NETL Life Cycle Inventory Data
Process Documentation File

Process Name:	LNG Loading
Reference Flow:	1 kg of LNG loaded
Brief Description:	This Unit Process includes feed LNG, energy requirements, losses, boil-off gas generation and GHG emissions associated with loading LNG into tanker/ship for exporting

Section I: Meta Data

Geographical Coverage: United States of America   **Region:** N/A

Year Data Best Represents: 2016

Process Type: Basic Process (BP)

Process Scope: Gate-to-Gate Process (GG)

Allocation Applied: No

Completeness: Individual Relevant Flows Captured

Flows Aggregated in Data Set:

☒ Process   ☒ Energy Use   ☒ Energy P&D   ☒ Material P&D

Relevant Output Flows Included in Data Set:

Releases to Air:	☒ Greenhouse Gases	☐ Criteria Air Pollutants	☐ Other
Releases to Water:	☐ Inorganic Emissions	☐ Organic Emissions	☐ Other
Water Usage:	☐ Water Consumption	☐ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

Std_loading_rate

   Standard loading rate of LNG on to the tanker

ship_capacity_loaded

   Percentage of ship capacity that needs to be loaded with LNG

Boil_off_rate

   Boil-off rate i.e. the rate at which Boil-off Gas is generated

BOG_recondensor_power_consumption_kW

Power consumption of the recondensor used to re-liquefy the BOG

BOG_recondensor_handling_capacity

Handling capacity of the recondensor used to re-liquefy the BOG

Tracked Input Flows:

LNG Feed

[Technosphere] LNG that needs to be fed from the liquefaction facility to be able to load 1 kg of LNG on ship after losses

Diesel, Combusted

[Technosphere] Energy requirement for the loading process met by diesel combustion

Electricity

[Technosphere] Energy requirement for re-liquefaction of BOG generated during loading

Tracked Output Flows:

LNG loaded

Reference flow

Section II: Process Description

Associated Documentation

Loading_UP.docx

This unit process is composed of this document and the data sheet (DS) DS_O_LNG_*Loading_2018.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

This unit process provides a summary of relevant input and output flows associated with loading 1 kg of LNG on to a tanker/ship to be exported from the US. The equipment used to load the LNG is assumed to be operating on diesel. The Boil-off Gas generated during the process is also re-liquefied and loaded. The reference flow of this unit process is: 1 kg of LNG loaded.

Boundary and Description

The loading UP represents the process of loading LNG from the liquefaction facility onto an ocean tanker. This UP assumes the ship capacity to be in the range of 150,000 m3 to 180,000 m3 (IGU, 2017). The boil-off gas (BOG) generated during loading is assumed to be re-liquefied and directed back into the supply chain, so the net loss of LNG during loading is assumed to be zero. Based on literature, a standard loading rate of 10,000-12,000 m3/hour and a boil-off rate (BOR) of 20,000 kg/hour is assumed (Dobrota, Lalic, & Komar, 2013). It is assumed that in any journey only 98% of the total ship capacity is utilized. During loading, it is assumed that 0.15% of the volume is still occupied by the heel leftover from the previous ballast voyage, hence 97.85% (98%-0.15%) is to be loaded. The loading equipment is assumed to be diesel based and the total diesel consumption is estimated by back-calculating from a literature based CO2 emission data point (PACE Global, 2015). It is assumed that the BOG re-liquefaction compressor operates on purchased grid mix electricity. Compressor specifications from literature are used to estimate the energy requirement to re-liquefy 1 kg of BOG (Li & Wen, 2016). The functional unit of this process is the mass of LNG loaded on the ocean tanker.

