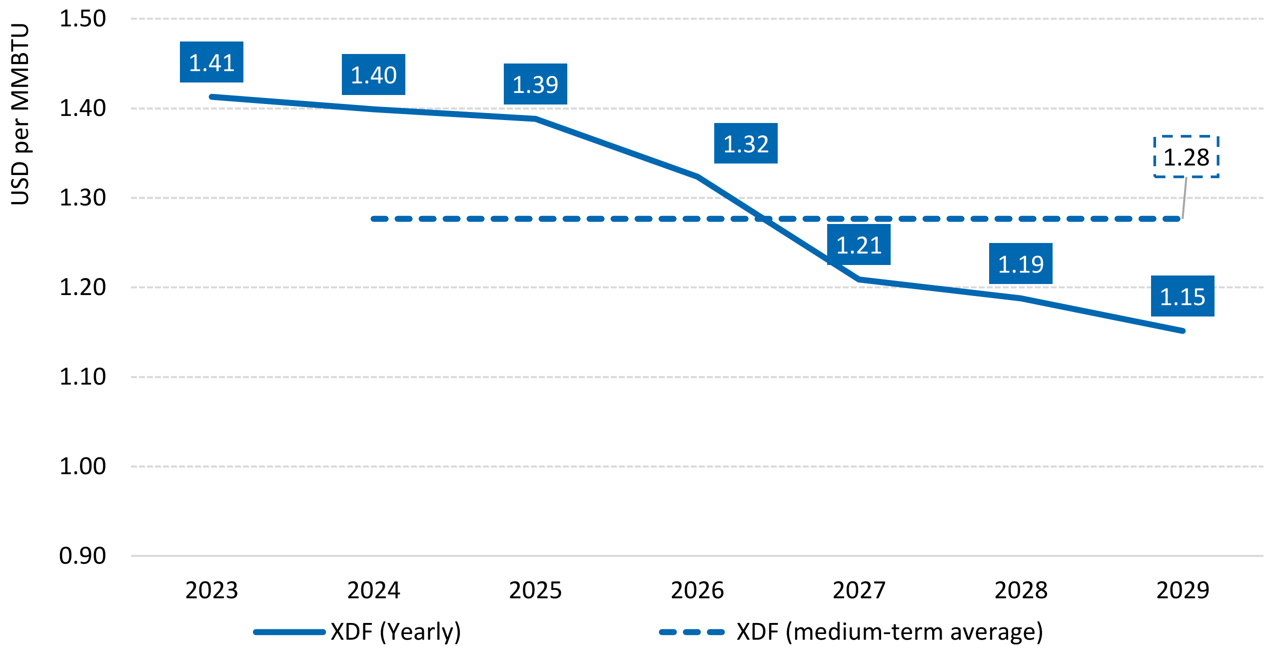
Note: The medium-term average considers the period of 2024 to 2029

9. The estimated freight rates of 81k USD/day to 97k USD/day for XDF, for the period from 2024 to 2027, are similar to the estimates from the previous report (i.e., from 87k USD/day to 102k USD/day for XDF) with an average difference of -5%. The upward revision in shipping demand (paragraph 22) for this period partially but not fully balances out the expected further increase in shipping supply (paragraph 24). The freight rates are expected to remain high due to the increase in shipping demand by 2028 to 2029.

10. The progressive introduction of the EU carbon price in the EU shipping market starting in 2024 adds to the operating costs of a portion of the LNG carriers trading with Europe, with ST ships mainly affected due to their higher emissions through higher fuel and LNG consumption.

11. The yearly estimates and the medium-term average for the LNG shipping price for a round trip from Gladstone to Tokyo are presented in the following Figure 2. The results presented correspond to the XDF propulsion technology, which is expected to be the most common technology on the water from 2025 onwards.[7] As our model assumes a global price equilibrium of freight rates (in USD/tonne-mile) across propulsion technologies, the Gladstone-Tokyo shipping prices of other technologies would be similar (+/- 2%) to the one presented for XDF below.

Figure 2: Average price of shipping Gladstone-Tokyo by year and medium-term average for an XDF propulsion technology for the period 2023-2029 (real 2023 USD/MMBtu)



Sources: FTI analysis

[7] See Figure 11 for overview of forecasted LNG carrier vessels fleet.

Note: The medium-term average considers the period of 2024 to 2029

12. The estimate of the medium-term average shipping price from Gladstone to Tokyo for the period 2024-2029 is 1.28 USD/MMBTU and is lower than the previous report (1.37 USD/MMBTU over 2023-2028). The slight decrease is due to the reduction of forecasted LNG prices, an increased front-loading of the existing LNG carrier order book, and the addition of new orders for new vessels in the 2025 to 2028 period.[8]

1.3. Structure of the report

13. This report is structured as follows:

- **Section 1** is the present section, which summarises the context, content and the structure of the report;
- **Section 2** presents the calculation of the demand side of the model, i.e., the annual global shipping demand in tonne-mile;
- **Section 3** presents the calculation of the supply side of the model, i.e., the annual global shipping supply evolution including all the LNG carrier vessel investments and disinvestments;
- **Section 4** presents the results of the equilibrium between supply and demand, i.e., the global shipping price and the annual freight rates per propulsion technology at equilibrium; and
- **Section 5** presents a comparison of the modelled results with alternative estimates from other sources.

[8] For more details, see Table 1.

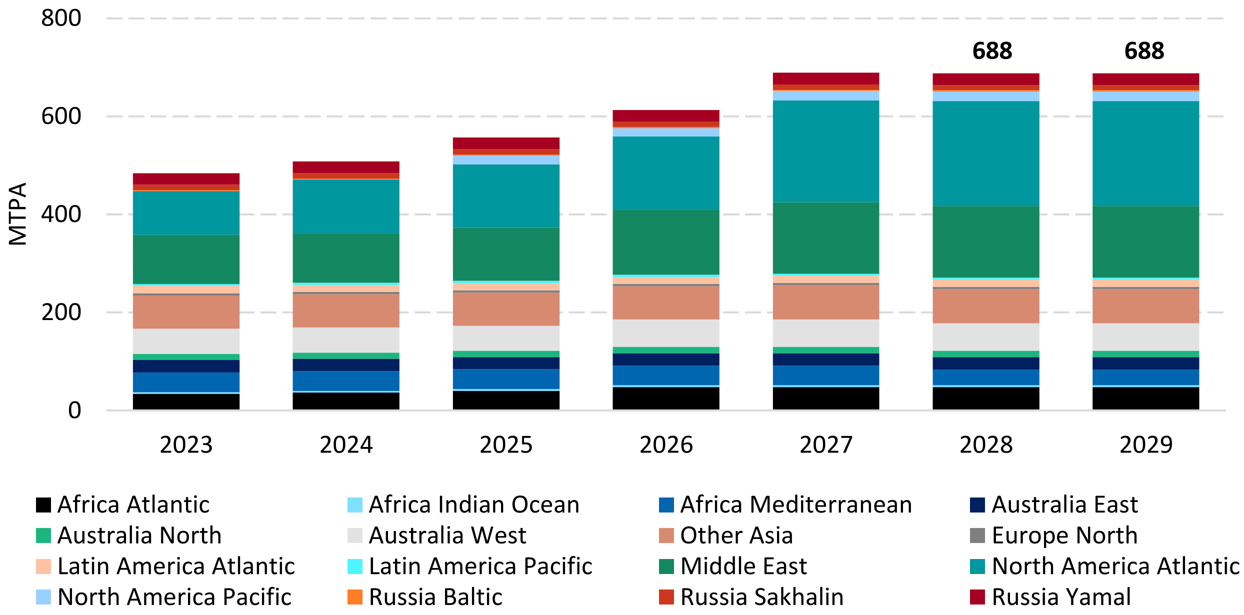
2. Calculation of shipping demand

14. As explained in Section 4 of the FTI methodology report dated 9th August 2022, to quantify LNG shipping demand, we construct a forecast of the global LNG molecule trade based on the evolution of planned new liquefaction infrastructures (Figure 3), and from that determine the volume of imports and exports per region, augmenting historical imports and exports in proportion to the new infrastructure's capacities to be commissioned (Figure 4 and Figure 5).

15. Since our previous report (with data as of June 2023), our liquefaction capacities forecast for 2023 to 2027 have only marginally changed (-3% on average). However, our liquefaction capacities forecast for 2028 (Figure 3) decreased from 725 to 688 million tonne per annum (-37 MTPA) due to cancellations and postponements of announced liquefaction projects. In producing our liquefaction capacities forecast over 2023-2029, we have also adopted a stricter approach of considering only the projects that have reached Final Investment Decision (FID), given the long-term uncertainty in LNG trade forecasts that market players have increasingly recognised, which primarily impacted 2028 and 2029 capacity additions downward.

