



LPG As Marine Fuel: The BW LPG Experience

5 December 2021



Delivering cleaner energy safely and sustainably with LPG



Maximising current assets; minimizing emissions from well-to-wake perspective

A Commitment to Decarbonize

- The sector's largest investment to decarbonise at USD 130 million; committed 15 Very Large Gas Carriers (VLGCs) to be retrofitted with pioneering LPG dual-fuel propulsion technology
- Retrofitting maximises use of current assets and we save ~1 million tons in CO2 emissions vs newbuilds

Proven and Scaled

- 12 VLGCs on water; final 3 planned in Q1 2022
- >10,000 operational hours at sea and counting
- Shipping is ready for LPG

Benefits of LPG Propulsion

- LPG propulsion makes environmental, operational and economic sense
- LPG is a cleaner energy fuel, and is part of the solution as we work towards a zero carbon future

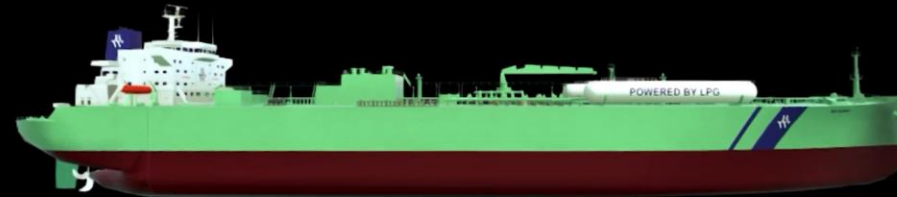


Liquefied Gas Injection (Propane) Technology

Pioneering technology in collaboration with major engine manufacturers MAN ES and Wärtsilla

A Step Ahead

- LPG is drawn into fuel gas supply system & piped to engine
- A small amount of compliant pilot fuel such as VLSFO or MGO is injected into the engine as the piston nears the top
- It sparks under pressure, and LPG burns cleanly to create propulsive force
- Reduce emissions:
 - Sulphur Oxides (~97%)
 - Particulate Matter (~90%)
 - Carbon Dioxide (~20%)
 - Nitrous Oxides (~20%)
- Increase efficiency on many fronts



Moving people and parts was key operational challenge

Safety of crew a priority while minimizing logistical impact from Covid-19



Smooth adoption of new technology onboard current ships

- No major surprises during retrofitting process, including for world's first LPG-powered VLGC, BW Gemini
- Importance of filters to manage organic materials in LPG
- Selecting ideal cylinder lube oil to prevent clogging of fuel injectors
- Simultaneous retrofitting of 2-3 vessels

LGIP technology scaled successfully, collaboration is key

- Experienced, dedicated site team is critical to project success
- Had to manage quality concerns from main and sub-suppliers, but overall good experience
- Special thanks to Yiu Lian dockyard for their flexibility and patience
- Special thanks to Wärtsilä and MAN ES for partnering us in this pioneering project

Impact from Covid-19 on project progress

- Over 14,000 hours spent in quarantine. Colleagues spend 2 weeks in hotels upon arrival in China/ back home (Singapore/ Norway)
- Crew confined to vessel and yard with no shore leave
- Shipping delays for critical parts

Ship-to-Ship Transfer (STS) of LPG as bunker

An innovative approach to a common maritime practice – saving time and giving control over timelines



Dedicated Service at Sea

- Time charter of LPG Carrier Epic St Martin for ~1 year, dedicated to LPG retrofitting project
- 19 STS conducted to-date
- Fitted Epic St Martin with fenders, and a dedicated STS Supervisor onboard oversees operations
- Rendezvous points and timings planned with weather in mind for safest STS at sea
- Mooring during daylight, uncasting any time
- Discharge LPG heel before drydock
- Bunker LPG after drydock

Beyond marine fuel and towards a Better World with LPG

Significant growth prospects beyond maritime transportation of LPG



Replacing pollutive biomass, saving lives and ecosystems

- Cooking for Life Campaign by WLPGA aims to facilitate the transition of 1 billion people to cook with LPG by 2030
- > 4 million people die from illnesses related to household air pollution annually
- Replacing biomass with LPG reduces deforestation and degradation

Investing and expanding our shipping presence in India

- BW LPG is India's largest operator and operator of world-class VLGCs with a growing fleet of India-flagged vessels
- Well-positioned to lead the Middle East - India LPG trade
- Governmental push to increase LPG as part of energy mix, with retail consumption outpacing domestic production; industrial demand for LPG is also growing

Looking beyond shipping and into gas infrastructure

- Opportunities to invest directly into modern terminals to increase utilization and efficiency
- Floating storage may increase useful life of vessels beyond 35 years
- Potential for onshore investments eg pipelines and distribution



THANK YOU

