

The Carbon Call

Roadmap to more interoperable greenhouse gas emissions accounting

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c e n t e r



Version 1. This living document has been developed with the expectation that it will be updated in line with new developments and consensus.



About ClimateWorks Foundation

ClimateWorks Foundation is a global platform for philanthropy to innovate and accelerate climate solutions that scale. We equip philanthropy with the knowledge, networks, and solutions to drive climate progress. Since 2008, ClimateWorks has granted over \$1.3 billion to more than 600 grantees in over 40 countries.



The Carbon Call

About the Carbon Call

The Carbon Call, a ClimateWorks Foundation-hosted initiative, mobilizes collective action, investment, and resources to strengthen a more reliable and interoperable carbon accounting system for the planet.



About the ICF Climate Center

The ICF Climate Center offers compelling research and unique insights that help organizations achieve their climate goals.

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Executive Summary

Improved interoperability can

- Build confidence among regulators and financial institutions and support faster and more accurate decision-making
- Increase corporate data accessibility, transparency, and reliability for companies and governments
- Accelerate corporate GHG disclosures while reducing the resource burden
- Facilitate sharing of new and updated calculation methodologies and proxy data standards
- Provide companies with transparent access to up-to-date, industry-specific, and referenceable emissions factors

Greenhouse gas (GHG) accounting is experiencing unprecedented expansion. Driven by greater, and more concerted, ambition to address the climate crisis, companies in particular are accelerating and extending long-standing work to assess, reduce, and report GHG emissions. Financial, regulatory, and statutory drivers further amplify the need for more and better GHG information within companies and the need for all companies to be able to compare, share, and use information across the corporate GHG ecosystem.

The global trend of increased GHG accounting and reporting places increased demand on companies to compile comparable and sharable GHG information—that is, demand for interoperability, or the ability to compare, share, and use information across GHG accounting and reporting systems and the supporting digital data ecosystem.

Increased interoperability within corporate GHG accounting and reporting will

- Build confidence among regulators and financial institutions and support faster and more accurate decision-making by enabling companies to take bold steps toward GHG reductions, investments, and the implementation of climate solutions.
- Increase corporate data accessibility, transparency, and reliability for companies and governments through anomalies detection and standard quality control checks and procedures as well as by ensuring data are valid and available regardless of jurisdiction or intended downstream use.
- Accelerate corporate GHG disclosures while reducing the resource burden for large companies with thousands of business relationships, for small companies with relatively little capacity to manage data, and for companies within supply chains that must meet the requirements of both upstream and downstream partners.
- Facilitate sharing of new and updated calculation methodologies and proxy data standards with solution providers, advisory firms, companies, and other stakeholders; verification of these methodologies and standards; and, potentially, crowdsourcing of proxy data and rating of their accuracy.
- Provide companies with transparent access to up-to-date, industry-specific, and referenceable emissions factors.

Through this roadmap, the Carbon Call is building on its mission to mobilize collective action, investment, and resources to strengthen the carbon accounting system, making it more reliable and interoperable for the planet. The roadmap is the result of five months of collective problem solving and is backed by case studies from the Carbon Call's expert advisory group. It is a living document developed with the expectation that it will be updated in line with new developments and consensus.

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New solutions to support interoperability must be built and existing solutions must be amplified. Over the last few months, the Carbon Call has evaluated solution blueprints and elements of a connected set of solutions are emerging.

In the absence of interoperability, constraints that companies face when gathering, interpreting, or sharing data and information or when performing analyses to prepare GHG estimates will endure and possibly exacerbate. The Carbon Call roadmap identified four primary constraints that can be addressed through interoperability:

- **Vocabulary constraints (I don't understand you).** Use of different terminology, naming conventions, or metrics affects transparency and accuracy.
- **Validity constraints (I don't trust you).** Lack of transparency about data sources and the basis for assumptions.
- **Methodological constraints (You don't have exactly what I need).** Limited data, information, and resources may force companies to use less reliable methods, which results in less accurate GHG accounting and reporting.
- **Awareness constraints (I can't find you).** Lack of a central system or framework for finding emissions inventory information runs the risk of duplicated efforts and limits comparability.

A host of challenges is associated with these constraints and their impacts on GHG data and emissions estimates. Some of these challenges are described in this roadmap to illustrate companies' experiences as evidenced by case studies.

Interoperability can help to address each of these constraints—from creating conditions that allow for better conversations among professionals within different industries (e.g., financial, sustainability, data science) to increasing access to good data and improving software compatibility.

Therefore, new solutions to support interoperability must be built and existing solutions must be amplified. Over the last few months, the Carbon Call has evaluated solution blueprints and elements of a connected set of solutions are emerging.

- **Digital smart dictionary.** A digital smart dictionary promotes consistency in preferred terms and allows for reported data to be transformed into digital reporting taxonomies and classifications that will enable the data to be processed and shared quickly.
- **Discoverable data.** Discoverable data can be more easily located, mapped, and integrated into software systems, analyses, and tools and have the potential to increase the interoperability of emissions estimates as well as the underlying data and emissions factors used to produce them.
- **Metadata requirements.** Metadata increases transparency, traceability, and auditability of GHG accounting and reporting by ensuring that reported emissions values are accompanied by the critical information (e.g., units of measure, data quality, timestamps, data sources) needed to understand how they were developed.

Executive Summary

This roadmap to more interoperable GHG emissions accounting further explores the drivers that necessitate, and the emerging solutions that provide the path toward, interoperability within corporate GHG accounting and reporting.

This *roadmap to more interoperable GHG emissions accounting* further explores the drivers that necessitate, and the emerging solutions that provide the path toward, interoperability within corporate GHG accounting and reporting.

As we continue working with the Carbon Call expert advisory group and others to mature these solutions and attain consensus, companies will be able to better respond to the expanding GHG accounting pressures and better discover, understand, and share data and to compare their data with others' data.





With increasing regulatory pressure—for example, the United States Securities and Exchange Commission’s (SEC) proposed climate risk disclosure rule, the European Union’s (EU) new rules on corporate sustainability reporting—new requirements from financial institutions, and the drive to set emissions reduction targets within the value chain, there is increased urgency for reliable and shareable corporate emissions data and, consequently, greater interoperability of GHG accounting systems.

Purpose of this roadmap

Greenhouse gas (GHG) accounting, a field of expertise that has evolved steadily over many decades, is facing an unprecedented expansion. Building on the establishment of the Intergovernmental Panel on Climate Change (IPCC) in 1988 and the GHG Protocol in 1997, the GHG accounting community has prepared guidelines for GHG inventory development at national, corporate, state, and municipal levels. These guidelines, including the IPCC Guidelines for National GHG Inventories, ISO 14064-1, and Greenhouse Gas Protocol standards, guidance, and tools, provide the basis for every GHG inventory prepared at any scale worldwide. Recently, the momentum for universal participation in understanding and disclosing GHG emissions has been accelerating. With the backdrop of the Paris Agreement, stakeholders from the public and private sectors have made commitments to aggressive emissions reduction targets. These commitments are backed by the calculation and reporting of their contribution to global emissions using a GHG inventory. In response to stakeholder and regulatory pressure, the private sector, in particular, is engaging as never before. As routine reporting of corporate emissions and information exchange needs expand exponentially, new tools will be required to expand the capacity for and increase the efficiency and transparency of reporting.

Such rapid progress toward addressing emissions will exacerbate existing constraints that the GHG accounting field has navigated to date. Specifically, corporate GHG accounting at scale is impeded because it is difficult to combine and share reliable GHG data and estimates. With increasing regulatory pressure—for example, the United States Securities and Exchange Commission’s (SEC) proposed climate risk disclosure rule, the European Union’s (EU) new rules on corporate sustainability reporting—new requirements from financial institutions, and the drive to set emissions reduction targets within the value chain, there is increased urgency for reliable and shareable corporate emissions data and, consequently, greater interoperability of GHG accounting systems. By increasing consistency and interoperability, results from corporate GHG inventories will become more comparable over time. Without increased interoperability, it will remain challenging to track progress against emissions reduction targets across the supply chain and difficult to create a level playing field for adherence to the aforementioned regulatory pressures. These pressures provide a unique opportunity for the community to leverage advances in technology and data management, along with lessons from the field of financial accounting, to improve and accelerate corporate GHG accounting and reporting at scale.

As noted above, important standard-setting and reporting initiatives are underway, most prominently through the GHG Protocol and supplemental standards and resources (e.g., CDP, TCFD, PCAF, and others) that continually improve the reliability of corporate GHG accounting and emissions estimates. However, challenges related to data quality, data comparability, data

Purpose of this roadmap

reporting and measurement semantics, siloed GHG accounting software platforms, and digital infrastructure need to be overcome. Without new advances, it is difficult for companies to combine and share reliable data. According to a [2021 BCG survey](#), only 9% of surveyed companies are able to estimate their emissions comprehensively (full scope). It was estimated that there may be as much as 40% uncertainty in emissions measured by those respondents due to errors in measurement data. Collectively, we need GHG accounting and reporting that is increasingly reliable, interoperable, and up to the task of universal corporate reporting and measurement of progress toward decarbonization.

The Carbon Call

The Carbon Call, a ClimateWorks Foundation-hosted initiative, was launched in February 2022 to mobilize collective action, investment, and resources to strengthen a more reliable and interoperable carbon accounting system for the planet. The Carbon Call builds on, promotes, and helps accelerate ongoing work to improve measurement, reporting, and verification of GHG emissions and removal, primarily for the corporate sector. As of October 2022, the initiative had gathered support from 28 participating organizations and 45 signatories. Participating organizations are active contributors to the mission of the Carbon Call and include leading private sector, scientific, philanthropic, NGO, and inter-governmental organizations. Participating organizations appoint senior experts to guide the development of a roadmap for reliable and interoperable GHG emissions accounting. A full list of the expert advisory group members can be found in the [annex](#). Signatories commit to reporting GHG emissions and offset information according to the latest best practices and to support the enabling conditions for a more reliable global system of interoperable carbon accounting ledgers.



Scope and purpose of this roadmap

With guidance from the expert advisory group, we are developing a roadmap that mobilizes collective action, investment, and resources to address the need for rapid scaling of reliable and interoperable corporate GHG accounting and reporting. Over a two-year period, we aim to

- Explore the ability of different organizations, GHG accounting software platforms, and data providers to exchange GHG data and estimates and to examine the limitations posed by interoperability constraints.
- Assess the science and data needs, explore the opportunities presented by new and emerging technologies for data management and interoperability, and address the identified needs for improving the reliability of GHG accounting.
- Draft initial guidance for improved reliability and interoperability across protocols, platforms, organizations, and the digital data ecosystem that supports them.
- Consider alternative finance and operating models for sustaining an increasingly reliable and interoperable GHG accounting system.

This roadmap reflects the first five months of collective problem solving and addresses the first of the four aforementioned goals: *interoperability*.

Through this roadmap, the Carbon Call seeks to

- Build on and advance ongoing work to improve measurement, reporting, and verification of GHG emissions and removal, primarily for the corporate sector.
- Accelerate efforts to clarify and strengthen the comparability of corporate GHG data and estimates, GHG inventories, and other GHG reports.
- Leverage recent scientific and technological advances in data streams, machine learning, and cloud computing to improve data management and interoperability.

The Carbon Call seeks to complement current standards, protocols, and GHG registries by agreeing to consensus-based ways forward to address key constraints to interoperability and by providing guidelines based on best practices in technology, data management, and finance for companies to follow.

Consequently, this roadmap should be viewed as a supplement to existing transparency initiatives and GHG accounting methods and standards, including the GHG Protocol, relevant ISO standards, and the World Business Council for Sustainable Development's Partnership for Carbon Transparency (including its frameworks and guidelines seeking to standardize emissions accounting and data exchange).



The Carbon Call seeks to complement current standards, protocols, and GHG registries by supporting companies in their progress to adhere to these guidelines by harnessing best practices in technology, data management, and finance.

Improved interoperability can

- **Build confidence** among regulators and financial institutions and support faster and more accurate decision-making by enabling them to take bold steps toward GHG reductions, investments, and the implementation of climate solutions.
- **Increase corporate data accessibility**, transparency, and reliability for companies and governments through anomalies detection and standard quality control checks and procedures as well as by ensuring data are valid and available regardless of jurisdiction or intended downstream use.
- **Accelerate reliable corporate GHG disclosures** while reducing the resource burden for large companies with thousands of business relationships, for small companies with relatively little capacity to manage data, and for companies within supply chains that must meet the requirements of both upstream and downstream partners.
- **Facilitate sharing of new and updated calculation methodologies** and proxy data standards with solution providers, advisory firms, companies, and other stakeholders; verification of these methodologies and standards; and, potentially, crowdsourcing of proxy data and rating of their accuracy.
- **Provide companies with transparent access** to up-to-date, industry-specific, and referenceable emissions factors.

