Green x Digital Consortium

CO2 Visualization Framework

Edition 2.0.1

September 20, 2024

Green x Digital Consortium

Methodology Sub-Working Group

Revision history

Edition	Date	Changes
1.0	June 30, 2023	New
2.0	July 23, 2024	Updates to Edition 1 ① Updates based on the results of the joint POC experiment conducted from 2022 to June 2023 ② Updates to accommodate revisions from Version 1 to Version 2 of the Pathfinder Framework ③ Additions concerning the relationship to the Carbon Footprint Guidelines and Carbon Footprints Practical Guide issued by the Japanese government
2.0.1	September 20, 204	p.21 Revised Figure 1-4-3 p.22 Due to the revision of Figure 1-4-3, the related text has been deleted. p.23,87 Corrected typographical errors

Contents

1. Introduction

- This chapter presents how the Green x Digital Consortium aims to visualize CO2.
- To the greatest extent possible, we have left a record of the various discussions on CO2 visualization conducted in the Methodology SWG to serve as a baseline to which we can return in future. As a result, a lot of conceptual discussion is also recorded.
- Readers who are interested in practical methods for calculating and disclosing CO2 data may simply skim this chapter and proceed to Chapters 2, 3, and 4.

What is the CO2 Visualization Framework

1-1. What is the CO2 Visualization Framework?

1-1-1. Positioning of the CO2 Visualization Framework

- The Green x Digital Consortium CO2 Visualization Framework (below, this document) is a framework document for CO2 visualization published by the Green x Digital Consortium.
- It was created by the Methodology Sub-Working Group (SWG), a sub-group of the Green x Digital Consortium's Visualization Working Group (WG).
  - The Visualization WG aims to use digital technology to achieve visualization of CO2 data throughout the entire supply chain and to establish a mechanism to appropriately reflect CO2 reduction efforts in data.
  - The SWG is in charge of examining methods for calculating CO2 data that are shared throughout the supply chain using digital technology, as well as elements to be disclosed when data is shared.
- This document presents (1) methods of calculating CO2 data to be exchanged throughout the supply chain using digital technology, and (2) sharing methods (data quality disclosure methods). (The use of digital technology will be discussed in the Data Format and Exchange SWG.)
- In addition, this document outlines the basic concepts in relation to the CO2 data calculation method for transportation and logistics but leaves more detailed explanations to the guidance developed separately by the Logistics SWG.

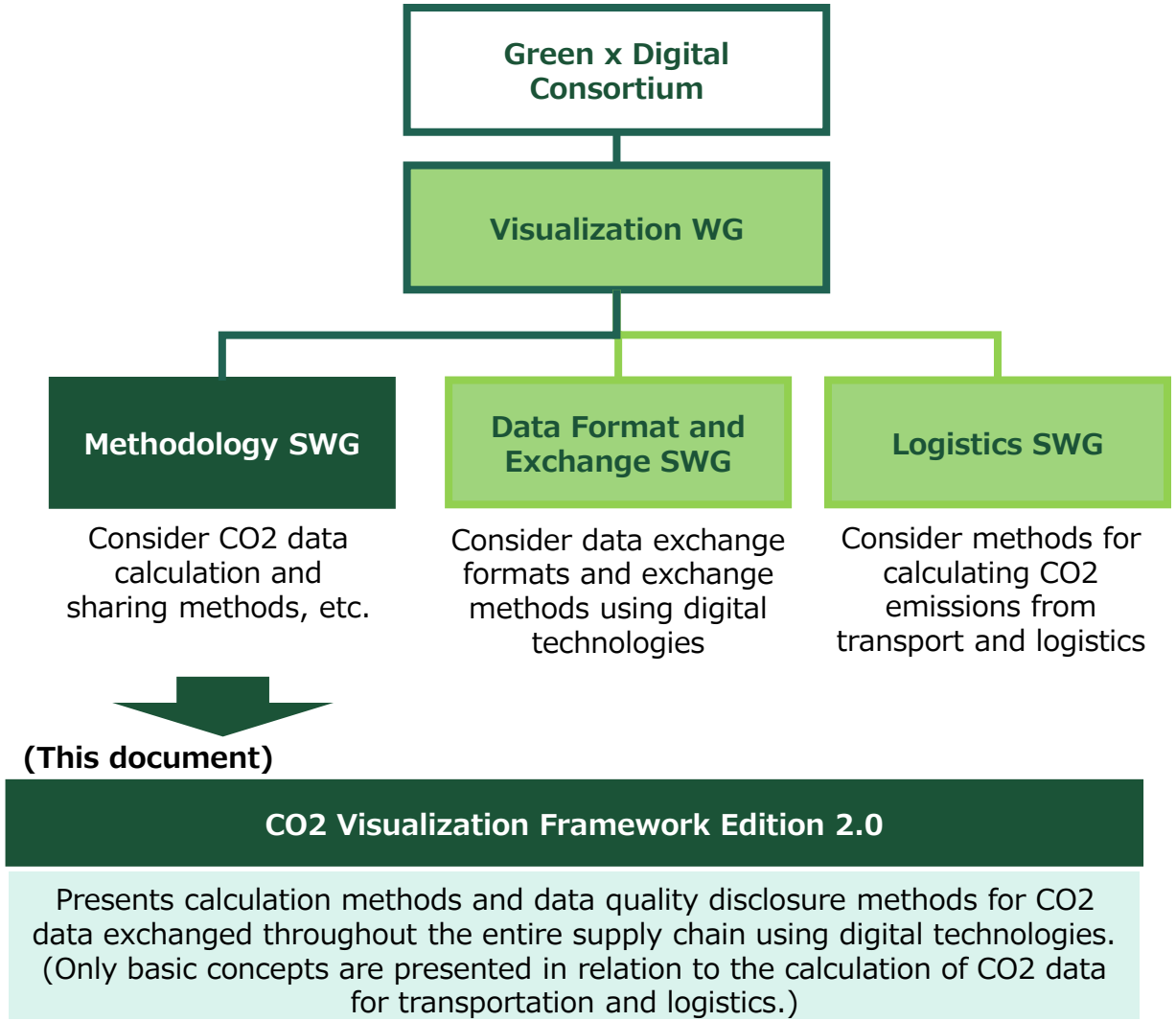


Figure 1-1-1 Positioning of the Methodology SWG and this document

Creating a connected world

- The aims of the Green x Digital Consortium's Data Visualization Project are to use digital technology to visualize CO2 data throughout the entire supply chain and to build a mechanism that appropriately reflects CO2 reduction efforts in data.
- In this system, the data collection, calculation, and sharing solutions used by each company in the supply chain are connected by the solutions used by the other companies in the same chain so as to facilitate data exchange between companies. Each company's CO2 data is calculated in a way that reflects the company's actual emissions and reduction efforts based on common data collection and calculation methodologies and is shared through a unified data format.
- Companies downstream in the supply chain will be able to measure and monitor Scope 3 emissions while reflecting the emissions status and reduction efforts of suppliers.
- This data exchange can also be interlinked with major global frameworks and platforms, ensuring that the CO2 reduction efforts of Japanese companies receive proper recognition overseas.

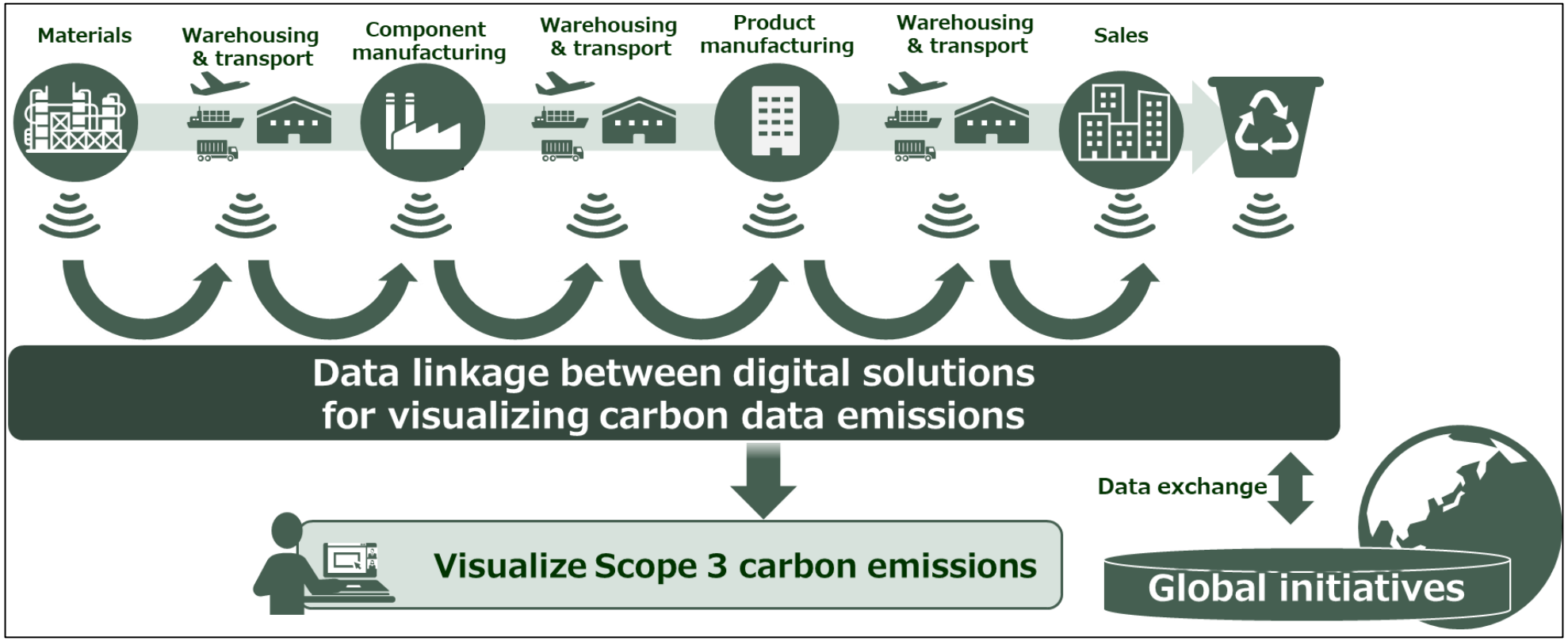


Figure 1-1-2 The connected world sought by the Visualization WG

Source: NEC

Authors and document preparation steps

1-1-2. Authors of this document

- The authors of this document are shown in Figure 1-1-3. The leader and sub-leaders of the Methodology SWG were the main authors, with other SWG members cooperating in the study and offering their opinions.
- The contributions of each company in the preparation of this document are described separately at the end of this document.

Leader	Mizuho Research and Technologies
Sub-leaders	NTT Data, Brother Industries
SWG Members	IHI,Asuene, Amazon Web Services Japan, NTT DATA, Omron,Kajima, Canon, Sustech, Sumitomo Electric Industries, Zero Board, TÜV SÜD Japan,Deloitte Tohmatsu Consulting, Toshiba, Nagase Sangyo, Nitto Denko Corporation, NEC, Nomura Research Institute, Panasonic Pendingings, Hitachi, PwC Advisory, PwC Consulting, Forval, Fujitsu, Brother Industries, Mizuho Research & Technology, Mitsui, Mitsubishi Electric, Murata Manufacturing, Yokogawa Electric

Figure 1-1-3 Document authors and co-authors

1-1-3. Steps involved in preparing this document

- The Methodology SWG developed this document through the following steps.

	Date	Issues and requirements	Investigation of existing methodologies	Document preparation
1	2022 April 19	• Presentation of each company's issues • Summary of issues in initial report	• Identification of existing methodologies to be investigated	
2	May 10	• Summary of issues • Handling of indirect sectors	• Preliminary methodology investigation results (1)	• Table of contents organization, identification of proposed elements
3	June 7	• Verification • Treatment of comparability	• Preliminary methodology investigation results (2)	• Preparation and presentation of draft plan aiming at completion by 1/3
4	July 12	• Document positioning	• Preliminary methodology investigation results (3)	• Preparation and presentation of draft plan aiming at completion by 2/3
5	Aug. 9			• Draft presentation (for comment)
6	Sept. 20			• Revision based on comments received, presentation of revised draft
7	2023 June 28	• Identify issues toward developing Edition 2		
8	Aug. 1	• Discuss issues toward developing Edition 2		• Presentation of first draft of Edition 2
9	Aug. 22	• Discuss issues toward developing Edition 2		• Presentation of second draft of Edition 2
10	Nov. 15*			• Presentation of third draft of Edition 2
11	2024 Jan. 24			• Presentation of final draft of Edition 2

Figure 1-1-4 Steps involved in preparing this document

* November 15: Report at Visualization WG

Envisaged users

1-1-4. Envisaged users

- Edition 1 of this document was intended for use by companies participating in the Green x Digital Consortium PoC project* conducted in FY2022 and FY2023.
- Edition 2 has been updated based on the results of the PoC project and is expected to be widely used by members of the Green x Digital Consortium as well as the general public.
- The envisaged users of Edition 2 are:

- Suppliers that calculate and share (provide) CO2 data
- Buyers that share (receive) and utilize CO2 data
- Solution providers supporting the calculation, sharing and utilization of CO2 data
- Consultant firms supporting the calculation, sharing and utilization of CO2 data
- Assurance and verification bodies that verify and assure the results of CO2 data calculation and utilization

- Figure 1-1-5 shows the relationships between suppliers and buyers who calculate, share, and utilize CO2 data, the consultants and solution providers that support them, and assurance and verification bodies that assure and verify data reliability.

