

LNG as a marine fuel boosts profitability while ensuring compliance

BUSINESS WHITE PAPER



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The choice of fuel is an increasingly important decision for ship operators, affecting both profitability and environmental compliance. Liquefied natural gas, or LNG, is an attractively priced and sustainable fuel that reduces environmental risks and harmful emissions. Using LNG engines decreases fuel costs while ensuring compliance with increasingly stringent regulations. These market trends and the increasingly stringent regulations require even more advanced technology, driving a need for new, innovative approaches to maintenance.

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Market trends favour the greener choice

— Industry has responded to environmental concerns by finding new and significantly better fuel sources, of which gas is emerging as the fuel of choice.

Ship owners today operate in an environment that is continuously changing and evolving. Huge advances are made in technology and new innovations have the potential to disrupt the entire marine market. Meanwhile, competition remains fierce and at the same time, operating costs are climbing, making it harder to increase profitability and keep up growth.

On the other hand, protecting the marine environment becomes increasingly urgent and regulations more stringent. Compliance may require investments, and ship operators must also consider future requirements when making investment decisions in order to future-proof their vessels against changing regulations.

When it comes to fuel, the low oil prices of recent years may have slowed down the shift towards more environmentally friendly alternatives somewhat. However, the need to abandon oil and coal in favour of cleaner options remains, and more and more shipping companies are making the greener choice. The global trade volume in LNG has more than tripled in 20 years.

Liquefied natural gas (LNG)

Liquefied natural gas is natural gas that has been cooled to about -260°F/-162°C at normal pressure, turning it into liquid form. LNG takes up about one six hundredth of the volume of gaseous natural gas. LNG can be transported, creating a global market and making use of even remote natural gas deposits.

Source: The Office of Fossil Energy (Energy.gov)

Fuel price and efficiency are key drivers

Fuel expenses are one of the biggest factors affecting a ship operator's profitability. Switching to LNG reduces fuel costs significantly, making the total lifecycle cost of LNG-fuelled engines lower than that of oil-fuelled ones – even when the higher initial investment and maintenance costs are taken into account. Natural gas is one of the most efficiently burning fossil fuels and converting an existing engine to operate on gas can offer significant economic benefits.

The primary financial driver for using LNG as a marine fuel is one of pure cost to purchase. At the end of 2016, the purchase price of LNG was approximately 6,1% lower than that of Heavy Fuel Oil (HFO), unit for unit. While fuel prices do fluctuate, the trend favours LNG as the less expensive choice. The fuel efficiency of modern gas-fuelled engines is also far better in a like for like comparison, with improvements ranging from 5 to 14% over conventional fuelled engines.

When comparing costs between oil and LNG-operated vessels, after-treatment solutions for the exhaust of oil-powered vessels must also be taken into account, as such solutions are required for environmental compliance. Once these costs – as well as the maintenance of the after-treatment equipment – are factored in, the case for LNG conversion becomes even more attractive.

A joint study carried out by Shell and Wärtsilä concluded that there was a significant lifecycle saving to be realised by vessels, small, medium and large, utilising LNG as a fuel compared to HFO. The following chart demonstrates the difference in lifecycle costs between ships operating on LNG and those using HFO as their primary fuel.

20 year lifecycle analysis, current industry scenario

(LNG engine under Dynamic maintenance planning™ (DMP™)* vs. oil engine under calendar-based maintenance)

	No. of Engines	Engine Type	Power (kW)	Total Opex Cost M USD	Engine Capex	Scrubber Capex	Capex M USD	Total Cost of Ownership M USD
Gas								
Small	2	9L20DF	1584	22.13	1.45	0.00	1.45	23.58
Medium (Cyl Matched)	2	9L34DF	4050	48.75	2.54	0.00	2.54	51.29
Medium (Power Matched)	2	9L34DF	4050	48.75	2.54	0.00	2.54	51.29
Large	2	8L50DF	7800	84.23	5.76	0.00	5.76	89.99
Oil Engine								
Small	2	8L20	1600	24.79	0.84	1.50	2.64	27.43
Medium (Cyl Matched)	2	9L32	4500	64.19	2.33	1.80	4.51	68.70
Medium (Power Matched)	2	8L32	4000	58.12	2.05	1.70	4.11	62.23
Large	2	8L46F	9240	120.53	5.88	2.10	8.46	128.99

Fuel costs based on bunker prices as of January 2017

The figures are based on a study by Shell and Wärtsilä.

