CLIMATE LEADERSHIP COUNCIL

COUNTING CARBON
VOLUNTARY AND MANDATORY EMISSIONS REPORTING PROGRAMS

PREPARED BY: CLIMATE LEADERSHIP COUNCIL AND ERM

MAY 2023

Contributing Authors:
Matt Porterfield, Daniel Hoenig, Joel Martin, Margaret McCallister, Holly Rooper, Michael Sussman

TABLE OF CONTENTS

I. INTRODUCTION

Until recently, efforts by governments to address climate change have primarily focused on reducing greenhouse gas (GHG) emissions produced within their own borders. This approach fails to address the nearly 25% of global emissions associated with goods and services that are produced in one country and exported to another.[1]

Governments are now developing policies to address this "carbon loophole" by differentiating between internationally traded products (particularly industrial products from energy-intensive industries) based on their carbon intensity. These new policies include the European Union's Carbon Border Adjustment Mechanism (CBAM), the U.S.-EU Global Arrangement on Sustainable Steel and Aluminum (GASSA), and the United Nation's Industrial Deep Decarbonization Initiative (IDDI). While these initiatives differ in the scope of emissions they cover, each will require clearly defined, verifiable, administratively feasible, and (ideally) interoperable processes for determining the carbon intensity of internationally traded products.

This paper examines existing voluntary and mandatory emissions reporting programs and assesses the extent to which they provide a foundation for the product-level carbon accounting that will be necessary to address the carbon loophole.

Section II discusses the criteria we used to compare these programs, including the reporting level, scope of emissions and gases covered, approaches to quantifying and allocating emissions, verification procedures, and public disclosure of data. Section III reviews key voluntary GHG accounting and reporting programs for products and organizations across a variety of industries. These frameworks range from the product-level to the corporate-level and can apply at the sector-specific, industry-specific, regional, or global scale. Section IV provides an overview of mandatory emissions accounting and reporting programs focused on the facility and corporate levels. Specifically, we review programs in G7 countries (the United States, the European Union, Canada, France, Japan, Germany, Italy, and the United Kingdom) and China.[2]

Based on our review of these programs, we conclude that a broad foundation of emissions reporting data is available under existing voluntary and mandatory reporting programs that can provide a basis for product-level accounting. There is, however, significant variation among the different programs. New mandatory product-level reporting policies will require clear standards and will likely need to rely in part on secondary data, including industry and country averages, while systems for producing primary data continue to be developed and implemented.

Our other findings include the following:

1. Reporting level: Voluntary emissions reporting programs are applicable at both the corporate and product levels. Current mandatory programs, in contrast, apply at the facility level for most large industrial facilities in the countries examined in this report. Some countries also require reporting at the corporate level. Reporting is not currently required at the product level (excluding requirements for fuel products in certain jurisdictions, which are not covered in this report).

1 See Ali Hasanbeigi and Aldy Darwili, Embodied Carbon in Trade: Carbon Loophole (Nov. 2022), https://www.globalefficiencyintel.com/2022-embodied-carbon-in-trade-carbon-loophole .

2 India, which was originally included within the scope of this report, does not have a mandatory GHG reporting program. However, India is expected to open a voluntary carbon market that will transition to a mandatory cap and trade system, which will require a mandatory GHG reporting system. See Lou Del Bello, India Gets Ready to Launch a National Carbon Market, Energy Monitor (October 18, 2022), https://www.energymonitor.ai/policy/carbon-markets/india-gets-ready-to-launch-a-national-carbon-market. India's Bureau of Energy Efficiency (BEE) released the blueprint of the first stage of the introduction of a voluntary carbon credit trading scheme in October 2021. National Carbon Market—Draft Blueprint for Stakeholder Consultation (2021), https://beeindia.gov.in/sites/default/files/NCM%20Final.pdf. See also India Establishes Framework for Voluntary Carbon Market and Outlines Pathway towards Cap-And-Trade System, International Carbon Action Partnership (Sept. 1, 2022), https://icapcarbonaction.com/en/news/india-establishes-framework-voluntary-carbon-market-and-outlines-pathway-towards-cap-and-trade. In 2022, the Lower House of Parliament adopted an amendment to the 2001 Energy Conservation act that will serve as the legal basis for the voluntary carbon market. The system is expected to have a similar design as the EU ETS. Id.

2. Scope of emissions: Voluntary reporting programs at the corporate level typically apply to scope 1, 2, and 3 emissions as defined under the Greenhouse Gas Protocol. Voluntary reporting programs at the product level generally cover either "cradle-to-gate" or "cradle-to-grave" emissions, which encompass scope 1 and 2 emissions and some portion of scope 3 emissions, depending on the system boundaries. Mandatory facility and corporate reporting programs include some portion of scope 1 emissions, with corporate-level programs also usually requiring disclosure of scope 2 emissions.

3. Covered gases: Most voluntary standards require reporting of all gases covered under the Kyoto Protocol, and some encourage reporting of other GHGs. Most mandatory reporting programs discussed in this report also cover all Kyoto gases, although the EU's facility-level reporting under the Emissions Trading System applies only to only carbon dioxide (CO2), nitrous oxide (N2O), and perfluorocarbons (PFCs).

4. Emissions quantification approach: All voluntary programs permit the use of both primary and secondary data. Primary data is derived from "specific activities within a company's value chain." Secondary data, which is frequently used, can include broad industry averages and emissions factors. Mandatory programs typically focus on primary data obtained from direct measurement or calculation-based methods.

5. Emissions allocation approach: In voluntary product-level accounting, the allocation of emissions from the facility level to the product level can be done by mass, volume, or energy content. Allocation is not addressed in the mandatory programs reviewed in this report because they do not quantify emissions at the product level.

6. Verification requirements: There is significant variation in the data verification rules in voluntary GHG accounting standards, ranging from specific requirements to none at all. Most mandatory reporting programs require external verification of data by either government or third-party verifiers, although the rigor of the verification standards also varies substantially.

***7.* Public disclosure:** Public disclosure of emissions data is required under some, but not all, voluntary programs. All mandatory programs in G7 countries require disclosure; China, however, does not.

TABLE 1: COMPARISON OF VOLUNTARY GHG REPORTING PROGRAMS

	Reporting Level	Scope	All Kyoto Protocol Gases?	Allocation Approach	Emissions Quant. Approach	Verification	Public Disclosure
GHG Protocol – Corporate Accounting and Reporting	Corporate	Scopes 1, 2, 3	Yes*	N/A	Primary and secondary data allowed	Self-certification or 3rd party review	Optional
GHG Protocol – Product Life Cycle Accounting and Reporting	Product	Cradle-to-Gate	Yes*	Mass, volume, energetic content; economic	Primary and Secondary data allowed	Self-certification or 3rd party review	Optional
ISO Standards for Corporate Accounting	Corporate	Scopes 1, 2, 3	Yes*	N/A	Primary and secondary data allowed	Self-certification or 3rd party review	Optional
ISO Standards for Product Accounting	Product	Cradle-to-Gate	Yes*	Mass, volume, energetic content; economic	Primary and secondary data allowed	Self-certification or 3rd party review	Optional
WBCSD Pathfinder Framework	Product	Cradle-to-Gate	Yes*	Mass, volume, energetic content; economic	Primary and secondary data allowed	Self-certification or 3rd party review	To supply chain stakeholders
European Commission – Product Environmental Footprint (PEFs)	Product	Cradle-to-Grave	Yes*	Mass, volume, energetic content; economic	Primary and secondary data allowed	3rd party review required	Yes
European Commission – Organizational Environmental Footprint (OEFs)	Corporate Product Portfolio	Cradle-to-Grave	Yes*	Mass, volume, energetic content; economic	Primary and secondary data allowed	3rd party review required	Yes
Environmental Product Declaration (EPD) Systems	Product	Cradle-to-Grave	Yes*	Mass, volume, energetic content; economic	Primary and secondary data allowed	3rd party review required	Yes
GRI Sustainable Reporting Standards	Corporate	Scope 1, 2, 3	Yes*	Product quantity, volume, size, financial	Primary and secondary data allowed	3rd party review	Yes
TfS – The PCF Guideline for the Chemical Industry	Product Corporate	Cradle-to-Gate	Yes*	Mass, volume, energetic content; economic	Primary and secondary data allowed	Self-certification or 3rd party review	Yes
EU RED II	Product	Cradle -to-Gate	CO_2, CH_4, N_2O	Energy content or financial	Primary	3rd party review required	Member country specific
International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)	Product	Cradle-to-Gate	CO_2, CH_4, N_2O	Mass, volume, energetic content; economic	Primary	3rd party review required	Not specified
GIIGNL MRV and GHG Neutral Liquified Natural Gas Framework	Product	Cradle-to-Gate	Yes	Mass, volume, energetic content; economic	Primary and secondary data allowed	3rd party review required	To supply chain stakeholders
Responsible Steel International Standard 2.0	Product Corporate	Cradle-to-Gate	Yes	Not Specified	Primary and secondary data allowed	3rd party review required	Yes
Aluminum Stewardship Initiative	Product Corporate	Cradle-to-Gate	Yes	Not Specified	Primary and secondary data allowed	3rd party review required	Yes
American Iron and Steel Institute	Product Corporate	Cradle-to-Gate	Yes	Mass, energy	Primary and secondary	No	Not specified

*Includes voluntary inclusion of additional GHGs.

**The GHG Protocol lists temporal representativeness as a data quality indicator. This refers to the degree to which the data reflects the actual time or age of the activity or process.

TABLE 2: MANDATORY GHG REPORTING PROGRAMS

	Reporting Level	Scope	All Kyoto Protocol Gases?	Allocation Approach	Emissions Quant. Approach	Verification	Public Disclosure (available information)
United States	Facility Corporate (pending)	1 (Facility) 1, 2, & 3 (Corporate)	Yes	Direct measurement & calculation	Government administrators	Yes (Facilities, sectors, & region)	Optional
European Union ETS	Facility	1	No**	Direct measurement & calculation	3rd party team appointed by Member State	Yes (Facilities & sectors)	Optional
Canada	Facility	1	Yes	Direct measurement & calculation	Self-certification & agency review	Yes (Facilities, sectors, & region)	Optional
France	Corporate	1 & 2*	Yes	Direct measurement & calculation	No	Yes (Corporate level, & Region)	Optional
Japan	Facility Corporate	1 & 2*	Yes	Direct measurement & calculation	Self-certification & 3rd party review	Yes (Aggregated data, facility-level available upon request)	To supply chain stakeholders
Germany	Facility	1	Yes	Direct measurement & calculation	Government administrators	Yes	Yes
Italy	Facility	1	Yes	Direct measurement & calculation	Government administrators	Yes	Yes
UK	Corporate	1 & 2	Yes	Direct measurement & calculation	No	Yes (Individual gases and corporate)	Yes
China	Facility Corporate	1 & 2	Yes	Direct measurement & calculation	Yes (Government administrators)	No	Yes

*Scope 3 is encouraged.

**CO2, N2O, and PFCs.

II. ELEMENTS OF VOLUNTARY & MANDATORY GHG REPORTING PROGRAMS

Various stakeholders, including companies, facilities, and governments, use GHG reporting programs to document emissions. These reporting schemes have evolved to meet specific goals. Voluntary reporting programs are often used to assist organizations in developing goals, managing risks, identifying reduction opportunities, and disclosing emissions. Mandatory reporting programs assist governments in establishing and tracking progress for emissions reductions and inform national GHG inventories. These reporting programs may capture data at different levels of aggregation: by product, by individual facility, and by individual corporations.

A. REPORTING LEVEL

Emissions accounting programs are directed at either the corporate, facility, or product level. Corporate-level accounting takes into consideration GHG emissions across the entire organization and can cover emissions from more than one facility, attributed to the corporation based on equity share (ownership percentage), operational control, or financial control.[3] Facilities are often defined as installations characterized by one or more emitting activities and/or emissions sources located within a boundary (e.g., a power plant or manufacturing facility).[4] Product-level accounting focuses on identifying the GHG emissions related to the production of an individual product or family of products. While companies can determine which voluntary programs to use, covered entities under mandatory reporting programs are defined by sector, size of the corporation, or levels of emissions or consumption of fuel or energy.[5]

B. SCOPE OF EMISSIONS

The Greenhouse Gas Protocol categorizes emissions as scope 1, 2, or 3.6 This classification system is the most widely used taxonomy for GHG emissions. Scope 1 emissions are "direct" emissions from sources owned or controlled by the reporting entity.[7] Scope 2 covers "indirect emissions" from the generation of the electricity purchased by the reporting entity for its own consumption.[8] Scope 3 includes all other indirect emissions that occur both upstream and downstream in the value chain of the reporting entity.[9]

This classification system is not used in many mandatory reporting programs. And because it was developed for corporate-level reporting, it is arguably not optimal for determining product-level carbon intensity.

In voluntary reporting, the scope taxonomy applies to corporate-level but not product-level accounting, which focuses on emissions attributable to the product's life cycle. A product-level footprint can be completed with various boundaries but typically uses "cradle-to-gate" or "cradle-to-grave." Cradle-to-gate includes all stages of the product life cycle up to the point the product leaves the hands of the manufacturing company, excluding emissions from product use and end-of-life. Cradle-to-grave includes all stages of the product life cycle, including product use and end-of-life emissions.

