LPG as a marine fuel: A pathway to decarbonisation

World Liquid Petroleum Gas Association (WLPGA)

Decarbonisation is a major challenge for the shipping industry, with some tough targets set by the International Maritime Organization (IMO) and increasing pressure to reduce greenhouse gas (GHG) emissions. In 2018, IMO committed to reduce the shipping industry's total GHG emissions in 2050 by at least 50% from levels in 2008, and to reduce CO_2 emissions from transport work by at least 40% by 2030. IMO 2020 further mandates a maximum sulphur content of 0.5% in marine fuels globally. How can the industry achieve these targets?

Retaining efficiency and cost-effectiveness of operations goes alongside the urgent need to reduce carbon footprint. There are several fuels and technologies on the horizon offering promising solutions to this challenge, but the shipping industry is also in need of an immediate, practical solution that requires relatively low investment.

Lower emission fuel alternatives

Alternatives to marine fuel oil fall into three broad categories: Carbon, carbon neutral and zero carbon fuels. Long-term solutions will likely incorporate zero carbon options, such as hydrogen and ammonia, but, at present, these represent significant investment both in terms of capital expenditure (capex) and fuel cost. Operational issues, storage and bunkering also present challenges, given the high flammability of hydrogen and toxic effect of ammonia on human health. However, as the percentage of renewable energy sources used in electricity grids grows, electrolysis of water to split hydrogen and oxygen will unquestionably add to the environmental appeal of hydrogen in the future.

Carbon neutral fuels will surely have a part to play in the marine landscape for the future. At present, however, there are still challenges to overcome to create large-scale production and lower fuel costs.

Carbon-based fuel alternatives include liquefied natural gas (LNG), LPG, methanol, and ethanol. While methanol and ethanol are easy to handle and have a developed terminal network, they currently need investment and development to lower fuel price. There is growing infrastructure availability for LNG, which is safe to handle, but there are issues around investment costs and methane slip (emissions of unburnt methane). Methane is one of the six greenhouse gases listed by the Intergovernmental Panel on Climate Change (IPCC), and methane released could arguably nullify benefits to the environment and counteract steps to slow global warming today. Propane and butane – the main components of LPG – are not on the IPCC list. Although not yet widely used as a marine fuel, LPG is a safe, economically sustainable, future-proof and immediately available solution. As the

The BW Gemini has been converted to use LPG as fuel Photo credit: BW LPG


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fuel does not require any cryogenic technology, it is easier to handle and maintain and, ultimately, less expensive to store than LNG. The process of retrofitting produces significantly lower carbon emissions than building a new vessel, and offers potential for a smooth transition to carbon-free ammonia if needed in the future.

To be clear, the future of the shipping industry will almost certainly incorporate different technologies and fuels as development of zero carbon and carbon neutral fuels continues. In the meantime, fuels such as LPG offer a way to react to the urgent need today to reduce emissions and lower the industry's impact on the environment.

A 'quick win'?

LPG is already a widely accepted alternative fuel with proven performance, excellent clean handling properties and low emissions, and offers a viable alternative to traditional marine fuels in all sizes of vessels. Its combustion results in lower carbon dioxide emissions compared to oil-based fuels due to its lower carbon to hydrogen ratio. As LPG is nontoxic, hence not harmful to soil or water when spilled or leaked, it is also ideal for use in protected waters.

LPG does not require scrubbers and meets IMO's 0.5% sulphur cap. Compared to 'traditional' compliant LSFO bunker fuels, it reduces fuel consumption by around 10%, reduces particulate matter by 90%, lowers GHG emissions by 15%, and nitrogen oxides by 10%. Compared with using HSFO and scrubbers, operators can expect a reduction of 15% in fuel consumption, 50% reduction in particulate matter, 20% less GHG emissions and 10% fewer nitrogen oxides, along with near elimination of sulphur oxides.

Supply chain and infrastructure

Like LNG, LPG is available in large quantities throughout the world and global production already meets the level of fuel oil consumption in the marine sector. A large network of LPG import and export terminals is available around the world to address trade needs and, in locations which currently have LPG storage facilities, there is opportunity for relatively straight forward development of bunkering infrastructure. Immediate bunkering needs can be met through shore to ship transfers from LPG road tankers, and with over 1,000 storage facilities and terminals worldwide, the potential is already in place to create a network of LPG bunker stations offering flexibility on routes and destinations.

Economic viability of LPG

LPG engines can use higher compression ratios resulting in more power and better fuel efficiency due to a higher-octane rating and efficient combustion, offering by around 10% lower consumption than a traditional compliant fuel and savings of up to $20 per ton of fuel in bunkering operations for LPG carriers.

The obvious place to begin introduction of the fuel is on LPG carriers, where using LPG as fuel offers significant savings in bunkering time. However, with both two and four-stroke engines available, fleets in many other sectors could also be converted to LPG operation. BW LPG has already successfully retrofitted its very large gas carrier (VLGC) *BW Gemini* with dual-fuel engines to enable it to be run on LPG or traditional fuel with seamless switching between the two. It has also committed to retrofit a further 11 vessels with dual-fuel LPG propulsion engines. According to WLPGA records, about 40 vessels are currently in preparations to use LPG as a fuel (new or retrofits). Klaus Rasmussen of MAN Energy Solutions claimed recently that of the 70 LPG carriers on order with a cargo capacity of more than 2000m³, 55 will be built with LPG fueled engines.

A renewable resource?

Hydrogen, ammonia, biomethane and synthetic methane are all bright prospects for helping to reduce human impact on the environment in the shipping industry and beyond. Another promising fuel for the future, is renewable LPG, produced from renewable sources and feedstock materials. Propane and butane, the gases that make up LPG, can come from sustainable sources such as waste oils or animal fats. Research is also looking into production from cellulose sources, such as wood, or completely carbon neutral and renewable synthetic LPG produced from green hydrogen and sequestered carbon dioxide. Using hydrogen to produce synthetic LPG converts the energy from the more difficult to handle gas into a liquid bunker fuel. Conversion of biomethane to biopropane is another process path for renewable LPG.

Although renewable LPG is only currently available in modest quantities, its use can reduce carbon emissions by a further 80% compared with traditional LPG. Refineries are investing in increasing production from renewable feedstock and, as renewable LPG is chemically identical to traditional LPG, when production is ramped up it offers a 'drop in' solution for increased sustainability in the future.

Although there are several new fuels that will be important factors in a future shipping landscape, attractive pricing, low capital investment, and existing supply chain infrastructure make LPG an appealing option to increase the sustainability of shipping today. For the future, it offers an easy transition to zero carbon alternatives. As the production of renewable LPG increases, the environmental benefits of using LPG as a marine fuel will also naturally increase without further investment, making LPG, along with new fuels such as hydrogen and ammonia, a great investment for the future of the industry and the planet.


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