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Assessing Global LNG Bunkering Vessel Capacity and LNG-Fuelled Shipping Fleet Growth from a Supply–Demand Perspective

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ABSTRACT

Liquefied natural gas (LNG) has been widely adopted as a key marine fuel, driving rapid growth in both LNG-fuelled vessels and LNG bunkering vessels. However, whether LNG bunkering vessel capacity expansion is keeping pace with the growth of the LNG-fuelled shipping fleet remains insufficiently examined. This study provides a global supply–demand assessment of LNG bunkering vessel capacity and LNG-fuelled fleet growth using in-service and orderbook data as of January 2026. The analysis adopts a stock-based framework, using aggregate bunkering capacity and LNG-fuelled vessel numbers as proxies for supply and potential demand, respectively. A set of indicators is applied to evaluate aggregate alignment, structural characteristics, and temporal investment patterns, focusing on ship-to-ship bunkering provided by bunkering vessels. The results show that global LNG bunkering vessel capacity is expanding rapidly, with a clear scale-up trend in vessel size in the orderbook. LNG-fuelled fleet growth is highly concentrated in a limited number of vessel segments, particularly container ships and pure car carriers. At the aggregate level, bunkering vessel capacity expansion is broadly aligned with fleet growth. However, increasing concentration in shipyard delivery and geographic deployment, together with strong temporal clustering of investments, suggests potential execution risks and regional imbalances. Overall, the study provides a data-driven perspective on supply–demand alignment and highlights the importance of structural and operational considerations in evaluating LNG bunkering readiness.

Keywords: shipping decarbonisation, alternative marine fuels, LNG bunkering vessels, LNG-fuelled ships, supply–demand.

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1 INTRODUCTION

The decarbonisation of international shipping has accelerated in response to increasingly stringent regulatory frameworks at both global and regional levels. At the global scale, the International Maritime Organization (IMO) has progressively strengthened its greenhouse gas (GHG) control regime through measures such as the Energy Efficiency Design Index (EEDI) (International Maritime Organization [IMO], 2016), the Energy Efficiency Existing Ship Index (EEXI) (IMO, 2021a), and the Carbon Intensity Indicator (CII) (IMO, 2021b), while advancing its revised GHG strategy towards net-zero emissions by or around 2050 (IMO, 2023). The proposed IMO Net-Zero Framework (NZF), which includes GHG Fuel Intensity (GFI) standards and economic measures, is scheduled for final vote in November 2026 (IMO, 2025). In parallel, the European Union (EU) has introduced binding maritime measures, including the inclusion of shipping in the EU Emissions Trading System (ETS) and the FuelEU Maritime regulation (European Commission, n.d.), imposing both carbon pricing and fuel-intensity constraints on ships calling at EU ports. Together, these regulatory developments have substantially increased compliance pressure on shipowners and accelerated the adoption of alternative marine fuels.

Within this regulatory context, liquefied natural gas (LNG) has emerged as the most widely deployed marine fuel (Clarksons Research, n.d.). LNG enables immediate compliance with sulphur and nitrogen oxide emission limits and offers moderate reductions in carbon dioxide emissions compared with conventional marine fuels, while relying on relatively mature engine technologies and established cryogenic handling practices (Balcombe et al., 2021; Fan et al., 2021; Jeon et al., 2026; Lee et al., 2020; Wang et al., 2021). Importantly, LNG-fuelled ships can meet near-term regulatory requirements without fundamental changes to vessel design or operational concepts, making LNG a pragmatic compliance option, particularly for deep-sea vessels (Balcombe et al., 2021; Koh et al., 2020; Tam et al., 2019).

Compared with other alternative fuels, such as green methanol, green ammonia, and green hydrogen, LNG currently benefits from higher technological readiness, broader engine availability, and a more developed global supply chain. Methanol offers simpler storage and handling but faces constraints related to fuel availability (Cui et al., 2025; Shen, 2024), while ammonia and hydrogen promise near-zero carbon pathways but remain challenged by low technology maturity, safety considerations, and the lack of scalable fuel production (Fan, Abdussamie, et al., 2025; Fan, Chen, et al., 2025; Hammer et al., 2025; Lloyd's Register, 2026). As a result, LNG has been adopted at scale ahead of these fuels. At the same time, concerns regarding fossil LNG's long-term compatibility with decarbonisation objectives have shifted attention towards renewable and low-carbon LNG, including bio-LNG and synthetic LNG (Hine, 2022; SEA-LNG, 2025). These fuels are chemically compatible with existing LNG-fuelled engines and bunkering systems, offering a pathway to progressively reduce lifecycle emissions (DNV, 2026; European Biogas Association et al., 2020; Watanabe et al., 2022).

Despite extensive literature on LNG-fuelled ships and LNG bunkering, such as planning (Guo et al., 2024; He et al., 2024); technologies (Wen et al., 2025; Yang et al., 2025), emissions (Kim et al., 2026; Xu & Yang, 2020), safety (Čapalija et al., 2025; Fan et al., 2023), and costs (Balcombe et al., 2021; Jeong & Yun, 2023; Wang et al., 2021), little research has quantitatively assessed whether the expansion of LNG bunkering capacity is keeping pace with the growth of the LNG-fuelled shipping fleet. Existing studies often focus on existing fleet counts or regional case studies (Butarbutar et al., 2023; Rozmarynowska-Mrozek, 2015), while forward-looking indicators embedded in vessel orderbooks remain underexplored. In particular, the alignment between bunkering vessel capacity and bunker demand has not been systematically examined at the global level. To address these gaps, this study provides a global, data-driven assessment of LNG bunkering vessel capacity versus LNG-fuelled shipping fleet growth using comprehensive in-service and orderbook vessel-level datasets as of January 2026. The analysis is guided by the following research questions (RQs):

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- **RQ1** (Aggregate alignment): To what extent is LNG bunkering vessel capacity aligned with the LNG-fuelled shipping fleet at both the current (in-service) and forward-looking (orderbook) levels?
- **RQ2** (Structural alignment): How do the structural characteristics of LNG bunkering vessel capacity compare with the composition of LNG-fuelled shipping demand?
- **RQ3** (Temporal dynamics): How are supply and demand developments temporally aligned, and what structural or regional mismatches may emerge from current investment patterns?