C. COVERED GASES

Most voluntary and mandatory GHG reporting programs apply to the major greenhouse gases covered under the Kyoto Protocol.[10] The Protocol, as originally adopted in 1997, applied to six gases:

- carbon dioxide (CO2),
- methane (CH4),
- nitrous oxide (N2O),

3 Neelam Singh and Kathryn Bacher, "Guide for Designing Mandatory Greenhouse Gas Reporting Programs," World Resources Institute, May 27, 2015, https://files.wri.org/d8/s3fs-public/guide_for_designing_mandatory_greenhouse_gas_reporting_programs.pdf.

4 Singh et al., supra, at 40.

5 OECD, n.d. "Climate Change Disclosure in G20 Countries: Stocktaking of Corporate Reporting Schemes." https://www.oecd.org/daf/inv/mne/Report-on-Climatechange-disclosure-in-G20countries.pdf

6 See Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard (revised edition) at 25, https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf.

7 See Singh et al., supra, at 41.

8 Id.

9 Id.

10 See Kyoto Protocol to the United Nations Framework Convention on Climate Change, Annex A (Dec. 1997), https://unfccc.int/resource/docs/convkp/kpeng.pdf.

- hydrofluorocarbons (HFCs),
- perfluorocarbons (PFCs), and
- sulfur hexafluoride (SF6).

In 2012, the Doha Amendment to the Kyoto Protocol added a seventh gas—nitrogen trifluoride (NF3).[11]

The Greenhouse Gas Protocol document titled "Required Greenhouse Gases in Inventories; Accounting and Reporting Standard Amendment" mandates the reporting of the seven Kyoto Protocol gases.[12] Additionally, it encourages the reporting of other GHGs that have a 100-year Global Warming Potential (GWP) value as defined by the Intergovernmental Panel on Climate Change's (IPCC) Assessment Reports.[13]

According to the Protocol, the optional emissions must be reported outside of the scope of a corporate inventory. Examples of these compounds include fluorinated ethers (HFEs), chlorofluorocarbons (CFCs), and hydrochlorofluorocarbons (HCFCs).

D. EMISSIONS QUANTIFICATION APPROACH

Voluntary programs either rely on "primary" data, which is collected specific to the company, product, or process in question, or "secondary" data, which is not specific to the company's value chain. Primary data is determined via direct measurement and/or calculation, typically in accordance with either the GHG Protocol[14] or ISO 14064/14067.[15] The calculation of GHG emissions within voluntary programs is more variable, but some of the industry-specific voluntary standards may still specify certain calculation methodologies or emissions factors.

Mandatory programs are generally more specific about the required data collection methodology to ensure that results from different facilities are comparable. They require that corporate- and facility-level data is quantified using one of two approaches, either separately or in combination: "direct measurement" and "calculation."[16]

The direct measurement approach uses monitoring equipment to measure emissions directly emitted from the source where they are vented into the open air.[17] The calculation-based approach uses input and output data to determine emissions. For emissions from many processes, emissions factors (factors in the form of a rate of emissions that result from the consumption of a unit of input, e.g - kg CO2/gallon of gasoline) can be used to determine emissions based on the amount of consumption of specified inputs (e.g., gasoline, natural gas, or limestone).[18] Rather than using emissions factors, a mass balance approach can be used for industries—such as petrochemical production and integrated iron and steel manufacturing—where it is difficult to correlate emissions to individual input materials. This approach calculates emissions based on the difference between the amounts of carbon and GHGs (by weight) entering the facility in inputs and the amounts leaving the facility embedded in products.[19]

E. EMISSIONS ALLOCATION APPROACH

In voluntary corporate-level accounting, GHG emissions are directly or indirectly associated with the organization or facility based on the established boundary (equity or control). In voluntary product-level accounting, the emissions are attributed to the product, and ideally the data for emissions related directly to that product is available. However, for manufacturing processes with multiple co-products it is often not possible to collect emissions data at the individual product level and instead the total emissions from the manufacturing process must be partitioned among the multiple co-products. This partitioning of emissions is known as allocation. Allocations should be avoided where possible.[20] When they are unavoidable, emissions can be attributed through various approaches that define the relationship between the studied product and the co-product(s): physical allocation (based on the physical relationship such as energy, mass, or volume), economic allocation (based on individual market value), or other relationships (based on an established and justifiable relationship other than physical or economic).

Since the mandatory programs discussed in this report do not require product-level GHG accounting, emissions allocation is not addressed in these programs.

11 See Doha Amendment to the Kyoto Protocol (8 December 2012) (entered into force 31 December 2020), Article 1(B), https://unfccc.int/files/kyoto_protocol/application/pdf/kp_doha_amendment_english.pdf.
12 See Required Greenhouse Gases in Inventories, Amendment 1.a (Feb. 2013) http://www.ghgprotocol.org/sites/default/files/ghgp/NF3-Amendment_052213.pdf
13 Id., Amendment 1.b.
14 See discussion infra Section III(A).
15 See discussion infra Section III(C).
16 See Singh et al., supra, at 48.
17 Singh et al., supra, at 50.
18 Singh et al., at 48-49.
19 Singh et al., at 49-50.
20 ISO 14040:2006 states that allocation can be avoided using strategies such as i) process subdivision – dividing a process common to multiple co-products into sub-processes for each product; ii) system expansion – using emissions data from an alternative product with the same functional unit as the co-product (limited in application); or iii) redefining the functional unit of the analysis – to include co-products within the functional unit.

F. VERIFICATION REQUIREMENTS

Verifying emissions data helps to ensure that results are accurate, complete, and credible. Most verification methods, whether conducted internally or via a third party, aim to assess risks of potential material misstatement of the data or disclosed results.

Some data management systems apply controls (internal checks) to validate data before submission. These controls can include type, range, yearly, statistical, and algorithm checks. Additionally, reporting programs may require other verification requirements. There are three broad approaches to ensure the accuracy of submitted data: self-certification by the reporting entity, review by an administrator, or third-party verification. A program can apply one of these verification methods or use them in combination.[21]

G. PUBLIC DISCLOSURE

Public disclosure of GHG inventory data increases transparency and enables comparability of results across accounting frameworks. Disclosure requirements vary across both voluntary and mandatory frameworks. Disclosures may differ in the amount of information disclosed related to methodology, boundaries, exclusions, or allocations.

All G7 members disclose their mandatory emissions data to some degree. Programs often use a data management system and reporting platforms for simplification and transparency. The level of publicly available information can vary from aggregated averages (e.g., by sector) to disaggregated form (e.g., by individual facility); some programs have searchable online databases to maximize transparency. There are various levels of data that can be disclosed, including individual GHGs or aggregated CO2e figures at the facility, corporate, sector, and/or regional level.[22] Programs may disclose additional information, such as an annual data analysis.

21 Singh et al., supra, at 64.

22 Singh et al., supra, at 62.

III. SUMMARIES OF VOLUNTARY PROGRAMS

A. WRI/WBCSD GHG PROTOCOL – CORPORATE ACCOUNTING AND REPORTING STANDARDS

The World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) first published the Corporate Accounting and Reporting Standard in 2001 (revised in 2004)[23] as a standard for companies and other types of organizations preparing GHG emissions inventories.[24] In addition to the Corporate Standard, WRI and the WBCSD published the Corporate Value Chain Accounting and Reporting Standard (Scope 3 Standard) in 2011 and the GHG Protocol Scope 2 Guidance (Scope 2 Guidance) in 2015 as an amendment.

All seven GHGs covered under the Kyoto Protocol must be reported. Voluntary reporting of additional GHGs is encouraged, and any additional GHGs included in the inventory calculation must be listed in the inventory report.

The WRI and WBCSD Corporate Standard establishes a standard and guidance for corporate-level reporting for scope 1, 2, and 3 emissions. The Scope 2 Guidance amendment sets requirements and guidance on corporate-level scope 2 emissions reporting. The information provided in this amendment replaces the previous guidance on scope 2 emissions in the Corporate Standard. The Scope 3 Standard addresses corporate-level reporting of upstream and downstream scope 3 emissions occurring in the reporting company's value chain.

GHG emissions can be consolidated for annual corporate reporting using an equity share or control approach. Both approaches, if applied consistently for all scope inventories, are acceptable. Scope 1 emissions are quantified from direct emissions owned or controlled by the company. Scope 2 emissions are calculated using market-based or location-based methods.[25] Companies should use the most appropriate, accurate, precise, and highest-quality emissions factors available for each method.[26]

The WRI/WBCSD GHG Protocol Scope 2 Guidance[27] provides a more detailed approach to calculating Scope 2 emissions. The approach includes a hierarchy of emissions factors for the location-based method, which indicates regional or subnational emissions factors as preferred data, followed by national production emissions factors. The hierarchy of market-based data provided in Scope 2 Guidance is rated by instrument precision. The highest to lowest emissions factor precision ranking is listed as 1. energy attribute certificates, 2. contracts, 3. supplier/utility emissions rate, 4. residual mix, and 5. other grid-average emissions factors.

Scope 3 emissions are quantified based on primary or secondary data.[28] Primary data is preferred, but secondary data is acceptable. Allocation of scope 3 emissions should be avoided or minimized when possible. Otherwise, companies should consider physical allocation methods or economic allocation as a final option.

The Scope 3 Standard suggests that primary and secondary data should be evaluated for temporal representativeness, among other data quality indicators. Depending on the difference in time between collection and usage, data

23 The GHG Protocol Corporate Accounting and Reporting Standard is currently be updated and a revision is expected in 2023 or 2024.

24 World Resource Institute; World Business Council for Sustainable Development. 2004. Greenhouse Gas Protocol - Corporate Accounting and Reporting Standard. Methodological Framework, World Resource Institute; World Business Council for Sustainable Development. https://ghgprotocol.org/corporate-standard.

25 Location-based and market-based are the two types of Scope 2 accounting methods. As defined in the GHG Protocol Scope 2 Guidance: "In short, the market-based method reflects emissions from electricity that companies have purposefully chosen (or their lack of choice), while the location-based method reflects the average emissions intensity of grids on which energy consumption occurs." https://ghgprotocol.org/scope-2-guidance.

26 An emission factor allows GHG emissions to be estimated from activity data (such as fuel consumption) by ascribing a quantity of GHG emissions to a given unit of the activity, e.g., 10 kgCO2/gallon of fuel consumed.

27 GHG Protocol Scope 2 Guidance Table 6.2 "Location-based method emission factor hierarchy" and Table 6.3 "Market-based scope 2 data hierarchy examples"

28 Primary data is activity data which has been collected specific to the company, product, or process in question. Secondary data is data collected or established by others, for example a published industry average value, which may not completely reflect the details of a specific activity or process.

can be rated as very good (less than 3 years difference), good (less than 6 years difference), fair (less than 10 years difference), or poor (more than 10 years of difference or the age of the data is unknown). Companies should consider the specific circumstances of data when using this temporal rating as a basis for collecting new data or evaluating data quality.

Verification, either internally or by a third party, is highly encouraged to increase confidence in internal and publicly disclosed information. Disclosure is voluntary; however, to fully align with the standard, users should account for and publicly report scope 1, 2, and 3 emissions separately in conformance with the GHG Protocol Standards.

B. WRI/WBCSD GHG PROTOCOL – PRODUCT LIFE CYCLE ACCOUNTING AND REPORTING STANDARD

The WRI and WBCSD published the Product Life Cycle Accounting and Reporting Standard (Product Standard)[29] in 2011 as a set of requirements and guidance for stakeholders to quantify and publicly report GHG emissions and removals associated with a single product.[30] The objective of the Product Standard is to provide a general framework for companies to make informed choices to reduce GHG emissions from the products they design, manufacture, sell, purchase, or use.

The Product Standard covers the seven GHGs listed in the Kyoto Protocol. Voluntary reporting of additional GHGs is encouraged and must be accounted for in the inventory report if used in the inventory calculation.

The WRI and WBCSD Product Standard account for life cycle emissions and removals at the individual product level. It also provides guidance for conducting and reporting a product carbon footprint (PCF) or product GHG inventory. Product life cycle emissions consist of direct and indirect emissions both upstream and downstream of the reporting company. The reporting company is responsible for defining the GHG inventory boundary (such as cradle-to-gate or cradle-to-grave).

The product GHG inventory must follow the life cycle and attributional approach. Life cycle GHG emissions and removals are based on attributable processes identified along the life cycle of a product. Attributable processes consist of service, material, and energy flows that become the product, contribute to its manufacturing, and carry it through its life cycle. For emissions quantification, companies must collect primary data for all processes that they oversee. For all other processes in the product's life cycle, primary data should be collected if it is available and of sufficient quality. If a company does not have primary data, secondary data (data collected by someone outside of the value chain that is representative of the processes in the value chain) may be used.

Companies must allocate total emissions and removals for common processes to reflect contributions from the studied product and co-product(s). Allocations should be avoided whenever possible.[31] If unavoidable, emissions and removals should be allocated based on the underlying physical relationships between the studied product and co-product(s). When physical relationships cannot be used, this program encourages the use of economic allocation or other methods that reflect the relationship between the studied product and co-product(s).

The Product Standard suggests rating primary and secondary data for temporal representativeness like the Scope 3 Standard.[32]

The Product Standard requires assurance by a first or third party for any product GHG inventory. Assurance can be achieved through either verification or critical review. Verification is conducted before the public release of the inventory report by the reporting company. In order to conform with the GHG Protocol Product Standard, a report containing all applicable reporting requirements must be publicly disclosed.

29 World Resource Institute; World Business Council for Sustainable Development. 2011. Greenhouse Gas Protocol - Product Life Cycle Accounting and Reporting Standard. Methodological Framework, World Resource Institute; World Business Council for Sustainable Development. https://ghgprotocol.org/product-standard.

