GIIGNL MRV and GHG Neutral Framework

Appendices

Version 1.0

November 2021

GIIGNL MRV and GHG Neutral LNG Framework

Appendix A: Abbreviations and Glossary

November 2021

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APPENDIX A: Abbreviations and Glossary

ABBREVIATIONS

Acronym	Definition
ACR	American Carbon Registry
AIS	Automatic Identification System
AGRU	Acid Gas Removal Unit
API	American Petroleum Institute
BOG	Boil Off Gas
CAR	Climate Action Reserve
CARB	California Air Resources Board
CCUS	Carbon Capture, Utilisation and Storage
CDM	Clean Development Mechanism
CEMS	Continuous Emission Monitoring System
CH_4	Methane
CO_2	Carbon Dioxide
CTMS	Custody Transfer Management System
DAC	Direct Air Capture
DES	Delivered ex-Ship
EAC	Energy Attribute Certificate
EEOI	Energy Efficiency Operational Indicator
EGR	Enhanced Gas Recovery
EOR	Enhanced Oil Recovery
EPA	Environmental Protection Agency
EU ETS	European Union Emissions Trading System
FOB	Free on Board
FSRU	Floating Storage and Regasification Unit
GCV	Gross Calorific Value
GDU	Gas Distribution Utilities (or Gas Disposal Unit)
GHG	Greenhouse Gas
GIIGNL	International Group of Liquefied Natural Gas Importers
GLEC	Global Logistics Emission Council
GO	Guarantee of Origin
GREET	The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
HHV	Higher Heating Value
ICROA	International Carbon Reduction and Offset Alliance

Acronym	Definition
IMO	International Maritime Organisation
IPCC	Intergovernmental Panel on Climate Change
iREC	International Renewable Energy Certificate
ISO	International Organisation for Standardisation
JCM	Joint Crediting Mechanism
LCA	Life Cycle Assessment
LDAR	Leak Detection and Repair
LHV	Lower Heating Value
LNG	Liquefied Natural Gas
MACC	Marginal Abatement Cost Curve
mmBtu	Million British Thermal Unit
MRV	Monitoring, Reporting and Verification
N_2O	Nitrous Oxide
NCV	Net Calorific Value
NDC	Nationally Determined Contribution
NF_3	Nitrogen Trifluoride
NGERS	National Greenhouse and Energy Reporting Scheme (Australia)
NGLs	Natural Gas Liquids
OGMP	Oil and Gas Methane Partnership
OPGEE	The Oil Production Greenhouse Gas Emissions Estimator
PFCs	Perfluorocarbons
PPA	Power Purchase Agreement
REC	Renewable Energy Certificate
RNG	Renewable Natural Gas
SAR	Search and Rescue
SBTi	Science Based Targets Initiative
SF_6	Sulphur Hexafluoride
t	Metric Tonne – 1000kg, the unit used for reporting of GHG emissions as tCO_2e
TSVCM	Taskforce on Scaling Voluntary Carbon Markets
UNFCCC	United Nations Framework Convention on Climate Change
US EPA	United States Environmental Protection Agency
VCMI	Voluntary Carbon Markets Integrity Initiative
VCS	Verified Carbon Standard
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

GLOSSARY

A guide to definitions of terms used in the Framework are provided below. Note that different standards may use slightly different definitions, and as appropriate the Reporter should align with the standard(s) selected for application of the Framework criteria.

Term	Definition
Activity data	Data that represents the quantity for a given period (e.g., standard cubic feet (scf)/cubic metres (m^3) of fuel gas burned, number of low-bleed pneumatic controllers, etc.). Activity data are ideally measured, but may be estimated based on assumptions*. GHG Protocol Product Life Cycle Accounting and Reporting Standard*
Allocation	The partitioning of emissions and removals from a common process between the studied product's life cycle and the life cycle of the co-products. *GHG Protocol Product Life Cycle Accounting and Reporting Standard*
Assurance	The level of confidence that the inventory results and report are complete, accurate, consistent, transparent, relevant, and without material misstatements. *GHG Protocol Product Life Cycle Accounting and Reporting Standard*
Attributable processes	Service, material and energy flows that become the product, make the product, and carry the product through its life cycle. *GHG Protocol Product Life Cycle Accounting and Reporting Standard*
Boil Off Gas (BOG)	The amount of LNG which evaporates from the tank during transportation or storage. *GIIGNL Glossary*
Boundary	Identifies which emissions and removals are included in the GHG inventory. The boundary of the product GHG inventory shall include all attributable processes. *GHG Protocol Product Life Cycle Accounting and Reporting Standard*
Carbon dioxide equivalent (CO_2e)	The universal unit of measurement to indicate the global warming potential (GWP) of greenhouse gases, expressed in terms of the GWP of one unit of carbon dioxide. *GHG Protocol Product Life Cycle Accounting and Reporting Standard*
Carbon footprint	Absolute sum of all emissions of greenhouse gases cause directly and indirectly by a subject either over a defined period or in relation to a specified unit of product or instant of service and calculated in accordance with a recognised methodology. *PAS 2060:2014*
GHG intensity	A ratio expressing GHG impact per unit of activity. In this framework, carbon intensity is expressed in GHG impact per unit of energy (e.g. mmBtu, MJ). *Based on GHG Protocol Corporate Accounting and Reporting Standard*
Carbon neutral	Condition in which during a specified period there has been no net increase in the global emission of greenhouse gases to the atmosphere as a result of the greenhouse gas emissions associated with the subject during the same period. *PAS 2060:2014*
Carbon offset	Mechanism for compensating for all or for a part of the carbon footprint of a product or the partial carbon footprint of a product through the prevention of the release of, reduction in, or removal of an amount of greenhouse gas emissions in a process outside the product system. *ISO 14067:2018*
Co-products	Any of two or more products coming from the same unit process or product system. *ISO 14067:2018*
Cradle to gate	A partial life cycle of an intermediate product, from material acquisition through to when the product leaves the reporting company's gate (e.g. immediately following the product's production). *GHG Protocol Product Life Cycle Accounting and Reporting Standard.*
Cradle to grave	Removals and emissions of a studied product from material acquisition through to end-of-life. *GHG Protocol Product Life Cycle Accounting and Reporting Standard.*
Decarbonisation	An action that leads to permanent elimination or removal of a GHG emission source.
Declaration Pathway	Category of claim made for a LNG Cargo against criteria set out in the GIIGNL MRV and GHG Neutral Framework.

Term	Definition
Emission factor (EF)	GHG emissions per unit of activity data (e.g., tonnes CO_2/standard cubic feet (scf) fuel gas, kg CH4/low-bleed pneumatic controller, etc.). The emission factor can be based on measured data (e.g., gas compositional analyses) or a default for a given fuel or equipment type.
Energy attribute certificate	Category of contractual instruments used in the energy sector to convey information about energy generation to other entities involved in the sale, distribution, consumption or regulation of electricity. This category includes instruments that may go by several different names, including certificates, tags, credits etc. *GHG Protocol Scope 2 Guidance*
Fossil fuel	Carbon-based fuels from fossil hydrocarbon deposits, including coal, oil and natural gas. *IPCC*
Fugitive emissions	Emissions that are not physically controlled but result from the intentional or unintentional releases of GHGs. *GHG Protocol Corporate Accounting and Reporting Standard*
Functional unit	The quantified unit of the studied product. *ISO 14067:2018*
Carbon credit	A tradeable, non-tangible instrument representing a unit of carbon dioxide-equivalent (CO_2e) – typically one tonne – that is reduced, avoided or sequestered by a project and is certified/verified to an internationally carbon accounting standard. *ICROA*
Carbon footprint of a product	Sum of GHG emissions and GHG removals in a product system expressed as CO_2 equivalents and based on a life-cycle assessment using the single impact category of climate change. *ISO 14067:2018*
GHG impact	The results calculated when GHG emissions and removals are multiplied by the relevant global warming potential (GWP). *GHG Protocol Product Life Cycle Accounting and Reporting Standard*
Global Warming Potential (GWP)	Index measuring the radiative forcing following a pulse emission of a unit mass of a given GHG in the present-day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide. *ISO 14067:2018*
Greenhouse gas (GHG)	Gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds. *ISO 14067:2018*
Intermediate products	Goods that are used as inputs to the production of other goods or services. *GHG protocol Product Life Cycle Accounting and Reporting Standard*
Level of assurance	The degree of confidence in the GHG statement . *ISO 14064-3:2019*
Life cycle	Consecutive and interlinked stages related to a product, from a raw material acquisition or generation from natural resources to end-of-life treatment – *ISO 14067:2018*
Life cycle assessment (LCA)	Compilation and evaluation of inputs, outputs and potential environmental impacts of a product system throughout its life cycle. *ISO 14067:2018*
Life cycle stage	The categorisation of the interconnected steps in a product's life cycle for the purposes of organising processes, data collection, and inventory results. *GHG Protocol Product Life Cycle Accounting and Reporting Standard*
Limited Assurance	Level of assurance where the nature and extent of the verification activities have been designed to provide a reduced level of assurance on historical data and information. *ISO 14064-3:2019*
Liquefaction	Volume reduction of gas through the application of refrigeration technology which makes it possible to cool the gas down to approximately -162ºC (-256ºF) when it becomes a liquid. *GIIGNL Glossary*
Misstatement	Errors, omissions, misreporting or misrepresentations in the GHG Statement. *ISO 14064-3:2019*
Material misstatement	Individual misstatement of the aggregate of actual misstatements in the GHG Statement that could affect the decisions of the intended user. *ISO 14064-3:2019*
Methane slip	Methane emissions arising from incomplete combustion of hydrocarbon fuels, including liquid fuels, gas and LNG, and from flaring.
Net zero	Balancing of anthropogenic emissions of greenhouse gases to the atmosphere by anthropogenic removals over a specified period. *IPCC*