By explicitly examining fleet size, aggregate LNG tank capacity, vessel type distribution, ordering dynamics, and market concentration on both the supply and demand sides, this study offers quantitative insights into capacity adequacy and structural alignment. The findings aim to inform fleet planning, investment strategies, and policy discussions on the evolving role of LNG, and its transition towards bio-LNG and synthetic LNG, in maritime decarbonisation pathways.

Beyond its empirical findings, this study contributes to literature by developing an integrated analytical framework for assessing the alignment between alternative fuel bunkering capacity and fleet development. The framework combines stock-based capacity indicators, structural concentration measures, and temporal investment dynamics to capture the configuration and timing of supply–demand interactions. While not intended as a formal theoretical model, the framework provides a structured basis for analysing bunkering capacity–fleet co-evolution under data constraints and may be applicable to other alternative fuel pathways in maritime transport.

2 DATA AND METHODOLOGY

This section describes the data sources, scope definition, and quantitative framework adopted to evaluate the alignment between LNG bunkering capacity and LNG-fuelled fleet growth. The analysis is based on vessel-level in-service and orderbook data and employs a set of stock-based and structural indicators to assess fleet scaling, demand concentration, and temporal synchronisation. Stock-based indicators refer to measures derived from the aggregate installed or contracted capacity of assets at a given point in time, rather than operational fuel throughput or annual consumption flows.

2.1 Data Sources and Scope

This study is based on two global vessel-level datasets covering LNG bunkering vessels and LNG-fuelled ships, compiled and cross-validated from four primary industry data sources: the Clarksons Research vessel database (Clarksons Research, n.d.), the Society for Gas as a Marine Fuel (SGMF) vessel database (Society for Gas as a Marine Fuel [SGMF], n.d.), the SEA-LNG Bunker Navigator database (SEA-LNG, n.d.), and the DNV Alternative Fuels Insight (AFI) platform (DNV, n.d.). Together, these sources provide comprehensive and complementary coverage of LNG-fuelled ships and LNG bunkering vessels at the global level. Clarksons Research serves as the primary source for vessel data. The DNV AFI database provides systematically curated information on alternative-fuelled ships. The SGMF and SEA-LNG databases complement these sources, offering detailed insights into vessels.

Cross-referencing these four datasets enables consistency checks and validation of data. Discrepancies across sources are resolved through comparison of multiple fields, including vessel type, contract year, and delivery status, thereby improving data robustness and reducing uncertainty. The combined datasets include vessels that are in service and on order as of January 2026. For LNG bunkering vessels, key variables include

LNG tank capacity, vessel status, build and contract years, shipyard, owning or operating company, and declared service area. In this study, LNG bunkering vessels with an LNG tank capacity below 1,000 m^3 are excluded, as these vessels primarily serve small domestic ships and fall outside the scope of the present analysis. For LNG-fuelled ships, the dataset includes vessel type, status, build and contract years, shipyard, owning or operating company, and propulsion characteristics. These variables provide a consistent basis for assessing both current market conditions and forward-looking developments in LNG marine fuel supply and demand.

2.2 System Boundary

On the supply side, this study defines LNG bunkering capacity exclusively in terms of dedicated LNG bunkering vessels that provide ship-to-ship (STS) services. These vessels represent the most flexible and scalable form of LNG fuel supply, particularly for seagoing ships operating across multiple ports and along major liner routes. Shore-based station-to-ship and truck-to-ship bunkering are not considered. While both modes play an important role in the early stages of LNG adoption and in specific port contexts, they are inherently constrained by local infrastructure, port availability, and regulatory conditions. Shore-based station bunkering capacity is closely tied to fixed assets and port-specific layouts, making it difficult to quantify consistently at the global level. Truck-to-ship bunkering, by contrast, is typically characterised by small transfer volumes, lower operational efficiency, and limited suitability for large vessels. As a result, neither mode provides a scalable or globally comparable measure of LNG bunkering capacity capable of supporting the rapid expansion of deep-sea LNG-fuelled shipping.

On the demand side, the analysis focuses on LNG-fuelled ships that rely on external bunkering services. LNG carriers, LNG bunkering vessels, and regasification units are excluded from the core demand assessment, as these vessels typically utilise onboard cargo boil-off gas or internal fuel arrangements and therefore do not represent conventional bunkering demand. Following this screening, the demand dataset primarily comprises non-carrier LNG-fuelled vessels, including container ships, pure car carriers, tankers, bulk carriers, cruise ships, and other commercial vessel types. Consistent with this scope, conventional LNG import and export terminals are not included in the supply-side assessment. Although they form part of the broader LNG logistics chain, such terminals are generally designed for LNG carrier operations rather than for direct bunkering of non-LNG carrier vessels. Under prevailing safety protocols and operational practices (Society of International Gas Tanker and Terminal Operators, 2024), LNG-fuelled ships are typically not permitted to conduct bunkering operations at LNG terminals. As a result, terminal capacity does not represent practically accessible bunkering supply for the vessel segments considered in this study.

