

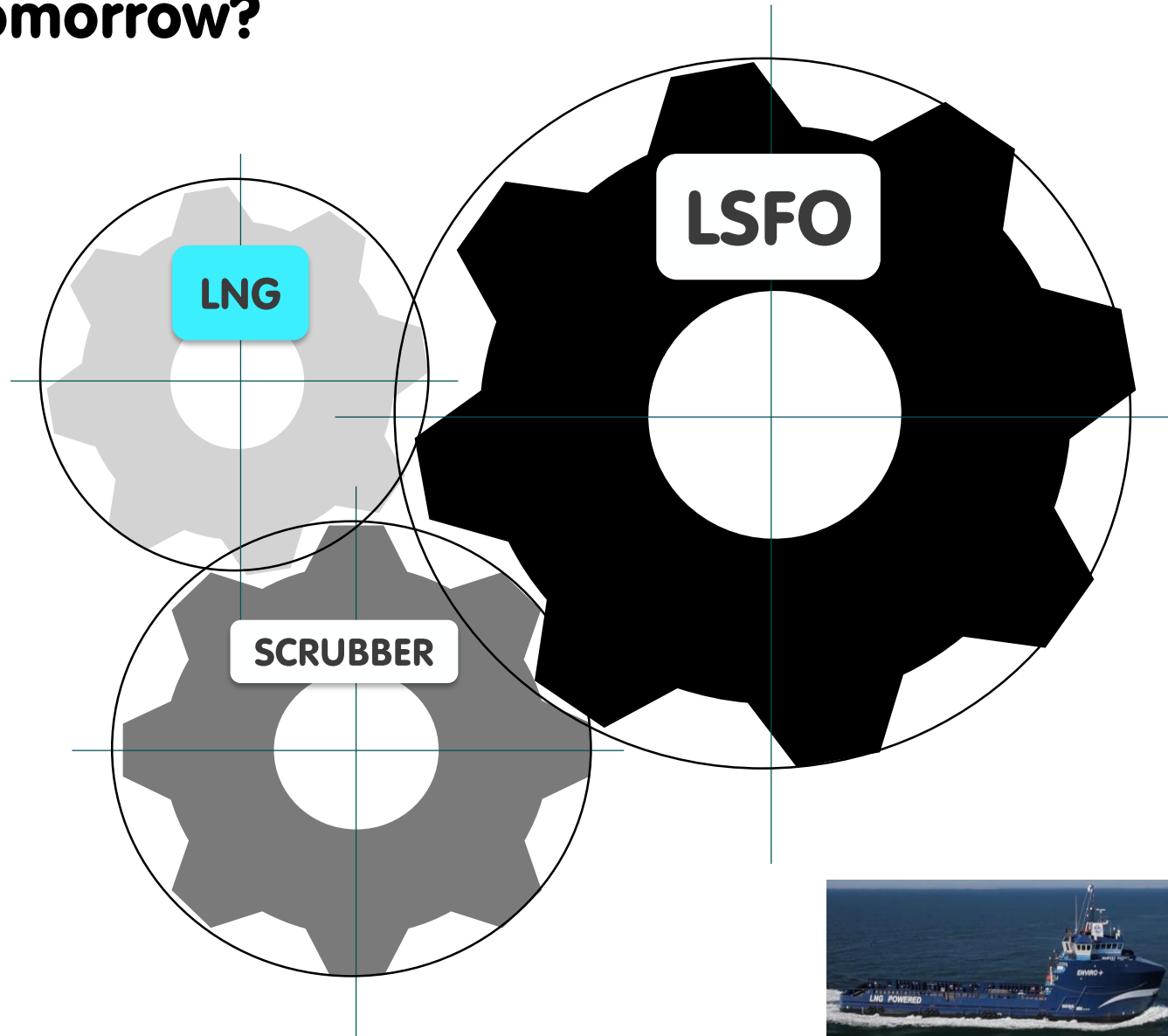
The logo features the letters 's', 'g', 'm', and 'f' in a white, lowercase, rounded font. The letter 'g' is replaced by a stylized teal water drop shape. Below the logo, the text '2019 sea change.' is written in a white, lowercase, sans-serif font.

sgmf
2019 sea change.