30 As noted in the standard, "both emissions to the atmosphere and removals from the atmosphere are accounted for in order to calculate the total GHG inventory of a product. Removals of CO2 generally occur during photosynthesis."

31 Strategies for avoiding allocation are outlined in Section II(E) of this paper.

32 See supra Section III(A).

C. ISO FAMILY OF STANDARDS

The ISO Standards,[33] promulgated by the International Standards Organization, are voluntary standards that use a network of guidance documents to support users' individual needs. The standards apply to conducting GHG inventories or life cycle assessments in any industry. Reporting based on life cycle assessments falls under the 14040 series.[34] The ISO standards for GHG calculation and verification are contained within the ISO 14060 series of standards.[35] Standard 14064-1 focuses on GHG inventory development for organizations.[36] ISO 14064-2 includes requirements for documentation and quantification of monitoring and reduction/removal enhancements.[37] ISO 14064-3 provides the specification for verification and validation.[38] ISO 14064 is supplemented by both ISO 14065 and ISO 14066. 14065 provides requirements for the third-party entities responsible for validation and verification,[39] while 14066 provides the competence requirements for those teams defined in 14065.[40] ISO 14067 pertains to product carbon foot printing calculations and reporting.[41] Organizations may also use ISO 14069 for guidance on the implementation of the GHG standard.[42]

The following subsections provide a high-level summary of the most relevant ISO standards and requirements.

i. ISO 14040

This standard includes life cycle assessment (LCA) and life cycle inventory (LCI) studies. It addresses the framework and the relationships of the different phases;[43] however, it does not go into the methodology of the studies nor nuanced methods of analysis.

ii. ISO 14044

This standard is typically used in conjunction with 14040, 14044 specifies the best practices and requirements for LCAs, including the goal/scope of the LCA and critical review of the phases.[44]

iii. ISO 14046

This standard pertains to water footprint; additional LCA guidelines are found in ISO 14046.[45] Air and soil emissions are only included as they pertain to water aspects.

iv. ISO 14047 & 14049

These two standards provide examples of how to apply the ISO 14044 standard to specific situations: impact assessment (14047);[46] and scope definition and inventory analysis (14049).[47]

v. ISO 14048

This standard provides data documentation guidelines for LCAs.[48]

vi. ISO 14064-1

This document outlines principles and requirements for quantifying GHG emissions and removals at the organizational level.[49]

33 International Organization for Standards, 2023. ISO. Accessed March 1, 2023. https://www.iso.org/standards.html.
34 ICS 13.020.60, Product life-cycles Including environmental footprint, carbon neutrality. https://www.iso.org/ics/13.020.60/x/
35 ICS 13.020.40, Pollution, pollution control and conservation, Including ecotoxicology and greenhouse gas emissions. https://www.iso.org/ics/13.020.40/x/
36 ISO 14064-1:2018, Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals. https://www.iso.org/standard/66453.html
37 ISO 14064-2:2019, Greenhouse gases — Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements. https://www.iso.org/standard/66454.html
38 ISO 14064-3:2019, Greenhouse gases — Part 3: Specification with guidance for the verification and validation of greenhouse gas statements. https://www.iso.org/standard/66455.html
39 ISO 14065:2020, General principles and requirements for bodies validating and verifying environmental information. https://www.iso.org/standard/74257.html .
40 ISO 14066:2011, Greenhouse gases — Competence requirements for greenhouse gas validation teams and verification teams. https://www.iso.org/standard/43277.html .
41 ISO 14067:2018, Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification. https://www.iso.org/standard/71206.html .
42 ISO/TR 14069:2013, Greenhouse gases — Quantification and reporting of greenhouse gas emissions for organizations — Guidance for the application of ISO 14064-1. https://www.iso.org/standard/43280.html
43 ISO 14040:2006, Environmental management — Life cycle assessment — Principles and framework. https://www.iso.org/standard/37456.html .
44 ISO 14044:2006, Environmental management — Life cycle assessment — Requirements and guidelines. https://www.iso.org/standard/38498.html .
45 ISO 14046:2014, Environmental management — Water footprint — Principles, requirements and guidelines. https://www.iso.org/standard/43263.html .
46 ISO/TR 14047:2012, Environmental management — Life cycle assessment — Illustrative examples on how to apply ISO 14044 to impact assessment situations. https://www.iso.org/standard/57109.html .
47 ISO/TR 14049:2012, Environmental management — Life cycle assessment — Illustrative examples on how to apply ISO 14044 to goal and scope definition and inventory analysis. https://www.iso.org/standard/57110.html .
48 ISO/TS 14048:2002, Environmental management — Life cycle assessment — Data documentation format. https://www.iso.org/standard/29872.html .
49 ISO 14064-1:2018, supra.

vii. ISO 14064-3

This standard provides the verification and validation requirements for any GHG reporting/statements.[50]

viii. ISO 14067

This standard provides PCF or partial PCF requirements, including emissions coverage and calculation methodology. It does not include reporting requirements or carbon offsets.[51] Carbon offsets are included, in part, as part of 14064.

The ISO standards generally cover the seven GHGs listed in the Kyoto Protocol. Voluntary reporting of additional GHGs is encouraged. The inventory report must list any additional GHGs included in the inventory calculation.

The general principles of quantification of organizational GHG emissions are established by ISO 14064-1, which establishes approaches to setting GHG emission and removal boundaries, quantifying an organization's GHG emissions and removals, and improving GHG management.[52] For GHG quantification, the use of primary data is prioritized if the data quality is high; secondary data can also be used when necessary.

The ISO standards related to product-level accounting set a hierarchical approach to emissions allocation. Ideally, allocation is to be avoided wherever possible.[53] Where unavoidable, allocations should be based on the underlying physical relationship between the products and co-products, such as mass, volume, or energy content. Economic allocation is a less preferred option, and any other relationship can be used as a final option.

ISO 14064-3 establishes verification requirements for GHG statements on GHG inventories, GHG projects, and carbon footprints of products. It describes the process for validation and verification, including planning, assessment procedures, and the evaluation of organizational, project, and product GHG statements.[54]

50 ISO 14064-3:2019, supra.
51 ISO 14067:2018, supra.
52 ISO 14064-1:2018, supra.
53 Strategies for avoiding allocation are outlined in Section II(E) of this paper.
54 ISO 14064-3:2019, supra.

D. WBSCD – PATHFINDER FRAMEWORK, GUIDANCE FOR THE ACCOUNTING AND EXCHANGE OF PRODUCT LIFE CYCLE EMISSIONS

The WBCSD published the Pathfinder Framework (Version 2.0)[55] in 2023 as an overarching framework to guide the use of existing calculation methodologies and promote the exchange of high-quality product-level carbon footprint (PCF) data. Framework includes a quality assurance and verification scheme to ensure the comparability and reliability of data across industries and standards. The WBCSD is developing an accompanying technology called the Pathfinder Network[56] to support value chain data sharing. The objective of the Pathfinder Framework and Network is to enable businesses along the value chain to obtain cradle-to-gate PCFs based on primary data from upstream suppliers.

Framework builds upon and aligns with existing methods and standards for the calculation and allocation of emissions, including:

Product Environmental Footprint method (PEF)

- Product Category Rules (PCRs) established for Environmental Product Declarations
- GHG Protocol Product Life Cycle Accounting and Reporting Standard
- GHG Protocol Corporate Value Chain (Scope 3) Standard
- ISO Standards (14044, 14040, 14067, 14025)

Framework prioritizes the use of product-specific and sector-specific rules when available.[57] When unavailable, the Framework permits the use of the GHG Protocol Product standard or the equivalent ISO standards. All seven GHGs covered under the Kyoto Protocol are included, and reporting of additional GHGs is encouraged.

Framework adheres to an attributional LCA approach.[58]

55 World Business Council for Sustainable Development (WBCSD). 2023. Pathfinder Framework, Guidance for the Accounting and Exchange of Product Life Cycle Emissions. World Business Council for Sustainable Development. https://www.wbcsd.org/Programs/Climate-and-Energy/Climate/SOS-1.5/Resources/Pathfinder-Framework-Version-2.0 .
56 Partnership for Carbon Transparency (PACT), Pathfinder Network. https://www.carbon-transparency.com/our-approach/pathfinder-network
57 WBCSD, 2021, supra.
58 Id. See discussion supra in Section III(B) on the attributional LCA approach.

Unless product-specific rules exist, calculation and allocation must comply with the GHG Protocol Product Standard or equivalent ISO standards (ISO 14067). The scope is cradle-to-gate PCF, comprising all product life cycle stages, including transportation but excluding product use and end-of-life.[59]

GHG intensity is calculated from emissions from material and energy inputs, purchased product components, inbound transportation and storage, production waste treatment, and any other direct emissions. Manufacturing of production equipment, buildings, and other capital goods, business travel by personnel, travel to and from work by personnel, and research and development activities are generally excluded unless there is available and relevant data. Primary data is preferable for calculations; however, secondary data can be used in the absence of primary. All data must be classified as either direct or upstream activity. Allocations should be avoided whenever possible.[60]

Under the Pathfinder Framework, data is updated and reported annually using the calendar or reporting year.[61] Framework accepts averaged emissions under a five-year period. However, data over five years old should be flagged in supplemental documentation. The minimum verification process is a self-declaration. Alternatively, a more extensive audit through a third-party provider can be conducted.[62] Audit and verification standards are drawn from existing environmental product declarations (EPD) or ISO-compliant audit systems.

Guidance towards disclosure is limited to data sharing of elements relating to the PCF between stakeholders within the supply chain.

E. EUROPEAN COMMISSION – PRODUCT ENVIRONMENTAL FOOTPRINT (PEFS)

The European Commission developed the Product Environmental Footprint (PEF)[63] and Organizational Environmental Footprint (OEF)[64] methodology in 2012. These programs aim to create consistent and specific rules for calculating environmental information for products and organizations.[65] The PEF covers product-level guidance, while the OEF covers corporate-level guidance. PEF studies enable comparisons between comparable products. OEF studies allow comparisons between organizations or production sites within the same sector or a single organization or production site over time. The use of PEFs is currently voluntary but is expected to become mandatory for organizations in the EU in the future.[66,67]

The PEF and OEF are wider ESG (environmental, social, and governance) standards that address a variety of impact categories and are industry agnostic. GHGs include the seven Kyoto gases and any additional GHGs on a voluntary basis.

The system boundary follows a general supply-chain logic from cradle-to-grave. The default categories include raw material acquisition and preprocessing (including production of components), main product manufacturing, distribution, product use, and end of life (including product recovery and recycling).[68]

The six phases of PEF and OEF define the goals, scope, baseline assumptions, life cycle inventory (LCI), life cycle impact assessment (LCIA), interpretation of results, and verification of the data.[69] The LCI and LCIA are iterative processes. Data collection and calculation for quantifying inputs and outputs include energy, raw material, and other physical inputs, (co-)products and waste, and emissions to air, water, and soil. The LCIA phase classifies emissions into impact categories (e.g., climate change, acidification, or resource use) and characterizes the data using a common unit (CO_2e).[70] Results are reported for both the total life cycle and the total life cycle excluding the end use.

59 Id.
60 Strategies for avoiding allocation are outlined in Section II(E).
61 WBCSD, 2021. supra.
62 Id.
63 European Commission (EC), 2021. Annex I. Product Environmental Footprint Method. https://environment.ec.europa.eu/system/files/2021-12/Annexes%201%20to%202.pdf.
64 European Commission (EC), 2021. Annex III. Organisation Environmental Footprint Method. https://environment.ec.europa.eu/system/files/2021-12/Annexes%203%20to%204_0.pdf.
65 Further Information on the PEF and OEF can be found at the link below: https://environment.ec.europa.eu/publications/recommendation-use-environmental-footprint-methods_en
66 Eurovent, Product Environmental Footprint (PEF) and MEErP (GEN - 1248.00). https://eurovent.eu/?q=articles/product-environmental-footprint-pef-and-meerp-gen-124800
67 European Commission (EC), 2021. Commission Recommendation on the use of the Environmental Footprint methods. https://environment.ec.europa.eu/document/download/cb899bd7-bb06-491d-9989-c856a401fcd0_en?filename=Commission%20Recommendation%20on%20the%20use%20of%20the%20Environmental%20Footprint%20methods_0.pdf
68 EC, 2021, Annex I, supra. & EC, 2021, Annex III, supra.
69 Id.
70 Id.

Emissions allocation follows ISO 14044:2006 guidance. Subdivision and system expansion should be prioritized over allocation. When allocations are unavoidable, inputs and emissions of multi-functional processes are partitioned between the product of interest and co-products.

Verification and validation with an external party are mandatory if any information is used for public disclosure.[71] Verification assesses the conformity to PEF and OEF, while validation ensures the reliability, credibility, and correctness of the data in the study. PEFs and OEFs are completed annually.[72]

F. ENVIRONMENTAL PRODUCT DECLARATION (EPD) SYSTEMS

Environmental Product Declaration (EPD) and the Product Category Rules (PCR) are standardized disclosures managed by program operator organizations (such as The International EPD® System[73]). An EPD provides objective, comparable, and third-party verified product life cycle data. EPDs can be used for all products but are especially prevalent in the building and construction sector.

The foundation of an EPD is a life cycle assessment (LCA) and it typically accounts for the entire cradle-to-grave value chain. The complete LCA is generally not publicly disclosed but summarized in an EPD. EPDs are typically multidimensional but can be single issue, such as one that discloses only product carbon footprint information aligned with ISO 14067.