It should be noted that LNG-fuelled vessel numbers are used as a proxy for potential bunkering demand rather than actual LNG consumption. Actual fuel demand depends on operational factors such as vessel utilisation, routing, and engine load, which are not consistently available at the global level. The approach adopted therefore focuses on stock-based demand capacity for the purpose of assessing supply–demand alignment.

2.3 Supply-Side Assessment of LNG Bunkering Capacity

LNG bunkering supply is evaluated by examining both the scale and structure of the global bunkering vessel fleet. Fleet size and aggregate LNG tank capacity are analysed separately for in-service and on-order vessels to distinguish between current capacity and committed future expansion.

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To capture investment dynamics, contracting and delivery patterns are analysed using contract and build year information. In addition, the distribution of bunkering capacity by owning or operating company, shipyard, and declared service area is examined to identify structural concentration and potential regional imbalances in supply availability. Together, these indicators provide a comprehensive picture of how LNG bunkering capacity is evolving.

2.4 Demand-Side Assessment of LNG-Fuelled Fleet Growth

Growth in LNG-fuelled shipping demand is assessed using fleet size, vessel-type composition, and ordering dynamics for LNG-fuelled ships. The analysis distinguishes between in-service vessels and those on order to capture both realised and anticipated demand growth. Vessel type is used to identify segments that are driving LNG fuel adoption and to assess the degree of demand concentration.

Rather than estimating absolute LNG consumption volumes, which would require detailed operational and route-specific data, fleet growth and vessel-type composition are used as proxies for relative bunkering demand pressure. This approach allows for consistent global comparison while remaining grounded in the available vessel-level data.

2.5 Supply–Demand Matching Framework

To quantitatively evaluate the alignment between LNG bunkering capacity and the growth of the LNG-fuelled shipping fleet, this study develops a set of supply, demand, and matching indicators based on vessel-level data. The framework is designed to assess capacity adequacy, structural alignment, and temporal synchronisation.

2.5.1 Quantification of LNG bunkering supply

LNG bunkering supply is represented by the aggregate LNG tank capacity of dedicated LNG bunkering vessels. For a given time horizon *t*, the nominal LNG bunkering tank capacity (C_t^{BV}, m³) at time *t* is defined as:

$$C_t^{BV} = \sum_{i=1}^{N_t} V_i \tag{1}$$

where V_i is the LNG tank capacity (m³) of bunkering vessel i, and N_t is the number of LNG bunkering vessels considered at time *t*.

In addition to aggregate capacity, vessel scale is characterised using the median LNG capacity ($\tilde{V}_t$) of the LNG bunkering vessel fleet:

$$\tilde{V}_t = median\ (V_i) \tag{2}$$

This indicator is used to identify structural changes in bunkering vessel size, particularly the scaling-up trend observed in recent orderbooks.

2.5.2 Quantification of LNG-fuelled shipping demand

On the demand side, LNG fuel demand is proxied by the size and structure of the LNG-fuelled shipping fleet. The nominal demand size (D_t, number of ships) at time *t* is defined as:

$$D_t = \sum_{j=1}^{M_t} 1 \tag{3}$$

where M_t is the number of LNG-fuelled ships at time *t*.

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2.5.3 Supply–demand matching indicators

Based on the above definitions, a supply-to-demand ratio (SDR) is constructed to evaluate the adequacy of LNG bunkering capacity relative to fleet growth:

$$SDR_t = \frac{C_t^{BV}}{D_t} \tag{4}$$

The SDR is interpreted as a capacity-based indicator (m³ per vessel) rather than a direct measure of fuel supply–demand balance. An increase in SDR indicates improving capacity availability per LNG-fuelled ship, while a decrease implies rising supply pressure. Comparing SDR values across different time horizons allows the assessment of whether committed bunkering capacity expansion is keeping pace with anticipated demand growth.

2.5.4 Temporal alignment analysis

To examine the temporal alignment between bunkering capacity expansion and LNG-fuelled fleet growth, annual contracting activity is analysed using contract-year data. Annual increments in bunkering capacity (ΔC_y) and annual increments in LNG-fuelled ship demand (ΔD_y) are defined as:

$$\Delta C_y = \sum_{i \in y} V_i \tag{5}$$

$$\Delta D_y = \sum_{j \in y} 1 \tag{6}$$

where *y* denotes the contract year.

Rather than estimating statistical correlations, the analysis focuses on the co-movement and concentration of contracting activity over time. This approach provides insights into the temporal relationship between LNG bunkering vessel investments and LNG-fuelled ship ordering, indicating whether investment patterns are aligned with or lag behind fleet development, without implying causality.

2.5.5 Structural concentration metrics

To assess structural concentration and potential regional imbalances in LNG bunkering supply availability, the distribution of nominal bunkering tank capacity C_t^{BV} (m³) is examined by owning company, shipyard, and declared service area. Concentration is quantified using (i) the share of the top five entities by capacity and (ii) the Herfindahl–Hirschman Index (HHI) computed from capacity shares (HHI ranges from 0 to 1, with higher values indicating stronger concentration). The Herfindahl–Hirschman Index (HHI) is calculated as the sum of squared market shares and is widely used to assess market concentration (Rhoades, 1993), see Equation (7). In this study, HHI values are interpreted following the 2023 U.S. Department of Justice and Federal Trade Commission Merger Guidelines. Markets with an HHI below 0.10 are considered unconcentrated, values between 0.10 and 0.18 indicate moderate concentration, and values above 0.18 indicate high concentration (U.S. Department of Justice & Federal Trade Commission, 2023).

$$HHI = \sum_{i=1}^{N} s_i^2 \tag{7}$$

where s_i is the capacity share of entity *i*.