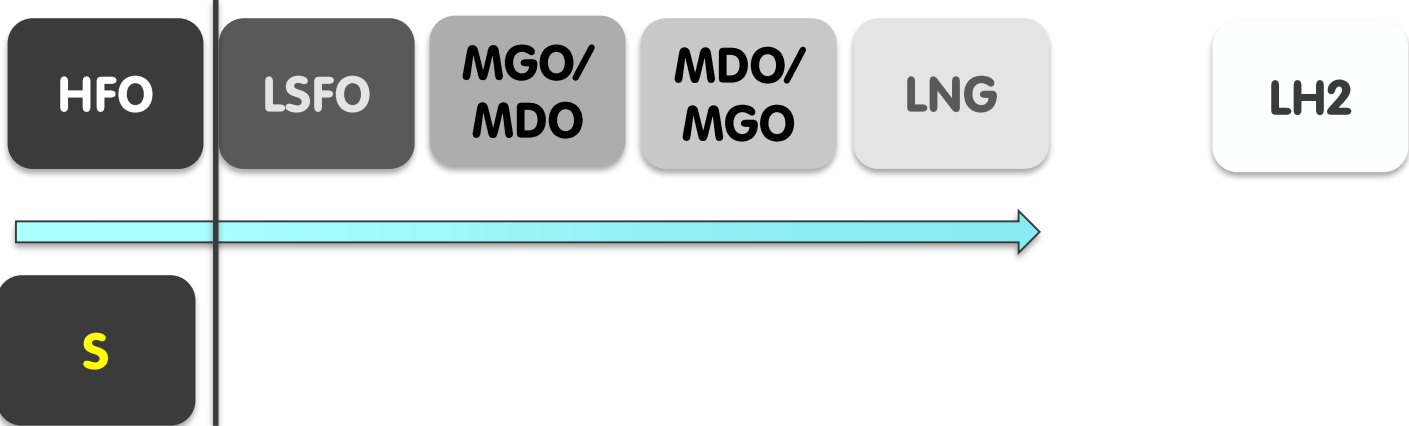
IMO Symposium
Oct 2019

Mark Bell – SGMF
Dr Oliver Schuller - ThinkStep

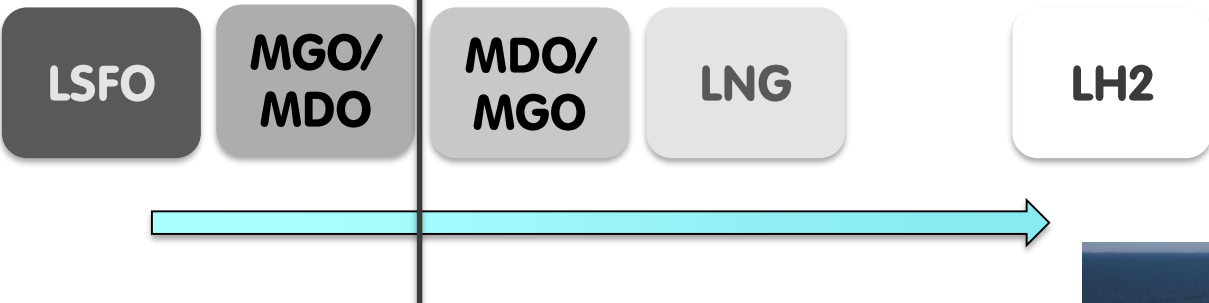
COMPLIANT FUEL CHOICES TODAY – Tomorrow?



1) Use of LNG as a Marine Fuel to comply with IMO 2020?



2) Use of LNG as a Marine Fuel to comply with IMO 2050?



SGMF at a glance....

Membership Based NGO representing best practice for SAFE and SUSTAINABLE Gas fuelled shipping

- Formed in 2013 now with over 140 members across the sector
Including Suppliers / Owners / Operators / Class / OEMs / Shipyards / Port Authorities
(Open to all – not for profit)
- Provides Regulators with key guidelines as key input for National and International Standards
- Works with Industry at all Levels
IMO – EU – USCG – MPA and other NGOs
- Analyses and solves issues with regard to Safe Operations, Technical, Quality and Quantity, Training and Competence and Environmental matters
- Regular meetings and Forums across all Geographies for members interaction
- SGMF Portal is key resource for Industry data and member interaction www.sgmf.info
- IGF Code Vessel Focus



Who we work with.....



