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Validere Insights

Analyzing the landscape of voluntary initiatives for natural gas.

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Introduction

A variety of voluntary initiatives, targeting the shoring up of reported methane emissions along the oil and natural gas value chain, have launched over the last several years. Meanwhile, owners and operators along the entire natural gas value chain seek to demonstrate strong environmental stewardship, in a way that is credible and comprehensible to stakeholders. Four such initiatives (OGMP 2.0, GIIGNL MRV and Carbon Neutral Framework, MiQ, and Veritas) have been selected for review due to their particular relevance to measurement, reporting, and verification (MRV) for LNG because of their applicability to and growing prominence on a value chain wide basis. A collective analysis with a focus on the measurement informed inventory/emission intensity derivation approach and a summary of each initiative is presented *vide infra*.

Voluntary initiatives to address emissions credibility

The voluntary initiatives broadly seek to contribute in some way to emissions credibility across the oil and natural gas value chain and support or drive mitigation efforts. Some initiatives identify and target substantive issues, encompassed within the three principal issues hindering emissions credibility below.

For example, the most consistently referenced issue among the environmental non-governmental organization (eNGO), regulatory, scientific, and financial stakeholder communities is a vote of no confidence regarding the credibility of reported emissions data. Our view is that the principal factor contributing to this lack of confidence in emissions data is the preponderance of academic research[1] and media content[2] highlighting significant discrepancies between site level measurement campaigns and (1) **total emissions** reported based largely on generic emissions factors methods, such as those required by the U.S. Environmental Protection Agency's Greenhouse Gas Reporting Program.[3]

A related secondary issue was substantiated by findings from recent efforts to reconcile differences in measured emissions and those estimated from generic emissions factors.[4] In addition to reaffirming underestimation of total emissions, in part due to omission of certain sources and malfunctioning equipment, the (2) **source attribution** (understanding of the relative contribution to the total emissions by source) is also likely errant.

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[1] Zavala-Araiza, D. et al. Reconciling divergent estimates of oil and gas methane emissions. Proc. Natl Acad. Sci. USA 112, 15597–15602 (2015). Zimmerle, D. et al. Methane emissions from the natural gas transmission and storage system in the United States. Environ. Sci. Technol. 49, 9374–9383 (2015). Robertson, A. M. New Mexico Permian Basin measured well pad methane emissions are a factor of 5-9 times higher than U.S. EPA estimates. Environ. Sci. Technol. 54, 13926–13934 (2020). Alvarez, R. A. et al. Assessment of methane emissions from the U.S. oil and gas supply chain. Science 361, 186–188 (2018). Omara, M. et al. Methane emissions from natural gas production sites in the United States: data synthesis and national estimate. Environ. Sci. Technol. 52, 12915–12925 (2018).

[2] Kessel, J. M. and Tabuchi, H., "It's a Vast, Invisible Climate Menace. We Made It Visible." NYT (Dec. 12, 2019). Clark A., "The Cheap, Powerful Climate Fix Energy Companies Are Ignoring." Bloomberg (February 21, 2023 at 12:00 AM CST). Mufson, S., "A blowout turned an Ohio natural gas well into a methane 'super-emitter'." Washington Post (December 16, 2019). Mider, Z. R. and Adams-Heard, R. "BP Looks Dirtier Than Exxon in New Data From Giant U.S. Oil Field." Bloomberg (November 2, 2021).

[3] Limited opportunities to incorporate measurement or site-specific emissions estimating methods have been included as options in the GHGRP Subpart W to date, including measurements for liquid unloadings, completions and workovers, blowdowns, transmission storage tanks, flare flow, and compressor venting (75 FR 74488). However, EPA proposed revisions to Subpart W in June 2022, which include options for direct measurement for additional sources, including fugitive component leaks and large emissions events, and revisions to improve the accuracy of the method to estimate emissions from intermittent bleed pneumatic controllers (87 FR 36920).

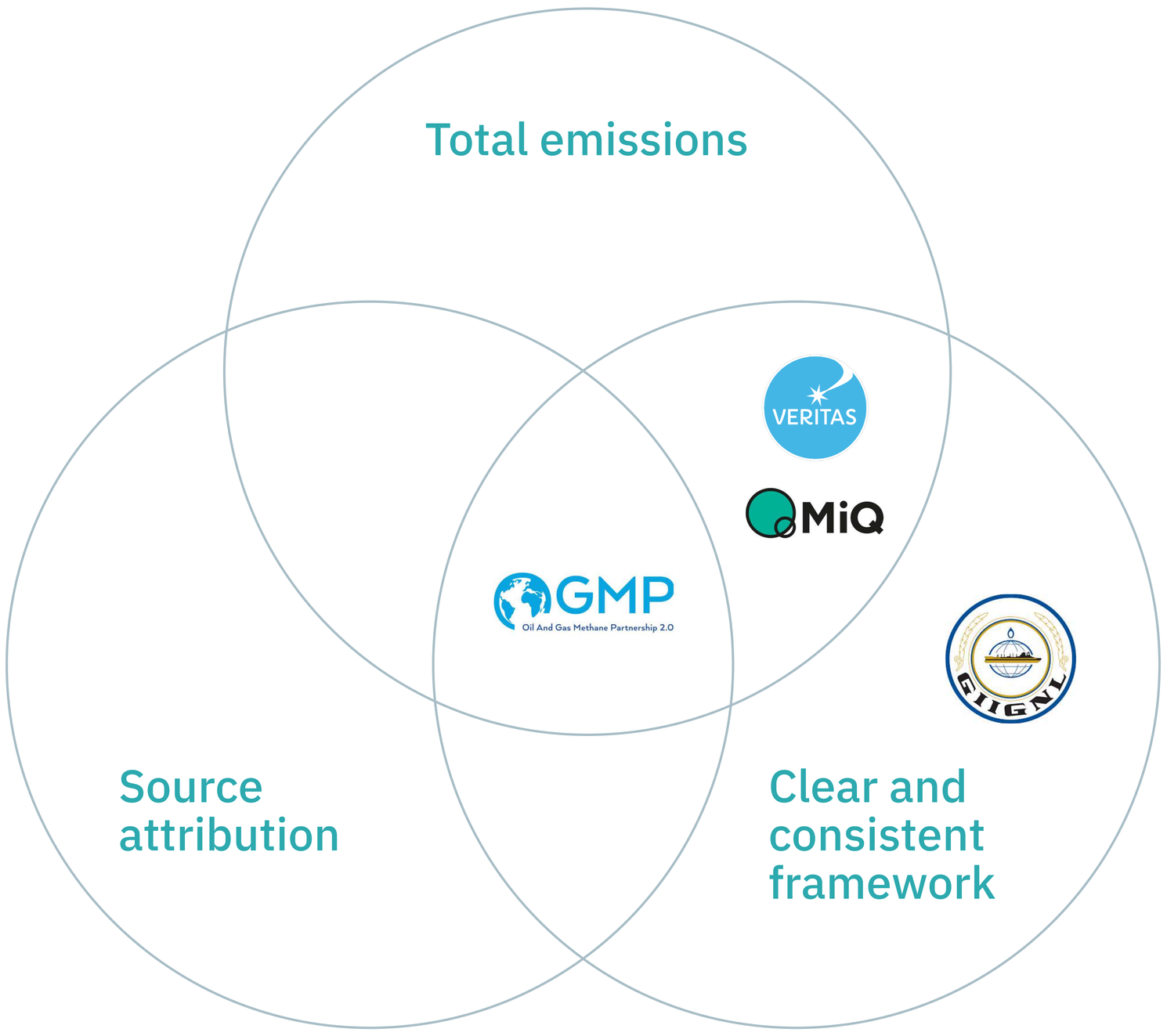
[4] Rutherford, J. S. et al. Closing the methane gap in U.S. oil and natural gas production emissions inventory. Nat. Comm. 12, 4715 (2021).

