Greenhouse Gas (GHG) Emissions Measurement

A Primer to Map-Collective's Approach and Platform

map COLLECTIVE

Contents

Executive Summary

The climate change literature published in the last two decades has improved upon its confidence level in the anthropogenic nature of the present climate change. It has been sounding an alarm on the sustained increase in the average temperature of earth's surface, which is continuing to have repercussions for the future of humanity. It also highlights that we have entered the mitigation and adaptation stage, where our systems must adjust to the changed climate and work towards avoiding further changes that can threaten our collective future.

"What can be measured can be acted on". Map-Collective Inc. was built on the idea that the earth has limits to its ecological boundaries and being cognizant of those boundaries informs our strategies to act responsibly. Given the need for urgent action, map-collective.com was set up as a carbon tracking and supply chain transparency platform, backed by blockchain technology, for public and private enterprises to measure, track and improve their value chains and associated carbon emissions. The current edition of our software builds upon the idea of effective measurement including data collection, measurement, and visualization, providing enhanced experience for all users while retaining the idea of usability, transparency, and reproducibility.

The following pages allow the reader to dive deeper into the why, what and how of our carbon tracking platform-highlighting its background, setup and usability. The basic motive for publishing this document is to improve transparency and accountability at our end. We continue to believe that the platform will remain a work in progress as the GHG emissions calculation systems improve and future versions will account for those changes.

Introduction

The scientific evidence for anthropogenically caused climate change has been getting stronger by the decades. There have been numerous reports and evidence submitted that highlight the effect human operations have had on our environment. Established in 1988, The Intergovernmental Panel on Climate Change (IPCC) has been reviewing and publishing existing literature on climate assessment.[1] The reports have played a key role for the United Nations Framework Convention on Climate Change (UNFCCC), which established a treaty in 1992 as a framework to combat climate change by 'limiting the average global temperature increase'.[2]

The Kyoto Protocol was concluded in 1997, establishing legally binding obligations on signatories to limit their Greenhouse Gas (GHG) emissions.[3] Subsequently, the Paris Agreement was adopted at COP 21 of the UNFCCC, calling for stabilizing "the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels" (UNFCCC, 2015). The various United Nations Climate Change Conferences, also known as the Conference of Parties (COP) have continued to establish mandates, guidelines and highlight the urgency in combating climate change.

Figure 1: Exhaust emissions from an energy facility

A quintessential precursor to combating global warming and climate change is to be cognizant of the earth's limits, which amongst other boundaries, translates to being able to measure the GHG emissions- their contribution to global warming and the effect they have on the ecological boundaries.

Addressed as GHG accounting, the activity involves creating an inventory and auditing GHG emissions for contributors including, but not limited to- projects, corporations, and governments. Efforts have been made in measuring and standardizing the exercise from both national and international parties since the 1990s.

(image credits-unsplash)[4]

[1] *https://www.ipcc.ch/site/assets/uploads/2018/09/ipcc-principles.pdf*
[2] *https://unfccc.int/process/the-convention/history-of-the-convention#eq-1*
[3] *https://unfccc.int/process-and-meetings/the-kyoto-protocol/what-is-the-kyoto-protocol/kyoto-protocol-targets-for-the-first-commitment-period*
[4] *https://unsplash.com/photos/c7RWVGL8lPA?utm_source=unsplash&utm_medium=referral&utm_content=creditShareLink*

Evolution and Standardization

The earliest and the most widely discussed efforts for GHG accounting were made by World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), who along with other NGOs, worked on creating the GHG Protocol Initiative with a mission to "develop internationally accepted GHG accounting and reporting standards for businesses and promote their adoption"[5]. The first GHG Protocol Corporate Accounting Standard under the initiative was published in 2001. The protocol in its current form provides accounting and reporting standards for the private and public sector to measure and manage their emissions.

GREENHOUSE GAS PROTOCOL

The Paris Agreement commits countries to reduce greenhouse gas emissions to keep the global temperature rise below 1.5 degrees Celsius, in order to avoid the worst impacts of climate change. The GHG Protocol arose out of the need to help countries and companies account for, report, and mitigate emissions, based on a report that identified an action agenda to address climate change that included the need for standardized measurement of GHG emissions.

The Greenhouse Gas Protocol (GHGP) provides accounting and reporting standards, sector guidance, calculation tools and trainings for businesses and local and national governments. It has created a comprehensive, global, standardized framework for measuring and managing emissions from private and public sector operations, value chains, products, cities and policies to enable greenhouse gas reductions across the board.