Gas Fueled Value Chain

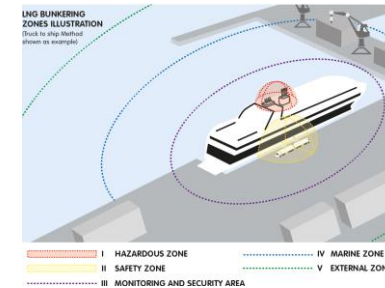
Regulatory Framework – SGMF Guidelines



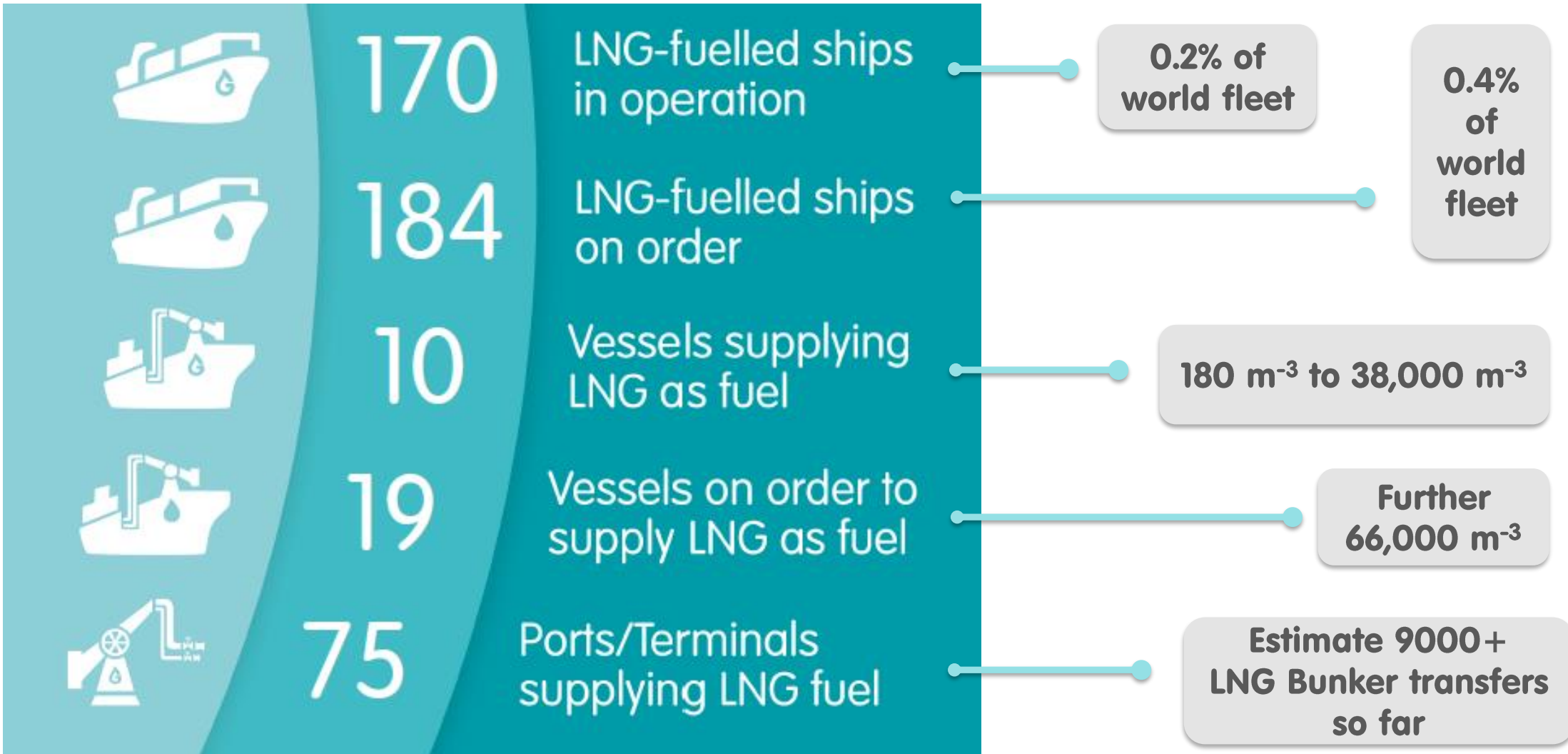
- Gas as Fuel an introductory guide
- Bunkering Operational Guidelines
- Bunkering Competency Guidelines
- Quality & Quantity Contractual Guidelines
- Recommendations of Controlled Zone for LNG Bunkering
- Simultaneous Operations for LNG Bunkering
- Manifold Arrangements for IGF Vessels
- Quick Connect /Disconnect Couplings
- Safe Working Distances for LNG Bunkering
- ESD and Control systems
- LCA study for Gas Fuelled Shipping

Soon to come...

- Flexible Hose Selection and Handling
- Methane Number Considerations
- Dry Docking and Maintenance for IGF vessels



Gas Fuelled Fleet Progress 2019



New Bunker LNG Bunker Vessels

SHIP	Operator	IMO	Delivery	Cont	Capacity [m ³]	Region
Seagas	Sirius	7382691	2013	Type C	187	Baltic
Engie Zeebrugge	Engie NYK Fluxys	9750024	2017	Type C	5000	N EU
Cardissa	Shell	9765079	2017	Type C	6500	EU
Coralius	Gasum		2017	Type C	5800	Baltic
Oizmendi		9494981	2018	Type C	600	EU
Coral Methane	Anthony Veder	9404584	2018 (Conv)	Type C	7500	Carib
Kairos	BSM	9819882	2019	Type C	7500	EU
Clean Jacksonville	TOTE	\	2018	Membrane	2200	USA
FlexFueler 1	Titan LNG	\	2019	Type C	1480	EU
LNG London	Victrol / CFT	ENI 06105621	2019	Type C	3000	EU
10 In operation					39,767	
19 on order					+66,600	