Term	Definition
Paris Agreement	International commitment signed in 2015 by participating countries to reduce greenhouse gas emissions in order to keep the global temperature rise below 1.5 degrees Celsius and to avoid the worst impacts of climate change. *World Resources Institute*
Primary data	Quantified value of a process or an activity obtained from a direct measurement or a calculation based on direct measurements. *ISO 14067:2018*
Process map	A process map illustrates the services, materials, and energy needed to move a product through its lifecycle. *GHG Protocol Product Life Cycle Accounting and Reporting Standard*
Product	Any good or service. *GHG Protocol Product Life Cycle Accounting and Reporting Standard*
Proxy data	Data from a representative activity that is used as a stand-in for the given activity. Proxy data can be extrapolated, scaled up, or customised to represent the given activity. *GHG Protocol Product Life Cycle Accounting and Reporting Standard.*
Reasonable Assurance	Level of assurance where the nature and extent of the verification activities have been designed to provide a high but not absolute level of assurance on historical data and information*. ISO 14064-3:2019*
Registry	A public database of organisational GHG emissions and/or project reductions. *GHG Protocol Corporate Accounting and Reporting Standard*
Removal	The sequestration or absorption of GHG emissions from the atmosphere, which most typically occurs when CO_2 is absorbed by biogenic materials during photosynthesis. *GHG Protocol Product Life Cycle Accounting and Reporting Standard*
Retirement	To permanently remove carbon credits from circulation through the use of a 3rd party registry as a method offsetting carbon emissions. *ICROA*
Secondary data	Data which do not fulfil the requirements for primary data. *ISO 14067:2018*
Scope 1	A reporting organisation’s direct GHG emissions. *GHG Protocol Corporate GHG Accounting and Reporting Standard*
Scope 2	A reporting organsation’s emissions associated with the generation of electricity, heating/ cooling, or steam purchased for own consumption. *GHG Protocol Corporate GHG Accounting and Reporting Standard*
Scope 3	A reporting organisation’s indirect emissions other than those covered in scope 2. *GHG Protocol Corporate GHG Accounting and Reporting Standard*
Uncertainty	Parameter associated with the result of quantification that characterises the dispersion of the values that could be reasonably attributed to the quantified amount. *ISO 14067:2018*
Verification	Process for evalutating a statement of historical data and information to determine if the statement is materially correct and conforms to defined criteria. *ISO 14064-3:2019*
Verification opinion	Formal written declaration to the intended user that provides confidence on the GHG statement in the responsible party’s GHG report and confirms conformity with the criteria. *ISO 14064-3:2019*
Verifier	Competent and impartial person with responsibility for performing and reporting on a verification. ISO *14064-3:2019*
Vintage	The year that a carbon credit was certified or verified and entered into a registry.
Waste	An output of a process that has no market value. *GHG Protocol Product Life Cycle Accounting and Reporting Standard*

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Appendix B: Standards Overview and References

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APPENDIX B:
Standards Overview and References

Reference Standards and Methodologies

There are a wide range of standards and methodologies that will act as reference for Reporters applying the GIIGNL MRV and GHG Neutral Framework (the 'Framework'). It is expected that Reporters will apply established standards that are relevant to the operational, geographic and market context of the LNG Cargo life-cycle stages under evaluation. The Framework does not mandate the use of particular standards but does require full disclosure of the standards and methodologies that have been applied.

SELECTED GHG EMISSION QUANTIFICATION AND ACCOUNTING METHODOLOGIES

This section sets out the key standards and methodologies that have informed the development of the Framework. It is not intended to be a complete list of all standards and methodologies available.

Standard/ Methodology	Description
ISO 14064-1:2018	• International Organisation for Standardisation. ISO 14064-1 Greenhouse Gases. Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals. 2018. Geneva. The ISO standard that sets the principles and requirements for organisational level quantification and reporting of GHG emissions. Specifies principles and requirements at the organisation level for the quantification and reporting of greenhouse gas (GHG) emissions and removals. It includes requirements for the design, development, management, reporting and verification of an organisation's GHG inventory.
GHG Protocol Corporate Standard	• Greenhouse Gas Protocol. Corporate Accounting and Reporting Standard. 2004. The GHG Protocol Corporate Standard specifies requirements and guidance for companies and other organisations preparing a corporate-level GHG emissions inventory. Linked to the Corporate standard are: • GHG Protocol Scope 2 Guidance. Provides guidance on GHG accounting for imported energy • GHG Protocol Scope 3 Guidance. Provides guidance on GHG accounting for other indirect emissions

Standard/ Methodology	Description
API Compendium	• Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry. American Petroleum Institute, 2015. • API Liquefied Natural Gas (LNG) Operations Consistent Methodology for Estimating Greenhouse Gas Emissions, May 2015. The Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil & Gas Industry documents a number of currently recognised calculation techniques and emission factors available for developing GHG emissions inventories for oil and gas industry operations. The API Compendium provides detailed methodology guidance for calculating GHG emissions from sources specific to the oil and gas sector. It is structured by source type, covering combustion, process/venting, fugitive and indirect sources of emission. API has also developed specific guidance for LNG operations in order to enable consistent and comprehensive internationally accepted methodologies to estimate GHG emissions from the liquefied natural gas (LNG) operations segment.
IPIECA	• IPIECA Petroleum Industry Guidelines for Reporting Greenhouse Gas Emissions, 2011. The IPIECA Guidance builds on the GHG Protocol, the API Compendium and other accounting and reporting approaches to provide a sector specific guide to GHG accounting IPIECA convenes a significant portion of the oil and gas industry across the value chain, bringing together the expertise of oil and gas companies and associations to develop, share and promote good practice and knowledge.
OGMP 2.0	• The Climate and Clean Air Coalition Oil and Gas Methane Partnership OGMP 2.0 Framework. Climate and Clean Air Coalition, 2020. OGMP 2.0 is a UN Environment Programme (UNEP) led initiative providing a reporting framework for methane emissions in the oil and gas sector. The OGMP 2.0 is the new reporting Framework designed to improve the reporting accuracy and transparency of anthropogenic methane emissions in the oil and gas sector through use of a tiered approach.

PRODUCT CARBON FOOTPRINT AND LIFE CYCLE ASSESSMENT STANDARDS

Standard	Description
ISO 14067:2018	• International Organisation for Standardisation. ISO 14067:2018 Greenhouse Gases. Carbon Footprint of Products. Requirements and Guidelines for Quantification. Geneva. ISO 14067:2018 specifies principles, requirements and guidelines for the quantification and reporting of the carbon footprint of a product, in a manner consistent with International Standards on life cycle assessment (LCA) (ISO 14040:2006 and ISO 14044:2006).
ISO 14040:2006 ISO 14044:2006 ISO 14047:2012	International Organisation for Standardisation: • ISO14040:2006 Environmental management — Life cycle assessment — Principles and framework. • ISO 14044:2006 Environmental management — Life cycle assessment — Requirements and guidelines. • ISO 14047:2012 Life Cycle Assessment. These standards provide the basic framework for LCA specify requirements and provide guidelines for life cycle assessment (LCA) including definition of the goal and scope of the LCA, the life cycle inventory analysis (LCI) phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, relationship between the LCA phases, and conditions for use of value choices and optional elements. Whilst not directly product carbon footprint standards, the approaches used in LCA studies are applied to carbon footprint studies as a specific subset of LCA and these and forms the basis for the carbon footprint standard ISO 14067:2018.
PAS 2050:2011	• British Standards Institution PAS 2050:2011 – Specification for the assessment of the life cycle greenhouse gas emissions of goods and services. Specification for the assessment of the life cycle greenhouse gas emissions of good and services.
Greenhouse Gas Protocol – Product Life Cycle Accounting and Reporting Standard, 2011	• GHG Protocol Product Life Cycle Accounting and Reporting Standard. World Resources Institute, 2011. The GHG Protocol Product Standard can be used to understand the full like cycle emissions of a product and focus efforts on the greatest GHG reduction opportunities. Using the standard, companies can measure the greenhouse gases associated with the full life cycle of products including raw materials, manufacturing, transportation, storage, use and disposal.

‘CARBON NEUTRAL’ STANDARDS

Standard	Description
PAS 2060:2014[1]	• PAS 2060:2014, Specification of the Demonstration of Carbon Neutrality, published by British Standards Institution (BSI). Specifies the requirements to be met by an entity seeking to demonstrate carbon neutrality through the quantification, reduction and offsetting of greenhouse gas (GHG) emissions from a uniquely identified subject.

[1] A new international standard for determining carbon neutrality, *ISO/WD 14068 Greenhouse Gas Management and Related Activities – Carbon Neutrality* is under development by the International Organisation for Standardisation (ISO). This is expected to be published in 2023.

VERIFICATION, ASSURANCE AND ACCREDITATION STANDARDS

Standard	Description
ISO 14064-3:2019	• International Organisation for Standardisation. ISO 14064-3 Greenhouse Gases. Part 3: Specification with Guidance for the Verification and Validation of Greenhouse Gas Statements. 2019. Geneva. Specifies principles and requirements and provides guidance for verifying and validating greenhouse gas (GHG) statements. It is applicable to organisation, project and product GHG statements.
ISAE 3410, Assurance Engagements on Greenhouse Gas Statements	• International Standard on Assurance Engagements (ISAE) 3410, Assurance Engagement on Greenhouse Gas Statements. 2012. The objective of an engagement under ISAE 3410 is to obtain either limited or reasonable assurance, as applicable, about whether a GHG statement is free from material misstatement, whether due to fraud or error. GHG statements are assured to enhance the reliability of the emissions information being reported on. As the demand for companies to disclose their emissions information increases, public confidence in assured GHG Statements becomes significant.
ISO 14065:2020	• International Organisation for Standardisation. ISO 14065 General Principles and Requirements for Bodies Validating and Verifying Environmental Information. 2020. Geneva. Specifies principles and requirements for bodies performing validation and verification of environmental information statements.

Industry and Regional Regulatory Frameworks

There are many national or regional regulations that govern reporting of GHG emissions from entities involved in the LNG life cycle stages. Note that regulatory programs adopt boundaries and calculation approaches (e.g., emission factors or GWPs) that will not provide a complete data set that is calculated in line with this Framework. Additional calculations may therefore be required to supplement data reported into a regulatory programme.

Examples include:

- Alberta Specified Gas Reporting Regulation (SGRR), 2004
- California Air Resources Board. (CARB)
- Carbon Competitiveness Incentive Regulation. Alberta Climate Change Legislation, 2018
- Carbon Footprint of Global Natural Gas Supplies to China. Nature Communications, 2020
- European Union (EU) Carbon Border Adjustment Mechanism (CBAM). European Commission. 2021
- European Union (EU) Emissions Trading System (EU ETS). European Commission: Energy, Climate, Environment: Climate Change
- EU Emissions Trading System Monitoring and Reporting Regulation (EU ETS MRR) EUR-Lex, 2018
- European Union (EU) Methane strategy. European Commission: Energy, Climate, Environment: Climate Change. 2020
- European Union Monitoring, Reporting and Verification Regulation, 2018
- Global logistics Emissions Council. (GLEC) 2016
- International Maritime Organisation. IMO, Energy Efficiency Design Index (EEDI) Regulations, 2011
- Mandatory Greenhouse Gas Accounting and Reporting System, Japan.
- National GHG and Energy Reporting (NGER) Scheme. Australian Government National Greenhouse and Energy Reporting

- Sea Cargo Charter, Aligning Global Shipping with Society's Goals, 2021
- Quantification Methodologies for the Carbon Competitiveness Incentive Regulation and the Specified Gas Reporting Regulation. Alberta Government: Open Government Publications, 2006
- United States Environmental Protection Agency (EPA). Greenhouse Gas Reporting Program, 2009

Environmental Claims and Declarations

- ISO 14020:2000, Environmental labels and declarations — General principles, which sets out the guiding principles for the development and use of environmental labels and declarations
- ISO 14021:2016, Environmental labels and declarations — Self-declared environmental claims (Type II environmental labelling), which specifies requirements for self-declared environmental claims and includes specifications relating to declarations of a carbon footprint and carbon neutrality
- ISO 14025:2006, Environmental labels and declarations — Type III environmental declarations — Principles and procedures, which is relevant for labels that disclose an 'environmental product declaration' resulting from a life cycle assessment of a product. including a carbon footprint