Why interoperability?

Historically, GHG accounting at the corporate level has been neither designed for comparability nor aimed at facilitating data access and sharing. At the national level, however, GHG accounting is supposed to facilitate both comparability (i.e., the global stocktake and the enhanced transparency framework of the Paris Agreement) and data access and sharing. The Paris Agreement mandates that parties follow specific methodologies (i.e., UNFCCC reporting guidelines¹ and IPCC guidelines²), using a tabular format (Common Reporting Format) that facilitates comparable and consistent reporting by all parties. Although corporate GHG accounting has typically been voluntary, some countries are set to regulate large companies to report their emissions with a rigor similar to that of financial disclosures (see [Regulatory context](#)).

This roadmap is focused on the concept of *interoperability*. Interoperability in this context is the ability to compare, share, and use information across GHG accounting and reporting systems and the supporting digital data ecosystem. In the context of the Carbon Call, interoperability means the extent to which results generated by different implementations of GHG accounting principles and processes can be compared, leveraged, or both. Importantly, the comparability of outputs (i.e., emissions results or estimates) is also driven by factors such as data entry (which depends on data availability, transfers, reliability, and compilation), regulatory dependence, scope, and resources.

GHG accounting allows corporations to apply methodological choice, i.e., to apply the appropriate GHG accounting methods using different variations and input data, even when following similar standards and protocols. The approach to and interpretation of interoperability should be discussed from both the activity data entry side (GHG data compilation) and the results side (e.g., emissions estimates preparation).

There is now considerable momentum to drive increased rigor in GHG accounting and reporting and to do so on tighter timelines. We will never achieve perfect uniformity, and we do not need to. Interoperability does not require uniformity but rather requires design for the comparison and translation of digital information across different systems.

Interoperability is critical for data accessibility, transparency, and reliability (across corporate value chains). Strengthening our GHG accounting and reporting system is urgently needed if we are to take effective action to reduce GHG emissions drastically and quickly. We cannot make decisions about products and services or companies on the basis of a GHG report, inventory, or carbon footprint if we cannot understand, verify, or use the data in a timely manner.

1 The United Nations Framework Convention on Climate Change was adopted in 1992 with the core objective to stabilize greenhouse gases in the atmosphere at a level that will prevent dangerous human interference with the climate system. To facilitate standardized and thus comparable national accounts of emissions, the UNFCCC developed reporting guidelines for annual GHG inventories (<http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf#page=2>).

2 The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body in charge of assessing the latest science related to climate change. The IPCC Task Force on Inventories (TFI) developed the standard for national-level GHG accounting, outlined in the 2006 Guidelines on National Greenhouse Gas Inventories (<https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html>) and the 2019 Refinement to the 2006 Guidelines for National Greenhouse Gas Inventories, which presents scientific advances in GHG accounting since 2006 (<https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html>).

Progress to date is reflected by the following milestones in 2022:

- **APRIL:** A chair (Marian Van Pelt, ICF) and a co-chair (Liv Watson, Capitals Coalition) were appointed to steward the expert advisory group. Participating organizations were invited to nominate one individual to the expert advisory group to support development of the roadmap.
- **MAY:** The Carbon Call held a kick-off meeting with the expert advisory group to identify key constraints to strengthening interoperability. This workshop elicited a prioritized set of constraints outlined in chapter 3. Participants offered their unique perspectives and expertise in proposing initial ideas for the most achievable and impactful solution areas that form the roadmap's foundation.
- **JUNE:** The Carbon Call shared a proposed roadmap outline with the expert advisory group.
- **JULY:** The expert advisory group was asked to submit case studies describing the interoperability, data sharing, and other challenges faced during creation of complete GHG emissions accounts and the impact of these challenges on the reliability of GHG accounts.
- **AUGUST:** The Carbon Call reviewed use cases and developed the first draft of the Carbon Call roadmap.
- **SEPTEMBER:** The Carbon Call shared the draft with the expert advisory group and a workshop was held during Climate Week NYC to discuss quick wins, recommendations, and solutions.
- **OCTOBER:** The Carbon Call shared a draft with Carbon Call signatories.
- **NOVEMBER:** At COP27, the Carbon Call will launch version 1 of the Carbon Call roadmap.

Process and engagement to date

Development of this roadmap is driven by ClimateWorks and the ICF Climate Center, with direction and guidance from the expert advisory group. The expert advisory group is a group of senior experts nominated by the participating organizations to the Carbon Call.

These senior experts bring interoperability expertise across the GHG accounting system. The expert advisory group contributed to the evolution of the roadmap to incorporate diverse expertise regarding description of the constraints, impacts, and potential solutions that the Carbon Call recommends be addressed as a priority by the GHG management community.

How to apply the Carbon Call roadmap

The primary audience for this roadmap includes corporate decision makers and sustainability teams that wish to address the most common constraints to greater interoperability in GHG accounting and reporting, thereby minimizing the constraints' impacts on the accuracy of GHG emissions accounts and related decision-making. These constraints are brought to life through practical examples and proof points from case studies sourced from the Carbon Call's participating organizations, allowing readers to identify with real-life experiences from peers and to rally behind common solutions.

Although the Carbon Call and this roadmap are predominantly focused on corporate GHG accounting, the roadmap serves the wider GHG accounting and reporting ecosystem. As laid out in the next section, GHG accounting involves a complex ecosystem with many interlinkages not just between GHG solutions providers and corporations, but also among regulators, standard setters, governments, and other parties.

This roadmap discusses how increased interoperability can provide a path forward and suggests several quick wins and recommendations that enjoy support from Carbon Call's participating organizations. Going forward, we hope to rally support from Carbon Call signatories and others. This roadmap is, therefore, also a call to action—a call to join the Carbon Call and to rally behind shared goals and solutions to move forward and mobilize collective action, investment, and resources to strengthen a more reliable and interoperable GHG accounting system for the planet. By identifying related initiatives to improve GHG accounting, this roadmap seeks to elevate and accelerate complementary efforts.

A Call to Action

This roadmap is a call to join the Carbon Call and to rally behind shared goals and solutions to move forward and mobilize collective action, investment, and resources to strengthen a more reliable and interoperable GHG accounting system for the planet.

Understanding key terms

At the heart of the Carbon Call roadmap are two key concepts: interoperability and reliability, which we define as follows:

- **Interoperability:** the ability to compare, share, and use information across GHG accounting and the supporting digital data ecosystem. In the context of the Carbon Call, interoperability means the extent to which results generated by different implementations of GHG accounting principles and processes can be compared, leveraged, or both. Many corporate GHG reports use different interpretations and data, even when following similar standards and protocols. There is now considerable momentum to drive comparability and alignment. We will never achieve perfect uniformity, and we do not need to. Interoperability does not require uniformity but rather requires design for the comparison and translation of digital information by different systems.
- **Reliability:** the availability, accuracy, and consistency of the data used to prepare, and the outputs of, GHG accounting. For example, uncertainties regarding GHG emissions and removal data and their interpretation may lead to misrepresentation of reported emissions, making it difficult to assess the speed with which GHG emissions are being reduced and the true effectiveness of decarbonization actions. With better incorporation of data collection procedures and evolving standards and protocols, the process and methodologies for emissions measurement, verification, and accounting can be further improved and can over time help close the gaps in comprehensive reporting of emissions.

The roadmap leverages the “TRACCC” principles of GHG accounting:^{3, 4}

- **Transparency:** Transparency refers to the degree to which information on the processes, procedures, assumptions, and limitations of the GHG inventory are disclosed in a clear, factual, neutral, and understandable manner based on clear documentation and archives (i.e., an audit trail).
- **Accuracy:** Accuracy refers to the principle that data should be sufficiently precise to enable intended users to make decisions with reasonable assurance that the reported information is credible. GHG measurements, estimates, or calculations should be systemically neither over nor under the actual emissions value, as far as can be judged, and uncertainties should be reduced as far as practicable. The quantification process should be conducted in a manner that minimizes uncertainty.
- **Consistency:** Consistency refers to the use of consistent methodologies to allow for meaningful comparisons of emissions over time. Any changes to activity data, emissions factors, inventory boundary, calculation methods, or any other relevant factors over the course of the time series

³ World Resources Institute and World Business Council for Sustainable Development, *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard*, <https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf>.

⁴ IPCC, *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, <https://www.ipcc.ch/report/2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/>.



At the heart of the Carbon Call roadmap are two key concepts: **interoperability** and **reliability**.

Purpose of this roadmap

are transparently documented and justified.

- **Comparability:** Comparability refers to the ability to compare activity data, emissions estimates, and GHG reports and information produced by an entity to those produced by other entities within the same accounting system boundaries.
- **Completeness:** Completeness refers to the principle that all relevant emissions sources within a chosen GHG accounting boundary should be accounted for so that a comprehensive GHG account is compiled.
- **Relevance:** Ensure the GHG inventory appropriately reflects the GHG emissions of the company and serves the decision-making needs of users – both internal and external to the entity.

The roadmap will provide a pathway to improve the information corporations and other stakeholders use to assess GHG emissions. A variety of terms are used to describe GHG emissions reports. The two most common are GHG inventory and carbon footprint. The roadmap uses these terms interchangeably.

- **GHG inventory:** A GHG inventory is a list of GHG emissions sources and the associated GHG emissions quantified using standardized methods.
- **Carbon footprint:** Carbon footprint refers to the total amount of GHGs emitted into the atmosphere each year by a company and expressed as carbon dioxide equivalent.
- **Product life-cycle accounting:** Compilation and evaluation of inputs, outputs, and potential environmental impacts of a product system throughout its life cycle.
- **Emissions factors:** A representative value that attempts to relate the quantity of emissions released to the atmosphere with an activity associated with the release of those emissions.
- **Activity data:** Data (e.g., fuel consumed, electricity purchased) for emissions-generating activities that, when multiplied by a corresponding emissions factor, result in an emissions estimate.
- **Methodologies/methods:** Standardized processes and procedures to calculate emissions using emissions factors and activity data as inputs.
- **GHG report:** Submission, sharing, or disclosure of data and information pertaining to estimated, measured, or monitored GHG emissions, such as a GHG inventory or carbon footprint. GHG reports are often prepared to support public disclosure of GHG emissions for voluntary, statutory, or regulatory purposes.
- **Product environmental footprint:** A measure of the environmental performance of a good or service throughout its life cycle, taking into account its emissions in each part of the supply chain.



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Direction of travel

The confluence of international climate standards and regulatory requirements to ensure ESG disclosures and the convergence of financial reporting and ESG impact reporting are likely to move GHG accounting, reporting, and disclosures toward a more robust data capture, management, control, and reporting process—one akin to that already in use for financial data.

Regulatory context

Regulations are progressively shaping sustainability management and reporting and changing how companies do business in different jurisdictions. Multiple authorities are increasing requirements on corporations to disclose climate risk, including GHG emissions. This trend increases the pressure on corporations to accurately track, disclose, and manage their emissions and underlying activity data.

Environmental reporting is regulated broadly through environmental, social, and corporate governance (ESG) regulations, which differ by region and which may require reporting of information, like energy use data, which may be useful for GHG accounting. GHG reporting is a specific form of environmental accounting and relates to statutory and non-statutory public disclosure of information on greenhouse gases released as a result of a company's activities. The confluence of international climate standards and regulatory requirements to ensure ESG disclosures and the convergence of financial reporting and ESG impact reporting is likely to move GHG accounting, reporting, and disclosures toward a more robust data capture, management, control, and reporting process—one akin to that already in use for financial data. Users' growing expectation that sustainability reporting and financial reporting will be linked only strengthens their expectation of audits and consequently their need for a data management ecosystem for GHG accounting.

Each of the below-noted regulatory and oversight authorities seeks technology-driven solutions to develop machine-readable data to support effective and efficient compliance.

Securities market authorities

Some companies or boards of directors of companies are already reporting and disclosing sustainability and GHG data. This activity has supported accountability to shareholders and has helped companies more clearly define their purpose and describe their impact for a broad group of stakeholders. Companies are seeking the ability to communicate and assess the effects of carbon-related business activities to inform the financial community and, by extension, support sustainable finance systems and economies.