*For details, see the final report released in August 2023 (https://www.gxdc.jp/pdf/report02.pdf)

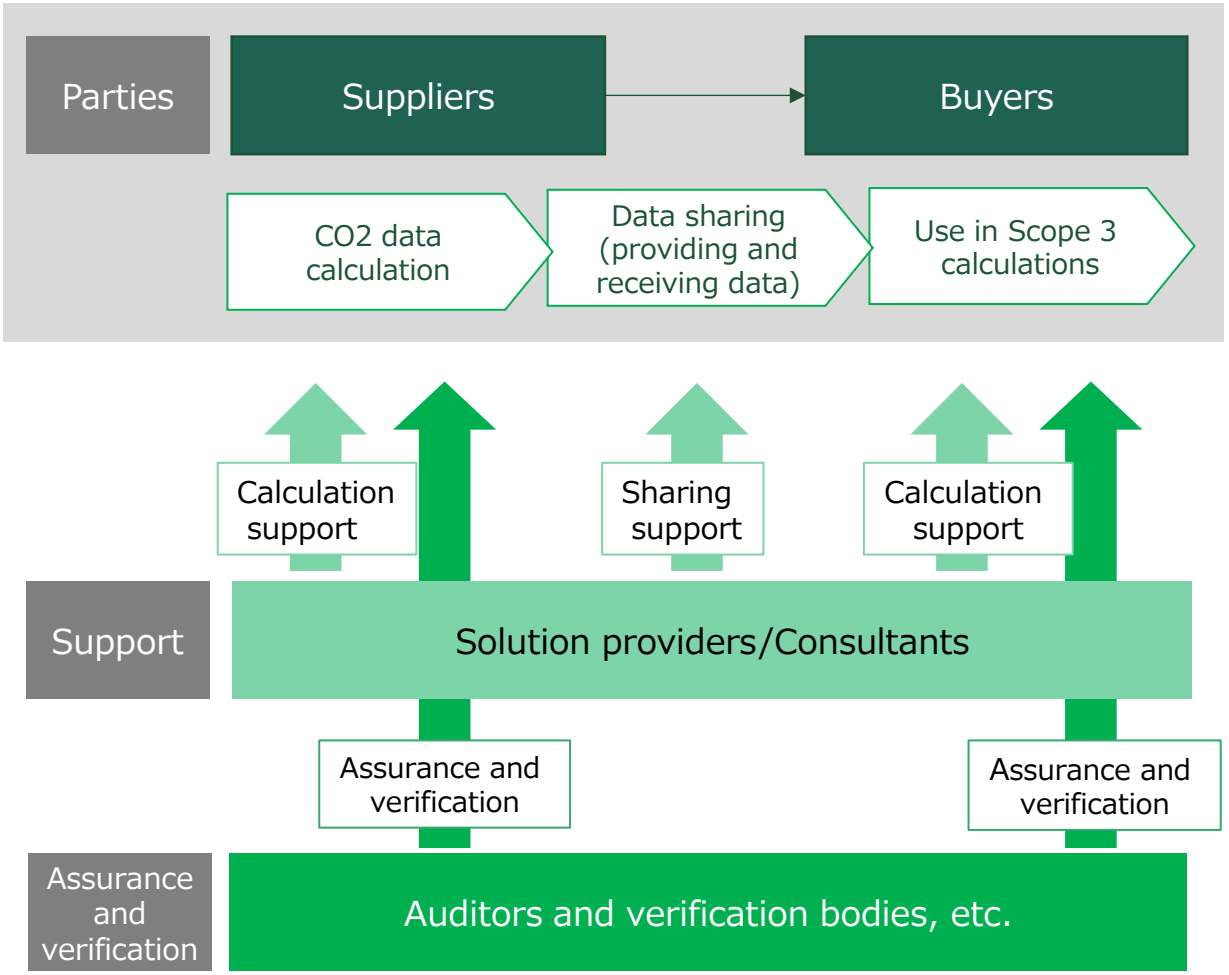


Figure 1-1-5 Envisaged users of this document

Notes regarding CO2 data

1-1-5. Notes about the term “CO2 data"

- Unless otherwise specified, the definition of the term “CO2 data” is as follows:

  - The CO2 equivalent (expressed as kg-CO2e, etc.) of greenhouse gas emissions (GHG emissions) specified by the IPCC (i.e., not limited to CO2 emissions alone)
  - It assumes a lifecycle boundary for cradle-to-gate emissions calculations, covering emissions right up to the top of the supply chain in addition to a company’s own processes.
    (The reason for adopting the cradle-to-gate method will be explained later in 1-4-6.)

- In other words, “CO2 data” in this document corresponds to numerical information called **“**cradle-to-gate GHG emissions” in the worlds of LCA (Life Cycle Assessment) and CFP (Carbon Footprint of Products).
- The term “CO2 data” is used in this document because:
  - The terms “CO2 visualization” and “supply chain CO2 visualization” are familiar to Japanese industry; and
  - The addition of “data” captures the emphasis of the Green x Digital Consortium on the use of digital technology.

CO2 data Term used in this document

Note 1

Refers to the CO2 equivalent (kg-CO2e) of greenhouse gases (GHG) as defined by the IPCC

Note 2

Lifecycle boundary for calculating emissions = cradle-to-gate

Intention of use

- To communicate the aim of the document to users based on the expression “CO2 visualization,” which is familiar to Japanese industry
- To capture the Consortium’s emphasis on the utilization of digital technology through the addition of the term “data”

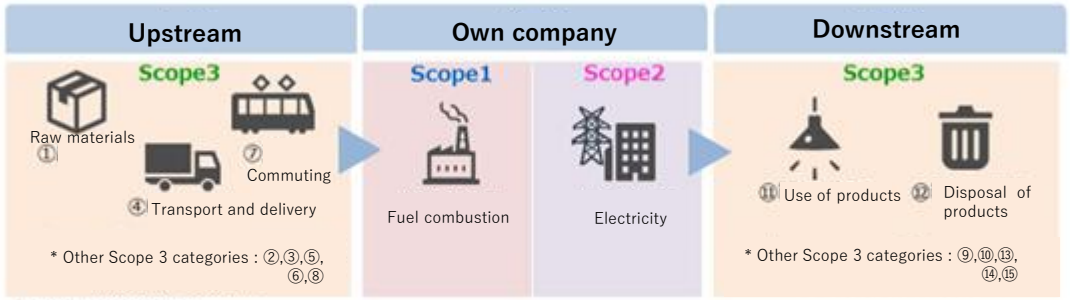
Figure 1-1-6 Notes and intention in using the term “CO2 data”

Background (1) Supply chain CO2 visualization progress and limitations

1-2. Background and objectives

1-2-1. Background: (1) Supply chain CO2 visualization progress and limitations

- In recent years, it has become common in Japan to comply with the GHG Protocol in the calculation and reporting of companies' GHG emissions.
- The GHG Protocol is an initiative to develop standards for the calculation and reporting of GHG emissions, co-sponsored by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). In addition, the standards developed are often referred to as "GHG protocols."
- The GHG Protocol has long been treated as a de facto standard, but in practice it was mainly applied by global companies. Recently, however, international information disclosure frameworks such as the TCFD and the ISSB standards (IFRS S2) have required emissions to be calculated in line with the GHG Protocol, prompting a rapid increase in the number of companies aiming to apply these standards.
- The GHG Protocol introduces Scope 1, 2 and 3 categories into the calculation and reporting of corporate GHG emissions. Scope 3 covers emissions from other companies related to corporate activities and includes companies' procurement networks (supply chains) (Figure 1-2-1).
- However, because supply chains comprise a chain of the activities of many supplier companies, GHG emissions are not easily calculated.
- As a result, secondary data emission factors became the mainstream in the calculation of Scope 3 emissions. These describe the amount of GHG emissions associated with the manufacture and supply of unit quantities of procured products (raw materials, parts, etc.), prepared from secondary data such as industry averages and model estimates.
- In practical terms, the supply chain emissions of procured products were calculated by multiplying the company's own activities (procurement volume, etc.) by the secondary data emission factors, utilizing LCA databases such as IDEA, eco-invent, and Gabi as data sources.
- Today, many more companies are calculating supply chain GHG emissions as part of their Scope 3 emissions calculations.
- However, there is growing recognition of the limitations of the current mainstream calculation method using econdary data emission factors, namely, that because it does not use suppliers' actual GHG emissions (primary data), it fails to take into account suppliers' emissions reduction efforts.



Numbers in circles indicate Scope 3 categories.

Scope1 : **Direct emissions of greenhouse gases by business** (Fuel combustion and industrial processes)

Scope2 : **Indirect emissions from the use of electricity, heat and steam supplied by other companies**

Scope3 : **Indirect emissions other than Scope 1 and Scope 2** (emissions by other companies related to business activities)

Figure 1-2-1 Introduction of Scope 1, 2 and 3 under the GHG Protocol

Source: Ministry of the Environment and Mizuho Research & Technologies "Towards the Calculation and Reduction of Supply Chain Emissions"

Background: (2) CO2 visualization in an era of carbon neutrality

1-2-2. Background: (2) CO2 visualization in an era of carbon neutrality

- When the calculation of “emissions = activity data × secondary data emission factor” is used for CO2 visualization, the main means of reducing emissions is to reduce the amount of activity (energy and raw material procurement, etc.). Specifically, reducing production loss and slimming down parts through improved design were the main approaches to Scope 3 reduction.
- However, in an era in which Japan aims to reduce greenhouse gas emissions to “carbon neutral” (net zero) by 2050, efforts to reduce activities alone are insufficient.
- As long as the formula “activity data × secondary data emission factor” is used, achieving zero emissions requires reducing activity to zero, but this means companies ceasing their business, which is not a realistic solution.
- Attention has turned instead to the use of primary data emission factors using primary data (data pertaining to a specific product or activity within a company’s value chain).
- If suppliers reduce emissions and downstream companies incorporate these effects into their emissions through the calculation “emissions = activity data x primary data emission factor,” synergy will emerge between activity reduction and improvements in emission factors (supplier efforts) (Figure 1-2-2).
- In addition, the spread of renewable energy in recent years has made it possible for companies to significantly reduce emissions while maintaining their business activities. If each company in the supply chain visualizes the effects of these efforts and provides them as primary data emission factors to companies downstream in the supply chain, it will pave the way for decarbonization of the entire supply chain (Figure 1-2-2).

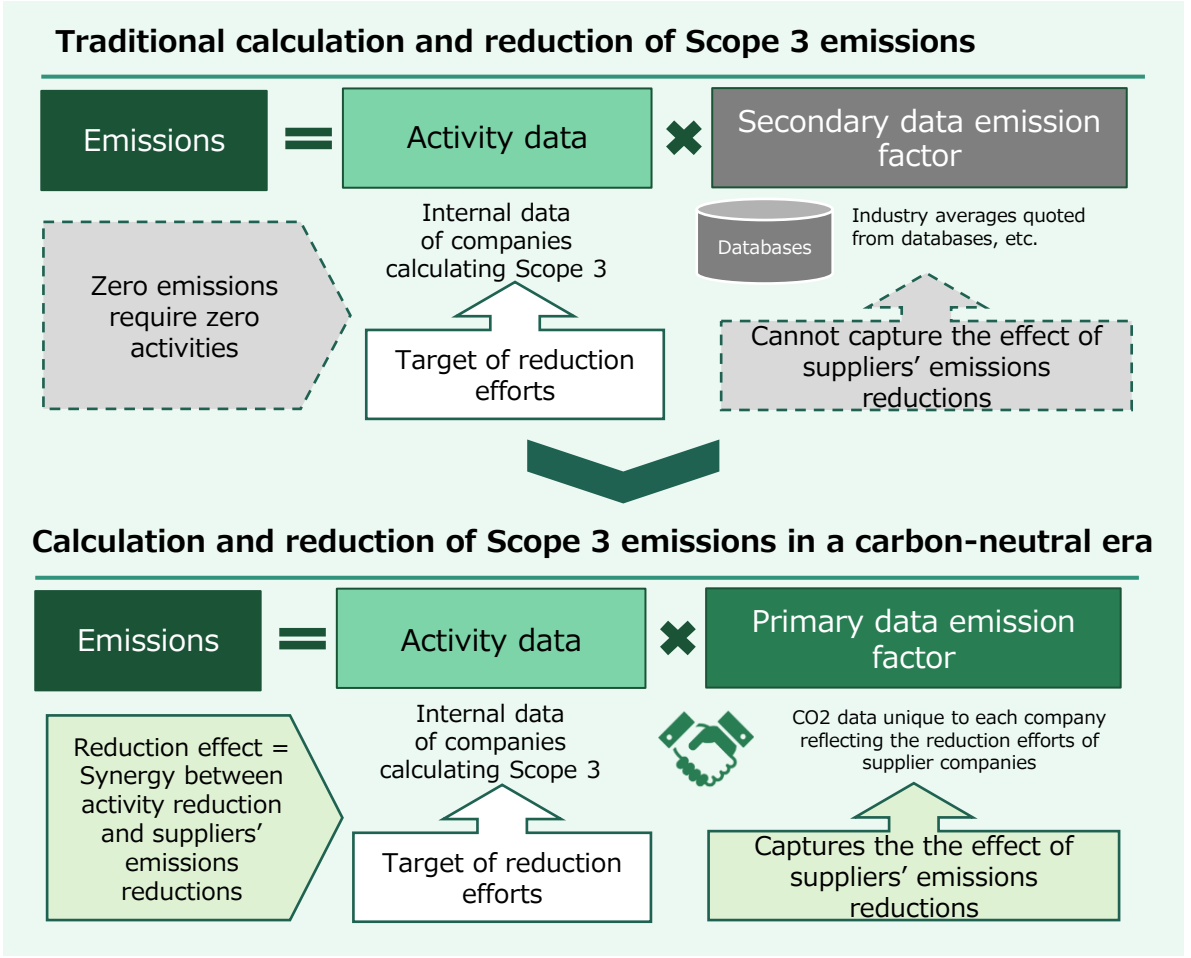
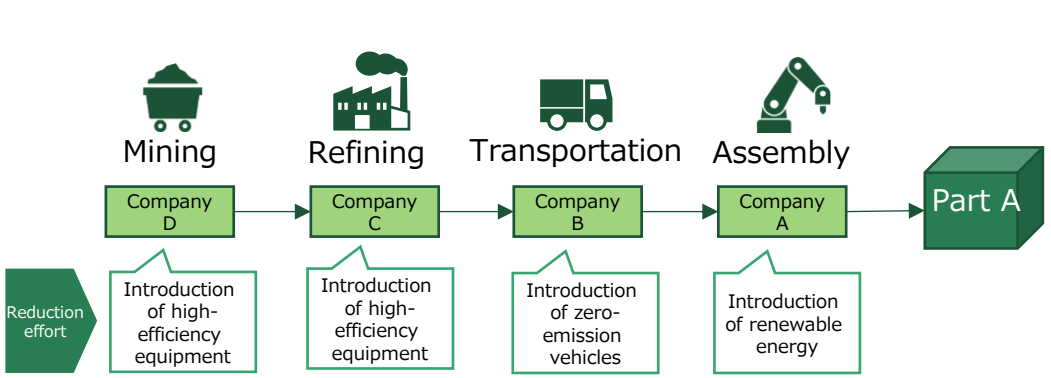


