

THE DEFINITIVE STUDY ON LIFECYCLE ANALYSIS FOR LNG AS A MARINE FUEL

SPHERA'S 2ND LIFECYCLE GHG EMISSION STUDY ON THE USE OF LNG AS A MARINE FUEL



SEA-LNG

APRIL 2021

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SEA-LNG and SGMF commissioned an update to the Lifecycle GHG Emission Study on the use of LNG as a Marine Fuel. Conducted to stringent ISO standards by independent specialist consultants, Sphera (formerly thinkstep), the study is peer-reviewed by a panel of internationally-recognised academic experts.

The aim of the study is to provide an update to the research conducted in 2018 / 2019, using the latest available engine and supply chain data, including planned developments for the reduction of methane emissions and slip.

The research updates and supports the findings from the previous thinkstep study, widely recognised as the definitive view of lifecycle emissions analysis of the use of LNG as a marine fuel. It reinforces the fact that LNG is the only operationally-proven marine fuel available today, and for the foreseeable future, which significantly reduces GHG emissions for deep-sea shipping.

Waiting is not an option, tackling climate change is a shared responsibility and must start now.

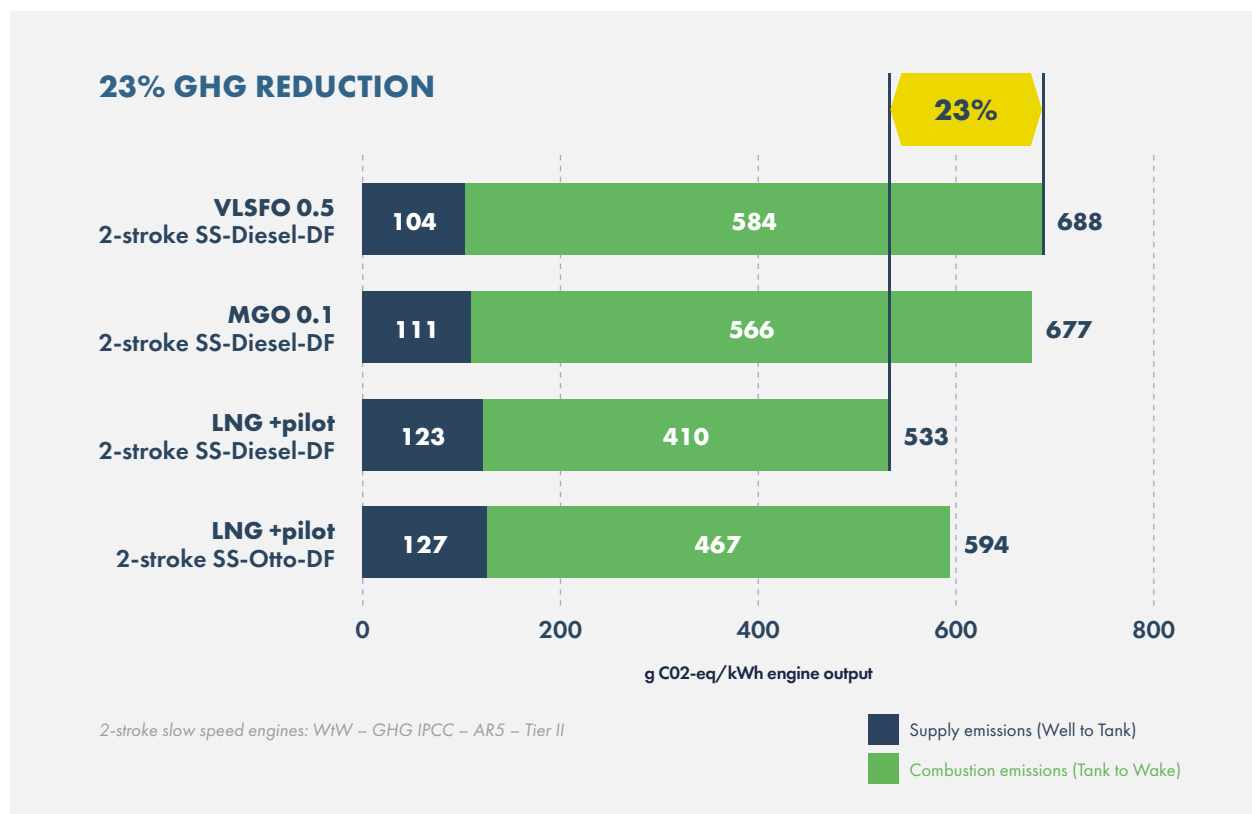


Photo credit: John Calambokidis, Cascadia Research

KEY FINDINGS

LNG is the only operationally proven and scalable marine fuel that offers immediate reductions NOW in GHG and local emissions.