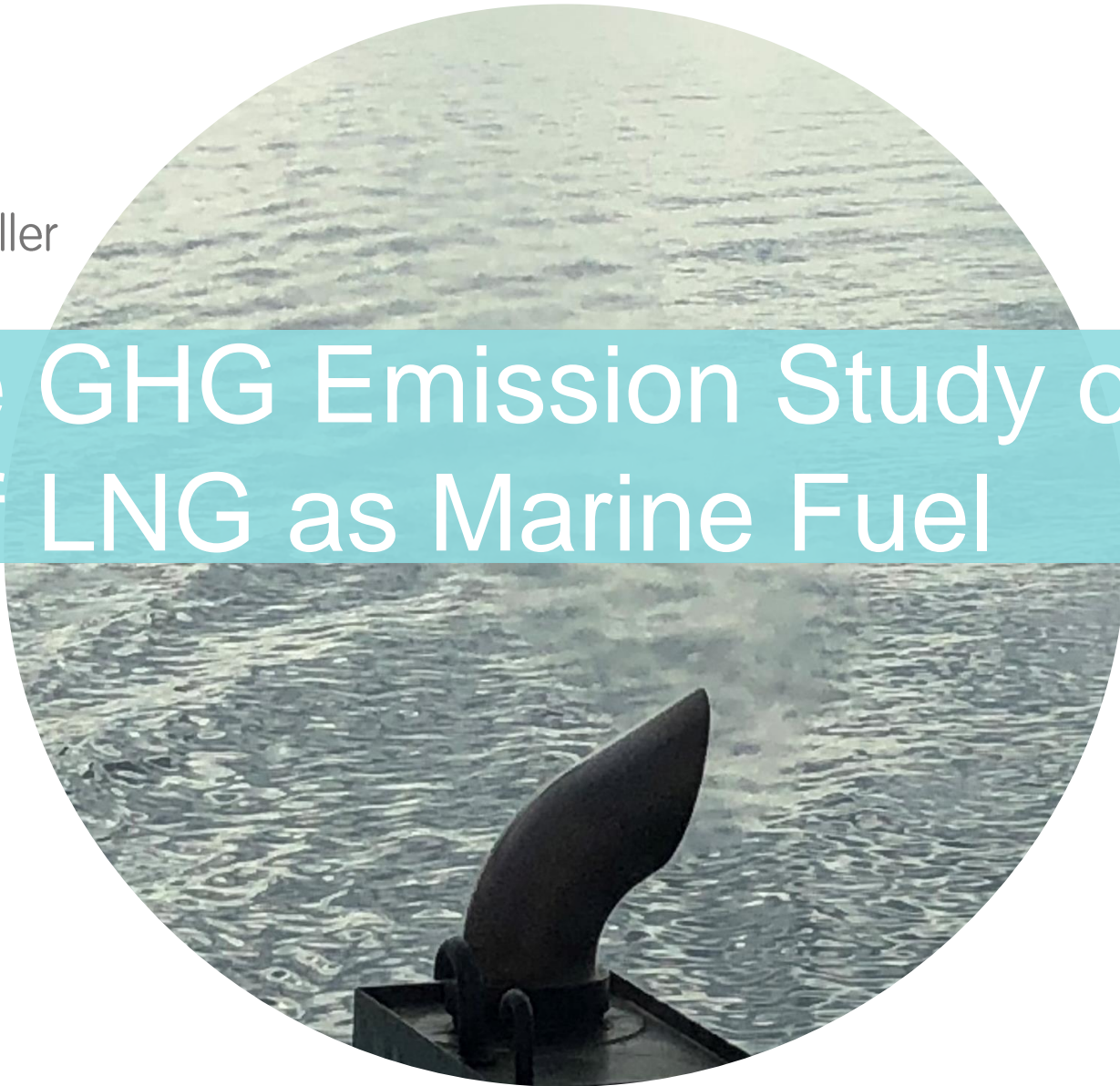


thinkstep

Dr Oliver Schuller

Life Cycle GHG Emission Study on the use of LNG as Marine Fuel

Final Results



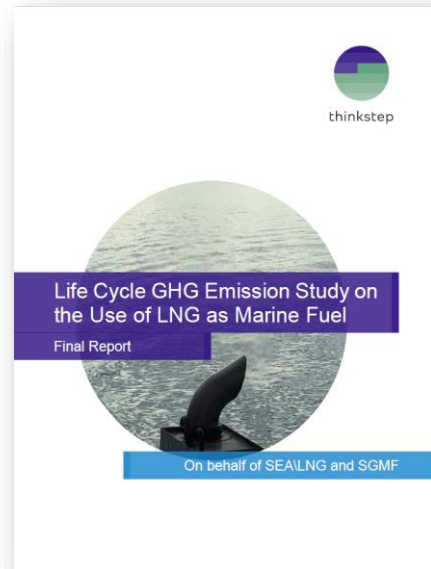
Why this Study?

Context

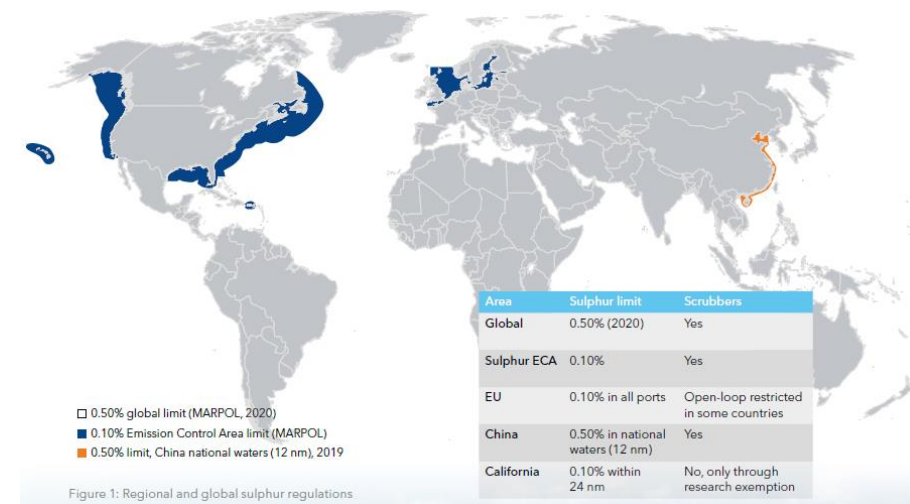
The international shipping industry, as other industry sectors, are under pressure to reduce emissions.