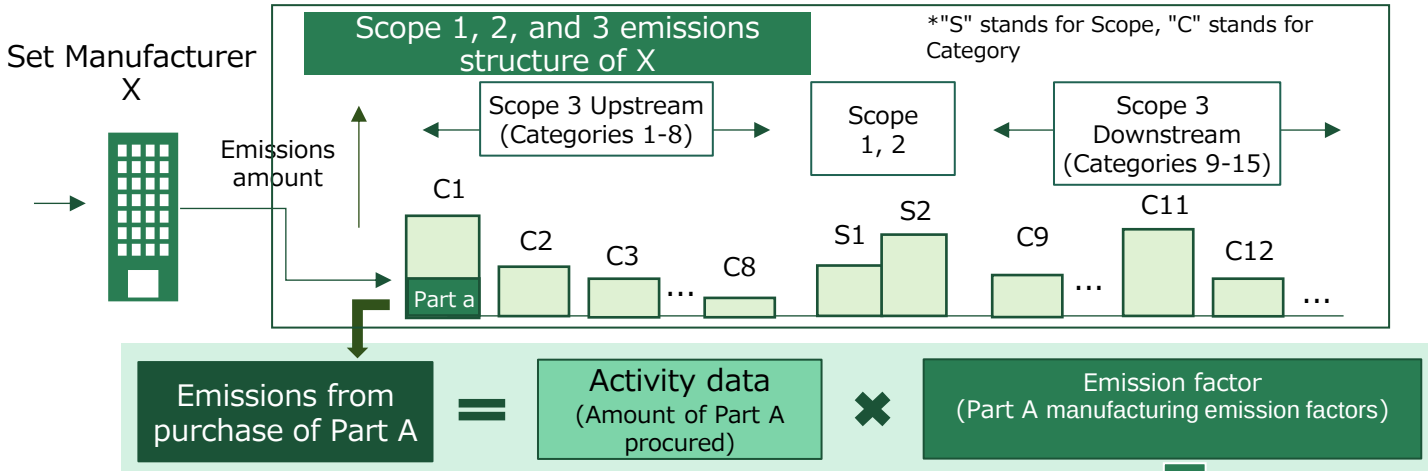
Figure 1-2-2 Significance of using “activity data x primary data emission factor”

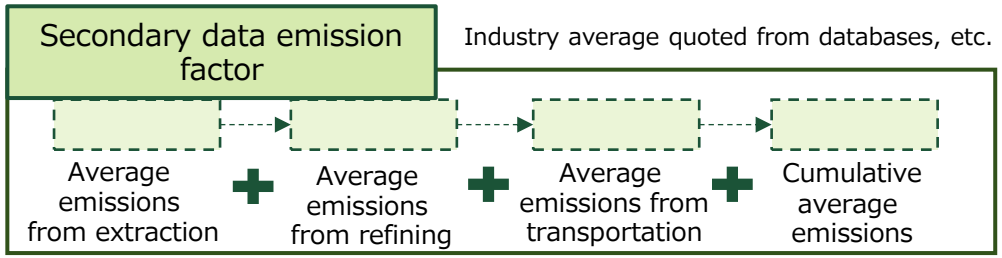
Source: Created by Mizuho Research & Technologies

Significance of addressing “activity data × primary data emission factor”

- Assume that Set Manufacturer X procures Part A from a supply chain consisting of mining, refining, transportation, and assembly.
- For Company X, emissions from the purchase of Part A are part of Scope 3 Upstream Category 1: Purchased Goods and Services.
- If the CO2 emissions specific to each supplier A to D can be obtained from primary data, reductions can be achieved through the efforts of each supplier rather than relying on reducing purchase volume.

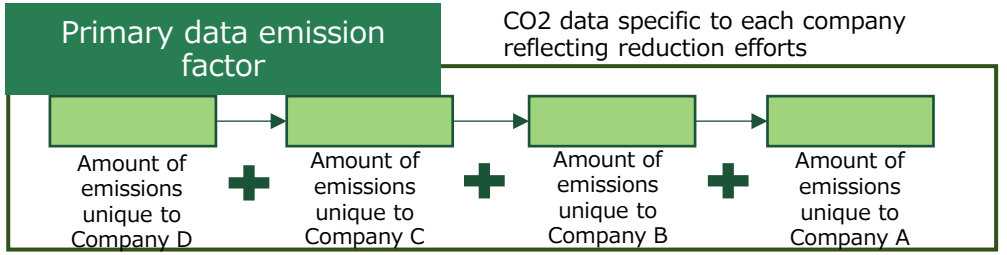






When secondary data emission factors are used for calculation, the results of the reduction efforts of Companies A to D are not reflected in the data.
In order to reduce emissions from Part A, Set Manufacturer X must reduce the amount of activity (amount purchased).

Secondary data emission factor does not reflect individual companies’ efforts



When primary data are used for emission factors, the results of the reduction efforts of Companies A to D are reflected in the data.
By encouraging its suppliers to make reduction efforts, Set Maker X can achieve emissions reductions without reducing the amount of activities (amount purchased).

Efforts of each company are reflected in primary data emission factor

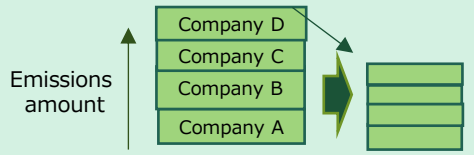


Figure 1-2-3 Significance of using “activity data x primary data emission factor”

Source: Created by Mizuho Research & Technologies

SWG Discussion: (1) Discussion on the definition of primary data (1/2)

- The Methodology SWG examined existing standards to confirm primary data definitions, identifying two main approaches: (a) ISO 14067:2018, which emphasizes direct measurement or calculation based on direct measurement; and (b) the GHG Protocol and Pathfinder Framework (covered in 1-4-3), which focus on whether data is unique to processes, activities, and enterprises.

Methodologies and standards	Primary data definitions
ISO 14067:2018	Quantified value of a process or an activity obtained from direct measurement or a calculation based on direct measurement
GHG Protocol	• Data from specific processes in the lifecycle of the product being evaluated (Product Standard) • Data from specific processes in the studied product's life cycle (Scope 3 Standard)
Pathfinder Framework	Primary data is site-specific, company-specific or supply chain–specific

Figure 1-2-4: Primary data definitions in major standards

- This document emphasizes alignment with PACT's Pathfinder Framework v2 to achieve CO2 data calculations of an internationally acceptable data quality, defining "primary data" as "data pertaining to a specific product or activity within a company's value chain," as noted in 1-2-2.
- The SWG also considered whether data quality standards should be set when identifying primary data.
- This question arises from this document's adoption of a policy of recognizing both Product-based calculation (using LCA and PCF methods on a product basis) and Organization-based calculation (extraction of organizational emissions data such as Scope 1, 2, and 3 emissions through allocation to specific suppliers, etc. (see 1-4-2).
- The CO2 data obtained from the two methodologies may differ in the degree of specificity to the target product. For example, in the case of Organization-based calculation, emissions data related to the manufacturing of a product other than the target product may be mixed in (see 1-4-2).
- On the other hand, there is no standard for CO2 calculation that disallows primary data based on differences in calculation methods and data quality, even if the data is specific to a company or process.
- In light of these issues, this document has adopted the following approach:
  a. Recognize site-specific, company-specific, and supply-chain specific data as primary data
  b. BUT introduce a mechanism to ensure that CO2 data users recognize that the nature and quality of primary data will vary depending on the calculation methodology and the quality of the data used and cannot necessarily be treated equally (continued on next page).

SWG discussion: (1) Discussion on the definition of primary data (2/2)

■ Mechanism 1: Specification of calculation criteria

- We enabled avoidance of confusion between primary data drawn from Product-data based and Organization-data based calculations (the issue which most concerned SWG members) by making it mandatory to disclose the methodologies and standards used in calculations when data is shared. (For definitions of Product-data based calculation and Organization-data based calculation, see 1-4-2 (1)).

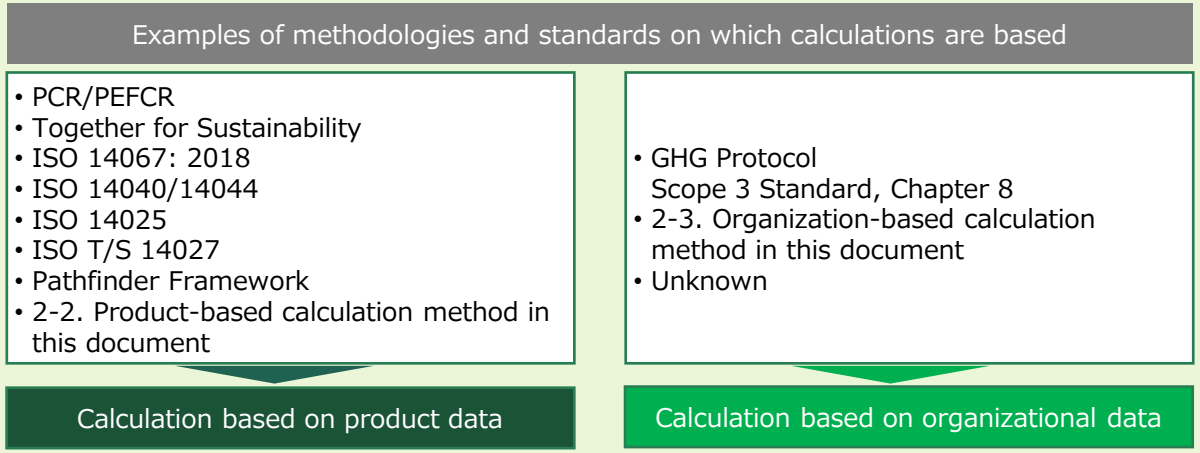


Figure 1-2-5: Avoiding confusion between primary data drawn from Product-data based and Organization-data based calculations
(See Fig. 3-1-5 for a complete listing of methodologies and standards)

- The thinking behind Figure 1-2-5 is explained in 1-4-2 (4). Figure 1-2-5 is an excerpt from the options in the referenced standards in relation to data disclosure elements shown in Chapter 3. See Chapter 3 for details.
- As a result, it is possible for a downstream operator to determine whether the primary data provided has been calculated based on product-data or organization-data.
- In addition, this document introduced the provision that when CO2 data based on Organization-data based calculations is used for upstream emissions from Product-data based calculations, parties using Product-data based calculations should not treat the primary data derived from Organization-data based calculations as primary data (see 2-1-3 for details). This decision is based on the fact that Organization-data based calculations are often inferior to Product-data based calculations in terms of specificity to the target product.
- This approach avoids primary data from Product-data based calculation and from Organization-data based calculation being assessed as equal.

■ Mechanism 2: Implementation of data quality assessment

- In addition, this document introduces data quality assessment as a means of making CO2 data users aware that primary data does not necessarily guarantee high data quality.
- Similar to the approach introduced in Version 2 of PACT's Pathfinder Framework, with which this document seeks to align, the quality of the activity data and emission factor data forming the basis of emissions calculations will be evaluated on the basis of five indicators (see 2-2-8 (2) for details).
- Thus, the data activity side can identify whether the data is primary data and whether data quality is high or low.

Achieving “activity amount × primary data emission factors”

1-2-3. Purpose: Realization of “activity amount × primary data emission factors”

- The objective of this document is to provide a supply chain CO2 visualization system based on the “activity amount × primary data emission factors” that has been discussed so far.
- However, adopting this calculation method raises new issues. For example, if the method of calculating CO2 data varies widely among suppliers, CO2 data of varied quality will be distributed. Following Gresham’s principle of bad money driving out good money, there may be cases of unreasonably low calculation of a company’s product CO2 data.
- In order to prevent such situations, this document establishes ① a calculation method based on primary data and ② sharing methods (methods for disclosing data quality) for CO2 data subject to data exchange throughout the supply chain using digital technology.

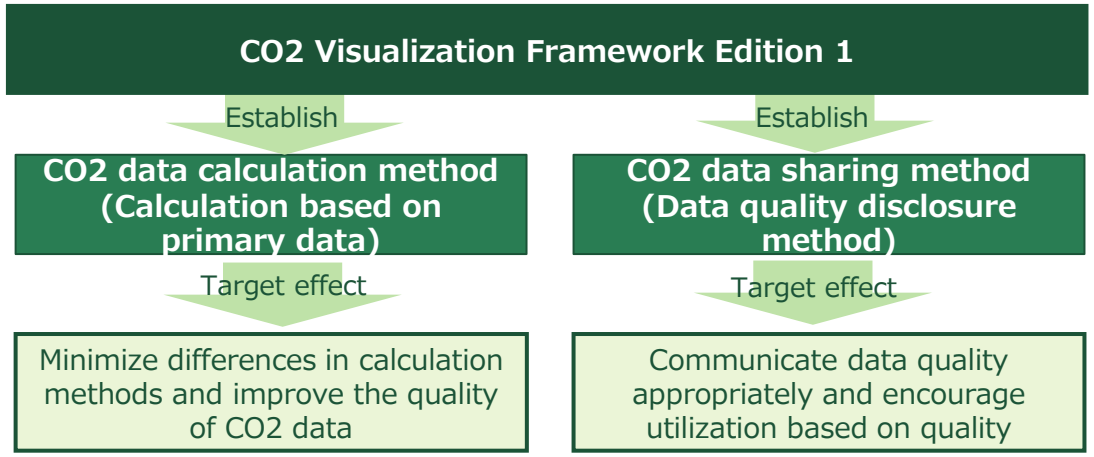


Figure 1-2-5 Two methods implemented by the CO2 Visualization Framework

- The purpose of developing an approach to CO2 data calculation based on primary data is to minimize as much as possible the variations and differences in CO2 data calculation methods used by suppliers, and to improve the data quality of CO2 data exchanged using digital technology. Details are given in Chapter 2.
- However, in a situation where each supplier calculates CO2 data based on its own primary data, the CO2 data groups distributed in the future will have a certain variation in calculation methods and data quality. Therefore, it is necessary to establish methods for sharing CO2 data (methods for disclosing data quality).
- The purpose of developing data quality disclosure methods is to create an environment in which companies downstream in the supply chain that use CO2 data can correctly understand the quality of the data provided, as well as to encourage users to make appropriate use of the data based on its quality. With this preference for high-quality CO2 data, we aim to achieve a situation where “good money drives out bad money.” Details are given in Chapter 3.

CO2 data calculated and shared by suppliers

1-3. Scope of this document

1-3-1. Measures taken by supplier companies

- Scope 3 calculation and disclosure methodologies are defined by the GHG Protocol Scope 3 Standard. However, sufficient guidance has not been provided for companies downstream in the supply chain that perform Scope 3 calculations on how companies (suppliers) upstream should calculate CO2 data and what information should be attached and submitted.