Concerned that voluntary climate and carbon disclosures fail to adequately protect investors, securities market regulators are establishing additional disclosure requirements to provide consistent and comparable information to markets. An increasing number of governments have mandated statutory GHG emissions reporting and have further strengthened national and international regulatory enforcement processes and actions. Today, approximately 40 countries, including the European Union (EU), Australia, Japan, South Africa, the United Kingdom (UK), and the United States, mandate some form of organizational GHG emissions reporting.⁵

Financial auditing and assurance

Historically, GHG accounting (1) has been decoupled from the financial statement audit process and (2) from a financial auditor's perspective,⁶ has been reported on the basis of **limited assurance**—meaning that the information provided is not found to be materially misstated. Limited assurance requires less evidence than **reasonable assurance**, which is typically the bar for financial statement audits and which indicates that the information provided is reasonably stated.

Looking forward, it is likely that sustainability and financial reporting assurance will no longer be decoupled and that this change will impact GHG accounting, reporting, and disclosures. For example, the International Auditing and Assurance Standards Board (IAASB) is actively working on a project to develop sustainability audit standards that address and prioritize audit and assurance needs for many stakeholders, in particular investors, regulators, and non-governmental organizations. The growing expectation that sustainability reporting and financial reporting will be linked only strengthens the expectation of audits. Accordingly, climate-related risks are likely to be considered a key audit matter (KAM) or a critical audit matter (CAM) for the board of directors—one potentially subject to disclosure.⁷



It is likely that sustainability and financial reporting assurance will cease to be decoupled and that this change will impact GHG accounting, reporting, and disclosures.

5 Some jurisdictions also require large companies to report their environmental and social impact. In the EU, this activity, called non-financial reporting, is covered under the Non-Financial Reporting Directive, or Directive 2014/95/EU. It is limited to public interest companies, such as banks and insurance companies, with 500 or more employees, currently some 6,000 companies. But it will apply to nearly 50,000 companies under the new Company Sustainability Reporting Directive (CSRD), starting in 2024. On March 22, the U.S. Securities and Exchange Commission (SEC) issued a proposed climate risk disclosure requirement that would require companies to disclose information about financial and business risks posed by climate change. The final requirement is expected to be published by November 2022.

6 Audit services are generally performed in accordance with International Audit Standards (as published by the International Auditing and Assurance Standards Board) by audit professionals, the regulated individuals who and organizations that examine the accuracy of recorded business transactions.

7 A critical audit matter is defined as any matter arising from the audit of the financial statements that was communicated or required to be communicated to the audit committee and that (1) relates to accounts or disclosures that are material to the financial statements and (2) involves especially challenging, subjective, or complex auditor judgment.

Direction of travel

Regulators are likely to adopt international sustainability standards (or regional ones in the case of the EU or country ones in the case of the SEC), thereby raising the importance of sustainability data being captured, managed, controlled, and reported in a manner akin to that already used for financial data. As an example, within the United States, the Public Company Accounting Oversight Board (PCAOB) has explicitly stated that its 2022 focus will specifically include climate-related risks and climate changes that may materially impact a reporting entity's financial statements.⁸ As one of its thematic review areas for 2022–2023, the UK's Financial Reporting Council (FRC) has chosen the Task Force on Climate-related Financial Disclosure (TCFD) Reporting and Climate-related Reporting in Financial Statements.

Environmental regulatory authorities

Environmental regulatory authorities are taking steps to obtain the data necessary from companies to allow policy makers and other stakeholders to understand the nation's total aggregated emissions and to take action where required. This effort, which will impact companies of all industries and sizes, includes understanding the sources and types of emissions, down to individual facilities.

One challenge: in some geographies, regulations are fragmented between state or provincial regulatory agencies and those of federal or national environmental regulatory agencies which impacts businesses of all sizes for their carbon reporting and disclosures. In the United States, the federal government has an agency specifically devoted to environmental protection, the Environmental Protection Agency (EPA), which, through the GHG Reporting Program (GHGRP), requires mandatory reporting of GHG emissions by large emitters. Once the U.S. SEC finalizes its proposed rule that would require public companies to report GHG emissions, it is possible that companies may face two different sets of emissions reporting or disclosure requirements regarding temporal, physical, or operational boundaries, methods, and emissions factors. Moreover, these boundaries, methods, and emissions factors may differ from those specified for voluntary reporting to entities such as CDP.

Financial regulatory authorities

The financial sector is undergoing significant regulatory reforms to move toward “sustainable” finance. Political initiatives such as the European Union's Green Deal or Switzerland's Responsible Business Initiative (RBI) highlight the societal and political realization that action is needed, and they do so within the context of a global community.

For example, the European financial sector, which consists of 6,701,615 employees and contributes 16 percent of the European Union (EU) GDP,

⁸ The PCAOB registers public accounting firms that prepare audit reports for issuers and for SEC-registered brokers and dealers; establishes or adopts auditing and related attestation, quality control, ethics, and independence standards; and inspects registered public accounting firms' audits and quality control systems, among other activities.

Direction of travel

is at the heart of the current EU regulatory debate on how to support the transition to a low-carbon, resource-efficient, and sustainable economy. Annual investment of €180 billion or so is needed to achieve the EU's targets for energy and climate policy alone. Consequently, labor market demand for professional finance expertise in this space and demand for businesses and projects to deliver on sustainable ESG practices are rising rapidly.



The acceleration of automated analysis of critical data provides substantial economies of scale and competitive advantages.

Authorities' need for tech-driven data solutions

Digital machine-readable data affords regulators, central banks, tax authorities, investors, and analysts of all kinds the ability to understand risk, compliance, and relative performance. The data are increasingly digital and standardized (at a technical level) to drive standard business reporting regimes into policy making. Recently, regulations have begun to embed requirements to ensure the veracity of GHG data and estimates.

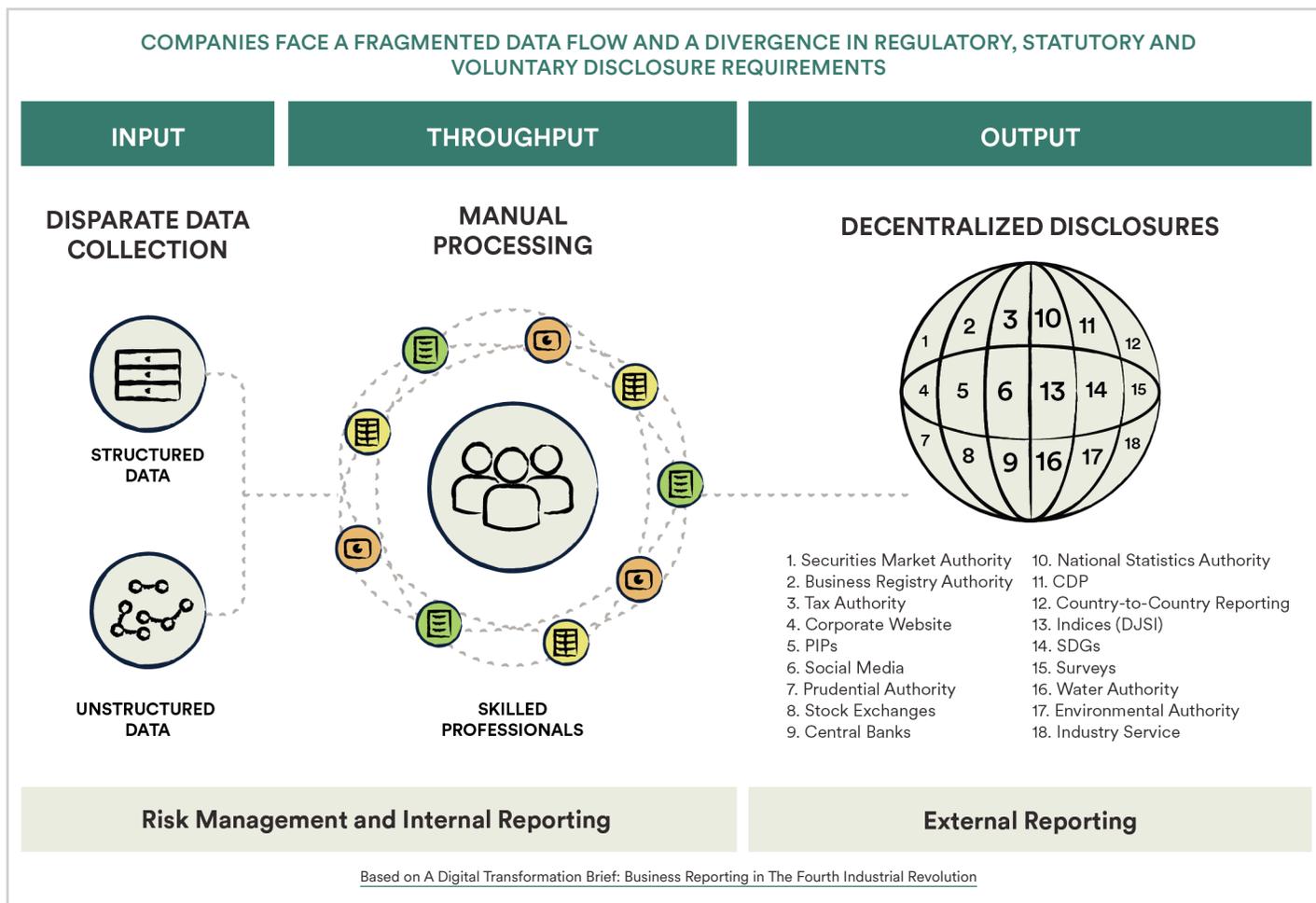
The regulatory shift is being supported and accelerated by a tech- and data-driven approach for monitoring activities, with machine-readable data and the power of computing algorithms to run checks, keep records, and systemize processes. For example, regulators in more than 60 countries have mandated using XBRL-based open digital business reporting standards for reporting across more than 200 reporting domains from SEC reporting in the United States to EDINET reporting in Japan, Superintendencia de Sociedades reporting in Colombia, ECB reporting in Europe, and ATO reporting in Australia, to name but a few. The SEC has stated that on any given day, as much as 85% of the iXBRL data in the SEC's Electronic Data Gathering, Analysis, and Retrieval (EDGAR) system is visited by bots and the iXBRL data are therefore more discoverable and avoids much of the risk of human error. The acceleration of automated analysis of critical data provides substantial economies of scale and competitive advantages. Technologies and computing have dramatically increased processing speeds and volumes of information sent between entities and regulators.

Innovation in data-capture technologies is accelerating the accurate capture of carbon data, which auditors need for their assurance work. These technologies include Earth-observation (EO) technology (e.g., remote sensing satellites, unmanned aerial vehicles or UAVs orbiting the planet) and the Internet of Things (IoT) (e.g., ground-based smart connected meters, real-time sensors, and actuators). They offer the promise of advances in data collection for monitoring climate change, mitigation effects, and reporting.

The GHG accounting data ecosystem

As the regulatory focus on GHG reporting intensifies, companies are subject to an increasing amount of localized, and sometimes fragmented, regulatory regime changes, legislation, reviews, audits, and queries. The ramifications of failing to satisfy the reporting demands of regulators are costly: penalties, undesirable news coverage, the cloud of operating under a MRIA (Matter Requiring Immediate Attention), or, in some cases, suspension of operating licenses.

A real challenge companies face in meeting regulatory reporting and disclosure requirements is that GHG data represent only one data stream within the sustainability data ecosystem. The global corporate sustainability reporting ecosystem is fragmented with respect to data formats, modes of submission, data definitions for certain common elements, business validation rules, access controls, and validations for similar reporting elements across different forms and regulators. There is currently no alignment of input, throughput, and output across various GHG accounting and data management systems. Alignment often requires manual data intervention to ensure that the output of one system is reprocessed in the correct format to be validated for submission to the next system. It is further connected to multiple output reports, where the need to ensure a single source of truth is essential for auditors.



Direction of travel



The assembling, dismantling, and repackaging of carbon data in the required format can cause compliance issues and unintentional information filing errors.

For example, the data from a regulated entity’s enterprise resource planning (ERP) software needs to be compiled and repackaged to meet a regulator’s “form” and “data format” requirements for filing submissions. Seamless integration of internal and external interfaces depends on codified and universal digital standards for data generation, validation, and sharing. One of the most common challenges is dealing with different data types. Data held in an ERP system often must be converted into a different data type in order to be transmitted to another system. Different regulators require the same information in their specific formats or data types. Surprisingly, some individual regulators call for the same information in different forms and in different data formats. The assembling, dismantling, and repackaging of carbon data in the required format can cause compliance issues and unintentional information filing errors.

Further complicating the GHG data ecosystem are the myriad stakeholders involved in GHG accounting. A preliminary analysis of GHG accounting stakeholders revealed at least 13 distinct stakeholder groups.⁹ Incompatible GHG accounting approaches impair comparability, cross-jurisdictional disclosure, and supply chain data flow among and within stakeholder groups. Each supplier within a supply chain may have applied its own unique estimation methods, emissions factors, and quality assurance controls. Additionally, each supplier may have stored data using its own standards, data formats, and units. Adoption of common codified standards—including machine-readable data creation and exchange across all stakeholders within the compliance ecosystem—could result in a giant leap toward coherence and comparability among GHG accounting stakeholders.

