NETL Life Cycle Inventory Data
Process Documentation File

Process Name: LNG Tanker, 150,000 to 180,000 m3 Capacity, Operations

Reference Flow: 1 kg of

Brief Description: This unit process includes operation of a liquefied natural gas (LNG) ocean tanker. The tanker is fueled by boil-off natural gas, with other supplemental fuel, based on Wartsila 50DF engine specifications.

Section I: Meta Data

Geographical Coverage: Global **Region:** n/a

Year Data Best Represents: 2016

Process Type: Transport Process (TP)

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:

One_Way_Distance

[miles] Adjustable Parameter: The One-way distance a tanker travels

ship_speed_laden

[knots] The laden voyage speed of the ship

ship_speed_ballast

[knots] The ballast voyage speed of the ship

perc_usable_volume

[percent] It is assumed that 98% of the LNG tanker is usable volume **perc_heel**

[percent] 2.5% of the tank's volume is left on the tanker at the regas site to fuel and keep cool the ship on its ballast journey

perc_heel_used

[percent] 95% of the heel is used on the ballast journey

BOR_tanker_laden

[percent/day] the percent volume per day of LNG that is captured in the form of boil-off gas. Note: As a technical simplification, this Boil-off rate is used on the total volume of LNG, instead of accounting for the negligible changes in volume from boil-off gas created on prior days

loading_rate

[m^3/hour] loading/unloading rate for ocean tanker

manuevering_time

[hours] Adjustable parameter for time spent maneuvering

ramping_time

[days] adjustable parameter for time spent ramping up and down

BOG_compressor_energy

[MWh/kg compressed] Energy requirement (assumed to be small scale combusted diesel) for compressing BOG to the main engine

BOG_compressor_emm

[kg/kg compressed] Methane compressor emissions per kg compressed

Tracked Input Flows:

LNG

[Technosphere]

Diesel, Combusted

[Technosphere] Diesel Combustion for energy to fuel the ship

BOG/NG, Combusted

[Technosphere] Mass of BOG combusted for energy to fuel the ship (assumed to be the same as natural gas combustion)

Electricity

[Technosphere] Energy for the compression of BOG for fuel use

Tracked Output Flows:

Liquefied Natural Gas

Reference flow

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_O_LNG_Ocean_Tanker_2018.01.xls*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

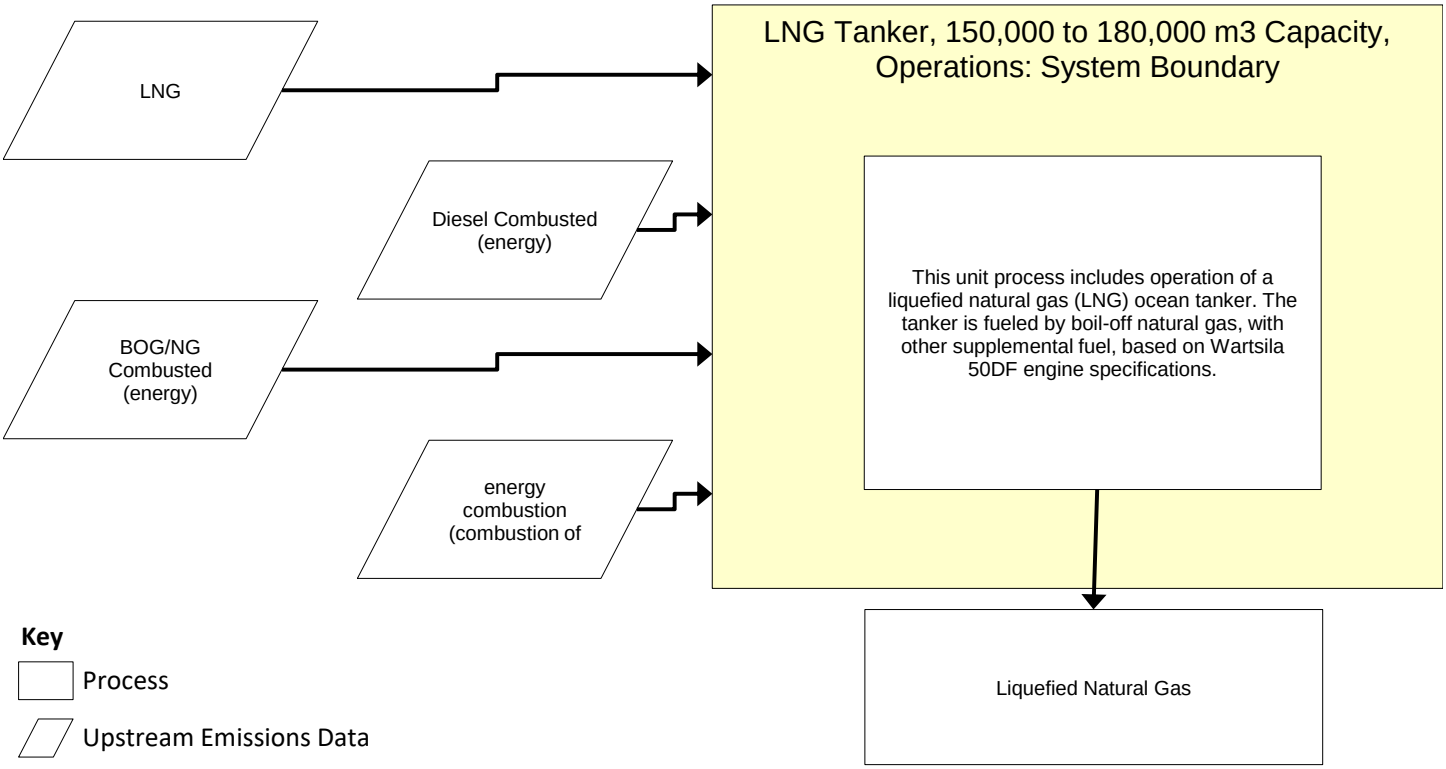
This unit process provides a summary of relevant input and output flows associated with the operation of an ocean tanker for the transport of LNG. The tanker is assumed to be fueled by a combination of natural gas from LNG boil-off, along with diesel fuel, which is used to supplement the natural gas. The lifecycle boundaries of this unit process start with the loading of LNG onto the tanker, and end prior to deberthing. The reference flow of this unit process is: 1 kg of