A third issue pertains to the credibility, transparency, consistency, and coherence of data from operators who, with the best of intentions, begin individually reporting emissions data in a bespoke way, which may or may not be based on generic emissions factors. Other times, operators claim an environmental attribute, such as carbon neutrality, based on, perhaps, a combination of emissions estimates and some offsets. In these cases, a lack of standardized (3) **framework** in which to contextualize and interpret these emissions or claims contributes to the lack of credibility.

Therefore, we compare (**Figure 1**) the four voluntary initiatives under review, for how they address these three principal issues:

1. **Total emissions** were based on a credible, transparent, measurement-informed basis.
2. With accurate **source attribution**.
3. Described in the context of a **clear and consistent framework** that ensures third parties can ascertain the meaning and quality of the emissions report either at an asset, enterprise, or value chain level.

Figure 1 | Principle issue(s) addressed by voluntary initiatives



Source | Validere

It is noteworthy that it is possible to layer these initiatives together. For example, MiQ allows for reconciled emissions to be reported on an OGMP 2.0 Level 4/5 basis. Similarly, the GIIGNL Framework allows for the use of OGMP 2.0 quantification methods.

Another issue that occasionally surfaces, which we view as of limited salience, at least until the first three are addressed, is a belief that buyers have low confidence in emissions data because molecules change hands multiple times through the value chain, complicating any tracking of an individual molecule's environmental attributes. Solutions to this issue generally incorporate distributed ledger (e.g., blockchain) technologies. These solutions tend to simply incorporate generic emissions estimating methods as the quantification method, while focusing on solving for the emissions data chain of custody.

As an additional layer, certain initiatives aim to establish a distinct monetization pathway for differentiated (low emissions intensity) products to encourage actions towards emissions reduction. For some pollutants, market mechanisms drove emissions reductions, such as the cap-and-trade program for SO2 and NOx as part of the Clean Air Act or CO2 in the EU's Emissions Trading Scheme. At present, the supply of differentiated products significantly outpaces the demand, as no major international, federal, or state regulatory body has required differentiated products. We believe such an adoption is unlikely until the first three issues are addressed. Importantly, some gas certification schemes simply adopt the generic emissions factor based estimating methods (Project Canary, MPCs by Xpansiv), which fails to address any of the aforementioned principal issues, while others simultaneously address the emissions estimating credibility (MiQ and Equitable Origin).

The balance of this text provides an executive summary of each of the four initiatives (OGMP 2.0, GIIGNL MRV and Carbon Neutral Framework, MiQ, and Veritas), where an overview summary of highlights is shown below in **Table 1**.

Table 1 | Overview comparison of voluntary initiatives (GIIGNL, MiQ, Veritas, OGMP 2.0)

	Administers certification	Primary product	Audit	Applicability/ scope	GHG's	Allow use of generic emission factors for material sources	Adoption	Requirements
GIIGNL	No	Framework	Optional (includes audit elements in framework)	LNG life cycle	All 7 GHGs	Yes	Low	Depends on stage (MRV/ reductions/offsets) along supply chain for a cargo
MiQ	Yes	Certification — based on custom framework	Yes — field verification + desktop by verified auditors	One or more operated assets	Methane (new LNG Standard includes CO2 and nitrous oxides)	Yes	Moderate (based in U.S.)	Company practices, calculated methane intensity (assured via measurement reconciliation with deployed technology), measurement/detection technology deployment criteria
Veritas	No	Technical protocols	Optional (includes audit elements in framework)	One or more operated assets	Methane	Yes	N/A — recently publicly released in first version	MRV per protocols (measurement only or a combination of inventoried emissions + measurement)
OGMP 2.0	No	Framework/technical protocols	Yes — desktop by UNEP staff	All operated and non-operated assets of a member	Methane	No	High	Reduction goals Annual reporting into UNEP — Level 4/5 by years 3/5 for all material operated/ non-operated assets

Source | Validere

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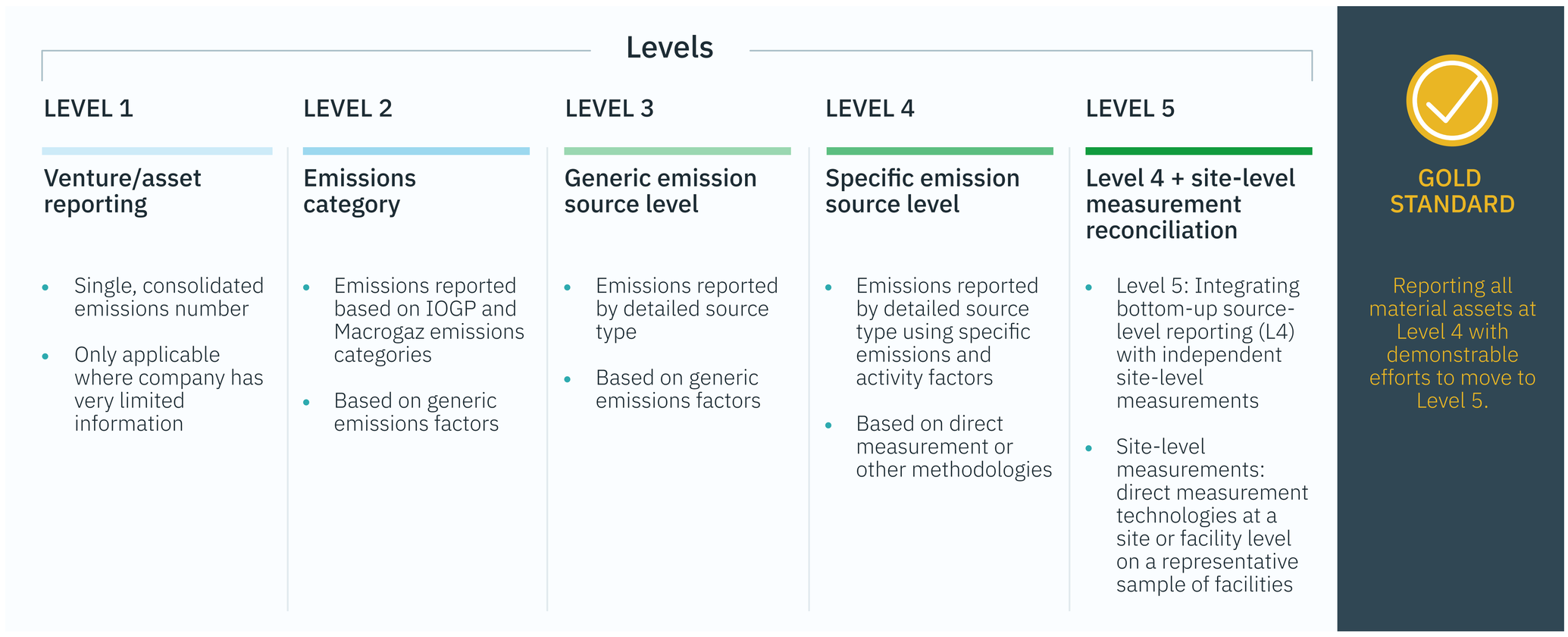
OGMP 2.0: A voluntary, company-level reporting framework and partnership

Overview: The Oil and Gas Methane Partnership 2.0 (OGMP 2.0) is a multi-stakeholder partnership focused on acceleration of methane reductions on a global, value-chain wide basis. Oil and natural gas companies join at an enterprise-wide level and commit to report emissions against the OGMP 2.0 Reporting Framework. The Framework is a comprehensive, measurement-based, international reporting framework for the sector where methane emissions are reported at increasing levels of granularity and accuracy (beyond generic emissions factors) as seen in **Figure 2**. Member companies disclose a methane emissions reduction target and submit an annual emissions report conforming to the Framework, demonstrating progress against their publicly disclosed reduction targets.

