Natural gas in the transition to low-carbon transport systems: focus on marine bunkering and NGVs

by

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Abstract

The introduction of alternative fuels for the transport sector has become an integral part of the energy policy of countries that are implementing active climate and environmental agendas. In this context, the use of natural gas in road and marine transport represents one of the most effective solutions to curb climate change and improve air quality, while its demand has significant potential for growth, underpinned by favourable government policy support.

Nowadays natural gas vehicle (NGV) markets are developing in dozens of countries. Being a readily available alternative to diesel and petrol-based engines, NGVs both compressed natural gas (CNG) and liquefied natural gas (LNG) technologies offer an immediate reduction of emissions and pollutants in all the sub-segments – from passenger cars to heavy goods vehicles (HGV). In marine transport, the introduction of the International Maritime Organization's (IMO) global cap of 0.5% sulphur content has already accelerated the adoption of LNG. Simultaneously, the shipping industry is increasingly focused on meeting the IMO's 2030 and 2050 targets and switching to LNG appears as a viable option for shipping decarbonisation.

This study reflects the GECF Global Gas Outlook 2050 reference case scenario and highlights the evolution of natural gas demand in road and marine transport, taking into account current energy policies, trends related to the use of traditional and alternative fuels in the transport sector, technology developments and the potential introduction of new policies that are likely to materialise throughout the period to 2050.

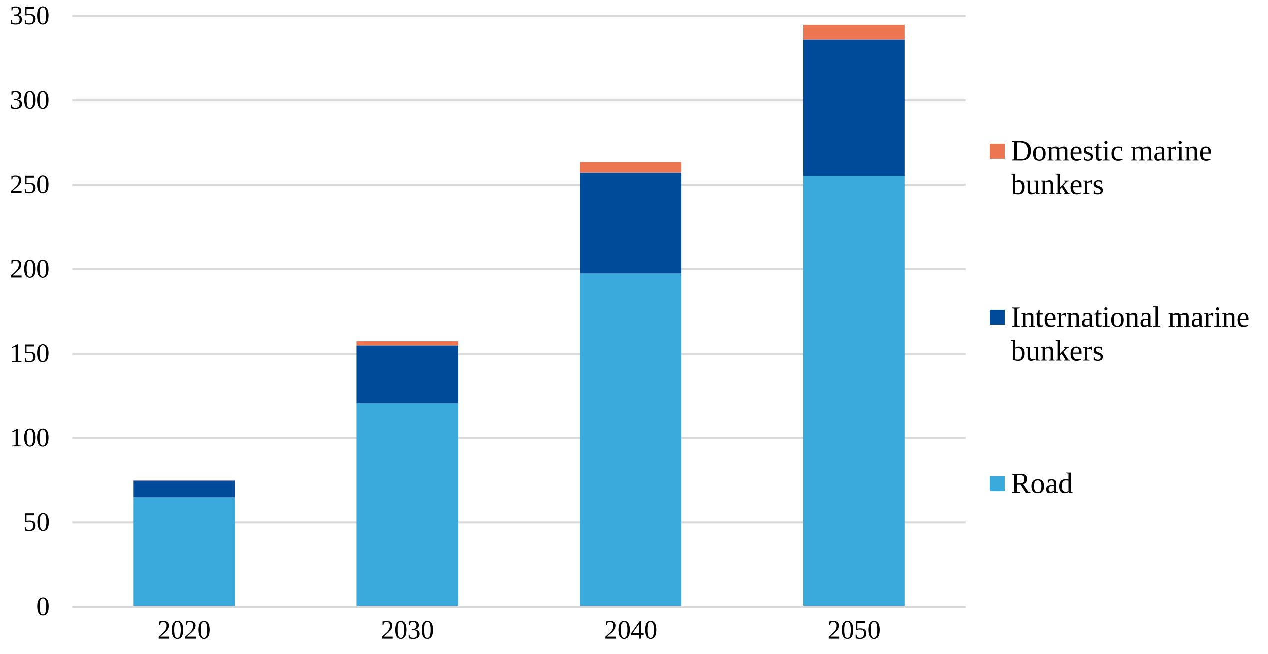
Introduction

In the context of energy transition and countries' intentions to mitigate the negative impact on the climate, natural gas, which today provides almost one quarter of the world's energy supply, will play a critical and unique role in meeting the growing demand for clean and affordable energy. With its important role in the decarbonisation process, natural gas has the potential to achieve progress within the environmental and sustainable development agendas.

Natural gas continues to receive a high level of policy support. It is projected to increase its share in the global energy mix, from over 23% today to 27% in 2050 (1). This ascending trend is partly thanks to the rise in demand in road and marine transport, which is forecast to be particularly robust, growing from 75 bcm in 2020 to around 345 bcm by 2050 (the rise by 360%) on the back of policy initiatives aimed at abating emissions.

The majority of gas demand growth will stem from the development of the global NGV market. Tougher rules imposed by the International Maritime Organization (IMO) on shipping will further increase gas consumption in this area, with shipowners already beginning to switch to LNG to reduce the carbon intensity of their fleets.

Figure 3.1. Global natural gas demand trends in the road and marine transport (bcm)



Source: GECF Secretariat based on data from the GECF GGM
Note: Demand in international marine bunkers includes boil-off gas

It is important to mention, that the Doha Declaration, the 6th GECF Summit of Heads of State and Government, headlined «Natural Gas: Shaping The Energy Future» emphasizes specifically GECF Member Countries determination to work towards increasing the share of natural gas in marine and road transport, and to develop necessary infrastructure to provide natural gas to consumers (2). In this context, this study is a part of the ongoing efforts to promote the expansion of natural gas use in the transport sector, thereby unlocking its great potential for air quality improvement and climate change mitigation.

I. Current state and projections for LNG as a bunker fuel

The global bunker fuel market started to undergo sweeping changes with the introduction of the IMO's global cap of 0.5% sulphur content in 2020 (excluding the mandated emission control areas (ECAs), where the limit was already 0.1%). To phase out high-sulphur fuel oil, shipowners have responded by investing in exhaust gas cleaning systems, known as scrubbers, and by switching to lower-sulphur but more expensive oil-based fuels. These IMO regulations have also accelerated the adoption of LNG. The uptake of this fuel has been predominantly visible in orders for larger vessels, including crude carriers, such as Aframax tankers, cruise ships and ultra large container ships.