The EPD utilizes ISO standards to define the calculation and reporting structure, particularly ISO 14025, 14027, 14040/ISO 14044, and ISO 14067.[74] Beyond the ISO standards, EPDs build on Product Category Rules,[75] providing industry- or product-specific instructions for conducting the LCA. The Product Category Rules set system boundaries, define the declared/functional unit (the unit of measure for the LCA), define the use phase and end-of-life options to be considered, and establish which impact categories need to be assessed.[76]

EPD validity typically lasts up to five years.[77] An expired EPD can still be published to give environmental information but should not be used in marketing. Regardless of the validity, a published EPD must be updated if one of the environmental indicators has changed by more than 10% compared with the previously published data.[78]

EPDs require verification by an approved third-party verifier[79] with knowledge of and experience with the industry, relevant standards, and types of products covered by the EPD and its geographical scope.

The EPD reports include a production summary, product range, technical characteristics, and uses. EPDs are published by a program operator using the ISO 14025 standard[80] and are typically accessible via the program operator's website.[81]

G. GRI SUSTAINABLE REPORTING STANDARDS

The Global Sustainability Standards Board (GSSB) published the Global Reporting Initiative (GRI) Sustainable Reporting Standards[82] in 2016. GRI Standard 305 addresses emissions into the air, including GHGs and other air pollutants (ozone-depleting substances, nitrogen oxides, and sulfur oxides, among other pollutants).[83] GRI 305 can be used by organizations of any size, type, sector, or geographic location.

With respect to the GHG component of the GRI Standards, the requirements are derived from other existing frameworks, including those of the WRI, WBCSD, and the GHG Protocol's Corporate Standard and Corporate Value Chain Standard.[84]

Reporting organizations are required to report scope 1, 2, and 3 emissions and to disclose any standards

71 Id.
72 Id.
73 The International EPD System, https://www.environdec.com/home .
74 The 14040 family of standards is summarized earlier in this report. See supra Section III(C).
75 The International Environmental Product Declaration System, n.d. "EPD Product Category Rules," https://www.environdec.com/product-category-rules-pcr/the-pcr.
76 Id.
77 The International EPD System, FAQ https://www.environdec.com/faq#epdfaq .
78 Id.
79 The International EPD System, Approved Independent Verifiers. https://www.environdec.com/resources/verifiers .
80 The International EPD System, Environmental Product Declarations. https://www.environdec.com/all-about-epds/the-epd .
81 The International EPD System, FAQ. supra.
82 The Global Sustainability Standards Board (GSSB), 2023. Global Reporting Initiative (GRI). Accessed March 1, 2023. https://www.globalreporting.org/standards/.
83 GRI 305, 2016, https://www.globalreporting.org/standards/media/1012/gri-305-emissions-2016.pdf
84 Id.

and factors used and any emissions excluded from the inventory.[85] Organizations may report all scopes together and report organization-specific emissions intensities. The organization-specific emissions intensity is determined by dividing the combined emissions from scopes 1 and 2 by an organization-specific denominator. Intensity ratios can be provided for products, services, and sales. The organization-specific denominators can include product units, production volume, size (such as floor space), number of full-time employees, monetary units (such as revenue or sales), and more. Intensity ratios for scope 3 are reported separately from the intensity ratios for scopes 1 and 2.[86] GHG emissions should be broken down by business unit or block, country, type of source, and activity, product, or service. Emissions reduction reporting is also required in the standard and requires a baseline, along with its rationale.[87]

Gases included in the calculation include the seven Kyoto gases.[88] Although the standard does set out details on developing intensities, it is silent on allocation methods.

Reporting of GHG data is one component of the larger reporting, which is governed under the universal standards—GRI 1, 2, & 3:

a. GRI 1 Foundation: specifies the organizational requirements for compliance with the GRI Standards.[89]

b. GRI 2 General Disclosures: contains disclosures that the organization uses to provide information about its reporting practices and other organizational details, such as its activities, governance, and policies.[90]

c. GRI 3 Material Topics: provides guidance on how to determine what topics are important for the organization to disclose (material topics).91 It also contains guidance on how organizations can determine material topics, list material topics, and manage each topic.[92]

GRI recommends an independent evaluation of the sustainability reports prepared by organizations.

85 Id.
86 Id.
87 Id.
88 Id.
89 GRI 1: Foundation 2021. https://globalreporting.org/pdf.ashx?id=12334
90 GRI 2: General Disclosures 2021. https://www.globalreporting.org/pdf.ashx?id=12358
91 GRI 3: Material Topics 2021. https://globalreporting.org/pdf.ashx?id=12453
92 Id.

H. TOGETHER FOR SUSTAINABILITY (TFS) – THE PRODUCT CARBON FOOTPRINT GUIDELINE FOR THE CHEMICAL INDUSTRY

Together for Sustainability (TfS) published the Product Carbon Footprint Guideline for the Chemical Industry (Version 2.0) (TfS Guideline)[93] in 2022. This program is a sector-specific guideline for the chemical industry for calculating and reporting PCFs and Scope 3 Category 1 emissions from purchased goods and services (referred to as Scope 3.1). The objective of the TfS Guideline is to design a consistent process for Scope 3.1 data collection.[94] Additionally, the guidelines instruct companies on how they can calculate their corporate GHG inventories with supplier-specific data while providing guidance on how to calculate the PCFs of their chemical products.[95] All seven Kyoto Protocol gases are covered.[96]

The TfS Guideline provides guidance for both corporate-level Scope 3.1 emissions reporting and product-level carbon footprinting calculations. PCFs are calculated by suppliers and, under the TfS Guideline, are meant to be shared downstream to support further emissions reporting. For annual corporate reporting, the PCF of each purchased good (provided by the supplier) is aggregated to one value and is reported in the category Scope 3.1.[97]

The scope and boundary of the guideline are cradle-to-gate PCFs, comprising all upstream emissions processes of extracting, manufacturing, and transportation until the product leaves the factory gate. A prioritization hierarchy of guidelines is to be followed for PCF calculations according to the TfS guidance to increase the consistency of calculations along the value chain.[98]

The hierarchy consists of:

(1) PCR that was developed based on TfS Guideline,

(2) Product- or sector-specific guidelines based on ISO 14000 series,

93 Together for Sustainability. 2022. Product Carbon Footprint Guideline. Together for Sustainability. Accessed March 1, 2023. https://www.tfs-initiative.com/how-we-do-it/scope-3-ghg-emissions
94 Id.
95 TfS, The Product Carbon Footprint Guideline for the Chemical Industry, Specification for product Carbon Footprint and Corporate Scope 3.1 Emission Accounting and Reporting. Version 2.0, November 2022. https://www.tfs-initiative.com/app/uploads/2023/04/TfS_PCF_guidelines_2022_English.pdf
96 Id.
97 Id.
98 Id.

(3) TfS Guideline,

(4) ISO 14067 standard,

(5) Pathfinder Framework (follows the GHG Protocol Product Standard), and

(6) Product Environmental Footprint Category rule (PEFCR) developed under the EU PEF.

TfS PCF emissions are based on indirect energy emissions and direct emissions. Manufacturing of production equipment, buildings, infrastructure, and other capital goods, business travel by personnel, travel to and from work by personnel, and research and development activities should be excluded from the boundaries of a cradle-to-gate PCF.[99] The use of primary data is preferable when high-quality data is available. Otherwise, secondary data can be used. Allocation is to be avoided when possible; process subdivision can be used instead.[100] However, where necessary, allocations should be based on the underlying physical relationship between the products and co-products, such as mass, volume, or energy content, with economic allocation as a final option.

Data used in the calculation of PCFs can have various representative time boundaries. Primary data used in calculating PCFs should prioritize the most recent data but should not be older than five years.[101] Secondary data used for all inputs and outputs should reflect the most recent activity data and/or the latest life cycle inventories (LCI) available. LCI data used in the calculation of the PCFs should be as current as possible and no older than ten years.[102] PCF values have a maximum validity period of up to five years from the reference year of data collection if there have not been major changes to the production processes.[103] Companies may update their PCF calculations on a more regular basis.

Verification of PCF data prior to sharing with others in the supply chain is strongly encouraged.[104] Users must also disclose the utilized verification approach, either internal or third-party, to further enhance supply chain transparency. TfS guidelines require that users specify the methods or standards applied within their GHG inventory calculation processes.

99 Id.
100 Id.
101 Id.
102 Id.
103 Id.
104 Id.

I. EUROPEAN UNION RENEWABLE ENERGY DIRECTIVE (RED II)

The European Commission's Renewable Energy Directive (RED II) is a legal framework,[105] not a disclosure or reporting framework. The RED II framework is a revision to the original European Commission directive (2009/28/EC), which sets fuel suppliers' requirements for the sustainability and carbon footprint of transport fuels sold in the EU. The 2018 revision introduced transport sub-targets of a minimum of 14% renewable energy for road and rail transport.[106] The overall directive provides guidance for road and rail transport, power, and building heating and cooling.[107] RED II established criteria for GHG emissions of biofuels and biomass fuels and introduced criteria for the sustainability of forestry feedstock.[108] RED II is a voluntary program. However, companies must follow requirements to count emissions reductions from these fuels toward GHG emissions targets in the EU or to obtain financial support from public authorities. Many other programs and standards reference this as a foundational program.

The framework applies to CO2, CH4, and N2O. The scope of GHG calculations is cradle-to-grave.[109] Fuel suppliers register with voluntary schemes, which monitor, audit, and certify the renewable fuel supplied to the EU.

RED II prescribes different GHG emissions calculation methodologies for fuels of biogenic origin, renewable fuels of non-biological origin (RFNBO), and recycled carbon fuels (RCF).[110] For biofuels, calculations include emissions from cultivation and extraction of raw materials, carbon stock changes caused by land-use change, processing, transport and distribution, fuel use, and emissions savings from carbon capture. RFNBO and FCF calculations include emissions from inputs, processing, transport and distribution, fuel use, and emissions savings from carbon capture. GHG emissions savings may be claimed during a three-month window.[111] When mass balance systems are used, a balance must be achieved within a three-month period.[112]

105 EU, 2023. Science Hub. Accessed March 1, 2023, https://joint-research-centre.ec.europa.eu/welcome-jec-website/reference-regulatory-framework/renewable-energy-recast-2030-red-ii_en.
106 Id
107 RED II, 2018. Renewable Energy Directive 2018/2001/EU.https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001.
108 Id.
109 Id.
110 Id.
111 Id.
112 Id.

Biofuel GHG emissions allocations are divided between co-products in proportion to their energy content. RFNBO and RCF allocations are divided using energy content but could alternatively be allocated in proportion to the economic value of the co-products.[113]

Verification is done through a third-party audit. The audit includes verification of GHG calculations and chain of custody traceability. Physical segregation or mass balance are the two authorized chains of custody systems.[114] Disclosure is member country specific.

J. INTERNATIONAL PARTNERSHIP FOR HYDROGEN AND FUEL CELLS IN THE ECONOMY (IPHE)

The International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) published the "Methodology for Determining the Greenhouse Gas Emissions Associated with the Production of Hydrogen"[115] as a procedure for measuring the GHG emissions from hydrogen production. The guidelines are applicable to hydrogen production in all industries.

The assessment evaluates emissions using a cradle-to-gate (referenced here as a "well-to-gate") system boundary consisting of three sections: hydrogen production, conditioning, and transportation.[116] If buffer storage is incorporated into a plant, emissions associated with the energy consumption of that storage facility will be included.[117] As a variety of hydrogen production methods exist, IPHE provides emissions boundaries for six main routes: electrolysis of water, steam reforming of natural gas with carbon capture and storage (CCS), industrial by-products, coal gasification, biomass, and auto-thermal reforming of natural gas with CCS.[118]

The IPHE provides guidance for product-level reporting. Scope 1, scope 2, and partial scope 3 emissions are incorporated in the determination. Partial scope 3 emissions originate from acquiring and transporting raw materials and producing and manufacturing hydrogen. Emissions from manufacturing assets, construction, decommissioning, employee travel, commuting, and upstream leased resources are excluded.[119] The GHGs considered are CO2, CH4, and N2O, and the results are expressed as CO2e.[120]

Emissions quantification uses combustion emissions, fugitive emissions, industrial process emissions, and energy supply calculations. Emissions allocation can be avoided by expanding the system to include additional co-product functions.[121] When unavoidable, the allocation for all hydrogen production pathways and managed co-products will use ISO 14067, 14040, and 14044 and utilize one of the following allocation approaches: energy content, mass basis, system expansion, or economic value.[122] Calculations developed according to key regulations, such as EU RED II, are also allowed. Similar inputs and outputs of the product system will have uniform allocation procedures.

IPHE states that emissions and removals must be calculated at least every year.[123] Calculations should treat delayed GHG emissions and removals as if they occurred at the beginning of the assessment period. Where there is variation throughout the life cycle, data should be collected over a period that may reflect the average.

Under the IPHE framework, reporting is managed by the national energy authority of the country where the project is located. A public service platform recognized by the national energy authority must receive a formal verification application. The national energy authority may also carry out a third-party verification.[124] The agency may conduct on-site verification aided by document verification. In case of a change in feedstock, on-site verification is mandatory.[125]

113 Id.
114 Id.
115 The International Partnership for Hydrogen and Fuel Cells in the Economy. 2022. "Methodology for Determining the Greenhouse Gas Emissions Associated with the Production of Hydrogen." Methodological Working Paper. https://www.iphe.net/_files/ugd/45185a_03457347901844c3856e196689f3227c.pdf.
116 Id.
117 Id.
118 Id.
119 Id.
120 Id.
121 Id.
122 Id.
123 Id.
124 Id.
125 Id.