LCA Studies

- *ACS Sustainable Chem. Eng*. (2021, 9, 32, 10857–10867 Publication Date: August 3, 2021) https://doi.org/10.1021/acssuschemeng.1c03307
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- Life Cycle Associates. (2018). *CA-GREET* (Low Carbon Fuel Standard). The California Air Resources Board. https://www.lifecycleassociates.com/lca-tools/ca_greet/
- Life Cycle Associates. (2020) GHGenius LCA Model (British Columbia. *Renewable & Low Carbon Fuel Requirement Regulation* https://www.ghgenius.ca/
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- Stanford School of Earth, Energy and Environmental Sciences. *OPGEE: The Oil Production Greenhouse Gas Emissions Estimator* (3.0 for Natural Gas, not yet released). Environmental Assessment & Optimization Group. https://eao.stanford.edu/research-areas/opgee
- Tagliaferri, C., Clift, R., Lettieri, P. et al. *Liquefied natural gas for the UK: a life cycle assessment*. Int J Life Cycle Assess 22, 1944–1956 (2017). https://doi.org/10.1007/s11367-017-1285-z

Voluntary Carbon Markets

- Taskforce for Scaling Voluntary Carbon Markets (TSVCM). 2021. https://www.iif.com/tsvcm
- The International Attribute Tracking Standard v1.0, April 2021 https://www.irecstandard.org
- Voluntary Carbon Market Integrity Initiative (VCMI). https://vcmintegrity.org/

Industry Methane Emission Initiatives

- Methane Guiding Principles: Scaling ambition to drive down emissions. https://methaneguidingprinciples.org/
- Methane Intelligence. Standard for Methane Emissions Performance (MiQ) www.miq.org
- M.J. Bradley & Associates. (2019). *Natural Gas Sustainability Initiative (NGSI), Methane Emissions Intensity Protocol*. a voluntary, industry-wide approach for companies to calculate methane emissions intensity by segment, https://legacy-assets.eenews.net/open_files/assets/2020/01/10/document_ew_02.pdf
- ONE Future - Coalition of natural gas companies working together to reduce methane, www.onefuture.us
- Project Canary www.projectcanary.com

General Reference

- Department for Business, Energy & Industrial Strategy, United Kingdom. (2013, Last updated 2 June 2021. *Government Conversation Factors for Company Reporting of Greenhouse Gas Emissions*. https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting
- European Standard. (2008-04) DIN EN 15446 Fugitive and diffuse emissions of common concern to industry sectors - Measurement of fugitive emission of vapours generating from equipment and piping leaks.
- IPIECA Scope 3 Reporting Task Force. (2016). Estimating Petroleum Industry Value Chain (Scope 3) Greenhouse Gas Emissions. American Petroleum Institute. https://www.ipieca.org/resources/good-practice/estimating-petroleum-industry-value-chain-scope-3-greenhouse-gas-emissions-overview-of-methodologies/
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- IPCC. (2014): Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
- IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.
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- United Nations. (1998). Annex A to the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC)

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Appendix C: GHG Footprint Quantification Guidance and Criteria

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APPENDIX C: GHG Footprint Quantification Guidance and Criteria

Introduction

The following seven steps guide the development of a GHG Footprint using one of the three carbon footprint standards referenced under the MRV and GHG Neutral Framework (the 'Framework'):

- ISO 14067:2018
- GHG Protocol Product Life Cycle Accounting and Reporting Standard (GHG Protocol Product Standard), 2011
- PAS 2050:2011

The approach does not replace the standards, but provides context for using the standards for the assessment of a GHG footprint for an LNG cargo.

Step
Step 1: Select GHG footprint standard
Step 2: Identify attributable processes within each life-cycle stage
Step 3: Set time boundary for the GHG footprint assessment
Step 4: Determine emission quantification and allocation methodologies
Step 5: Collect data for each stage
Step 6: Roll up data from each stage, taking account of allocation of emissions associated with co-products
Step 7: Quantify total emissions associated with the LNG Cargo, and the emissions intensity

Further elaboration on each step is provided below.

Step by Step Guidance

Step 1: Select the GHG Footprint Standard

The reporting entity will determine which GHG footprint standard will be applied. ISO 14067:2018, the GHG Protocol Product Standard and PAS 2050:2011 all provide standardised approaches that are aligned, with only minor differences.

The approach set out in the Reporter's GHG Footprint Methodology must reflect the content and definitions set out in the selected standard.

The selected GHG footprint standard and the criteria set out in this Framework, together with the Reporter's GHG Footprint Methodology and reference GHG quantification methodologies (e.g. API Compendium) will form the basis for verification of the calculated GHG Footprint.

Stage Statements and Cargo Statements must be supported by evidence to enable verification against both the chosen standard, this Framework, and supporting calculation methodologies applicable to the subject and boundary of the declaration made.

Step 2: Identify Attributable Processes within each Life-Cycle Stage

Under this step, the attributable processes directly related to the LNG production and use life cycle are identified for each life cycle stage included within the GHG footprint boundary. Each stage in the LNG life cycle can be broken down into a series of unit processes, to a level at which inputs and outputs can be quantified and defined as relevant or not to the production of the LNG cargo (expressed in units of energy content). The GHG emissions are then allocated to any co-products based on the flows through the unit processes. Emissions that can be quantified and determined as arising from processes that are not relevant to the LNG cargo are excluded from the footprint calculation.

Where possible the overall process should be broken down in to unit processes small enough to avoid the need for allocation between co-products within that process.

As an example, if an LNG plant also produces domestic gas from a slipstream of its incoming gas, and can specifically isolate relevant emissions, these will not be allocated to the product system. For an operator of a facility producing oil and associated gas, with quantified emissions related to gas flared from the separation train, these emissions should be allocated to the gas and oil streams as at this stage, both are relevant to the functional unit of the gas that will become LNG.

Where gas compression is related to gas export only, this can be identified as a stage that is fully attributable to the LNG production and does not require sub-allocation.

A **process map** should be developed and included in the GHG Footprint Methodology, which clearly identifies all processes within the stage boundary and clearly indicates those that are attributable (fully or partially) or non-attributable to the LNG cargo.

An illustrative example of processes that would be included is shown below, recognising that there will be considerable variation in the operational characteristics and levels of integration.

Actual processes identified and classified as attributable or non-attributable will be determined by the Reporter and set out in the GHG Footprint Methodology.

Stage	Example attributable processes (note individual operations will vary and Reporters may merge stages for the assessment)		Example non-attributable processes
Production and infill drilling (if applicable)	Utility systems (power/heat) Flare and vent systems	Support vessels Drilling fluid and cuttings management	
Production	Utility systems (power/heat) Flare and vent systems Purchased energy	Liquids unloading Gas treatment and compression Gas/Liquid Separation	Crude/NGL treatment, Storage and transport
Gathering, boosting & processing	Utility systems (power/heat) Flare and vent systems Purchased energy Acid gas removal Dehydration	NGL fractionation (de-methaniser) Other contaminant removal (H_2S, mercury etc.)	NGL processing (post de-methaniser) NGL storage NGL transport
Gas transport	Purchased energy Compression Pigging	Pipeline transport (vents/fugitives) Monitoring	Processes handling only gas that is not sent for liquefaction
LNG Production and loading	Utility systems (power/heat) Flare and vent systems Purchased energy Gas treatment Acid gas removal Compression and refrigeration	Liquefaction LNG Storage LNG Loading NGL fractionation (de-methaniser) Marine activities Sulphur production	NGL processing (post de-methaniser) NGL storage NGL transport Helium or sulphur handling (post separation) Processing domestic gas feeds post tee-off
Shipping	Propulsion at sea Loading/unloading/reloading (on-board emissions)	Tugs and service vessels Transshipment (ship to ship)	n/a
Unloading, Storage and Regasification	Utility systems (power/heat) Flare and vent systems Purchased energy Compression Regasification Loading/unloading/reloading (shore-based emissions)	LNG storage and marine activities LNG regasification LNG reloading (to ships/trucks) Transshipment (ship-shore-ship)	n/a
Gas Transmission	Purchased energy Pigging Compression	Monitoring Pipeline Transport	n/a

Stage	Example attributable processes (note individual operations will vary and Reporters may merge stages for the assessment)		Example non-attributable processes
Gas Storage (long term and geological storage)	Utility systems (power/heat) Flare and vent systems Purchased energy Compression	Gas treatment facilities (dehydration etc.) Cooling Gas injection	n/a
Gas Distribution	Purchased energy Compression	Pipeline Transport	n/a
End Use	Purchased energy Combustion	Process emission (e.g. NH_3 production)	n/a

Table 1: Example Attributable and Non-attributable Processes

Note that periods of shut down for maintenance or other abnormal conditions are attributable and associated emissions should be included within the quantification time period and averaged.

GIIGNL Framework Criteria – PROCESS MAP

- Process map of attributable (and non-attributable) processes included in the footprint calculation at each stage

Step 3: Set Time Boundary for the Footprint Assessment

In line with the footprint standards, a time period must be defined to form the period of assessment of the quantification of emissions. According to ISO 14067:2018, the time boundary for data is the time period for which the quantified figure for the GHG Footprint is representative, and should consider intra- and inter-annual variability where this is relevant. Data should be collected over a time period appropriate to establishing the average GHG emissions associated with the life cycle of the LNG product.

Production, Distribution, Liquefaction

For the stages from production to liquefaction, a temporal boundary for reporting needs to be defined that is both practicable and representative. 12 consecutive months is considered reasonable as this may be synchronised with annual reporting cycles and will smooth the impact of seasonal variation and abnormal events (e.g. shut downs). The 12 month period may be on a fixed or rolling basis and must be reviewed annually. Emissions associated with attributable processes outside that operating period (such as production drilling) should be amortised and allocated to the assessment period in a manner that can be transparently justified and verified.

The verification process must also be aligned to the data collection and reporting timeline. Therefore, where a calendar year is chosen this would be compatible with extending the scope of an inventory verification to verify the stage GHG intensity footprint as well. A rolling 12-month period may require more complex or more frequent verification.

The chosen time period must be transparently stated in the Stage Statement or Cargo Statement. If there are circumstances that require an assessment period of more than 12 months, then this must be clearly stated and subject to verification that there is no material impact on the GHG Footprint.

Where a significant proportion of secondary data is being used, such as that drawn from public reporting databases and regulatory programmes, it is recognised that there may be a lag between reporting and data availability for use in calculations. The principle, however, remains the same in that the most recent data available should be used and the data reviewed and updated with a frequency not greater than every 12 months and the most recent data available must be applied.

Shipping

In the case of shipping, the time boundary is expected to cover the actual LNG Cargo delivery and be specific to the laden and inward ballast voyage.