The International Maritime Organization (IMO) has announced the ambition to reduce the GHG emissions from international shipping by at least 50% by 2050 compared with 2008.

More stringent air quality regulations, such as the IMO 2020 global sulphur cap, are almost upon us.



Accurate, up-to-date and reliable GHG inventory data as all well as local pollutant data are key to understand if LNG is a viable option to reduce GHG emissions and improve air quality in the international shipping industry.



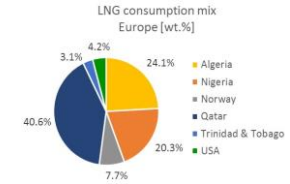
Source: DNV GL – Global Sulphur Cap 2020, 2018

Goal & Scope

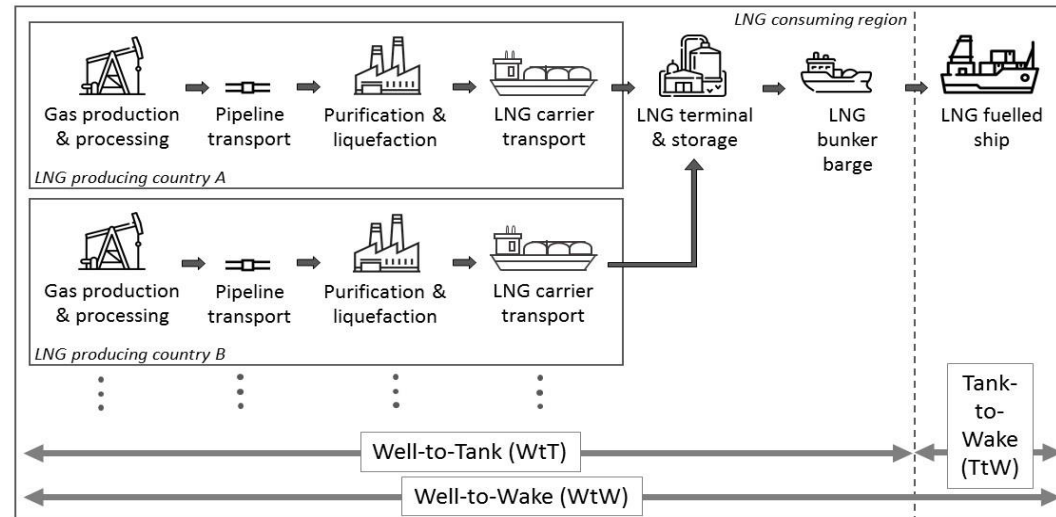
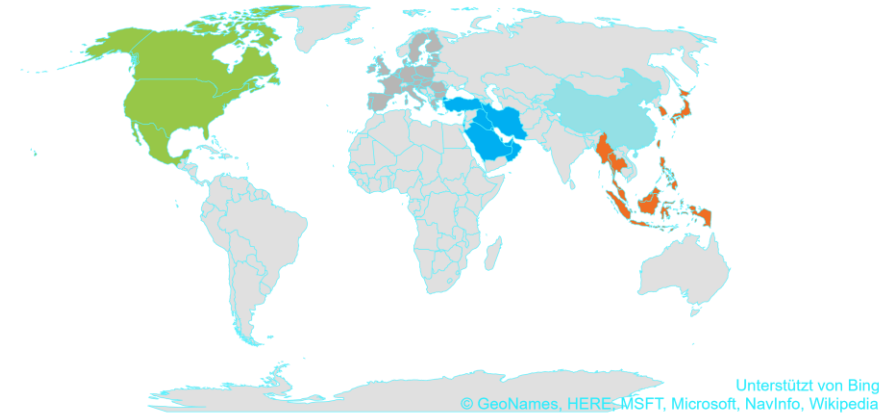
Approach and Methodology

The analysis was performed:

- by following the life cycle approach (ISO 14040/44) from Well-to-Wake (WtW)
- for a global average fuel supply inventory, based on specific regional consumption mixes by specific production countries
- for current and post-2020 fuels
- for gas and oil-based ship engine technologies
- considering the most common ship engine technologies in operation, taken into account the specific fuel consumption and methane slip
- looking at GHG emissions and air quality
- using industry data, provided by