Figure 2 | OGMP 2.0 reporting levels



Source | OGMP 2.0 Overview

An operator achieves OGMP 2.0's Gold Standard when its reporting is at Level 4 with demonstrated progress toward Level 5 for all material operated and all material non-operated assets by years three and five, respectively. The Gold Standard Pathway is awarded prior to years three and five on the basis of a credible implementation plan to achieve Gold Standard by the respective deadlines. Each year, UNEP publishes an analysis of the results of the partnership as part of the International Methane Emissions Inventory Annual Report, including fact sheets for each company which disclose total emissions, Gold Standard status, and the company target.

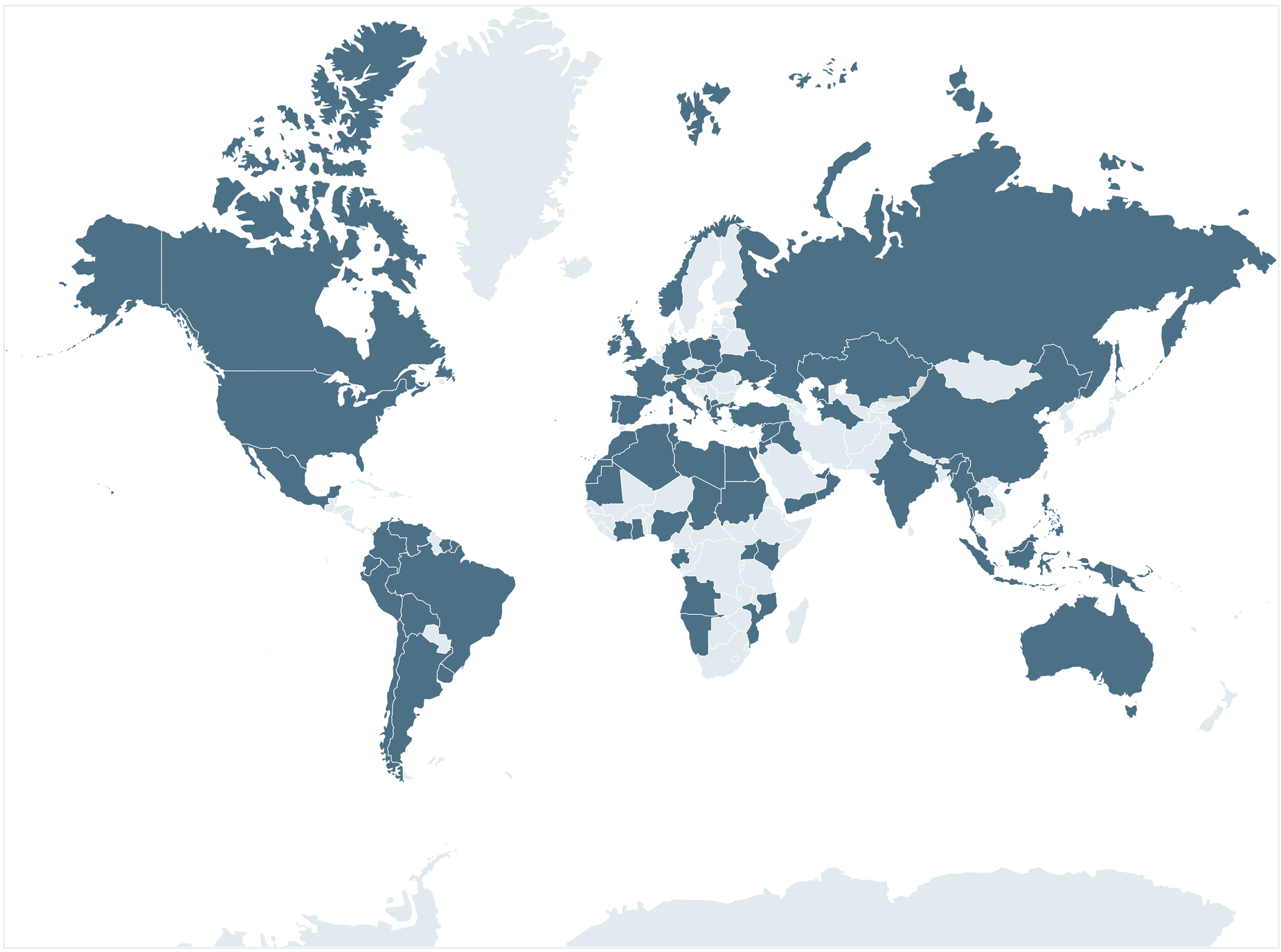
Technical Guidance documents are collaboratively developed and approved on a consensus basis within the partnership, providing implementation guidance for the Framework, while maintaining a principles-based, rather than rules-based, approach.

Purpose: The OGMP 2.0 aims to create a widely accepted and achievable-but-tough standard for accurately and transparently reporting oil and gas sector methane emissions. This organization operates under a theory of change that methane mitigation can be accelerated by equipping asset managers, those with the agency to make emissions reductions, with high quality, source-level emissions data. The organization also endeavors to accelerate progress through knowledge sharing and participation in a broad, global community of practice.

Organization: The United Nations Environment Programme (UNEP) administers the program, where the OGMP 2.0 staff are organized within the International Methane Emissions Observatory's (IMEO)[5] broader team. The OGMP 2.0 is governed by a Steering Group consisting of representatives from each member company and non-company member, including the European Commission, the Environmental Defense Fund, the Clean Air Task Force and UNEP, where decision making occurs by consensus.

Adoption: As of May 2023, 104 member companies across 60 countries (20 companies from the United States) comprise the OGMP 2.0, covering substantive portions of the entire oil and natural gas supply chain as illustrated in **Figures 3 and 4**.

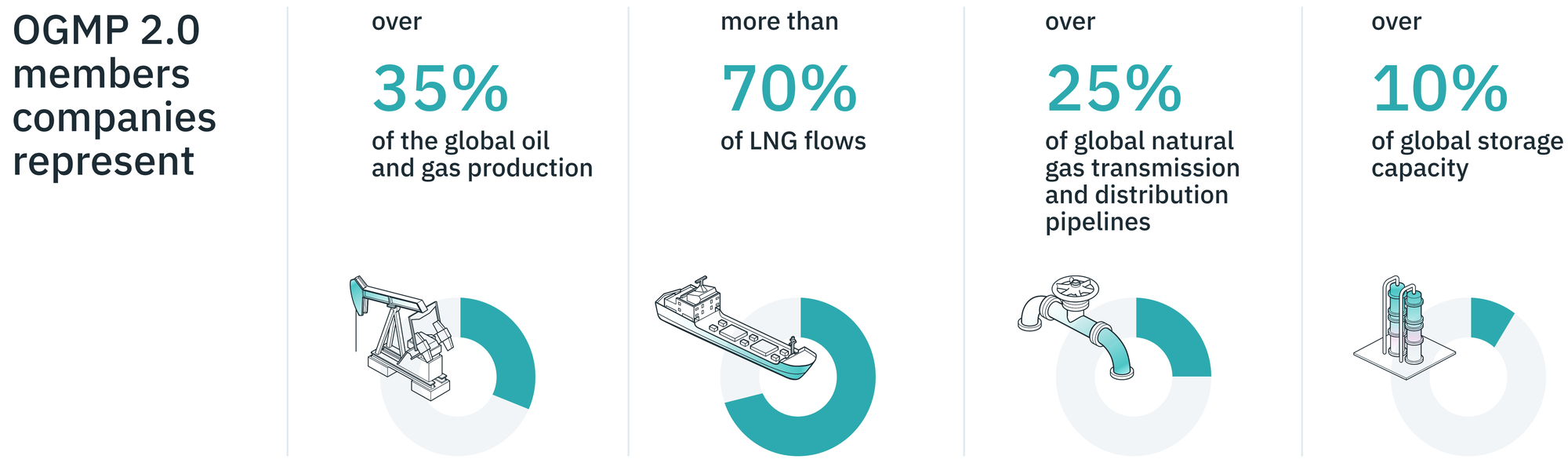
Figure 3 | Global coverage of OGMP 2.0 company operated and non-operated assets



Source | OGMP 2.0 website

[5] The IMEO is a key implementing partner of the Global Methane Pledge through the procurement of a unique global dataset of empirically verified methane emissions. IMEO collects and reconciles data from multiple sources, including company reports through OGMP 2.0, satellites, global science studies, and national inventories.