About the organizations:

World Resources Institute

World Resources Institute (WRI)[6] is a global research organization that works with governments, businesses, multilateral institutions, and civil society groups to develop practical solutions that improve people's lives and ensure nature can thrive. We organize our work around seven global challenges: Food, Forests, Water, Energy, Climate, the Ocean and Cities. We analyze these issues through the lenses of our four Centers of Excellence: Business, Economics, Finance and Equity.

World Business Council for Sustainable Development

World Business Council for Sustainable Development[7] WBCSD is the premier global, CEO-led community of over 200 of the world's leading sustainable businesses working collectively to accelerate the system transformations needed for a net zero, nature positive, and more equitable future. We do this by engaging executives and sustainability leaders from business and elsewhere to share practical insights on the obstacles and opportunities we currently face in tackling the integrated climate, nature and inequality sustainability challenge; by co-developing "how-to" CEO-guides from these insights; by providing science-based target guidance including standards and protocols; and by developing tools and platforms to help leading businesses in sustainability drive integrated actions to tackle climate, nature and inequality challenges across sectors and geographical regions.

In March 2006, the International Organization for Standardization (ISO) completed its four-year development of ISO 14064, a three-part international standard for GHG management activities, including the development of

[5] *https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf*
[6] *https://www.wri.org/*
[7] *https://www.wbcsd.org/Overview/About-us*

entity emission inventories. The development process included the involvement of over 175 experts representing 45 countries. The standards include minimum requirements for GHG inventories which provide a basic structure against which credible and consistent independent auditing can be performed.[8]

ISO 14000 is a family of standards related to environmental management that exists to help organizations (a) minimize how their operations (processes, etc.) negatively affect the environment (i.e. cause adverse changes to air, water, or land); (b) comply with applicable laws, regulations, and other environmentally oriented requirements; and (c) continually improve in the above.[9] ISO 14064 exists as a climate policy neutral guide for the private and public sector in developing GHG inventories for their organization as well as a foundation for policy makers and program developers for initiatives to address the global environmental challenge of climate change.[10]

Structure of ISO 14064

ISO 14064[11] consists of three parts, each with a different technical focus. Part 1 of the standard is titled "Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals." This part of the standard addresses conducting greenhouse gas emission inventories of organizations such as corporations using a bottom-up approach to data collection, consolidation, and emissions quantification. Part 2 of the standard addresses quantification and reporting of emission reductions from project activities. Part 3 of the standard is titled "Specification with guidance for the validation and verification of greenhouse gas assertions." This part of the standard establishes a process for verification of a greenhouse gas statement, including organization inventories, regardless of whether the inventory was developed under Part 1. This verification process is also applicable whether the verification is being conducted by an independent third-party verifier or by an organization's internal auditors.

ISO 14064 Part 1 establishes a process for quantifying GHG emissions for the inventory. The first steps of this process are identification of specific emission sources within the operational boundaries as well as selection of an emissions quantification methodology applicable for the sources identified. The next steps are the collection of data required by the methodology for the source and the identification of established emission factors for the data collected. Finally, the data and the emission factors, applied consistently with the quantification methodology, are used to quantify emissions from individual emission sources. The emissions quantified for each source are then consolidated with the other sources within the operational boundaries, ensuring that direct and indirect sources are kept separate.

It is important to note that the key aspects for conducting a greenhouse inventory under ISO 14064 are generally consistent with, and in most cases are derived from, those identified by the broadly recognized Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard developed by the World Business Council for Sustainable Development and the World Resources Institute. The difference between these two documents is that the GHG Protocol identifies, explains, and provides options for GHG inventory best practices, while ISO 14064 establishes minimum standards for compliance with these best practices.

[8] *https://www3.epa.gov/ttnchie1/conference/ei16/session13/wintergreen.pdf*
[9] *https://www.iso.org/iso-14001-environmental-management.html*
[10] *https://www3.epa.gov/ttnchie1/conference/ei16/session13/wintergreen.pdf*
[11] *https://www3.epa.gov/ttnchie1/conference/ei16/session13/wintergreen.pdf*

Defining the Scope of Emissions & Measurement

Earth's greenhouse gases trap heat in the atmosphere and warm the planet. The main gases responsible for the greenhouse effect include carbon dioxide, methane, nitrous oxide, and water vapor (which all occur naturally), and fluorinated gases (which are synthetic).[12]