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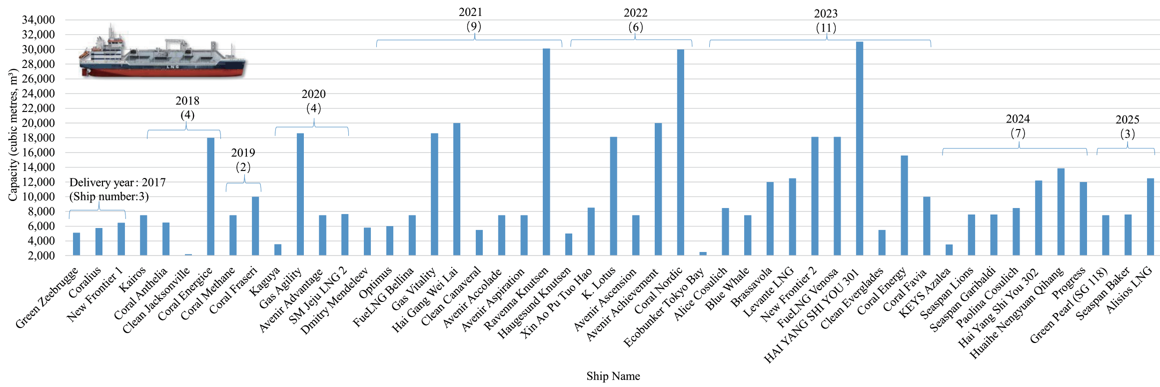
3 RESULTS

This section presents the empirical results of the global supply–demand assessment based on vessel-level in-service and orderbook data as of January 2026. The analysis first examines the overall market scale, including aggregate LNG bunkering capacity and LNG-fuelled fleet size. It then evaluates supply-side developments in terms of vessel scale and ordering patterns, followed by demand-side growth and structural composition. Finally, aggregate supply–demand alignment is assessed using the stock-based supply–demand ratio, structural concentration metrics, and annual investment increments.

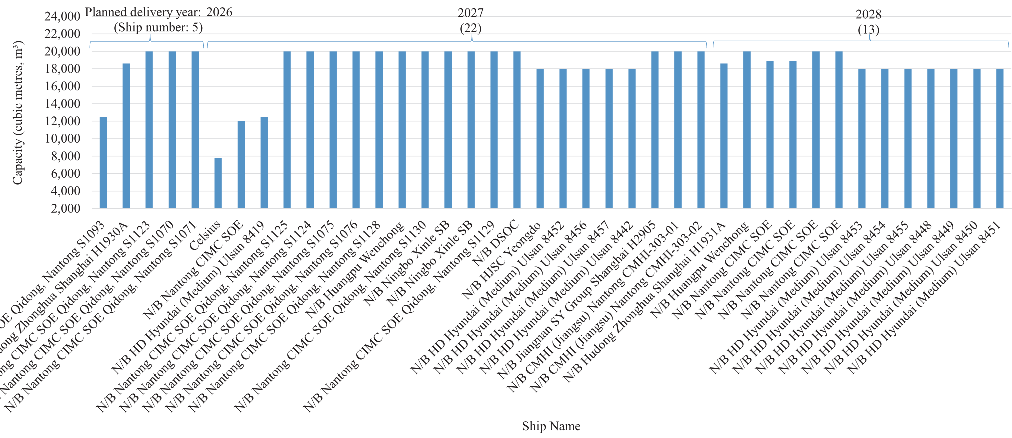
3.1 Global Market Overview

The global market is assessed by jointly examining the nominal bunkering tank capacity C_t^{BV} and the LNG-fuelled fleet size D_t. Because these variables have different units, their relationship is evaluated using the supply-to-demand ratio $\mathrm{SDR}_t = C_t^{BV}/D_t$ (m³/ship number). This indicator provides a normalised measure of nominal bunkering tank capacity per LNG-fuelled ship and is used here as a stock-based proxy for fleet scaling.



Notes: All vessels are derived from the vessel-level in-service dataset as of January 2026 (Clarksons Research, n.d.; DNV, n.d.; SEA-LNG, n.d.; SGMF, n.d.); a few vessels are converted from small LNG carriers, and the delivery year refers to their entry into service as bunkering vessels.

Figure 1. In-service LNG bunkering vessels.



Notes: All vessels are derived from the vessel-level orderbook dataset as of January 2026 (Clarksons Research, n.d.; DNV, n.d.; SEA-LNG, n.d.; SGMF, n.d.)

Figure 2. On-order LNG bunkering vessels.

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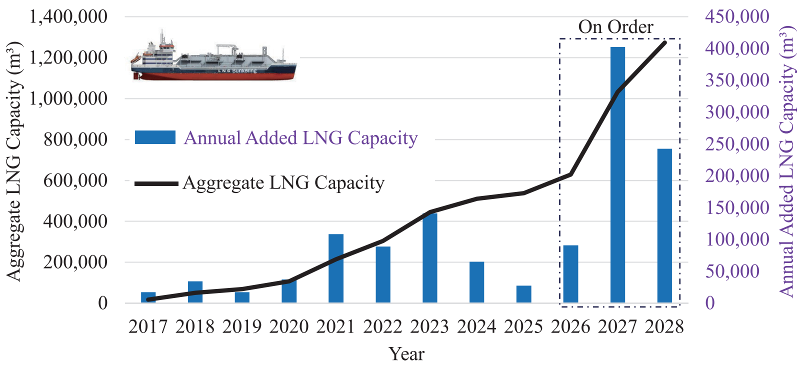
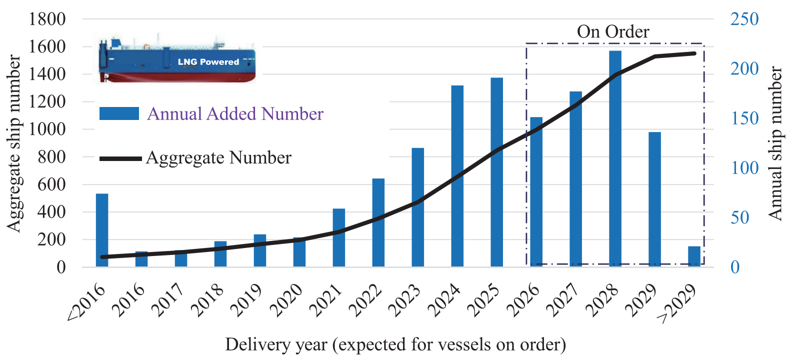
As of January 2026, the global LNG bunkering vessel fleet comprises 89 vessels, including 49 vessels in service and 40 vessels on order. Figure 1 illustrates the distribution of in-service LNG bunkering vessels, while Figure 2 presents those currently on order. The corresponding aggregate LNG tank capacities amount to 538,184 m³ for the in-service fleet and 735,800 m³ for the orderbook. Figure 3 depicts the annual additions to LNG bunkering tank capacity and the cumulative aggregate capacity over the period 2017–2028.