Figure 4 | OGMP 2.0 oil and gas value chain coverage



Source | OGMP 2.0 website

Similar initiatives: OneFuture is a coalition of U.S. operators across the value chain that report their emissions under a standard protocol, with the common objective to achieve a value chain wide emissions intensity of less than 1%. Though generic emissions factor based, the reporting protocol is more comprehensive than the U.S. EPA Greenhouse Gas Reporting Program methods.

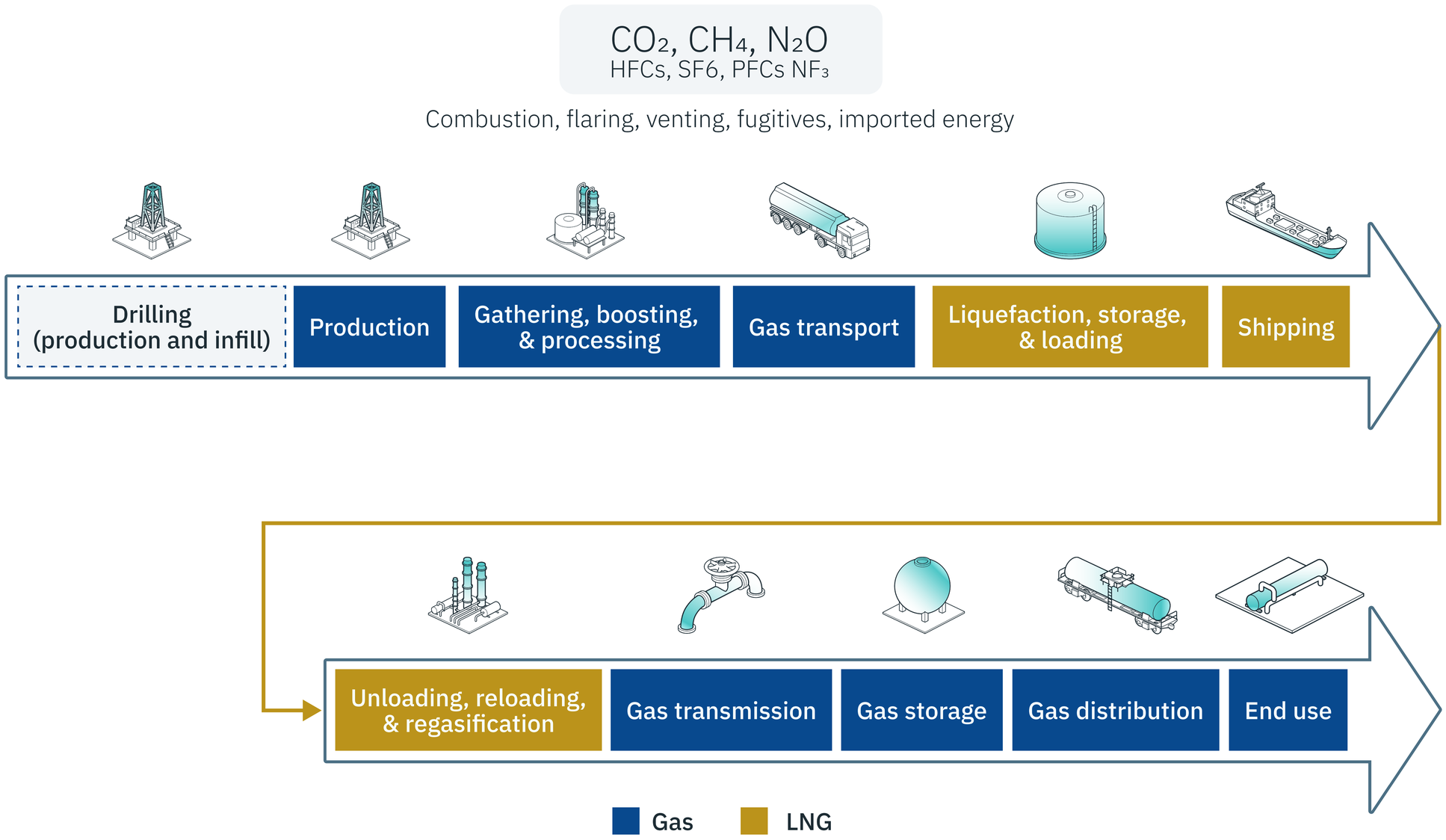
GIIGNL MRV and GHG Neutral Framework: A voluntary LNG cargo reporting framework

Overview: The GIIGNL MRV and GHG Neutral Framework sets out an accounting approach to describe GHG emissions associated with an LNG cargo. The Framework can be used either:

- By an LNG owner/operator seeking to make a claim associated with an LNG cargo.
- By a life-cycle stage owner/operator, who may be asked by the LNG owner/operator to issue a conforming statement with respect to the GHG intensity for a particular life-cycle stage that will be used in the broader GHG footprint calculation.

The GIIGNL Framework covers all sources of GHG emissions, all GHGs, and all stages of the LNG value chain from well to end use and is illustrated in **Figure 5**.

Figure 5 | LNG life-cycle stages covered in the GIIGNL MRV and GHG Neutral Framework



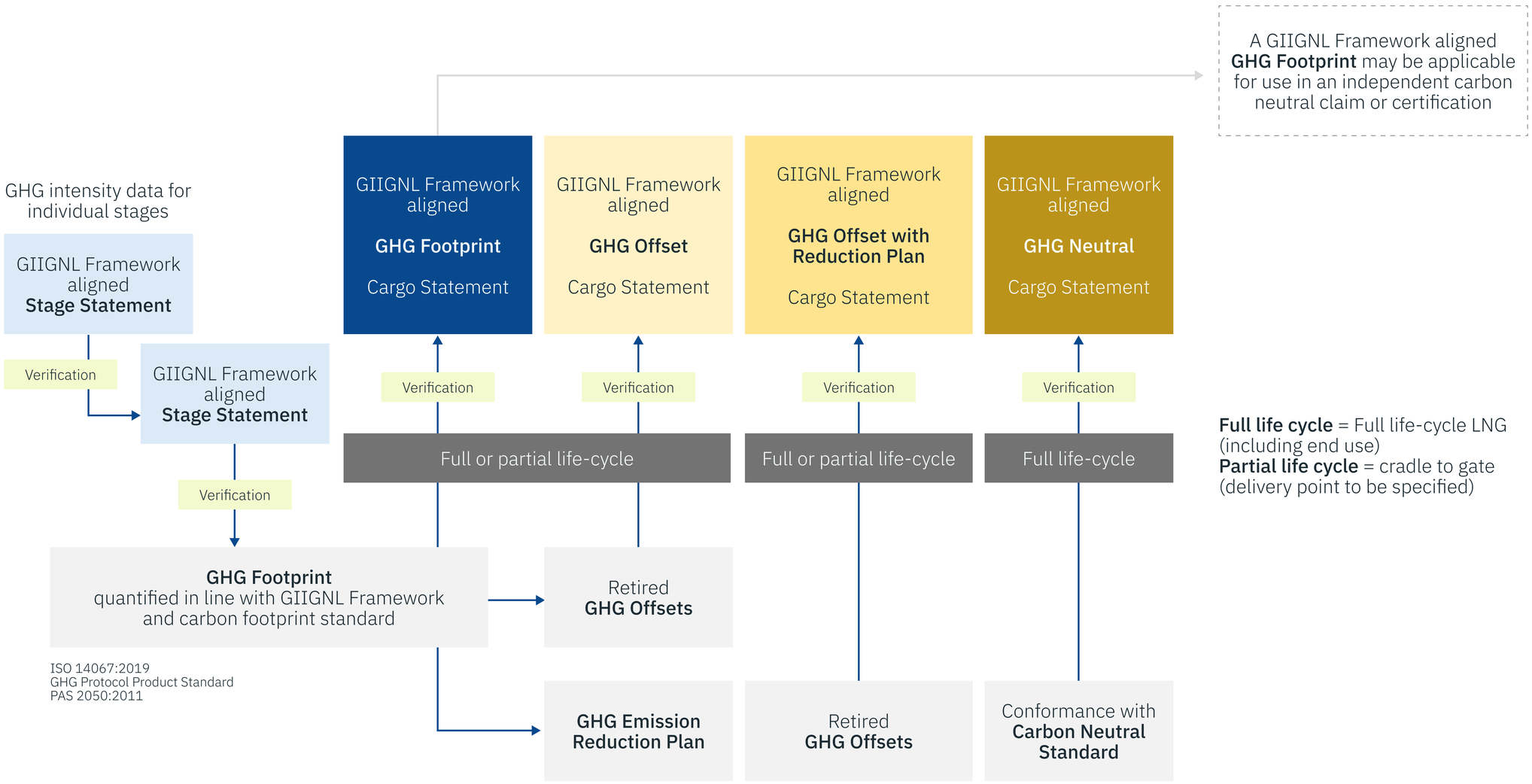
Note: Stages included will be defined according to the assesment proces and may be combined