Over the long-term, demand for LNG will be driven by the IMO's decarbonisation strategy, which envisages a cut of GHG emissions from international shipping by 50% by 2050, in addition to a reduction in carbon intensity by 40% by 2030 and efforts towards achieving 70% by 2050, compared to 2008 levels (3). It is expected that recent flurry of orders for LNG-powered vessels will maintain high expectations in terms of fuel use at a global level and will bring about material gains in associated emission savings, specifically for long-haul shipping.

LNG is in a good position to offer enhanced competitiveness thanks to the existing gas infrastructure and supply chains as well as being able to provide significant advantages by complying with future requirements for the major types of emissions and improvement in overall air quality. Compared to oil-based marine fuels, LNG almost eliminates sulphur oxides (SO_x), particulate matter (PM) and emits up to 95% less nitrogen oxides (NO_x). Another factor in its favour is the 20-25% reduction in CO_2 emitted. Recent study, conducted by consultants Sphera, estimates that LNG use in shipping reduces GHG emissions by up to 23% on a full well-to-wake lifecycle basis, compared with very low sulphur fuel oil, when two-stroke slow-speed engines are used (4). These gains could be increased further with improvements in reducing methane emissions along the LNG supply chain. In addition, methane slip in LNG engines does not present a serious hurdle and is on track to being eliminated.

The shipping industry is increasingly focused on meeting the IMO's 2030 and 2050 targets and shipowners are considering alternatives fuels, such as hydrogen, ammonia, methanol, biofuels and electric batteries. However, many of them are in a nascent stage of development and have commercial and technical limitations. For instance, while electric vessels could be an option for inland and short-sea routes, there is a problem with long sea voyages requiring large-scale battery packs. Zero-carbon fuels, such as ammonia and hydrogen (either blue or green), still need considerable research, extensive operational testing and regulatory frameworks.

Specifically, the shipping industry is hopeful about the use of ammonia, as supply and distribution networks exist around the world, given its widespread use as a fertiliser. But ammonia faces certain challenges, such as its toxicity and corrosivity due to the production of NO_x, its flammability and combustion in traditional engines, as a result of its high ignition temperature and low flame velocity (5). LNG, conversely, has already become a technically and economically viable bunker fuel option. Although switching to LNG is not enough in itself to meet the 2050 targets, it helps without having to wait for alternative fuels, which could offer potentially CO_2-neutral propulsion, to be developed and be commercial for large ships. Eventually, replacing conventional LNG with bio- or synthetic LNG (without making upgrades to vessel equipment) offers an additional and practical way for shipping decarbonisation.

As of April 2022, LNG-powered vessels in operation totalled 286 ships (excluding over 600 LNG carriers). Based on the order book, according to the classification society DNV GL, the number of such vessels will continue to rise, reaching over 785 by 2028 (6). LNG-powered containerships, car carriers, crude oil tankers and bulk carriers account for the majority of orders, resulting in substantial change in demand in the future. This gives confidence to fuel suppliers to invest in bunkering operations. Moreover, over 220 ships in the existing fleet and under construction are 'LNG-ready' (equipped with the technology to use LNG as an alternative fuel), and this could result in additional potential for further LNG demand.

A number of European and Asia Pacific shipping companies have started to shift their fleet to LNG with particular companies taking the lead. For example, in April 2021, CMA CGM placed an order for twelve LNG-fuelled container ships (with the capacity of 13,000 TEU and 15,000 TEU) to be delivered in 2023-24. The French company is investing heavily in LNG as a fuel and expects to have 44 LNG-powered ships in its fleet by 2024 (7). In June 2021, German shipping line Hapag-Lloyd ordered six ultra large container vessels (over 23,500 TEU) with deliveries to begin in 2024. The company had already placed an order for six ships of the same size at the end of 2020 and considers LNG as the most promising fuel on the path towards zero emissions (8). Japan's NYK Line ordered twelve LNG-powered car carriers (loading capacity of about 7,000 vehicles each) in June 2021 with delivery expected between 2025 and 2029. By the end of 2028, the company aims to have twenty LNG-fuelled transporters, seeing LNG as a bridge solution until future zero emissions ships can be realized (9). Switzerland-based MSC, which operates a fleet of more than 600 vessels, recently welcomed its first LNG-powered containership and ordered in total 20 LNG-dual fuel containerships (7,900 TEU each, deliveries start in 2025). The company is working on a large fleet of LNG-powered vessels in order to comply with more stringent IMO rules (10).

The bunkering infrastructure is responding dynamically to the expansion of the world's LNG-powered fleet and many more ports are projected to ensure refuelling capacity. According to Clarksons Research, at present 128 ports worldwide offer LNG bunkering services, including ship-to-ship, truck-to-ship, and shore-to-ship transfers, compared with only 60 ports five years ago. Northwest Europe in particular has reached a sufficient density of infrastructure, which allows shipowners to eliminate the risk of fuel supply availability from their calculations when taking investment decisions over what propulsion system to opt for.

At the same time, ship-to-ship bunkering services are expected to evolve rapidly as the most flexible and promising solution. Currently 37 bunkering vessels are active and 19 are under construction. Some oil and gas companies are aiming to develop their bunkering fleets and new players are entering this market. For example, Shell, which has six bunkering vessels in operation, plans to double this number by 2025 to strengthen its position in covering key international trade routes (11).

Regulations will continue to be a fundamental driver behind the adoption of LNG. In Europe, the gradual inclusion of shipping in the EU's Emissions Trading System (ETS) from 2023 in line with the 'Fit for 55' package is forecast to provide a strong regulatory incentive for more shipowners who might be considering LNG as a fuel of choice. In addition, the establishment of a Mediterranean ECA (expected to come into force in 2025) will have major consequences for LNG, accelerating the expansion of refuelling infrastructure in this sub-region and offering new point-to-point routes amid growing trade as part of the development of the 21st Century Maritime Silk Road (a key component of China's Belt and Road Initiative).

Simultaneously, LNG bunkering looks promising in Asia Pacific region given the existing extensive LNG infrastructure and government support being a significant catalyst. In particular, Singapore is striving to become a key LNG bunkering hub for the region and the comprehensive Maritime Singapore Green Initiative, launched in 2011 and extended until the end of 2024, has a new focus on the decarbonisation of shipping. The country provides grants for the construction of LNG-powered vessels, while vessels with LNG engines are eligible for discounts on port dues. The South Korean government has decided to offer tax rebates for LNG-powered ships starting from 2021 as part of its efforts to develop LNG bunkering services and meet strict marine fuel regulations (12). In Japan, the ports of Tokyo, Yokohama and Kawasaki waive entry fees for ships powered by LNG (the exemption runs for five years from April 2021) (13).