- This document focuses on supplier efforts.
- It describes how suppliers calculate and share CO2 data as the primary data emission factors used by downstream companies in calculating Scope 3.
- If downstream companies request that suppliers comply with the CO2 data calculation and sharing methodologies in this document, they should communicate with suppliers in such a way as not to violate the Subcontract Act and the Act on the Promotion of Subcontracting Small and Medium-sized Enterprises.

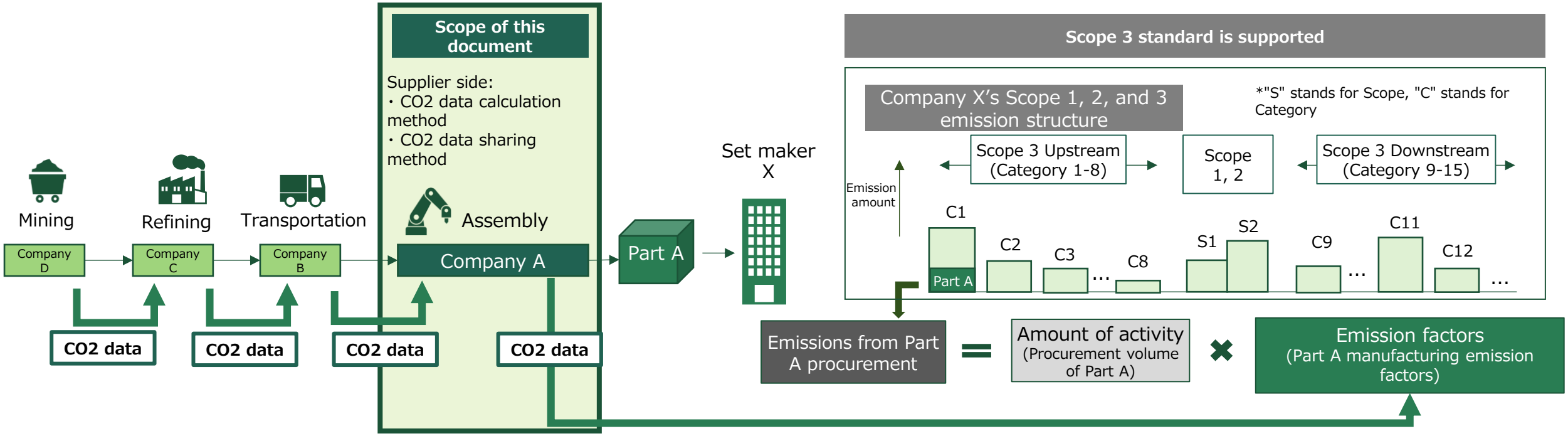


Figure 1-3-1 Scope of this document = Efforts by suppliers

Source: Created by Mizuho Research & Technologies

Supplier CO2 data calculation and sharing methods for Scope 3 Category 1 calculation

1-3-2. Scope 3 categories targeted

- Scope 3 upstream areas are classified and structured into Categories 1-8 according to the GHG Protocol. Suppliers (including service providers) exist for each category.
- Of these, this document covers methods for calculating and sharing CO2 data of suppliers corresponding to Category 1 “Purchased goods and services.”
- This document addresses Category 1 because it has the following characteristics:
  - It is often the largest source of Scope 3 upstream emissions, regardless of industry.
  - This category covers the chain of activities of many supplier companies across multiple industries, including manufacturing, such as the procurement, processing, and transportation of raw materials, appropriate to the expression "supply chain" (supply network).
    (Categories 2 and 3 have similar characteristics.)
- The Scope 3 upstream emissions categories are roughly divided into 1, 2, and 3, which cover the activity chains of multi-industry supplier companies, manufacturing included, and 4, 5, 6, 7, and 8, which cover activities in specific industries (mainly service industries). The concepts of this document for Category 1 may be applicable to the similar Categories 2 and 3.
- For Categories 4-8, which are of a different nature, the concepts in this document are conceptually applicable, but the provisions for primary data collection should be considered by industry.

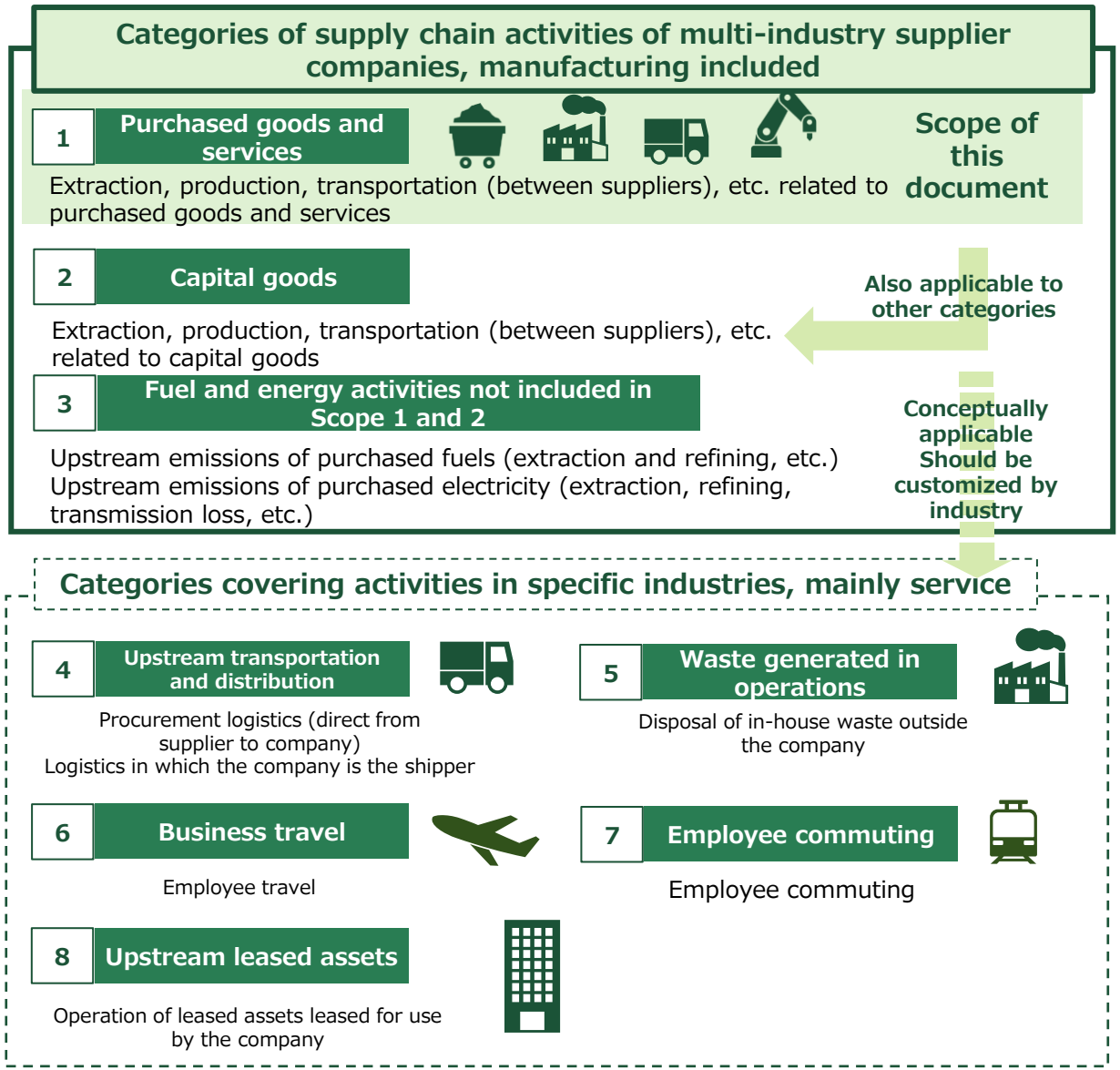


Figure 1-3-2 Scope 3 upstream categories and the scope of this document

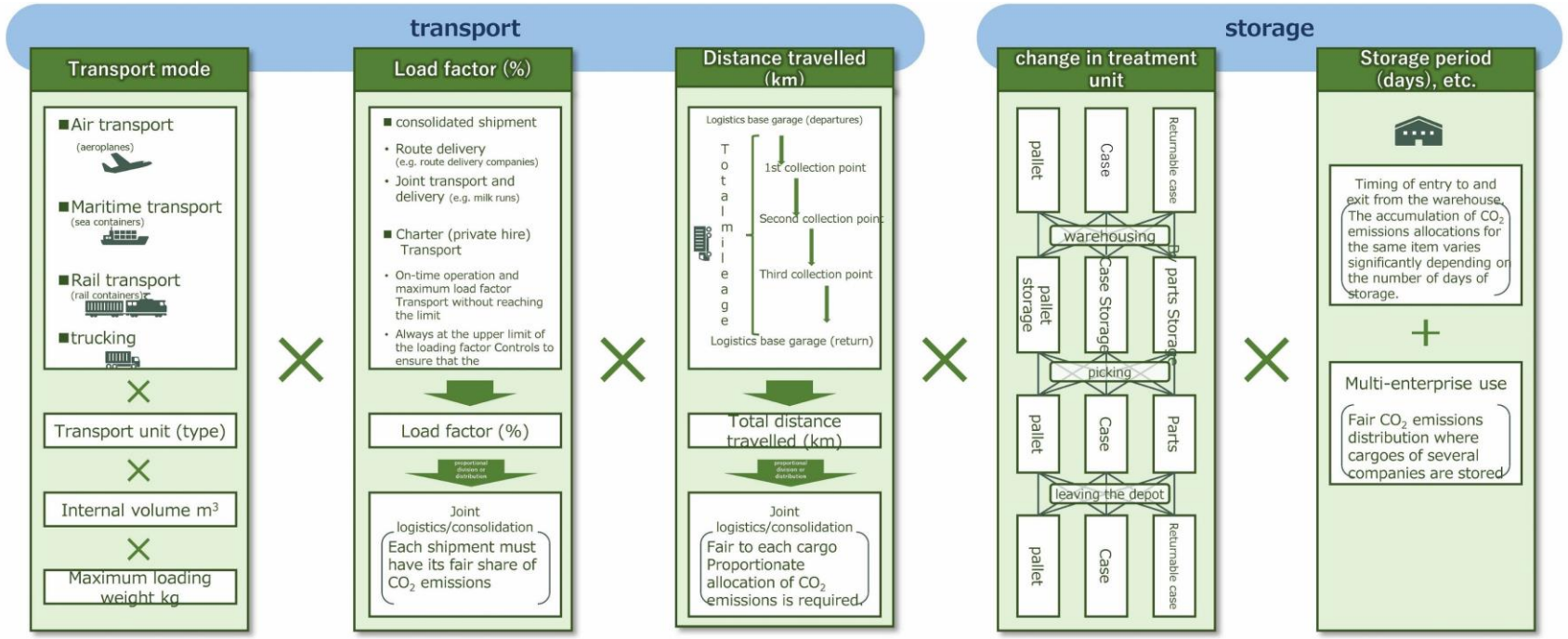
Source: Created by Mizuho Research & Technologies

Calculation method for the service category

1-3-2. Scope 3 categories targeted (continued)

- In particular, it has been pointed out that with the pursuit of cooperation and consolidation further complicating transportation and storage, emissions from which are covered by Category 4, fair guidance needs to be established for this category that can deal with various cases (Figure 1-3-3).
- The Logistics SWG was established under the Visualization WG in September 2022 to develop CO2 data calculation methods for transportation and storage in response to the above issues.
- When the Logistics SWG completes its methodology, guidance will be added to this document on the utilization thereof as well as connection in terms of CO2 data.
- Category 5 "Waste generated in operations", Category 6 "Business travel", Category 7 "Employee commuting", and Category 8 "Upstream leased assets" should also be organized separately in light of the specific circumstances of each industry.

"In short, logistics = transportation + storage, but in reality, these are classified into multiple forms and change as the business environment changes. In addition, green logistics is expected to become increasingly cooperative and consolidated in terms of transportation and distribution. Therefore, fair guidance needs to be established to deal with various cases. "



Source: Green x Digital Consortium Data Visualization Project (2022) 'Study Preparation Phase/Primary Report for Establishment of Mechanism for Visualization of Supply Chain CO2'

Figure 1-3-3 Category 4 upstream transportation and distribution issues

Ideal CO2 Visualization Framework

1-4. Ideal shape and direction of realization

- In addition to the purposes described above, there were many views within the Methodology SWG regarding the ideal form of this document.
- These can be roughly classified into the six elements below.
- Some of these elements are clearly contradictory (1 and 2, 3 and 4, etc.).
- The following sections describe the implementation methods adopted by the SWG.

1 Aim for an internationally applicable methodology and data quality

- Don't create guidance limited to Japan.
- Aim for consistency with international frameworks/platforms for supply chain CO2 data exchange to enable data exchange and collaboration.

1-4-1 | 1-4-3 | 1-4-4

2 Enable the participation of diverse businesses

- Instead of enforcing detailed calculation methods, each company should be allowed to calculate CO2 in a realistic manner.
- Create a mechanism facilitating participation by companies with limited capabilities and those which use other methodologies for CO2 visualization.

1-4-1 | 1-4-2

3 Achieve both primary data utilization and protection of confidential information

- Establish a mechanism to promote the use of primary data so as to reflect the reduction efforts of supplier companies.
- Also establish a mechanism to protect supplier companies' confidential information (raw material composition, suppliers, etc.).

1-4-5

4 Cover emissions right up to the top of supply chain

- Data traceback will stop if there are suppliers that do not participate in CO2 data calculation and sharing.
- Even in this situation, CO2 emissions at the top of the supply chain should be covered.

1-4-6

5 Coexistence with existing standards

- There are various methodologies and standards in the world of CO2 visualization, and many companies that perform their calculations using them.
- The manner of coexistence and division of roles with existing methodologies and standards must be clarified.

1-4-7

6 Enable some level of data analysis

- While it is important to protect supplier companies' confidential information, it is also important to allow companies that use data to analyze to some extent the emission structure and potential for reduction upstream in the supply chain.