Source | GIIGNL MRV and GHG Neutral Framework Executive Summary

While GIIGNL does not administer a certification program against this Framework, it is envisioned to be a potential basis for other third-party certification programs. GIIGNL requests submission of verified Cargo Statements to establish a basis to track evolving GHG intensity within the sector and to prepare a database of emissions reductions actions and low GHG features referenced in the Cargo Statements.

The Framework includes five declaration pathways (use cases), reflecting varying levels of readiness and commercial expectations across users of the Framework. A company seeking to make a claim associated with a delivered cargo has a series of four progressive options from having a verified “GHG Footprint” to a “GHG Neutral” cargo. The fifth declaration pathway provides a basis for stages that are not under the claimant’s control, to provide a conforming “Stage Statement” for the individual stage. The declaration pathways are illustrated in **Figure 6**.

Figure 6 | Five declaration pathways under the GIIGNL framework



Source | GIIGNL MRV and GHG Neutral Framework Executive Summary

Declaration Pathways:

- **GIIGNL Framework Aligned Stage Statement ("Stage Statement"):** A verified statement of GHG intensity and emissions associated with a specified amount of gas exported from defined life-cycle stage(s) within the LNG value chain that conforms to the GIIGNL Framework criteria and associated GHG Footprint standard.

- **GIIGNL Framework Aligned LNG Cargo GHG Footprint ("GHG Footprint"):** A verified full ("cradle to grave") or partial ("cradle to gate") life-cycle GHG Footprint that conforms to the GIIGNL Framework criteria and defined GHG Footprint standard (e.g., ISO14067:2018).

- **GIIGNL Framework Aligned GHG Offset LNG Cargo ("GHG Offset"):** A verified full or partial life-cycle GHG Footprint, which has been offset with carbon credits that meet the criteria set out in the Framework.

- **GIIGNL Framework Aligned GHG Offset LNG Cargo with Reduction Plan ("GHG Offset with Reduction Plan"):** This is a verified full or partial life-cycle GHG Footprint that embodies an emission reduction plan. Residual emissions have been offset with carbon credits that meet the criteria set out in the Framework.

- **GIIGNL Framework Aligned GHG Neutral LNG Cargo ("GHG Neutral"):** A verified full life-cycle GHG Footprint that embodies an emission reduction plan and commitment to long-term decarbonization, has been offset with carbon credits that meet the criteria set out in the Framework and conforms to an internationally accepted carbon neutral standard (PAS 2060:2014 or equivalent).

The Framework does not require a Stage Statement (explicit application of the Framework at each stage) for each stage, but recommends that the Reporter work with suppliers to build the stage GHG Footprint based on as much primary, site-based data as possible. Further, the Framework declines to prescribe specific quantification methodologies to avoid duplication or replacement of existing calculation approaches or require exclusive use[6] of "primary direct data." Instead, the Framework instructs emissions quantification within each stage to be based on relevant and appropriate industry calculations, with specific examples including the API Compendium (generic emissions factors), other regulatory programs (often largely generic emissions factor based), OGMP 2.0. Methods must be disclosed for each stage and, for a Cargo Statement, the approximate portion of primary data used to produce the emissions data must be disclosed against four bands divided into quartiles from 0-100%.

Purpose: The Framework is designed to provide a common set of principles for emissions MRV and a common terminology used for carbon neutral LNG. Its stated goals include a common set of best practices with respect to monitoring, reporting, reduction, offsetting and verification, accounting for methane as well as carbon dioxide and other applicable GHGs, and consistently applied in a common disclosure framework that form the basis of declarations associated with an LNG cargo. Adoption of this Framework is expected to help distinguish between cargoes on an emissions basis[7] and incentivize GHG emissions reductions through quantification and reporting both:

- Because a GHG emission reduction plan is a core component of a claim of GHG neutrality.
- In a way that is specific to an individual cargo.

Organization: The International Group of Liquified Natural Gas Importers (GIIGNL) is a non-profit trade organization focused on the promotion of LNG development and related activities. The Framework was prepared in 2021 under the supervision of a Steering Committee of Executive Committee Members (Cheniere, CNOOC, Engie, Jera, Shell, Tokyo Gas, TotalEnergies) and Pavilion Energy. GIIGNL hosts and makes freely available the Framework on its website. GIIGNL intends to periodically review and revise the Framework to reflect emerging practices and obligations for GHG accounting, offsetting, and GHG neutrality claims.

Adoption: The first "GHG Neutral" LNG cargo, piloting the use of the GIIGNL verification framework, was delivered to Taiwan from Gorgon by Shell Eastern LNG in January 2023.

Similar initiatives: Company developed frameworks, such as:

- Cheniere's Cargo Emissions (CE) Tags which include quantified GHG emissions estimates of LNG cargoes from wellhead to cargo delivery point, utilizing Cheniere's proprietary life-cycle analysis model, data from value chain participants, and operational data from the Sabine Pass and Corpus Christi liquefaction facilities.
- MiQ recently launched a comprehensive GHG certification and registry for LNG, where the new framework tracks all methane, carbon dioxide, and nitrous oxide emissions from every segment of the LNG supply chain from production through regasification.
- Individual bilateral deal terms with inconsistent criteria. Deals are not always public and transaction details are scarce. These issues are largely the problem GIIGNL sought to solve with its Framework.

[6] A GHG Footprint built entirely from secondary data is not expected to conform to the requirements of ISO14067:2018 or to other GHG footprint standard, and therefore will not conform to this Framework.
[7] Emissions may be estimated or measured.

- The Statement of Greenhouse Gas Emissions (SGE) for delivered LNG cargoes, which sets out a quantification and reporting methodology, covers GHGs from wellhead-to-delivery point, based on industry standards.[8] The SGE framework was jointly published by Pavilion Energy, QatarEnergy, and Chevron, with a stated intention for wide adoption and asserting complementarity with the contemporaneously developed GIIGNL Framework (facilitated by the same contract firm, ERM). The SGE is similar to the GIIGNL Framework Aligned LNG Cargo GHG Footprint. The Methodology requires the use of the highest-quality data available, preferably primary data, ranked by declining uncertainty within a hierarchy matching that in GIIGNL (**Figure 7**) and requires independent assurance.