Figure 1: Unit Process Scope and Boundary

Key
- ☐ Process
- ▱ Upstream Emissions Data
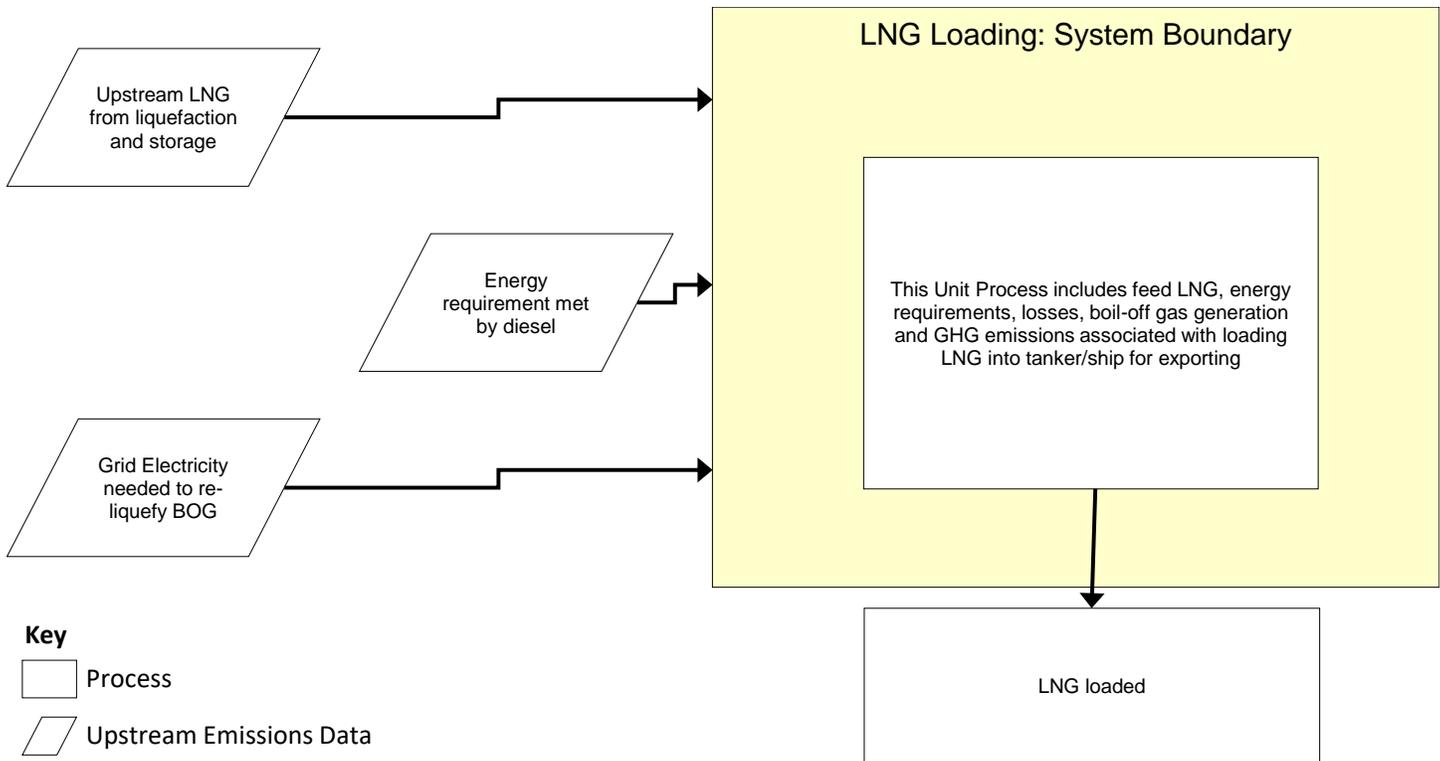
Embedded Unit Processes
None.

References

Dobrota, D., Lalic, B., & Komar, I. (2013). Problem of Boil-off in LNG Supply Chain *Transactions in Maritime Science, 2*, 91-100. doi: 10.7225/toms.v02.n02.001

IGU. (2017). *2017 World LNG Report*. IGU Website: Retrieved November 20, 2018, from https://www.igu.org/sites/default/files/103419-World_IGU_Report_no%20crops.pdf

Li, Y., & Wen, M. (2016). Boil-Off Gas Two-Stage Compression and Recondensation Process at a Liquefied Natural gas Receiving Terminal *Chemical Engineering & Technology, 40*, 18-27. doi: 10.1002/ceat.201500751

PACE Global, A. S. B. (2015). *LNG and Coal Life Cycle Assessment of Greenhouse Gas Emissions*. Retrieved September 26, 2018, from http://www.paceglobal.com/wp-content/uploads/2015/10/LNG-and-Coal-Life-Cycle-Assessment-of-Greenhouse-Gas-Emissions.pdf

Section III: Document Control Information

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Original/no revisions

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