*see page 7 for explanation of DMP

Easiest route to compliance

Retrofitting a vessel with LNG engines can be considered a way of future-proofing it against tightening regulations

Concern for the marine environment is rising and new measures have been, and will continue to be implemented to protect the oceans and seas. The marine industry must adapt to the changing legislation, which places restrictions on emissions of sulphur oxides (SOx), nitrogen oxides (NOx) and particulates. However, it is not enough for ship operators to keep up with the last regulatory changes – they need to consider potential future changes as well. Switching to an environmentally friendly fuel eliminates the need to keep updating or adding exhaust treatment solutions. Retrofitting a vessel with LNG engines can be considered a way of future-proofing it against tightening regulations.

Environmental restrictions prohibit vessels running on HFO from entering ports in Emission Control Areas (ECAs) unless they are equipped with scrubbers or similar after-treatment technology that cleans their exhaust output. The Baltic Sea, Artic Ocean and Californian coast are current examples of areas in which oil-powered vessels can face heavy financial penalties for exceeding the tight emission limits, but ECAs are expected to increase and become more widespread, further limiting the operating possibilities of vessels running on oil. IMO has announced that the global ECA will come into force in 2020.

Ships operating in ECAs must either use expensive low-sulphur marine gas oil (MGO) or operate on LNG, the emissions of which are lower and which is less costly. The risk of environmental damage is lower with LNG as the primary fuel, and choosing an environmentally friendly fuel can help build a shipping company's reputation as a sustainable operator.

**Fossil fuel emission levels
– Pounds per billion btu of energy input**

Pollutant	Natural gas	Oil	Coal
Carbon dioxide	117,000	164,000	208,000
Carbon monoxide	40	33	208
Nitrogen oxides	92	448	457
Sulphur dioxide	1	1,122	2,591
Particulates	7	84	2,744
Formaldehyde	0.750	0.220	0.221
Mercury	0.000	0.007	0.016

Source: Natural Gas Supply Association (Naturalgas.org)

Sensitive waters, such as Arctic waters and the waters around Alaska, can suffer significant damage due to combustion of hydrocarbons. Offshore operators and cruise vessels operating in such areas can reduce their emissions as well as environmental risks by adopting LNG-based power generation. Fishing vessels will also have to consider their fuel choices in the future to prevent damage to coastal ecosystems and consequently to their own livelihood.

Regulatory landscape

- Ship pollution regulations are defined in the International Convention on the Prevention of Pollution from Ships
- Governing organisation is the International Maritime Organization (IMO), United Nations organization
- Includes Tier I, II and III standards; Tier I was ratified in 2004 and Tiers II and III contain amendments to it
- Sets limits for NOx and SOx content in emissions
- Defines Emission Control Areas
- Also addresses greenhouse gas emissions, ozone depleting substances and energy efficiency.

Source: IMO

Optimising costs by converting to gas

Dual fuel engines allow ships to be operated on either conventional liquid marine fuels or LNG

The reduction of emissions, environmental fees and fuel costs are the main drivers for converting an engine to gas operation. Cleaner combustion also means that with a gas fuelled engine, coupled with DMP™, maintenance costs can be lower than with other fuels.

Selecting LNG as a fuel option is not limited just to newly built vessels, as it is often feasible to convert conventional engines to be more flexible in fuel type, including LNG. This conversion does not limit the engine to using only LNG - it introduces true fuel flexibility where more than one fuel type can be used. These engines are known as dual fuel engines.

Whether a vessel can be converted to operate on LNG depends mainly on the space required by the LNG tanks and additional equipment required. In most cases, the most economical option is to convert the existing engines of a vessel, but installation of new dual fuel engines is in some cases a feasible option as well.