K. GIIGNL MRV AND GHG NEUTRAL LNG FRAMEWORK

In 2021, the International Group of Liquefied Natural Gas Importers (GIIGNL) published the MRV and GHG Neutral LNG Framework.[126] GIIGNL is a global non-profit organization for the Liquefied Natural Gas (LNG) industry. The framework is designed to promote a consistent product-level GHG accounting for LNG, standardize a definition of "GHG Neutral" LNG, and set standards for the monitoring, reporting, and verification (MRV) and disclosure of verified emissions.[127]

The framework uses a cradle-to-gate approach, referenced as a "well-to-tank" approach, to establish the product carbon footprint of LNG. The framework defines LNG production stages and establishes a complete statement of the GHG emission burden of an LNG cargo, including all stages (up to but excluding the point of delivery to the customer).[128] The framework includes scopes 1, 2, and some of scope 3 (primarily purchased feedstocks and transportation) emissions. Some non-material operations are excluded, including construction activities and materials, minor production materials, gas exploration and drilling activity, and commissioning and decommissioning.[129] A significant portion of the framework is devoted to determining and reporting shipping emissions.

The seven Kyoto gases are to be assessed in the calculation of CO2e under this framework. However, the standard recognizes that within the LNG life cycle, SF6, PFCs, HFCs, and NF3 are likely to be deemed insignificant, and reporting of CO2, CH4, and N2O are set as the minimum criteria.[130] The exclusion of any GHG emissions from reporting must be sufficiently justified and documented.

The framework is designed to support, and not replace, established standards and methodologies that govern GHG emissions calculations and GHG footprint determination. It references ISO 14067:2018, the Greenhouse Gas Protocol – Product Life Cycle Accounting and Reporting Standard, and British Standards Institution's publicly available specification known as PAS 2050:2011. The framework also references the ISO series of standards regarding verification and reporting. The framework specifies that the allocation of emissions to products will be performed on an energy content basis except for products that do not have energy content, such as helium, where a physical basis, such as mass, is preferred over an economic or another basis of assessment.[131]

The temporal boundaries for the PCF vary according to the process stage. Data from a twelve consecutive-month period on a fixed or rolling basis are used for the stages from production to liquefaction. In the case of shipping, the time boundary covers the actual LNG cargo delivery and is specific to the laden and inward ballast voyage. Emissions associated with attributable processes outside the twelve-month period are amortized and allocated to the assessment period.[132]

Statements of GHG intensity must be subject to independent third-party verification in accordance with ISO 14064-3:2019.[133] This verification may be on a cargo-by-cargo basis or on a group of cargo. There is no defined regularity verification other than a minimum annual verification of cargoes delivered/used within the reporter's selected temporal boundary.

The framework sets out various declaration pathways that the reporter can follow based on their position in the value chain and the report's intended use. In reporting, details may be classified as confidential and not disclosed to external parties, with the exception of the verifier.[134]

L. RESPONSIBLESTEEL INTERNATIONAL STANDARD – VERSION 2.0

ResponsibleSteel™, a not-for-profit organization, published the ResponsibleSteel™ International Standard – Version 2.0 in 2022 to provide guidance for the steel industry on responsible governance and social and environmental principles.[135] Within the environmental principles, there is guidance on GHG emissions reporting. Steel producers can become ResponsibleSteel™ certified if they meet set

126 GIIGNL, 2021. International Group of Liquefied Natural Gas Importers. MRV and GHG Neutral LNG Framework. Version 1.0, November 2021. https://giignl.org/wp-content/uploads/2021/11/MRV-and-GHG-Neutral-Framework-1.pdf.
127 International Group of Liquefied Natural Gas Importers. "Driving transparency on emissions and GHG Neutral LNG cargoes." https://giignl.org/framework/.
128 GIIGNL, 2021. supra.
129 Id.
130 Id.
131 Id.
132 Id.
133 Id.
134 Id.
135 ResponsibleSteel™, 2022. ResponsibleSteel International Standard, Version 2.0. 14 September 2022. https://www.responsiblesteel.org/wp-content/uploads/2022/10/ResponsibleSteel-Standard-2.0.1.pdf.

standards.[136] Further, guidance is provided for product- and corporate-level reporting, with a primary focus on the corporate level because it is at the corporate level that companies may become ResponsibleSteel™ certified.

Corporate-level reporting includes scope 1, scope 2, and partial scope 3 emissions. Partial scope 3 emissions include upstream material extraction, material preparation, and transportation. The endpoint of the scope boundary for crude steel production is the point at which crude steel is first produced.[137] Further processing after casting is not included. Downstream waste disposal is the only consideration beyond initial production. The endpoint of the scope boundary for a product's carbon footprint is different and should account for further processing of crude steel after first casting.[138]

The covered gases include all Kyoto Protocol gases using Global Warming Potential values relative to CO2e. However, if a gas contributes less than 0.5% of the direct scope 1 emissions or less than 5% of the total emissions for a source of upstream emissions, then it can be excluded.[139]

Emissions quantification at the corporate level uses the GHG Protocol, EN 19694, and ISO 14404. Emissions quantification at the product level uses the GHG Protocol Product Life Cycle Accounting and Reporting Standard, ISO 14067, and PAS 2050. Allocation is avoided when possible. There is no reduction in emissions due to the allocation of GHG emissions to the production of steel by-products.[140] However, when a site produces and exports intermediate products such as coke, pig iron, granulated pig iron, or industrial gases, they should be deducted from the total GHG emissions.[141]

Data should be assessed annually and submitted to the Secretariat for publication on the ResponsibleSteel™ website.[142]

136 Id.
137 Id.
138 Id.
139 Id.
140 Id.
141 Id.
142 Id.

M. THE ALUMINUM STEWARDSHIP INITIATIVE

The Aluminum Stewardship Initiative (ASI) published the ASI Performance Standard (Performance Standard)[143] to establish principles and criteria that address sustainability issues in the aluminum value chain.[144] ASI also issued the ASI Performance Standard Guidance[145] to assist an entity (businesses, organizations, companies, or groups of activities) in earning the ASI Performance Standard certification.[146]

ASI's standard requires facility-level reporting of GHG emissions and energy. The data is reported in an itemized manner, based on timeframe, scope, activity, location, and/or facility—not reported in a consolidated manner. The facility-level GHG reporting guidance includes scope 1 and scope 2 emissions and suggests that it is good practice to include scope 3 GHG emissions that are considered material. Material emissions are defined as sources that are greater than 5% of the total emissions inventory for scope 1 and 2 and 10% for scope 3.

The ASI standard sets a GHG emissions intensity threshold and reporting requirement for aluminum smelters. The scope of this Performance Standard is cradle-to-gate, referred to as "mine-to-metal."[147] Mine-to-metal emissions include scope 1, 2, and 3 GHG emissions. Scope 3 emissions for mine-to-metal are limited to sources upstream of the smelter and to source categories 3.1 (purchased goods and services), 3.3 (fuel- and energy-related activities), and 3.4 (upstream transportation and distribution).[148]

The mine-to-metal scope is calculated at an individual smelter level, not averaged across operations.[149] Use of the GHG Protocol Corporate Accounting and Reporting Standard and related aluminum tools for aluminum-specific process emissions calculation is recommended for mine-to-metal

143 The Aluminium Stewardship Initiative. ASI Performance Standard. Version 3.1, April 2023, https://aluminium-stewardship.org/wp-content/uploads/2023/04/ASI-Performance-Standard-V3.1-April-2023.pdf.
144 The Aluminium Stewardship Initiative. ASI Standards Overview. Accessed March 1, 2023. https://aluminium-stewardship.org/asi-standards/overview.
145 The Aluminium Stewardship Initiative. ASI Performance Standard Guidance. Version 3.1, April 2023. https://aluminium-stewardship.org/wp-content/uploads/2023/04/ASI-Performance-Standard-Guidance-V3.1-April-2023.pdf.
146 Id.
147 ASI Performance Standard, Version 3.1. supra.
148 Id.
149 Id.

emissions quantification. The use of alternative methods is generally not recommended but is still provided for under the criterion.[150] The GHG Protocol Corporate Accounting and Reporting Standard and associated guidance and calculation tools are recommended for the facility-specific emissions calculation process. Specific guidance is not provided on the temporal representativeness of data.

The reporting entity is required to account annually and publicly disclose the material, energy use, GHG emissions by source, and aluminum smelter GHG emissions intensity (if applicable). All publicly disclosed energy and GHG emissions data must be independently verified prior to publication.[151] The ASI Assurance Manual provides guidance on what constitutes an appropriate level of independent verification and requires that it must be performed by ASI Accredited Auditors.

The Performance Standard requires that the reporting entity establish a GHG emissions reduction plan. The plan must publicly report a GHG emissions reduction pathway consistent with a 1.5 °C warming scenario, including an intermediate target covering a period of no more than five years. Entities are required to review the plan annually.[152] The pathway should also be reviewed when changes are made to the baseline or target or when the reduction plan is not met. The latest version of the pathway and plan must be publicly disclosed. The entity must implement the necessary management system, evaluation procedures, and operating controls to achieve performance aligned with the GHG emissions reduction plan and targets.[153] This includes verification in addition to the independent verification requirements of the disclosure of GHG emissions and energy use.

N. AMERICAN IRON AND STEEL INSTITUTE GUIDANCE

The American Iron and Steel Institute (AISI) published the "Steel Production Greenhouse Gas Emissions Calculation Methodology Guidelines"[154] to provide members with a consistent set of guidelines for GHG emissions calculations for carbon steel and stainless steel production. The guidelines are not a new standard but set instructions comprised of existing methods. The guidance is aligned with ISO requirements, which are used to develop the AISI LCI data for the steel industry.

AISI provides guidance for calculating GHG emissions for product- and corporate-level reporting. Product-level emissions calculations should be used for trade, procurement, and certified EPDs. Product-level emissions represent all processes associated with a specific steel mill product. Corporate-level emissions for corporate-level reporting are included when reporting scopes 1 and 2 emissions and upstream raw materials, energy, and transportation scope 3 emissions. The guidance does not specify gases to include in the calculations but references the GHG Protocol and EPA's GHGRP, which includes reporting emissions for six gases.
The guidance directs members to use the "cradle-to-gate" boundary in calculating GHG emissions. The LCA uses cradle-to-gate, referring to the steps required to manufacture a product. The guidance references the U.S. Environmental Protection Agency's (EPA)[155] definitions of the three scopes of GHG emissions. A list of processes for inclusion within the recommended system boundaries for GHG emissions reporting is defined in the guidance for consistent reporting in the steel industry.[156]

Direct scope 1 emissions should be calculated using the EPA's Greenhouse Gas Reporting Program (GHGRP) methodology.[157] The corporate-level emissions include facilities below the EPA's facility-level reporting emissions threshold of 25,000 metric tons and emissions from ancillary sources that are not included in the EPA GHGRP methodology. Both inclusions depart from the GHGRP rule and result in a more accurate depiction of a company's corporate inventory. The guidance directs members to include emissions from biogenic sources and follow calculation methodologies from the Product Category Rules (PCR) for North American Steel Construction Products[158] for EPDs and the GHG Protocol Corporate Standard for corporate reporting.

150 Id.
151 Id.
152 Id.
153 Id.
154 AISI, 2022. The American Iron and Steel Institute. "Steel Production Greenhouse Gas Emissions Calculation Methodology Guidelines." November 3, 2022. Methodological Guidelines. https://www.steel.org/wp-content/uploads/2022/11/AISI-GHG-Emissions-Calculation-Methodology-Guidelines-final-11-3-22.pdf.

155 US EPA. Scope 1 and 2 Inventory Guidance. https://www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance.
156 AISI, 2022. supra.
157 US EPA GHGRP, see infra at V.A.
158 Product Category Rule (PCR) Guidance for Building-Related Products and Services Part B: Designated Steel Construction Product EPD Requirements, UL 10010–34, Second Edition, Dated August 26, 2020. Note: Biogenic carbon accounting methods are described in UL's core PCR Part A Building-Related Products and Services.

Scope 2 emissions are primarily from purchased electricity for the steelmaking industry. The guidance requires members to use the methodology outlined in the PCR for North American Steel Construction Products[159] to represent purchased electricity in EPDs. The emissions factors in PCR are based on specific regional mixes relative to a manufacturing facility's location. The specific grid data is based on EPA's Emissions & Generation Resource Integrated Database (eGRID).[160] When reporting scope 2 GHG emissions from the corporate level, members should use the GHG Protocol's market-based methodology for purchased electricity, which allows for the use of Renewable Energy Credits (RECs) and Purchase Power Agreements (PPAs).