- **Laden Leg**: Emissions associated with the laden leg both in port and at sea will be included, and the boundary is CTMS open at loading port up to and including CTMS close at discharge port for the laden leg.
- **Ballast Leg**: The inward (preceding) ballast leg will be used and is defined as the full inward ballast leg from the last delivery port or dry dock/layup location, based on the commercial in-charter agreement, which may be based on CTMS open/closed as above.

Transmission, Storage, Distribution and End Use

If the Cargo Declaration is made at the point of delivery, the actual emissions associated with regasification, distribution and use of the gas after regasification will necessarily take place in the future. Therefore, for the stages downstream of delivery, the most recent available 12-month period of the relevant downstream emissions should be included in the calculations. Reasonable assumptions may need to be made and justified to the verifier.

Validity of Stage Statements

The provision within this Framework for individual stage operators to issue a Stage Statement provides a means for Reporters to access primary data from stages that they do not operate themselves. It is recognised that the availability of Stage Statements will increase over time and it is recommended that, where possible, Reporters work with operators of individual stages to promote the development of this information across the LNG life-cycle stages. Where Stage Statements are used in the roll up of emissions based on primary data in the GHG Footprint, there may be differences in the choice of time boundary for the intensity calculations, and the chosen time boundary for each stage should be dislosed in the Cargo Statement.

Any Stage Statements used in the quantification of a Cargo Footprint should be reviewed at least every twelve months, or in the event of a significant change that could impact the GHG intensity calculation.

For example, a liquefaction plant may receive gas from multiple suppliers and request a Stage Statement from each supplier to enable intensities based on primary data for the feed gas to be used in its GHG footprint calculation. Parties may need to work together to align time boundaries and optimise the relevance and applicability of data used in the footprint calculation. The data from all parties can then be used to develop a representative GHG footprint for a cargo loaded from that liquefaction plant.

The Framework does not require a Stage Statement from every stage in the life cycle. However, a Reporter is strongly encouraged to work with suppliers to build a GHG Footprint based on as much primary, site based data as possible.

GIIGNL Framework Criteria – TIME BOUNDARIES	
Shipping	• Laden leg - CTMS open at loading port up to and including CTMS close at discharge port for the laden leg. • Ballast leg - Full inward ballast leg from the last delivery port or dry dock/layup location, based on the commercial in-charter agreement
All other stages	• Most recent representative 12 months (fixed or rolling basis), including periods of shutdown • Historic/future attributable processes (e.g., production drilling, commissioning) to be amortised across the temporal boundary, if included

Step 4: Determine Emission Quantification Methodologies

The Framework does not seek to duplicate or replace existing calculation approaches, of which a variety will be used by Reporters depending on life-cycle stage, geography and regulatory/ corporate reporting commitments. Emissions quantification within each stage must be based on relevant and appropriate industry calculation methodologies (e.g., American Petroleum Institute (API) Compendium, Oil & Gas Methane Partnership (OGMP2.0), or regulatory programmes such as California Air Resources Board (CARB), National Greenhouse and Energy Reporting (NGER), European Union Emissions Trading System (EU ETS)).

Where regulatory reporting is in place, it will be necessary to confirm whether the reporting boundary (particularly completeness of emission sources and inclusion of all GHGs (including at least CO_2, CH_4, N_2O) and emission calculation methods (e.g. the GWPs used) are aligned with the criteria set out in this Framework. Supplementary calculations to ensure full coverage of emissions and sources may be required.

GHG Emission Calculations

The overarching equation for calculating GHG emissions from both combustion and non-combustion sources is shown below:

$$GHG\ emissions\ = activity\ data * emission\ factor * calculation\ factor * GWP * oxidation\ factor$$

Where:

GHG Emissions Calculated GHG emissions, metric tonnes CO_2 equivalent (tCO_2e)

Activity Data: Transactional data that represents the quantity for a given period

Emission Factor GHG emissions per unit of activity data. The emission factor may be based on measured data specific to the site and process, or a default value for a given fuel or equipment

Calculation Factor(s) e.g., unit conversions, adjustment of default emission factors or compositions, calorific value[1] Calculation factors need to be appropriate to the method in question and consistent with the basis of any other factors used

GWP Global Warming Potential of the individual GHG constituents.

Oxidation Factor A specific calculation factor that defines the percent conversion of hydrocarbon molecules into CO_2 during the combustion process. Note that this is primarily relevant for flaring emissions based on primary data for which there is typically a 2% unburnt fraction. A gas-specific stoichiometric emission factor may be used in conjunction with an oxidation factor for CO_2 emissions, and methane emissions calculated using (1-Oxidation Factor)

Note that activity data and emission or calculation factors used in any calculations need be in compatible units of measure[2], or unit of measure conversions must be made to ensure that the calculation of GHG emissions is correct.

For consistency, reporting GHG intensity under this Framework will be on the basis of higher heating value (HHV), also known as Gross Calorific value (GCV) as GHG/energy content of the relevant stage product (HHV basis). This is distinct from calculation of GHG emissions which may use either HHV or LHV, but must be consistent within a calculation when applying the relevant calculation factors.

Example:

When estimating emissions from diesel fuel, it is possible to use an approach of

$$CO2e = fuel\ consumed * fuel\ specific\ energy\ content\ \left(\frac{energy}{unit}\right) * emission\ factor\ \left(\frac{CO2e}{energy\ content}\right) * oxidation\ factor$$

In this case, because the emission factor is expressed as CO_2e, the oxidation factor is effectively 1.

In all cases case, units of measure for fuel consumed, energy content and emission factor must be dimensionally consistent and use the same basis for calorific value (all in HHV or all in LHV).

Other methods for GHG quantification may also be used under this Framework such as:

- direct measurement of emissions from a source (e.g. leak measurement data for fugitives, CEMS for combustion emissions)
- mass balance approach (e.g. CO2 from Acid Gas Removal Units (AGRU)); and/or
- process simulation modelling (e.g. CH4 from Glycol Dehydrators)

In order to fulfil the reporting needs of this Framework, the calculation will need to provide breakdown of GHGs (CO_2, CH_4 and N_2O at least) as well as the overall CO_2e value.

[1] Calorific value must be on the same basis as the chosen emission factor (Gross Calorific Value (GCV) / Higher Heating Value (HHV) or Net Calorific Value (NCV) / Lower Heating Value (LHV))

[2] e.g., if activity data is ‘mmBtu, HHV/yr,’ the emission factor denominator must be in compatible units of ‘mmBtu, HHV’

Step 5: Collect Data for Each Stage

A key objective of this Framework is to promote the use of primary, stage specific data across the LNG value chain. This will provide for a genuine comparison between cargoes and also support targeted emission reduction plans. Primary and secondary data in this context includes both data related to GHG quantification and to product or co-product quantification.

Primary data should be used as far as practicable. Primary data are those data related to a particular stage or process and obtained from direct measurements or a calculation based on site specific data, including direct measurement of flows and gas composition, component counts etc. Use of proxy data from a comparable production stage or process can be considered primary data provided there is sufficient correspondence.

Where clearly attributable to a specific operator or stage, regulatory reporting data may be considered primary data within the bounds laid out in Step 2, however these data may not represent a complete and optimally allocated dataset. It is therefore recommended that stage operators align and communicate primary data directly where possible.

Secondary data are any other data that do not meet the definition of primary data, including aggregated data at basin, regional, or industry levels. Secondary data should only be used where it can be demonstrated that it is not technically or economically possible to source primary data, and may impact the verifiability of the footprint. The carbon footprint reference standards (e.g. ISO 14067:2018) expect primary data at least from those processes over which the Reporter has control.

Reporters are encouraged to develop plans to increase the availability and use of primary data within their control boundary where applicable. To expand the use of primary data, efforts should also be made to source primary data from the operator of non-controlled stages via a verified Stage Statement aligned with this Framework.

As an example, it would not be reasonably practicable to develop a specific emission factor for a commercially traded fuel such as diesel. However, in the case of fuel gas, it is technologically possible and would be reasonably practicable to sample the gas and derive a specific emission factor rather than use a non-specific industry or basin default.

A specific example of use of secondary factors is the **post-delivery** section of the life cycle, i.e. after unloading at the discharge port. It may be assumed that the LNG will be combusted at end use. However it is also necessary to take into account the additional emissions associated with CH_4 losses (with higher GWP) and imported energy (both electricity and other fuels) during regasification, transmission, storage and distribution.

Hierarchy of Data Preference

A hierarchy of data preference flows from direct primary data through to global default secondary data that has no direct relationship to the actual stages within the LNG Cargo life cycle. These are set out below, in decreasing order of preference.

1. **Primary Direct**: Direct primary data, such as metered flow measurements, gaseous fuel sampling, and product flow measurement. It is particularly important to source primary data for the most significant emission sources.
2. **Primary Indirect**: Indirect primary data, such as component counts and engineering assumptions, modelled gaseous fuel composition based on the specific process. Standardised component leakage rates, if modified based on primary direct gas compositions would also be primary indirect data.
3. **Secondary Direct**: Cargo-aligned secondary data, including process level default factors and those based on specific regional or basin level assumptions. Use of LCA models that allow input of primary data from the cargo life cycle (e.g. LCA models such as OPGEE) fall into this level.
4. **Secondary Indirect**: Secondary factors and LCA models that are not related to the characteristics of the specific stage owners across the defined cargo life cycle. This would include stage based emission factors and LCA models that are unrelated to the characteristics and sources of the cargo. Whilst secondary factors may be a pragmatic approach to calculating emissions from minor sources, significant use of non-specific secondary data will not meet the requirements of the GHG footprint standards and the criteria defined for this Framework. This exclusion does not apply to factors commonly applied for commercially available fuels such as diesel, marine bunker fuel and fossil based natural gas after liquefaction, where quality standards closely control the fuel compositions and hence emission factors.

This hierarchical approach applies to both activity data and to calculation factors and it is expected that the quality of secondary factors and availability of primary data will increase over time. Due to regional variations, the Framework does not recommend specific standards or LCA models. It is the responsibility of the Reporter to determine if the approach aligns with the specifications of the Framework.

It will be the responsibility of the Reporter to demonstrate to the verifier that the best available data in terms of position on the above data hierarchy have been used. The expectation is that that the Reporter will be able to demonstrate why they are unable to meet a higher level if Primary Direct data are not used.

The Reporter must disclose in the Declaration statement the approximate proportion of primary data used in the calculation of the disclosed GHG intensity and absolute emission data. This requirement requests disclosure against four bands

- 0-25% primary data
- 25-50% primary data
- 50-75% primary data
- 75-100% primary data

A GHG Footprint built entirely from secondary data is not expected to conform to the requirements of ISO14067:2018 or other GHG footprint standard, and therefore will not conform with this Framework.

GIIGNL Framework Criteria – SOURCE DATA

Data to be preferentially sourced from primary data, according to a hierarchy of data preference

1. Primary Direct
2. Primary Indirect
3. Secondary Direct
4. Secondary Indirect

Estimated percentage of primary data to be disclosed in the Declaration Statement.