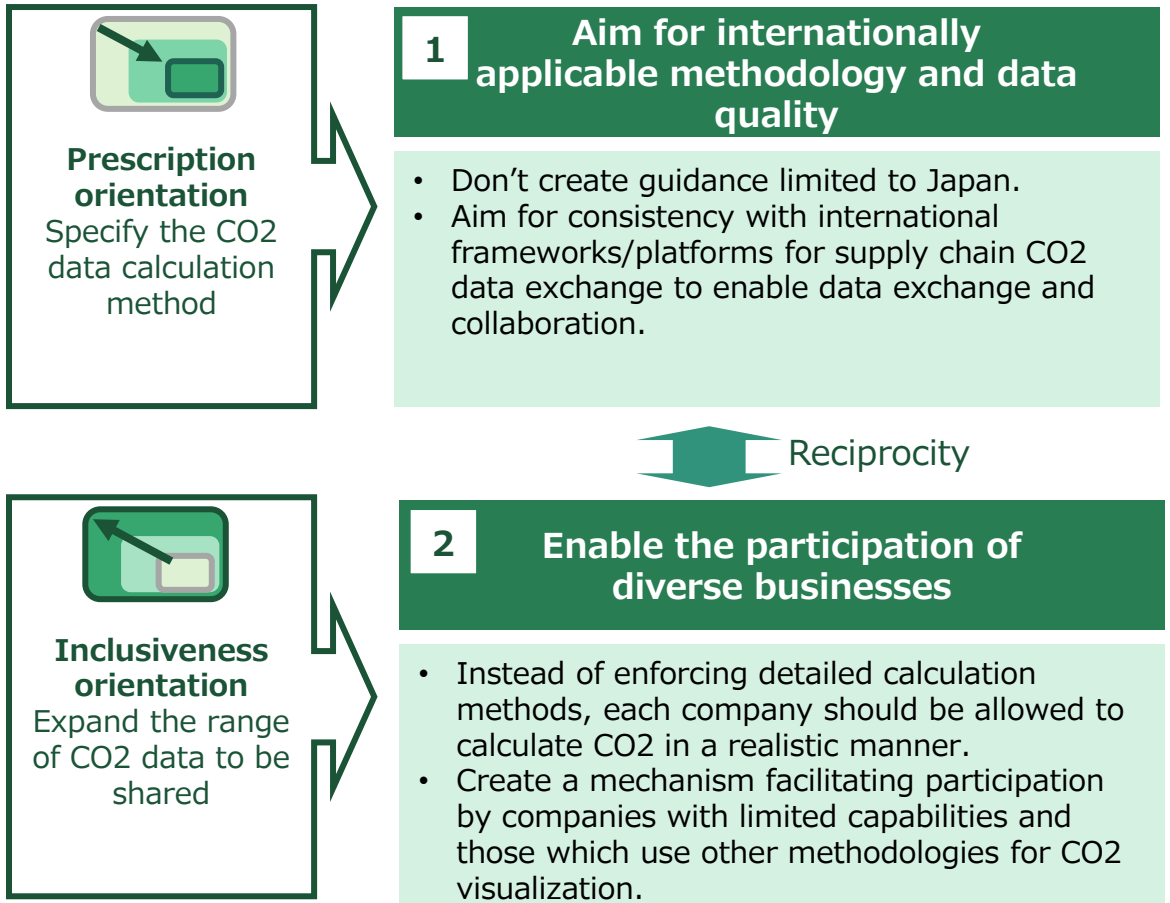
1-4-8

Figure 1-4-1 Ideal CO2 Visualization Framework

Balancing prescription and inclusiveness

1-4-1. Balancing prescription and inclusiveness

- Of the ideal forms shown in Figure 1-4 -1, there is a certain degree of conflict between "1" and "2".



- The former calls for a higher level of prescription in the CO2 data calculation method (prescription orientation).
- The latter calls for a broader scope of CO2 data to be shared in terms of calculation methods and data quality (inclusiveness orientation).
- These two contradictory orientations need to be reconciled.
- In this document, based on the discussion within the SWG, we aim to achieve a balance between the two orientations through the following approach.

  - **The calculation methodology recommended in this document aims for a level of quality acceptable for international supply chain CO2 data exchange (prescription orientation).**

  - **In sharing, constraints will not be place on the CO2 data to be shared, subject to appropriate disclosure of calculation methods and data quality (inclusiveness orientation).**

- In other words, this is a two-tiered approach whereby (a) hurdles for participation in supply chain CO2 data exchange are lowered by providing inclusiveness in data sharing while (b) internationally acceptable calculation methods and data levels are recommended, and companies with the necessary capacity for high-level CO2 calculation are encouraged to do so.

Figure 1-4-2 Prescription and inclusiveness in CO2 data calculation and sharing

Illustration: Balancing prescription and inclusiveness

This document provides a roadmap for companies that want to reduce the barriers to participation by suppliers and to calculate and share CO2 data at a high level.
Calculation and compliance methods must be disclosed in sharing CO2 data, but the origin of that data is not restricted (inclusiveness orientation).
The new CO2 calculation method presented in this document aims for an internationally accepted calculation method and data quality (prescription orientation)

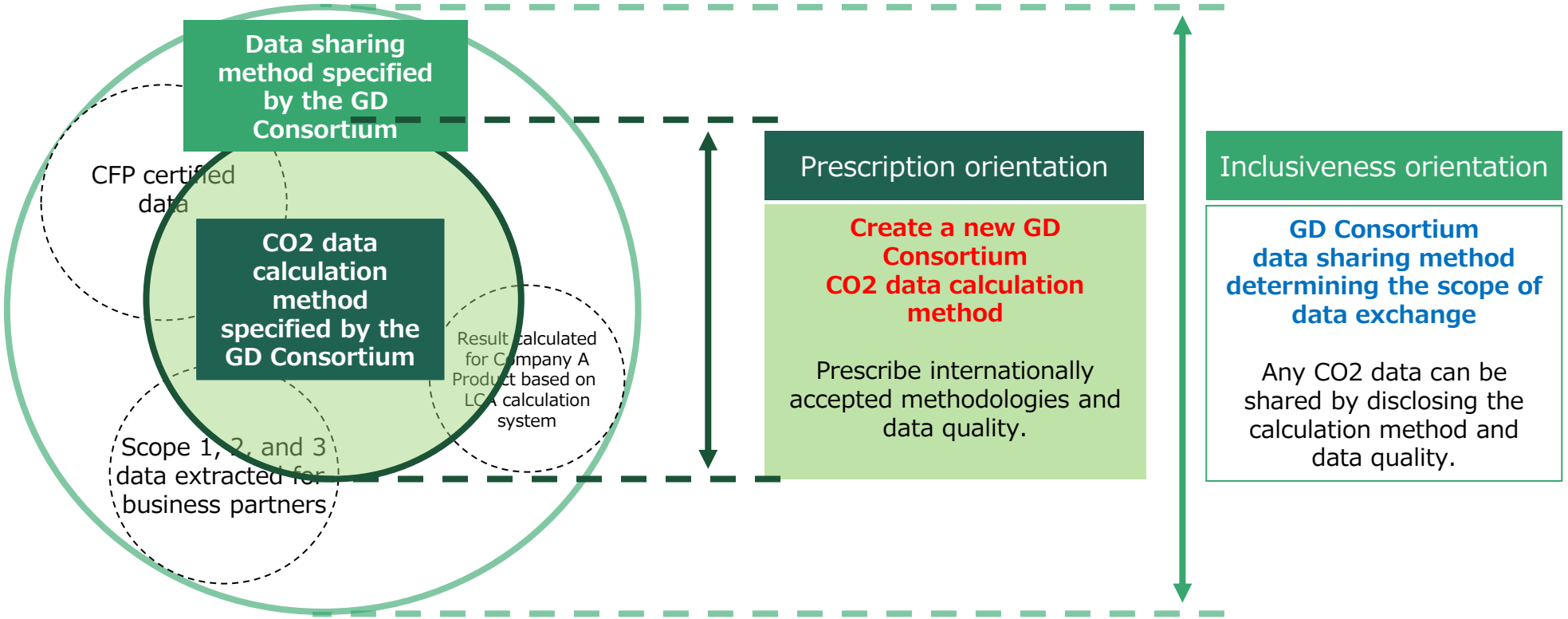


Figure 1-4-3 Approach to balancing prescription and inclusiveness of CO2 data calculation and sharing

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Scope of CO2 data that can be shared

1-4-2. Scope of CO2 data that can be shared

(1) Examples of CO2 data that can be shared

- In line with the concept presented in the previous section of not placing constraints on the CO2 data to be shared, subject to appropriate disclosure of calculation methods and data quality, this document also takes the position of allowing the sharing of the following CO2 data: (Examples in Figure 1-4-3)

a. Product carbon footprint conforming to methodological standards (e.g., ISO 14040/14044, 14067, GHG Protocol Product Standard, etc.) other than those described in this document (Section 2)

b. Greenhouse gas emissions data under Type III environmental labels (quantitative environmental information on product life cycles)

c. organization-based CO2 data (Scope 1, 2, and 3, etc.) extracted from the calculation of allocation by customer, etc.

- It should be noted that all of these correspond to so-called “cradle-to-gate” CO2 data, in which emissions are traced right back to the start of the lifecycle. The reason why this document adopts the cradle-to-gate method in principle is described later in 1-4-6.

(2) Product-data based calculation and Organization-data based calculation

- As indicated on the left, this document includes CO2 data calculated with “organization” as the target for evaluation (Scope 1, 2, and 3, etc.) in addition to CO2 data calculated with “product” as the target for evaluation .
- In order to describe the methodology in the future, these two CO2 data are defined and named as follows (Figure 1-4-4):

- **As shown in (a) and (b) on the left, cradle-to-gate greenhouse gas emissions for products are based on product-related data (BOM, production site, and facility unit data) and are called “Product-data based calculation” or “Product-based calculation.”**
- **Equates to the product carbon footprint (CFP).**

- **As shown in (c) on the left, the amount of greenhouse gas emissions from cradle-to-gate that is evaluated by organization is extracted by calculating allocation by customer, etc., and this is called “Organization-data based calculation“or “Organization-based calculation.”**
- **Equates to the method whereby Scope 1, 2, and 3 emissions are extracted and provided for each supplier**

Illustration: Product-data based calculation and Organization-data based calculation

- "Product-data based calculation" and "Organization-data based calculation" in CO2 data calculation can be conceptualized as follows.
- However, this conceptualization highlights the differences between the two, whereas in practice there are cases where it is difficult to distinguish between them in CO2 data calculation. This will be discussed later in 1-4-2 (4).

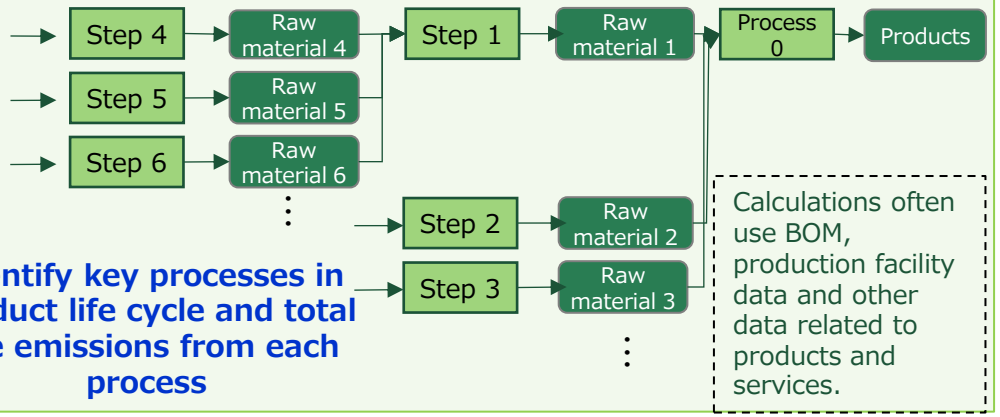
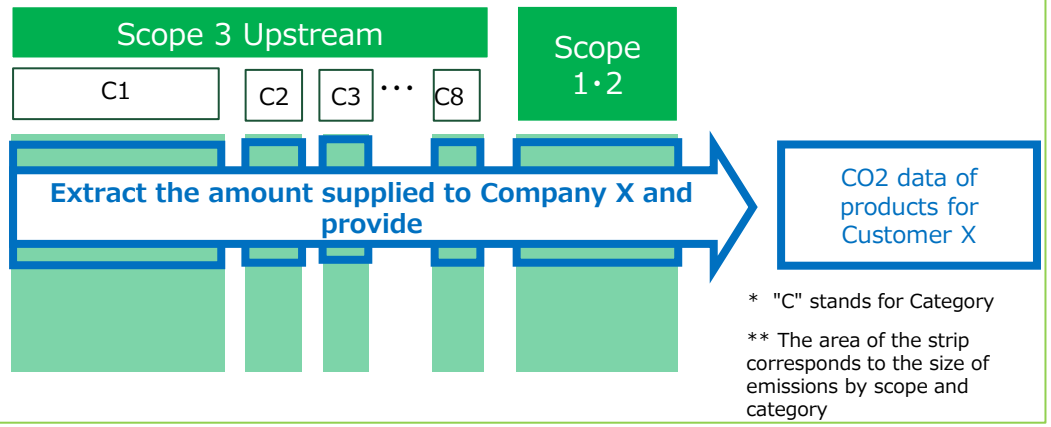
	Product-data based calculation (Product-based calculation)	Organization-data based calculation (Organization-based calculation)
Overview	Conduct a lifecycle inventory analysis of greenhouse gas emissions by product and service (calculation of the so-called carbon footprint of products) 	Allocation calculation by customer of Scope 1, 2, and 3 data as an organization (e.g., allocation in proportion to delivery amount) 
Existing calculation standards	PCR (Product Category Rules), PEFCR ISO 14067, GHG Protocol Product Standard, etc.	GHG Protocol Scope 3 Standard (Chapter 8) (However, priority is placed on Product-based calculations.)
Platforms/ frameworks	Catena-X, PACT Pathfinder, CDP Supply Chain Program	CDP Supply Chain Program (Also handles CO2 data reporting for Product-based calculations)
Special features: Accuracy	The accuracy of calculation results is generally considered to be high.	The accuracy of calculation results is generally considered to be low.
Special features: Operational burden	The operational burden tends to be high due to the need to collect data for each product.	Operational burden tends to be low because some allocation methods allow lump-sum calculation.