Countries of the 5 Bunkering Regions



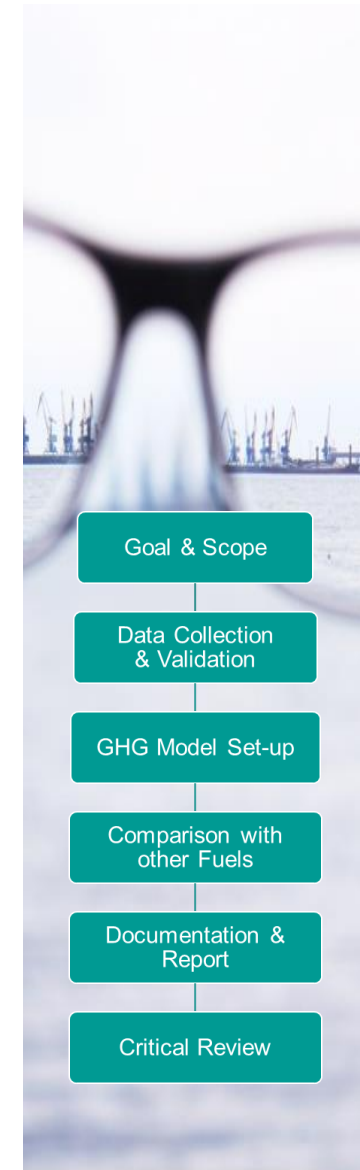
Well-to-Wake GHG Emissions

Critical Review

Following ISO 14040/44, this study is critical reviewed by independent experts

Reviewers are:

Reviewer	Organisation, Location, Position	Role
Philippe Osset	Solinnen, Paris (France) <i>CEO, member of the ISO 14040/14044 working group</i>	Chair of Panel
Prof. Dr. Atsushi Inaba	Kogakuin University (Japan) <i>Department of Environmental and Energy Chemistry</i>	Reviewer
Prof. Dr. Friedrich Wirz	Hamburg University of Technology (Germany) <i>Head of Department Marine Engineering</i>	Reviewer
Dr. Michael Wang	Argonne National Laboratory (USA) <i>Head of Systems' Assessment Department</i>	Reviewer



Key Messages

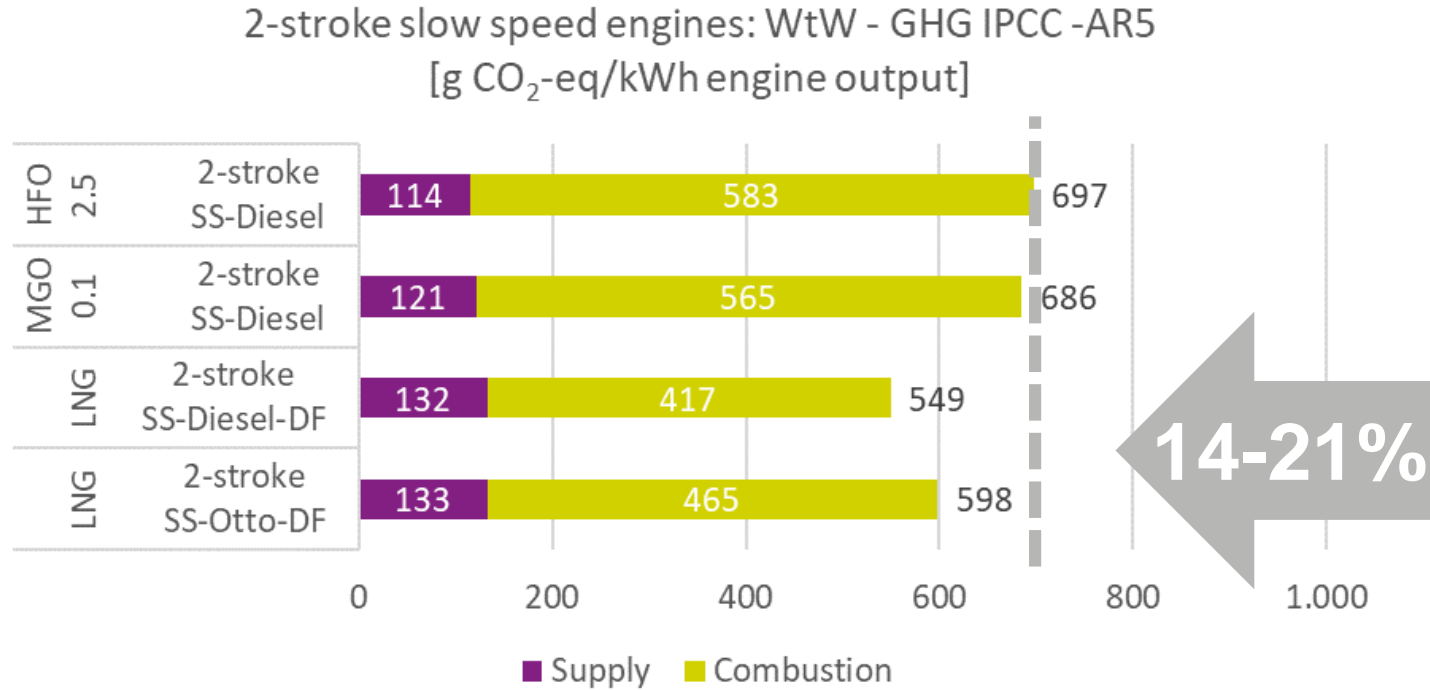
TOP 12

1. The use of LNG shows GHG reduction of **up to 21 %** compared with current oil-based marine fuels over the entire life cycle from Well-to-Wake (WtW).
2. On an engine technology basis, the WtW GHG emission reduction for gas fuelled engines compared with today's HFO fueled engines are between **14-21 %** for 2-stroke slow speed engines, and between **7-15 %** for 4-stroke medium speed engines.
3. On a Tank-to-Wake (TtW) basis, the combustion process for LNG as a marine fuel shows GHG benefits of up to **28 %** compared with current oil-based marine fuels. On an engine technology basis, the TtW emissions reduction benefits for gas fuelled engines compared with HFO fueled engines are between 18 to 28 % for 2-stroke slow speed engines and between 12 to 22 % for 4-stroke medium speed engines.
4. **Local pollutants**, such as sulphurous oxides, nitrogen oxides and particulate matter, are reduced significantly when using LNG.