- **Carbon dioxide (CO_2)**: Carbon dioxide enters the atmosphere through burning fossil fuels (coal, natural gas, and oil), solid waste, trees and other biological materials, and also as a result of certain chemical reactions (e.g., manufacture of cement). Carbon dioxide is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.
- **Methane (CH_4):** Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices, land use and by the decay of organic waste in municipal solid waste landfills.
- **Nitrous oxide (N_2O):** Nitrous oxide is emitted during agricultural, land use, industrial activities, combustion of fossil fuels and solid waste, as well as during treatment of wastewater.
- **Fluorinated gases:** Hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for stratospheric ozone-depleting substances (e.g., chlorofluorocarbons, hydrochlorofluorocarbons, and halons). These gases are typically emitted in smaller quantities, but because they are potent greenhouse gases, they are sometimes referred to as High Global Warming Potential gases ("High GWP gases").

What are Scopes 1, 2 and 3?

The GHG Protocol has defined three scopes of emissions.[13] The scopes correlate to who 'owns' those emissions and the level of control applicable to changing those emission levels at each stage.

Scope 1 and 2 emissions are a mandatory part of reporting for many organizations across the world and relate to systems that are within reasonable control of an entity, such as onsite and purchased energy.

Scope 3 emissions are centered on sources of emissions that are more external to a specific organization, such as those across the supply chain. Scope 3 emissions remain mostly voluntary to report, however, in most cases the reduction of Scope 3 has the potential to have the largest impact.

[12] *https://www.nrdc.org/stories/greenhouse-effect-101#:~:text=Earth's%20greenhouse%20gases%20trap%20heat,gases%20(which%20are%20synthetic).*
[13] *https://www.anthesisgroup.com/scope-1-2-3-emissions/*

Scope	Emission Type	Definition
Scope 1	Direct Emissions	GHG emissions directly from operations that are owned or controlled by the reporting company
Scope 2	Indirect Emissions	Indirect GHG emissions from the generation of purchased or acquired electricity, steam, heating, or cooling consumed by the reporting company
Scope 3		All indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions

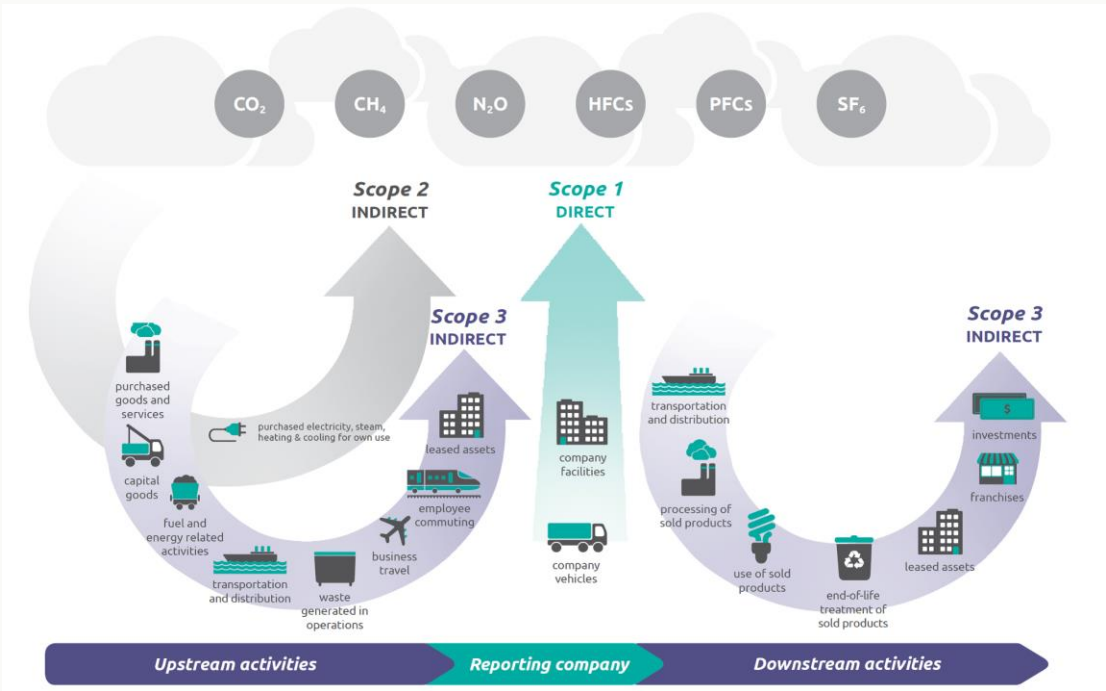

Figure 2: Overview of GHG Protocol scopes and emissions across the value chain[14][15]

[14] *https://www.anthesisgroup.com/scope-1-2-3-emissions/*
[15] *https://www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance*

Calculating the Emissions

Map-Collective bases its definition and calculation methodology of GHG emissions calculations on EPA's inventory guidance.

- EPA's Scope 1 and Scope 2 Guidance provides methods to calculate and report GHG emissions from these sources. Scope 1 emissions are direct GHG emissions that occur from sources that are controlled or owned by an organization (e.g., emissions associated with fuel combustion in boilers, furnaces, vehicles). Scope 2 emissions are indirect GHG emissions associated with the purchase of electricity, steam, heat, or cooling.
- EPA's Scope 3 Inventory Guidance provides resources and emission factors to help organizations develop a scope 3 emissions inventory. Scope 3 emissions are the result of activities from assets not owned or controlled by the reporting organization, but that the organization indirectly impacts in its value chain. Scope 3 emissions include all sources not within an organization's scope 1 and 2 boundary. Scope 3 emissions, also referred to as value chain emissions, often represent the majority of an organization's total GHG emissions.
- GHG Emission Factors Hub. EPA's GHG Emission Factors Hub provides organizations with a regularly updated, easy-to-use, and consolidated set of default emission factors with streamlined units for organizational GHG reporting.

  A key component of developing a GHG inventory is the use of emission factors. An emission factor presents the quantity of a GHG emitted to the atmosphere associated with a specific activity. The following are two examples of emission factors:

  - The amount of carbon dioxide (CO_2) emitted to the atmosphere when combusting natural gas in a boiler is typically expressed as kilograms (kg) of CO_2 per million British thermal units (MMBtu) of natural gas combusted (kg CO_2/MMBtu natural gas).
  - The amount of CO_2 emitted to the atmosphere when generating electricity is typically expressed as kg CO_2 per megawatt-hour (MWh) electricity generated (kg CO_2/MWh).
- When quantifying GHG emissions it is also important to apply the correct global warming potentials (GWPs) to individual GHGs so that GHG emissions can be reported in units of carbon dioxide equivalent (CO_2e). The GHG Emission Factors Hub includes GWPs for methane (CH_4) and nitrous oxide (N_2O) that are consistent with EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks*.

EPA guidance documents describing methods to calculate and report emissions from these sources.

- Direct Emissions from Stationary Combustion (December 2020)
  This document is used to identify and estimate direct GHG emissions from stationary (non-transport) combustion of fossil fuels at a facility (e.g., boilers, turbines, process heat).
- Direct Emissions from Mobile Combustion Sources (December 2020)
  This document is used to identify and estimate direct GHG emissions associated with fuel combustion in owned or operated mobile sources.
- Indirect Emissions from Purchased Electricity (December 2020)
  This document is used to identify and estimate indirect GHG emissions resulting from the purchase of electricity, steam, heat, or cooling.
- Direct Fugitive Emissions from Refrigeration, Air Conditioning, Fire Suppression, and Industrial Gases (December 2020)

Formulae for calculating Scope 1 and 2 emissions[16]

Scope 1 Emissions

Fuel analysis method 1

In this method, the following equation is used to calculate emissions:

Emissions = Fuel × EF1
Here is an explanation of the equation:
Emissions = Mass of CO_2, CH_4, or N_2O that is emitted
Fuel = Mass or volume of fuel that is combusted
EF1 = CO_2, CH_4, or N_2O emission factor per mass or volume unit
Method 1 is used when the heat content of the fuel is unknown, or when the fuel consumption is known only in mass or volume units. Because there is less certainty, this method is less preferred than method 2.

Fuel analysis method 2

In this method, the following equation is used to calculate emissions:

Emissions = Fuel × HHV × EF2
Here is an explanation of the equation:
Emissions = Mass of CO_2, CH_4, or N_2O that is emitted
Fuel = Mass or volume of fuel that is combusted
HHV (higher heating value) = Fuel heat content, in units of energy per mass or volume of fuel

[16] *https://docs.microsoft.com/en-us/industry/sustainability/calculate-scope1*

EF_2 = CO_2, CH_4, or N_2O emission factor per energy unit
Method 2 is the preferred method when the fuel usage is provided in energy units such as therms or British thermal units (BTUs), and when the heat content of the fuel is known.

Mobile combustion

The calculations differ from the calculations for stationary combustion emissions in that there are separate equations for CO_2 and for N_2O and CH_4.

CO_2 emissions

For CO_2, one of the following two methods are used to calculate mobile combustion emissions, depending on the information that is available for the fuel.

CO_2 emission calculation method 1

In this method, the following equation is used to calculate CO_2 emissions:

Emissions = Fuel × EF_1
Here is an explanation of the equation:
Emissions = Mass of CO_2 that is emitted
Fuel = Mass or volume of fuel that is combusted
EF_1 = CO_2 emission factor per mass or volume unit
Method 1 is the recommended method only when the heat content of the fuel is unknown, and when the quantity of fuel is given in mass or volume units. Because there is less certainty, this method is less preferred than method 2.

CO_2 emission calculation method 2

In this method, the following equation is used to calculate CO_2 emissions:

Emissions = Fuel × HHV × EF_2
Here is an explanation of the equation:
Emissions = Mass of CO_2 that is emitted
Fuel = Mass or volume of fuel that is combusted
HHV (higher heating value) = Fuel heat content, in units of energy per mass or volume of fuel
EF_2 = CO_2 emission factor per energy unit
Method 2 is the preferred method when the heat value of the fuel is known, and when the consumption of fuel is given in energy units such as therms or BTUs.

N_2O and CH_4 emissions

For N_2O and CH_4 emissions, the calculation is determined by the vehicle type: on-road (cars, trucks, or buses) or non-road (construction or agricultural equipment, forklifts, ships, boats, rail vehicles, or aircraft).

On-road vehicle N2O and CH4 emission calculation

For on-road vehicles, the following equation is used to calculate N2O and CH4 emissions:

Emissions = Distance × EF4
Here is an explanation of the equation:
Emissions = Mass of CH4 or N2O that is emitted
Distance = Distance that the vehicle traveled
EF4 = CH4 or N2O emission factor per distance unit

Non-road vehicle N2O and CH4 emission calculation

For non-road vehicles, the following equation is used to calculate N2O and CH4 emissions:

Emissions = Fuel × EF5
Here is an explanation of the equation:
Emissions = Mass of CH4 or N2O that is emitted
Fuel = Volume of fuel that is combusted
EF5 = CH4 or N2O emission factor per volume unit

Fugitive emissions

After the emissions are calculated, they are multiplied by the global warming potential (GWP) for the relevant refrigerant. You can find the GWP for different refrigerants in the tables in the following EPA reference document.

Screening method

The screening method relies on equipment-specific emission factors. Therefore, there is one screening method for refrigeration and air conditioning equipment, and another for fire suppression equipment. Because of the uncertainty in this method, an organization should use one of the other methods if it determines that fugitive emissions are significant.

Refrigeration and air conditioning equipment

Equation 1: Estimated emissions from installation
The following equation is used to estimate emissions from the installation of refrigeration and air conditioning equipment:
Emissions from installation = CN × (k ÷ 100)
Here is an explanation of the equation:
CN = Amount of refrigerant that was charged into the new piece of equipment
k = Assembly losses as a percentage of the amount that was charged

Equation 2: Estimated emissions from operation

The following equation is used to estimate emissions from the operation of refrigeration and air conditioning equipment:
Emissions from operation = C × (x ÷ 100) × T
Here is an explanation of the equation:
C = Refrigerant capacity of the piece of equipment
x = Annual leak rate as a percentage of the capacity
T = Time in years that the piece of equipment was used during the reporting period (For example, T equals 0.5 if the equipment was used during half the reporting period and then disposed.)

Equation 3: Estimated emissions from disposal
The following equation is used to estimate emissions from the disposal of refrigeration and air conditioning equipment:
Emissions from disposal = CD × (y ÷ 100) × (1 – z ÷ 100)
Here is an explanation of the equation:
CD = Refrigerant capacity of the piece of equipment that is being disposed of
y = Percentage of the capacity that remains at the time of disposal
z = Percentage of the refrigerant that is recovered

Fire suppression equipment

Emissions from fixed systems are assumed to be 2.5 percent (0.025) of the total capacity of the units for each gas. Emissions from portable equipment are assumed to be 3.5 percent (0.035) of the total capacity of the units for each gas.

Scope 2 Emissions[17]

The following equation is used to calculate emissions:

Emissions = Electricity × EF
Here is an explanation of the equation:
Emissions = Mass of CO_2, CH_4, or N_2O that is emitted
Electricity = Quantity of electricity purchased
EF = CO_2, CH_4, or N_2O emission factor per mass or volume unit

[17] *https://www.epa.gov/sites/default/files/2020-12/documents/electricityemissions.pdf*

Getting the Questionnaire Right

One of the central ideas behind creating a primer is to create a guiding document illustrating the methodology utilized for calculating and reporting Scope 1,2 and 3 emissions. While the backend should be exhaustive enough to convert and capture the inputted data, the front end, where the interaction occurs, needs to be human centered in its design and engagement. The idea is to keep the questionnaire limited on jargon and still help the user complete the survey with a bit more understanding about sustainability practice to improve their carbon metrics. Harvard University Program lists out a few tips in creating a research survey.[18]

- Don't reinvent the wheel
- Pre-test the survey
- Think about the mode of your survey
- Keep the questionnaire short
- Keep question order in mind
- Choosing closed ended vs open ended questions

The ideal question accomplishes three goals: It measures the underlying concept it is intended to tap. It doesn't measure other concepts. It means the same thing to all respondents.

Match Up Against Globally Recognized Reporting Standards

The GHG standards follow a path of accounting, disclosing and target setting, which are covered under various global standards released[19]. The image below depicts the most used platforms for the process, with the GHG protocol being the most widely used standard for accounting. The Environmental, Social and Governance (ESG) reporting space for sustainability metrics has been seeing a continued evolution. Map-Collective's data collection and reporting is in line with the CDP and GRI reporting guidelines to provide a seamless match for using the dashboards for additional reporting activities.

[18] *https://psr.iq.harvard.edu/files/psr/files/PSRQuestionnaireTipSheet_0.pdf*
[19] *https://www.globalreporting.org/media/zrtnajcx/gri-standards-and-cdp-2017-climate-change-linkage-document.pdf*

Figure 3: Global spectrum for various GHG standards

STANDARD	FOCUS	WHY REPORT	SCORING	WHO REPORTS	REPORTING PERIOD
CDP DISCLOSURE INSIGHT ACTION	GHG emissions as well as governance actions and business strategies to mitigate climate change and deforestation and promote water security.	CDP holds the largest repository of GHG emissions and energy use data in the world. In 2021, more than 590 investors with over US$110 trillion in assets requested companies disclose through CDP. CDP's transparent scoring methodology helps respondents understand exactly what's expected of them.	Companies are scored based on four criteria: Disclosure, Awareness, Management, and Leadership. CDP recognizes top scoring companies in the Carbon Disclosure Leadership Index (CDLI).	Cities and companies	For companies, CDP's online reporting system opens in early April and responses are due in late July.
Dow Jones Sustainability Indexes	Industry-specific criteria considered material to investors, including economic, social, and environmental indicators	Members of DJSI represent the top 10% of the 2,500 largest companies in the S&P Global Broad Market Index. The Corporate Sustainability Assessment (CSA) brings a sector-specific focus and need-to-know simplicity to disclosure for public companies.	Companies receive a total Sustainability Score between 0-100 and are ranked against peers. Those with scores in the top 10% are included in the index.	The 2,500 largest public companies in the world.	April 6 - July 13
GRI	Corporate social responsibility with an equal weight on environmental, social and governance factors. Heavy on stakeholder engagement to determine materiality	GRI was announced as the official reporting standard of the UN Global Compact, making it the default reporting framework for the compact's more than 5,800 associated companies. It's among the oldest, most widely adopted and most widely respected reporting methodologies in the world. Its thorough focus on social and governance aspects of ESG is unparalleled.	The GRI Standards - A constantly updated set of guidelines focusing on transparency and accountability rather than a set score. Designed to give a high level look as well as a more detailed breakdown depending on your organization's material topics	Public and private companies, cities, government agencies, universities, hospitals, NGOs	Anytime, but typically integrated into a company's traditional annual report
GRESB	Environmental, social and governance performance in the global commercial real estate sector only. Includes asset- and entity-level disclosures	Private and public institutional investors look to GRESB's annual survey as the barometer of sustainability performance in the commercial real estate industry. Its niche target audience allows it to give deeper and more accurate insights into industry performance and reveal "investment grade" results.	Responses scored out of a possible 100 points distributed across three data components which are then divided into multiple aspects. More weight is attributed to performance and development components.	Commercial real estate owners, asset managers and developers.	April 1 - June 30
SASB SUSTAINABILITY ACCOUNTING STANDARDS BOARD	SASB aims to align organizations and investors on the financial impacts of ESG. Industry-specific standards focus on material aspects of an organization's sustainability performance.	SASB offers disclosure standards for more than 75 industries to ensure information disclosed is most relevant to the financial performance of an organization's industry. The standards focus on financially material aspects so that the disclosure can help drive business and investment decisions.	SASB Standards offer guidelines on material information to report and can be used in conjunction with other frameworks.	Any corporation can use SASB to guide its disclosure.	No specific reporting period, but this framework may be complemented by other organizational disclosures.

Figure 4: Various reporting standards for organizations and their use

As mentioned above, the following table provides an overview of the reporting services covered under Map-Collective's platform's accounting output.

CDP	**GRI**	Map-Collective
CC1. Governance	GRI 102: General Disclosures: Disclosures 102-18, 102-20, and 102-35 (b) GRI 103: Management Approach (applied together with GRI 305: Emissions): Disclosure 103-2 (c-iv) (and reporting recommendations in clauses 1.6.1 and 1.6.2)	COVERED UNDER LARGER CARBON PLAN
CC2. Strategy	GRI 102: General Disclosures: Disclosures 102-12, 102-13 (and reporting recommendations in clause 1.5), 102-14, 102-15 (and reporting recommendations in clauses 2.2.3, 2.2.4, 2.2.9, 2.2.10 and 2.2.12), 102-29, 102-30, and 102-31 GRI 103: Management Approach (applied together with GRI 305: Emissions): General requirements for reporting the management approach in clause 1.2, Disclosures 103-1 (a) (and related 'Guidance'), 103-2 (c-i) (and reporting recommendations in clause 1.3), and 103-2 (c-vii) (and reporting recommendations in clause 1.9) GRI 415: Public Policy: Management approach disclosures (reporting recommendations in clauses 1.2.1 and 1.2.2)	COVERED UNDER LARGER CARBON PLAN
CC3. Targets and Initiatives	GRI 102: General Disclosures: Disclosures 102-14 (and reporting recommendations in clauses 2.1.5 and 2.1.6) and 102-15 (and reporting recommendations in clauses 2.2.10 and 2.2.11) GRI 103: Management Approach (applied together with GRI 302: Energy and/or GRI 305: Emissions): Disclosure 103-2 (c-iii) (and reporting recommendations in clauses 1.5.1, 1.5.3, 1.5.4 and 1.5.5) GRI 103: Management Approach (applied together with GRI 305: Emissions): Disclosure 103 (c-vii) (and reporting recommendations in clause 1.9) GRI 305: Emissions: Disclosures 305-3 (e) and 305-5 (a, d)	COVERED UNDER CARBON PLAN
CC5. Climate Change Risk	GRI 102: General Disclosures: Disclosure 102-15 (and reporting recommendations in clauses 2.2.1 and 2.2.8) GRI 201: Economic Performance: Disclosure 201-2	COVERED UNDER CARBON PLAN

CC6. Climate Change Opportunities	GRI 102: General Disclosures: Disclosure 102-15 (and reporting recommendations in clauses 2.2.1 and 2.2.8) GRI 201: Economic Performance: Disclosure 201-2	COVERED UNDER LARGER CARBON PLAN
CC7. Emissions Methodology	GRI 305: Emissions: Disclosures 305-1 (b, d, e, g), 305-2 (c, d, e, g), and 305-5 (b, e)	COVERED UNDER EMISSIONS MEASUREMENT
CC8. Emissions Data	GRI 102: General Disclosures: Disclosure 102-56 (a, b-i) GRI 103: Management Approach (applied together with GRI 305: Emissions): Disclosure 103-1 (b, c) GRI 305: Emissions: Disclosures 305-1 (a, c, f), 305-2 (a, b, f, g), and 305-3 (c)	COVERED UNDER EMISSIONS MEASUREMENT
CC9. Scope 1 Emissions Breakdown	GRI 305: Emissions: Disclosure 305-1 (b) (and reporting recommendations in clause 2.2.5)	COVERED UNDER EMISSIONS MEASUREMENT
CC10. Scope 2 Emissions Breakdown	GRI 302: Energy: Disclosure 302-1 (reporting recommendations in clause 2.2.6) GRI 305: Emissions: Disclosure 305-2 (reporting recommendations in clause 2.4.5)	COVERED UNDER EMISSIONS MEASUREMENT
CC11. Energy	GRI 302: Energy: Disclosure 302-1 (a, b, c, e, g)	COVERED UNDER EMISSIONS MEASUREMENT
CC12. Emissions Performance	GRI 305: Emissions: Disclosures 305-4 (a, b, c) and 305-5 (a, c, d) (and related 'Guidance')	COVERED UNDER LARGER CARBON PLAN
CC13. Emissions Trading	GRI 305: Emissions: Management approach disclosures (reporting requirements in clause 1.2)	FUTURE
CC14. Scope 3 Emissions	GRI 102: General Disclosures: Disclosure 102-56 (a, b-i) GRI 305: Emissions: Disclosures 305-3 (a, d, f, g) (and related 'Guidance') and 305-5 (a, c, d) (and related 'Guidance')	COVERED UNDER EMISSIONS MEASUREMENT

Appendix 1: Sources and scope covered under GPC

Sectors and sub-sectors	Scope 1	Scope 2	Scope 3
STATIONARY ENERGY			
Residential buildings	✓	✓	✓
Commercial and institutional buildings and facilities	✓	✓	✓
Manufacturing industries and construction	✓	✓	✓
Energy industries	✓	✓	✓
Energy generation supplied to the grid	✓		
Agriculture, forestry, and fishing activities	✓	✓	✓
Non-specified sources	✓	✓	✓
Fugitive emissions from mining, processing, storage, and transportation of coal	✓		
Fugitive emissions from oil and natural gas systems	✓		
TRANSPORTATION			
On-road	✓	✓	✓
Railways	✓	✓	✓
Waterborne navigation	✓	✓	✓
Aviation	✓	✓	✓
Off-road	✓	✓	
WASTE			
Disposal of solid waste generated in the city	✓		✓
Disposal of solid waste generated outside the city	✓		
Biological treatment of waste generated in the city	✓		✓
Biological treatment of waste generated outside the city	✓		
Incineration and open burning of waste generated in the city	✓		✓
Incineration and open burning of waste generated outside the city	✓		
Wastewater generated in the city	✓		✓
Wastewater generated outside the city	✓		
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)			
Industrial processes	✓		
Product use	✓		
AGRICULTURE, FORESTRY AND OTHER LAND USE (AFOLU)			
Livestock	✓		
Land	✓		
Aggregate sources and non-CO_2 emission sources on land	✓		
OTHER SCOPE 3			
Other Scope 3			

✓ Sources covered by the GPC

Sources required for BASIC reporting

+ Sources required for BASIC+ reporting

Sources required for territorial total but not for BASIC/BASIC+ reporting (*italics*)

Sources included in Other Scope 3

Non-applicable emissions

Appendix 2: Emission source sectors covered under GPC

Sectors in the GPC	
STATIONARY ENERGY	
	Stationary energy sources are one of the largest contributors to a city's GHG emissions. These emissions come from the combustion of fuel in residential, commercial and institutional buildings and facilities and manufacturing industries and construction, as well as power plants to generate grid-supplied energy. This sector also includes fugitive emissions, which typically occur during extraction, transformation, and transportation of primary fossil fuels.
TRANSPORTATION	
	Transportation covers all journeys by road, rail, water and air, including inter-city and international travel. GHG emissions are produced directly by the combustion of fuel or indirectly by the use of grid-supplied electricity. Collecting accurate data for transportation activities, calculating emissions and allocating these emissions to cities can be a particularly challenging process. To accommodate variations in data availability, existing transportation models, and inventory purposes, the GPC offers additional flexibility in calculating emissions from transportation.
WASTE	
	Waste disposal and treatment produces GHG emissions through aerobic or anaerobic decomposition, or incineration. GHG emissions from solid waste shall be calculated by disposal route, namely landfill, biological treatment and incineration and open burning. If methane is recovered from solid waste or wastewater treatment facilities as an energy source, it shall be reported under Stationary Energy. Similarly, emissions from incineration with energy recovery are reported under Stationary Energy.
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	
	GHG emissions are produced from a wide variety of non-energy related industrial activities. The main emission sources are releases from industrial processes that chemically or physically transform materials (e.g., the blast furnace in the iron and steel industry, and ammonia and other chemical products manufactured from fossil fuels and used as chemical feedstock). During these processes many different GHGs can be produced. In addition, certain products used by industry and end-consumers, such as refrigerants, foams or aerosol cans, also contain GHGs which can be released during use and disposal.
AGRICULTURE, FORESTRY AND OTHER LAND USE (AFOLU)	
	Emissions from the Agriculture, Forestry and Other Land Use (AFOLU) sector are produced through a variety of pathways, including livestock (enteric fermentation and manure management), land use and land use change (e.g., forested land being cleared for cropland or settlements), and aggregate sources and non-CO_2 emission sources on land (e.g., fertilizer application and rice cultivation). Given the highly variable nature of land-use and agricultural activity across geographies, GHG emissions from AFOLU are amongst the most complex categories for GHG accounting.