

LNG as a marine fuel

an introductory
guide

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While the advice given in **LNG as a marine fuel – an introductory guide** has been developed using the best currently available information, it is intended solely as guidance to be used at the owner's own risk.



The Society for Gas as a Marine Fuel (SGMF)

The Society for Gas as a Marine Fuel (SGMF) is a membership-based non-governmental organisation (NGO) established in 2013 to promote the safe and sustainable use of gas as a marine fuel. The Society has full consultative status at the IMO and is the recognised representative body for the gas-fuelled shipping industry.

About this Guide

As its name suggests, *LNG as a marine fuel – an introductory guide* sets out the key facts about LNG: what it is, how it is used, its environmental and safety profile, which countries have invested in it, LNG ship design and systems, bunkering facilities and process, how it is purchased, and how personnel involved in handling LNG should be trained and familiarised.

Although it is of necessity a high-level document, the Guide links to more technically rigorous SGMF guidelines, aimed at assisting the growing LNG-as-fuel industry to develop.

Marine fuels in context

The maritime transport industry is under mounting pressure to improve its environmental performance. The central aim is to reduce emissions from fuel: sulphur oxides (SO_x), nitrogen oxides (NO_x) and particulate matter (PM) which harm the atmosphere and human health, and carbon dioxide (CO₂) and other greenhouse gases (GHG) which contribute to climate change.

The International Maritime Organization (IMO), the industry's international regulatory body, has set targets to reduce SO_x, NO_x and CO₂ emissions, and the final stage of the sulphur emission rules (the 'global sulphur cap') was successfully introduced in 2020.

SO_x emissions are fuel-related, and under the regulations, the maximum allowable sulphur levels in marine fuels have been reduced. Fuels exceeding the limits may only be used in combination with an approved exhaust gas cleaning system (EGCS).

NO_x emissions are engine-related. Engine manufacturers have made improvements to their engine designs to reduce NO_x emissions. In general, gas-fuelled engines have lower NO_x emissions than oil-fuelled engines.

PM emissions are both fuel and engine-related and are regulated by IMO together with SO_x.

The main focus of the shipping industry's attention has now moved to GHG reduction. CO₂ emissions are directly linked to the quantity and type of fuel used and these emissions may be reduced in two ways, firstly by increasing the vessel's fuel efficiency and thus reducing its fuel consumption, and secondly, by selecting a fuel with a relatively low carbon content.

Sustainably produced zero carbon/carbon-neutral fuels will be required to meet the emission reduction targets for the industry.

Introduction



The advantages of natural gas as a marine fuel

Liquefied Natural Gas (LNG) compares positively with traditional marine residual and distillate fuels as regards its impact on the environment:

- It emits up to 23% less CO₂ than marine fuel oil.
- It is less polluting than fuel oil, with reductions of 95% NO_x, and at least 95% of SO_x and PM.

LNG also has an excellent track record. It has been produced and transported efficiently and safely for over 50 years, it is compliant with existing regulations and its bunkering infrastructure is now reaching maturity.

That is why LNG is being increasingly adopted as primary energy source by the shipping industry, both for propulsion and for power generation on board. It is regarded as an essential transitional fuel until affordable zero carbon alternatives, including drop-in options liquefied bio gas (LBG) and liquefied synthetic methane (LSM), become available at scale.

What is LNG?

LNG is natural gas that has been cooled sufficiently to condense into a liquid. At atmospheric pressure, this happens at a temperature of -162°C (-260°F). As the natural gas condenses, about 600 volumes of gas become one volume of liquid and this makes it commercially feasible to transport large volumes of gas in a ship. The LNG is generally regasified by heating at its destination before being fed into a pipeline grid or power station. Alternatively, it is distributed to off-grid customers for industrial use or for use as transport fuel.

LNG is a mixture of hydrocarbons, predominantly methane (80-99%). Other significant components include other alkanes – ethane, propane and butane. Nitrogen may also be present at levels up to 1%. All the more complex hydrocarbons, along with carbon dioxide and sulphur compounds, are removed to trace levels during production.

Introduction

Physical properties

LNG, a colourless and odourless liquid, burns only when in its vapour state. Its very low temperature means that at ambient temperature the liquid is always boiling and creating vapour.

The vapour is heavier than air until it warms to about -110°C. The vapour is colourless but can be seen as it mixes with air. The water vapour in the air is condensed by the coldness of the warming natural gas and the result is a white cloud.

How is LNG made and where does it come from?

LNG is produced using a physical process: natural gas is compressed to 50-80 times atmospheric pressure and then cooled from ambient temperature until it liquefies.