A GHG footprint based on 100% secondary data will not conform with this Framework

Documenting the sources of GHG data

As a basis for verification, Reporters must document the approach to data selection and collection, describing in detail the data sources that will be used in their stage-based GHG emissions calculations and allocation approaches. This will be set out in the GHG Footprint Methodology.

The approach would include details such as:

- Frequency of data collection and calculation where relevant, including both activity data and compositional data
- List of data sources (meters, gauges, logbooks, reports etc.) and sources of secondary data
- How data accuracy and reliability are addressed, including internal assurance of data
- List of fixed or default factors (and their sources)
- Characterisation of approaches as primary or secondary approaches, and % of primary and secondary data contribution to the GHG Footprint
- Calculation and estimation approaches to be used

A plan should be included within the GHG Footprint Methodology to improve data quality and the proportion of primary data within the GHG Footprint over time.

GIIGNL Framework Criteria – DATA COLLECTION

- The best available data from all stages should be used for the GHG Footprint calculation, based on a preference for primary direct data where possible
- A plan should be established to improve data quality and the proportion of primary data within the GHG Footprint over time
- As far as practicable, use should be made of Stage Statements, aligned with this Framework and based on primary data, from operators of stages where Reporter does not have operational or financial control
- This Framework does not mandate specific standards or regulatory approaches, or specific modelling approaches for secondary data
- Where models or approaches are selected by a Reporter, the use of these will need to be justified within the verification process in line with the hierarchical approach described above
- A GHG Footprint built entirely from secondary data is not expected to conform with the requirements of ISO14067:2018 or other GHG footprint standard, and therefore will not conform with this Framework

Step 6: Roll up Data from each Stage, Taking Account of Allocation of Emissions Associated with Co-products

Where there are multiple products produced in a stage or process, it is necessary to allocate GHG emissions to a) gas that will be used ultimately for LNG delivery and b) co-products that are sold separately. The allocation to gas used ultimately for LNG delivery is then used to calculate a stage GHG intensity ($tCO_2e/mmBtu$) to be used in the GHG Footprint assessment for an LNG Cargo.

Co-product allocation

A co-product must have economic value and accordingly no emissions are allocated to waste products. Examples of co-products in this context include natural gas liquids (NGLs), crude oil, H_2S or sulphur, domestic gas and helium; the product under this Framework is the gas or LNG that is transferred from one stage to the next. Allocation will not be required for the unloading terminal onwards as all subsequent emissions will be attributed to the delivered LNG Cargo.

Co-products include natural gas that is not included in an LNG Cargo. This would therefore also include gas exported to a national distribution network prior to liquefaction, or a cargo that has been split during the shipping leg.

Where the chosen boundary is a partial life cycle ('cradle to gate') then the Reporter should be mindful that the Cargo GHG intensity will depend on the exact end point of the boundary (for example ex-ship, all product will be LNG. However ex-regasification there may be both LNG and natural gas products. Full transparency of the life cycle boundary is therefore required in the Cargo Statement.

An energy-based co-product allocation across the value chain has been established within this Framework as the preferred approach. Where energy allocation is not possible, other physical property such as mass should be used. Allocation on economic basis is considered a 'last resort' option.

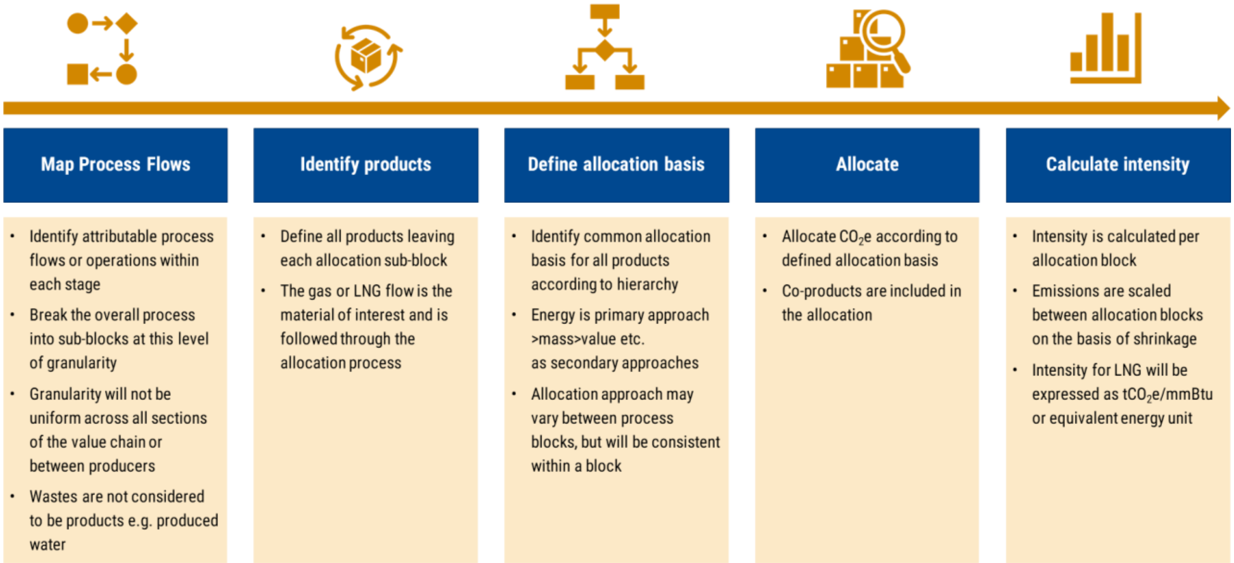

Figure C.1: Process of Co-Product Allocation

Figure C.1 depicts the overall approach to co-product allocation that is used in the GHG footprint standards. This begins by breaking the process stages down into suitably sized sub-blocks at which level the allocation can be carried out (see Step 2). Where possible, allocation should be avoided by splitting the process stages into sufficiently small blocks that it is possible to exclude non-attributable.

However, it is recognised that this may not always be practicable depending on data quality and availability. Allocation to co-products should be performed at the most granular level possible in order to increase the accuracy of the allocation between products and co-products. In this case, because the primary measure of intensity is $tCO_2e/mmBtu$, the preferred principle for allocation will be by energy content. Some co-products such as helium, or CO_2 sold for enhanced oil recovery (EOR) or other third party commercial use, do not have an energy content and therefore an alternative approach, such as mass-based allocation, may be used. It is not possible to apply both mass and energy-based allocation in the same sub-block, and further sub-division will be required in these cases.

Auto-consumption of gas for utilities is not considered a co-product for allocation purposes and may increase demand (and associated emissions) from the previous stage.

As an example, In the LNG production process, where LPGs are produced in the liquefaction plant, and helium subsequently extracted, two sub blocks will be needed, one to carry out energy based allocation of attributable emissions between the LPGs and LNG (including the helium that will subsequently be removed) and one to carry out the mass based allocation between helium and the final LNG product.

Shrinkage

It is necessary with the allocation process to account for losses, or ‘shrinkage’, from one stage to the next occurring due to the use of gas as a fuel within some of the processes, losses due to flaring, venting and fugitives, or due to removal of co-products.

.

Example:

A release to atmosphere constitutes a waste in the context of a co-product allocation approach. The loss is not considered a co-product as it has no economic value and therefore will have no emissions allocated to it, though it may itself represent an emission source. Consider three scenarios for CO_2 removal at an acid gas removal unit (AGRU):

- CO_2 used for EOR (a saleable product) or other utilization – emissions associated with energy used in the AGRU may be allocated between the CO_2 and gas streams leaving the AGRU, in this case likely to be on a mass basis. No further emissions are allocated to the CO_2. Where possible net stored CO_2 should be considered.
- CO_2 is captured and permanently stored. The emissions associated with energy used in the AGRU will be allocated to the gas stream leaving the AGRU. Residual emissions from the carbon capture and storage operation (due to incomplete capture) and associated with energy use in that capture and storage operation should also be allocated to the gas stream leaving the AGRU.
- CO_2 is released directly from the AGRU – all emissions of CO_2 and those associated with the energy used are allocated to the gas stream leaving the AGRU. The CO_2 in this case is a waste, with no economic value.

Allocation Approaches

The approach laid out above is the preferred approach. However, it is recognised that data gathering and differentiation may not be sufficiently developed in the early life of this Framework. Reporters may therefore need to estimate a basis of allocation initially, or may allocate at a stage level. The use of stage-based allocation will not however result in the most appropriate partitioning of the GHG data and allocation to the co-products, and following the principle of continuous improvement, development of a more granular approach would be expected.

Illustrative guidance is provided below, showing two alternative calculation approaches to allocate the GHG data between gas that will be used ultimately for LNG delivery and co-products, and then to aggregate the GHG data allocated to LNG across life-cycle stages. The approaches utilise either an ‘absolute emissions’ or an ‘intensity-based’ approach. Further guidance is provided in worked illustrative examples of these two approaches in Appendix C.

1. Absolute emissions based (or 'carry forward') approach

A GHG intensity is estimated for a stage in the life cycle and, when combined with the energy content of the interim product transferred to the next stage, can be used to estimate the absolute GHG emissions footprint of that interim product. In this case, the interim product of interest is that process flow which will eventually become LNG, or is LNG or regasified LNG. The GHG footprint of that interim product along with the energy content then constitute a material and energy input to the next stage of the life cycle as 'embedded carbon'. The embedded carbon can be allocated between co-products from the next stage on the basis of the allocation principles, and so on.

For example:

- Stage A produces a gas stream with an intensity of 2 tCO_2e/mmBtu. A flow of 100 mmBtu will have 200 tCO_2e embedded emissions
- In Stage B, the 100mmBtu is split into NGLs and Gas. If 20 mmBtu of NGLs are produced, these will be allocated 20/100 x 200 tCO_2e, the remainder allocated to the gas stream

This assumes no losses for illustrative purposes.

GHG emissions are only allocated to co-products through to the point that they leave the process. GHG emissions are not allocated backwards in the chain to co-products that have already left the life cycle flow as the emissions from a given stage are not attributable to the operations of the prior stages.

2. Emissions intensity based (or 'shrinkage') approach

In this approach, GHG intensities are calculated independently in each stage of the life cycle, based on energy allocation. A scaling factor is also derived to account for the losses, or shrinkage, of gas from one stage to the next:

$$scaling\ factor = sum\ of\ input\ quantity\ /\ sum\ of output\ quantity$$

As an example, for a gas transmission system this could be:

$$scaling\ factor = total\ energy\ entering\ network / \ total\ energy\ in\ gas\ exiting\ network\ (mmBtu)$$

In this way, the effects of losses, e.g. as fuel gas to power compression, or losses to flaring and venting can be accounted for.

Each stage can then independently calculate a stage output intensity.

$$output\ intensity = (input\ intensity * scaling\ factor) + stage\ intensity$$

Aggregating Data from Value Chain Segments

Integrated operators will have access to data across the life-cycle stages under their control, but it is unlikely that an operator will control the complete value chain from production to end use. The GHG footprint standards allow for the use of secondary data for stages outside the control of the reporter. However, given the intent of this Framework to promote a footprint that is as close as possible to the emissions associated with the actual supply chain, it is intended that Reporters will aim, where possible, to utilise Stage Statements provided by the owners of stages controlled by other parties as far as possible, with full transparency in the Cargo Statement.