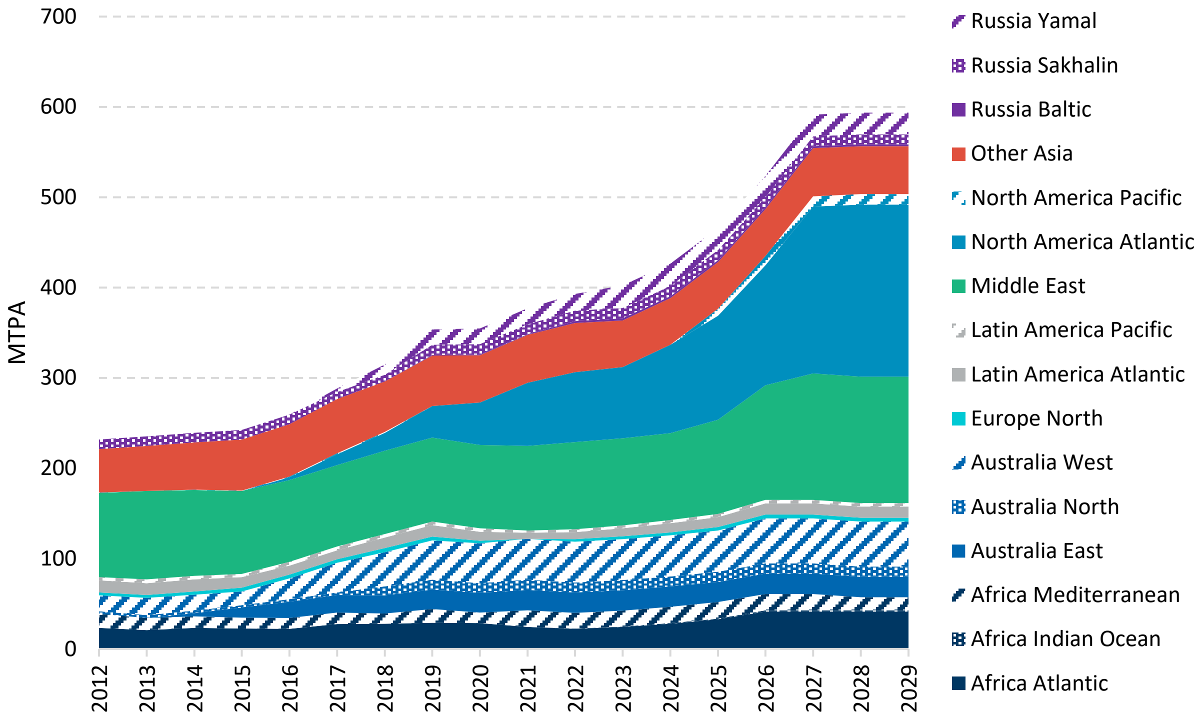
16. Based on our methodology, as the capacity of LNG liquefaction terminals increases, imports and exports also increase depending on the expected utilisation (as presented in Figures 4 and 5).

Figure 3. Capacity of LNG liquefaction terminals for the period 2023-2029, in MTPA



Sources : ICIS, FTI analysis

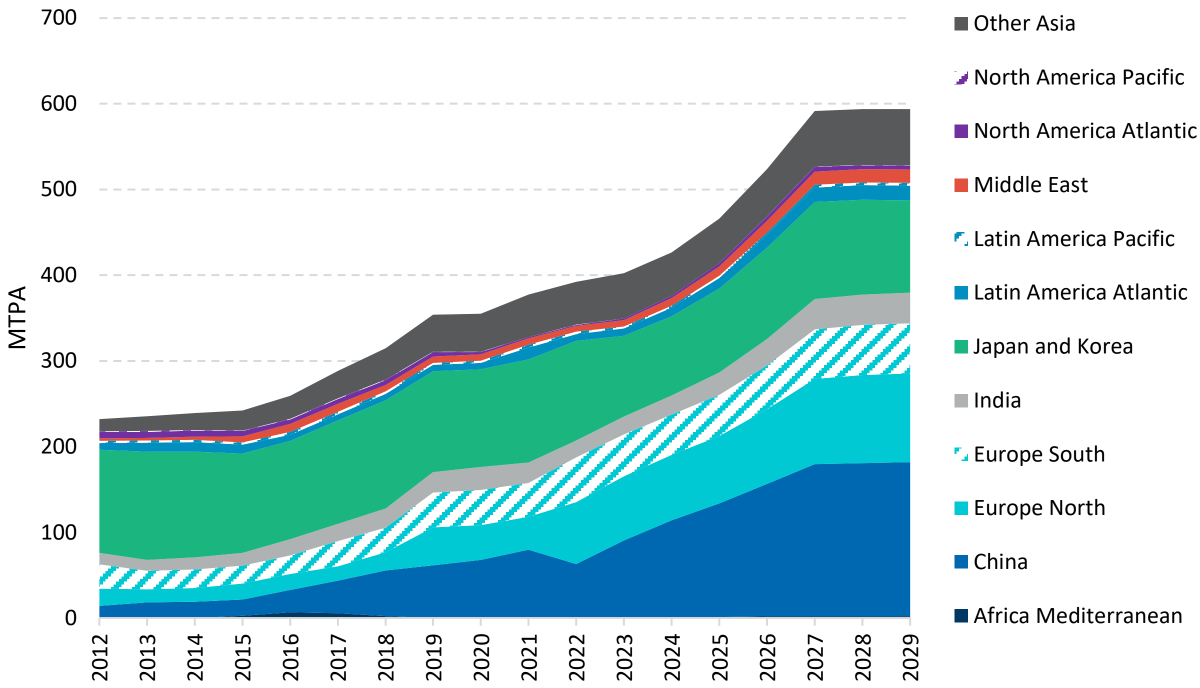
Figure 4. LNG exports scenario for the period 2012-2029, in MTPA



Sources: BP, ICIS, FTI analysis

Note: Refer to Methodology Report §30-32 for details

Figure 5. LNG imports scenario for the period 2012-2029, in MTPA

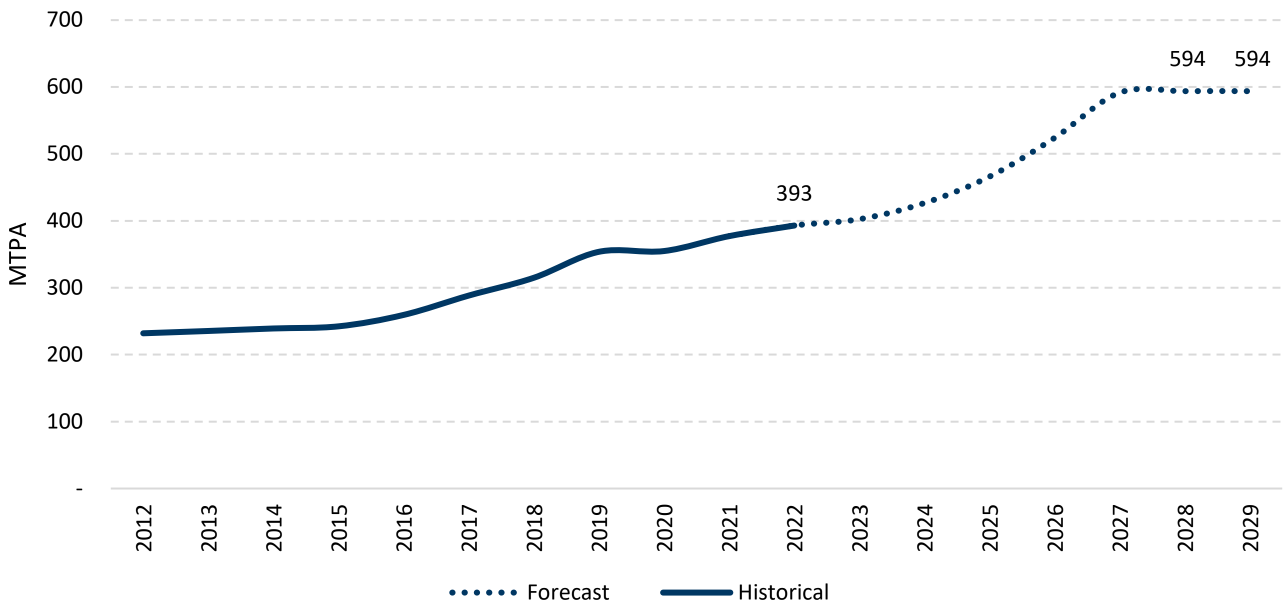


Sources: BP, ICIS, FTI analysis

Note: Refer to Methodology Report §30-32 for details

17. The global LNG demand forecast is then the sum of the projected imports for each of the 20 zones presented above[9]. Despite the uncertainty over long-term demand, medium-term LNG demand is expected to continue to grow, supported by increased utilisation of liquefaction terminals. The demand in 2028 is expected to reach 594 MTPA and represents a 0.2% upwards revision from our previous report's 2028 forecasted LNG demand. The demand is expected to plateau by 2029, in line with stable LNG liquefaction capacities.