Key Messages

TOP 12

6. Well-to-Wake GHG emissions (today's fuels)

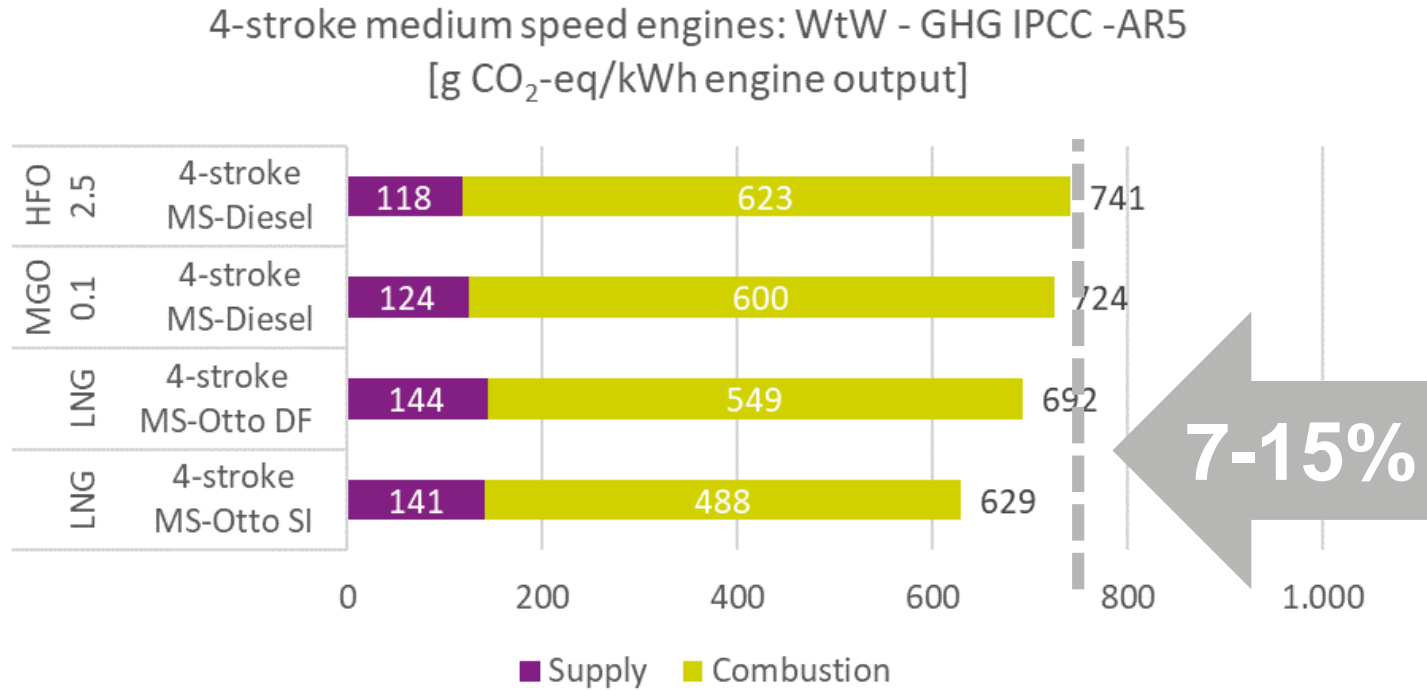


➔ GHG reduction when using LNG: 14-21% compared with HFO_{2.5}

Key Messages

TOP 12

6. Well-to-Wake GHG emissions (today's fuels)



➔ GHG reduction when using LNG: 7-15% compared with HFO_{2.5}

Key Messages

TOP 12

7. For **post-2020 oil-based marine fuels** (LSFO) or the use of HFO in combination with an exhaust gas cleaning system, the result is slightly better. LNG 2-stroke engines have GHG advantages between **14-22 %**, and 4-stroke engines between **6-16 %** compared with HFO fueled engines.
8. As a direct comparison if the global marine transport fleet²⁰¹⁵ were to completely switch to LNG then there would be a GHG emission reduction of **15 %** based upon engine technology alone.
9. GHG emission benefits are reduced depending upon the degree of methane slip incurred during the combustion process.
 - High pressure 2-stroke Diesel cycle engines and marine gas turbine propulsion units incur methane slip less than **1 %** of the overall WtW GHG emissions.
 - Low pressure 2-stroke and 4-stroke Otto cycle reciprocating engines are more sensitive to methane slip with **10-17 %** of the WtW GHG emissions resulting from unburned methane in the combustion process.

Key Messages

TOP 12

10. This study presents the current status of the industry; Ongoing optimisation in the fuel supply chain and engine technology developments will further enhance the benefits of LNG as a marine fuel.
11. An indicative analysis showed that bioLNG and synthetic LNG can provide an additional significant benefit in terms of WtW GHG intensity.
12. GHG emissions of fuel supply chains differ from region to region due to a large number of variables, specific supply chain analyses are key in order to get to a global average GHG intensity.