Notes: Data are derived from vessel-level in-service and orderbook datasets as of January 2026 (Clarksons Research, n.d.; DNV, n.d.; SEA-LNG, n.d.; SGMF, n.d.).

Figure 3. Trends in LNG bunkering tank capacity.



Notes: Data are derived from vessel-level in-service and orderbook datasets as of January 2026 (Clarksons Research, n.d.; DNV, n.d.; SEA-LNG, n.d.; SGMF, n.d.).

Figure 4. Trends in the number of LNG-fuelled vessels.

On the demand side, the global LNG-fuelled shipping fleet consists of 1,550 vessels, including around 847 vessels in service and 703 vessels on order. Figure 4 shows the temporal evolution of LNG-fuelled vessels in service and on order. The in-service fleet increases steadily from 2017, with growth accelerating markedly after 2021. The orderbook rises sharply from 2023 onward, indicating a surge in contracting activity and strong forward momentum in LNG adoption. The apparent decline in vessel numbers beyond 2029 does not reflect a reduction in market demand, but rather the current data boundary, which includes firm contracts placed up to January 2026. Additional orders placed in 2026 and beyond are expected to extend the delivery profile further into the early 2030s.

Table 1 summarises the key values and the implied SDR_t. At the aggregate level, the normalised ratio SDR_t suggests that committed bunkering capacity expansion is broadly consistent with anticipated fleet growth. This provides an initial indication of aggregate supply–demand alignment, directly addressing RQ1.

Table 1. Global overview of LNG bunkering supply and LNG-fuelled fleet growth.

Item	In service	On order
LNG bunkering vessels (>1,000 m^3), number	49	40
C_t^{BV}	538,184	735,800
D_t	847	703
SDR_t	635	1,047

Notes: Data are derived from vessel-level in-service and orderbook datasets as of January 2026 (Clarksons Research, n.d.; DNV, n.d.; SEA-LNG, n.d.; SGMF, n.d.); SDR is a stock-based normalised indicator (m^3/ship) and does not represent annual fuel throughput.

3.2 Supply-Side Results: LNG Bunkering Vessels

Supply-side developments are assessed using the nominal bunkering capacity indicator C_t^{BV}, the vessel scale indicator $\tilde{V}_t$, and the annual capacity increment ΔC_y. These indicators jointly describe the scale, structure, and timing of LNG bunkering fleet investment.

3.2.1 Scale and structure of bunkering capacity

As of January 2026, the in-service bunkering fleet comprises 49 vessels with an aggregate LNG cargo capacity of 538,184 m^3. In contrast, the orderbook comprises 40 vessels with a total cargo capacity of approximately 735,800 m^3. While the number of vessels on order is smaller than the in-service fleet, the associated aggregate capacity is significantly larger. More importantly, the median LNG cargo capacity of bunkering vessels increases substantially from 7,600 m^3 in the in-service fleet to 19,450 m^3 in the orderbook. This shift in $\tilde{V}_t$ provides clear quantitative evidence that recent capacity expansion is driven primarily by vessel scale rather than by vessel count, indicating a structural transition towards higher-throughput bunkering assets.

3.2.2 Timing of bunkering capacity expansion

The timing of supply-side investment is analysed using the annual capacity increment ΔC_y. As shown in Table 2, LNG bunkering vessel orders in the orderbook are highly concentrated in recent years, with the majority of contracted capacity committed in 2025. Compared with the more gradual accumulation of the in-service fleet, this pattern indicates a decisive acceleration in investment. The concentration of ΔC_y suggests that bunkering capacity expansion is forward-looking, reflecting expectations of near-term LNG-fuelled fleet growth rather than a response to historical demand alone.

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Table 2. Annual increments in LNG bunkering tank capacity by contract year.

Contract year	Number of vessels ordered	ΔC_y (m^3)	Share of total orderbook capacity (%)
2023	2	40,000	5
2024	15	265,600	36
2025	23	430,200	59

Notes: Data are derived from the vessel-level orderbook dataset as of January 2026 (Clarksons Research, n.d.; DNV, n.d.; SEA-LNG, n.d.; SGMF, n.d.).

3.2.3 Structural concentration and potential regional imbalances in bunkering supply

Capacity ownership is relatively dispersed in both the in-service and orderbook fleets, see Table 3. For the in-service fleet, the top five owning companies account for 52.4% of total in-service capacity (HHI=0.080). For the orderbook fleet, the top five account for 40.3% (HHI=0.067), suggesting slightly less concentration than the in-service fleet in capacity ownership.

Table 3. Top 5 owning companies by LNG bunkering capacity (m^3).