Figure 6. Global LNG demand for the period 2012-2029, in MTPA



Note: Referencing historical data up to 2022 due to incompleteness of referenced data of 2023 (up to December)
Sources: Historical data: BP, Forecasts: ICIS, FTI analysis

18. Then, using a dispatch optimisation model, we compute the LNG shipping demand, in tonne-mile, 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[10]. In this optimisation, we take into account forced routes stemming from fixed-destination LNG trade set by long-term contracts, which are assumed as fixed and are hence not subject to the route optimisation algorithm.

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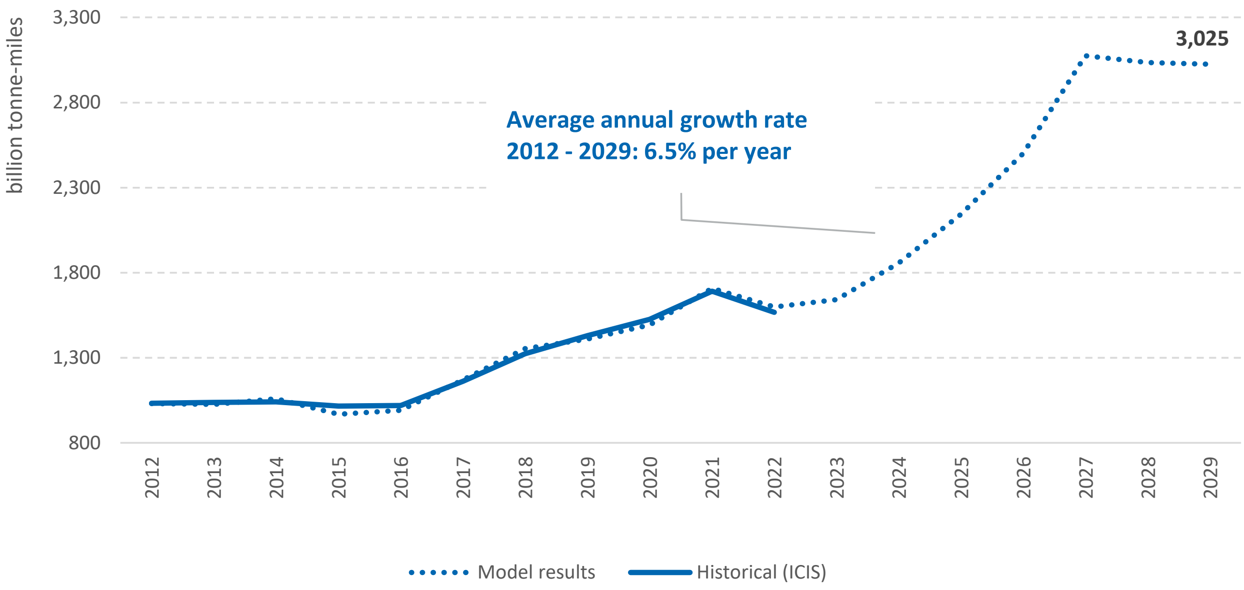
[9] The model takes into account estimated reductions in Russian LNG exports from the Yamal and Sakhalin zones, as identified in the IEA Gas Market Report Q2 2023. https://www.iea.org/reports/gas-market-report-q2-2023

[10] The total cost of shipping on each route is based on the cost of transporting LNG using an average LNG carrier with standard capacity.

19. Thus, FTI Consulting's shipping demand model determines the optimal global LNG flows between export and import zones (considering obligations of long-term contracts) and establishes the annual shipping demand in billion tonne-miles, as shown in the Figure 7.

Figure 7. Shipping demand modelled for the period 2012-2029, in billion tonne-miles



Note: Reference historical data up is limited to 2022 as 2023 voyages have not been fully complete as of 15 December

Sources: FTI analysis

20. Our modelled shipping demand follows the same trends as the actual shipping demand calculated based on the historical ICIS LNG carrier voyages database, confirming the accuracy of our LNG shipping demand estimation.

21. As shown in Figure 7, the shipping demand increases on average by 6.5% per year between 2012 and 2029, reaching 3,025 billion tonne-miles in 2029. The evolution of the shipping demand primarily follows the accelerated LNG molecule demand growth trends over the same period: global LNG liquefaction capacity increases at an average annual growth of 5.7% between 2012 and 2029. In line with LNG molecule trade, we forecast a plateau of LNG shipping demand in 2028-2029.

22. The modelled shipping demand by 2028 is 16% higher compared to the previous report due to the longer optimal routes calculated. The stricter approach towards terminal capacities as discussed in paragraph 14 entailed the removal of announced liquefaction capacity in Asia that have not yet entered FID. This led to a larger portion of forecasted demand in Asia to be fulfilled by the confirmed liquefaction capacities from North America instead, resulting in the higher tonne-miles calculated.

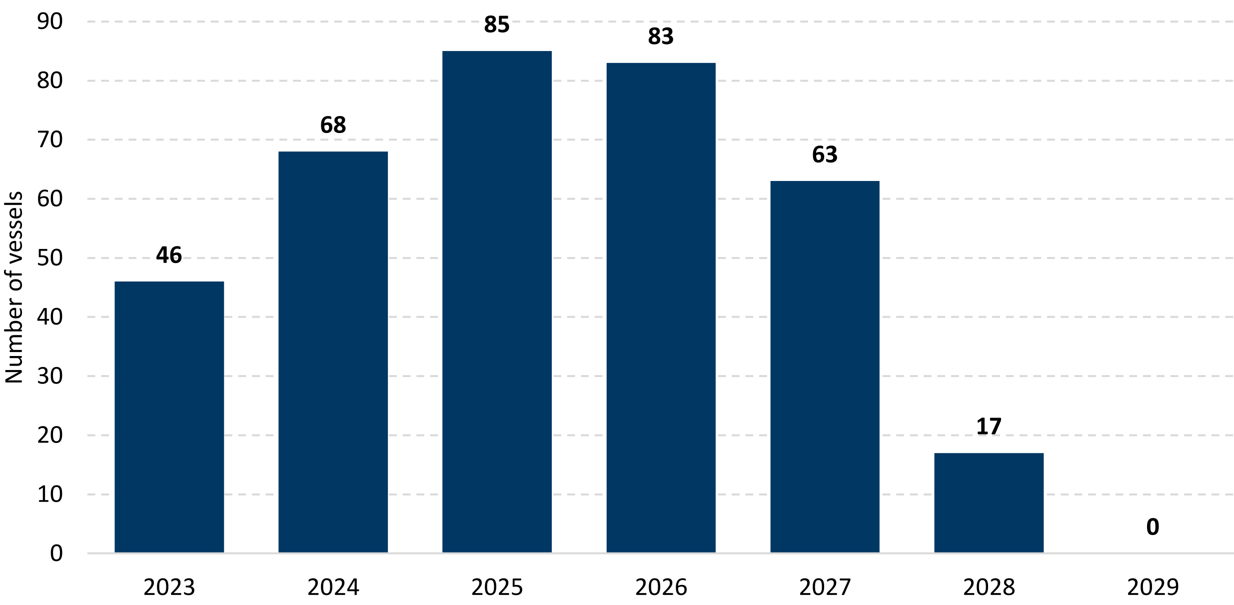
3. Calculation of shipping supply

23. On top of the operational LNG carrier vessels fleet and the LNG carrier vessel orders actually registered by the shipyards, our model endogenously balances supply and demand for shipping by investing in new ships (modelled investment) and removing old and uncompetitive ships (modelled disinvestment).

3.1. Known fleet and modelled investment

24. First, we rely on the existing operational fleet and firm orders in the ICIS order book, and information from HRP. Compared to our previous report, a net total of 74 new LNG carrier vessels have been added in the order book for 2024-2028. In more detail, the difference in the yearly order book compared to our previous report is due to (i) a front-loading of ordered vessels to 2024-2026 to anticipate increasing demand, (ii) new orders for 2027-2028, and (iii) additional orders that were previously not accounted in ICIS. For 2029, there has so far been no confirmed and registered orders according to HRP or ICIS.