Figure 7 | Hierarchy of data sources and effect of uncertainty

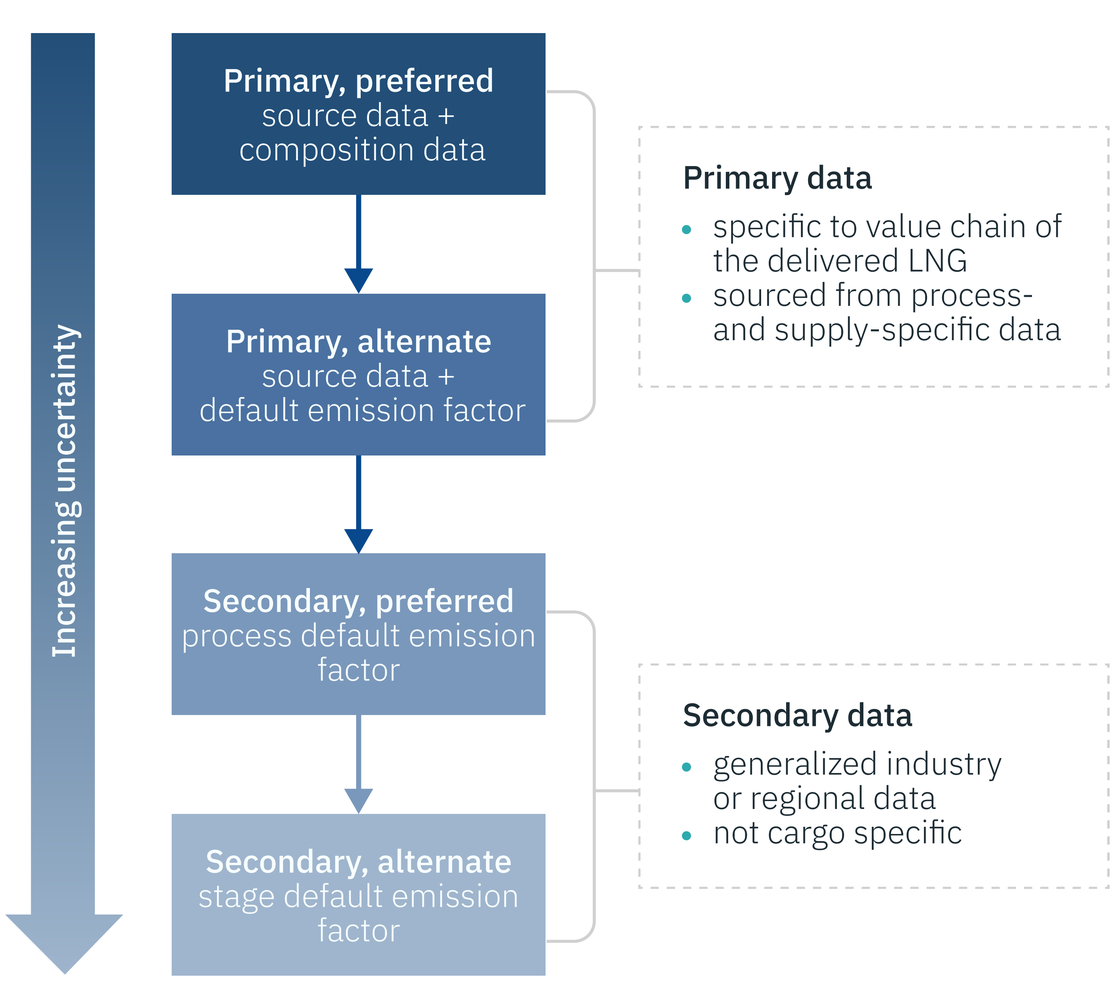


Exhibit E.3 Hierarchy of data sources and effect on uncertainty

Source | SGE Methodology

MiQ: A voluntary, asset-level, methane-specific gas certification program

Overview: The MiQ certification standard is an independent framework for assessing methane emissions from assets along the natural gas supply chain. Although initiated for production first, MiQ provides standard documents that are segment specific, covering upstream and midstream, as shown in **Figure 8**. MiQ recently launched a comprehensive GHG certification and registry for LNG, where the new framework tracks all methane, carbon dioxide, and nitrous oxide emissions from every segment of the LNG supply chain from production through regasification.

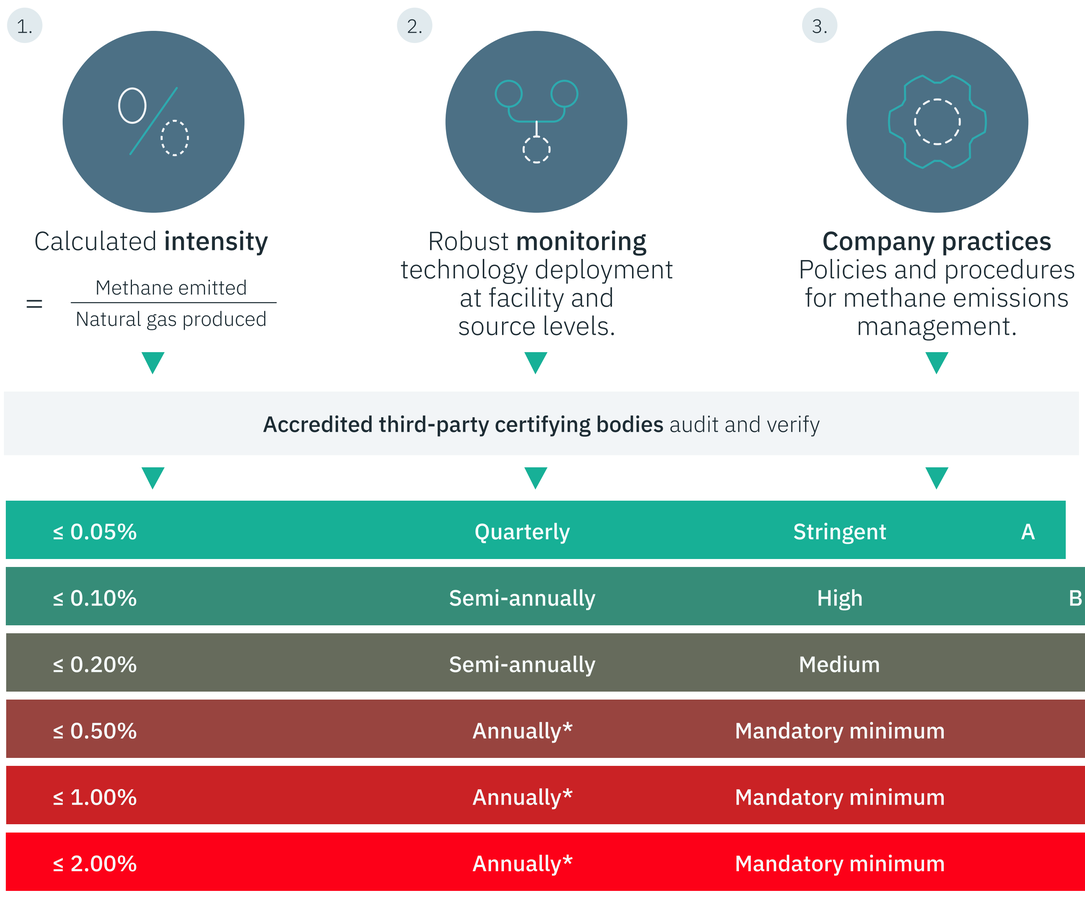
[8] The SGE Methodology is designed with reference to currently available product life-cycle accounting standards, principally the GHG Protocol Product Life Cycle Accounting and Reporting Standard and ISO14067:2018.

Figure 8 | Segment coverage by MiQ Certification Standard documents

Source | MiQ website

Certification occurs at an asset level on the basis of an independent audit against the MiQ standard by an auditor who has been accredited by MiQ. The audit process includes both a desktop review of methods, company procedures and relevant documents, and a field verification component. The auditor produces a report, which is reviewed by MiQ and its appointed certificate issuing body, a company called Evident. Each certificate represents the methane emissions performance attributes (graded on a scale from A to F) associated with one MMBtu of natural gas. The Standard requirements are inclusive, so a facility must meet or exceed the minimum requirements of each of three categories to receive a given grade. The grades are depicted in **Figure 9** below.

Figure 9 | Grading scale of MiQ Standard



*Source-level only

Source | MiQ website

The calculation by segment and requisite grades are defined within individual Standard documents by segment. Generally, methane intensity is methane emissions divided by the methane portion of throughput, with the exception of transmission and storage, which is normalized by pipeline distance. The numerical grading scale is identical for all segments, except transmission and storage, which, instead, ranges from 3-100%. There are minor differences in the specific numeric scoring for the technology deployment and company practices categories among the segments.