Figure 1-4-4 Product-data based calculation and Organization-data based calculation in CO2 data calculation

Source: Created by Mizuho Research & Technologies

Scope 1, 2 and 3 data use also permitted

(3) Discussion on Organization-data based calculation

- Some argue that CO2 data based on Organization-data based calculation and CO2 data based on Product-data based calculation should not be allowed to be shared because of the major differences in calculation methods and data quality.
- In this regard, the Methodology SWG notes that:
  - The CDP Supply Chain Program, an international supply chain CO2 data exchange program, has adopted reporting based on CO2 data through the allocation of Scope 1, 2, and 3, and many companies related to the program have already reported CO2 data based on this method to their suppliers.
  - The GHG Protocol Scope 3 Standard allows suppliers to provide organization-based CO2 data to their suppliers.*

> Chapter 8 of the Scope 3 Standard notes that""Companies should avoid or minimize allocation by
> collecting more detailed data through one of the following approaches:
> (1) Obtaining Product-based GHG data from value chain partners following the GHG Protocol Product Standard 2
> (2) Separately sub-metering energy use and other activity data (e.g., at the production line level)
> (3) Using engineering models to separately estimate emissions related to each product produced."

In light of the above, the following policy shall be adopted:

(1) Given that this is in widespread practice, calculation of Organization-based calculation and sharing of the data will be allowed to the extent that it is made explicit that this is not Product-based CO2 data.

(2) However, Organization-data based calculation will be positioned as a provisional response, with a phased transition to Product-data based calculation recommended.

- The methodology for product-data based calculation is detailed in 2-2 of this document, and the methodology for Organization-data based calculation is detailed in 2-3.
- In regard to clarification of the difference between the two methodologies, it was suggested in the SWG that in practice, there are cases where the accuracy of Organization-data based calculation has increased in recent years, so there is no need to make a distinction between this and Product-data based calculation.
- However, the SWG confirmed that a gap remains between the two methodologies, leading to the formulation of the above policy. Because this debate will provide a point of return when similar debates arise in future, it will be discussed further in (4).
- Furthermore, from here on, this document will primarily use the abbreviations 'Product-based calculation' and 'Organization-based calculation'.

Distinguishing between Product-based and Organization-based calculation

(4) Boundary between Product-based and Organization-based calculations

- In the SWG, many participating companies pointed out that the difference between Product-based calculation and Organization-based calculation was narrowing in a practical business sense (see (2) from SWG discussion).
- In this context, this document adopts the following concepts:

- Product-based calculation and Organization-based calculation will be distinguished by the methodologies and standards used in the calcuation.

- Cases in which Product-based calculation methodologies and standards are used shall be deemed Product-based calculation.
- The main Product-based calculation methodologies and standards are as follows:
  - Product classification rules such as PCR (Product Category Rules) and PEFCR
  - Rules for calculating the product carbon footprint by industry
  - Cross-sectoral carbon footprint standards for products such as ISO 14067 and the GHG Protocol Product Standard
  - Standards that set out Product-based LCA frameworks and requirements, such as ISO 14040/14044 (including the METI/MoE Carbon Footprint Guidelines)
  - Standards for calculation, verification, and PCR preparation for the display of Type III environmental labels, such as ISO 14025
  - The Pathfinder Framework and the product-based CO2 calculation method described in Section 2-2 of this document
- The main Organization-based calculation methodologies and standards are as follows:
  - GHG Protocol Scope 3 Standard (Chapter 8)
  - The organization-based CO2 calculation method described in Section 2-3 of this document
- If these are used, or if the methodological basis of the calculation is unknown, the calculations shall be deemed Organization-based calculations.
- If it is deemed that careful implementation of organisation-data besed calculation meets the requirements for the product-data besed calculation methodology and standards (appropriateness of boundaries, data collection, and allocation, etc.), this too will be deemed Product-based calculation. However, the Product-based calculation metholdology and standard must be provided.

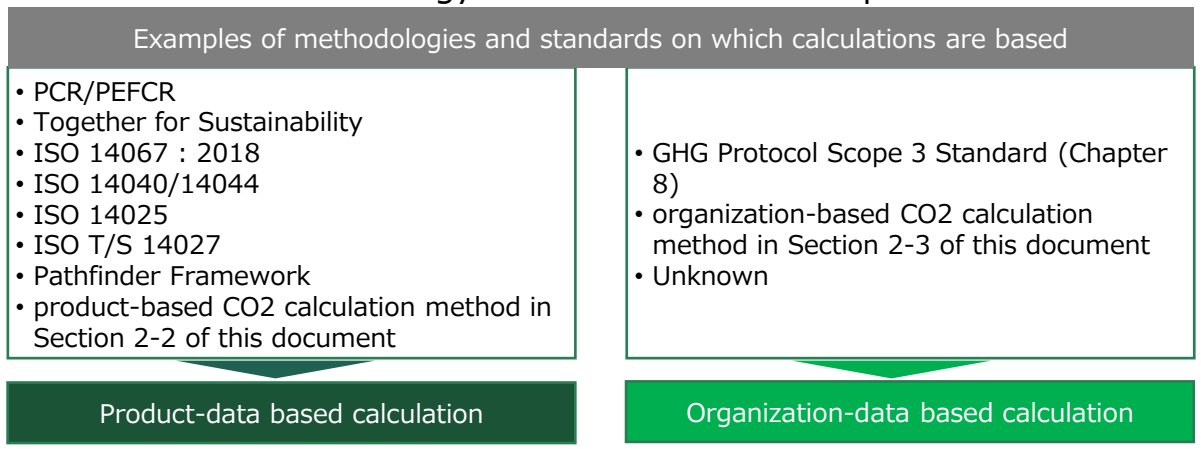
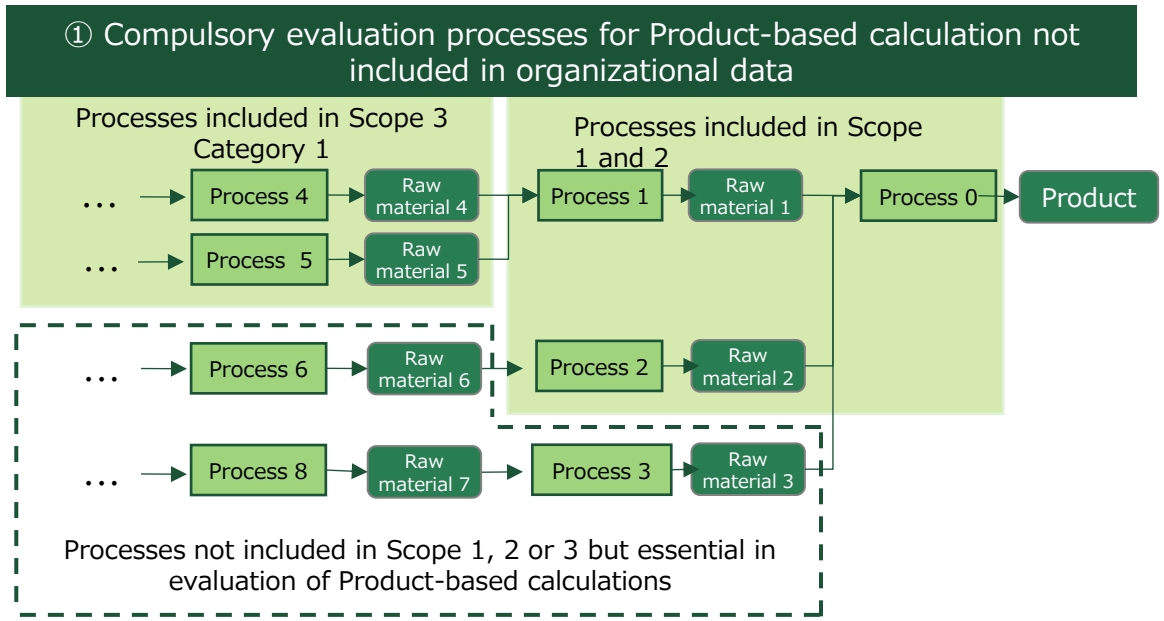


Figure 1-4-5 Product-based and organization-based data calculation

Distinguishing between Product-based and Organization-based calculation

(4) Boundary between Product-based and Organization-based calculations

- Even when organizational data such as Scope 1, 2 and 3 data is used, some cases could, depending on data granularity and the appropriateness of allocation and other processing, be regarded as Product-based calculation. The key points are the completeness of the life cycle boundary and the validity of the allocation calculation.
- Completeness of the lifecycle boundary: If the underlying Scope 1, 2, and 3 emissions do not include processes for which evaluation is required by Product-based calculation methodologies and standards, the CO2 data obtained by these allocation calculations cannot be regarded as Product-based calculation.
- Validity of allocation calculation: Considering that most of the methodologies and standards for Product-based calculation adopt the concept of allowing the allocation of emissions only when it cannot be avoided by process subdivision n, etc., it is unlikely that avoidable allocation calculations will be considered Product-based calculation.
- The final decision is left to third party verification, but the above two points are considered to be important factors in determining whether CO2 data using Scope 1, 2 and 3 data can be considered Product-based calculation.



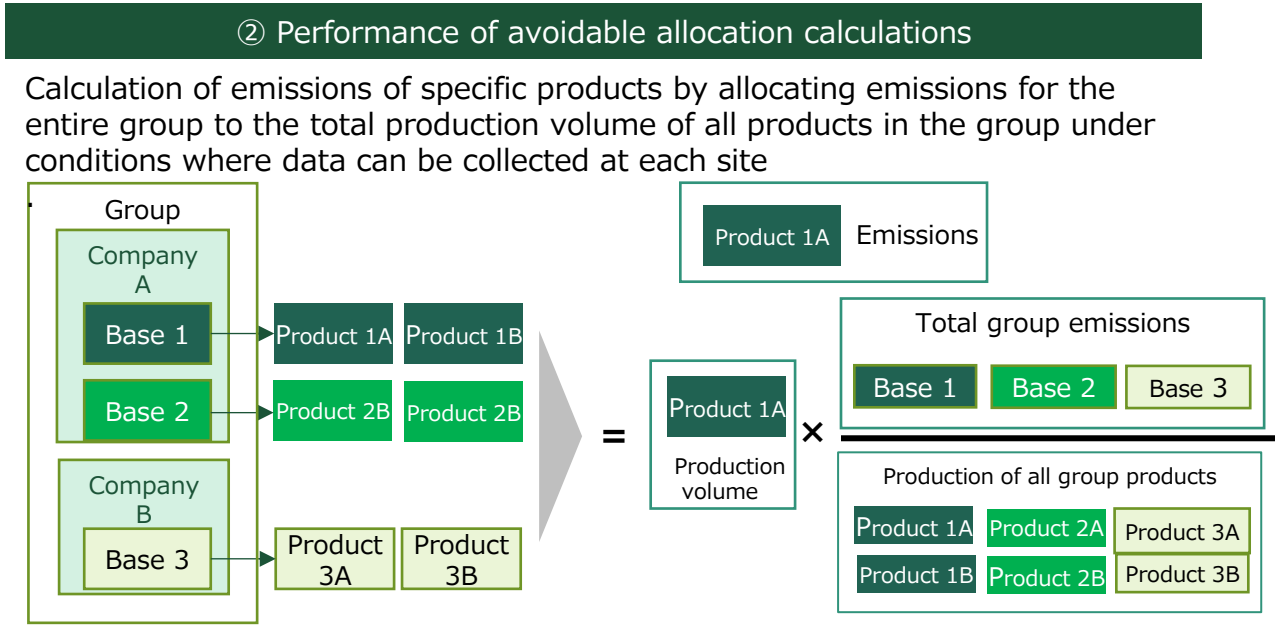


Figure 1-4-6 Two representative cases in which Organization-based calculation cannot be regarded as Product-based calculation

Source: Created by Mizuho Research & Technologies

SWG discussion: (2) Boundary between Product-based and Organization-based calculation (1/2)

- In the SWG, it was pointed out that there are practical cases where it is difficult to draw a clear distinction between the two. As this discussion contains important points in terms of the practical application of CO2 data calculation, it is introduced below.

① Closing the gap between organization data and product data through digitization

- Organization-based calculations are generally considered to be less accurate than Product-based calculations because it is assumed that Scope 1, 2, and 3 emissions will have been totalled at the company or consolidated group level and allocated according to the volume of all products and services produced at the company or consolidated group level.
- Today, however, due to increasing digitization, organization data (CO2 data for each site and line) collected to calculate organizational emissions is often stored in systems and thus easily accessible.
- In such cases, emissions per site or line can be allocated by the production of products and services produced by site or by line. These calculations are also commonly used in Product-based calculations.
- If organization data is managed at the level of granularity described above, the CO2 data obtained from the allocation thereof will be less likely to differ from the results of Product-based calculation.