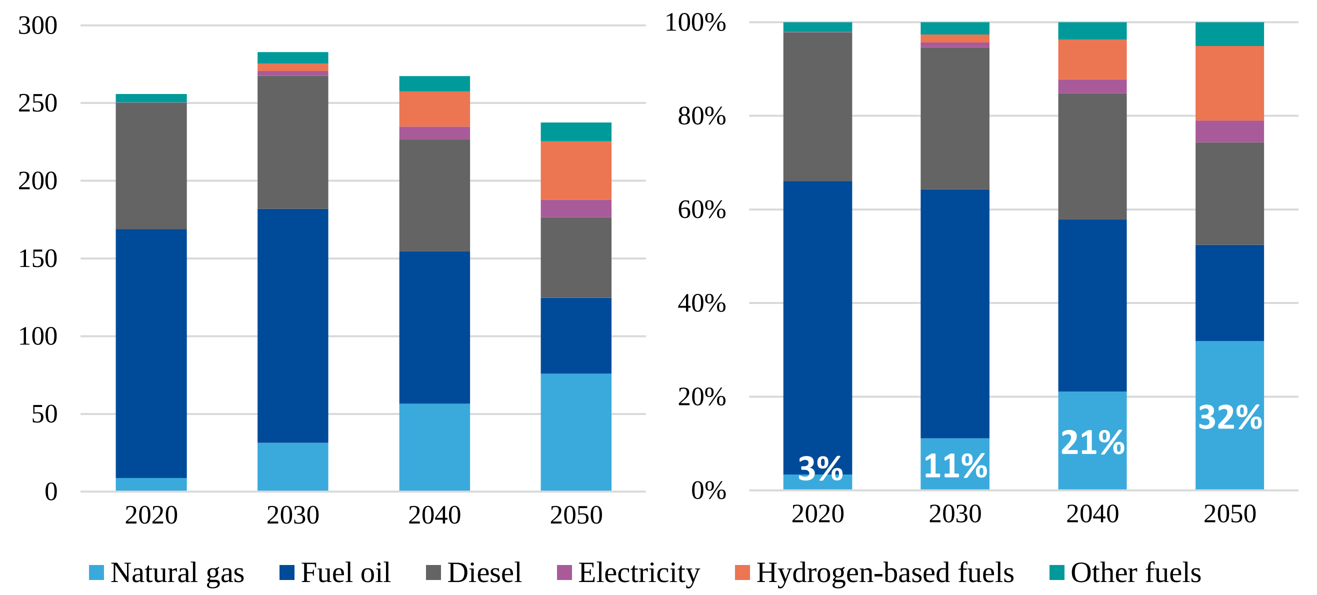
Development of the LNG-powered fleet for inland rivers is also forecast, with a large portion of demand coming from China amid government plans to promote water transportation systems for natural gas usage along the Yangtze River and other major channels. Total LNG demand for domestic shipping will reach 9 bcm by 2050.

By and large, global marine LNG demand will accelerate post-2025. In the mid-term LNG propulsion will face competition from low-sulphur oil products as well as the installation of scrubbers. The economics of retro-fitting and LNG-fuelled engines are not good compared with scrubbers, but it is expected that new ships will increasingly be constructed with LNG engines. As a result, the move to LNG will be gradual with demand centres concentrated in North America (mainly the US), Asia Pacific (China, South Korea, Singapore, Japan) and a range of European countries.

Stricter environmental regulations, such as the existing 0.1% limit on sulphur content within the ECAs, as well as local restrictions applying to open-loop scrubbers (particularly due to concerns about the disposal of sulphur-rich wash water and other waste products) will play an important role. Some ports like Singapore do not allow ships with open-loop scrubbers to discharge scrubber wash water in the port.

Overall, in 2050, the total demand of bunker fuels is projected to be around 240 Mtoe. Thanks to the combination of environmental advantages and increasing availability, the share of LNG in the global bunker fuel market will rise from 3% in 2020 to 32% by 2050. Accordingly, LNG demand in marine transport is forecast to reach 90 bcm by 2050, compared to 10 bcm in 2020 (which is currently mostly consumed as LNG boil-off gas). Hydrogen-based fuels are seen as the next generation fuel for shipping and will potentially start to penetrate the shipping sector after 2030. As it could take several decades for the fleet to move to zero-carbon fuels, LNG will continue to provide an efficient alternative to conventional fuels in the long-term.

Figure 3.2. Marine demand by energy carriers (Mtoe) and their shares (%)



Source: GECF Secretariat based on data from the GECF GGM

II. The prospects of natural gas usage as a fuel for vehicles

Environmental advantages of NGVs

The increasing availability of natural gas, together with its environmental advantages, made NGVs a very prominent alternative to diesel and petrol-based engines in the road transport. Liquefied petroleum gas (LPG) is also widely used across the world. However, being a by-product of oil industry, it represents a mixture of propane and butane and not as clean as natural gas, while the main chemical component of the fuel for NGVs is methane.

Switching to natural gas offers a readily available solution to diminish air pollution and CO_2 emissions. According to the World Health Organization, 90% of population live in areas with high levels of particulate matters (especially, PM2.5), largely induced by emissions from the transportation mode. It is estimated that NGVs emit up to 95% less PM and up to 70% less NO_x than their diesel and petrol counterparts, making vehicles running on natural gas much more competitive even under the framework of the strictest Euro VI fuel standards. Exhaust gases from natural gas engines are also free of other harmful and carcinogenic pollutants.

Various studies show a clear reduction in GHG emissions when using gas for mobility.[1] Benefits amount up to 15-30% compared to diesel and petrol engines, taking a holistic well-to-wheel approach. This reduction could be as high as 95% or close-to-zero and even with a negative emissions balance if pure biomethane is used. Thus, blending natural gas with just a small amount of biomethane (for example, produced out of straw, manure, municipal or agricultural waste) will increase environmental performance significantly. Besides, natural gas engines produce 50% less noise than those running on diesel – an additional benefit, especially for trucks operating in urban areas.

The current debate is strongly focused on the deployment of electrical vehicles (EV) as a way to decarbonise the road transport. However, electrical technologies alone cannot meet climate goals despite the fact that they are listed as having zero tailpipe emissions. On the one hand, a significant portion of electricity comes from «dirtier» generation processes (in 2020, coal accounted for 35% of the global power generation mix) and assertive EV policy push in some countries/regions could potentially increase the carbon footprint. This is particularly the case in Asia Pacific, where coal at present accounts for 58% of regional electricity supply. In this context, the transition to e-mobility implies a mandatory change in the power generation mix, as EVs can be effective only with increasing share of renewables, while the use of NGVs does not require investments in the power generation (14). At the same time, massive investments in power grids will be needed to handle extra loads for recharging the electric fleet.