Figure 8. Orderbook for LNG carrier vessels for the period 2023-2029

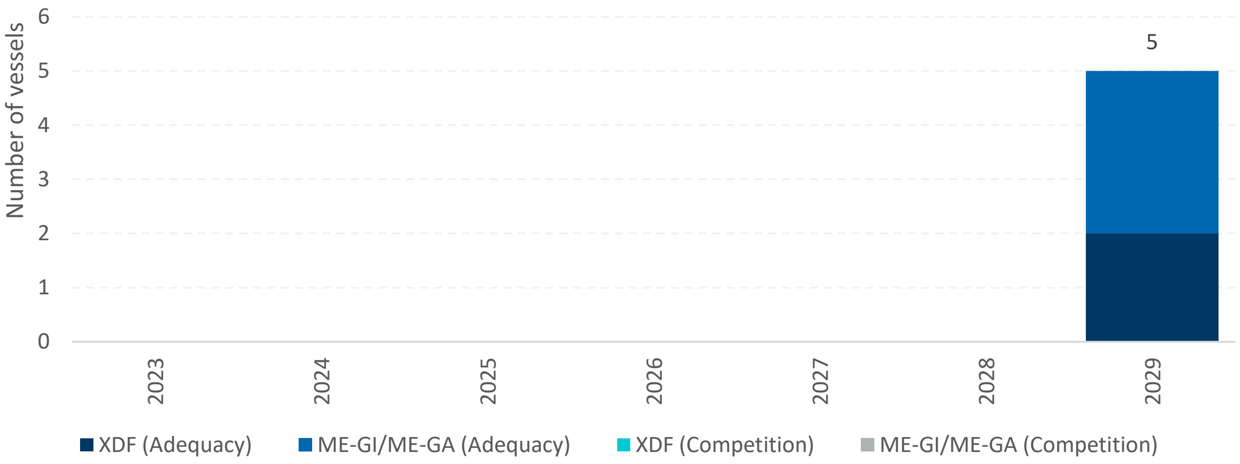


Sources: ICIS order books, HRP, FTI analysis

25. Second, we model two types of new ship investments that add to the operational and ordered LNG carrier vessels: (1) adequacy investment, and (2) competition investment.

26. The results of the expected investments to be made between 2023 and 2029 are presented in Figure 9 below. New vessels joining the fleet based on the modelled investments have the average properties of the vessels expected to be commissioned between 2023 and 2029, based on the order book.

Figure 9. Modelled investments in new LNG carrier vessels for the period 2023-2029



Sources: FTI analysis

27. In Figure 9 above, the modelled investments in new ships correspond to adequacy investments only. There is no additional competition investment, which means that the Long-Run Marginal Cost (LRMC) of new investments in ME-GI/ME-GA or XDF technologies remain above the Short-Run Marginal Cost (SRMC) of the operating LNG carrier vessels.

28. The modelled investments are lower compared to the previous report, as some of the adequacy needs previously identified are now captured in the updated order book, i.e., what was before modelled as expected market players' reaction to the supply/demand balance has now been confirmed by actual new ship orders by market players. Moreover, we have also refined our ship investment algorithm after collecting insights from shipowners and other market players on how they approach the uncertainty on the level of shipping demand post-2030. We thus extended the time horizon (to 15 years) for assessing the average supply gap that could trigger adequacy investment in new ships. This would limit over-investing, thereby potentially better reflecting observed behaviours from investors.

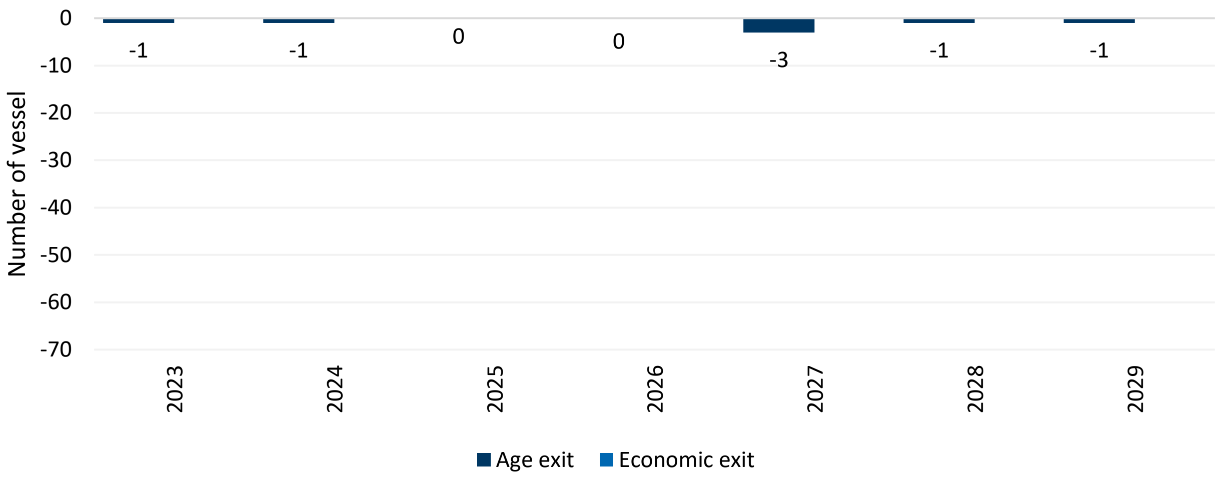
3.2. Modelled disinvestment

29. As explained in the methodology report (Paragraph 53) from August 2022, we model two different mechanisms for LNG carrier vessels to exit the market: (1) age exit, and (2) economic exit[11]. The exit of vessels is capped at 20% of the existing fleet to reflect a degree of inertia in shipowners' disinvestment decisions, as suggested by LNG shipbroker HRP.

30. The results of the model for disinvestment are illustrated in the Figure 10 below.

[11] Vessels converted to FSRUs are also removed from the existing fleet, based on the FSRUs mentioned in the most recent GIIGNL report.

Figure 10. Exit of LNG carrier vessels for the period 2023-2029



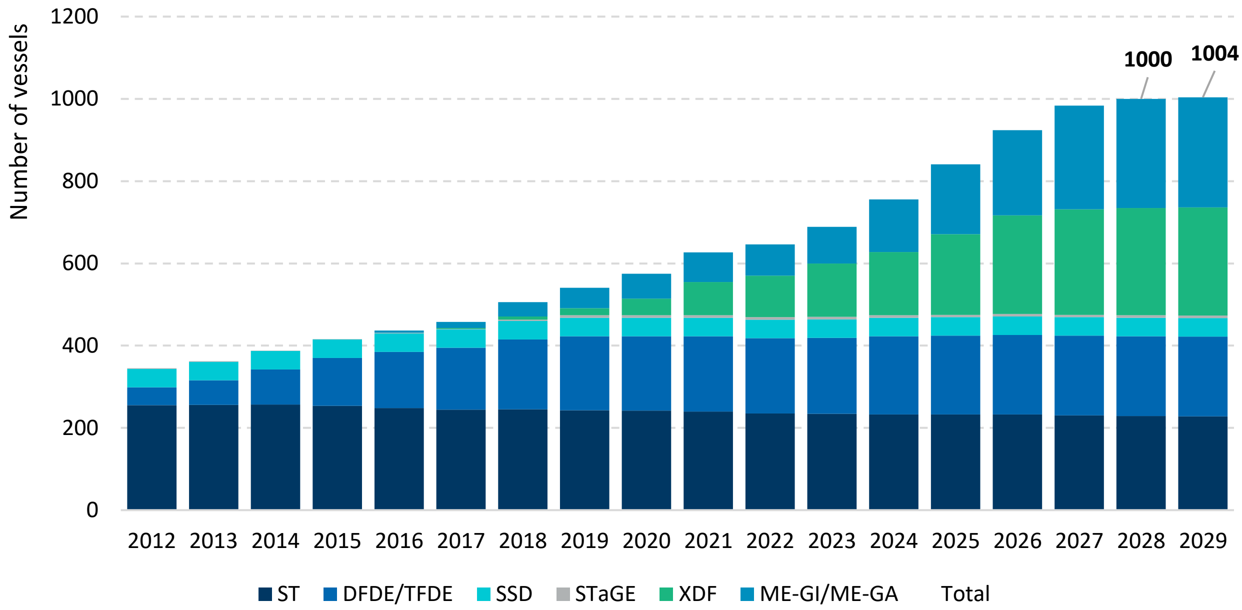
Sources: FTI analysis

31. Between 2023-2029, 7 vessels are expected to exit due to age, based on announced and confirmed scrappages and estimated lifespans of remaining vessels. The economic exits estimated from the previous report are no longer expected, due to the upward revision of shipping demand leading to prolongation of tight conditions as discussed in paragraph 21.