Calculation of scope 3 emissions should include the following categories: Scope 3.1 purchased goods and services; Scope 3.3 fuel- and energy-related activities not included in Scopes 1 and 2; Scope 3.4 upstream transportation and distribution; and Scope 3.5 waste generated in operations.[161] The guidance does not require the use of the GHG Protocol as the calculation methodology for scope 3 emissions. However, the guidance refers to specific scope 3 emission categories in the GHG Protocol.[162]

Primary data is preferred and should be used whenever possible. Secondary data, such as EPA's eGRID, should be the most up-to-date data and should be representative of the region.[163]

Emissions allocation is guided by ISO 21930[164] for the development of construction product EPDs, and the GHG Protocol for corporate-level emission reporting. Both methodologies state that physical allocation, based on energy and mass, should be the first choice if the allocation of emissions is required. There are limitations on the use of economic allocation and system expansion in the ISO standards and the GHG Protocol, making physical allocation the most appropriate approach.[165]

The temporal boundaries for GHG emissions calculations are specific for product- and corporate-level reporting. For product-level reporting, GHG emissions are typically reported using an intensity-per-finished-product metric (metric tons CO2e/unit). Corporate reporting for GHG emissions is inclusive of all manufacturing in a given calendar year.[166]

AISI also addresses emissions offsets, which refer to reductions in GHG emissions outside the operation of a company's value chain. Companies use carbon offsets or credits to reduce their GHG emissions. Offsets should not be included in the calculation of GHG emissions for EPDs, and members should follow GHG Protocol requirements when using offsets in corporate-level reporting.[167]

AISI does not address the validation and verification of GHG emissions data. The Institute states that it is important that GHG emissions calculations are clearly and transparently reported.

O. VOLUNTARY EMISSIONS REPORTING KEY FINDINGS

1. Voluntary GHG reporting methodologies and standards continue to be developed and issued at a rapid pace by many organizations, especially industry groups.

2. The voluntary standards are generally aligned with some of the "fundamental" standards of ISO 14040/14064/14067 and the WBCSD GHG Protocol standards. Some standards also refer to existing regulatory systems, such as proposed rules developed under the EU PEF.

3. In product-level accounting, the assignment of GHG emissions to co-products generally follows the hierarchy set out in the ISO standards. Avoiding allocation is preferred, but if unavoidable, allocation may be based on the underlying physical relationships between the co-products (mass, volume, or energy content), with economic allocation as a less preferred option.

4. Most standards include reporting of all gases covered under the Kyoto Protocol; however, certain frameworks only include reporting of CO2, CH4, and N2O, including those of IPHE and RED II. Some standards also encourage but do not require voluntary reporting of other GHGs.

159 Id.
160 US EPA. Emissions & Generation Resource Integrated Database (eGRID). https://www.epa.gov/egrid
161 AISI, 2022. supra.
162 Id.
163 Id.
164 ISO 21930:2017, Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services. https://www.iso.org/standard/61694.html.
165 AISI, 2022. supra.
166 Id.
167 Id.

5. All reporting programs prefer primary data over secondary data. However, all recognize that there is a need for secondary data in most cases. Industries recognize that secondary data and even allocated public emissions data may not allow for the differentiation of less carbon-intensive products or processes.

6. There are a variety of approaches to the verification of GHG data across the standards. Some require external data verification, some recommend it, and some are silent on the matter. The usefulness of the data published by organizations using the standards should be weighed based on the rigor of applied verification procedures.

7. The existing voluntary standards address the key components needed to establish corporate or product carbon footprints and are generally written to allow flexibility and to be interdependent on a few key foundational standards. This flexibility and interoperability allow for widespread adoption and implementation. The organizations that have implemented these standards have likely established the data and governance processes needed to prepare for potentially forthcoming GHG accounting policies, so long as those new policies follow these same tenants of flexibility and interoperability.

IV. SUMMARY OF MANDATORY PROGRAMS

A. THE UNITED STATES: THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S GREENHOUSE GAS REPORTING PROGRAM (GHGRP)

The U.S. Environmental Protection Agency (EPA) GHGRP requires the reporting of GHG emissions from facilities that emit more than 25,000 metric tons of CO2e annually and from certain facilities regardless of their emissions level (including electricity generators and manufacturers of aluminum, ammonia, and cement).[168] The reporting requirements apply to both emissions from fuel combustion and chemical process emissions for all gases covered under the Kyoto protocol.[169] For 2021, a total of 2.71 billion tonnes CO2e of emissions was reported by 7,608 facilities.[170]

Under the GHGRP, different methodologies for calculating emissions are identified for each of 46 "source categories," (e.g., "iron and steel production" or "aluminum production").[171] Covered facilities, however, generally have some discretion in choosing among the different methodologies identified for their relevant category.[172] Emissions from the combustion of fuels can be measured directly by a continuous emissions monitoring system (CEMS), calculated based on fuel composition data, or determined according to default emissions factors.[173] Similarly, depending on the source, process emissions can be determined through different methodologies including CEMS, the mass balance approach, or default values.[174]

Data submitted under the GHGRP are subject to a multi-step verification process.[175] Before the report is certified and submitted, there are pre-submittal checks that highlight errors (e.g., missing data) and allow for the facility reporter

168 The GHGRP also requires reporting by (1) facilities that inject more than 25,000 metric tons CO2 underground annually and (2) suppliers of fossil fuels and GHG-emitting industrial gases to submit full reports of GHG data at the facility level. See Mandatory Greenhouse Gas Reporting, 40 C.F.R. Part 98.

169 See Congressional Research Service, EPA's Greenhouse Gas Reporting Program at 2 (Nov. 16, 2021), https://sgp.fas.org/crs/misc/IF11754.pdf.

170 EPA, GHGRP Reported Data, https://www.epa.gov/ghgreporting/ghgrp-reported-data#:~:text=For%20reporting%20year%20(RY)%202021,Gas%20Reporting%20Program%20(GHGRP)

171 See 40 C.F.R. Part 98, subparts Q and F.

172 Environmental Protection Agency, Greenhouse Gas Reporting Program: Emission Calculation Methodologies, https://www.epa.gov/sites/default/files/2017-12/documents/ghgrp_methodology_factsheet.pdf (last visited Oct. 31, 2022).

173 Id.

174 Id.

175 Environmental Protection Agency, Greenhouse Gas Reporting Program: Report Verification, 2, https://www.epa.gov/sites/default/files/2017-12/documents/ghgrp_verification_factsheet.pdf.

to correct mistakes. After submission, a series of checks are run on the report to ensure accuracy. Checks include verifying that the reported data are within an expected range, statistical checks to evaluate the report in the context of reports from similar facilities, algorithmic checks to cross-examine the submitted information in the larger context of the entire report (e.g., whether quarterly data and annual data align), and year-to-year checks to assess variations.[176] Facilities must also maintain records of their monitoring and reporting procedures for at least three years.[177]

The EPA releases the data submitted pursuant to the GHGRP annually in several forms; by reporting aggregated data once it is collected, through gas- and sectoral-level analysis, in the annual Inventory of U.S. Greenhouse Gas Emissions and Sinks, and in the searchable "facility-level information on greenhouse gases tool" or FLIGHT platform where data can be accessed online and is aggregated by industry, gas, state, and facility.[178]

Looking ahead, the U.S. Securities and Exchange Commission (SEC) has proposed rules to introduce mandatory reporting of GHG emissions at the corporate level as part of broader disclosure requirements pertaining to climate-related risks for public corporations. In accordance with these provisions, registrants would have to disclose records of direct emissions, indirect emissions, and emissions from upstream and downstream activities in the registrant's value chain. The rule is expected to be adopted in mid-2023.[179] Given controversy around the rule and SEC's authority to issue it, a lawsuit challenging the new requirements is likely to follow.

176 Id.
177 Id.
178 EPA, Greenhouse Gas Reporting Program, Find and Use GHGRP Data, https://www.epa.gov/ghgreporting/find-and-use-ghgrp-data
179 Denise Lugo, "New Climate and Sustainability Disclosure Rules on Track for Issuance by June," Reuters, January 26, 2023. https://tax.thomsonreuters.com/news/new-climate-and-sustainability-disclosure-rules-on-track-for-issuance-by-june/ (accessed January 27, 2023).

B. THE EUROPEAN UNION: THE MONITORING, REPORTING, AND VERIFICATION (MRV) PROCESS

As the overarching reporting program for the EU's Emissions Trading System (ETS), the Monitoring and Reporting Regulation (MRR) covers emissions from facilities for three of the Kyoto gases in specific contexts.[180] It requires reporting of the following:

1. CO2 from electricity and heat, commercial aviation within the European Economic Area, and energy-intensive industry sectors (including oil refineries, steel works, and the production of iron, aluminum, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids, and bulk organic chemicals);[181]
2. N2O from the production of nitric, adipic, and glyoxylic acids and glyoxal; and
3. PFCs from the production of aluminum.

There are several exceptions to the reporting requirements, including for certain small facilities if member states meet certain requirements.[182]

According to the monitoring and reporting guidelines of the MRR, operators are allowed to choose a calculation-based or a measurement-based methodology that is consistent over time, comparable and transparent (recorded/documented in a manner that allows results to be reproduced), complete (covers all processes/combustion sources and source streams free of data gaps and double counting), accurate

180 "Guidance Document: The Monitoring and Reporting Regulation – General guidance for installations," European Commission, February 10, 2022, MRR Guidance Document #1, https://climate.ec.europa.eu/system/files/2022-02/gd1_guidance_installations_en_0.pdf , at 33-37. The remaining four Kyoto gases—CH4, HFCs, SF6, and NF3— are still reported annually under the EU's broader commitments under the UNFCCC. This is a separate set of EU reporting requirements distinct from those under the ETS, but it is not review in this paper because it simply guides the collection process of UNFCCC-mandated emissions data that is already required of Member States within their national reporting mandates. See "Emissions Monitoring & Reporting," European Commission, https://climate.ec.europa.eu/eu-action/climate-strategies-targets/progress-made-cutting-emissions/emissions-monitoring-reporting_en .
181 The MRR will also cover CO2 emissions from ocean shipping beginning in 2024, as well as from buildings and fuel from road transport in 2027 or 2028.
182 Facilities with avg. annual CO2 emissions <25,000 tonnes are allowed to use simplified monitoring plans. The next three tiers of 25,000 - 50,000, 50,000 - 500,000, and >500,000 tonnes require increasingly accurate emissions monitoring. Specific source streams at the facility level require similar tiers of accuracy, with increasingly accurate monitoring expectations for <1,000, <5,000, and >5,000 tonnes CO2 / year (de minimis, minor, and major source streams, respectively).

(not systemically or knowingly inaccurate), and monitored with a high level of integrity (operator avoids bias and chooses a calculation methodology that aims for highest achievable accuracy, unless a method is infeasible or incurs "unreasonable" costs).[183] Each state appoints a competent authority (CA), for example the German Environment Agency, which is responsible for implementing the monitoring rules of the EU ETS directive within their state.[184] Facility operators must submit a monitoring plan to the CA that includes a procedural description, monitoring parameters, applied European Standards,[185] a risk assessment (risk of a data omission, misrepresentation, or error), and evidence of compliance with uncertainty thresholds[186] for each major and minor source stream.[187]

The verification guidelines of the Accreditation and Verification Regulation (AVR) establish a system to authenticate the verifiers of the emissions reporting process. Member states preside over the accreditation processes within their borders by appointing a CA, establishing procedures for resolving appeals, and monitoring conduct to take corrective action when necessary.[188] In order to verify an installation's annual emissions report, the CA must assemble a team consisting of an EU ETS lead auditor, technical and language experts, and an independent reviewer. The verifier is obliged to provide a verification report which concludes, with reasonable assurance, that the operator's report is complete, free of material mistakes, and in compliance with the approved methodology.189 Operators must submit a verified emissions report to the CA for the previous year by March 31st. The emissions figure is then entered, either by the CA or the operator directly, into a central database called the Union Registry.[190] The Registry is a centralized online database that collects information on verified emissions, allowance holdings and transfers, and the reconciliation of verified emissions and allowances.191 The European Union Transaction Log (EUTL), a supplemental resource run by the European Commission, also provides facility-level emissions data aggregated by country, sector, year, and corresponding obtained and surrendered allowances.[192]

C. CANADA: MANDATORY GREENHOUSE GAS REPORTING PROGRAM (GHGRP)[193]

The Canadian government mandates annual facility-level GHG reporting under the Greenhouse Gas Reporting Program (GHGRP). GHGRP covers emissions from entities that emit 10 kilotonnes (CO2e) or more of CO2e emissions per year[194] and companies that engage in carbon capture, transport, or storage activities.[195] Reporting requirements apply to six of the seven Kyoto gases.[196] This facility-level data collected through GHGRP is used to validate and sometimes even aid in estimations for industrial sources of the national inventory estimates for Canada's GHG inventory Program sent to the UNFCCC.[197]

Under the GHGRP, facilities calculate total emissions of the covered gases from the emissions sources on site.[198] Each facility must identify and calculate the emissions of every source of emissions. Industrial processes, fugitive emissions (venting, leakage, or flaring), or stationary fuel combustion on site must be accounted for.[199] Reports should include general information about the facility, including name, location, contacts, parent companies, GHG emissions data,

183 Commission Implementing Regulation (EU) 2018/2066," European Commission, Articles 5-8, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02018R2066-20210101.
184 "Special Report: The integrity and implementation of the EU ETS," European Court of Auditors, 2015, No. 6, https://www.eca.europa.eu/Lists/ECADocuments/SR15_06/SR15_06_EN.pdf, pg. 8.
185 European Standards (EN Standards) are technical standards drafted and maintained by the European Committee for Standardization.
186 The uncertainty threshold characterizes the range within which the true value is expected to lie with a specified level of confidence. See "Guidance Document: the Monitoring and Reporting Regulation – Guidance on Uncertainty Assessment," European Commission, October 7, 2021, https://climate.ec.europa.eu/system/files/2021-10/policy_ets_monitoring_gd4_guidance_uncertainty_en.pdf, 9.
187 Id., Article 12.
188 Commission Implementing Regulation (EU) 2018/2067," European Commission, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02018R2067-20210101, Articles 73, 54, and 66.
189 Id., Article 37 & 7.
190 "Guidance Document: The Monitoring and Reporting Regulation," 15.
191 "Union Registry," European Commission, https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/union-registry_en
192 "EU Emissions Trading System (ETS) data viewer," European Environment Agency, https://www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1
193 https://open.canada.ca/data/en/dataset/a8ba14b7-7f23-462a-bdbb-83b0ef629823
194 Id.
195 Id.
196 Id.
197 Canada, Environment and Climate Change. 2021. "Reporting Greenhouse Gas Emissions Data: Technical Guidance 2020." February 15, 2021. https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/facility-reporting/reporting/technical-guidance-2020.html.
198 Id.
199 Canada, Environment and Climate Change. 2021. "Reporting Greenhouse Gas Emissions Data: Technical Guidance 2020." Aem. February 15, 2021. https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/facility-reporting/reporting/technical-guidance-2020.html.

and additional sector-specific information.[200] Facilities are required to report the emissions of each GHG type expressed in units of tonnes for each (e.g., 100 tonnes of N20). All facilities must report estimations methods used to calculate emissions, such as monitoring or direct measurement, mass balance, engineering estimates, etc.