On the other hand, from the standpoint of a life-cycle emission assessment, the advantages of EVs over NGVs are not so obvious, as this considers GHG emissions from a much bigger perspective including the energy

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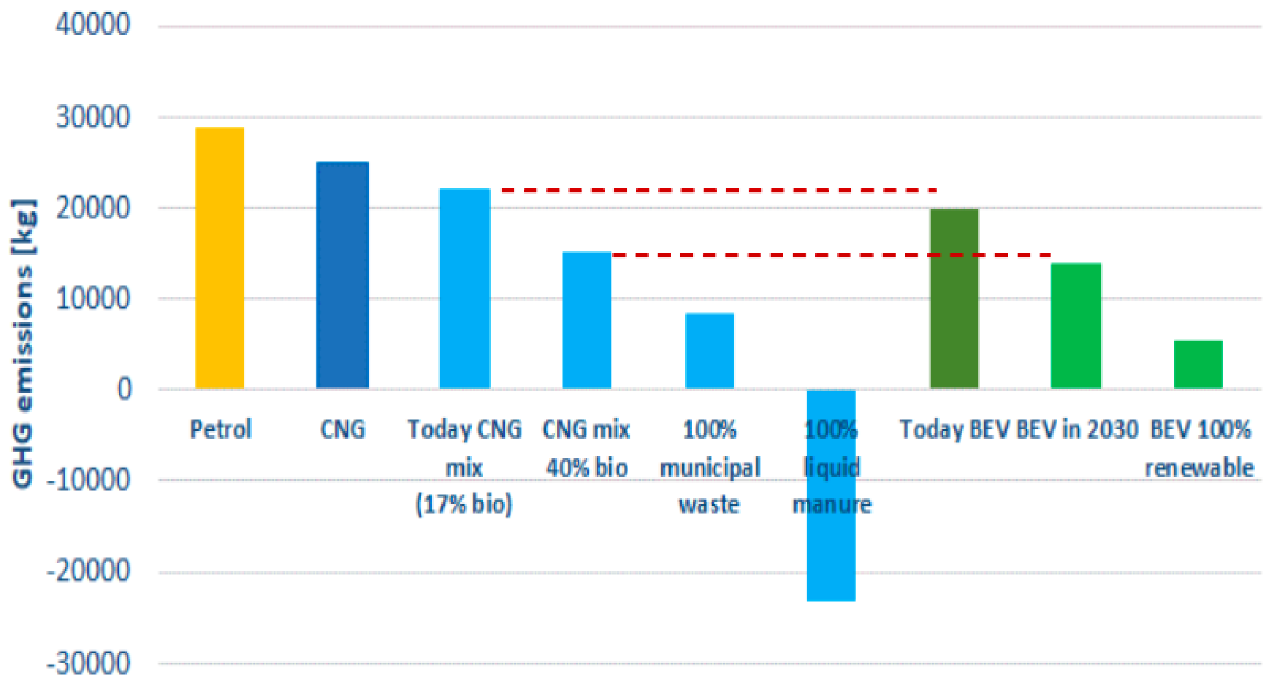
[1] For example: European Commission's Joint Research Centre, Eucar and Concawe (2014) – «Well-to wheels analysis of future automotive fuels and powertrains in the European context»; Thinkstep (2017) – «Greenhouse gas intensity of natural gas»; Spiers, J., Balcombe, P., Blomerus, P., and Stettler, M. (2019) – «Can natural gas reduce emissions from transport? Heavy goods vehicles and shipping»; NGVA Europe, https://www.ngva.eu/medias/going-beyond-well-to-wheel-life-cycle-emissions/

intensity of the vehicle manufacturing process, dismantling and recycling batteries (which is particularly important due to the scarcity of materials like lithium, cobalt and nickel which they contain). Thus, when setting policy actions for lower emissions trajectories, a mix of solutions on the deployment of sustainable alternative transport fuels will be required and NGVs should be considered as a viable technology, which can increasingly contribute to the decarbonisation process, complementing electrification.

Figure 3.3. Cradle to Grave GHG emissions comparison



Source: NGVA Europe
Note: GHG emission for considered technologies incudes footprint over lifetime with the overall mileage of 160,000 km (Manufacturing+EoL, TTW, WTT). The study has been carried out for C-segment vehicle, given the EU power generation mix.[2]