To transfer emissions from each Stage to the next along the chain in order to compile the GHG footprint, two key parameters are needed:

- The GHG intensity from the preceding stage
- Quantity of gas passed from one stage to the next

These two values will enable the emissions to be ‘rolled along’ from one stage to the next and may require further manipulation by the reporter or by operators of specific life cycle stages, though the principles of the approaches remain valid.

When passing data between different Operators of life cycle stages, it is recommended that all data are provided, including, where possible, total carried forward emissions, stage intensity and stage scaling factor, and energy content of gas.

Where an operator of a single stage such as liquefaction, is receiving gas from multiple suppliers, the information can be used to develop an aggregated input intensity or aggregated input emissions, provided sufficient data is provided by the suppliers (See Appendix C.1). Such information will also be required if a Reporter wishes to have an emissions statement verified.

Accounting for Emissions Post-Delivery

Whilst accounting for GHG emissions to the point of delivery of LNG ex-ship is effectively ‘backward accounting’ based on gas or LNG exiting each stage of the LNG production chain, from point of delivery onwards, a ‘forward accounting’ approach can be taken by an end user of the gas.

Example:

Consider a power generation operator, purchasing 1000 mmBtu of LNG delivered. A verified GHG intensity can be attached to that quantity of gas. The LNG must then be regasified and put into a transmission network to the power generation operator. A proportion of that gas may technically be consumed in delivering a quantity of gas (say 950 mmBtu) to the power generation plant. Practically, this gas has been combusted, and it is irrelevant where in the supply chain, post-delivery, the combustion occurs. However, there will also be additional emissions associated with fugitive losses, because of the higher GWP of methane, and also from the use of other energy sources such as electricity and liquid fuels.

From an allocation perspective, the relevant emissions are those associated with moving gas from the point of delivery to the end user, based on the input quantity of gas i.e. for the 1000 mmBtu, plus emissions associated with methane losses to the atmosphere and the use of other fuels and imported energy.

The calculation could equally be considered based on the emissions cost of delivering 1000mmBtu to an end user from the point of delivery. The GHG Footprint Methodology will need to be clear on the basis used and the approach taken in either case.

Stage Statements

Where a Reporter is accounting for one or more stages of the life cycle, these may be verified individually (see Step I, Conformity Assessment) and accompanied by suitable emissions reports and verification statements. In order to allow subsequent reporters to effectively allocate incoming emissions, any such partial emissions and verification statement must include:

- Stages included in the accounting
- Sufficient data to allow calculation of:
  - per stage GHG emissions
  - gas quantity by energy content
  - carried forward/included emissions
  - GHG intensity of the gas or LNG stream

GIIGNL Framework Criteria – CO-PRODUCT ALLOCATION AND AGGREGATION

- Co-product allocation to be undertaken on energy basis if possible. If not possible, alternative physical basis (e.g. mass) is preferred over economic allocation.
- Shrinkage must be allowed for, taking account of gas use and losses within each stage
- Emissions from each stage are 'carried forward' to aggregate the overall GHG footprint

Step 7: Quantify Total Emissions Associated with the LNG Cargo

The last step in the GHG Footprint assessment is to prepare the emissions data based on the GHG quantification, allocation and aggregation across all relevant stages, for presentation in the Stage Statement or Cargo Statement.

These data will include, at Cargo and/or Stage level as applicable:

- GHG intensity (CO_2e/mmBtu)
- Methane intensity (tCH_4/mmBtu)
- GHG emissions (tCO_2e)
- Methane emissions (tCH_4)

Note that other mass : energy unit can be utilised, with energy on HHV basis

The Reporter will also need to ensure that appropriate evidence is retained and accessible for verification.

Estimating Uncertainty

The GHG footprint standards all ask for the uncertainty in the reported GHG footprint to be reduced as far as possible, and both the GHG Protocol Product Standard and ISO 14067:2018 require an assessment of at least qualitative uncertainty.

Uncertainty is typically based on quantitative estimates of the value of uncertainty and a qualitative discussion of the causes of uncertainty. Uncertainty may relate to quantification factors (such as emission factor applied or a measurement from a meter), the calculation methodologies used, or the inherent uncertainty within models used where activity data are not available, including assumptions. Reporters should use data that reduce uncertainty as far as possible by using the best available data, characterised by quantitative and qualitative aspects.

As a minimum, Reporters will need to issue a qualitative statement on uncertainty related to the stages for which they are reporting. The use of Data Quality Indicators, e.g. as described in the GHG Protocol Corporate Accounting Standard, may be used to inform a Reporter of the sources of uncertainty. Sensitivity analysis such as Monte Carlo Simulation methods may be used to provide a quantitative assessment of overall uncertainty and sensitivity of the reported emissions to specific parameters. It is acceptable to use default values of uncertainty, subject to verification, so long as all references are recorded in the Statement.

Reference should also be made to the guidance issued jointly by API and IPIECA on Addressing uncertainty in oil and natural gas industry greenhouse gas inventories[1], which provides a summary of technical considerations that are important for understanding and calculating greenhouse gas (GHG) emission inventory uncertainty. The guidance was designed as a companion to the API Compendium.

Where a Reporter has identified sources of uncertainty that can be reduced in a cost-effective manner, they are expected to do so, in line with the general principle of continuous improvement.

The GHG Protocol Product Standard has set out a description of factors that affect data uncertainty, which is included below.

[1} IPIECA and API. (2015). Addressing uncertainty in oil and natural gas industry greenhouse gas inventories. Technical considerations and calculation methods.

	Representativeness to the process in terms of:				
Score	**Technology**	**Time**	**Geography**	**Completeness**	**Reliability**
Very Good	Data generated using the same technology	Data with less than 3 years of difference	Data from the same area	Data from all relevant process sites over an adequate time period to even out normal fluctuations	Verified data based on measurements
Good	Data generated using a similar, but different technology	Data with less than 6 years of difference	Data from a similar area	Data from more than 50% of sites for an adequate time period to even out normal fluctuations	Verified data partly based on assumptions or non-verified data based on measurements
Fair	Data generated using a different technology	Data with less than 10 years of difference	Data from a different area	Data from less than 50% of sites for an adequate time period to even out normal fluctuations or from more than 50% of sites, but for shorter time period	Non-verified data partly based on assumptions or a qualified estimate (e.g., by sector expert)
Poor	Data where technology is unknown	Data with more than 10 years of difference or age unknown	Data from an area that is unknown	Data from less than 50% of sites for a shorter time period or representativeness is unknown	Non-qualified estimate

Source: Table 8.2 of the GHG Protocol Product Standard

Table 2: Sample Data Quality Indicator Scoring Criteria

Errors are distinct from uncertainty in that errors are able to be quantified and are therefore able to be corrected. A statement of emissions under this Framework should not be issued with remaining errors that have not been corrected. In the rare cases that potential errors are identified, but are unable to be fully quantified, these should be noted and a potential value range estimated.

GIIGNL Framework Criteria – GHG FOOTPRINT QUANTIFICATION	
Reported emissions	• GHG intensity (CO_2e/mmBtu) • Methane intensity (tCH_4/mmBtu) • GHG emissions (tCO_2e) • Methane emissions (tCH_4)
Uncertainty assessment	• Qualitative uncertainty assessment as minimum

Illustrative Energy Allocation Approaches

Overview

Allocation is the process of apportioning GHG emissions from within an operational boundary to the gas that flows through the system boundary. For a full life cycle, the process accumulates the emissions at each life-cycle stage to build the GHG footprint from well head to end use inclusive.

Within this Framework, this means that an entity level GHG inventory is apportioned between the gas that is part of the LNG life cycle and other co-products based on a common underlying physical relationship. In the case of LNG, the basis for allocation will be energy. A small number of co-products, such as helium, will need an alternative approach for which mass is recommended. Allocation on an economic basis is considered a last resort.

Where possible, allocation should be avoided by breaking a life-cycle stage down into smaller sub-stages. This will allow removal of processes that are not attributable to the LNG product if they can be isolated, for example by sub-metering.

Reporters are encouraged to reference LCA studies and methodologies as well as the carbon footprint standards applied in developing the GHG Footprint (e.g. GHG Protocol Product Standard, ISO 14067:2018), when developing their allocation methodology for development of the LNG GHG footprint.

An overview of the process was shown in Figure C.2 below.

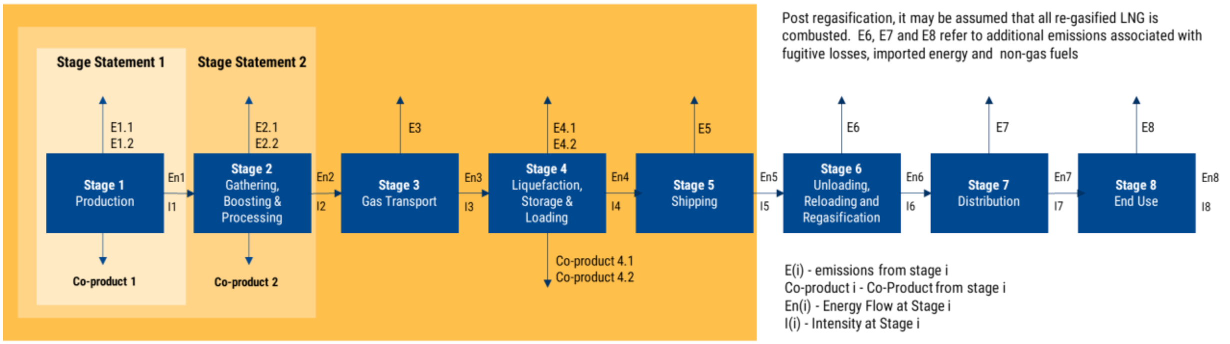

Figure C.2: Illustrative Overview of Stage-based Approach to Allocation

As illustrative guidance for users of this Framework, example approaches are illustrated in this Annex, addressing

a) An **absolute emissions, or 'carry-forward'** approach, based on a sequential summation of absolute emissions apportioned to the LNG gas chain from each stage to the next

b) An **intensity based, or 'shrinkage'** approach, in which each unit process is assessed individually to calculate the product GHG intensity (as tCO_2e/mmBtu) and a 'scaling factor' that accounts for losses within the process (e.g. due to fuel use, flaring).

Illustrative Absolute Emissions Based (or 'Carry-Forward') Approach

In the absolute emissions based approach, each stage or sub-stage in the life cycle is assessed separately with absolute emissions allocated to the various products, intermediate streams and co-products. These allocated absolute emissions (and data on material flows) are then carried forward into the next stage and can be further allocated to products/co-products from that stage using the appropriate allocation rules along with the emissions arising from that next stage.

In this way, total absolute emissions and total energy content of the product are tracked from stage to stage, which ultimately allows an intensity to be calculated for the chosen product footprint.