Emissions Fact Sheet | Gas as a Marine Fuel

LNG IS SAFE TO USE, FULLY COMPLIANT AND READILY AVAILABLE AS A MARINE TRANSPORT FUEL

Standards, Guidelines and Operational protocols are all in place to ensure that the SAFE WAY is the ONLY WAY when using gas as a ship fuel.



LNG meets and exceeds all current and 2020 Marine fuel compliance requirements for content and emissions, local and GHG.



With the world LBV fleet doubling in the next 18 months and those vessels being deployed at major bunkering hubs, LNG as a ship fuel is rapidly becoming readily available.



OBJECTIVE - Peer reviewed by leading academics from key institutions in Germany, Japan and USA.

QUALITY ASSURED - Assesses the supply and use of LNG as marine fuel according to relevant ISO standards.

COMPREHENSIVE - Uses latest primary data to assess all major types of marine engines and global sources of supply.

THIS REPORT IS THE DEFINITIVE STUDY INTO GHG EMISSIONS FROM CURRENT MARINE ENGINES



LNG IS THE MOST ENVIRONMENTALLY-FRIENDLY FUEL FOR SHIPPING TODAY AND IN THE FORESEEABLE FUTURE

LNG marine fuel GHG reduction Benefits:



HFO+scrubber = LSFO WtW emissions But with LNG:



Methane slip can reduce GHG reduction benefits:



If LNG fuelled the world fleet today it would emit 15% less GHG



Local pollutant reduction results with LNG



Whats next....

Ship operation optimisation will further reduce emissions



Use of L_{BIO}G and L_{SYN}G further reduce WtW GHG emissions. Just a 20% blend can reduce it by a further 13%



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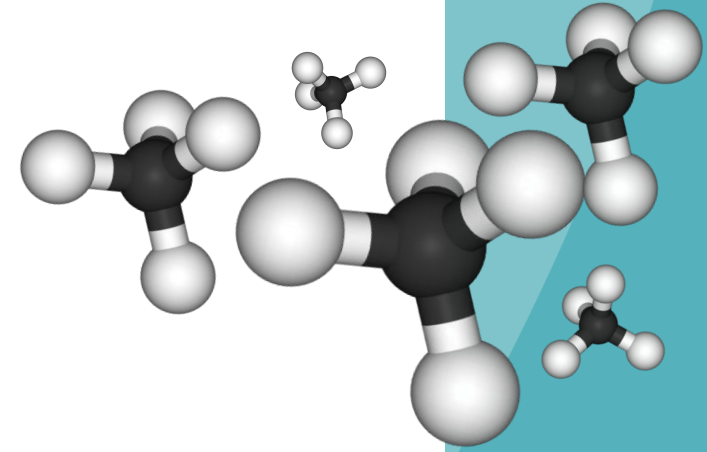
Natural Gas as a Marine Fuel

- Safe to Use and becoming readily available
- Natural Gas [LNG] is a fully compliant IMO 2020 fuel
 - GHG reduction: 21% wtw to 28% ttw
 - Significant Local pollutant reduction: 100% SO_x, 95% NO_x, 99% PMs
- 15% CO₂ reduction achieved if the world fleet switched today
- Distribution and supply is taking time and will continue to do so
- Marine Propulsion Engines can readily burn Methane
- Use of BioMethane and Synthetic methane would further improve wtw %
- Upstream CH₄ losses can be reduced - improves wtt
Further on board CH₄ slip improvement is needed (4Stroke Gas engines)



Conclusions

- **Alternative fuels are available – Natural Gas is one of them**
- **2020 is already here and Gas is a Fully Compliant 2020 fuel**
- **2050 trading ships are being built now**
Difficult to meet 2050 reductions without it's extensive use
Ship operational efficiency improvements will be key
- **Currently 0.2% - Expect 2% (1500) - Won't see 20% for a long time**
Deep sea sector – Cruise and Container showing large take – up of LNG
- **2020 – Another year of change for maritime fuels**

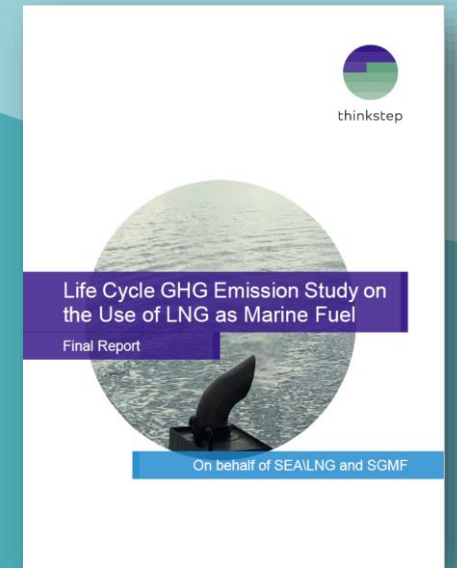


<https://info.thinkstep.com/LNG-GHG-Study>

we sea change, do you?

THANK YOU

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2019 sea change.



Download the full report
and infographic at:

