RYSTAD ENERGY'S LNG WELL-TO-TANK EMISSIONS ASSESSMENT, 2025

REPORT KEY FINDINGS

SEA-LNG

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THE DEFINITIVE STUDY ON GHG EMISSIONS FROM LNG BUNKER SUPPLY CHAINS

INTRODUCTION

SEA-LNG commissioned a GHG emissions study on the use of LNG as a marine fuel. The study was conducted in line with the IMO's Well-to-Tank (WtT) lifecycle analysis guidelines, using asset-based data from 2024 by independent consultants Rystad Energy.

With the transition from fossil fuels in its early stages across most industry sectors including maritime, around 95% of vessels are still powered by oil-based marine fuels. LNG is the only viable option available at scale at a commercially competitive price. Consequently, it represents the leading alternative and already accounts for nearly 20% of the vessel orderbook.

As the industry transitions toward net-zero and prepares for a rapidly expanding fleet of LNG-fuelled vessels, understanding the real-world lifecycle emissions of LNG is critical to shaping effective regulation and guiding future investment decisions.

By better understanding the WtT emissions of a given fuel source, this study provides insights for the shipping industry to better understand the potential impacts of fuel selection within the marine industry.

SEA-LNG commissioned Rystad Energy to research the greenhouse gas emissions from LNG bunker supply chains using data from 2024.

The study analyses emissions originating from the five key lifecycle stages of LNG: upstream, transportation & processing, liquefaction, shipping and distribution & bunkering operations.

Alongside the relative contribution of methane and carbon dioxide from each stage, the study summarises the well-to-tank emissions on both global and regional levels.

METHODOLOGY AND DATA

The methodology used by Rystad Energy in developing the analysis aligns with the WtT system covered in the IMO's LCA guidelines and IPCC's AR5 GHG definitions.

The analysis presented in the report is based on 2024 data from Rystad Energy's GasEmissionsTracker database, which provides the emissions data associated with the global gas and LNG trade from well to market. The GasEmissionsTracker is a bottom-up asset level database, which can be aggregated up from individual value chains/cargoes up to country, regional or global overviews.

The study is based upon the individual value chain emissions intensity of each LNG cargo used for bunkering purposes. With each of these individual value chains volume/energy- weighted to calculate the aggregated views on the regional or global level.

Rystad's methodology ties specific feed gas upstream assets to liquefaction facilities, rather than using regional or basin level-averages. This allows for greater accuracy when calculating the emissions intensity of feed gas, especially when utilising satellite detected methane plume analysis and reported asset level data.

Furthermore, Rystad's approach is specific to LNG directly used for loading into the 'tank' of LNG fuelled vessels, rather than global averages for LNG supply as a whole.

Pioneering LNG ferry VIKING GLORY being bunkered in Turku at dawn by Gasum's LNG Bunker Vessel SEAGAS. Photo credit: Gasum.

KEY FINDINGS

The global well-to-tank emissions intensity for LNG used for bunkering fuel are estimated to be 13.9 g CO2e/MJ (LHV) in the calendar year 2024.

WELL-TO-TANK INTENSITY FOR LNG BUNKERED IN 2024

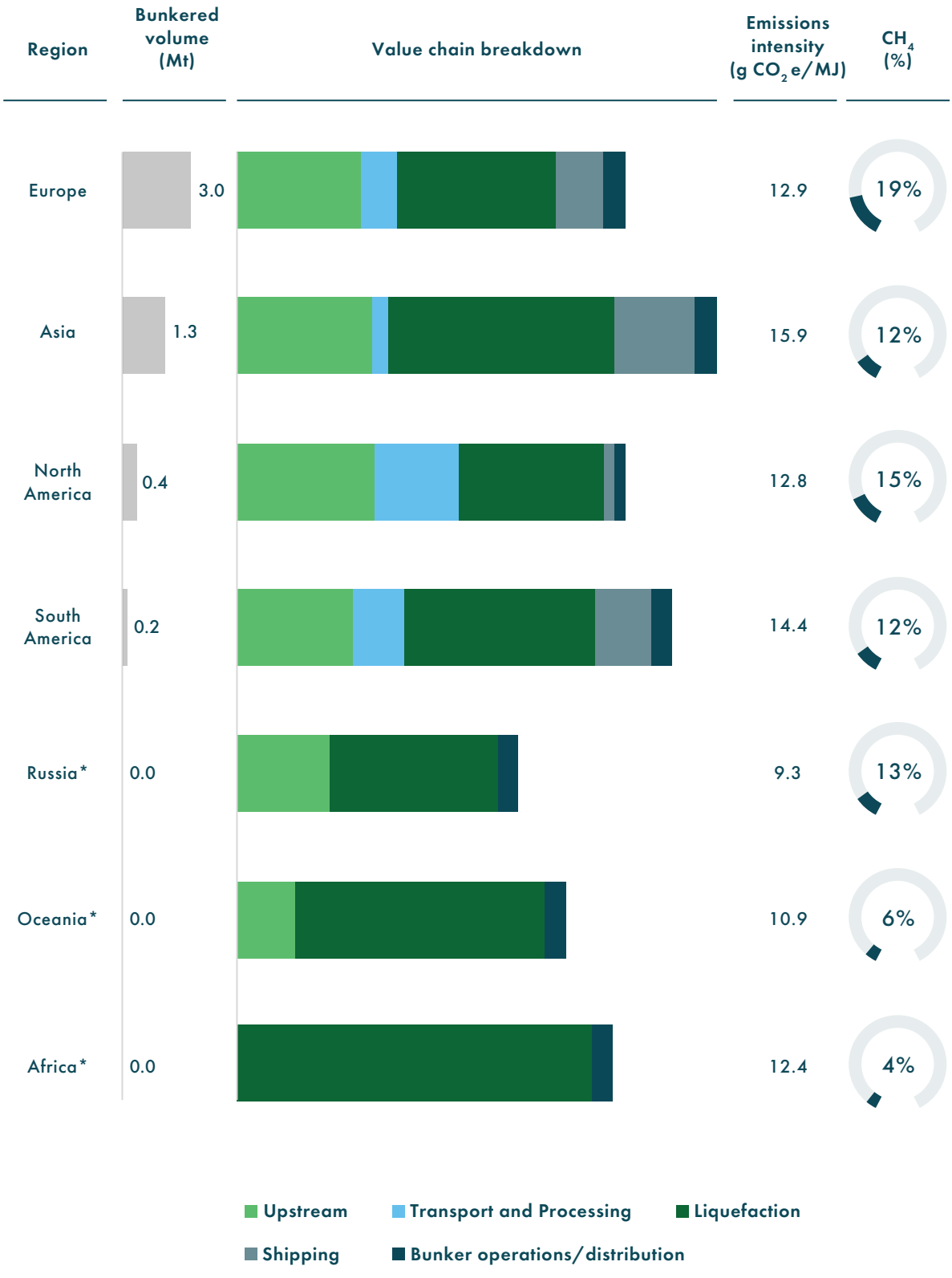
Value chain stage	Emissions intensity (g CO2e/MJ)	CH_4 Impact* (% of stage total)
Upstream	4.2	38%
Transport & processing	1.3	7%
Liquefaction	5.9	1%
Shipping	1.8	8%
Bunker operations/ distribution	0.7	37%
Well-to-tank	**13.9**	**16%**

Figure 1 - CH_4 impact denotes the percentage that stages overall GHG emissions methane responsible for (i.e. a 10% value with an intensity of 10 g CO2/MJ, denotes a methane contribution of 1 g CO2e/MJ)

- On a global basis upstream gas production and liquefaction were responsible for the majority of bunker supply chain emissions at 30% and 43% respectively.
- Transportation & processing, shipping and distribution & bunkering were responsible for the remaining 27%.
- Carbon dioxide dominates global WtT emissions, responsible for 84% of emissions. Carbon dioxide emissions were most prevalent in the liquefaction stage, responsible for 99% of the stage's 5.9 g CO2e/MJ.
- Methane emissions were responsible for 16% of total WtT emissions, equivalent to 2.2 g CO2e/MJ.
- Methane emissions were most prevalent in upstream gas production lifecycle stage, responsible for 38% of total emissions from that stage.
- The number of stages in each of the value chains can vary significantly, depending on where, and at what point in the value chain, bunkering takes place. Loading fuel into an LNG fuelled vessel directly at the point of production, can significantly reduce overall well-to-tank emissions by around 2.5 g CO2e/MJ.

Carnival MARDI GRAS bunkering LNG in the Port of Canaveral. Photo credit: Carnival.

REGIONAL VARIATIONS FOR LNG BUNKERED IN 2024



The variation of WtT intensity from different exporting regions is significant, highlighting the impact that feed gas, liquefaction technology and shipping can all have on WtT emissions.

- Regional differences have been shown to be large as 6.6 g CO2e/MJ, and the variation between individual cargoes is greater still.
- Methane emissions for the bunkering locations varied significantly among regions, with European well-to-tank methane emission representing the highest levels, of 19%.

  The reason for this is two-fold. Firstly, the fleet delivering LNG volumes into Europe is more modern than many vessels used elsewhere, reducing shipping emissions as a whole, but increasing the share of methane from slippage, since their LNG duel fuel engines cut overall fuel use but do allow more slip in the combustion process. Secondly, facilities fed predominantly with LNG from the US and Russia can have more methane emissions than those receiving more direct feed gas supplies from subsea tiebacks or offshore facilities.

The world's first LNG Bunker Vessel CARDISSA, bunkering the world's first large LNG-powered Cruise vessel AIDAnova. Photo credit: Carnival

IMPLICATIONS FOR POLICY MAKERS

Rystad Energy's analysis has major implications for policy makers developing regulations to decarbonise shipping:

1. **Regulations should incentivise participants using the LNG bunker supply chain to continue reducing GHG emissions, particularly in relation to natural gas production and liquefaction.**

2. **Policy makers should introduce a process to regularly update Well-to-Tank (WtT) default emissions factors used in regulation, particularly those relating to methane emissions.**

3. **This report justifies lowering the current EU Well-to-Tank (WtT) default of 18.5 gCO2e/MJ (in FuelEU Maritime), which is too conservatively high.**

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