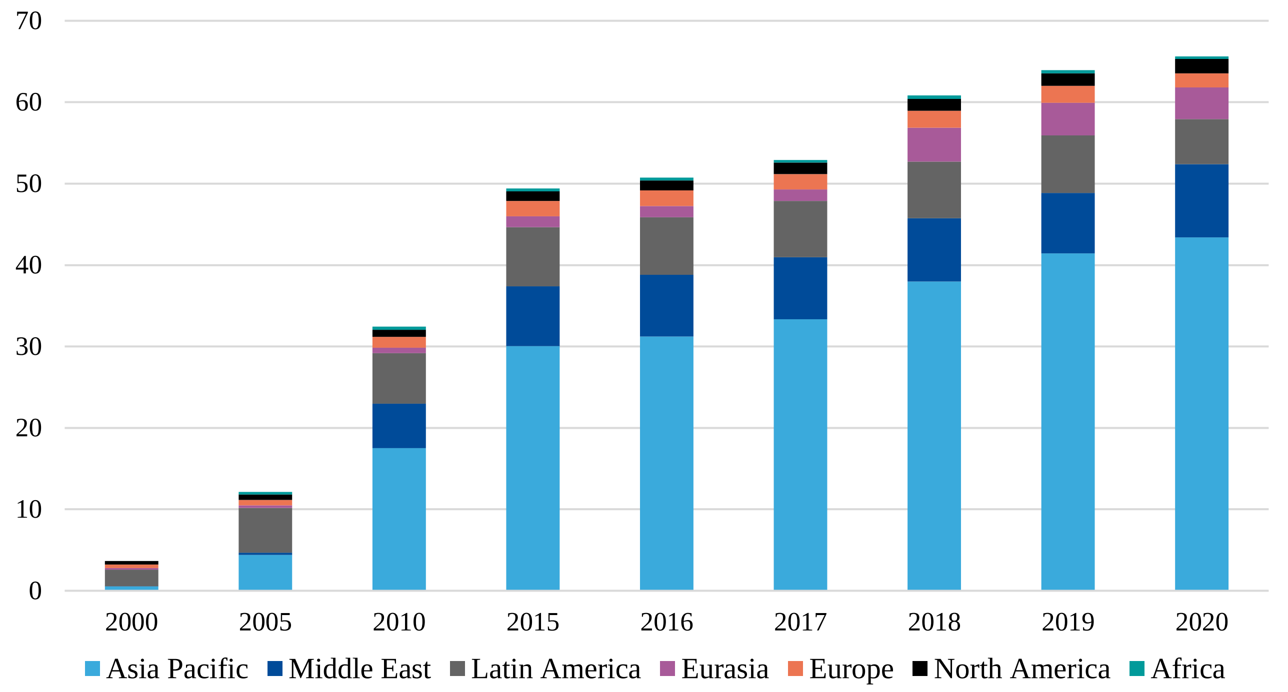
Global NGV market

At standard conditions of pressure and temperature, natural gas exists in the gaseous state and it has a lower energy density compared to diesel/gasoline. To make it a suitable transport fuel and provide a longer driving range, natural gas is compressed to a pressure of 200 to 300 bars (stored on-board in high-pressure cylinders) or cooled to -162°C (stored on-board in a liquid form in highly insulated cryogenic tanks). Based on the difference in fuel storage systems and engine designs, there are compressed natural gas (CNG) and liquefied natural gas (LNG) vehicles. At the same time, the volumetric energy density of LNG is more than 2.5 times higher than CNG, meaning more energy is contained in the same space. Nevertheless, LNG powertrains are an expensive option and mostly limited to heavy-good vehicles (HGVs) taking into account their long haul operations.

[2]https://www.ngva.eu/medias/going-beyond-well-to-wheel-life-cycle-emissions/;
UNECE (2021) "Improving capacities of the UNECE member States to decarbonize the transport sector by increasing the use of natural gas as a motor fuel", p. 16-17. https://unece.org/sites/default/files/2021-04/NGV_report.pdf

Nowadays NGV markets are developing in dozens of countries, including China, Iran, India, Argentina, Brazil, Thailand, Pakistan, Bangladesh, Italy, Germany, Russia, Uzbekistan, South Korea and the US. Over the last decades, natural gas, predominantly in the form of CNG, has made a remarkable progress in various sub-markets – passengers, buses, light commercial vehicles (LCVs) as well as HGVs and special trucks of mining and haulage companies. Surging by almost 16% per annum, natural gas demand in road transport increased from 4 bcm in 2000 to over 65 bcm in 2020. Major contributions to this growth came from Asia Pacific (China, India, Pakistan) and the Middle East (particularly, Iran), while Latin America countries (mainly, Argentina and Brazil) experienced moderate rise, staying around the same volumes throughout from 2005 to 2020. In spite of the impressive growth rate, natural gas represents less than 3% share of the total energy consumed in the global road transport market, which is currently dominated by oil-based products.

Figure 3.4. Natural gas demand in road transport by region, 2000-2020 (bcm)



Source: GECF Secretariat based on data from the GECF GGM

According to the latest data from the NGV Global, total methane-driven fleet is accounted for more than 30 million[3], including dedicated (running solely on natural gas), bi-fuel (natural gas and gasoline) and dual-fuel (running on a blend of diesel and methane, where diesel is used to provoke the ignition) vehicles. The vast majority of NGV population constitutes passenger vehicles, LCVs and buses, while HGVs, powered by CNG or LNG, represent relatively small share, operating mostly in China, India, the US and Europe.

The penetration of NGVs varies significantly across the regions: Asia Pacific and the Middle East countries account for about 70% of the total NGV fleet, Latin America countries make up 20%, while the remaining 10% is distributed among Europe, Eurasia, North America and Africa. On a country level, currently, more than 85%

[3] It includes OEM vehicles, factory-approved conversions and post-sale conversions

of the world's NGV fleet is concentrated in eight markets: China, Iran, India, Pakistan, Argentina, Brazil, Italy and Uzbekistan. China has the world's largest fleet of vehicles running on gas, with more than 7.5 million on the road.

It is important to note that major vehicle makers are entering mass production of NGVs. For example, there are over 65 original NGV models available in Europe. Passenger cars are similar in price to equivalent diesel versions, while buses and heavier CNG/LNG vehicles have higher purchase prices. However, both CNG and LNG powertrains offer shorter payback periods thanks to savings in fuel expenses[4] and the total cost of ownership – a crucial economic case for truck operators. Moreover, NGVs are characterized by a high level of safety and reliability that enhance public trust in this technology.

Policy measures supporting natural gas expansion in road transport

Policy support has been a key driver for increasing gas demand in road transport. Countries that have achieved significant progress for NGV uptake pushed for natural gas in order to meet policy priorities. These mainly include mitigating air pollution and reducing the reliance on oil-based products, since natural gas remains more affordable and emits much less pollutants.

In addition, oil-producing countries have considered this option as a way to value their resources and reduce domestic oil demand, while dedicate oil to export for income or for energy security reasons. Iran has had the most success in this regard, assembling the second largest NGV fleet. Launching the Development Plan for Natural Gas Utilization in 2000, the government focused on retrofitting vehicles to run on CNG and constructing CNG refuelling stations with the target of countering gasoline shortages and as a response to air pollution. Another example is Argentina that has promoted natural gas in road transport since 1984 in the framework of its Liquid Fuels Substitution Program, as it aimed at freeing up more oil domestic resources for export.

The analysis of countries' experience shows that establishing targets for vehicle conversion is a key instrument in enhancing the penetration of natural gas in transport. Particularly China, the home of the world largest NGV fleet, introduced targets for alternative clean fuels, including natural gas in public transport and for taxi fleets, in order to curb pollution in urban areas. The government is actively supporting the target through R&D funding for industry, production subsidies and financial subsidies for buyers, tax exemptions and waiving highway tolls.

It is possible to distinguish between different types of policy measures, stimulating natural gas usage in road transport. They encompass measures targeting fuel price, infrastructure, manufacture/supply and utilisation of NGVs and other measures such as pollutant and carbon emissions standards that enhance the attractiveness of natural gas, taking into account its inherent environmental advantages. The most widespread supporting measures include subsidies for the construction of refuelling stations as well as for conversion and utilisation (ownership) of NGVs.