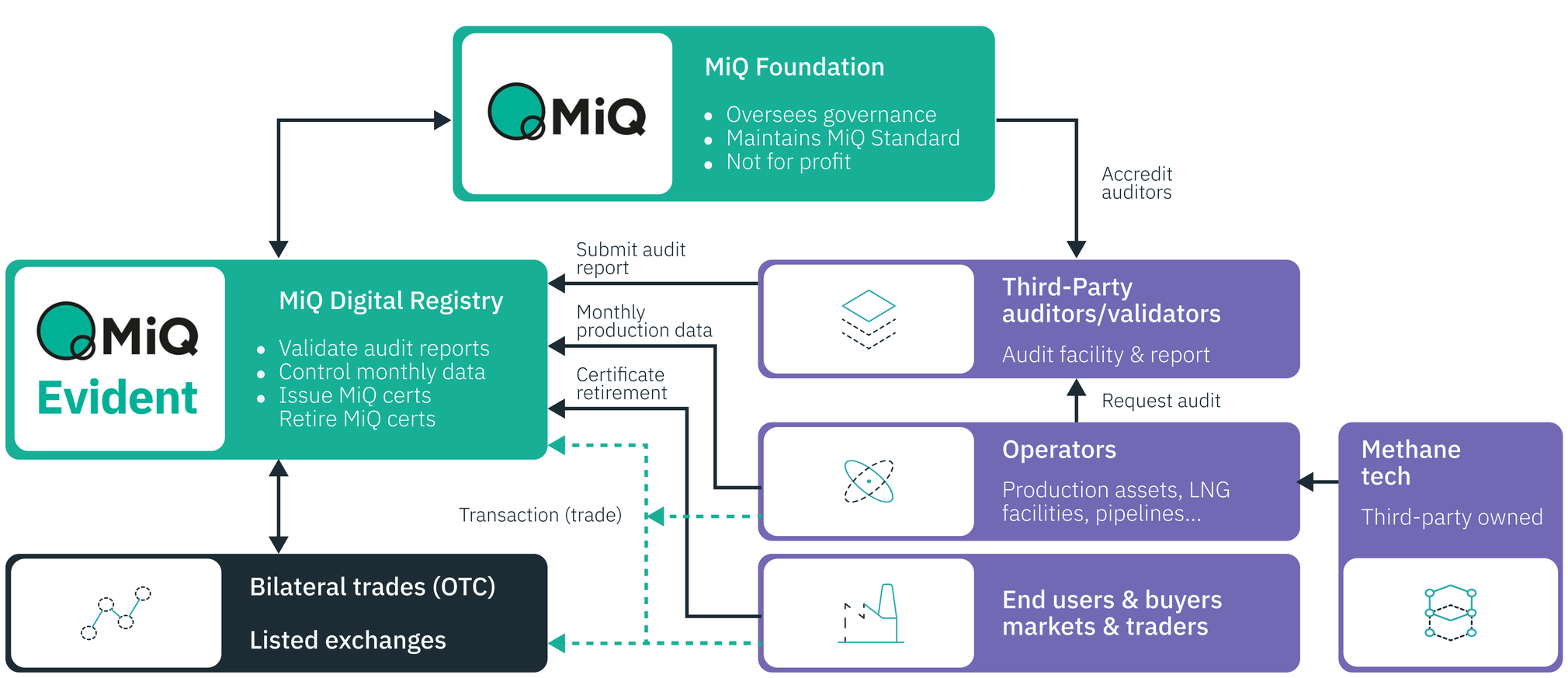
Although the methane intensity element allows for calculation via generic emissions factors, an operator is required to have a reconciliation procedure[9] that includes findings from detection and measurement surveillance.
Grades A-C require facility scale monitoring at increasing frequency with a minimum detection limit of 25 kg/hr.
The technology need not be capable of quantification, but observed emissions must be reconciled with and accounted for in the inventory.

MiQ Certificates are issued monthly on the MiQ Registry, a secure, digital ledger where all MiQ Certificates are held throughout their life cycle. Certificates can be transacted through bilateral deals or on exchanges.

Purpose: MiQ was created to catalyze a market for independently certified gas, based on an independently audited certification standard. The premise is that buyers will want to buy cleaner molecules, thus rewarding operators with cleaner operations and incentivizing others to make cost-effective investments to reduce their own methane emissions.

Organization: The MiQ Foundation is an independent not-for-profit organization created by RMI and SYSTEMIQ that is responsible for maintaining the MiQ Standard and accrediting third-party auditors. Auditing is performed by independent, accredited third-party auditors. Evident manages the MiQ Digital Registry and issues MiQ Certificates.
In 2022, MiQ launched the CG Hub as the world's first trading platform for certified gas, along with its partner COMET.
The ecosystem is illustrated in **Figure 10**.

Figure 10 | Ecosystem for MiQ Standard



*Evident provides registry services for other green certificate programs, including International RECs

Source | MiQ website

[9] Reconciliation procedure elements are defined in protocols and generally must include emission event detection, classification, causal determination of additionality, quantification process, and reconciliation procedure.

Adoption: MiQ is bullish on the certified gas market based on growth in liquidity seen in 2022, attributable to announcements of significant purchases of MiQ-certified gas by utility companies like Washington Gas and Virginia Gas, along with a fuel cell provider, Bloom Energy. Nonetheless, supply has significantly outpaced demand, with MiQ boasting methane emissions certification of nearly 20% of the U.S. market (>4% of global gas supply) but no state or public-utility commission is yet requiring certified gas volumes. MiQ has struggled to expand outside of the United States to date.

Similar initiatives: Other certification programs exist to address one or more environmental attributes in the energy sector. A recently published article[10] offered a critical review on the natural gas emissions certification programs in the United States.

- Project Canary's Trustwell Responsible Gas (RSG™) offers a turnkey, multi-environmental attribute certification program. The for-profit Project Canary is generally the standard creator, keeper, auditor, and provider of required measurement technologies. Recent pivots have included soliciting stakeholder input and publishing a low methane attribute standard and beginning to allow for other technology vendors as providers of monitoring technologies in the certification process. The standard continues to derive a methane intensity on a generic emissions factor basis. Canary's RSG™ has largely been confined to the United States.

- Equitable Origin, a Canadian non-profit, administers the EO100™ Standards for Responsible Energy Development. EO100™ is a broad certification against multiple ESG criteria and is applied to a range of energy projects, including explicit standards for some segments of the oil and natural gas supply chain. Market liquidity tends to be higher for severable attributes, whereas Equitable Origin combines dozens of attributes into one certificate. Equitable Origin has had a steady stream of activity over the last 13 years, but tends not to be the certification of choice in situations where methane or GHGs are the central driver. The firm has a partnership with MiQ and often pairs the certifications.

- Xpansiv, in partnership with S&P Global Platts, launched Methane Performance Certificates (MPCs). S&P developed the benchmark, and Xpansiv provides the global marketplace for ESG commodities. Methane intensities for MPCs are generated within a proprietary computational environment and appear to be largely based on generic emissions factors. MPCs are registered, issued, transacted, and retired within Xpansiv's Digital Fuels Program. Most of MPCs' limited traction to-date has come in Canada.

Veritas: A set of open-source technical protocols

Overview: Veritas is an initiative launched by GTI Energy in 2021 with the goal of creating a standardized, science-based, technology-neutral, measurement-informed approach to calculating and reporting methane emissions. To that end, the initiative recently published its first version of technical protocols covering six segments of the natural gas supply chain, including production, gathering and boosting, processing, transmission and storage, distribution, and liquified natural gas. Protocols for the six supply chain segments each include instructions on:

- Intensity: Segment-specific methane intensity definition.