GHG ACCOUNTING STAKEHOLDER GROUPS

Stakeholder Groups
1 Carbon initiatives
2 Carbon indexes and rating providers
3 Software and solution vendors
4 Advisory firms
5 Auditors—internal and external; financial and non-financial
6 Investors and asset managers
7 Regulators
8 Standard setters—frameworks, principles, and guidelines
9 Certifying bodies
10 Carbon markets
11 Carbon metadata management standards
12 Carbon philanthropy and funders
13 Data management frameworks

⁹ The GHG accounting stakeholder group categorization is subjective and incomplete given the dynamic GHG accounting landscape. The information presented here is intended to provide the reader with a conceptual understanding of the complex landscape companies face when accounting for GHG emissions.

Challenges and impact



I DON'T UNDERSTAND YOU



I DON'T TRUST YOU



YOU DON'T HAVE EXACTLY WHAT I NEED



I CAN'T FIND YOU

Overview of key constraints

The Carbon Call roadmap has identified four primary constraints that companies face when gathering, interpreting, and sharing data and information and performing analyses to prepare GHG estimates. Unlike other types of constraints that companies encounter in managing GHG data and preparing emissions estimates—from lack of resources to lack of incentive—these four constraints are those that can be minimized through interoperability. They point to the reasons that our systems are as yet not interoperable.

Constraint 1:

“I don’t understand you.”

Often, the barrier is simply that the language being used varies. Organizations may call the same data—whether activity data elements such as units of energy or categories of emissions—different names. They may call different data the same name. Recommendations focus on improvements in taxonomies and machine-readable information.

Constraint 2:

“I don’t trust you.”

Organizations must be able to assert that their GHG data and emissions estimates are accurate, and they also need to rely on their emissions data to make decarbonization investments. So, it is critical that they use only trustworthy information, thereby producing robust inventories to make business decisions. Trust can take many forms, from securing information so that it cannot be manipulated or changed, to understanding the genesis of information or the assumptions underlying it. Examples of untrustworthy data include activity data without source documentation or citations, information that is highly aggregated, data with unexplained assumptions, or data lacking timestamps or descriptions of geographic coverage.

Challenges and impact

Although it is understandable that there might be some assumptions in GHG accounting, this roadmap aims to avoid any uncertainty associated with those assumptions. Any assumptions must be precisely documented. Recommendations focus on the principle of transparency. They might include developing data handling and archiving protocols, standardizing documentation processes and metadata, filling or explaining identified data gaps, disaggregating data, and establishing and documenting verification processes.

Constraint 3:

“You don’t have exactly what I need.”

Every organization must make choices about how to spend limited time when compiling and managing GHG data and preparing emissions estimates. Deciding which calculation method to use, which activity data and emissions factors to use, whether to include a given emissions source, and so on often hinges on data availability. Furthermore, if the emissions information available is not exactly the information needed—for example if it’s aggregated, applies to a slightly different process, or is relevant to a different region with similar circumstances—the approach may need to be changed or justify its use and applicability accordingly.

Constraint 4:

“I can’t find you.”

Organizations around the world are increasingly capturing information related to GHG emissions. The quantity of information being collected and generated is vast, but this information can be hard to find. Furthermore, data can be located behind paywalls or on sites that have high financial barriers to entry. Difficulty in locating and accessing data can lead to duplicative efforts simply because organizations are not aware that their problem is being solved elsewhere. Information on emissions from industries across all sectors is not reaching those who need it.

All of these constraints impact the reliability of an organization’s GHG data and emissions estimates. The consequences can be significant. Resolution is lost, which inhibits business decisions that rely on the underlying data. Preparation of a complete GHG report may not be possible, creating an incomplete picture of an organization’s emissions and related risks and opportunities. As regulations requiring GHG reporting proliferate, organizations may fall out of compliance, with negative impacts on their credibility and bottom line.

A host of challenges is associated with the above-noted constraints and their impacts on GHG data and emissions estimates. Some of these challenges are described below to illustrate companies’ experiences as evidenced by case studies collected by the Carbon Call’s expert advisory group.



A host of challenges is associated with these constraints and their impacts on GHG data and emissions estimates, some described here to illustrate companies’ experiences as evidenced by case studies collected by the Carbon Call’s expert advisory group.



I DON'T UNDERSTAND YOU

The fundamental issue of “I don’t understand you” arises when different words or metrics are used to describe the same things, when the same term means different things, or when the definition of words is unclear or vague, setting the stage for differing interpretations.

Vocabulary constraints: I don’t understand you

Description of the challenge

The fundamental issue of “I don’t understand you” arises when different words or metrics are used to describe the same things, when the same term means different things, or when the definition of words is unclear or vague, setting the stage for differing interpretations.

This issue is magnified when information starts to move from one system to another because each system or step in the information supply chain can add yet another layer of interpretation.

It is unsurprising that the result is an alphabet soup of terms, definitions, metrics, standards, directives, protocols, guidance, and frameworks that lack interconnectivity.

For example, many companies produce reports about their GHG emissions for each scope, optionally disaggregating those emissions by source. These reports, regardless of industry sector, sometimes use different units of measurement for emissions (tons, tCO₂, tCO₂e, MtCO₂e, 000 tCO₂e). There is no unit standardization, meaning it can be challenging to know the precise unit of measurement in a specific report value when that value is read by a machine or used to produce comparative peer reports.

Information moves from those who compile and manage source GHG data and prepare emissions estimates to users working with their own form and terminology. Within today’s GHG accounting landscape:

- A company’s GHG value chain data is fraught with information gaps and issues that limit the usefulness of the data for decision making. The GHG information flows lack meaningful data that embed findability, accessibility, interoperability, and reusability built on a smart, shared vocabulary (i.e., a vocabulary that systematically links concepts, components, and metrics throughout information flows).
- A lack of cohesion in carbon standards, frameworks, and guidance across regulatory regimes results in higher entity and regulatory costs in terms of time and resources. It further weakens the auditability of information disseminated to regulators, which increases stakeholder risk resulting from increased subjectivity, differences in interpretations, misinformation, and inadvertent partial compliance or noncompliance.
- Markets, sustainability standard-setting boards, regulators, government authorities, policy makers, and industry initiatives using “bespoke” standards and data definitions for similar carbon data elements and concepts.
- Some GHG accounting systems provide the flexibility to report emissions at any frequency/time of the day/year, and these systems are not optimized to track consistency in GHG inventories, even if they use the same smart vocabulary.

Challenges and impact

Data management and governance processes ensure that data are collected, processed, stored, reported, and archived in a manner fit for purpose. To illustrate: information moves akin to a production assembly line. Pieces of information move from one station to another, from energy supplier to customer (for instance). At each production line station, the information is quality checked and validated, and then, either moved into the final product or passed along as an input into the next stage of the information assembly line. Throughout the production line, original data specifications and the quality of each attribute must be maintained to ensure the integrity of the final product. In other words, information must be standardized to ensure interoperability at each link within the information supply chain. This effort includes developing and using a shared vocabulary that builds on existing best practices.

Impact

The GHG accounting information on business activities that is needed by governments and other stakeholders has become more complex and diverse. Demand is increasing from a variety of agencies and public initiatives. The requirements can be confusing because different terms or concepts might refer to the same or similar pieces of information—or the same term can be used for different information. For example, “embodied carbon” may refer to upstream materials- and processes-related carbon, but sometimes includes downstream, end-of-life emissions. The information needed resides in business systems throughout the organization, and not necessarily in structured and controlled systems, so it must be analyzed, assembled, reformatted, modified, or re-entered before being sent to government agencies or other stakeholders.

Stakeholders tasked with aggregating, comparing, and contrasting reported GHG emissions data need to be able to accurately identify and normalize the unit of a given GHG emissions figure. Only then can reports using GtCO₂e and those using tCO₂e be compared with confidence and subsequently produce comparative peer reports.

In the context of GHG accounting information, data collection requires a high level of accuracy and precision as well as alignment with a shared smart dictionary; otherwise, data analytics, measurement, reporting, and decision-making become unreliable.

Evidence from case studies

Interoperability issues arising from non-standardized vocabulary result in both miscommunications among reporting entities and lost efficiency due to the extra effort required to normalize data to create comparable units. There is a good bit of overlap between the “I don’t understand you”/vocabulary constraint and other constraints, such as “I don’t trust you.” Issues arising from the “I don’t understand you” constraint are illustrated below.

Challenges and impact

CONSISTENCY AND COMPARABILITY

Without standardizing vocabulary around the supply chain, data aggregation poses challenges. Use of different vocabulary poses a real challenge in data exchange, aggregation, and comparison when reporting emissions. These challenges especially affect reporting by companies situated in the middle of a complex value chain and quantification of scope 3 emissions because they add complexity to an already resource-intensive calculation process. Facilitating data exchange is important for both calculation of emissions impacts and incentivization of emissions reductions based on those impacts. Data may need to be transformed at multiple points in the value chain; interoperable tools and systems would greatly facilitate this process. Issues related to data vocabulary and other constraints must be resolved without significant burden at each point in the value chain.

UNIT TRANSLATION MECHANISM ISSUES

Today, some emissions figures do not have an obvious unit specified.

Expert advisory group case study

UNIT TRANSLATION MECHANISM ISSUES

Many companies produce GHG emissions reports for each scope, preferably broken down by source. These reports, regardless of the business sector, use different units for emissions. Although reporting unit conventions exist (e.g., MTCO₂e), there are no standardized or universally applied units used across all corporate GHG reporting, a situation that can result in interpretation and transcription errors. Similarly, activity data used to produce GHG reports are collected and provided in many different units, which is to be expected. However, the unit is often unclear or ill-defined; for example, natural gas consumption units can include MMBtu, MBtu, kbtu, mcf, therms, and so on. This lack of clarity can be a problem for emissions calculations and reporting for companies that are using machine learning or other tools to streamline the data collection and reporting process. The data collection techniques and units of measure for each source need to be known and machine-readable so that aggregations are accurate and can be described with a stated precision.

MISALIGNED REQUIREMENTS AND AVAILABLE METHODOLOGIES

Most existing emissions accounting methods are substantial underestimates. Recent aerial and satellite-based surveys have made it very clear that methane emissions from the fossil fuel system are in some cases several times the currently reported rate. This is true internationally.

Expert advisory group case study

MISALIGNED REQUIREMENTS AND AVAILABLE METHODOLOGIES

Greenhouse gases are typically estimated using activity data and emissions factors instead of direct measurements taken at the emissions sources. To verify GHG estimates, oil and gas companies often employ additional emissions measurement technologies, such as aerial and satellite-based surveys. Unfortunately, these surveys often find that current GHG estimation methods underestimate methane emissions. Companies find themselves in a difficult situation. Current government regulations require them to report their emissions on the basis of estimates. If they report survey results for the sake of transparency, they create the impression that they are purposely reporting the lower emissions values to the government and take the risk that customers and stakeholders will complain about the emissions, which, again, may be higher than estimates. Potential negative consequences such as these undermine advances in emissions measurement technology, which help move society toward more accurate GHG accounting. These negative consequences owe to the general public's misunderstanding of how GHG

Challenges and impact

accounting works and how improvements in emissions measurements lead to more accurate, albeit often higher, results. This misalignment between companies producing GHG Inventories and the audience who uses the resulting information needs to be addressed.

INCONSISTENT UNITS OF MEASURE

Unified vocabulary, trusted metrics, and [easy-to-find] methodological choices and data needs could go a long way in facilitating this type of research.

Expert advisory group case study

DATA EXCHANGES ACROSS SUPPLY CHAINS AND COUNTRIES

We cannot make decisions about products, services, or companies based on carbon footprint if we cannot understand or use the data.

Expert advisory group case study

INCONSISTENT TERMS

Many systems are introducing new naming conventions to the hierarchy to facilitate user interaction within the tool.

Expert advisory group case study

INCONSISTENT UNITS OF MEASURE

Reconciling inconsistent use of units of measure by different companies can be time- and resource-intensive for researchers and recipients of data within the value chain. Unclear and inconsistent vocabulary poses a particular challenge to this work.

DATA EXCHANGES ACROSS SUPPLY CHAINS AND COUNTRIES

Exchanging data across the supply chain poses challenges to GHG accounting, especially when companies in many different industries and countries are involved. As data are exchanged, differences in vocabulary and differences in reporting structure to meet the requirements of various regulations often reduce understanding and use of the exchanged data. Consequently, companies at any level of the supply chain are burdened with performing additional transformations and quality assurance/quality control when collecting, giving, or receiving data. As data are exchanged across the supply chain, it is important to document the chain of custody, the ways that the data have been transformed, and additions to the dataset. The relative uncertainty of emissions factors varies. Some factors, such as upstream oil and gas, have high uncertainty, whereas the combustion-only emissions from combusting a gallon of fuel are more standardized and well-known. As yet, no solid or widely adopted tools ease the sharing of data by companies across the supply chain. Such tools would ensure that issues such as inconsistent vocabulary across the supply chain do not hinder the creation of accurate GHG Inventories.

INCONSISTENT TERMS

Client-facing GHG management systems commonly use new naming conventions that are not consistent with protocols and guidelines. For example, the terms for emissions sources and categories may differ. Consequently, tracing GHG management systems back to the protocols and guidelines used to develop them is difficult, as is building GHG inventories and comparing results once they are finalized.



I DON'T TRUST YOU

When sharing and receiving data in the process of developing a GHG report, corporations will only use data that they trust. The meaning of “I don’t trust you” depends on the level of distrust.

Validity constraints: I don’t trust you

Description of the challenge

When sharing and receiving data in the process of developing a GHG report, corporations will only use data that they trust. The meaning of “I don’t trust you” depends on the level of distrust. On one end of the spectrum, is distrust based on a history of purposeful deception or reputational dishonesty. In the middle of the spectrum is distrust based on data preparation or sharing at the lowest cost with the minimum compliance effort, that is, data preparation or sharing that merely “checks the box,” perhaps due to lack of resources or training or to little internal cooperation by those involved in the GHG estimates. Distrust can stem from intentional or non-structural actions. Distrust can’t be mitigated until the foundation of the distrust is resolved by influence, that is, peer pressure or regulation.

The most common cause of distrust is unintentional. This cause has roots deeply buried in how data are handled as they flow downstream from their sources. Unless data are sourced directly from a highly accurate device or method, for example, a digital meter or stoichiometric calculations, the data are a composite from disparate aggregated sources that are difficult to verify without contextual metadata. So, in this case, saying, “I don’t trust your emissions data,” is more accurate than saying “I don’t trust you.” The distrust is not likely personal.

Not all data that seem untrustworthy were shared with a desire to be deceptive, but rather reflect a privacy requirement or mandate. Furthermore, challenges with trust can stem from exactly the issue this roadmap is working to resolve: numerous as-yet non-standardized systems that have major information gaps and that require significant manipulation based on assumptions to arrive at a final figure. Regulatory or competitive constraints may hinder fully transparent data sharing. The resulting lack of transparency about how data were collected or aggregated makes use of the data in emissions mitigation and business decision-making on that data difficult. Even if the data seem to be transparent and are accompanied by claims of verification, their use, absent structural evidence, relies on the assumption that they were verified and were not tampered with or mishandled in their journey through the value chain.

Reluctance to trust information can also stem from lack of clarity about the genesis of the data being received. What spatial, temporal, scope, or other boundaries were used? What methods were used? How were assumptions introduced? How were emissions information and data transformed or interpolated?

Challenges and impact

EVIDENCE FROM CASE STUDIES

Heavy use of estimation and averaging by third parties also leads to inaccuracy and decreases trust:

Supply chain data often need a 3rd party to provide to customer, which can cause delay in data accuracy, is not specific to customer or allocated, and causes trust issues as it is self-reported.

Expert advisory group case study

A lack of metadata for data received leads to blind spots:

Chain of custody: Carbon footprint data has to be maintained across many different transaction points, adding data along the value chain as products are moved and transformed very differently across different types of businesses and countries. It is important that we can provide clear chain of custody information (data history) ...

Expert advisory group case study

When metadata is supplied, there is no standard schema for this data, leading to wide variations in quality:

GHG accounting systems must distinguish activity data and emissions factors with robust data quality checks and data sources tracking.

Expert advisory group case study

Impact

A good portion of the GHG data with which organizations must work is not internal data. Interpretation of external data and resultant emissions estimates may unintentionally perpetuate distrust downstream. Interpretation of the validity of external data is difficult because the data are aggregated, not cited, and reflect unverified assumptions. In addition, the interpolation or methodology used is not transparently documented at every step along the way.

As an example, an apparel manufacturer that would like to estimate the carbon embodied in its products may rely on emissions estimates reported by suppliers at each stage of the production process. Production stages can include raw material extraction (e.g., cotton), raw material processing (e.g., yarn), material production (e.g., fabric), and finished production (e.g., apparel). Each stage of the process may involve different suppliers using different types of activity data, applying different emissions factors, and making different methodological assumptions. The independent decision-making and underlying assumptions can be lost in the supplier's reported emissions estimates—reducing the apparel manufacturer's confidence in its final estimates.

As a consequence, organizations that prepare GHG estimates may reject data that could improve the accuracy, resolution, or completeness of their accounting. The effects of assumptions made during interpretation and aggregation perpetuate a decrease in accuracy of data downstream. In addition, there is a systemic burden across the GHG accounting life cycle as organizations coordinate to interpret, validate, or recreate information. The impacts range from lost time, to expenditures for efforts to sharpen the data before they can be used in emissions estimates, to incomplete emissions reports if corporations ultimately cannot incorporate the provided source data.

Evidence from case studies

Results from the case studies directly and indirectly point to issues of trust in shared emissions data and to a good bit of overlap with other constraints. For example, a lack of shared vocabulary can lead to distrust. When data nomenclature varies, and an incorrect interpretation is made, inaccurate calculations and assumptions can flow downstream through estimates.

A general theme from the case studies is the lack of consistent and relevant metadata provided at each step along the chain of custody, which reduces accounting transparency and contributes to the overall lack of trust in emissions data. Consistent and relevant metadata require standards to capture data aspects that need to be added and passed along each link in the chain of custody. Examples of such data aspects include methods and emissions factors used in calculations, source data, source attribution, temporal or geographical attributes, data authenticity and digital signatures, proof of verification and attestations, and thorough and complete characterization of assumptions.



YOU DON'T HAVE
EXACTLY WHAT I NEED

Companies begin with a vision of which GHG sources to include within the GHG report or inventory and the expectation that the emissions values estimated for those GHG sources are reasonably close to actual emissions.

In reality, the gap between estimated emissions and actual emissions varies considerably on the basis of the methods chosen.

Challenges and impact

Methodological constraints: You don't have exactly what I need

Description of the challenge

In the children's fairy tale, "The Three Little Pigs," three pigs each build houses made of different materials—hay, sticks, and bricks. Each pig starts with the same vision of a house, but the end result varied in quality and usefulness due to the materials and methods used.

When companies compile GHG data and prepare emissions estimates, their experiences can be similar to that of the three little pigs. Companies begin with a vision of which GHG sources to include within the GHG report or inventory and the expectation that the emissions values estimated for those GHG sources are reasonably close to actual emissions. In reality, the gap between estimated emissions and actual emissions varies considerably on the basis of the methods chosen.

If some methods result in more accurate emissions estimates, why not choose the best methods? The answer is that the choice of method is often not determined by which method would result in the most accurate estimate, but by which is viable given the data and information that are available. If all you have is sticks, your house will be made of sticks.

The issue is magnified when different companies choose different methods to estimate greenhouse gases from the same source or when one company uses different methods to estimate emissions for different reporting purposes (e.g., voluntary versus mandatory reporting). Among the types of methodological challenges companies face are the following:

- **Availability of data.** Whether of greenhouse gases from suppliers or nations, emissions estimates are only as good as the underlying data. Data quality and completeness vary across organizations. For example, Company A may report scope 2 emissions using a spend-based method to approximate electricity consumption (i.e., on the basis of expenditures and an average cost of electricity), whereas Company B may report using metered consumption data.
- **Lack of standardization.** Although robust accounting protocols exist, the choice of data for emissions factors, conversion factors, global warming potentials (GWPs), and other factors used to prepare emissions estimates are often left to those preparing the estimates. Is your company using GWPs from the IPCC Fourth Assessment Report (AR4), AR5, or AR6?¹⁰ Are your suppliers using your GWPs or other GWPs?
- **Availability of emissions factors.** As companies collect increasingly precise data on their emitting activities (activity data), they may find that available emissions factors do not support use of the activity data in more

¹⁰ The International Panel on Climate Change's Fourth Assessment Report includes summaries of the current state of scientific knowledge on climate change, its causes, potential impacts, and response options. AR4 was released in 2004. AR5 and AR6 were published in the years since.

Challenges and impact

precise estimates. As an example, a company tracks vehicle miles traveled for every vehicle in its varied fleet, but it still applies default CH₄ and N₂O emissions factors that generally apply to all light-duty gas vehicles.

- **Varied reporting purposes.** Companies may choose to estimate and publicly report their corporate GHG emissions and perhaps to allocate a share of their corporate emissions to each of their customers. Alternatively, they may choose to prepare a life-cycle assessment, or estimate the embodied carbon, of a particular product that any customer can use to estimate emissions from that product. The choice of underlying approach may be lost in the final reported emissions.
- **Multiple reporting requirements.** Companies that are subject to or that choose to report their emissions data to multiple reporting regimes may take the simplest approach that will suffice for all their reporting. This approach may result in use of methodologies that provide the simplest or most aggregated emissions estimates, but do not adequately, or accurately, align with the requirements of a given reporting regime.

Impact

As a result of the above-noted challenges, the GHG report is less reliable than it could be for both the company preparing the report and those with whom the company shares it.

Internally, unreliable results can undermine emissions reduction progress. As an example, even if an organization reduces its GHG emissions by increasing the fuel economy of its fleet, it may be unable to demonstrate progress if activity data are limited to total fleet vehicle miles traveled, without the additional specificity of a vehicle's fuel economy or actual fuel consumption. The inability of a company to track GHG reductions that have occurred due to company investment can undermine support for further investment in emissions reduction activities.

Externally, unreliable results can damage credibility. Interannual swings in reported emissions that result from approximating activity data can raise questions about the validity of a company's GHG accounting methods. Similarly, the inability of investors and consumers to accurately compare the accuracy and completeness of a company's reported GHG emissions relative to a competitor's emissions may lead to false assumptions about one company's performance relative to another's performance. Perhaps more concerning, for institutions that are incentivized to underestimate their emissions, methodological constraints can provide a defensible rationale for applying less nuanced methodologies or developing an incomplete GHG report or inventory.

Evidence from case studies

Types of methodological constraint issues relate to data and emissions factor availability, data usability, varied reporting purposes, and lack of standardization as evidenced by the following case studies.

Challenges and impact

DATA AVAILABILITY

Due to opacity in the industry standards, there is a strong need to drive methodology governance within an organization to ensure consistency and integrity in the overall emissions inventory reported, alignment in investment and decision-making to drive favorable intervention, and a practical need for storytelling and scorecarding within the organization in a consistent framework.

Expert advisory group case study

DATA USABILITY

We realized as a company that there was lots of great, highly detailed data that is not being utilized for GHG accounting. As a third party creating a relationship with the telematics company, this process could have been much more streamlined to leverage pre-existing data and support the digital data ecosystem when it comes to sustainability data.

Expert advisory group case study

VARIED REPORTING PURPOSES

Where these data are not disclosed, it is challenging to offer the high granularity measurements needed to support action.

Expert advisory group case study

DATA AVAILABILITY

Data drives GHG inventories. Many companies—particularly small- and mid-size suppliers for larger companies—have incomplete data or no data at all. They use varied methods to fill data gaps or exclude relevant emissions sources from their GHG accounting and reporting due to lack of data. For buyers of goods and services, this practice can mean that GHG information gaps exist within their supply chain: suppliers don't have the GHG data that buyers need. Supplier data are often delayed, unverified, ambiguous, or unavailable. When specific data from suppliers are altogether unavailable, various estimation methods must be employed. However, they involve generalizations that lead to inaccuracies and that limit entities' ability to compare periodical estimates and GHG information over time.

DATA USABILITY

Greater data fidelity results in more accurate emissions estimates; however, data management approaches may lead to a loss of fidelity. Digital metering and telematics are two examples of technologies that provide increasingly precise data. More precise data should, but do not always, lead to more precise emissions estimates. For example, digital metering can provide near real-time electricity consumption data that can be mapped to marginal emissions factors. Similarly, telematics information can provide vehicle-specific travel information down to the time spent idling. Unfortunately, companies may not be equipped to manage such large volumes of data and therefore may choose to aggregate data—thus losing fidelity. Similarly, companies may need to aggregate data to align them with available emissions factors such as regional eGRID factors or fleet-wide emissions factors.

VARIED REPORTING PURPOSES

Many companies have long prepared scope 1 and 2 GHG emissions inventories. Disclosure requirements, such as those proposed by the U.S. Securities and Exchange Commission and the EU Corporate Sustainability Reporting Directive will place greater emphasis on reporting, in particular among public companies. These efforts will increase the number of companies that report their scope 1 and 2 GHG emissions; however, purchasers of goods and services will still struggle to understand the amount of embodied carbon in products they buy. The Corporate Value Chain (scope 3) Standard encourages product-level, cradle-to-grave GHG accounting for supplier goods; however, in practice, many suppliers use a hybrid method that involves allocating a share of their scope 1 and 2 emissions to their customers, or they simply direct customers to their disclosed scope 1 and 2 GHG emissions. The underlying assumptions and data used to prepare emissions estimates are lost with this approach. Additionally, allocated scope 1 and 2 GHG emissions do not provide an accurate estimate of the actual embodied carbon present in a purchased product and can result in inaccurate estimates for companies that wish to prepare life-cycle assessments.

Challenges and impact

LACK OF STANDARDIZATION

Analysts trying to aggregate, compare, and contrast reported GHG emissions data need to be able to detect the units of a given GHG emissions figure accurately and normalize it so that they can compare a report measured in (different units) with confidence and produce reports that accurately show a company against its peers.

Expert advisory group case study

AVAILABLE EMISSIONS FACTORS

Industry-specific emissions factor databases would strike a better middle-ground between generic emissions factors and unique industry needs.

Expert advisory group case study

LACK OF STANDARDIZATION

Preparing a GHG report can require applying dozens of conversion factors, including factors for mass, energy, and distance, as examples. In the absence of standards, the ecosystem of entities involved in GHG accounting are destined to make their own decisions on items such as significant digits, activity data source, and emissions reporting units. For example, two software developers may choose to use different energy conversion factors for natural gas. As a result, they may obtain different results for their emissions estimates, depending on which software they use even though they used the same activity data.

AVAILABLE EMISSIONS FACTORS

The challenges arising with inconsistent use of conversion factors also apply to emissions factors. In the United Kingdom, the government releases comprehensive GHG reporting and conversion factors to be used in all reporting. Within the United States, the US EPA's Center for Corporate Climate Leadership has helped to provide consistency through the Greenhouse Gas Emission Factors Hub. Although extensive, the selection of emissions factors is limited—particularly for scope 3 source categories, for example, *Category 9: Downstream Transportation and Distribution* or *Category 12: End-of-Life Treatment of Sold Products*. More broadly, the emissions factors that are available often account for neither regional specificity—the emissions that result from a landfill in Canada are different than those from a landfill in Brazil—nor the diversity of use of products and end-of-life processes associated with those products, regardless of location. Additionally, state, provincial, national, and international reporting programs may require use of different emissions factors for similar sources, such as fuel combustion. The result is a landscape of incomplete and inconsistent emissions factors that reduce comparability across company inventories.



I CAN'T FIND YOU

Just like financial reports, GHG reports (carbon footprints, inventories, and other formats) and their related source data and calculation methods can be hard to find, unless you know exactly where to look.

Awareness constraints: I can't find you

Description of the challenge

As GHG accounting and reporting moves from mostly voluntary to mandated through regulation, access to reliable GHG data is increasingly important. It is even more important that data be accurate to allow for action to achieve the goals of the Paris Agreement. Better data availability and interoperability are necessary to enable carbon-conscious decision-making across the value chain and among different stakeholders (e.g., banks, consumers, procurement departments).

Just like financial reports, GHG reports (carbon footprints, inventories, and other formats) and their related source data and calculation methods can be hard to find, unless you know exactly where to look.

A straightforward example is the increasing number of corporate GHG inventories being prepared by companies across the globe. Given an increasingly connected global economy and supply chain, each report may contain valuable information for other companies across that supply chain, especially in the acquisition of data to calculate scope 3 GHG emissions. Companies may choose not to publicly publish their emissions data, and when they do, the reports may be difficult to find or access.

Similarly, a growing number of organizations, government bodies, and transparency initiatives provide information about GHG sources and sinks. For example, the U.S. EPA's FLIGHT (Facility Level Information on GreenHouse gases Tool) provides information about GHG emissions from large facilities. The GHG Protocol lists a further 52 databases that support data collection for product life-cycle and corporate value chain (scope 3) GHG inventories. These databases are valuable to the specific communities they serve, but they are necessarily limited in the amount of information they contain. Navigating through such databases to find the specific information needed for each unique GHG calculation can be time-consuming, and the databases may not contain exactly the information needed. Furthermore, investments in GHG-relevant data collection are proliferating at every scale, and without improved methods to access such data, relevant data (calculations, studies, measurements) may lay dormant when they could be broadly used.

One example: Lease arrangements can impede access to quality data when landlords maintain billing information but do not share data (e.g., electricity consumption) with tenants who claim the associated emissions. In this instance, the companies must then seek and apply publicly available data (e.g., from utilities or energy organizations) to work around the issue.

Organizations also experience internal issues when it comes to data discovery. For example, finding out which person, branch, or business entity has access to or knowledge of the energy consumption in a particular market or business line can be challenging and time-consuming.

Challenges and impact

EVIDENCE FROM CASE STUDIES

Today discovery is the weakest link.

Expert advisory group case study

Data must be usable by machines, not just humans. Policies MUST mandate that data be machine-readable in order that it may be collected and used in an efficient manner.

Expert advisory group case study

This isn't a problem that needs new technology. Many attempts to consolidate—new databases and portals—struggle to scale, and we're letting this opportunity slip through our fingers. Our economic and infrastructure systems are being digitalized in a decentralized and distributed way. There is no "center" in a system like this: we need to connect data, not collect it.

Expert advisory group case study

In short, this constraint describes a situation in which information needed to improve GHG accounting and reporting has been captured by someone somewhere but is not (easily) discoverable.

As a result, organizations are duplicating efforts because they are not aware that someone else is solving the problem. Information about how emissions occur in industries across all sectors is not reaching those who need it, leading to incomplete inventories and lost efficiency.

Impact

When data are not discoverable, they don't get used. In addition to causing frustration, the "I can't find you" constraint translates to duplication of efforts and, therefore, a loss of efficiency and increased costs for GHG accounting and reporting. The search for hidden and missing data reduces the effectiveness of GHG mitigation efforts at a time when the climate emergency requires immediate action.

As outlined in chapter 2, countries are increasingly making corporate GHG emissions reporting mandatory. In the next couple of years, it is expected that a large majority of large companies (public and private) globally will be subject to some mandatory GHG reporting. Digital data discoverability will be essential for companies to obtain the information they need to regularly fulfil their reporting duty. This discoverability is particularly important in those countries where digital information sharing has historically not been well established.

Huge quantities of data are being generated, but when they are undiscoverable, we miss the opportunity to more rapidly understand and manage GHG emissions to achieve a net-zero world.

Other relevant constraints

The Carbon Call roadmap focuses on interoperability constraints, but organizations face many other challenges while creating reliable GHG inventories. Notably, the expert advisory group highlighted four additional types of constraints that we recommend continue to be the focus of the GHG management community.



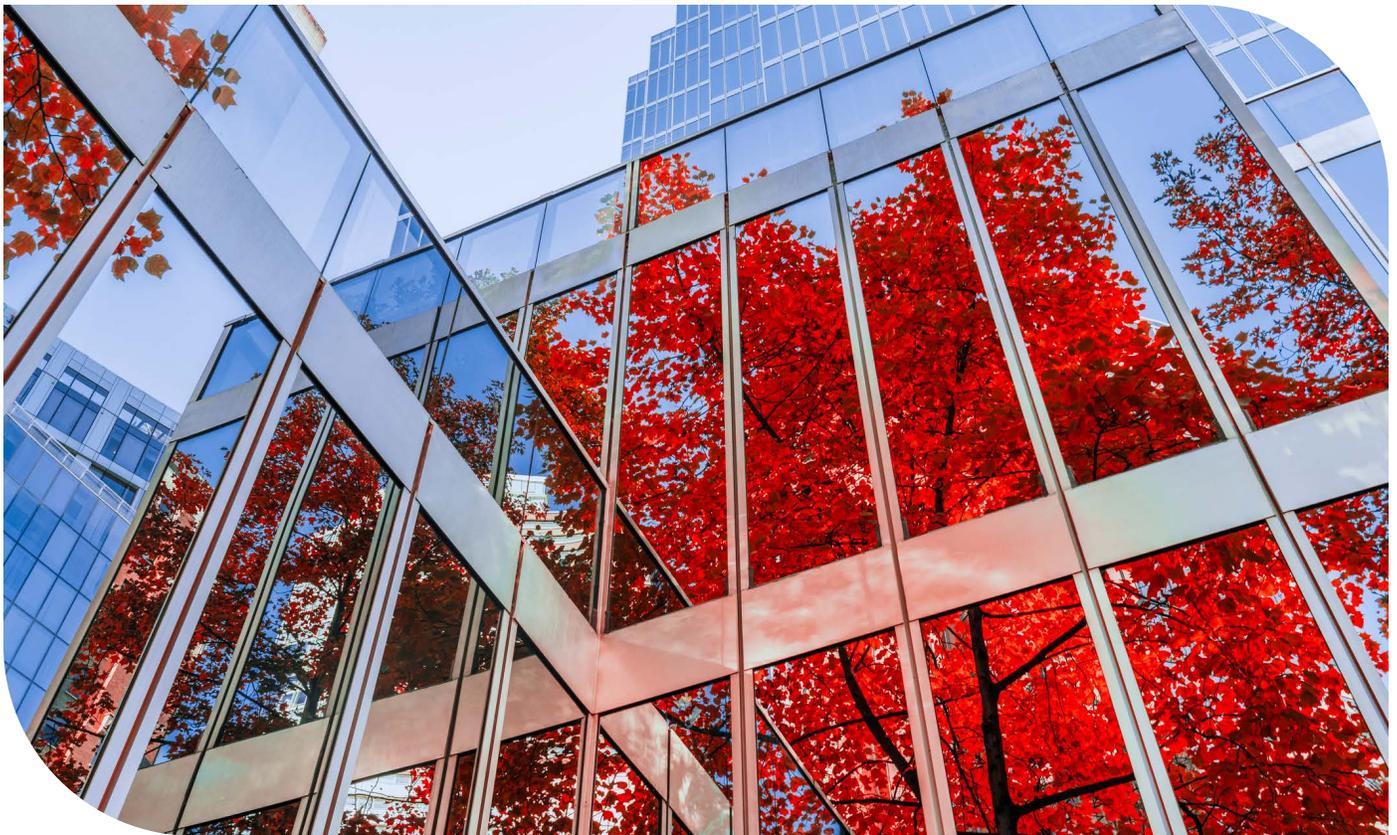
The expert advisory group highlighted four additional types of constraints that we recommend continue to be the focus of the GHG management community:

- **Capacity constraints**
 - **Verification**
 - **Increasing and inconsistent data requests**
 - **Ensuring data security**
- **Capacity constraints:** GHG management is not a core business for all entities that collect, manage, or interpret data. Data collection and management may be too costly for some organizations. In addition, organizational siloes limit effective gathering of the information needed to produce reliable and complete GHG accounting. And, particularly in the context of global disparities, financial constraints faced by organizations and data suppliers need to be addressed in order to improve organizational inventories worldwide.
 - **Verification:** Although many organizations make understanding and managing their GHG emissions a high priority, until recently, they have had little incentive to ensure that GHG accounting and reporting is complete and accurate (see Section 2 Direction of travel). Currently, there is little consistency in the GHG verification process, which can create perverse incentives for organizations to account for or address their carbon footprints in the most favorable, rather than accurate, manner. Additionally, organizations have limited ability to impact their scope 3 emissions due to lack of verification throughout the value chain and data opacity. Thus, even when using the best available data, GHG inventories may not reflect an organization's total global emissions, resulting in underly ambitious GHG reduction targets. The GHG accounting industry is debating who should be accountable for scope 3 emissions in order to create greater incentive for organizations to reduce all emissions, including the scope 3 upstream and downstream emissions. Verification will play a critical role in ensuring that emissions are rigorously, thoroughly, and standardly accounted for throughout the value chain.
 - **Increasing and inconsistent data requests.** Companies increasingly rely on forms and questionnaires to be filled by their suppliers when creating product carbon footprint or scope 3 estimates. These questionnaires are not in a consistent format, a particularly large burden on small companies, and they often rely on information further down the supply chain that may not be available to the company completing the questionnaire. Without central databases and shared data standards, these questionnaires create significant duplication and require companies completing them to search many sources and layers down the supply chain for information that is not readily available.

Challenges and impact

- **Ensuring data security.** As companies share GHG information, they must balance transparency with security—for example, by providing facility-specific information (e.g., electricity consumption) but redacting confidential site information. For companies that use external service providers to collect data and evaluate emissions, information sharing can sometimes create confidential information concerns.