[4] With respect to diesel and petrol, gas retail prices are lower in the majority of markets across the world, mostly because countries impose lower duties' rate on CNG/LNG than on oil-based fuels.

1) Fuel-related measures

Keeping gas as a competitive fuel is an important policy instrument in order to boost the uptake of NGVs. Further encouragement through subsidies and tax rebates are also applied, increasing the price gap between natural gas and diesel/gasoline counterparts. For instance, India has been subsidizing gas prices for vehicles as a part of the CNG Program at the City of New Delhi to tackle air pollution. Along with other measures to promote the usage of methane in road transport, a significant price difference was achieved in India several years ago, estimated at around 41-62% compared to diesel or gasoline. In 2022, with expensive imported LNG, the difference between the automotive fuels in the country is narrowing, as CNG is becoming costlier, however this situation is expected to be temporary as prices are being revised consistently (15).

The taxation of oil-based fuels is another approach that enables an environmental impact and provides cost advantages for clean fuels including natural gas. This instrument is extensively used in the EU and China. Its application is expected to spread in the future, driven by the growing number of countries introducing carbon taxation in road transport.

2) Measures encouraging the construction of gas infrastructure and refuelling stations

All the countries succeeding in the promotion of gas as a fuel for vehicles are making efforts to develop natural gas transmission and distribution infrastructure as well as facilitating the construction of refuelling stations, including through direct involvement of government investments, granting of lands for the setting up of CNG outlets, easing the bureaucracy procedures associated with project approval etc. In particular, improved city gas networks in India have been instrumental in increasing the number of gas refuelling stations (as of 2021, there were around 2,800 CNG stations in India) and the expansion of CNG cars.

China presents an even more vivid example. With such projects as the West to East Gas Pipeline, the number of stations supplying natural gas surged from near 1,000 in 2008 to above 8,400 in 2018. Simultaneously, the growth of small-scale LNG is occurring in China because of a lack of pipeline capacity and interconnections. Thus, in addition to a substantial fleet of CNG-powered vehicles, the implementation of an extensive cryogenic supply chain gave a strong push for the use of LNG in the HGV segment, especially amid restrictions on diesel truck movements in Northern and Eastern provinces.

3) Measures promoting NGV manufacture, supply and purchase

The development of a competitive and reliable NGV supply chain is an important factor in the creation of a market for natural gas consumption. Accordingly, countries have elaborated a set of tools and incentives targeting vehicle manufacturers to include NGVs in their range of models (e.g. the case of China, India, Italy) or stimulating conversion of existing vehicles to run on natural gas through specific fleet conversion programs (e.g. Argentina, India, China, Iran).

Moreover, R&D efforts (e.g. China, Italy), including establishing collaborative partnerships between the industry and government, continue to support NGVs as a cleaner alternative to gasoline- and diesel-fuelled competitors. Research programmes are prioritized to narrow barriers for NGV adoption, promoting innovations in gas-powered engines, refuelling and storage systems as well as working on the reduction of methane emissions from multiple lifecycle stages. Reducing the cost of NGVs to be competitive with diesel vehicles is another major area of collaboration.

Providing loans, purchase price subsidies and tax rebates for new sales as well as reduction of import taxes on various equipment and associated components related to vehicle conversions are also widely used. For example, in Italy, it is estimated that more than 50 NGV models in various segments are available and the country gives direct subsidies for the purchase of new CNG cars or CNG/LNG trucks. In addition, obligations to procure NGVs or to convert vehicles to gas in public and municipal transport (buses, refuse trucks, etc.) as well as in taxi fleets have been observed in many countries, such as India, China, Brazil, Argentina. Agreements with governments to adopt gas-fuelled public transport are poised as an effective mechanism to achieve national environmental goals and to create a market for NGVs and related equipment.

4) Incentives for NGV utilisation

These measures specifically include exemptions from driving restrictions in urban areas (for example, the exemption from the alternate-day travel scheme in India) or other benefits granted to NGV users, such as reduced license fees, road tax, parking and congestion charges, priority lanes, waiving highway tolls, insurance advantages etc. These instruments have been extensively used in European countries (e.g. Italy, Sweden and Spain), China, Malaysia, Hong Kong.

5) Emissions standards

The implementation of stringent emission standards is another mechanism that stimulates the uptake of NGVs. These measures affect both the technological progress in engines and the quality of transport fuels. For instance, the EU has implemented Euro standards for pollutants like NO_x and particulate matters since the mid-1990s. The gradual reinforcement of these standards to Euro VI, implemented since 2014, has contributed to increasing interest in NGVs.

Apart from the European market, other countries including China and India are also establishing regulations to limit atmospheric pollution. These measures are expected to have an impact on the development of the NGV market as a response to introduced standards.

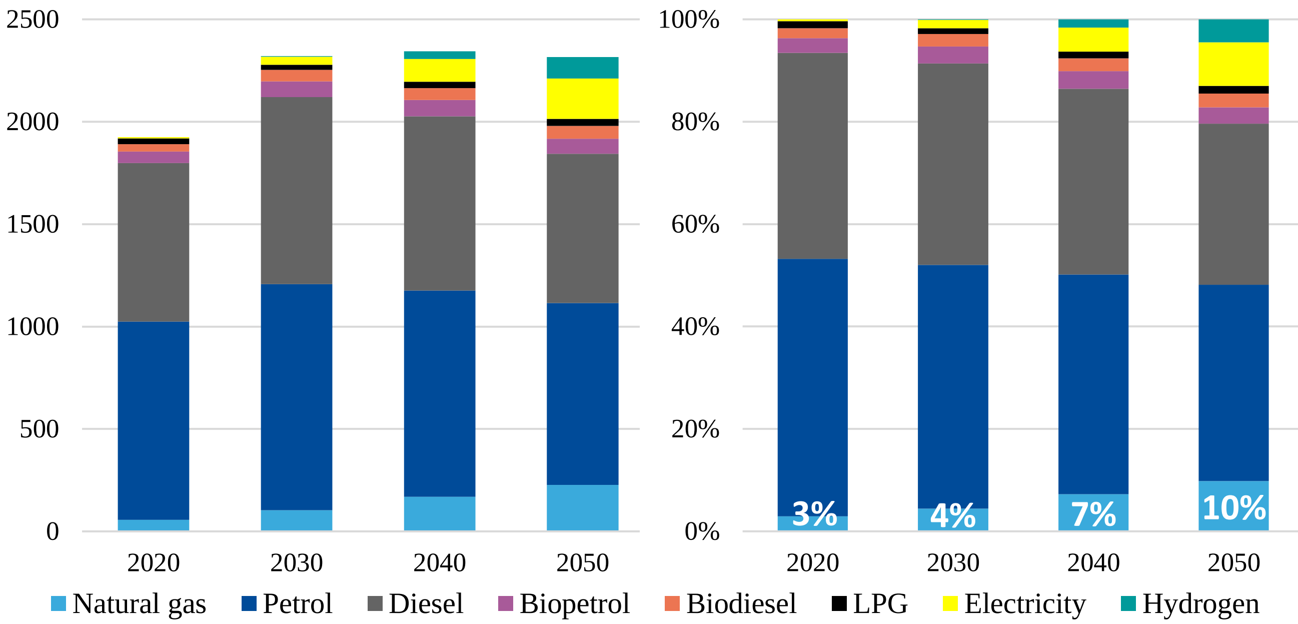
Projections of natural gas demand in road transport