3.3. Global fleet of LNG ships

32. The sum of the actual fleet of LNG carrier vessels as of 2023, the confirmed orderbook until 2029 and the modelled investments and divestments, result in a fleet of 1000 ships in 2028 and 1004 ships in 2029. This represents a decrease of 9 vessels compared to our previous report where 1009 vessels were expected by 2028, which we can principally link to a more refined adequacy investment decision algorithm to reflect perceived long-term demand uncertainty.

Figure 11. Global LNG fleet by technology for the period 2012-2029



Sources: 2012-2021: ICIS and GIIGNL, 2022-2028: ICIS and FTI analysis

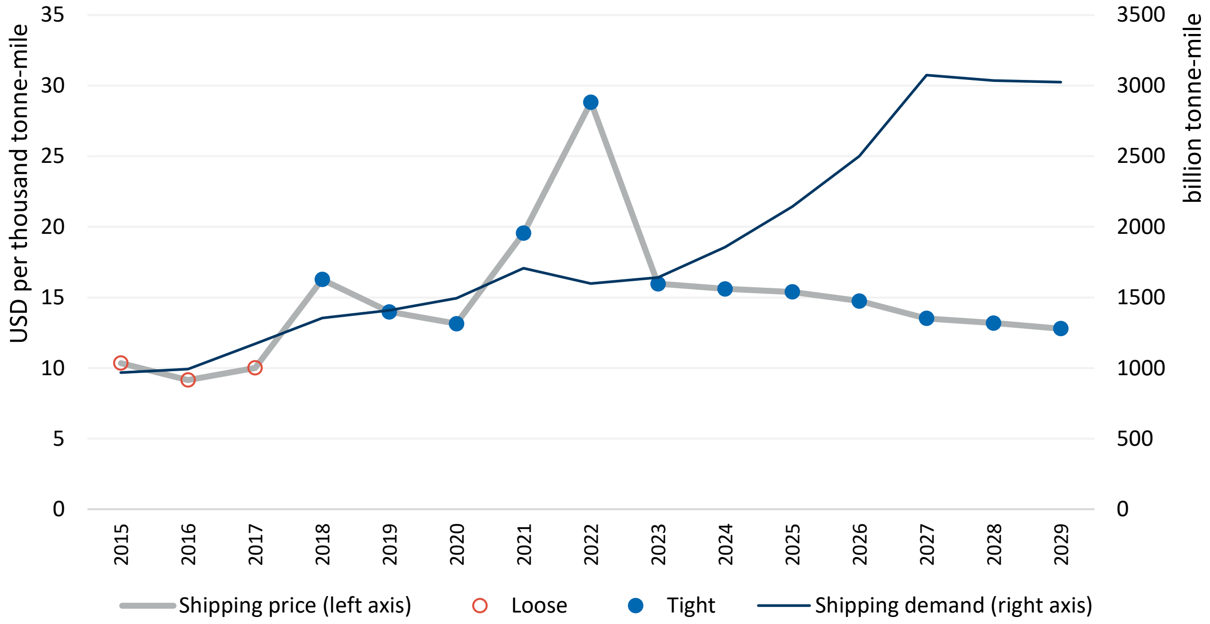
4. Determination of the price equilibrium and freight rates

4.1. Results of the model

33. The model assesses the equilibrium between LNG shipping supply and demand, on an annual basis. The result of the model is the equilibrium shipping price (USD/tonne-mile) which serves as the basis to calculate the average freight rates (USD/day) for each type of propulsion technology.

34. We present in Figure 12 below the results of the equilibrium shipping price.

Figure 12. LNG shipping demand (billion tonne-miles) and shipping price (real 2023 USD per thousand tonne-mile) for the period 2015-2029



Sources: IMF (for inflation), FTI analysis

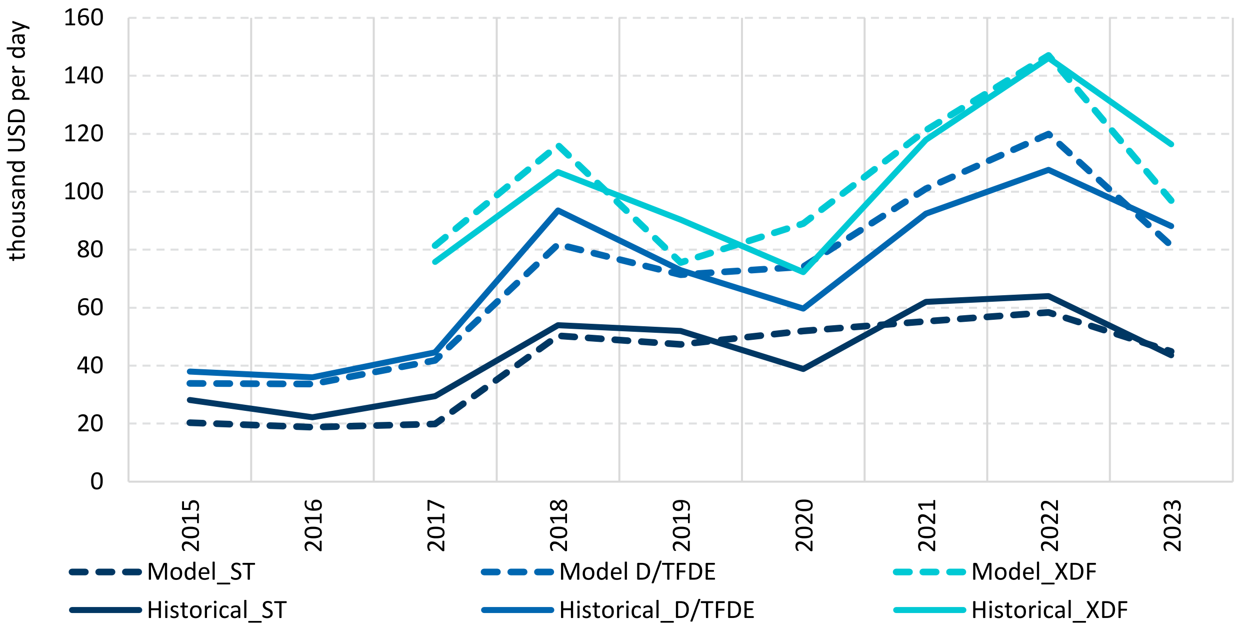
35. The equilibrium price varies between periods of tension between supply and demand, i.e., tight periods, when the price of shipping is higher, and loose periods, when the price of shipping decreases due to a higher supply/demand ratio. FTI Consulting models variation of equilibria between supply and demand over the years, resulting in variation in the shipping prices.

36. As described in the previous report, after an exceptional year in 2022 with record high gas prices in Europe and Asia, and record high LNG shipping prices, the regression model linking shipping prices and supply/demand equilibria was updated to capture less typical market behaviours displayed in 2022. Notably, we used a 2-factor regression of LNG shipping prices against LNG shipping market equilibria and gas prices. We thus allowed scarcity pricing for LNG shipping to be linked to prevailing LNG prices (as opposed to a fixed multi-year scarcity value previously used).

4.2. Back cast of the model

37. In Figure 13 below, we present the results of the modelled freight rates as well as actual data for the historical period between 2015 and 2023.

Figure 13. Modelled freight rates vs. historical actual freight rates for the period 2015-2023, in real 2023 USD