An example is illustrated below, with an assumed input carried forward from the previous stage, allocation within each stage, and an allocated output emissions value. Stage 2 has been expanded to show an example of allocating emissions between NGLs and export gas.

Emissions and energy data are simplified for illustration purpose only.

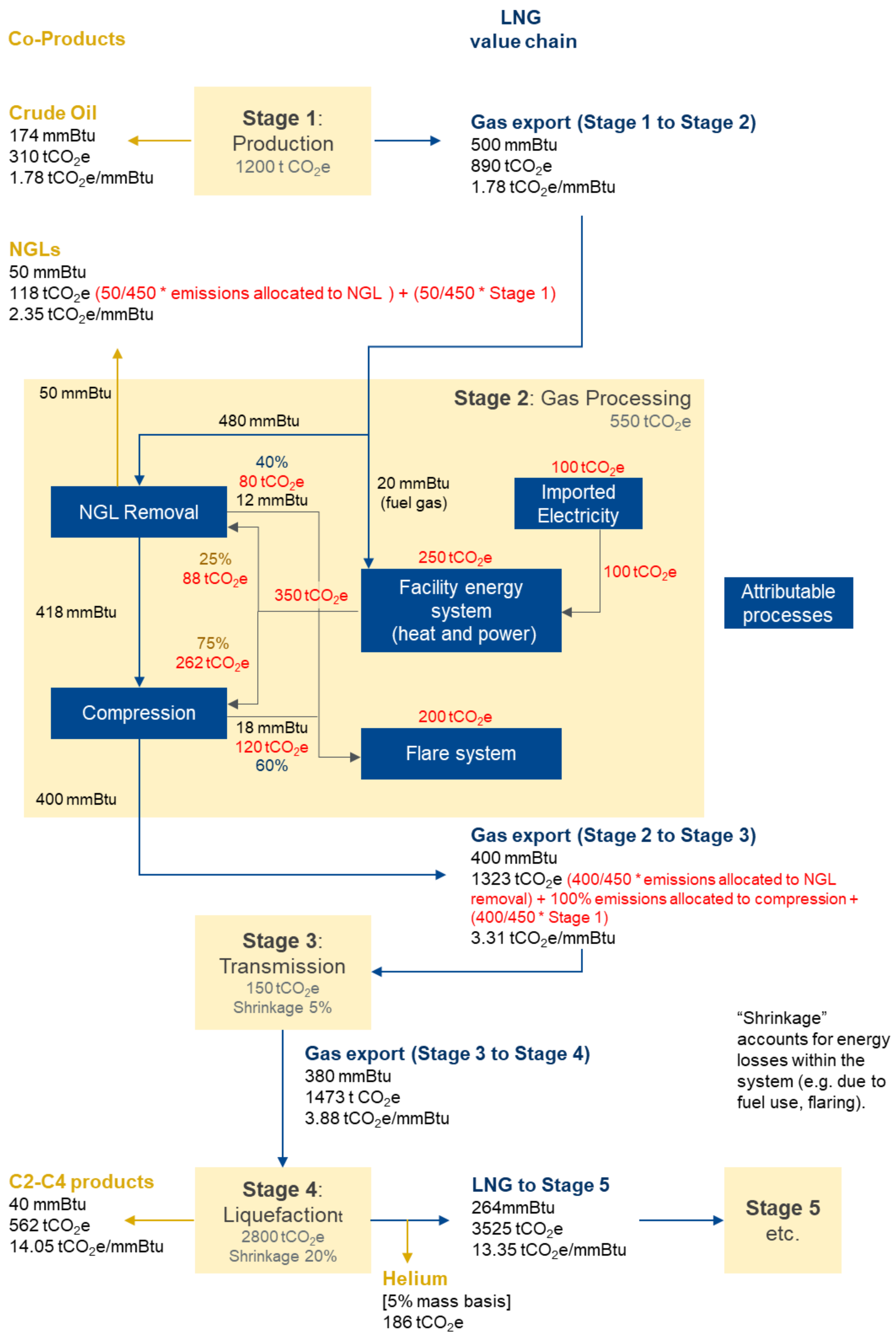

Figure C3: illustrated absolute emission based allocation approach

Calculations used in FigureC3 are shown below.

Stage 1

				Notes
Emissions				
Emissions from Stage 0 (n/a)	0.0		tCO_2e	
Stage 1 emissions	1200		tCO_2e	
Combined	1200			
Energy				
Input energy (n/a)	0		mmBtu	
Gas use allocation (n/a)	0	*Proportion*		
Gas export	500	*0.74*	mmBtu	
Oil export	174	*0.26*	mmBtu	
TOTAL	674		mmBtu	
Stage 1 emissions	1200.0		tCO_2e	
Gas export	890.2		tCO_2e	
Oil export	309.8		tCO_2e	
	Crude Oil	**Gas**		
Energy	174	500	mmBtu	
GHG	309.8	890.2	tCO_2e	
CO_2e from previous stage	0.0	0.0	tCO_2e	
TOTAL GHG	310	890	tCO_2e	
Intensity	1.78	1.78	tCO_2e/mmBtu	
GHG From Stage 0	0	0	tCO_2e	
GHG Stage 1	310	890	tCO_2e	
GHG export	310	890	tCO_2e	
	Crude Oil	**Gas**		
Export energy	**174**	**500**	**mmBtu**	
Export GHG	**310**	**890**	**tCO_2e**	
Intensity	**1.78**	**1.78**	**tCO_2e/mmBtu**	

Stage 2

				Notes
Emissions				
Emissions from Stage 1	890		tCO_2e	From Stage 1
Import electricity	*100*		tCO_2e	
Facility energy	*250*		tCO_2e	Emissions from fuel gas use and flaring are included in shrinkage
Flare	*200*		tCO_2e	Flare emissions - Part of Shrinkage
Emissions from Stage 2	550		tCO_2e	
Combined Stage 1 + Stage 2	1440			
Energy				
Input energy	500		mmBtu	From Stage 1
Energy losses (10% (50mmBtu))	50		mmBtu	Shrinkage - fuel gas use & flaring loss on site not considered an export for allocation purposes
Exported energy	450		mmBtu	NGL (50 mmBtu) + Gas (400mmBtu)
		proportion		
NGLs	50	0.11	mmBtu	Calculate energy-based proportion for allocation (50/450)
Gas Export	400	0.89	mmBtu	Calculate energy-based proportion for allocation (400/450)
TOTAL	450		mmBtu	
Allocate Energy and GHGs to processes	**NGL Extraction**	**Gas Compression**		
Energy system	0.25	0.75	%	% energy flow to each process unit (25% NGL:75% compression)
Energy system GHG	87.5	262.5	tCO_2e	Allocate energy GHG to each process unit (25% of 350 tCO_2e and 75% of 350 tCO_2e)
Flare system	0.40	0.60	%	% flaring to each process unit (40% NGL:60% compression)
Flare system GHG	80.0	120.0	tCO_2e	Allocate flaring GHG to each process unit (40% of 200 tCO_2e and 60% of 200 tCO_2e)
GHG Stage 2	168	383	tCO_2e	flare system GHG + Energy system GHG for each process

				Notes
Allocate GHGs to Co-products	NGLs	Gas		
GHG From Stage 1	99	791	tCO_2e	proportion of GHG from Stage 1 to each co-product (NGL: 0.11*890; Gas:0.89*890)
Allocation of NGL Removal process GHG to each co-product	19	149	tCO_2e	proportion of GHG from stage 2 NGL process to each co-product (NGL: 0.11*168; gas: 0.89*168)
Allocation of Compression process GHG to each co-product	0	383	tCO_2e	proportion of GHG from Stage 2 compression process to each co-product (NGL: 0*383; Gas: 1*383) (compression not relevant to NGL)
GHG Export	118	1323	tCO_2e	Total GHG associated with each co-product (NGL: 99+19+0; gas: 791+149+383)

	NGLs	Gas		
Export energy	**50**	**400**	**mmBtu**	
Export GHG	**118**	**1323**	**tCO_2e**	
Intensity	**2.35**	**3.31**	**tCO_2e/mmBtu**	

Stage 3

				Notes
Emissions				
Emissions from Stage 2	1322.7		tCO_2e	
Stage 3 emissions	150		tCO_2e	
Combined	1473		tCO_2e	
Energy				
Input energy	400		mmBtu	
Energy losses (shrinkage) 5%	20		mmBtu	
Exported energy	380		mmBtu	
		Gas		
Stage 3 emissions		150.0	tCO_2e	
GHG From Stage 2		1323	tCO_2e	
GHG Stage 3		150	tCO_2e	
GHG export		1473	tCO_2e	
	Co-product	**Gas**		
Export energy	**0**	**380**	**mmBtu**	
Export GHG	**0**	**1473**	**tCO_2e**	
Intensity	**0.00**	**3.88**	**tCO_2e/mmBtu**	

Stage 4

Emissions				
Emissions from Stage 3	1472.7		CO_2e	
Stage 4 emissions	2800		CO_2e	
Combined	4273		CO_2e	
Energy				
Input energy		380	mmBtu	
Energy losses (shrinkage) (20%)		76	mmBtu	
Exported energy		304	mmBtu	
NGLs export		40	mmBtu	
Helium (no energy content)				
Gas Export		264	mmBtu	
TOTAL		304	mmBtu	
Emissions	**NGL**	**Gas**		
Stage 4a emissions	2800.0		tCO_2e	
Proportion	0.13	0.87		
GHG	368	2432	CO_2e	
TOTAL GHG Stage 4	368	2432	CO_2e	
GHG From Stage 3	194	1279	CO_2e	
GHG Stage 4a	368	2432	CO_2e	
GHG export	562	3710	CO_2e	
Stage 4a	**NGL**	**Gas**		Stage 4a allocates total incoming GHG and stage 4 GHG emissions to the gas and NGL Streams on the basis of energy
Export energy	40	264	mmBtu	
Export GHG	562	3710	CO_2e	
Intensity	14.05	14.05	tCO_2e/mmBtu	
Stage 4b (Helium Extraction)	**He**	**LNG**		Stage 4b allocates between the final LNG and Helium products on the basis of mass
GHG from Stage 4a		3710		
Energy Content	**N/A**	**264**	**mmBtu**	
Allocation by mass 95% LNG	**186**	**3525**	**CO_2e**	If Helium was vented rather than recovered for economic value, this stage would allocate all remaining emissions to LNG
Intensity	**N/A**	**13.35**	**tCO_2e/mmBtu**	

Illustrative Emissions Intensity Based (or 'Shrinkage') Approach

An alternative example calculation method is based on emissions intensity, in which each unit process is assessed individually to calculate the product GHG intensity (as tCO_2e/mmBtu) and a 'scaling factor' that accounts for losses within the process (e.g. due to fuel use, flaring).

The overall GHG footprint for the defined life cycle boundary is then calculated by summing the GHG intensities of each stage, after accounting for losses by applying the scaling factors of the subsequent stages.