Boundary and Description

The ocean transport UP accounts for the operation of a tanker to transport LNG from a given export country to the import country. The UP is based on specifications for the Wartsila 50DF engine (Wärtsilä, 2018), operating in ME mode. The fuel oil and fuel gas consumption rates were equal for all 5 engine configurations, so a specific configuration was not chosen to be represented. The model calculates the laden and ballast voyage time based on ship speed and voyage length. A 2.5% volume heel is assumed for the ballast voyage. BOG from the storage of LNG is assumed to be compressed and used for fuel, with diesel used as the supplementary fuel. The amount of BOG generated during the laden voyage is dependent on the length of the journey (a boil-off rate of 0.1% volume/day is used (IGU, 2017)). The BOG generated during the ballast journey is taken to be 95% of the heel (i.e. most of the heel is used as energy on the return voyage, leaving only enough to keep the ship cold and ready to load). It is assumed that 100% of the available capacity is loaded onto the ship, and

that 98% of the tanker capacity is usable capacity (98% before the heel)(Hasan, 2009). The BOG is assumed to be compressed to 0.6 MPa gauge pressure before it is sent for combustion, as specified by the engine requirements in the product manual (Wärtsilä, 2018). The tanker is assumed to operate 24 hours per day during ocean transport. Full cruise fuel use is calculated using 100% load factors, ramp up/ramp down 75% load factor, and idling/maneuvering 50% load factor (Wärtsilä, 2018). While BOG is generated during idling, maneuvering, ramp up, and ramp down, BOG is assumed to be generated only during ramp up/down and full cruise, and combusted only when the ship is at full cruise. Diesel is assumed to be the only fuel used during non-full cruise operations. Roundtrip travel is accounted for in this unit process (i.e. emissions reported represent total emissions generated during the laden and ballast voyage). The ship is assumed to be idling during loading and unloading times. The ship is assumed to spend one day in maneuvering mode. The ship is assumed to spend one day ramping up and one day ramping down for both the laden and ballast journey (4 days total). The distance traveled during ramping up and down counts towards the total distance traveled for the journey. Distance traveled during maneuvering and idling is assumed to be negligible. Travel distances for different scenarios were calculated using SEA-DISTANCES (Sea-Distances.org, 2016). The PS tab contains the transport distances for 9 scenarios, using this data. The functional unit for this unit process is taken to be the mass of LNG delivered to the regasification terminal (import terminal). This is taken to be 98% of the ship capacity, minus BOG generation during the laden voyage, minus the 2.5% volume heel that will be left on the ship for the ballast voyage.

Figure 1: Unit Process Scope and Boundary



Embedded Unit Processes

None.

References

Hasan, F. (2009). Minimizing Boil-Off Losses in Liquefied Natural Gas Transportation (abstract). [Literature].

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

Sea-Distances.org. (2016). Sea-Distances Retrieved September, 27, 2018, 2018, from https://sea-distances.org/contact

Wärtsilä, C. (2018). Wartsila 50DF. Wartsila, Marine Solutions.

Section III: Document Control Information

Date Created: December 17, 2018

Point of Contact: Timothy Skone (NETL), Timothy.Skone@NETL.DOE.GOV

Revision History:

Original/no revisions

How to Cite This Document: This document should be cited as:

NETL (2010). NETL Life Cycle Inventory Data – Unit Process: LNG Tanker, 138000 m3 Capacity, Operations. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: May, 2010 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

Section IV: Disclaimer

Neither the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) nor any person acting on behalf of these organizations:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this document, or that the use of any information, apparatus, method, or process disclosed in this document may not infringe on privately owned rights; or

B. Assumes any liability with this report as to its use, or damages resulting from the use of any information, apparatus, method, or process disclosed in this document.

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by NETL. The views and opinions of the authors expressed herein do not necessarily state or reflect those of NETL.