There are two pathways for reporting entities depending on the sector: a less detailed reporting program and an expanded reporting program. The less detailed track has no specific protocol for reporting emissions besides being consistent with the guidelines that the UN IPCC published in 2006.[201] The expanded reporting program applies to specific GHG-intensive sectors, including aluminum, ammonia, hydrogen, iron and steel, petroleum refining, and mining.[202] Facilities under the expanded reporting program must follow sector-specific quantification methods.[203]

Data is submitted to the Environment and Climate Change Canada's (ECCC) Single Window system, where it undergoes two levels of verification. First, corporations submit a "statement of certification" or self-certification that is signed by an authorized signing authority that is approved by the Standards Council of Canada (SCC), stating that the information is accurate.[204] Second, the ECCC conducts several internal data checks and follows up to clarify any remaining uncertainties. All facilities are required to keep records of data collection for three years after the report is submitted.[205] The verified data is disclosed via an online portal.[206] The data is available aggregated by individual GHGs, facilities, sectors, and regions.[207] However, companies may submit a request to keep data confidential.

200 Id.
201 Id.
202 Id.
203 Government of Canada, Public Services and Procurement Canada. n.d. "Information Archivée Dans Le Web." Publications.gc.ca. Accessed January 3, 2023. https://publications.gc.ca/collections/collection_2022/eccc/En81-28-2021-eng.pdf.
204 Id.
205 Canada, Environment and Climate Change. 2021. "Reporting Greenhouse Gas Emissions Data: Technical Guidance 2020." Aem. February 15, 2021. https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/facility-reporting/reporting/technical-guidance-2020.html.
206 "Greenhouse Gas Reporting Program Data Search - Canada.ca." 2023. Canada.ca. 2023. https://climate-change.canada.ca/facility-emissions/?GoCTemplateCulture=en-CA.
207 Singh et al., supra.

D. FRANCE: BILAN D'EMISSION DE GES (BEGES)[208]

Bilan d' Emissions de GES (BEGES) is a corporate-level assessment covering a one-year time frame that is reported on a three-year cycle. BEGES covers scope 1 and 2 emissions from corporations with more than 500 employees (250 in the overseas departments), regions/municipalities with more than 50,000 inhabitants, public establishments (municipal services) with more than 250 employees, or state services.[209] The reporting requirements apply to all seven of the Kyoto Protocol gases.[210]

BEGES permits reporting entities to use a variety of internationally recognized corporate reporting standards, including ISO 14064-1, the GHG Protocol, and the ISO TR 14069, which may be used for measurement, reporting, and verification. BEGES requires reports to include general information on the corporation, methodology and how it was determined, and separate calculations of each GHG gas by calculations or measurements (or a combination of both).[211] Due to cost, the continuous measurement method is not widely used. The most commonly used methods are calculations using emissions factors and verifiable data.[212]

Reporting entities may use default factors from the Base Carbone, a public database of emissions factors used to determine the carbon footprint of an organization or territory established by the Agence de l'Environnement et de la Maitrise de l'Energie (ADEME) assessment board. Base Carbon is a centralized data source designed to coordinate varying methodologies in accordance with France's reporting requirements.[213] The tools available are an online consultation (for emissions factors), a downloadable CSV file (with emissions factor data), downloadable documentation,

208 https://www.ecologie.gouv.fr/actions-des-entreprises-et-des-collectivites-climat#scroll-nav__6
209 BEGES also applies to regions and municipalities with more than 50,000 inhabitants, public establishments with more than 250 employees, or state services ADEME - Bilans GES Site." n.d. Bilans-Ges.ademe.fr. Accessed November 10, 2022. https://bilans-ges.ademe.fr/en/accueil/contenu/index/page/fr_art75/siGras/0.
210 Id.
211 Id.
212 "Méthode Pour La Réalisation des Bilans d'Émissions de Gaz à Effet de Serre Conformément à l'Article L. 229-25 Du Code de L'environnement." n.d. https://www.ecologie.gouv.fr/sites/default/files/Guide%20m%C3%A9thodologique%20sp%C3%A9cifique%20pour%20les%20collectivit%C3%A9s%20pour%20la%20r%C3%A9alisation%20du%20bilan%20d%E2%80%99%C3%A9missions%20de%20GES.pdf.
213 See Base Carbone—Database of Greenhouse Gas Emissions Factors, https://bilans-ges.ademe.fr/docutheque/docs/1455%20BASE%20CARBONE%204P%20VA%20%28V4%29.pdf.

a contribution module, and a forum.[214] There are two relevant statuses of input in the Base Carbone method: generic valid and specific valid. Generic valid inputs allow defaults to be used, while specific valid status indicates that facility-specific data must be used.[215]

No outside verification is required. However, the corporations may apply to submit the report to an independent third party for verification. BEGES corporate data is disclosed on a public IT platform.[216] The online portal discloses data by individual GHGs, individual corporations, and regionally.[217]

Additionally, France, like all 27 EU member states, is required to submit facility-level data through a competent authority (CA) to the European Union Transaction Log (EUTL) to participate in the EU Trading Scheme. The emissions factors used for the EU-ETS are also from the Base Carbone. It is recommended that corporations align both EU ETS data and the GHG inventory data.

E. JAPAN: MANDATORY GHG ACCOUNTING AND REPORTING SYSTEM[218]

Japan's Mandatory GHG Accounting and Reporting System requires annual submissions of scope 1 and 2 emissions for qualifying entities. Such entities include facilities and corporations that emit over 3,000 tonnes CO2e per year,[219] consume a crude oil equivalent of 1,500 kiloliters, or have 21 full-time employees. All facilities must report all seven of the Kyoto-covered gases.[220] Under the GHG Accounting and Reporting system, the government assigns covered entities with sector-specific methodologies requiring facilities to use specific formulas and emissions factors stipulated for each selected activity.[221] Additionally, calculations of each individual (species) GHG emissions are required when certain thresholds are met, such as annual energy consumption of 1,500 kiloliters or GHG emissions of 3,000 tonnes CO2e.[222]

Facilities also must report "actual" and "adjusted" emissions. Actual emissions represent the total amount of GHG released, comprising CO2 emissions from combustion (from fuel and non-fuel sources) and all emissions from non-CO2 sources converted to CO2e based on global warming potential.[223] Adjusted emissions incorporate the number of GHG credits obtained by the reporting entity[224] or transferred to others.[225] There are five GHG credits available: domestic credit in Japan, green energy CO2 reduction amount, offset credit (J-VER), Japan Credit (J-Credit), and JCM credit.[226] The entities subtract the validated certified emission credits from the actual emissions. These credits can also be transferred to other entities.

Data is submitted to the appropriate authorities of the Ministry of Environment and the Ministry of Economy, Trade, and Industry after the report is self-certified and then validated by an independent third party.[227] The data is aggregated and disclosed on an online portal with specific facility emission data available upon request.[228]

Japan also has two regional cap and trade programs, the Saitama ETS and the Tokyo ETS. These programs require reporting of facility-level data (only on CO2) for the industrial sector and buildings.[229]

F. GERMANY: NATIONAL SYSTEM OF EMISSIONS[230]

The National System of Emissions (NSe) is used to fulfill both international and domestic climate targets, including obligations under the UNFCCC (including the Paris Agreement) and European Effort Regulations.[231] This program is coordinated by the Single National Entity (SNE), within the German Environment Agency, Umweltbundesamt

214 "ADEME - Bilans GES Site." n.d. Bilans-Ges.ademe.fr. Accessed January 17, 2023. https://bilans-ges.ademe.fr/en/accueil/contenu/index/page/user_guide/siGras/1.
215 Id.
216 Centre de ressources sur les bilans de gaz à effet de serre, https://bilans-ges.ademe.fr/.
217 Singh et al., supra.
218 https://ghg-santeikohyo.env.go.jp/about.
219 National Greenhouse Gas Inventory Report of JAPAN 2022." n.d. Accessed November 17, 2022.
220 Singh et al., supra.
221 Greenhouse Gas Inventory Office of Japan, Center for Global Environmental Research, Earth System Division, and National Institute for Environmental Studies. 2022. "National Greenhouse Gas Inventory Report of JAPAN." National Greenhouse Gas Inventory Report of JAPAN. Ministry of the Environment, Japan. 2022. https://www.nies.go.jp/gio/en/archive/nir/jqjm100000186dp5-att/NIR-JPN-2022-v3.0_GIOweb.pdf. Covered entities must also report "adjusted emissions," i.e., actual emissions adjusted for the number of greenhouse gas credits obtained by the reporting entity.
222 Id.
223 Id.
224 Id.
225 Id.
226 Id.
227 Singh et al., supra.
228 Id.
229 "Welcome to the ICAP ETS Map." n.d. Icapcarbonaction.com. https://icapcarbonaction.com/en/ets.
230 https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2022-05-31_climate-change_25-2022_nir-2022_en.pdf
231 "Federal Climate Change Act (Bundes-Klimaschutzgesetz) Contents." n.d. https://www.bmuv.de/fileadmin/Daten_BMU/Download_PDF/Gesetze/ksg_final_en_bf.pdf

(UBA). The SNE is supported by a variety of federal institutions and is responsible for planning, preparing, and archiving emissions data on the GHGs covered under the Kyoto Protocol. The qualifying entities are facilities and all significant emission sources and sinks in the "energy," "industry," "transportation," "agriculture," "building," and "waste and other" sectors.

The SNE retrieves data from Germany's statistical office, Länder, which collects data through primary surveys and secondary data (e.g., data on industry averages), including scientific studies and other third-party data when necessary.[232] The collected GHG data is compiled by the SNE annually following the methodology requirements of the European Monitoring Mechanism Implementing Regulation (EMMIR) or Article 26 of the European Governance Regulation.[233]

The SNE streamlines reporting by using the Central System Emission (CSE), a central database for emissions calculation and reporting. The CSE includes calculation methods, activity rates, and emissions factor data that is compatible with EMMIR requirements.[234] The program automates emissions calculations based on inputs from activity rates and emissions factors (developed by UBA).

Each National Inventory Report includes sectoral emissions, allocated emissions budgets, changes in sources or sinks, and the previous year's emissions data (that was transmitted from the European Commission).[235] The calculated emissions are then exported to a standardized reporting table.[236] Reports are released annually by the Emissions Situation Division of the UBA and the Single National Entity.

The UBA verifies data by comparing submissions to the German and EU ETS installations with emissions calculated from the energy balances.[237] Additionally, quality assurances and controls are used throughout CSE systems by using data checks and by ensuring that common methodologies are followed.[238]

The inventory is disclosed on the UMB website and in the National Inventory Report.

Additionally, like all 27 EU member states, Germany is required to report facility-level data to the European Union Transaction Log (EUTL) to participate in the EU ETS.

G. ITALY: ITALIAN NATIONAL GREENHOUSE GAS INVENTORY

The Italian National Greenhouse Gas Inventory (INGGI) collects GHG data to fulfill Italy's obligations under UNFCCC obligations and the EU's Greenhouse Gas Monitoring Mechanism. The inventory mandates annual reporting of scope 1 and 2 emissions of all significant sources and sinks of emissions from Kyoto-covered GHGs. The collection categories are broken down into "key sources categories," including "energy," "industry," "transportation," "agriculture," "building," and "waste and other" sectors.[239] Under this program, facilities and all significant sources of emissions are required to report their emissions.

The Institute for Environmental Protection and Research (ISPRA) is responsible for collecting data and determining emissions factors in line with the UNFCCC (guidelines and the EU monitoring mechanism regulation.[240] The Italian National Statistical System (SISTAN) collects and quantifies the basic statistical data used to estimate emissions.[241] These methodologies use the UNFCCC's 3 tier methodology. The tiers advance in data complexity with the top tiers: 2 & 3.