These constraints are institutional, governance, or capacity related, and they impact the reliability of GHG inventories but are not directly addressed by the interoperability constraints and recommendations presented here. Those recommendations will contribute to reducing capacity constraints by facilitating data sharing and standardizing data collection/management processes, thus reducing the effort required of individual organizations. The Carbon Call roadmap may help facilitate verification by standardizing reporting procedures and underlying data.





Findings and opportunities



This roadmap is a living document developed with the expectation that it will be updated in line with new developments and consensus.

Introduction

Findings

This roadmap is a living document developed with the expectation that it will be updated in line with new developments and consensus. Although there was general consensus about the need for more interoperable and reliable GHG emissions reporting and about reporting constraints, as described in the previous chapter, views on the path forward diverge to some degree. Over the last few months, the expert advisory group put forward various blueprints for solutions. Additionally, the Carbon Call has evaluated solution blueprints from partner initiatives and organizations. The good news is that there is dynamism, enthusiasm, and a wealth of ideas. We don't have to reinvent the wheel. There is, however, a need to build consensus around which solution blueprints are most effective and how they might be prioritized. The Carbon Call, during various consultations, identified several reasons that we cannot yet assert consensus:

1. **Corporate mandates are driving alignment between financial and GHG reporting.** With mandates emerging, corporate GHG accounting can no longer be decoupled from financial reporting, which will require GHG emissions calculation data management to include internal controls and satisfy a new set of data assurance quality and reporting standards.

Although the emergence of mandates will undoubtedly lead to compliance-driven standardization, it will not remove all the constraints identified by the Carbon Call.

Even when mandates do not compel increased frequency or transparency in reporting, organizations increasingly need improved access to GHG-related data to prepare scenario and pathways analysis and to monitor the success of decarbonization investments.

Findings and opportunities

The Carbon Call, during various consultations, identified several reasons that we cannot yet assert consensus:

- **Corporate mandates are driving alignment between financial and GHG reporting.**
- **GHG reporting occurs within a complex ecosystem.**
- **Understanding of GHG accounting is needed by an increasingly broad set of stakeholders.**
- **GHG reporting is increasingly digitized and digitally regulated.**

2. **GHG reporting occurs within a complex ecosystem.** One of the challenges to improving the interoperability of GHG emissions-related data is that the data ecosystem is complex; GHG emissions data are part of a broader set of companies' data needs. When specific emissions produced by their actual suppliers, distributors, and customers are not available, existing GHG accounting standards for scope 3 emissions allow organizations to use industry and regional averages or other proxy data. These data can be derived from internal or external sources, measured, or estimated, and require GHG accounting expertise in order to be applied to business decisions, scenario analysis, statutory reporting, and other uses. External sources of information may range from NGOs to energy suppliers, communities, governments, consultancies, data aggregators, and consumers.
3. **Understanding of GHG accounting is needed by an increasingly broad set of stakeholders.** With growing demand for the expertise, traditionally held within corporate sustainability teams, by a broader set of stakeholders—including chief financial officers, chief data officers, procurement and actuary professionals, and facility managers—the value of addressing the constraints described in this report becomes more apparent. Even the word “accounting” itself holds different meanings to different people depending on who is tasked to collect, aggregate, and report the required data. During discussions within the Carbon Call expert advisory group, it emerged that common concepts and terms (such as reporting and accounting) hold different meanings for the climate community than for the finance community.
4. **GHG reporting is increasingly digitized and digitally regulated.** GHG accounting is moving into a digitally regulated reporting regime starting in 2024 in Europe and in other geographies shortly afterward. Concepts such as “comply or explain” and “GHG emissions estimates” may no longer be fit for purpose. In other words, how emissions-related data are captured, managed, aggregated (and disaggregated), documented, audited, and reported to regulated bodies will change to align with how financial data are captured, managed, aggregated (and disaggregated), documented, audited, and reported.

Digitization and digital regulation will make GHG data lineage, as well as quality, more prominent considerations, requiring shared definitions and structures as well as connectivity between systems and entities within an information supply chain. By contrast, the lineage of financial data is not a prominent consideration because it is typically generated and managed exclusively within the reporting entity.

Opportunities

The good news is there is now considerable momentum to drive more reliable and interoperable GHG accounting and reporting. The Carbon Call will continue working with the expert advisory group, its signatories, and others to refine, increase buy-in for, and facilitate pursuit of three opportunities for which consensus is emerging.

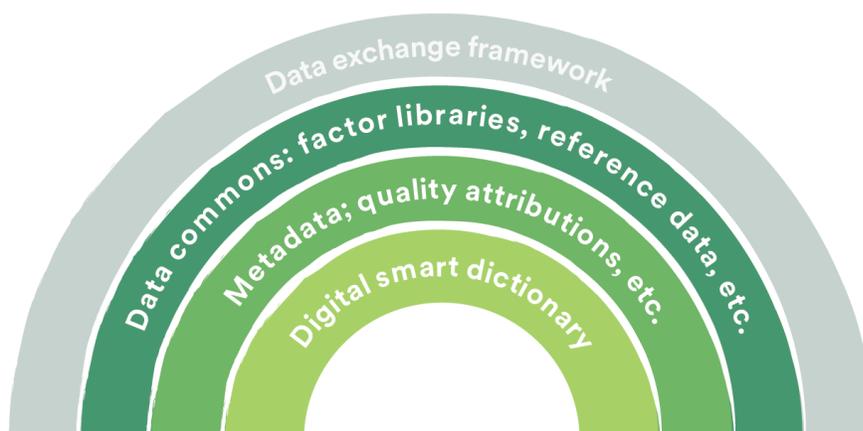
The three opportunities focus on convening expert subgroups to design and pilot the following activities:

1. Establishing shared vocabulary and taxonomies via a *digital “smart” dictionary*.
2. Improving companies’ ability to find and access relevant GHG information via *discoverable data*.
3. Improving accurate understanding of GHG information shared across systems by developing *metadata requirements*.

Notably, these three opportunities can serve as enabling conditions for a future data exchange framework that may further embody an interoperable GHG data management environment.

The Carbon Call intends to serve as an accelerator to translate these opportunities into implementation-ready blueprints by creating three expert subgroups. Each subgroup would convene the relevant topical and technical experts, refine its blueprint’s scope and timeline, and draft an implementation plan.

KEY ELEMENTS FOR ADDRESSING INTEROPERABILITY CONSTRAINTS



Three opportunities:

1. Establishing shared vocabulary and taxonomies via a **digital “smart” dictionary**.
2. Improving companies’ ability to find and access relevant GHG information via **discoverable data**.
3. Improving accurate understanding of GHG information shared across systems by developing **metadata requirements**.

Opportunity: Digital smart dictionary

Digital smart dictionary: What is it?

A digital smart dictionary is a controlled vocabulary for a given discipline. The purpose of a digital smart dictionary is to organize information and to provide terminology to catalog and retrieve information. A digital smart dictionary promotes consistency in preferred terms and the assignment of the same terms to similar content. It allows for reported data to be transformed into digital reporting taxonomies, or classifications, that will enable the data to be processed and exchanged quickly. These are the critical components of any digital financial, business, or GHG reporting system.

The lack of consistent and comparable data definitions hinders the flow of information (e.g., emissions factors, activity data, spatial and temporal information) across a supply chain and impacts decision-making throughout the stakeholder value chain. Speaking the same language is a basic building block to ensure interoperability and context for GHG emissions reporting, accounting, monitoring, and communication. Critical data elements need to be precisely defined and globally agreed upon as well as coupled with data management best practices.

A good example of an effort to establish consistent and comparable data definitions is offered by Australia's Standard Business Reporting (SBR) program. After an analysis revealed that, on multiple forms, participating agencies were using nine names to describe the Australian Business Number, the program, in collaboration with these agencies, began to develop a single set of definitions and specific language for the information reported by business to government. The key component of this effort is rationalization/harmonization of terms and definitions and taxonomy mapping. The most important part of the SBR program is the taxonomy of underlying definitions and the use of a consistent language to express their properties and reduce the cost of data management.

The smart features of the digital smart dictionary allow users to query standards and their interrelationships as well as to tag and map data against the concepts within the dictionary. Data that conform to the dictionary will be represented in other standards without reprocessing or rewriting.

An online digital smart dictionary, coupled with a registry of statutory reporting taxonomies, would be a technological reflection of a human agreement on how to best develop and maintain sustainability and financial data standards. These would be critical building blocks for achieving end-to-end digitization of consistent and contextualized GHG-related information for all users.

Due to different market needs and regulatory priorities, siloed digital dictionaries are under development around the world, resulting in an alphabet soup of definitions and digital reporting taxonomies not easily embedded into software for multi-taxonomy reporting.

Findings and opportunities

Constraints addressed

A digital smart dictionary addresses the “I don’t understand you” constraint and, to some extent, the “I can’t find you” constraint. Multiple stakeholders, including regulators, require companies to disclose information about their impact on the climate and their approach to risk management. A digital smart dictionary would enable them to express that information digitally using a shared language. This will make combining, comparing, and contrasting data easier than ever with greater interoperability and with increased automation as a result. A digital smart dictionary will allow terms, concepts, attributes, and definitions to be related, for example, to emissions factors and to be more easily and precisely shared. A shared goal of GHG accounting and reporting is to improve access to data, making a digital smart dictionary essential for understanding and finding GHG data.

A digital smart dictionary would also address other identified constraints, most significantly, the “I don’t trust you” constraint. Such a dictionary will establish a precise vocabulary, with which organizations will be better able to interpret the validity of the data they receive. In addition, a digital smart dictionary will improve data discoverability and will help define the metadata requirements that support data availability and methodological choice.

What would a Carbon Call expert subgroup work toward?

A Carbon Call expert subgroup would:

- Facilitate GHG taxonomies by researching, cataloging, documenting, and comparing existing statutory reporting taxonomies, and standards and regulations; interrogating them for completeness; seeking out commonalities; and identifying gaps.
- Facilitate shared GHG schemas by (1) evaluating the hierarchical structure of entities and attributes, deciding, for example, whether to group these entities and attributes by fuel, by commercial/industrial activity, or by end-use; (2) specifying the attributes associated with each category; and (3) proposing multiple schemas and providing flexibility to account for a range of organizations.
- Support a pilot program for developing a smart dictionary, including identifying the dictionary’s logical representation (GHG schemas), realizing that representation in software, and creating supporting infrastructure.

Relevant experts include GHG accounting experts from different domains, system integrators and developers, and conceptual data-modeling experts.

A CARBON CALL EXPERT SUBGROUP WOULD WORK TOWARD

- Facilitating GHG taxonomies
- Facilitating shared GHG schemas
- Supporting a pilot program for developing a smart dictionary

Opportunity: Discoverable data

Discoverable data: What is it?

As the need to reduce GHG emissions accelerates, organizations, industry groups, and governments will continue to develop increasingly robust and precise activity data and emission factor datasets. These datasets are necessary to support accurate and reliable GHG measurement and reporting. Perhaps equally important is making the datasets discoverable so that they can be adopted widely and applied accurately.

Data discovery describes the process for making datasets available so that they can be located, mapped, and integrated into software systems, analyses, and tools. Technological advancements such as machine-readable data, machine learning, and artificial intelligence will increasingly automate the process of data discovery. Making data platforms discoverable will be vital to the construction of open commons, or open-source software databases. A commons creates a legal space for data and information sharing in which technologies can be shared, changed, expanded, and adapted into new products.

One example of what global discoverable data could look like: XBRL, an open international standard for digital business reporting, is making public sustainability and financial reports accessible around the world by making information more discoverable and accessible via a GR.ID system. A GR.ID system captures diverse information about reports and reporting entities, including authoritative [legal entity identifiers](#), and assigns different levels of trust to different reports, depending on factors such as authenticity and access. The system accepts links to any kind of report, in any format, from anywhere in the world.

Discoverable data have the potential to increase the interoperability of emissions estimates as well as the underlying data and emissions factors used to produce them. Emissions factors supported by discoverable data will be compatible with many different types of software and data tools, allowing entities to access and use the information without barriers and to seamlessly integrate dataset updates into accounting systems.

Constraints addressed

Discoverable data addresses the “You don’t have exactly what I need” constraint by increasing consistent use of data and information. As an example, by creating public and discoverable emissions factor databases, GHG accounting and reporting across software platforms can be made more consistent. Current work to develop software solutions that perform multi-sectoral GHG accounting can be made more consistent if those solutions house standardized emissions factors. Emissions factors that are available from sectors such as utilities, construction, and shipping could be accessed and consistently applied across software platforms to ensure transparency, accuracy, and reliability.