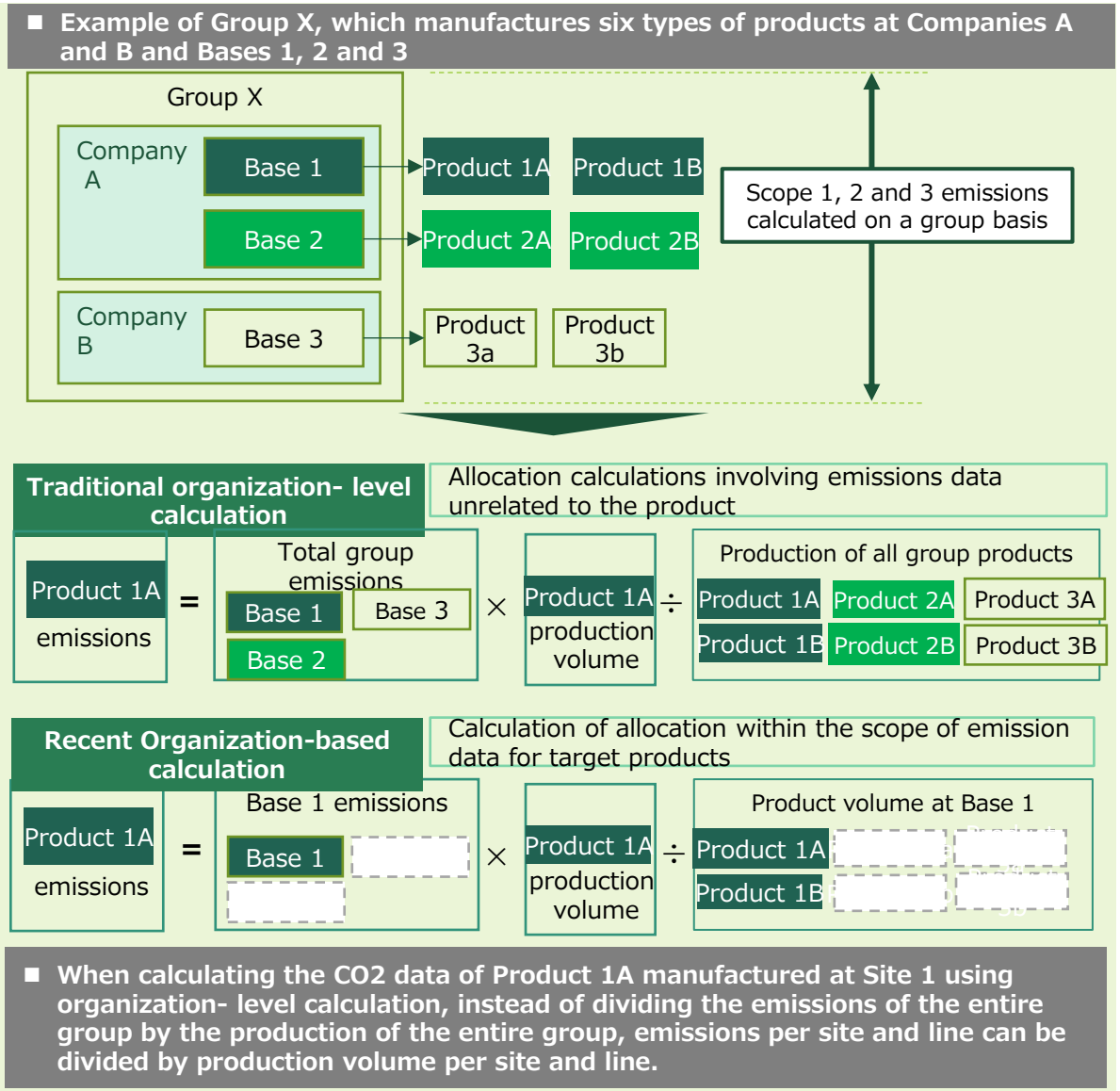


Figure 1-4-7 Refining Organization-based calculation

Source: Created by Mizuho Research & Technologies

SWG discussion: (2) Boundary between Product-based and Organization-based calculation (2/2)

② For SMEs, organization data ≒ product data

- In addition, many SMEs have only one manufacturing site and produce only a small number of elements.
- In this case, the CO2 data in the Organization-based calculation is equivalent to the CO2 data in which the emissions per site or line are allocated by the production volume of products and services produced at the site or line, and it is difficult to tell the difference from Product-based calculation.

③ Changes in Product-based calculation

- At the same time, the Product-based calculation side is also changing.
- Recently, the process of identifying the major processes in the product life cycle, collecting data on each process, and calculating total emissions recognized as characteristic of Product-based calculation is often omitted.
- This is due to the fact that with the enhancement of the LCA database, secondary data emission factors that go back to the most upstream processes (mining, etc.) related to manufacturing have been improved for many products and services.
- In Product-based calculation, too, only the activity data of the input/output of the company's processes should be collected, and emissions from upstream and downstream processes are increasingly calculated by multiplying the activity data by the secondary data emission factors obtained from the LCA database.
- This calculation method is similar to the calculation method used in Scope 1, 2, and 3, which are the emissions of organizations, indicating that there are a growing number of cases where the difference between Product-based and Organization-based calculation is not clear even in the treatment of upstream processes.

④ Boundary between Product-based calculation and Organization-based calculation

- Given that the distance between Product-based and Organization-based calculations is now less than previously thought, a member of the Methodology SWG suggested that if allocation calculations are made after Scope 1, 2, or 3 emissions have been identified at the site or production line level, they should be considered as Product-based calculations.
- However, it was also pointed out that since there are cases such as (1) in Figure 1-4-6, it is not possible to certify Product-based calculation only by the implementation level of allocation.
- In the end, the categorization of Product-based and Organization-based calculations was based on the comprehensive criteria of whether or not the calculation could be regarded as conforming to the Product-based calculation methodology and standards, including the appropriateness of determining lifecycle boundaries and allocation.
- In other words, CO2 data calculation along the same trajectory as Organization-based calculation can also be regarded as Product-based calculation if it can meet the requirements of the methodologies and standards for Product-based calculation given the appropriate allocation and boundary-setting, etc.

Alignment of Product-based calculation with the PACT Pathfinder Framework

1-4-3. Alignment with international frameworks/platforms

- As confirmed in 1-4, this document aims to develop methods for calculating CO2 data that are consistent with international frameworks/platforms in order to realize the ideal form “1. Aim for an internationally applicable methodology and data quality.”

(1) About Product-based calculation

- The Pathfinder Framework, a methodology for calculating and sharing CO2 data published by the Partnership for Carbon Transparency (PACT) hosted by WBCSD, was selected as an international framework aiming for consistency in Product-based calculation.
- We chose PACT’s Pathfinder Framework as the alignment framework because:

- It is operated by GHG Protocol co-organizer WBCSD and is considered to have considerable influence as a methodology for calculating Scope 3 emissions.
- In fact, many leading supply chain data sharing platforms such as Catena-X and many global companies participate in this framework.
- It provides a methodology for suppliers creating CO2 data based on primary data and sharing it across the supply chain using digital technology that is consistent in purpose and means with this document.

- Section 2-2 provides guidance on the concept of the Pathfinder Framework and how to apply it as a Japanese company, positioning it as a Product-based CO2 data calculation method that ensures internationally acceptable data quality.
- The Green x Digital Consortium is a member of PACT’s Pathfinder ecosystem and regularly exchanges views with PACT.
- This document has been reviewed and confirmed by PACT to ensure consistency with the Pathfinder Framework v2 for product-based calculations.

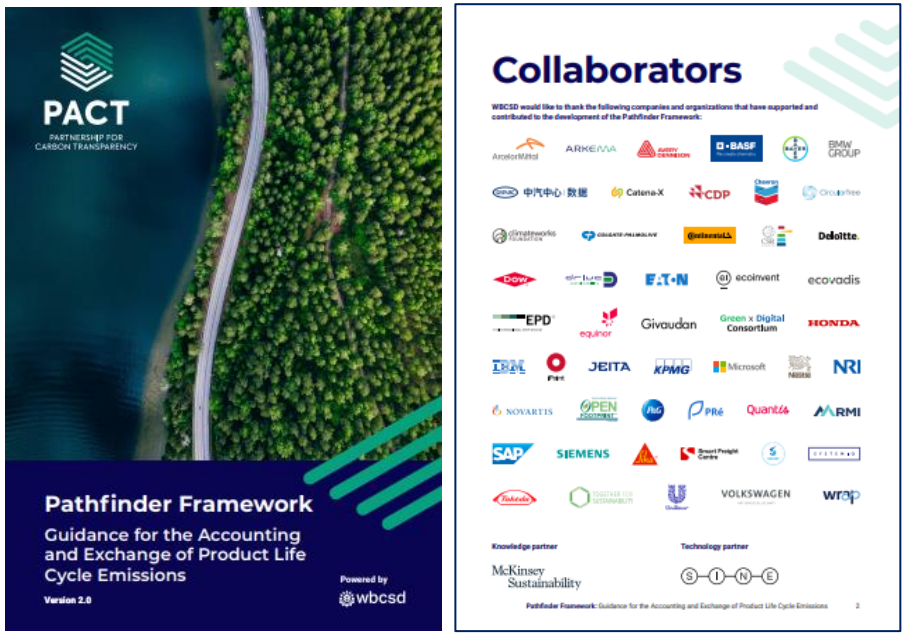


Figure 1-4-8 PACT Pathfinder Framework v2

Source: PACT Pathfinder Framework v2

Organization-based calculation based on Scope 3 Standard Chapter 8

(2) organization-based calculation

- The CDP-operated CDP Supply Chain Program is known as an international program for exchanging CO2 data obtained through Organization-based calculation, but the program does not provide rules or regulations on data generation methodology.
- Currently, Chapter 8 (Allocating Emissions) in the GHG Protocol Scope 3 Standard is the only document that can be called guidance in terms of a methodology for Organization-based calculation.
- Therefore, Section 2-3 of this document presents a methodology for calculating higher quality CO2 data at the organization level based on Chapter 8 of the GHG Protocol Scope 3 Standard.
- However, Chapter 8 only provides recommendations and does not include requirements. This document also recommends a gradual transition from Organization-based calculation to Product-based calculation. For this reason, the Organization-based calculation methodology presented in this document is positioned as a recommendation for improving data quality.
- Figure 1-4-9 reflects the above based on the original Figure 1-4-3 on prescription and inclusiveness in CO2 data calculation and sharing.

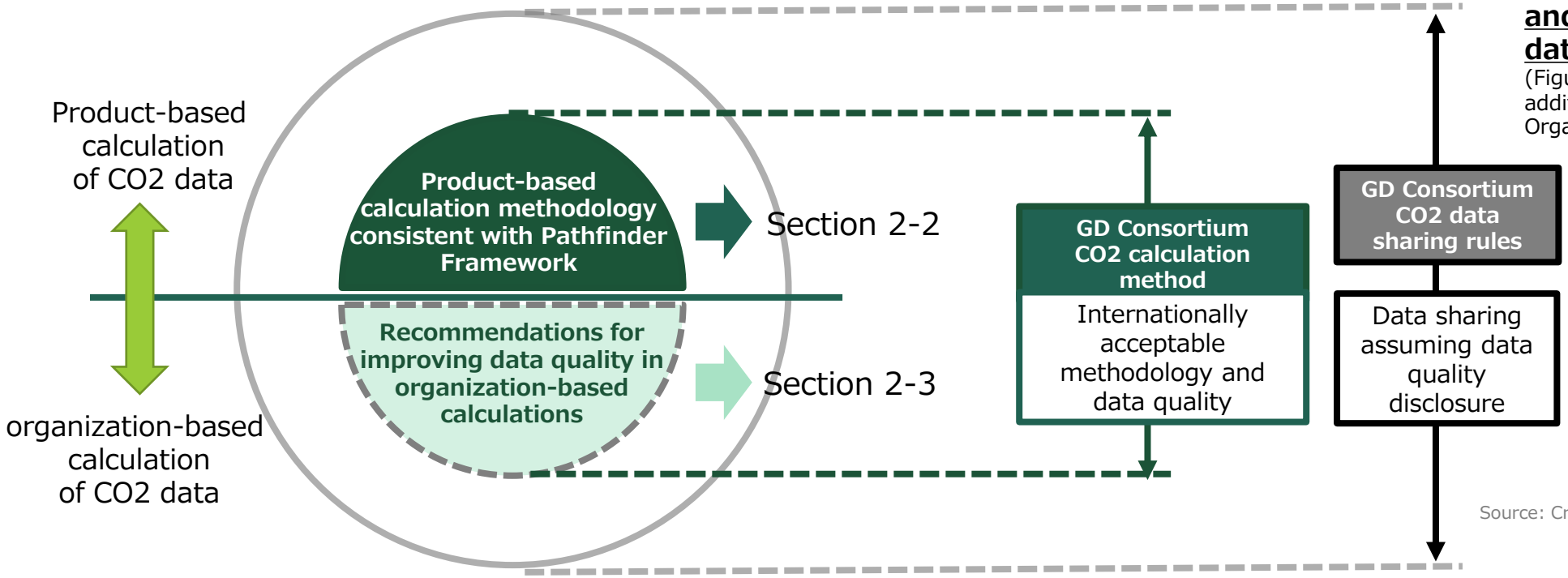


Figure 1-4-9 Prescription and inclusiveness in CO2 data calculation and sharing
(Figure 1-4-3 re-rendered with the addition of Product-based and Organization-based calculation concepts)

Source: Created by Mizuho Research & Technologies

Aim for a level that enables vertical comparison (evaluation of improvement over time)

1-4-4. Target level of CO2 visualization

- The Methodology SWG had two views on what the aim should be in developing a method for calculating CO2 data using primary data:
  - (1) For downstream companies that purchase similar goods and services from different supplier companies to compare which goods and services were provided with lower CO2 emissions (referred to as horizontal comparison in this document)
  - (2) To evaluate the degree to which CO2 reduction is progressing over time due to the reduction efforts of supplier companies that provide the same products and services (referred to as vertical comparison in this document)
- The Pathfinder Framework adopted in this document as an internationally accepted method for calculating CO2 data takes the position of aiming for both horizontal and vertical comparison.
- However, because (a) horizontal comparison would require establishing and sharing detailed calculation conditions, which could greatly reduce the number of companies able to participate, and (b) even if the Pathfinder Framework methodology is followed, it would not necessarily guarantee the feasibility of horizontal comparison, the SWG adopted the following approach:

  - For the time being, the target level of CO2 visualization should be a level that reflects supplier companies' efforts to reduce CO2 emissions through the use of primary data and enables evaluation of CO2 reductions over time (vertical comparison). The calculation method presented in Section 2 assumes a level consistent with this application.

- However, this does not preclude companies using CO2 data from performing horizontal comparisons at their own risk. A sharing method for communicating the data quality of CO2 data is presented so that it can be determined whether the data is cross-comparable.