Example::

I	intensity
S	shrinkage (e.g. fuel use, flaring)
En	energy flow embedded within a material stream (or other measure where energy allocation is not used

This is illustrated below using an example determining a 'cradle to gate' intensity, based on the example laid out in figure C.3. In all cases the approach follows steps A-D below. Note that all data shown are illustrative only.

A. Calculate Stage Scaling factor per stage or sub-stage, S(i) = En(i) / En(i-1)

   Where both energy and mass or other allocation are performed, a stage will need to be split to allow separate scaling factors for each allocation approach, as it is not possible to create a single scaling factor when multiple allocation methods are used.

B. Multiply each stage intensity using the scaling factors of the subsequent stage

   I(1), contribution at Stage 5 = I(1) x S(2) x S(3) x S(4) x S(5)

   I(2), contribution at stage 5 = I(2) x S3 x S(4) x S(5)

C. Total Intensity = sum of scaled Intensities

D. Total Emissions = final energy content x sum of scaled intensities

Application of Emissions Intensity Based Approach

Stage example (from example C1 above)	Allocation basis	Stage intensity (From allocation) $tCO_2e/mmBtu$	Stage Scaling factor
Stage 1 Upstream production	Energy	1.78	N/A – First Stage
Stage 2 Gas Processing	Energy	1.33 (532/400)	1.11 (500/450)
Stage 3 Transmission	Energy	0.395 (150/380)	1.053 (400/380)
Stage 4a LNG Liquefaction	Energy	9.21 (2800/304)	1.25 (380/304)
Stage 4b LNG Helium Removal	Mass	N/A – Direct multiplier	0.95 (5% He production)

Stage 1 scaled intensity	= I1 x S2 x S3 x S4a x S4b	= 1.78 x 1.11 x 1.053 x 1.25 x 0.95	= 2.471
Stage 2 scaled intensity	= I2 x S3 x S4a x S4b	= 1.33 x 1.053 x 1.25 x 0.95	= 1.663
Stage 3 scaled intensity	= I3 x S4a x S4b	= 0.395 x 1.25 x 0.95	= 0.469
Stage 4a scaled intensity	= I4a x S4b	= 9.21 x 0.95	= 8.750

This example gives a total intensity for LNG loaded onto a carrier of **13.35 $tCO_2e/mmBtu$.**

This value can be carried forward to subsequent stages. For example, assuming 5% of loaded cargo (by energy) is consumed in shipping as BOG, and the intensity of shipping is 2 $tCO_2e/mmBtu$ delivered, the intensity of the delivered LNG is given as

$$Intensity\ delivered = intensity\ loaded\ x \frac{1}{0.95} + shipping\ intensity = 14.06 + 2.0$$
$$= 16.06\ tCO2e/mmbt$$

Note the shipping intensity is given per mmBtu delivered, not per mmBtu loaded.

Combining Multiple Gas Supplies into Single Stage

Example 1 – An operator of a liquefaction plant receives gas from three different suppliers and needs to provide an intensity of produced LNG per mmBtu. The suppliers provide the following data

- Supplier 1 – gas supplied mmBtu and included GHG emissions
- Supplier 2 – gas supplied tonnes, gas HHV and GHG intensity
- Supplier 3 – gas supplied mmBtu and GHG intensity

Example of integration of multiple inputs

	Gas Supplied Quantity		Gas	Emissions brought forward	
	mmBtu	tonnes	mmBtu/ tonne (HHV)	tCO_2e	tCO_2e/ mmBtu
Plant 1	300			1000	
Plant 2		150	3		3.25
Plant 3	500				2.75

This requires normalisation as follows

- Plant 1 - Intensity = 1000 tCO_2e / 300mmBtu = 3.33 tCO_2e/mmBtu
- Plant 2 - mmBtu gas = 150 t x 3 mmBtu/t = 450mmBtu gas
- Plant 2 - included emissions = 450 mmBtu gas x 3.25 tCO_2e/mmBtu = 1462.5 tCO_2e
- Plant 3 - Included emissions = 500mmBtu x 2.75 tCO_2e/mmBtu = 1375 tCO_2e

This allows a normalisation of the inputs to the liquefaction plant.

	Normalised input quantities		
	Energy (mmBtu Gas)	included emissions (tCO_2e)	intensity (tCO_2e/mmBtu)
Plant 1	300	1000	3.33
Plant 2	450	1462.5	3.25
Plant 3	500	1375	2.75
Totals	1250	3837.5	3.07

The liquefaction plant operator is then able to allocate the total 3837.5 tCO_2e associated with its gas input to its products following the principles outlined in Figure C.1 above.

This assumes that the LNG plant operator is allocating GHG emissions equally to the energy content of the incoming gas. In reality, there may be specific allocation based on the incoming gas characteristics such as inherent CO_2 content, fraction of condensables (leading to higher LPG or NGL production) and so on

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GIIGNL MRV and GHG Neutral LNG Framework

Appendix D: Example Reporting Scenarios

November 2021

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APPENDIX D:
Example Reporting Scenarios

As guidance for Reporters, four illustrative reporting scenarios are illustrated. These address:

Scenario 1 – Integrated LNG Producer responsible for delivering a cargo of LNG to discharge terminal, making a 'GHG Offset' declaration for a partial life cycle (well to delivery point)

Scenario 2 – Upstream gas producer making a Stage Statement for input into the GHG Footprint calculation

Scenario 3 – Gas trader making a GHG Offset declaration for delivered LNG

Scenario 4 – End user

Scenario 1

Integrated LNG producer responsible for delivering a cargo of LNG to discharge terminal, making a 'GHG offset' declaration for a partial life cycle (well to delivery point)

An integrated LNG producer, operating the stages of the LNG Value chain from well-head to loading onto a carrier, and potentially having a high degree of control of shipping, or operating the shipping legs itself, would be expected to have good availability of primary data where reporting a 'cradle to gate' GHG footprint.

The steps that would be taken by the LNG producer in this case could include:

- Determine the declaration to be made (i.e. GIIGNL Framework aligned GHG Offset LNG Cargo)
- Determine temporal and physical boundaries for data collection from attributable processes within each stage within the boundary
- Determine allocation approach, at the most granular level possible (See Appendix C)
- Carry out allocation and determine GHG intensity, ex-LNG plant, and for shipping, based on physical and temporal boundaries selected (for continued claims, the intensity calculation will need to be maintained in line with the temporal boundary GHG Footprint Methodology)
- Collect data required for verification, including production data related to allocation, and any evidence related to GHG reductions and offsetting as relevant to the Declaration Pathway
- Prepare Cargo Statement in line with the Framework requirements
- Engage verifier (this can be at any point)
- Complete data verification, source offsets in line with Offset Strategy and record retirement
- Provide 'GHG Offset LNG' Cargo Statement and verification opinion to purchaser
- Share Cargo Statement with GIIGNL. Any commercially sensitive or confidential information in the Cargo Statement may be redacted in the version shared with GIIGNL

If the LNG buyer wishes to extend the supplier's GHG Offset declaration to a GHG Neutral declaration, then they will need to integrate the emissions associated with the regasification and downstream stages and implement a GHG Emission Reduction Plan before offsetting and completing a PAS 2060 QES in line with Framework criteria.

Scenario 2

Upstream gas producer making a Stage Statement for input into the Cargo GHG Footprint calculation

Considering that the gas produced will be included in a full or partial GHG Footprint made by another party, an upstream producer could undertake the following steps:

- Determine temporal and physical boundaries (well-head to gas export meter, possibly including production development drilling if significant)
- Determine allocation approach (break down into the most granular approach possible, for all energy products and emissions – See Appendix C)
- Carry out allocation and determine GHG intensity for gas exported. Identify any 'Low GHG Features'
- Collect data required for verification
- Complete the Stage Statement (incorporated in the Cargo Statement form provided with the Framework) for the gas supplied, including GHG intensity of the exported gas and associated Low GHG Features
- Engage verifier (this can be at any point)
- Complete verification
- Provide Stage Statement and verification opinion to purchaser(s), establish a process to maintain any Stage Statement up to date based on regular review of the monitoring approach
- Share Statement with GIIGNL. Any commercially sensitive or confidential information in the Cargo Statement may be redacted in the version shared with GIIGNL

Scenario 3

Gas trader making a GHG Offset declaration for delivered LNG

A gas trader has no part in LNG production and may not physically take ownership of the gas/LNG at any point and is therefore reliant on others to provide verified Cargo Statement and (if applicable) Stage Statement(s) in order to make a declaration of GIIGNL Aligned GHG Offset LNG. The Trader will likely need to rely on commercial arrangements with a supplier that is aligned to this Framework.

The steps that would be taken by the LNG trader in this case are:

- Determine the Declaration Pathway
- Determine the physical boundary (partial or full life cycle)
- Engage with LNG suppliers and, for full life cycle, buyer(s), to secure a GIIGNL Framework aligned GHG Footprint
- Establish whether part or all of the cargo is already subject to any offsetting or neutrality claims, including any prior verification opinions
- Collect data required for the declaration to be made, engage verifier
- Source offsets in line with Offset Strategy and record retirement and complete verification
- Provide GHG Offset Cargo Statement and verification opinion to purchaser(s)
- Share Cargo Statement with GIIGNL. Any commercially sensitive or confidential information in the Cargo Statement may be redacted in the version shared with GIIGNL

Scenario 4

End User

An end user of re-gasified LNG, in the power sector for example, is unlikely to have direct access to the primary data for production of the LNG and would be reliant on data from suppliers in order to obtain a full life cycle GHG footprint. This may be part of commercial considerations however, and they may wish to engage a supplier who is aligned to this GIIGNL Framework.

For re-gasified LNG used in power generation, it can be assumed that all gas entering the network has been combusted. The end user may have a contract based on gas supplied to them, or on gas purchased as LNG which has been fed into the network in their behalf. There may therefore be a need to 'back-calculate' emissions from the point of delivery taking into account any shrinkage occurring in supplying the gas to them.

The steps that would be taken by the end user of the gas in this case may be:

- Determine the Declaration Pathway
- Determine temporal boundaries and GHG data collection needs related to 'upstream' activities. Note that in this case the physical boundary would be determined based on the selected Declaration Pathway, and whether the user wishes to offset all or part of the life cycle emissions of the gas, including end-use
- Determine GHG Footprint assessment approach – note that the end user is not required to carry out any co-product allocation as this is in previous steps. The user does however, based on supply basis, need to determine any shrinkage effects due to gas usage in the supply post-delivery, and the effect of any additional emissions from electricity, gas heating etc. in the supply network
- Carry out allocation of GHG to the gas supplied to them (Delivered LNG Cargo Intensity + any network impacts) and determine GHG intensity post-combustion
- Collect data required for verification, and any evidence related to GHG reductions and offsetting as relevant to the Declaration Pathway. Include any verification opinions and offsetting prior to the point of supply
- Engage verifier (this can be at any point)
- Make any offsets required, and record retirement and complete verification
- Retain verification opinion and Cargo Statement and provide to purchasers or shippers as needed
- Share Cargo Statement with GIIGNL. Any commercially sensitive or confidential information in the Cargo Statement may be redacted in the version shared with GIIGNL