The GHG inventory is formatted using the UNFCCC's Common Reporting Format (CRF) and sent to the UNFCCC and European Commission in compliance with the EU's Greenhouse Gas Monitoring Mechanism. The CRF format is a standardized spreadsheet that provides GHG data per sector.[242]

232 Hogan, Pat, Angela Falconer, Valerio Micale, Alex Vasa, Yuqing Yu, and Xiaolu Zhao. 2012. Tracking Emissions and Mitigation Actions: Current Practice in China, Germany, Italy, and the United States CPI Working Paper Climate Policy Initiative (hereinafter Hogan et al.) https://www.climatepolicyinitiative.org/wp-content/uploads/2012/05/Tracking-Emissions-and-Mitigation-Actions.pdf.
233 "Federal Climate Change Act (Bundes-Klimaschutzgesetz) Contents." n.d. https://www.bmuv.de/fileadmin/Daten_BMU/Download_PDF/Gesetze/ksg_final_en_bf.pdf.
234 Hogan et al, supra.
235 Id.
236 Id.
237 Id.
238 Id.
239 Id. at 29.
240 Review of *Italian Greenhouse Gas Inventory 1990-2019. National Inventory Report*. 2021. Https://www.isprambiente.gov.it/It. Via Vitaliano Brancati, 48 – 00144 Roma: The Institute for Environmental Protection and Research (ISPRA). https://www.isprambiente.gov.it/files2021/pubblicazioni/rapporti/nir2021_italy_14apr_completo.pdf.
241 Id.
242 Review of *Reporting Requirements*. n.d. UNFCCC. United Nations Climate Change. https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/reporting-requirements#:~:text=Common%20reporting%20format%20(CRF)%20tables,detailed%20information%20on%20the%20inventory.

Throughout the collection process, ISPRA uses quality assurance and control processes, along with uncertainty analysis, and verifies the received data against ETS emissions trading data.243 The Ministry of Ecological Transition is responsible for approving the final inventory before it is submitted to the UNFCCC and the European Commission.[244] The national inventory is available at an aggregated level online at ISPRA.[245]

Additionally, Italy, like all 27 EU member states, is required by the European Directive 2003/87 to send facility-level data through a competent authority to the European Union Transaction Log (EUTL) to participate in the EU ETS.[246] Italy uses the National Registry System to store and compile data. Reported criteria follow the standards defined by the European Commission Decision 2007/589/EC.[247]

H. THE UNITED KINGDOM: STREAMLINED ENERGY AND CARBON REPORTING (SECR) PROGRAM[248]

The UK's SECR program is a GHG reporting program that requires corporations to report scope 1 and 2 emissions. Corporations that are UK incorporated and whose equity share capital is listed on the Main Market of the London Stock Exchange, European Economic Area State, the NYSE, or the NASDAQ are required to report as are large unquoted companies and large LLPs. These entities must report emissions of the gases covered under the Kyoto Protocol annually.[249] Individual figures for emissions of each of the GHGs is not required and results must be reported as the annual quantity in tonnes of CO2e. Disclosed data must include all emissions from company activities within the boundary (operational control, financial control, and also equity share are acceptable methods to set the boundary). This includes combustion of fuel and electricity for transportation and operation of facilities (scope 1 emissions); all scope 2 emissions from the purchases of electricity, heat, steam, and cooling; total aggregated emissions; GHG intensity levels (intensity ratios); and the methodologies used to calculate emissions. Scope 3 emissions reporting is optional. Participants have the option to report any on-site renewable energy consumption, any use of green tariffs, any purchase of Energy Attribute Certificates (EACs) to match grid electricity consumption with renewable generation certificates, and any other forms of offsets purchased.

There is "no prescribed methodology" that companies are required to use, but the GHG Protocol Corporate Accounting and Reporting Standard is recommended. However, the Department of Environment, Food, and Rural Affairs (DEFRA) published standard emissions factors for use.[250] Additionally, the Department for Business, Energy, and Industrial Strategy released Greenhouse Gas Conversion Factors or emissions factors that can be used for scope 1 and scope 2 emissions calculations.[251]

The GHG reporting program is a part of a broader "environmental strategy" for corporations, which requires qualifying corporations to supply information more comprehensively on climate impacts and risk.[252]

The GHG reporting program requires no verification besides self-certification. The data is disclosed publicly on an online platform with data at a corporate level for all entities covered by program and by individual GHGs. Carbon offsets reporting is optional for companies to include in their SECR report. Organizations can account for carbon offsets against their gross GHG emissions figure to report a net figure in tonnes of CO2e. This net figure should be additional to the organization's gross figure and should not replace it.

The UK also has an Emissions Trading Scheme that requires annual facility-level emissions data. The scheme went into force on January 2021, and its structure, scope, reporting, and verification methods are modeled after the EU's ETS.[253]

243 Id.
244 Hogan et al., supra.
245 "SINAnet." n.d. Www.sinanet.isprambiente.it. Accessed January 6, 2023. http://www.sinanet.isprambiente.it/acl_users/credentials_cookie_auth/require_login?came_from=http%3A//www.sinanet.isprambiente.it/it/sia-ispra/serie-storiche-emissioni.
246 Id.
247 Review of Italian Greenhouse Gas Inventory 1990-2019. National Inventory Report. 2021. https://www.isprambiente.gov.it/It. Via Vitaliano Brancati, 48 – 00144 Roma: The Institute for Environmental Protection and Research (ISPRA), https://www.isprambiente.gov.it/files2021/pubblicazioni/rapporti/nir2021_italy_14apr_completo.pdf. See also Commission Decision of 18 July 2007 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council, 2007/589/EC (2007), https://op.europa.eu/en/publication-detail/-/publication/329cbcd4-66d9-449c-a41c-81333a0963a5/language-en.
248 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/850130/Env-reporting-guidance_inc_SECR_31March.pdf
249 Id.
250 https://ec.europa.eu/environment/emas/emas_publications/policy_en.htm.
251 "Environmental Reporting Guidelines: Including Streamlined Energy and Carbon Reporting Requirements" (updated in 2022), https://www.gov.uk/government/publications/environmental-reporting-guidelines-including-mandatory-greenhouse-gas-emissions-reporting-guidance.
252 Id. at 26.
253 "Climate Change: UK Emissions Trading Scheme - Gov.scot." n.d. Www.gov.scot. https://www.gov.scot/policies/climate-change/emissions-trading-scheme/.

I. CHINA: 10,000 ENTERPRISE PROGRAM NATIONAL ETS PROGRAM AND PILOT REGIONAL ETS PROGRAM

China's National Development and Reform Commission (NDRC), the lead ministry on climate and energy matters, created the "1,000 Enterprise Program" (which operated from 2006-2010), and its extension introduced in 2011, the "10,000 Enterprise Program," to support China's national emissions reduction targets.[254] The program mandates an "energy conservation target-setting policy" that includes reporting obligations for qualifying entities.[255] The qualifying thresholds include entities in ten heavy industrial sectors that emit 26,000 tonnes of CO2 or above annually or meet an annual energy consumption threshold of 180,000 tonnes of coal equivalent (2004).[256]

The 10,000 enterprise program covers more than two-thirds of national energy use (and 85% of industrial enterprises).[257] The NDRC provided foundational GHG accounting and reporting guidelines for the Kyoto gases. Entities must report a yearly self-assessment that includes GHG emissions data, relevant production data, and supporting material. Additionally, the covered entities are required to design and implement energy management programs, consisting of emissions report data and energy-saving targets, and a legally binding "energy-saving target responsibility contract."[258] Data is submitted to the National Bureau of Statistics (NBS), where it is aggregated and submitted to a national portal.

The NDRC provides "toolboxes" to support successful implementation:[259]

- Energy audit standard (GB/T 17166-1997) software
- Energy measurement and statistic standard (GB/T17167) software
- Energy Management System standard (GB/T 23331) software
- Training on auditing, data management, and technology improvement

254 Hogan et al., supra.
255 "Implementing a National Energy Efficiency Programme | NDC Partnership." n.d. Ndcpartnership.org. https://ndcpartnership.org/case-study/implementing-national-energy-efficiency-programme.
256 Id.
257 Lu, Hongyou. 2014. Review of *Energy Assessment under China's Top 10,000 Program: A Case Study for a Steel Mill*. Lawrence Berkeley National Laboratory. June 2014.
258 "Implementing a National Energy Efficiency Programme | NDC Partnership." n.d. Ndcpartnership.org. https://ndcpartnership.org/case-study/implementing-national-energy-efficiency-programme
259 Id.

A working group consisting of a team of local environmental authorities verifies the submitted self-assessments.[260] The assigned working group reviews documents and visits the onsite locations before validating.[261]

In addition, China has implemented a national emissions trading system and a regional pilot ETS in 9 provinces.[262] The regional emissions trading systems will gradually transition to the national system. Until then, they will work in parallel with the national system.[263] The regional ETS went into effect on February 1, 2021. Its first phase was completed in early 2023 and it will continue operating until it is fully integrated into the national system.[264] Both ETS programs cover scope 1 and 2 emissions for CO2 and require facility-level annual reporting. The national ETS went into effect shortly after in July 2021, with the market opening at the price of CNY 48 (7.48 USD). The ETS programs aim to standardize the verification of GHG emission reports of enterprises in the national carbon emissions permit trading market.[265]

To date, the national ETS market only covers the power sector. This includes 2,000 companies that emit annual emissions of 26,000 tonnes of CO2 (or more).[266] It is estimated that this program covers 40% of China's carbon emissions, covering 2,162 power sector entities in 2020 and 2021.[267] Any power sector entities previously covered in the regional pilot programs have been integrated into the national system.

Until the national ETS market expands, the regional ETS markets will cover sectors and entities excluded from the national program. The regional ETS programs are in Beijing, Chongqing, Fujian, Guangzhou, Hubei, Shanghai, Shenzhen, Sichuan, and Tianjin.[268] The regional ETS program covers the energy, industrial, and transport, as well as commercial buildings sectors.[269] The program uses a threshold of 20,000 tonnes of CO2 per year for the industrial sector and 10,000 tonnes of CO2 per year for the non-industrial sectors.[270]

260 Id.
261 Id.
262 "China National ETS | International Carbon Action Partnership." n.d. Icapcarbonaction.com. https://icapcarbonaction.com/en/ets/china-national-ets.
263 Id.
264 "碳排放权交易管理办法（试行" n.d. www.mee.gov.cn. https://www.mee.gov.cn/xxgk2018/xxgk/xxgk02/202101/t20210105_816131.html.
265 Id.
266 China National ETS | International Carbon Action Partnership." n.d. Icapcarbonaction.com. https://icapcarbonaction.com/en/ets/china-national-ets.
267 Id.
268 Id.
269 Hogan et al., supra.
270 Hogan et al., supra.

Methodology, requirements, and verification are similar for both programs. Three defined methodologies are permitted, including two calculation-based methods, the emissions factor method, and the mass balance method.[271] Direct measurement methods are also accepted if they comply with national, industrial, and local standards. Additionally, facility operators must determine default emissions standards in line with GHG accounting and reporting guidelines released by the Ministry of Ecology and Environment (MEE). Covered entities must identify the description of the emissions sources and monitoring methodologies, information on measurement devices or quality assurance processes, data management systems used, and recording of measurements in their reports.[272]

ETS reports are verified by an accredited independent third party, which follows the verification guidelines established by a designated competent authority (CA).[273] The CA is made up of provincial-level ecological and environmental authorities that verify and provide oversight to the submitted GHG reports. Additionally, they are actively involved throughout the reporting process. Industries are required to submit a monitoring plan to the CA for approval. The monitoring plan includes information on the methodology used in GHG calculation, source streams, and technical approaches used.[274]

ETS data is not disclosed publicly. They are reported to the China Certified Emissions Reductions (CCER) registry.[275]

J. MANDATORY EMISSIONS REPORTING KEY FINDINGS

1. All facility and corporate mandatory reporting programs examined in this paper require disclosure of some portion of scope 1 emissions; corporate-level reporting programs also typically require disclosure of scope 2 emissions from purchased electricity. Disclosure of scope 3 emissions is not required under existing programs.
2. Each of these reporting programs covers most large industrial facilities of the nation in question and thus has created a broad base of facility-level emissions data and reporting requirements for energy-intensive industries.
3. Most programs require reporting of all gases covered under the Kyoto Protocol. Notably, the EU's facility-level reporting under the EU ETS applies to only CO2, N2O, and PFCs.
4. All reporting programs include elements of direct measurement combined with calculation-based approaches to quantify emissions, with variation depending on the particular emissions source.
5. Most countries, except for France and the United Kingdom, provide for external verification of submitted data by either the government or third-party verifiers. The rigor of different verification procedures, however, varies significantly.
6. All reporting programs in G7 member countries publicly disclose data, with varying approaches to aggregation by gas, facility, sector, and region. China, however, does not publicly disclose data.
7. While additional guidance on calculations would be needed to structure the allocation of facility-level emissions to individual products and handle interoperability across programs, there exists a foundation of emissions reporting data and accounting practices for scope 1 and scope 2 emissions of energy-intensive products from which to build a goods-level accounting system. However, this foundation is lacking for scope 3 emissions.

271 Id.
272 Id.
273 Stallmann, Martin. 2020. *Essential Elements of Robust MRV-Systems and Analysis of Their Relevance for Linking Emissions Trading Schemes. Www.umweltbundesamt.de*. Umweltbundesamt. https://www.umweltbundesamt.de/en/publikationen/essential-elements-of-robust-mrv-systems-analysis.
274 "企业温室气体排放报告核查指南." n.d. Accessed December 14, 2022. https://www.mee.gov.cn/xxgk2018/xxgk/xxgk06/202103/W020210329546745446406.pdf.
275 China National ETS | International Carbon Action Partnership." n.d. Icapcarbonaction.com. https://icapcarbonaction.com/en/ets/china-national-ets.

clcouncil.org