A complete vessel conversion includes the following elements:

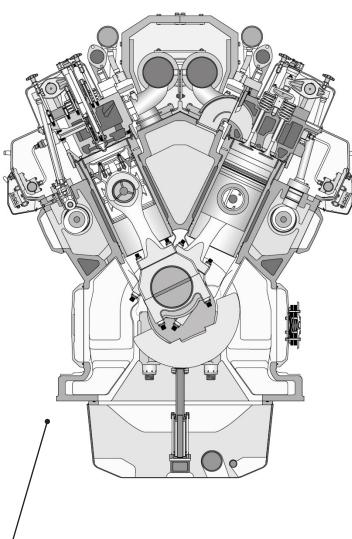
- Engine conversion
- LNG tank(s) and foundation
- LNG/NG double walled piping
- Gas detection and fire suppression Inert plant/N2 storage and control air
- Bunkering station(s)
- Automation and control system
- Exhaust pipe gas burst disc(s)
- Gas compression system

DUAL FUEL ENGINES BRING FLEXIBILITY

Dual fuel engines allow ships to be operated on either conventional liquid marine fuels (MGO, HFO, Light Fuel Oil (LFO) or liquid bio fuel) or LNG. The switch between fuels can be made seamlessly during operation without loss of power or speed. This fuel flexibility enables compliance with emission regulations in controlled areas, while giving operators the possibility to choose the fuel according to cost and availability.

When operating in gas mode, dual fuel engines are already compliant with IMO Tier III regulations without any secondary exhaust gas purification systems. When fuelled by gas, SOx and CO₂ emissions are significantly reduced.

In liquid fuel oil mode, dual-fuel engines are fully compliant with the IMO Tier II exhaust emissions regulations. The engine is able to run efficiently and economically on low sulphur fuels, allowing it to operate in emission-controlled areas.



Wärtsilä 50DF engine with multiple fuel systems

Maintenance and operations working with LNG

In the maintenance of dual fuel engines, smart decision-making is the key to optimising costs and maximising the lifetime of the equipment

Dual fuel engines introduce new technologies that require different approaches to maintenance and operational activities. This means that personnel involved in working with the engines both shore side and on board have to adapt their working practices to accommodate the new demands.

In the maintenance of these dual fuel engines, smarter decision-making is the key to optimising costs and maximising the lifetime of the equipment.

Operationally, the demands on the crew on board change for the better, meaning that efficiency gains and operational improvements can be implemented, which frees up resources.

Predictive maintenance extends vessels' lifecycle

Dual-fuel engines are in effect combinations of two engines, and therefore more complicated than engines running on a single fuel type. Because of this, their maintenance involves more than that of traditional HFO engines. As a consequence, overall maintenance costs for dual-fuel engines can be slightly higher, but they can be brought down with condition monitoring and dynamic maintenance planning (DMP™), which enable longer overhaul intervals based on the actual condition of the engines - which is better as LNG is a cleaner burning fuel. Any such moderate increases are far outweighed by the savings to be realised in fuel costs.

Digital solutions are designed to optimise a vessel's operations. Applying these solutions to LNG-powered vessels provides increased operational efficiency, availability and predictability. A lifecycle service agreement that includes continuous real-time monitoring and expert analysis of the received data also extends the lifecycle of the on-board equipment, reducing risk of failure or unscheduled downtime.

Streamlining operations

The value proposition of gas engines is not only based on cost savings but also reduced workloads. Benefits include reduced cleaning requirements, reduced person-hours required for maintenance and higher reliability due to reduced operational maintenance (soot blow, T/C cleaning, under piston space cleaning).

Summary

Switching to LNG as primary fuel, either by building from new or converting existing technology, requires an initial investment but can generate significant savings in fuel costs, increasing the profitability of vessel operators and reducing risks. This improvement in lifecycle cost for a vessel is a key motivation to change and take a competitive advantage.

LNG engines are an environmentally sound solution that enables regulatory compliance and allows vessels to operate in Emission Control Areas and other environmentally sensitive zones without damaging the marine ecosystem or releasing harmful emissions into the air. Companies that take ecological factors into account can also benefit from having a reputation as a sustainable operator, increasing the attractiveness of their brand.

An operational service agreement that involves real-time monitoring and Dynamic Maintenance Planning (DMP™) helps to keep dual-fuel engines performing optimally and reduces overall maintenance costs while extending the lifecycle of the equipment. Although operating dual-fuel engines requires new maintenance approaches and working practices, switching to dual-fuel allows operational improvements that can generate efficiency gains, freeing valuable personnel resources.

The combination of these benefits makes LNG a viable choice economically, ecologically and operationally.

Wärtsilä Services in brief

Wärtsilä Services creates lifecycle services for its customers, enhancing their business – whenever, wherever. We provide industry's broadest range of services for both shipping and power generation. Our solutions range from spare parts and basic support to ensuring maximised lifetime, increased efficiency and guaranteed performance of customer's equipment or installation – in a safe, reliable, and environmentally sustainable way.

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