[10] S. Garg et. al. Environ. Res. Lett. 18 (2023) 023002

- Measurement: How to acquire top-down measurement data.
- Reconciliation: Correction or replacement of emission-factor inventories with measurements.
- Value chain summation: Summation of multiple segments along a supply chain.
- Assurance: Verifying an emissions inventory, company documentation requirements, and third-party auditing.

The **measurement protocols**, while segment-specific, include five fundamental steps:

1. Categorize sites and sources (subdivide sources into those that would be “best measured” or “best calculated”).
2. Construct an expected emissions distribution (requires *a priori* knowledge of emissions sources and variability).
    a. Construct the expected emissions distribution by identifying expected source categories of emissions and considering variation in emissions rates.
    b. The protocols allow for this to be based on previous measurements, recent regional studies, or the latest reported inventory, in that priority order.
3. Select measurement methods.
    a. Identify measurement approaches and technologies, with established performance metrics from field testing and/or third-party evaluations, suitable to emissions sources identified as “best measured,” where the identified technologies should be capable of detecting and quantifying the largest emitters as specified in the derived expected emissions distribution.
    b. The measurement method features (detection limits, quantification capabilities, spatial and temporal coverage, attribution capabilities, and environmental conditions) should be considered in combination with the expected emissions distribution, where the goal is to maximize the percentage of emissions that can be quantified with a chosen technology.
4. Design sampling strategy.
5. Perform measurements.

The **reconciliation protocols** have three common core steps:

1. Analyze measurement results.
2. Reconcile measurements with bottom-up inventory (can be generic emissions-factor based) — additional steps within the production and the boosting and gathering segments to choose an appropriate reconciliation pathway and perform root cause analysis.
3. Test to ensure 50% of the reconciled inventory is based on measurement (with limited exceptions).

The stated combined objective of the measurement and reconciliation protocols is to “arrive at an annual estimate of total methane emissions based on measurement alone or a combination of measurements and inventoried sources.” This approach generally does not result in an improved understanding of the relative contributions of sources to an asset-level emissions inventory (source attribution) because the source level inventory is built on a generic emissions factor basis or eliminated altogether. The lack of focus on source attribution limits utility toward informing mitigation strategies, though the approach likely provides improved stakeholder confidence in total reported emissions or emissions intensity for an asset.

The open source protocols are freely available for independent use or in conjunction with other initiatives or certifications. Other stakeholders, such as regulators or investors, may adopt the protocols within their respective programs. GTI Energy will continue as custodians of the Veritas protocols, including responsibility for updating them at its discretion. GTI Energy offers services to provide assistance to companies implementing the protocols and to train implementers, auditors, assurance services, or other interested bodies such as governments or regulators.

Purpose: Veritas seeks to provide guidance to promote standardization and completeness of measured methane emissions data from the oil and gas industry to:

- Help unlock verifiable, low-carbon gas from the United States as an energy source.
- Provide a credible foundation for third-party certifiers to accurately assess whether a company's emissions meet import or procurement requirements.

Organization: GTI Energy is an independent, nonprofit research organization focused on developing, scaling, and deploying energy transition solutions. The initiative has accrued 35 partners, which generally means that a company has provided funding and may be participating in technical work streams and/or piloting draft protocols.

Adoption: Veritas launched the first round of open-source protocols in February of 2023 and thus has not realized any commercial adoption to date. GTI Energy self published results of its demonstration pilots,[11] which were used to inform revisions to the protocols prior to launch. The report provides summary information about the protocols, pilot demonstrations conducted during 2022 by 14 operators (18 demonstrations) from across the natural gas supply chain (all six segments were included, though generally companies piloted the protocols on subsets of their assets), challenges with the protocols discovered during piloting, and future work.

Key results, challenges, and conclusions from the demonstration pilots include:

- Presumably due to challenges developing expected emissions distributions, only one demonstration project constructed the required expected emissions distribution.
- A variety of platforms and emissions estimating methods were deployed: drone, aerial LiDAR, continuous monitoring systems, hi-flow samplers, stack testing, aerial mass balance, quantitative optical gas imaging, flowback fluid testing, flow meters, company specific emission factors, walking surveys, satellite, and advanced mobile leak detection.
- While all operators attempted to use collected measurements and some operators used measurement data from a prior year, operators had "varying levels of success performing reconciliation of measurements." Some were unable to reconcile entirely and others used some measurements, but ultimately most "measurement informed inventories" relied on current activity and emission factor based methods rather than the measurements and only one operator provided uncertainty quantification associated with their estimates.
- Operators were challenged in use of the measurement protocols:
  - Categorizing emissions as either best measured or best calculated (highly variable).
  - Construction of the expected emissions distribution (requires extensive *a priori* knowledge of segment emissions sources, company data, scientific literature, etc.).

[11] Moore, C. W. et. al. "Veritas Demonstrations: Results, Challenges, and Implications for Creation of Measurement Informed Inventories." GTI website. (March 31, 2023)

    - Determination of an appropriate number of measurement samples.
    - Financial and time cost of implementing measurements (anticipated to be exacerbated if protocols are scaled from pilot scale to the entirety of an asset or multiple assets).

- Operators were also challenged in use of the reconciliation protocols:
    - Harmonization of the data streams and results of multiple measurement systems (usually applied and analyzed individually).
    - Satisfying requirement to achieve 50% of emissions on a measurement basis (four of the 13 submitted reports met this goal).
    - Completing root cause analysis of observed large emissions events.
    - Computing uncertainty of final emissions estimates.

- The protocols were interpreted in different ways, attributed to the non-specificity of the protocols.

- Most companies did not share the pilot study data, limiting the ability to develop additional guidance.

Similar initiatives: Technical Guidance Documents approved and published from the OGMP 2.0, Best Practice Documents by the Methane Guiding Principles, tools available from or under development by Energy Emissions Modeling and Data Lab out of the University of Texas at Austin, and the NGSI provide overlapping guidance in varying respects.

Conclusions

In addition to solving slightly different problems, these initiatives have different strengths and weaknesses, as tabulated in **Table 2**.

Table 2 | Comparison of voluntary initiatives

	Strengths	Potential drawbacks
OGMP 2.0	• Globally recognized • No program fees • Company wide (avoids facility/asset cherry-picking) • Strong NGO and financial community support • Neutral third-party administration • Results in credible total emissions, accurate source attribution, against a defined framework • Flexible, promoting continuous improvement in emissions estimating • Encourages continued technology innovation	• No monetization mechanism • Principles-based, rather than rules-based, so guidance can be challenging to implement • No requirement for field verification • Requires detailed engineering knowledge of facilities
MiQ	• Monetizable • Results in credible total emissions (albeit potentially conservative) • Can be layered on OGMP 2.0 • Credibly bolstered by independent, third-party auditor including field verification	• Allows individual asset selection (potential cherry-picking) • Program, audit, and certification costs
GIIGNL	• Consistent framework to standardize LNG Cargo Statements • Promotes emissions reductions ahead of offsetting	• No monetization mechanism • Complex to administer for complicated value chains, especially where gas supplies are sourced from hubs rather than known operators • Self-administered • Allows for (but requires disclosure of) low-fidelity emissions estimating methods • No third-party audit requirement
Veritas	• Results in credible total emissions (albeit potentially conservative) • Prescriptive and standardized data handling for each segment of the value chain • Standardized value chain summation • Can be used with MiQ	• No monetization mechanism • Self-administered • Not presently compatible with OGMP 2.0 • No third-party audit requirement (though includes a detailed assurance protocol for optional use) • Requires extensive a priori knowledge of expected emissions, including understanding of spatial and temporal variation • Application limited in regions without a robust and demonstrated measurement technology ecosystem (most of the world)

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ERIN TULLOS, SENIOR ADVISOR, CARBON STRATEGIES

Erin Tullos focuses on leveraging operational data to develop ESG relevant insights, with 16 years of industry experience in environmental research, on regulatory advocacy and compliance, and as an environmental advisor. She is also a Visiting Research Fellow at the University of Texas at Austin, researching methane emissions and mitigation and a Consultant to the United Nations on OGMP 2.0.

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