With a growing concern for accelerating the transition to low-carbon transport systems, the role of methane is expected to be enhanced. Gas demand in road transport is forecast to rise robustly by 190 bcm, reaching 255 bcm by 2050, including both CNG and LNG, as many countries are adjusting legislation to reduce the environmental impact of transportation modes and setting targets to mitigate air pollution. Favourable government policies, regulatory frameworks and the expansion of refuelling infrastructure will be driving forces encouraging the higher uptake of NGVs. The development of biomethane and bio-LNG is also of crucial importance, as it provides additional opportunity for natural gas expansion.

Implementation of forward-looking national or regional sales bans on new diesel or petrol vehicles for 2025-2050 will implicitly support gas mobility, despite the rapid penetration of EVs. However, there is a higher potential for uptake of NGVs expected in the HGV segment, where electric technologies cannot fit the specifics in the best way due to the cost of batteries, their large size and weight, which limits available space and capacity for cargo haulage to be profitable. Accordingly, anticipated restrictions on diesel truck movements in a range of countries and large cities open up prospects for CNG and specifically for LNG powertrains, capable of delivering lengthy driving ranges. In this context, the majority of gas demand in road transport is expected to come from LNG-powered trucks thanks to their high annual mileage. Hydrogen fuel cell trucks will also develop, but they are not forecast to be scaled up before 2030.

According to our projections, the share of natural gas in the global road transport market (consumption of all fuels is estimated to rise from 1,925 Mtoe in 2020 to 2,316 Mtoe in 2050) will grow from 3% to 10% over the outlook period. The share of conventional petrol and diesel will fall from 91% to 70%, while electricity use, which is expanding in the passenger, public transport and LCV segments, will demonstrate the most impressive growth, raising its share of the total energy consumed in road transport from 0.4% in 2019 to 9% in 2050. Hydrogen use in road transport is expected to ramp up after 2030 and will reach 5% by 2050.

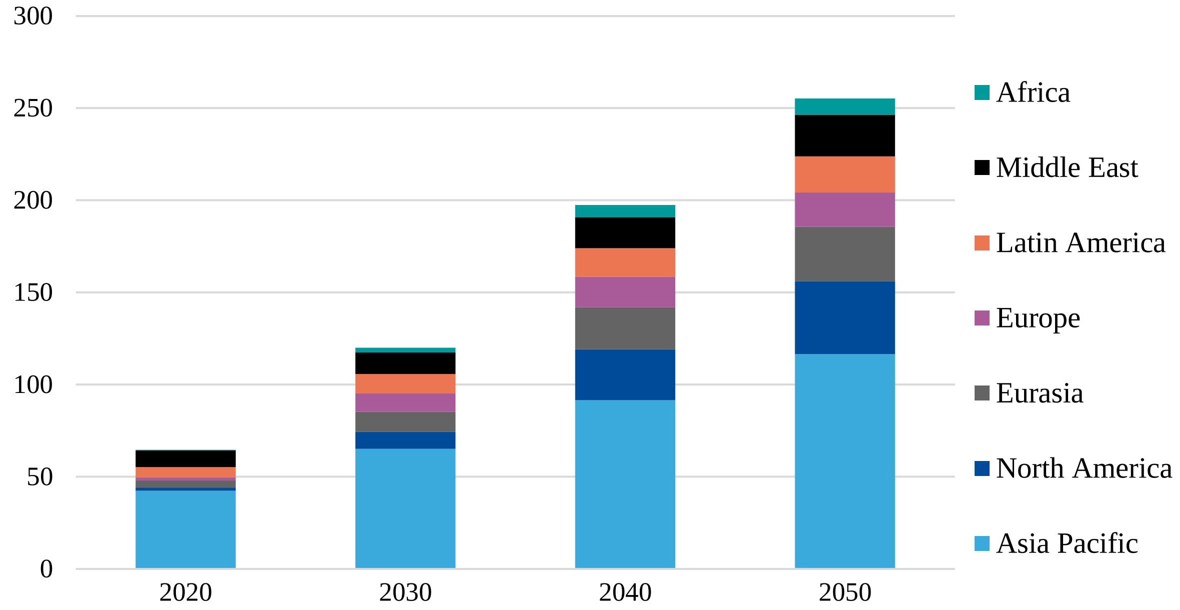
Figure 3.5. Road transport demand by energy carriers (Mtoe) and their shares (%)



Source: GECF Secretariat based on data from the GECF GGM

With additional potential of the global NGV market accounting for 190 bcm between 2020 and 2050, the Asia Pacific region will lead demand growth, adding almost 75 bcm by 2050. This rise will be driven by China and India at the forefront, although Pakistan, Bangladesh, Thailand, Australia and South Korea will demonstrate some expansion. North America, led by the US, represents another major source of growth with an additional 38 bcm through to 2050, followed by Eurasia with an extra 26 bcm. Europe, where the key driver is decarbonisation, will add around 17 bcm over forecasting horizon. A brief analysis for mentioned regions, with the focus on Asia Pacific, is provided below.

Figure 3.6. Natural gas demand in road transport by region (bcm)



Source: GECF Secretariat based on data from the GECF GGM

- *Asia Pacific*

In 2020, Asia Pacific region accounted for 66% of global gas demand in road transport. This region is forecast to remain the largest in terms of the use of CNG and LNG as a fuel for vehicles due to strengthening clean air policies and pollution emissions standards. With a growth potential of almost 75 bcm over the next three decades, gas demand will reach 117 bcm by 2050 (or 46% of projected global natural gas volumes consumed in road transport), while India and China will be the largest contributors.