Findings and opportunities

Discoverable data also addresses the “I can’t find you” constraint by making data and information more accessible. Discoverable data platforms will be vital to the construction via an open commons, or open-source software databases. Information sharing via a open commons supports innovation and allows entities to use pre-crafted base products to create tailored tools. For example, software developers use open commons databases to share base code languages for website building. Coders can adapt base codes for specific needs on the basis of design and concept.

For GHG accounting and reporting, open commons could support a public database for validated GHG inventory tools that pull from discoverable data platforms. This public database would ensure a level of consistency among GHG inventory tools and also allow companies to tailor their tools for their specific needs and to share data and information with other companies. Such a database could be particularly beneficial to support consistency among the GHG inventory tools of small and medium-sized businesses—e.g., suppliers within a manufacturer’s value chain.

What would a Carbon Call expert subgroup work toward?

A Carbon Call expert subgroup would:

- Define the parameters for making data discoverable. Explore ongoing pilot projects (GR.ID, XBRL) to better understand parameters used to make data discoverable, identify challenges and successes, and develop best practices for GHG data discovery. Discoverability of corporate information will require that newly generated or reported GHG-related data are associated with businesses using a unique corporate identifier, such as a legal entity identifier, corporate tax ID, or other unique attribution.
- Facilitate guidance for organizations that are generating GHG information (e.g., activity data, emission factor) and datasets to make that information discoverable for use within GHG accounting software and by GHG accounting practitioners as well as align with terminology used by digital smart dictionaries and specify metadata requirements.

Relevant experts include GHG accounting experts from different domains, software developers, and industry leaders to define the parameters for making data discoverable and to validate discoverable GHG information (e.g., emissions factors, activity data) for use within GHG accounting software and by GHG accounting practitioners in line with key regulatory frameworks used for GHG emissions reporting.

A CARBON CALL EXPERT SUBGROUP WOULD WORK TOWARD

- Defining the parameters for making data discoverable
- Facilitating guidance for organizations that are generating GHG information and datasets to make that information discoverable

Opportunity: Metadata requirements

Metadata requirements: What are they?

To calculate emissions, organizations need to gather information from multiple sources, both internal and external (across their supply chain). They are therefore reliant on many different sources of secondary data, and with complex organizations, even primary data are gathered by many people across departments or geographies. The quality of each data point used in the emissions calculation will vary. So, it is important that information describing a data point's attributes, including quality, travel with the data point. A metadata requirement allows data recipients to determine whether to incorporate a given data point into their calculation—and also to assign uncertainty ranges to the result. Data quality attributions and other metadata could include not only standard elements such as units of measure, timestamps, and geographic relevance, but also citations, calculated uncertainty ranges, instrumentation accuracy, expert judgment rationales, and other information. Moreover, metadata can include consistent taxonomies and common definitions, such as those called for as part of a digital smart dictionary. Interoperable systems can be designed to ensure such metadata can be transferred effectively across systems.

Metadata is becoming more important as GHG accounting moves into the financial regulatory realm. Since the 2008 financial crisis, regulators have increasingly influenced how banks approach data quality and management. A particular emphasis on whether and how financial institutions aggregate risk exposure has increased these institutions' data governance, systems, processes, and controls. This regulatory push toward better data management will influence financial institutions and their needs for GHG emissions data-quality attribution.

Constraints addressed

Metadata requirements primarily address the “I don't trust you” constraint. Transparent, accessible metadata that includes data quality attribution will give organizations increased confidence in adopting data provided by others and will allow them to judge which data points and methods to use when more than one choice is available.

Metadata requirements could also address other identified constraints:

- Metadata that include data quality attribution may provide more context for the data and its appropriate use, alleviating the “I don't understand you” constraint.
- Organizations can make better-informed methodological choices when they understand the quality of the data received, alleviating the “You don't have exactly what I need” constraint. For example, a more granular calculation may initially seem as though it would result in a more accurate emissions estimate; however, if the granular data is highly uncertain, a more generalized approach might be a better choice.

What would a Carbon Call expert subgroup work toward?

A Carbon Call expert subgroup would:

A CARBON CALL EXPERT SUBGROUP WOULD WORK TOWARD

- Identifying the metadata information that should be included
- Determining the mechanism(s) by which metadata will travel with GHG information
- Recommending improvements to facilitate understanding and use of metadata

- Identify the metadata information that should be included in company GHG accounting and reporting, including the minimum set of metadata as well as broader data elements that would complete an initial metadata dataset.
- Determine the mechanism(s) by which metadata will travel with GHG information, including how technology can support the gathering, transfer, and interpretation of metadata.
- Recommend improvements (e.g., in user interface features and components) to facilitate understanding and use of metadata in GHG accounting and reporting. Even with such improvements, individuals or teams will need to interpret the data, fill gaps, identify opportunities to improve, and make investment or other decisions using the emissions calculation. Their ability to assess the metadata and data quality attributes must be prioritized.

Relevant experts include GHG accounting experts from different domains and software developers capable of defining the types of metadata that would help data recipients understand the underlying methods, data, and decisions used to prepare reported GHG information.

Enabling conditions for a data exchange framework

If a digital smart dictionary, discoverable data, and metadata requirements are further developed and agreed upon, organizations will be better able to discover, understand, and qualify the data they use for their own purposes and to share their derivative data with others. A digital smart dictionary, discoverable data, and metadata requirements are the building blocks for a data exchange framework. A data exchange framework brings together shared schemas, a well-known taxonomy, well-defined terms, a communication protocol, and directory services. This framework could help companies and the public sector manage and understand the vast amount of GHG emissions-related data that are being collected, reported, and shared.

A data exchange framework is not proposed as an opportunity under the Carbon Call at this stage. However, it is possible that the Carbon Call's efforts could accelerate the enabling conditions for such a framework to emerge.

A data exchange framework would address constraints identified in the Carbon Call roadmap by providing corporations with more efficient ways to facilitate data “connection” instead of data “collection” and would have features to eliminate double counting and to support track and trace. Specifically, a data exchange framework would serve as a shared infrastructure, with a prescribed data format, to help users find relevant GHG emissions-related data without duplicating it.

Annexes

Glossary

Term	Definition
Activity Data	Data (e.g., fuel consumed, electricity purchased) for emissions-generating activities that, when multiplied by a corresponding emissions factor, result in an emissions estimate.
Assessment Report (AR4, AR5, and AR6)	Fourth Assessment Report from the Intergovernmental Panel on Climate Change. Assessment reports are summaries of the current state of scientific knowledge on climate change, its causes, potential impacts, and response options. AR4 was released in 2004, and AR5 and AR6 have since been published. The GWP values used in GHG accounting presented in AR4 are still recommended by the UNFCCC.
Australian Taxation Office (ATO)	Principle revenue collection agency of the Australian government.
Carbon Border Adjustment Mechanism	Mechanism that equalizes the price of carbon between domestic and international products.
Carbon Footprint	Total amount of greenhouse gases, including carbon dioxide and methane emissions, associated with all the activities of a person or other entity (i.e., company, country, or physical location).
Carbon Disclosure Project (CDP)	Private entity focusing on helping businesses and governments reach sustainability goals.
Company Sustainability Reporting Directive (CSRD)	New EU legislation requiring nearly 50,000 companies to report their environmental and social impact starting in 2024.
Corporate Sustainability	Approach to creating long-term value that focuses on environmental, sustainable, and ethical practices.
Corporate Sustainability Reporting	EU rules that require that large companies regularly publish reports on the social and environmental impacts of their activities.
Corporate Value Chain	Concept describing the full chain of a business's activities in the creation of a product or service.
Digital Smart Dictionary	Controlled vocabulary for a given discipline that promotes consistency and allows data to be organized, catalogued, and retrieved.

Findings and opportunities

Discoverable Data	Data that are made available to be located, mapped, and integrated into software systems, analyses, and tools.
Earth-Observation (EO) Technology	NASA-led initiative gathering of information about the physical, chemical, and biological systems of Earth.
Electronic Disclosure for Investors' NETwork (EDINET)	Japanese financial securities commission.
Emission Factors	Representative values that attempt to relate the quantity of emissions released with an activity associated with the release of those emissions.
Emissions and Generation Resource Integrated Database (eGRID)	Comprehensive data source from EPA's Clean Air Markets Division on the environmental characteristics of electrical power generated in the United States.
Environmental Protection Agency (EPA)	Independent agency of the U.S. federal government that maintains and enforces environmental protection laws.
Environmental, Social, and Governance (ESG)	Guides company and organizational best reporting practices.
European Union (EU)	Political and economic association of 27 European countries.
Financial Reporting Council (FRC)	Regulates auditors, accountants, and actuaries in the United Kingdom and Ireland.
GHG Inventory	Account of all GHG emissions sources and sinks, quantified using standardized methods.
GHG Protocol	Provides international standards and guidance that companies and organizations rely on for GHG accounting and inventory.
Greenhouse Gases (GHGs)	Gases, including carbon dioxide, methane, and nitrous oxide, among others, that trap heat in the atmosphere.
Global Warming Potential (GWP)	Potential of a molecule of one gas to contribute to global warming, with respect to a reference gas (most commonly carbon dioxide), over a set time frame. For example, the GWP of methane (CH ₄) as per the values outlined in AR4 is 25, that is, one molecule of methane is equivalent in terms of global warming potential to 25 molecules of carbon dioxide (CO ₂).
Intergovernmental Panel on Climate Change (IPCC)	United Nations body in charge of assessing the latest science related to climate change. The IPCC Task Force on Inventories (TFI) developed the standard for national level GHG accounting, outlined in the 2006 Guidelines on National Greenhouse Gas Inventories.

Annexes

Internal Control Systems	Accounting policies and auditing procedures, such as including statements and conducting assessments, that ensure an organization's accounting information is accurate and reliable.
International Auditing and Assurance Board (IAASB)	Issues standards, including the International Audit Standards, quality control guidelines, and provides other services.
International Organization for Standardization (ISO)	Brings together experts to share knowledge and develop voluntary, consensus-based, market-relevant international standards that support innovation and provide solutions to global challenges.
International Audit Standards	Standards issued by IAASB for the performance of financial audits.
Interoperability	Ability to compare, share, and use information across GHG accounting and the supporting digital data ecosystem.
ISO Standards	Quality management standards that aim to improve products and supply chains.
ISO 14064-1	Guidance for quantifying and reporting an organization's carbon footprint.
Metadata	Data that describe and give information about other data.
Non-Governmental Organization (NGO)	Group that functions independently of any government, usually as a non-profit.
Paris Agreement	Agreement to reduce the production of GHGs and limit global warming.
Partnership for Carbon Accounting Financials (PCAF)	Global partnership of financial institutions working to facilitate transparency and accountability of the financial industry to the Paris Agreement.
Product Life-Cycle Accounting	Accounting for a product's emissions at every step of its life cycle.
Public Company Accounting Oversight Board (PCAOB)	Non-profit organization overseeing the audits of public companies.
Regulatory Reporting	Submission of data and information to the relevant authority to demonstrate compliance with the associated regulatory provision.
Securities and Exchange Commission (SEC)	Independent agency of the U.S. federal government whose mission is to protect investors; maintain fair, orderly, and efficient markets; and facilitate capital formation.

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Standard Business Reporting (SBR)	Standard approach to online and digital record-keeping in Australia, most notable for the development of the SBR Taxonomy of underlying conditions and the use of consistent language.
Statutory Reporting	Mandatory submission of financial and non-financial information to a government agency.
Transparency, Accuracy, Completeness, Comparability, and Consistency (TRACCC) Principles	GHG accounting principles that include transparency, relevance, accuracy, completeness, and consistency (TRACC) according to the GHG Protocol Corporate Standard. IPCC Guidelines for National Greenhouse Gas Inventories excludes relevance as a principle and includes comparability (TACCC).
Task Force on Climate-Related Financial Disclosures (TCFD)	The Task Force consists of 31 members representing both preparers and users of financial disclosures from across the G20. It is focused on improving and increasing reporting of climate-related financial disclosures.
United Nations Framework Convention on Climate Change (UNFCCC)	Adopted in 1992 with the core objective to stabilize greenhouse gases in the atmosphere at a level that will prevent dangerous human interference with the climate system. To facilitate standardized and thus comparable national accounts of emissions, the UNFCCC developed a reporting guideline on annual GHG inventories.
Voluntary Reporting	Submission of information when there is no legal obligation for reporters to provide the requested information.
World Business Council for Sustainable Development's (WBCSD) Partnership for Carbon Transparency	Guidance for calculating and exchanging product-level carbon emissions across supply chains.
eXtensible Business Reporting Language (XBRL)	Open international standard for digital business reporting.

Expert advisory group members



The Carbon Call