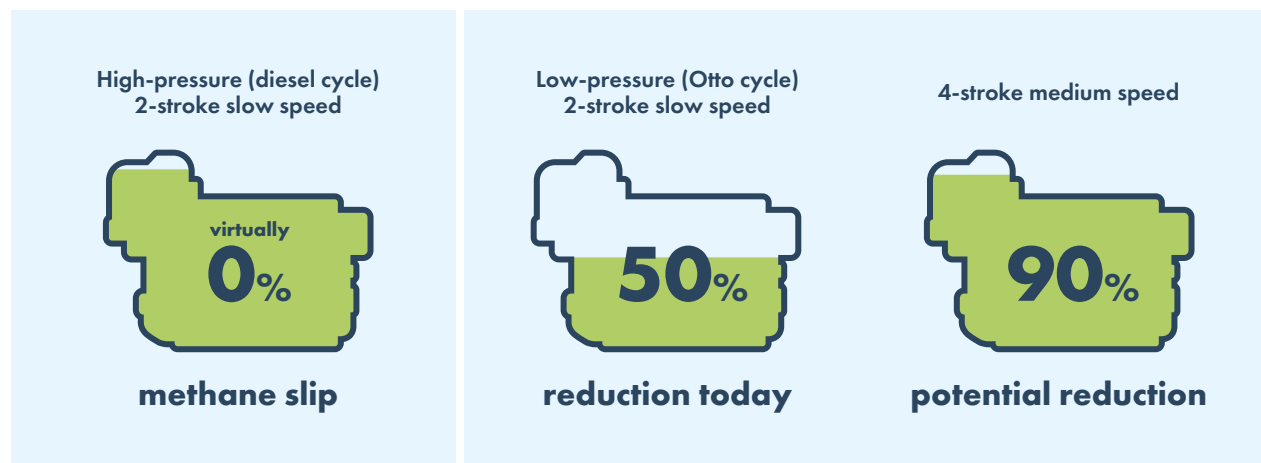
- The use of LNG as a marine fuel shows **GHG benefits of up to 23% on a Well-to-Wake (WtW) basis and up to 30% on a Tank-to-Wake (TtW) basis compared with current oil-based marine fuels**
 - On an engine technology basis, the absolute WtW emissions reduction benefits for gas-fuelled engines compared with VLSFO-fuelled ships are between 14% to 23% for 2-stroke slow-speed engines, and between 6% to 14% for 4-stroke medium-speed engines
 - On a TtW basis, emissions-reductions benefits for LNG-fuelled engines compared with VLSFO-fuelled engines are between 20% to 30% for 2-stroke slow speed engines, and between 11% to 21% for 4-stroke medium speed engines



- LNG provides a **major advantage** in terms of improving **air quality and human health**, particularly **important in ports and coastal areas**
 - Due to the negligible amount of sulphur in the LNG fuel, SO_x emissions are reduced close to zero
 - NO_x emissions can be reduced by up to 95 % to meet the IMO Tier III limits
 - LNG virtually eliminates particulate matter, including black carbon or soot, which while not yet regulated, is a growing environmental concern

Methane emissions outlook shows significant improvements by engine manufacturers and LNG suppliers

- Original Equipment Manufacturers (OEM)s continue to make substantial progress to reduce methane slip
- High-pressure 2-stroke slow speed diesel cycle engines already have virtually no methane slip
- Low-pressure 2-stroke slow speed Otto cycle engines ordered today offer a 50% reduction in methane slip
- The outlook for 4-stroke medium speed engines is also promising. Current technologies in research and development, such as oxidation catalysts and high-pressure gas injection, have the potential to cut methane slip by 90%
- By 2030 engine manufacturers forecast that all LNG-fuelled engine technologies will have minimal levels of methane slip
- Supply chain methane emissions account for about 6% of total WtW GHG emissions. These emissions could be reduced on average by 15% by 2025 and 35% by 2030, based on actual initiatives and communicated targets.



The study was undertaken using rigorous, best-practice lifecycle guidelines and globally recognised standards

- It is **COMPREHENSIVE** - using the latest **primary data** to assess **all major types of marine engines** and **global sources of supply**:
 - 2-stroke slow-speed (most common for high-powered ocean-going ships which burn 72% of marine fuel)
 - 4-stroke medium-speed (burning 18% of marine fuel, used mainly by cruise and ferry vessels)
 - 4-stroke high-speed (only 5% of overall fuel usage)
 - Others e.g. gas turbine (5% of overall fuel usage)
- It is **QUALITY ASSURED** - assesses the supply and use of LNG as a marine fuel according to **ISO standards**
- It is **PEER-REVIEWED** **by globally recognised academic experts** from key institutions in Germany, France, Japan and the USA.



RESEARCHERS

Sphera (formerly thinkstep) is a leading global consulting and software company in the field of sustainability, especially lifecycle thinking. The Sphera team has used the knowledge gained through work performed for 2,500 clients worldwide, including some of the world's most respected brands, to continuously improve its skills and abilities. This has led to new strategies, management systems, tools and processes needed to achieve leadership in sustainability. The Sphera project team was led by Dr Oliver Schuller.

PEER-REVIEWED BY ACADEMIC EXPERTS TO ISO STANDARDS

The study has been subjected to a critical review by a panel of independent experts according to ISO 14044, section 6. The members of the critical review panel were:

- Philippe Osset, Solinnen, Paris (France) – CEO, French delegate at ISO/TC 207/SC 5 (LCA), SC3 and SC7 (GHG), convenor of the WG which produced ISO/TS 14071:2014 on LCA Critical Reviews member – Chair of Review Panel
- Prof Dr. Atsushi Inaba, Japan Life Cycle Assessment Facilitation Center, President, Expert of ISO/TC207/SC3, SC5 and SC7 and TC323.– reviewer
- Prof Dr Friedrich Wirz, Technical University of Hamburg (Germany)- Head of Department of Marine Engineering – reviewer
- Dr Michael Wang, Argonne National Laboratory (USA), Director of Systems Assessment Center – reviewer.

LATEST DATA

Data for the study was provided by the following Original Equipment Manufacturers: Caterpillar, GE, Man D&T, Rolls Royce (MTU), Wärtsilä and WIN-DG, and, from the supply side: ExxonMobil, Shell and Total. The project oversight team, led by Steve Esau from SEA-LNG and Mark Bell from SGMF, was fully supported by senior technical personnel from the member organisations of both coalitions.

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