The promotion of NGVs in India is part of the government's efforts to increase the share of natural gas in the country's primary energy mix from the current 6% to 15% by 2030. India's programme to expand CNG access is the most ambitious globally. At present, there are more than 2,800 CNG stations across the country and it is planned to increase their number to 10,000 units by 2030 on the back of an ongoing rollout of city gas infrastructure. Recent implementation of Bharat Stage 6 emissions standards should encourage switching to CNG, including in the commercial sector, and stimulate national automotive manufacturers to expand their range of NGV models.

In addition, LNG is starting to penetrate the HGV segment in India and the government is planning to convert 10% of its current fleet of 10 million trucks, which use predominantly diesel, to LNG by 2035. The country has also introduced a plan to build 1,000 LNG stations by 2024 along main highway corridors. The initial 50 stations are being set up on the Golden Quadrilateral highways, connecting the cities of Delhi, Kolkata, Mumbai, and Chennai (16).

In China, the rise of gas demand in road transport will be entire driven by LNG. The country has nearly 600,000 LNG-fuelled trucks and buses, the largest such fleet in the world. The development of an extensive cryogenic supply chain, financial subsidies and local air quality policies, restricting diesel truck movements since 2017-

2018 (mostly in Northern and Eastern provinces in the framework of the Blue-Sky Defence plan), gave a strong push to increased sales of LNG-fuelled heavy trucks. The adoption of stringent emission standards across the country as well as economic and environmental gains over diesel trucks will support this trend.

At the same time, gas demand from CNG vehicles will expand much more slowly, peaking around 2030s. Despite a series of policy instruments including financial and fiscal incentives (subsidies, tax exemptions and conversion programs), CNG growth will be challenged by the development of EVs, which are increasingly favoured for passenger or light commercial vehicles. There is goal of over 50% EV sales by 2035 in accordance with 15-years New Energy Automobile Industry Development Plan.

Australia and South Korea will also become promising markets amid increasing use of LNG in the HGV segment. Bangladesh, Pakistan and Thailand conversely will see moderate growth in demand. Despite sizeable CNG fleets and developed refuelling infrastructure, further adoption of NGVs in these countries could be hindered by the existing gas allocation policy, which ranks CNG users as a low priority during times of domestic gas shortages. In this context, growing imports of LNG could provide relief to current limitations.

- *Other regions*

North America accounted for less than 2 bcm or 3% of global gas demand in road transport in 2020. It is expected that gas consumption will rise to almost 40 bcm by 2050. The US will lead the demand growth in this region. Along with the availability of low-cost gas arising from shale gas production, the basis of the strong outlook is the use of LNG in the HGV segment and environmental benefits. Future demand will also be buoyed by the expansion of requisite infrastructure with private sector investments.

Natural gas in the US is already used as a vehicle fuel by Amazon, UPS and Waste Management, amongst many other fleet owners. US policy supports NGVs, as almost all state governments provide incentives through fuel tax reductions, reduced vehicle sale taxes, grants and lower registration fees. For example, in June 2021, the governor of Texas signed a bill to expand the current grant programme for NGVs to include used models. This programme is the first of its kind in the US and provides larger fleets with a marketplace for their retired NGVs while helping small business owners with finance to purchase newer, clean-burning NGVs (17).

Eurasia is forecast to represent the third largest growth centre, driven by Russia. The Russian Energy Strategy to 2035 envisages continued support to expand the use of gas as a fuel for vehicles. The country has established all the prerequisites to facilitate the evolution of the NGV market: a well-developed gas distribution network, government support and a broad line-up of gas-fuelled models from domestic manufacturers (KAMAZ, UAZ, GAZ Group, Volgabus etc.). Moreover, Gazprom has been highly proactive in promoting NGVs and building infrastructure for refuelling vehicles, including with LNG. In addition, Rosneft and Tatneft are drawing up plans to retrofit their refuelling stations for CNG and LNG sales (18). The price differential over petrol and diesel will also create favourable conditions for the rise of demand.

In Europe, growth potential in road transport between 2020 and 2050 accounts for around 17 bcm of demand, with the majority of gas demand in this segment projected to come from Italy, Germany, the UK, Poland, Spain, Turkey and Belgium. The increase will be mostly concentrated in the HGV segment as a number of haulage, transport and logistics companies have started to shift their fleet to natural gas. Hydrogen fuel cell trucks are expected to ramp up after 2030s, but natural gas consumption will continue to grow due to the scope for displacing diesel in the HGV segment. The penetration of CNG in the passenger car market will conversely be limited in the region given an assertive EV and plug-in hybrid cars policy, although a sales ban on new diesel and petrol cars, switching from LPG and blending natural gas with biomethane will all ensure upside opportunities.

An important aspect that will support the expansion of NGVs is improving infrastructure. The European CNG/LNG refuelling network as of May 2022 already numbers over 4,700 stations, including almost 550 LNG stations, and it covers key highways in many countries (19). Stringent GHG emission standards together with the development of refuelling infrastructure, investments by proactive gas companies and promotion programmes will continue to accelerate the use of natural gas as a vehicle fuel.

Conclusion

The transition to low-carbon transport systems creates a promising source of natural gas demand, as this fuel is the most versatile and the cleanest burning convention alternative. Gas in the road and marine transport is slated to take off, predominantly in the form of LNG as bunker fuel and in HGVs, driven by stricter environmental regulations and targets to curb air pollution.

LNG in marine transport presents important opportunity. Many of alternative fuels are in a nascent stage of development and have commercial and technical limitations. LNG is in a good position to comply with future requirements for the major types of emissions, improve air quality and offer enhanced competitiveness thanks to existing gas infrastructure and supply chains. Eventually, replacing conventional LNG with bio- or synthetic LNG (without making upgrades to vessel equipment) provides an additional and practical way for shipping decarbonisation.

Natural gas usage in road transport has even more potential for growth as many countries are adopting stricter environmental requirements for vehicles because of pollution linked to the use of traditional liquid fuels. Mature CNG and LNG technologies may represent a bridge to sustainable and decarbonised mobility in the future. To capture the growth potential, it is important to support NGV penetration through sound solutions in the context of carbon mitigation (which surpasses EVs in coal-intensive energy systems), air quality and affordability.

Overall, natural gas can make a huge contribution towards decarbonisation of road and marine transport. Technologies are affordable, safe and well-developed, ecological advantages are meaningful, and the economics is attractive in many cases. As refuelling infrastructure grows, by maintaining a technological neutrality and a level-playing field between different alternative fuels, natural gas could play an important role in the transport sector.

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