Sources: Actual data: HRP, Modelled data: FTI analysis

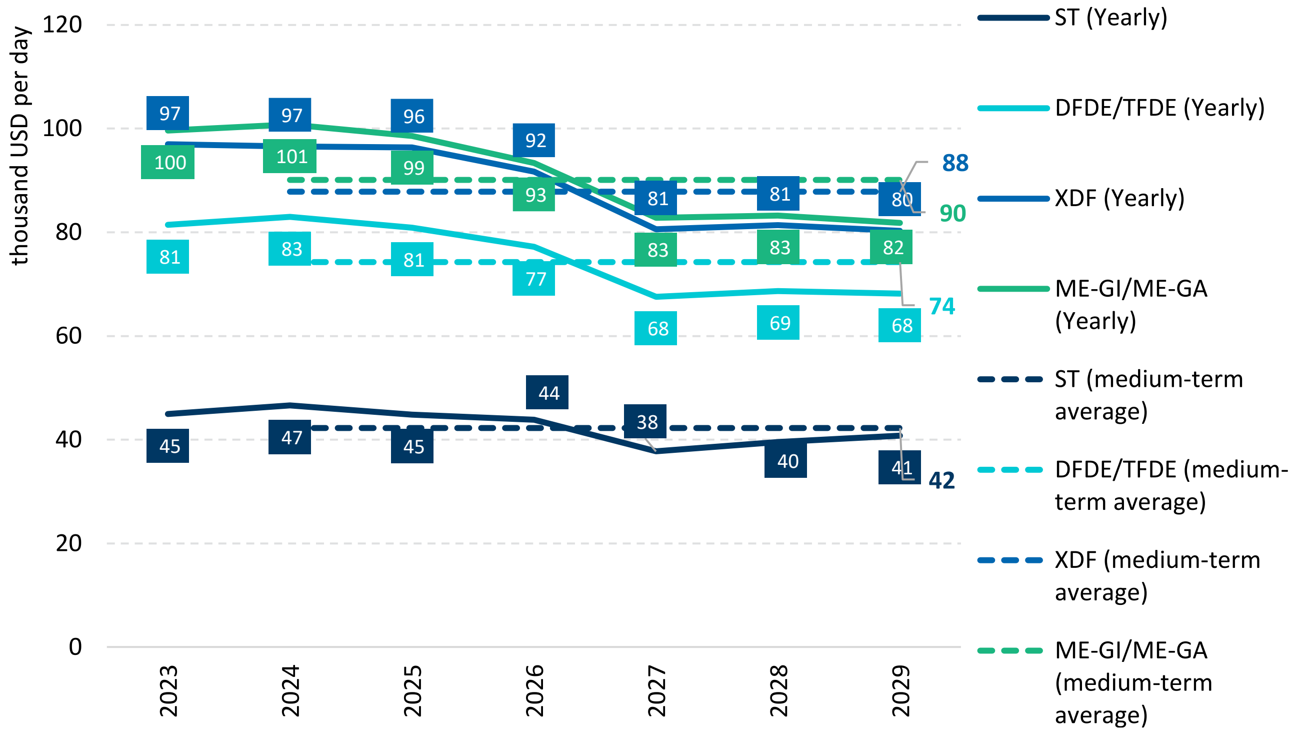
38. The model has a considerable fit with historical charter rates for the three main technologies: ST, DFDE/TFDE and XDF vessels, over the historical period 2015 to 2023.[12]

4.3. Forecasts from the model

39. Looking forward, the model estimates annual freight rates by propulsion engine technology for the period 2024-2029, as well as a medium-term average of these freight rates by technology representing a medium-term average freight rate based on opportunity costs.

12 ME-GI/ME-GA not represented in the back cast as it is very close to XDF and less representative.

Figure 14. Average freight rates by propulsion technologies by year and medium-term average for the period 2023-2029, in real 2023 USD per day



Source: FTI analysis

Note: The medium-term average considers the period of 2024 to 2029

40. The estimated freight rates of 81k USD/day to 97k USD/day for XDF, for the period from 2024 to 2027, are similar to the estimates from the previous report (i.e., from 87k USD/day to 102k USD/day for XDF) with an average difference of -5%. The upward revision in shipping demand (paragraph 22) for this period partially but not fully balances out the expected further increase in shipping supply (paragraph 24). The freight rates are expected to remain high due to the increase in shipping demand by 2028 to 2029.

41. The progressive introduction of the EU carbon price in the EU shipping market starting in 2024 adds to the operating costs of a portion of the LNG carriers' fleet trading with Europe, with ST ships mainly affected due to their higher emissions through higher fuel and LNG consumption.

42. FTI Consulting models different equilibria between supply and demand over the years, which drive the prices variation. Years 2023 to 2029 are "tight" in the sense that the reserve margin between total supply capacity and total demand is lower than the historical standard reserve

margin, which is expected to lead to some scarcity pricing, driven by the level of such reserve margin and the level of LNG price[13].

43. The price of the LNG shipping voyage from Gladstone, Australia to Tokyo, Japan is calculated using the shipping price (USD/MMBtu) for the Gladstone-Tokyo route distance. Below is our calculation, relying on the dominant new propulsion technology, XDF, for the price of shipping from Gladstone to Tokyo, in USD per MMBtu, for the years 2023 to 2029.

13 In the "tight" mode, the reserve margin is below the threshold determined by historical data, resulting in prices that follow a regression of historical data, while in the relatively "loose" mode, the model's reserve margin is above the threshold and prices are set as the Short Run Marginal Cost (SRMC) of the least efficient technology required to meet demand.

Table 1. Calculation of the shipping price from Gladstone to Tokyo and back for the XDF propulsion technology for the period 2023-2029, in real 2023 USD prices

	Source	Unit	2023	2024	2025	2026	2027	2028	2029
FTI Annual Charter Rates XDF		**thousand USD**	**2,652**	**2,641**	**2,636**	**2,508**	**2,204**	**2,226**	**2,196**
FTI Daily Freight rates XDF	FTI	thousand USD/day	96.96	96.57	96.38	91.69	80.58	81.39	80.31
Number of days for the round trip Gladstone-Tokyo(1)	ICIS, FTI analysis	day	27.35	27.35	27.35	27.35	27.35	27.35	27.35
Fuel		**thousand USD**	**101**	**100**	**99**	**98**	**98**	**97**	**97**
HFO price	IEA Stated Policies Scenario	USD/tonne	681.69	672.63	668.17	664.90	661.95	658.77	655.47
MDO price	IEA Stated Policies Scenario	USD/tonne	733.18	723.44	718.64	715.12	711.95	708.53	704.98
HFO consumption	Maran Gas Maritime	ton/day	5	5	5	5	5	5	5
MDO consumption	Maran Gas Maritime	ton/day	1	1	1	1	1	1	1
Number of days at sea (2)	ICIS, FTI analysis	day	24.35	24.35	24.35	24.35	24.35	24.35	24.35
Boil off		**thousand USD**	**1,898**	**1,862**	**1,830**	**1,734**	**1,638**	**1,541**	**1,445**
LNG consumption	HRP	ton/day	108	108	108	108	108	108	108
Gas price (3)	ICIS EAX, ICIS medium-term price forecasts, IEA	USD/tonne	642.47	630.28	619.63	586.99	554.35	521.71	489.07
Port fees		**thousand USD**	**269**	**269**	**269**	**269**	**269**	**269**	**269**
Load fee	HRP	USD	200,119	200,119	200,119	200,119	200,119	200,119	200,119
Discharge fee	HRP	USD	68,912	68,912	68,912	68,912	68,912	68,912	68,912
Other fees		**thousand USD**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
FTI Total price of the voyage XDF		**thousand USD**	**4,932**	**4,884**	**4,847**	**4,621**	**4,221**	**4,146**	**4,019**
Average ship capacity		MMBtu	3,491,021	3,491,021	3,491,021	3,491,021	3,491,021	3,491,021	3,491,021
FTI Total price of the voyage XDF		USD / MMBTU	1.41	1.40	1.39	1.32	1.21	1.19	1.15
HRP Total price of the voyage XDF		USD / MMBTU	1.55	1.42	1.34	1.26	1.22	1.19	1.15
FTI medium-term average		**USD / MMBTU**		**1.28**					

Sources: ICIS, HRP, FTI analysis, IEA WEO 2023

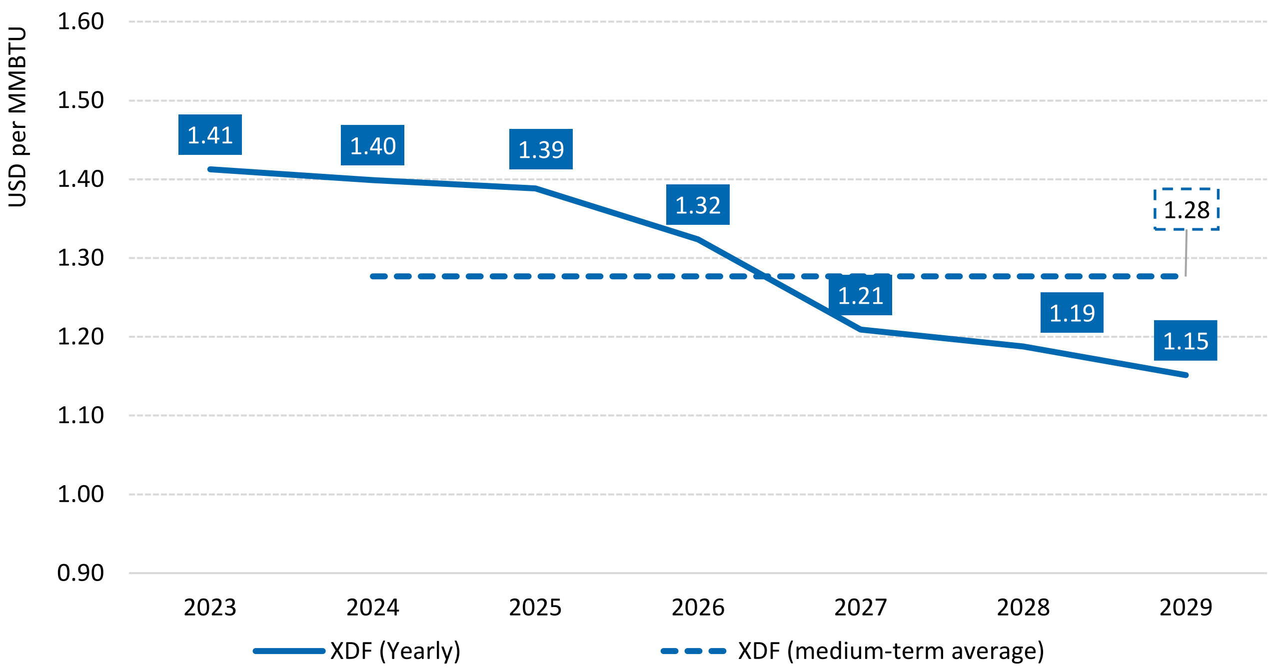
Notes: The total cost of the trip is expressed in real terms using IMF inflation estimates until 2028. The latest update is based on April 2023 IMF World Economic Outlook. https://www.imf.org/external/datamapper/datasets/WEO

(1) *The number of days for the round trip is calculated with a distance of 3,750 nm, a speed calculated as the average speed of all trips in the ICIS database above 851 nm, i.e., the shortest distance between two zones determined by FTI, for the period 2018-2021, and 3 additional days in ports.*

(2) *Same as above but without the 3 additional days in ports.*

(3) *The boil-off cost or the opportunity cost of LNG for the Gladstone-Tokyo route is based on the regional spot price for East Asia (EAX), taken as an annual average for the year 2023. For 2024-2025, the price is based on ICIS medium-term price forecast for Japan-Korea as of 13th December 2023. For the period of 2026-2029, the values are based on interpolating data between the 2025 ICIS medium-term price forecast and the available 2030 IEA Stated Policies Scenario for Japan/East Asia.*

Figure 15. Average price of shipping Gladstone-Tokyo by year and medium-term average for an XDF propulsion technology, for the period 2023-2029, in real 2023 USD/MMBtu



Source: FTI analysis

Note: The medium-term average considers the period of 2024 to 2029

44. The estimate of the medium-term average shipping price from Gladstone to Tokyo for the period 2024-2029 is 1.28 USD/MMBTU and is lower than the previous report from June 2023, published in September 2023 (1.37 USD/MMBTU over 2023-2028). The slight decrease is due to the reduction of forecasted LNG prices, an increased front-loading of the existing LNG carrier order book, and the addition of new orders for new vessels in the 2025 to 2028 period.

45. The results presented show the shipping price for the XDF technology, the soon-to-be dominant propulsion technology. Given the general price equilibrium assumed in the LNG shipping market, all technologies should offer the same price of transport (in USD per tonne-mile) on average globally. Accordingly, the shipping prices from Gladstone to Tokyo in USD/tonne-mile for the other technologies modelled (ST, DFDE/TFDE, ME-GI/ME-GA) are within a range of +/- 2% of the above XDF results.

5. Discussion of results - Cross-checks

46. The results obtained from the model are compared with alternative estimates from other sources, either (1) from future freight rate fixtures and forecasts, or (2) derived from current CAPEX of newbuild LNG carrier vessels.

5.1. Freight rates cross-checks

47. We compare the model's forecast of freight rates with two independent sources of medium-term freight rates estimates:

- **HRP data:** Average charter fixtures for 2023 to 2029, observed in the past 12 months; and
- **ICIS data:** Long-term freight rate, as estimated by ICIS.

48. The comparison is done with the freight rates of the most representative propulsion technology of the orderbook, which is expected to be the most representative of the operational fleet in the medium-term: the XDF propulsion technology.

49. Below is a table of active fixtures from HRP lasting different periods (4 months to 10 years) that we use to represent the cross-check of medium-term charter rates.

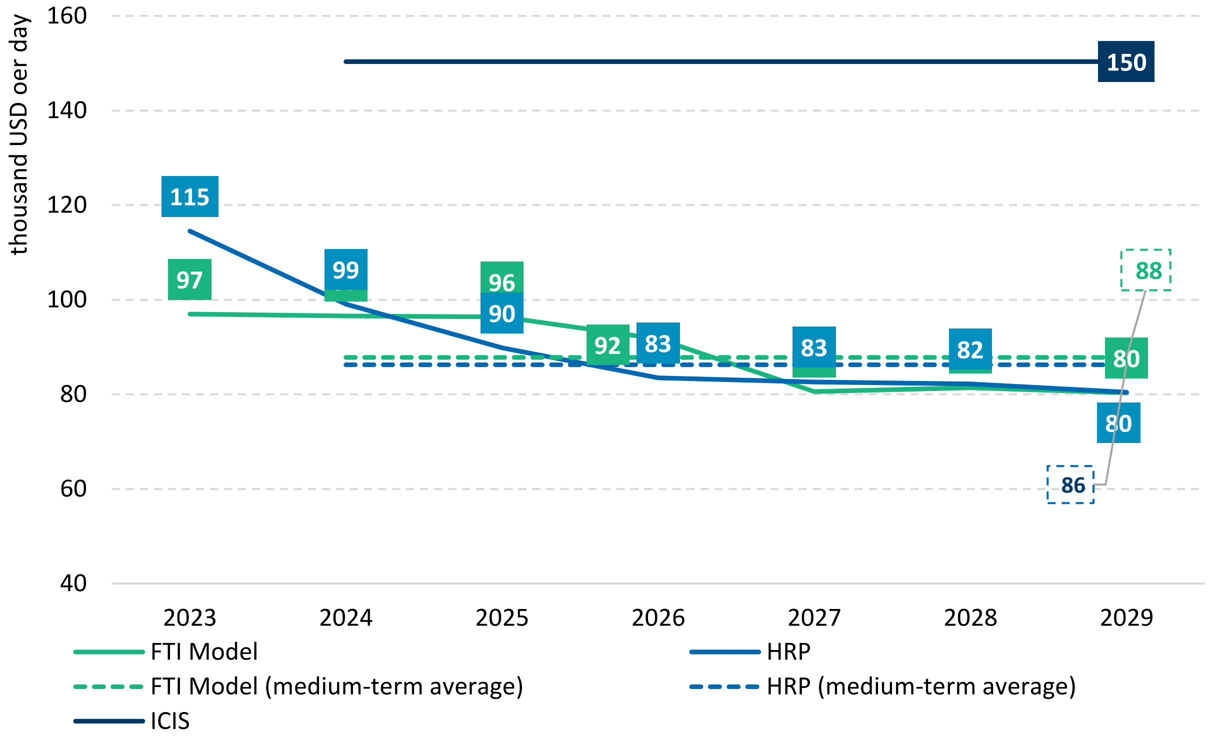
Table 2. Number of fixtures for XDF propulsion LNG carriers observed in the past 12 months, by year

Year	2023	2024	2025	2026	2027	2029
XDF	54	40	49	40	38	37

Sources: HRP, FTI analysis

50. We present below the annual average of the HRP fixtures for XDF, as well as the ICIS long-term freight rate estimate.

Figure 16. Model results and cross-checks for freight rates of XDF propulsion vessel for the period 2023-2029, in real 2023 USD/day



Sources: ICIS, HRP, FTI analysis

Note: The medium-term average considers the period of 2024 to 2029

51. The model average result (88k USD/day) is 2% higher than the HRP estimate of 86k USD/day and significantly lower (41%) than the ICIS long-term estimate of 150k USD/day.

52. We note that the model results are slightly more volatile than the cross-checks data, as the model is an annual optimisation assuming perfect information of the different stakeholders, which may differ from a limited sample of fixtures based on expectations of some market players for various future periods, as HRP collects and ICIS estimates. We however note that strong annual price variations are in line with historical price behaviours on the LNG shipping market (cf. Figure 13).

53. The long-term LNG freight rate estimate from ICIS is based on a single value, leading to a flat forecast, representing "fixtures for a chartering period of between one and seven years, with delivery to start within two years of the transaction date"[14]. As such, it represents a variety of periods which all start at a delay from current year, which is different from the medium-term

[14] ICIS, Global LNG Markets Methodology, 23 June 2021, p.19. https://cjp-rbi-icis-compliance.s3.eu-west-1.amazonaws.com/wp-content/uploads/2021/06/23112517/Global-LNG-Markets-Methodology-23-June-2021.pdf

horizon we compute. By including this delay, ICIS may also overweigh fixtures based on newbuild LNG carrier vessels that are typically set several years in advance. The actual price information used by ICIS to produce its long-term freight rate estimate is not disclosed by ICIS. We note that the ICIS estimate of long-term freight rate available for the previous report delivered in June 2023 is the same as found in December 2023, and is 12% lower than that of December 2022, which in turn is nearly three times as high as the ICIS estimate we collected in August 2022.

54. The average of HRP fixtures is computed by averaging all available HRP's freight price data (from the duration of 4 months to 10 years), which may not be representative of the trades that will take place in future annual markets. This sample, however, represents actual transaction data. We note that the average of HRP fixtures increased by 4% between June 2023 and December 2023.

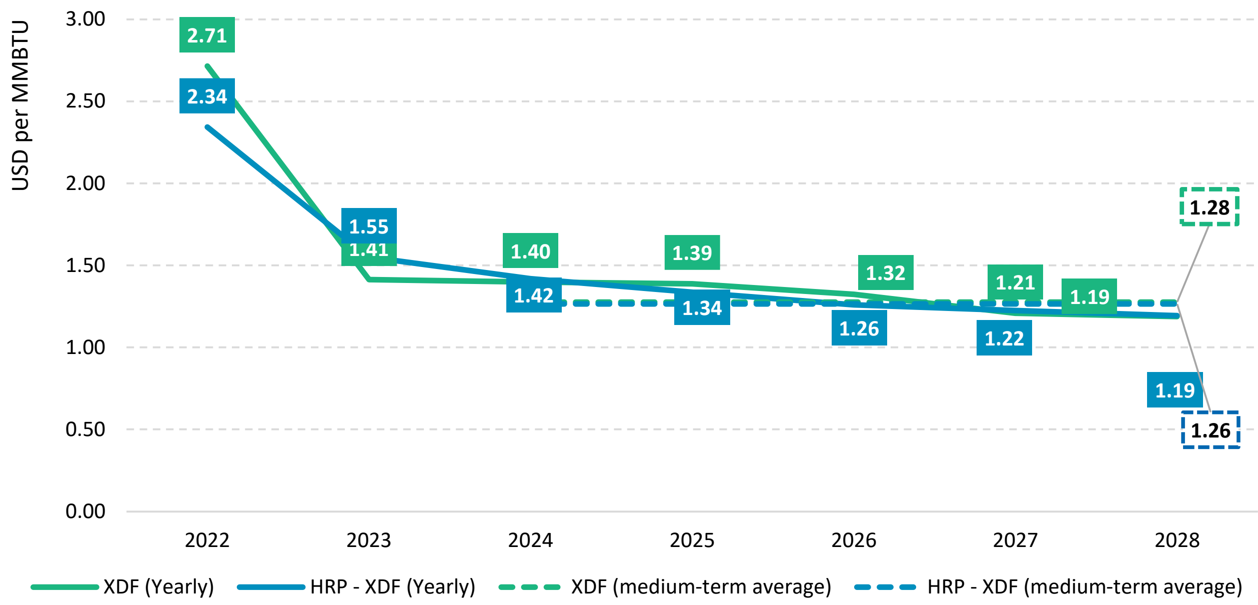
55. We note a significant difference between the ICIS estimate and the average of HRP fixtures, with the former being 1.8 times the latter. This suggests an absence of consensus on the medium-term LNG freight rate from market observers, amidst important spot freight rates movements in 2022[15], which may limit the relevance of cross-checks in the present report.

5.2. Gladstone-Tokyo route cross-checks

56. A comparison of the price of LNG transport from Gladstone, Australia, to Tokyo, Japan obtained with the model is made with HRP data (which we find may be a more relevant cross-check than ICIS, as it is based on actual transaction prices communicated to us).

[15] According to ICIS, spot LNG freight rates were multiplied by five (5) between June and November 2022.

Figure 17. Model forecast results and cross-checks for price of LNG transport Gladstone-Tokyo for the period 2023-2029, in real 2023 USD/MMBtu



Sources: ICIS, HRP, FTI analysis

Note: (1) The medium-term average considers the period of 2024 to 2029. (2) XDF and HRP -XDF (medium-term averages) are overlapping

57. The results show comparable prices for HRP data and the outputs from FTI model, with both the modelled and HRP fixtures average prices over medium-term of LNG shipping at around 1.28 USD/MMBtu. This value is slightly lower compared to the previously estimated value in June 2023 due to lower LNG price forecasts observed in the recent months.

58. Our calculated shipping costs are derived from modelled freight rates, and so the trends in variation commented earlier regarding freight rates are also applicable here for shipping costs.

5.3. CAPEX cross-check

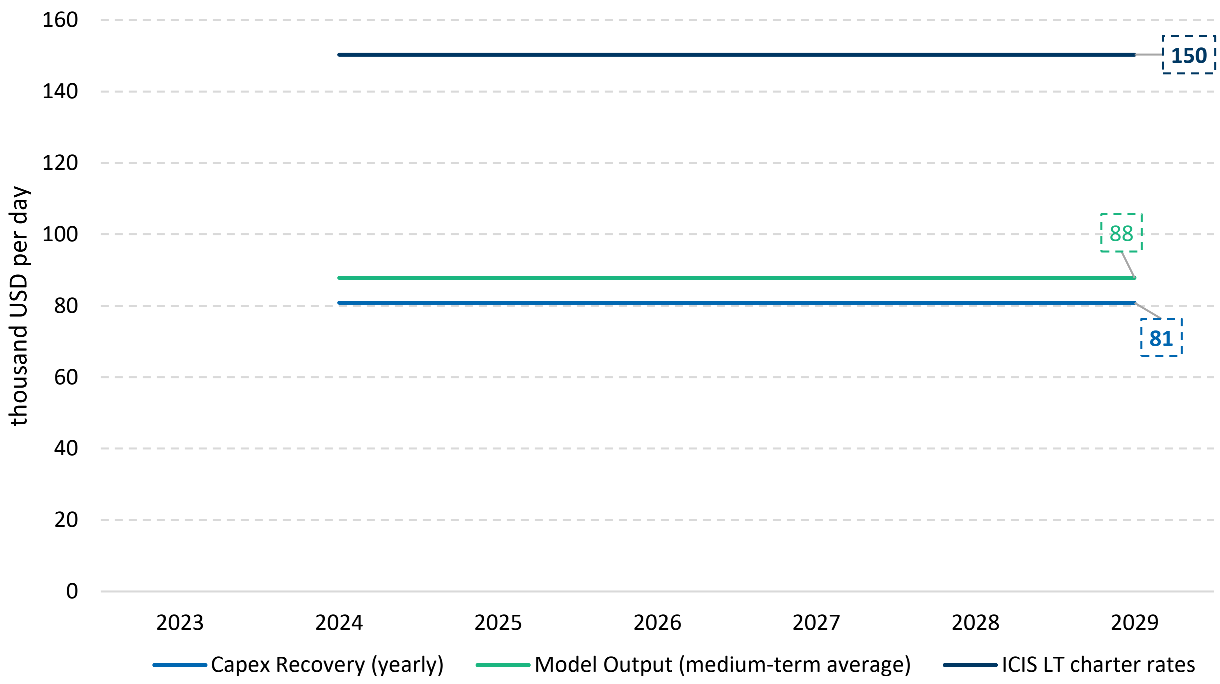
59. The CAPEX cross-check computes an indicative freight rate required to allow for the recovery of an investment in a new build LNG carrier at current CAPEX prices. Current LNG prices are estimated based on observed CAPEX for a newbuild XDF LNG carrier vessel contracted in the last 6 months, provided by HRP. Using an indicative estimate of industry Weighted Average Cost of Capital (WACC) and related time horizon[16], we define an annual CAPEX recovery payment, and add OPEX to determine the expected freight rate that can be expected for a newbuild. According to HRP, there are however significant variations in WACC at different periods of time and across shipowners, as well as different time horizons for CAPEX recovery; accordingly, this CAPEX-based

[16] Indicative industry Weighted Average Cost of Capital (WACC) of 5.9% (nominal) and investment horizon of 25 years. Source: Hellenic Shipping News. https://www.hellenicshippingnews.com/qatar-petroleums-tender-for-future-lng-ships-how-do-potential-returns-compare/

freight rate cross-check should be seen as indicative and not necessarily representing current average financing conditions, which would require specific further study to be determined robustly.

60. Indicatively, we find a yearly CAPEX recovery freight rate of 81k USD/day, which is lower than FTI's model-based forecast of the XDF freight rates, which has a medium-term average of 88k USD/day. This CAPEX recovery freight rate is based on an estimation by HRP of latest newbuilt dual strokes orders in the range of USD 260 million. The ICIS long-term charter rates are likely also to be based on newbuild prices, but they remain at 150k USD/day.

Figure 18. Long-term charter rates, model results, and CAPEX recovery yearly freight rate of newly built XDF vessels in the period 2023-2029, in real 2023 USD/day



Sources: ICIS, HRP, Hellenic Shipping News, FTI analysis
Note: ICIS long-term charter also represented as that of a similar long-term nature as CAPEX recovery charter rate
The medium-term average considers the period of 2024 to 2029