	Rank	Owning company	Capacity (m^3)	Share (%)
In service	1	Anthony Veder	103,337	19.2
	2	Mitsui OSK Lines	49,200	9.1
	3	Korea Line LNG	43,928	8.2
	4	CenerTech	43,247	8.0
	5	Avenir LNG	42,500	7.9
	Top 5 total	/	282,212	52.4 (HHI: 0.080)
On order	1	Ibaizabal Tankers	73,200	9.9
	2	Eastern Pacific Shipping	72,000	9.8
	3	Evalend Shipping	72,000	9.8
	4	Avenir LNG	40,000	5.4
	5	Continental Kapital	40,000	5.4
	Top 5 total	/	297,200	40.3 (HHI: 0.067)

Notes: Data are derived from vessel-level in-service and orderbook datasets as of January 2026 (Clarksons Research, n.d.; DNV, n.d.; SEA-LNG, n.d.; SGMF, n.d.).

Table 4 presents the top 5 shipyards by LNG bunkering tank capacity. For the in-service fleet, the top 5 shipyard HHI is 0.118, indicating moderate concentration. In contrast, the orderbook shipyard HHI increases significantly to 0.264, reflecting a high degree of concentration in future capacity delivery. This sharp rise in

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concentration suggests that upcoming bunkering capacity expansion is structurally dependent on a small number of large shipyards, thereby increasing exposure to shipyard-level execution risks and potential delivery bottlenecks.

Table 4. Top 5 shipyards by LNG bunkering tank capacity (m^3).

	Rank	Shipyard	Capacity (m^3)	Share (%)
In service	1	Hyundai Mipo Dockyard (South Korea)	133,632	24.8
	2	Keppel Offshore & Marine (Singapore)	42,500	7.9
	3	Kawasaki Heavy Industries (Japan)	40,000	7.4
	4	Hudong–Zhonghua (China)	38,000	7.1
	5	Hanwha Ocean (South Korea)	37,000	6.9
	Top 5 total	/	291,132	54.1 (HHI=0.118)
On order	1	Nantong CIMC SOE (China)	302,300	41.1
	2	HD Hyundai (South Korea)	210,500	28.6
	3	CMHI (China)	40,000	5.4
	4	Huangpu Wenchong (China)	40,000	5.4
	5	Ningbo Xinle (China)	40,000	5.4
	Top 5 total	/	632,800	86.0 (HHI=0.264)

Notes: Data are derived from vessel-level in-service and orderbook datasets as of January 2026 (Clarksons Research, n.d.; DNV, n.d.; SEA-LNG, n.d.; SGMF, n.d.).

Declared service areas are available mainly for in-service bunkering vessels, as presented in Table 5. The distribution shows a strong regional concentration: Europe alone represents 45.7% of in-service bunkering capacity, and the top five areas account for 90.3% (HHI=0.269). This indicates that, even if global aggregate capacity expands, regional availability may remain uneven, with supply more mature in a small number of established markets.

Table 5. Top 5 declared service area distribution of in-service LNG bunkering capacity.

Rank	Service area	Capacity (m^3)	Share (%)
1	Europe	245,831	45.7
2	China	85,597	15.9
3	US	73,327	13.6
4	Singapore	58,608	10.9
5	Canada	22,800	4.2
Top 5 total	/	486,163	90.3 (HHI=0.269)

Notes: Data are derived from the vessel-level in-service dataset as of January 2026 (Clarksons Research, n.d.; DNV, n.d.; SEA-LNG, n.d.; SGMF, n.d.).

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Overall, the concentration analysis suggests that (i) capacity ownership is relatively dispersed, (ii) orderbook capacity delivery is more vulnerable to shipyard concentration, and (iii) regional availability remains highly concentrated in a limited set of regions for the in-service fleet. These structural features help explain why aggregate indicators may suggest broad alignment, while localised bottlenecks can still occur in practice. These structural characteristics provide evidence for assessing the degree of alignment between supply configuration and demand composition, as posed in RQ2.

3.3 Demand-Side Results: LNG-Fuelled Shipping Fleet Growth

Demand-side developments are evaluated using the fleet size indicator D_t and the annual increment in LNG-fuelled ship orders ΔD_y.

3.3.1 Fleet growth and structural concentration

The composition of the LNG-fuelled shipping fleet by vessel type is summarised in Table 6. Growth in LNG-fuelled shipping is highly concentrated in a small number of deep-sea vessel segments. Container ships account for the largest share of both the in-service fleet and the orderbook, followed by pure car carriers. Together, these segments dominate the growth of D_t.

Table 6. LNG-fuelled shipping fleet by major vessel type.

Vessel type	In service (number)	On order (number)	Orderbook-to-in service ratio
Container ships	233	411	1.76
Pure car carriers	124	108	0.87
Tankers	76	44	0.58
Bulk carriers	68	31	0.46
Cruise ships	36	34	0.94
Other vessel types	310	75	0.24
Total	847	703	0.83

Notes: Data are derived from vessel-level in-service and orderbook datasets as of January 2026 (Clarksons Research, n.d.; DNV, n.d.; SEA-LNG, n.d.; SGMF, n.d.).

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3.3.2 Timing of demand growth

The temporal evolution of LNG-fuelled ship contracting is captured by ΔD_y. As summarised in Table 7, contracting activity accelerates markedly after 2023, with a strong clustering of orders in 2024 and 2025. This pattern indicates that growth in D_t is expected to materialise in relatively concentrated waves rather than through smooth, linear expansion.

Table 7. Annual increments in LNG-fuelled ship orders by contract year.