The scale and cryogenic temperatures involved make LNG production much more difficult than the underlying physics would suggest. Liquefaction plants are frequently valued in billions, or tens of billions, of US dollars. They require several hundred megawatts of electricity generation capacity (a megawatt (MW) of electricity is sufficient to power 500-1000 European homes), and can occupy an area of up to 1.5 km².

As of early 2021, 20 countries were producing LNG in bulk, with another nine producing smaller quantities for domestic consumption. According to the International Group of Liquefied Gas Importers (IGLIGL), the biggest producers in 2020 were Australia (77.77 million tonnes), Qatar (77.13 million tonnes) and USA (44.76 million tonnes).

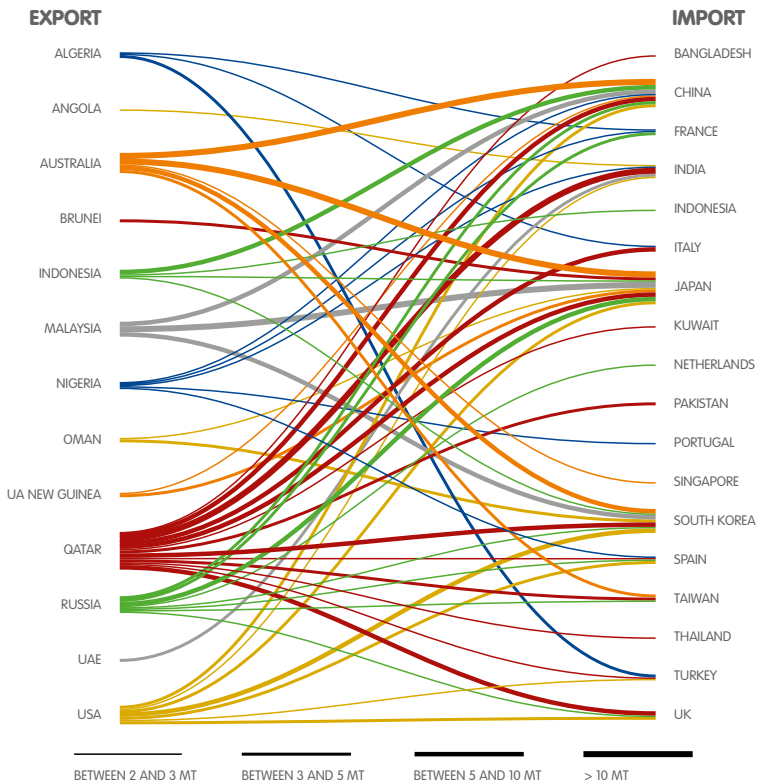
LNG industry overview

Some 356.1 million tonnes of LNG were traded worldwide in 2020. Japan was the biggest importer (74.43 million tonnes), followed by China (68.91 million tonnes) and South Korea (40.81 million tonnes). Virtually all the LNG



produced was used for electricity generation, industrial and commercial gas use, and by residential customers.

Well over 10 million tonnes per year of LNG are transported by road tanker from bulk import terminals and small LNG producers around the world. Road transport is most common in China, Spain, Turkey and the USA, and the quantity has more than doubled in recent years. Most of this LNG is consumed by large industrial users and power plants that do not have access to a gas pipeline network.



Bulk International LNG trade during 2020 indicating the major exporters and importers (Image courtesy of GIIGNL, Annual Report 2021)

Introduction

LNG as a fuel

Recently the use of LNG as a fuel has expanded significantly but volumes are still relatively small. For land transport it is mainly used by heavy-duty trucks or to fast-fill cars with compressed natural gas.

The gas-fuelled shipping fleet is also expanding rapidly, particularly in Europe, and the number of LNG bunker supply vessels is increasing fast, with over 20 LNG bunker vessels in operation and as many again on order. Every sector of shipping has at least one gas-fuelled vessel in its fleet and significantly the container, tanker and bulker fleets are all now ordering and operating gas-fuelled ships. There are over 250 vessels in operation worldwide that comply with IMO's International Code of Safety for Ships Using Gases or Other Low Flash-point Fuels (the IGF Code).

Using LNG to fuel railway locomotives takes place in India and Russia, and is being trialled in the USA and Canada, while Australian miners and American shale gas/oil producers are replacing diesel with LNG at their mines and production sites.

Compressed natural gas (CNG)

Compressed natural gas has been used for many years as a road transport fuel, but its use in shipping is limited to some small domestic CNG-fuelled ferries in Brazil and in the Netherlands. LNG is a better option due to CNG's low energy density and complicated bunkering process.



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