Work Group #4: Sustainable Marine Fuels

Deliverable 3.1 Report Review Template

1. Report title	**Increased use of LNG might not reduce maritime GHG emissions at all**
2. Publication date	June 2019
3. Author	Lindstad, Elizabeth (SINTEF, an independent research organization)
4. Client (organization and type of organization, specifying private/commercial/public; research institute/interest group etc.)	The paper can be downloaded from the website of Transport & Environment (T&E), an environmental NGO. It is not clear whether T&E actually funded the study.
5. Context of study (e.g. project in the context of which report is published or titles of other reports if part of a series)	The paper comments on the following study: thinkstep (2019), Life Cycle GHG Emission Study on the Use of LNG as Marine Fuel In the following publication, thinkstep has replied to the comment of SINTEF: thinkstep (2019), Addendum, Life Cycle GHG Emission Study on the Use of LNG as Marine Fuel
6. Length (pages)	7
7. Link (or where to get if not available online)	https://sustainableworldports.org/wp-content/uploads/SINTEF_2019_Inc.-use-of-LNG-might-not-reduce-maritime-GHG-emissions-report.pdf
8. Sector coverage	Maritime shipping

9. Main aim of the study	Main aim of the paper is to control the life cycle GHG reduction potential of LNG (compared to MGO and HFO) as determined by thinkstep (2019).
10. Methodology	Life cycle analysis
11. Topic(s) and indication of the level of detail For example: • System Description - *A description of the full marine energy system.* • System Components - *A description of all the components.* • Infrastructure requirements for new fuels • Applicability - *which of the new fuels are expected to replace existing fuels?*	• Discussion of the calculations and results from thinkstep (2019) – *Short paragraphs centered around different assumptions* • Comparative overview of CO_2 and CH_4 emissions calculations from SINTEF and thinkstep – *Bar charts*
12. What are the main conclusions from the report?	• In theory, liquefied natural gas (LNG) can, due to lower tank-to-wheel CO_2 emissions, result in about 25% lower tank-to-wheel GHG emissions than MGO or HFO. However, larger well to tank (WTT) GHG emissions for the LNG supply chain as well as uncombusted methane (CH_4) from the ship's engine might more than nullify any GHG gains. • The author finds that the thinkstep's (2019) conclusion that 15% GHG emissions reduction could be obtained if the whole world fleet would shift to LNG is the result of assuming a higher thermal efficiency for LNG than for MGO in the (engine) combustion process and of assuming low amounts of uncombusted methane in the exhaust gas from the ship's engines.

	• The results from the author's calculations indicate that the only LNG option which contributes to the reduction of GHG emissions is the use of LNG in 2-stroke high pressure dual fuel engines. For all other LNG options (engine types), the GHG emissions increase or are equal to using MGO or HFO.
13. What fuel/energy type(s) are discussed in the report and in what level of detail? For example: • Fuel description e.g. type, energy density, specific energy density, flash point, boiling point, fire point, flammability limits, hazards	For the following fuel types, WTT and TTW CO_2 and CH_4 emission factors, depending on engine types are presented: • LNG • MGO • HFO • MDO
14. What environmental aspects does the report consider? E.g. Air quality emissions, climate change emissions (GHG + BC), other (for example terrestrial or underwater noise, water quality, emergency releases, fugitive emissions, odour, water resources, mining)	Greenhouse gas emissions (CO_2 and CH_4)
15. Does the report consider exhaust emissions only, or life-cycle, or both (or some other range of emissions)?	Both.

16. If determined in the report, what are the emission rates/factors by pollutant? NOx, SOx, PM10, PM2.5, ultra fine PM, VOC, NH3, GHGs, Black carbon, and any others e.g. that may be unique to the fuel/energy.

CO_2-eq. emissions factors – global warming potential 100 years (g/kWh engine output):

		SINTEF (2019)			Thinkstep (2019)		
Fuel	**Engine**	**Well-to-tank**	**Tank-to-wheel CO_2**	**Tank-to-wheel CH_4**	**Well-to-tank**	**Tank-to-wheel CO_2**	**Tank-to-wheel CH_4**
LNG	2-stroke low-pressure dual fuel	139	434	120	133	400	65
	2-stroke high-pressure dual fuel	139	434	9	132	413	4
	4-stroke low-pressure dual fuel	148	463	159	144	431	117
	4-stroke low-pressure	148	444	132	141	428	60
MGO	2-stroke	108	558	0	121	565	0
	4-stroke	115	612	0	124	600	0
HFO	2-stroke, with scrubber	72	575	0	114	583	0
	4-stroke, with scrubber	77	631	0	118	623	0

CO_2-eq. emissions factors – global warming potential 20 years (g/kWh engine output):

Fuel	**Engine**	**Well-to-tank**	**Tank-to-wheel CO_2**	**Tank-to-wheel CH_4**
LNG	2-stroke low-pressure	199	434	340
	2-stroke high-pressure	199	434	26
	4-stroke low-pressure dual fuel	209	463	451

		4-stroke low-pressure	209	444	374	
	MDO	2-stroke	150	579	0	
	MGO	4-stroke	157	612	0	
	HFO	2-stroke, with scrubber	114	575	0	
		4-stroke, with scrubber	119	631	0	

17. Does the report discuss barriers and opportunities for ships to use the fuel(s)/energy? Does the report identify the maturity level of the fuel on a regional or global scale with respect to use by vessels?	No.
18. Does the report discuss barriers and opportunities for ports to provide the fuel(s)/energy? Does the report identify the maturity level of the fuel on a regional or global scale with respect to provision by ports?	No.
19. Does the report include capital and operating cost estimates for the ship and/or land-side?	No.
20. When are the fuel(s)/energy expected to be at a demonstration stage vs. commercialization?	This is not discussed.

For example: • Technology Readiness Level of the system - *Estimated maturity of the system technology* • On Board Safety Readiness Level of the system - *Estimated maturity of the risk mitigations on board (on a scale of 1-9)* • External Safety Readiness Level of the system - *Estimated maturity of the risk mitigations for bunker operations (on a scale of 1-9)*	
21. Are the fuels suitable for short and/or long (trans-oceanic) voyages?	This is not discussed.
22. Does the report identify/discuss potential issues around community acceptance for this fuel, or potential social/community impacts associated with the system?	This is not discussed.
23. Other?	Yes, the GHG emissions calculations for different marine fuels from the report by Thinkstep from 2019 are criticized, and set off against the author's calculations.