Contract year	ΔD_y (Number of LNG-fuelled ships ordered)	Share of total orderbook (%)
≤2022	71	10
2023	121	17
2024	311	44
2025	199	29
Total	702	100

Notes: Data are derived from the vessel-level orderbook dataset as of January 2026 (Clarksons Research, n.d.; DNV, n.d.; SEA-LNG, n.d.; SGMF, n.d.); one order in 2026 is not included.

3.4 Supply–Demand Matching and Implications

At the aggregate level, the stock-based supply–demand ratio (SDR_t in Table 1) indicates that committed bunkering capacity expansion is broadly consistent with LNG-fuelled fleet growth. The in-service fleet corresponds to 635 m^3 of bunkering tank capacity per LNG-fuelled vessel, while the orderbook represents an even larger forward capacity base relative to the contracted fleet. This suggests that, from a global stock perspective, bunkering fleet scaling is not lagging fleet adoption.

However, structural indicators reveal a more nuanced picture. Shipyard concentration increases significantly in the forward pipeline, with HHI rising from 0.118 (moderate concentration) in the in-service fleet to 0.264 (high concentration) in the orderbook. This indicates that future bunkering capacity deployment is increasingly dependent on a limited number of large shipyards, thereby heightening execution and delivery risk. In contrast, ownership concentration remains relatively low, suggesting that operational control of bunkering capacity is not highly centralised.

Geographically, the in-service fleet exhibits strong regional clustering, with an HHI of 0.269 and nearly half of capacity located in Europe. This implies that global aggregate adequacy does not necessarily translate into corridor-level sufficiency, particularly in emerging LNG-fuelled trade routes.

Temporal alignment further reinforces the coordinated nature of supply and demand expansion. In the orderbooks, 95% (ΔC_y) of total contracted bunkering capacity and 73% (ΔD_y) of LNG-fuelled ship orders were placed during 2024–2025. The correspondence between ΔC_y and ΔD_y suggests anticipatory investment behaviour rather than reactive expansion.

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Overall, while aggregate stock indicators demonstrate broad supply–demand alignment, structural and temporal concentration patterns indicate increasing sensitivity to execution risk and regional imbalance. The market therefore appears to be transitioning from concerns over capacity sufficiency to concerns over structural resilience. The observed synchronisation of investment cycles and the presence of structural and regional concentration patterns provide a basis for evaluating temporal alignment and emerging mismatches, as framed in RQ3.

4 DISCUSSION

The quantitative results provide a structured basis for interpreting how LNG bunkering fleet investment is evolving relative to LNG-fuelled fleet growth. By combining stock-based indicators of bunkering capacity (C_t^{BV}), fleet-based demand proxies (D_t), and contract-year dynamics (ΔC_y and ΔD_y), the analysis moves beyond descriptive trends and offers insight into the scale, structure, and timing of market development.

4.1 Aggregate Scaling of Bunkering Investment Relative to LNG-Fuelled Fleet Growth

At the aggregate level, the results indicate that LNG bunkering fleet investment is broadly scaling in line with LNG-fuelled fleet expansion. The aggregate LNG tank capacity of bunkering vessels on order exceeds that of the in-service bunkering fleet. When normalised using the supply-to-demand ratio (SDR_t), the implied nominal bunkering capacity per LNG-fuelled ship remains broadly stable between the current fleet and the combined in-service and orderbook scenario.

This finding is significant because it suggests that bunkering vessel fleet investment is not systematically lagging behind LNG-fuelled fleet. Instead, the bunkering sector appears to be responding proactively to anticipated growth in LNG-fuelled shipping. Importantly, this conclusion does not imply physical fuel sufficiency but rather indicates alignment between investment scale and fleet growth expectations at a global level.

4.2 Structural Concentration and Resilience Implications

Although aggregate stock-based indicators suggest broad alignment between bunkering capacity expansion and LNG-fuelled fleet growth, structural metrics reveal important concentration-related risks. Ownership concentration remains relatively dispersed. The top five owning companies account for approximately 52% of in-service bunkering capacity and 40% of orderbook capacity, with corresponding HHI values of 0.080 and 0.067. Under the HHI thresholds, these values indicate low concentration, suggesting that operational control of bunkering assets is not highly centralised.

In contrast, shipyard concentration increases markedly in the forward pipeline. The shipyard HHI rises from 0.118 for the in-service fleet (moderate concentration) to 0.264 for the orderbook (high concentration), while the top five yards account for 54% and 86% of capacity, respectively. This shift implies that future bunkering capacity deployment is structurally dependent on a small number of large shipbuilders, increasing exposure to delivery delays, production bottlenecks, and supply chain constraints in cryogenic systems.

Regional distribution further highlights potential imbalance. The in-service fleet exhibits a service-area HHI of 0.269, with Europe alone accounting for approximately 46% of total operational capacity and the top five regions representing over 90%. Even if global supply–demand ratios remain stable, such spatial clustering implies that corridor-level adequacy may diverge from global averages, particularly along emerging LNG-fuelled trade routes.

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Overall, these findings indicate that the primary risk facing the LNG bunkering market is shifting from aggregate capacity sufficiency to structural resilience. While global investment scaling appears coordinated with fleet growth, increasing concentration in shipyard delivery and geographic deployment suggests heightened sensitivity to execution and regional mismatch risks.

4.3 Timing and Synchronisation of Supply and Demand Commitments

The temporal dimension of supply–demand alignment provides further insight into market behaviour. Both bunkering capacity investment and LNG-fuelled ship contracting are highly concentrated in the period from 2024 to 2025. Approximately 95% of new bunkering capacity and nearly three-quarters of LNG-fuelled ship orders were committed during this period, indicating strong synchronisation between supply-side and demand-side expectations.

This co-movement of ΔC_y and ΔD_y suggests that bunkering fleet investment is predominantly anticipatory rather than reactive. Such synchronisation reduces the likelihood of near-term systemic bottlenecks as new LNG-fuelled vessels enter service. However, it also implies heightened sensitivity to delivery delays, project deferrals, or changes in regulatory or market conditions, given the clustered nature of commitments on both sides of the market.

4.4 Implications for Industry Stakeholders

The quantitative findings carry several implications for industry stakeholders. For LNG bunkering operators and fuel suppliers, the results highlight the importance of vessel scale optimisation and asset utilisation. The shift towards larger bunkering vessels reflects a move away from port-specific, low-throughput operations towards network-oriented service models capable of supporting liner trades and corridor-based demand. Ensuring flexibility in deployment and avoiding excessive concentration in a limited number of service areas will be critical to managing regional imbalances.

For shipowners, the observed aggregate alignment between bunkering fleet investment and fleet growth is a positive signal, but it does not eliminate operational risk at specific ports or along specific routes. The concentration of LNG-fuelled ship deliveries within a narrow time window suggests that securing reliable bunkering access, through long-term supply agreements or strategic partnerships, remains an important risk mitigation strategy, particularly for container and vehicle carrier fleets.

For ports, the implications are operational. Although conventional LNG terminals and project-specific shore-based bunkering stations were excluded from the supply-side quantification, LNG bunkering vessels typically perform bunkering operations within ports. The results suggest that port readiness should be assessed not only in terms of fuel availability, but also in terms of compatibility with bunkering vessel operations, including berth access, safety procedures, scheduling flexibility, traffic coordination, and the ability to accommodate larger bunkering vessels serving concentrated demand segments. From a policy perspective, the strong temporal alignment between bunkering vessel investment and LNG-fuelled ship orders also suggests that stable regulatory signals can support coordinated infrastructure and fleet development during transitional fuel adoption.

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5 CONCLUSIONS

This study assesses the alignment between LNG bunkering capacity and LNG-fuelled shipping fleet growth using vessel-level in-service and orderbook data as of January 2026. By integrating stock-based indicators, structural concentration metrics, and temporal investment dynamics, the findings can be interpreted in direct relation to the RQs as follows:

- **Aggregate alignment (RQ1):** At the global level, LNG bunkering capacity is broadly aligned with LNG-fuelled fleet growth. The in-service bunkering fleet comprises 49 vessels with an aggregate capacity C_t^{BV} of 538,184 m³, corresponding to approximately 635 m³ per LNG-fuelled vessel. The orderbook adds a further 735,800 m³ across 40 vessels, compared with 703 LNG-fuelled ships on order. The resulting stock-based supply–demand ratio (SDR_t) remains stable or increases in the forward-looking scenario (1,047 m³ per vessel), indicating that committed capacity expansion is not lagging behind anticipated fleet growth.

- **Structural alignment (RQ2):** The evolution of LNG bunkering capacity is characterised by a clear scale-up in vessel size, with the median capacity ($\tilde{V}_t$) increasing from approximately 7,600 m³ in the in-service fleet to 19,450 m³ in the orderbook. On the demand side, LNG adoption is highly concentrated in a limited number of vessel segments, particularly container ships (233 in service; 411 on order) and pure car carriers (124 in service; 108 on order). While this suggests broad structural alignment between supply scaling and demand concentration, it also indicates increasing demand intensity along major deep-sea trade routes.

- **Temporal alignment and emerging mismatches (RQ3):** Supply and demand developments are strongly synchronised in time. Approximately 95% of new bunkering capacity (ΔC_y) and 73% of LNG-fuelled ship orders (ΔD_y) were contracted during 2024–2025, indicating anticipatory investment behaviour. However, structural and regional mismatches persist. Shipyard concentration increases significantly in the forward pipeline, with HHI rising from 0.118 (moderate concentration) in the in-service fleet to 0.264 (high concentration) in the orderbook, and the top five shipyards accounting for 86% of contracted capacity. In addition, bunkering capacity is geographically concentrated, with a service-area HHI of 0.269 and Europe alone representing approximately 46% of in-service capacity. These patterns suggest that, despite aggregate alignment, execution risks and corridor-level supply imbalances may emerge in practice.

Overall, the findings suggest that the LNG bunkering market is transitioning from concerns over aggregate capacity sufficiency to challenges related to structural resilience and regional balance. While bunkering capacity expansion broadly aligns with fleet growth, increasing concentration in shipyard delivery and geographic deployment may heighten exposure to execution risk and localised bottlenecks. These insights provide evidence to support strategic fleet planning, investment decisions, and policy evaluation in the ongoing maritime energy transition.

Several limitations should be acknowledged. The analysis adopts a stock-based framework in which LNG-fuelled vessel numbers are used as a proxy for potential bunkering demand rather than actual LNG consumption, which depends on operational factors such as vessel utilisation and fuel use patterns. As a result, the study reflects capacity-to-capacity alignment rather than realised fuel demand. In addition, vessel operating profiles and bunkering frequency are not explicitly modelled, and declared service areas may differ from actual deployment. Accordingly, the results should be interpreted as indicative of relative scaling, structural alignment, and forward trends, rather than precise measures of LNG demand or utilisation.

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ABBREVIATIONS

AFI	Alternative fuels insight
CII	Carbon Intensity Indicator
EEDI	Energy Efficiency Design Index
EEXI	Energy Efficiency Existing Ship Index
ETS	Emissions Trading System
EU	European Union
GFI	GHG Fuel Intensity
GHG	Greenhouse gas
HHI	Herfindahl–Hirschman Index
IMO	International Maritime Organization
LNG	Liquefied natural gas
NZF	Net-Zero Framework
RQ	Research question
SDR	Supply-to-demand ratio
SGMF	Society for Gas as a Marine Fuel
STS	Ship-to-ship
U.S.	United States of America

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