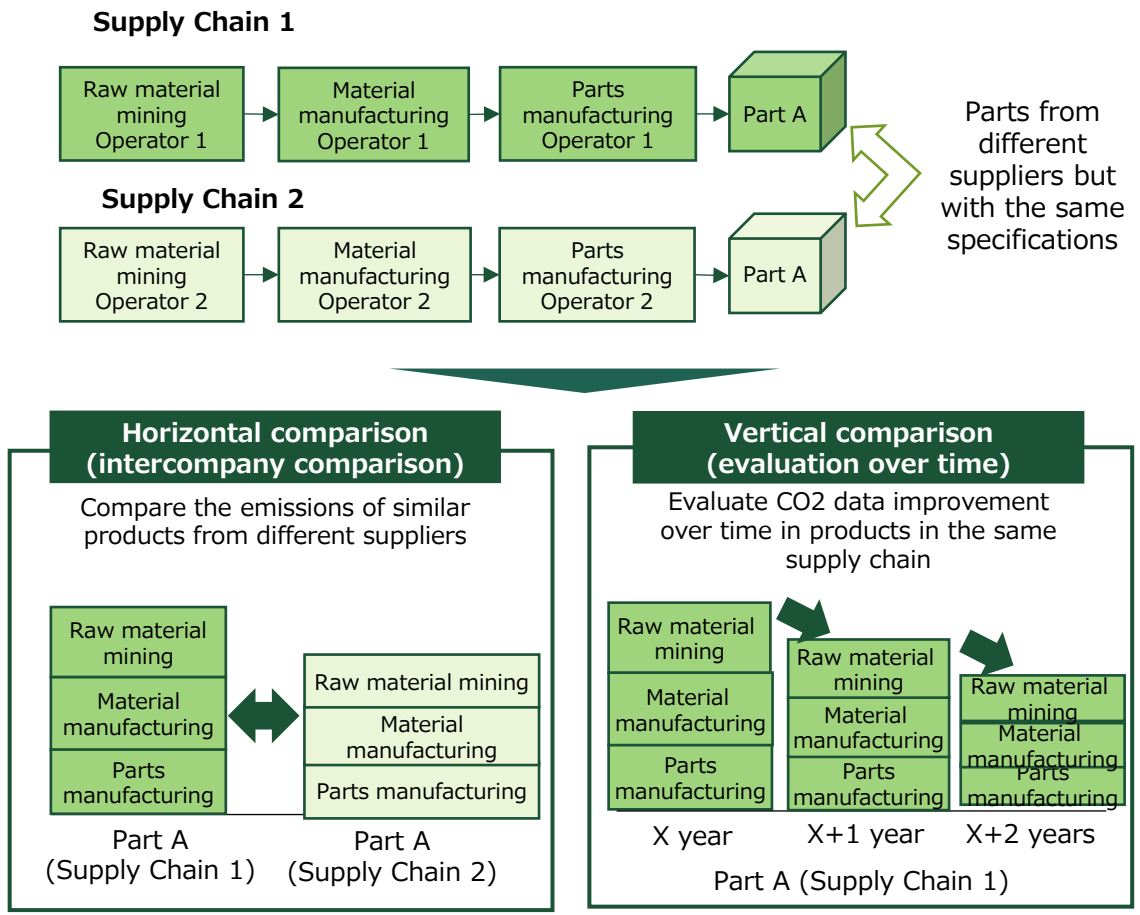


Figure 1-4-10 Vertical comparison and horizontal comparison

Source: Created by Mizuho Research & Technologies

SWG discussion: (3) Strictness of conditions enabling horizontal comparison

- As mentioned above, the SWG selected the Pathfinder Framework as an internationally accepted method for calculating CO2 data.
- However, the SWG has concluded that it is too early at this point to aim for cross-product and cross-company comparisons of CO2 data (horizontal comparison).
- This is because the conditions under which horizontal comparisons can be made are very strict, and it is expected that even calculations based on the Pathfinder Framework will not satisfy these conditions.
- For example, the international standard ISO 14067:2018, which sets out requirements and guidelines for quantification of the carbon footprint of products (CFP), requires that when a CFP comparative study (horizontal comparison) is made, the calculation is based on the same product category rule (PCR) under ISO 14027:2018. The METI/MoE CFP Guidelines take the same approach. Compliance with the Pathfinder Framework alone does not satisfy this condition.

■ Issues with system boundary equivalence

- To give a specific example, ISO 14067:2018 states that for horizontal comparisons, system boundaries must be equivalent (Annex B).
- However, while the Pathfinder Framework gives priority to the application of PCR, etc., as described below, CO2 data calculation using cross-sectoral standards such as ISO 14067 is also permitted in the absence of PCR. In this case, even if the CO2 data is based on the Pathfinder Framework, the system boundaries between products and between companies may not be aligned.
- The Pathfinder Framework also specifies cradle-to-gate as a system boundary, as described below, but this has not yet reached the level of a PCR specifying in detail the processes that should be included in CO2 data calculations for different companies.
- Based on the above discussion, the SWG concluded that it is premature to pursue horizontal comparison under the present circumstances, since there may be cases where calculations based on the Pathfinder Framework fail to satisfy the conditions enabling horizontal comparison.

■ Toward long-term realization of horizontal comparison

- However, it is expected that as the practice of CO2 data calculation spreads, boundary setting and data collection will converge at a certain level. By utilizing digital technology, data quality can be easily evaluated and exchanged, thereby avoiding poor quality data from the user side.
- Several SWG participants expressed the view that these developments will gradually enable horizontal comparisons of CO2 data over the long term.

Provision of calculation results (outputs)

1-4-5. Promotion of primary data utilization and protection of confidential information

(1) Provision of calculation results (outputs)

- When a supplier provides CO2 data using primary data to a company downstream in the supply chain, the challenge is to protect the supplier's confidential information.
- Primary data for calculating CO2 data includes activity data corresponding to inputs in supplier emissions calculations (energy and raw material inputs) and the calculation results of emissions corresponding to the output.
- Downstream customers also tend to want to receive input information so as to verify output validity, but this often comprises data that the supplier side wants to keep confidential from the customer.
- This document consequently takes the following approach:

  - What suppliers provide (share) to customers is CO2 data (output information) from calculations using primary data.
  - The activity data (input information) used to calculate CO2 data need not be provided (shared).

- Of course, if the supplier wants to provide the customer with activity data, they are free to do so.
- This concept is consistent with the Pathfinder Framework.

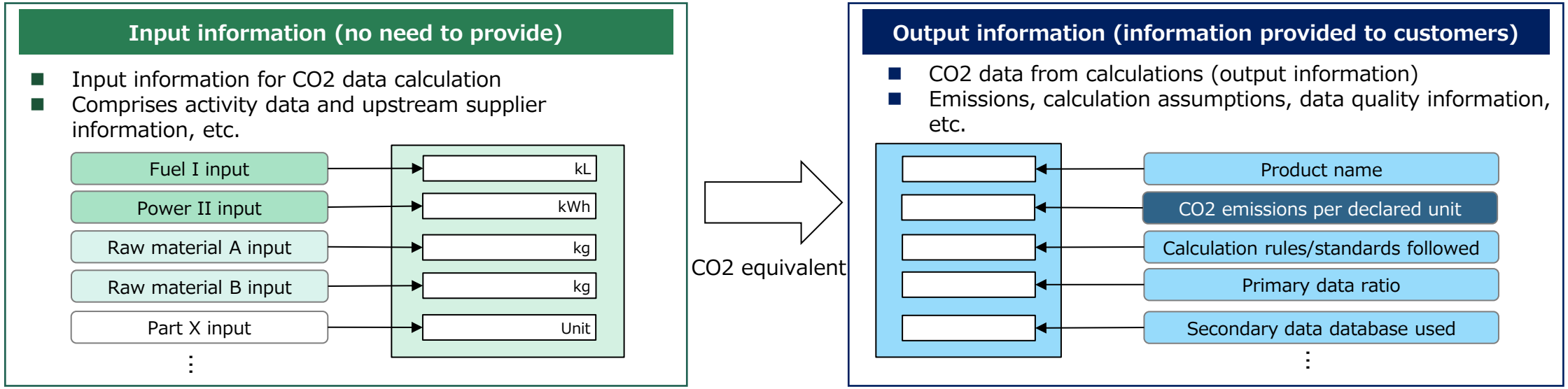


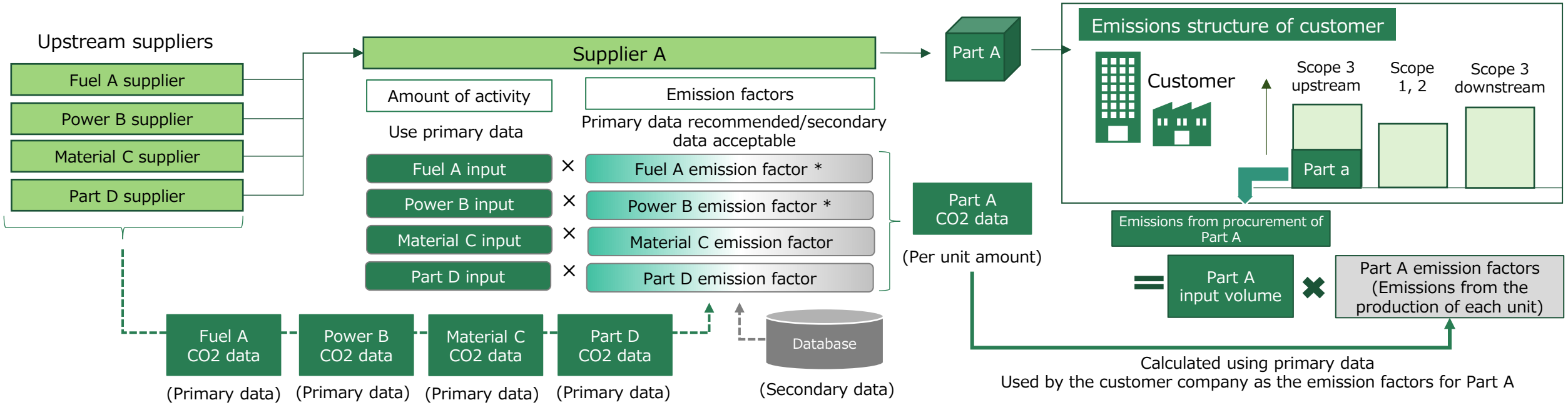
Figure 1-4-11 Input and output information related to CO2 data calculation

Source: Mizuho Research & Technologies

Image of CO2 data calculation using primary data

(2) Image of CO2 data calculation using primary data

- According to the arrangement on the previous page, when a company obtains data from an upstream supplier, in principle it receives the calculated CO2 data, not the upstream supplier's activity data.
- Based on this relationship, the figure below shows the image of the CO2 data calculation assumed in this document, taking the example of a supplier procuring fuel, power, materials, and parts.
- The supplier calculating the CO2 data (Supplier A in the figure below) does so by multiplying their activity data (primary data in principle) by its emission factors.
- At this time, (i) when CO2 data based on the primary data is obtained from upstream supplier, this data will be adopted as the emission factors, and (ii) when CO2 data cannot be obtained from the upstream supplier, secondary data will be cited from various databases and used as the emission factors.



* There are 2 types of fuel and electric power emission factors: (i) emission factors related to fuel combustion and (ii) emission factors related to the combustion supply chain (Figure 1-4-18). That difference is omitted here.

Figure 1-4-12 Image of CO2 data calculation using primary data

Source: Created by Mizuho Research & Technologies

Introduction of primary data share and data quality assessment

(3) Introduction of primary data share (PDS)

- To encourage suppliers to use primary data, this document follows the Pathfinder Framework and introduces the calculation and disclosure of primary data share (PDS).
- PDS is an indicator of the percentage of CO2 data provided by a supplier to downstream entities based on primary data.
- The PDS level enables companies downstream in the supply chain to determine to what extent the CO2 data provided by supplier companies (used as emission factor) includes primary data.
- Higher PDS values are desirable in order to reflect the reduction efforts of upstream suppliers in the Scope 3 emissions of downstream enterprises. Therefore, PDS calculation and disclosure encourage downstream companies to request upstream suppliers to improve their PDS.
- The PDS formula will be introduced for Product-based calculations (see Section 2-2-8 (1)) but postponed for Organization-based calculations (see 2-3-2 (6)).

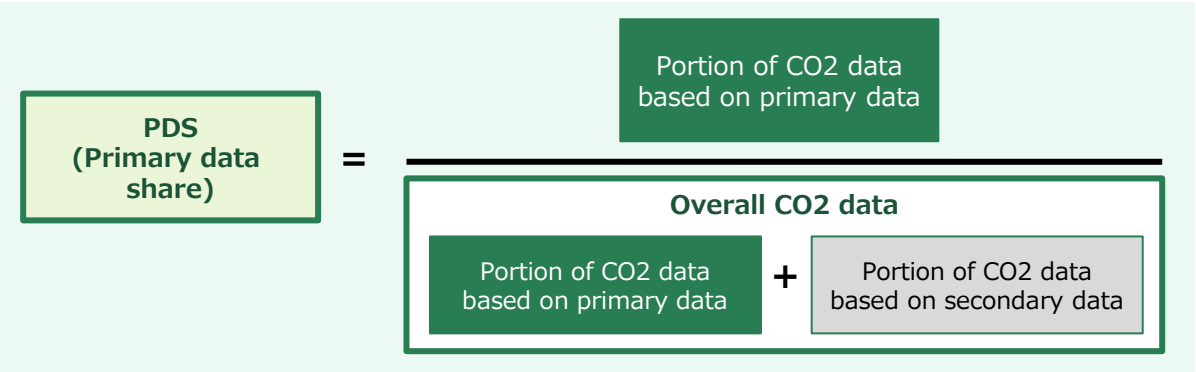


Figure 1-4-13 PDS concept

Source: Created by Mizuho Research & Technologies

(4) Introduction of Data Quality Ratings (DQR)

- This document also follows the Pathfinder Framework in introducing Data Quality Ratings.
- By introducing technological representativeness, temporal representativeness, geographical representativeness, completeness, and reliability as indicators, the aim is to enable data quality of CO2 data at a different point from the PDS and to help downstream companies make decisions on data utilization (such as whether to accept or reject data).
- Details will be given later in Section 2-2-8 (2).

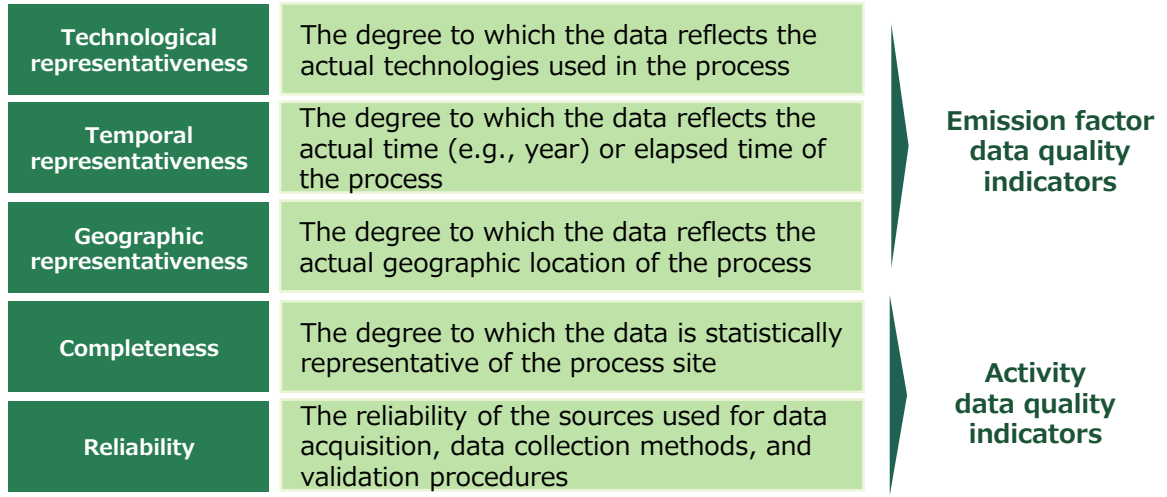


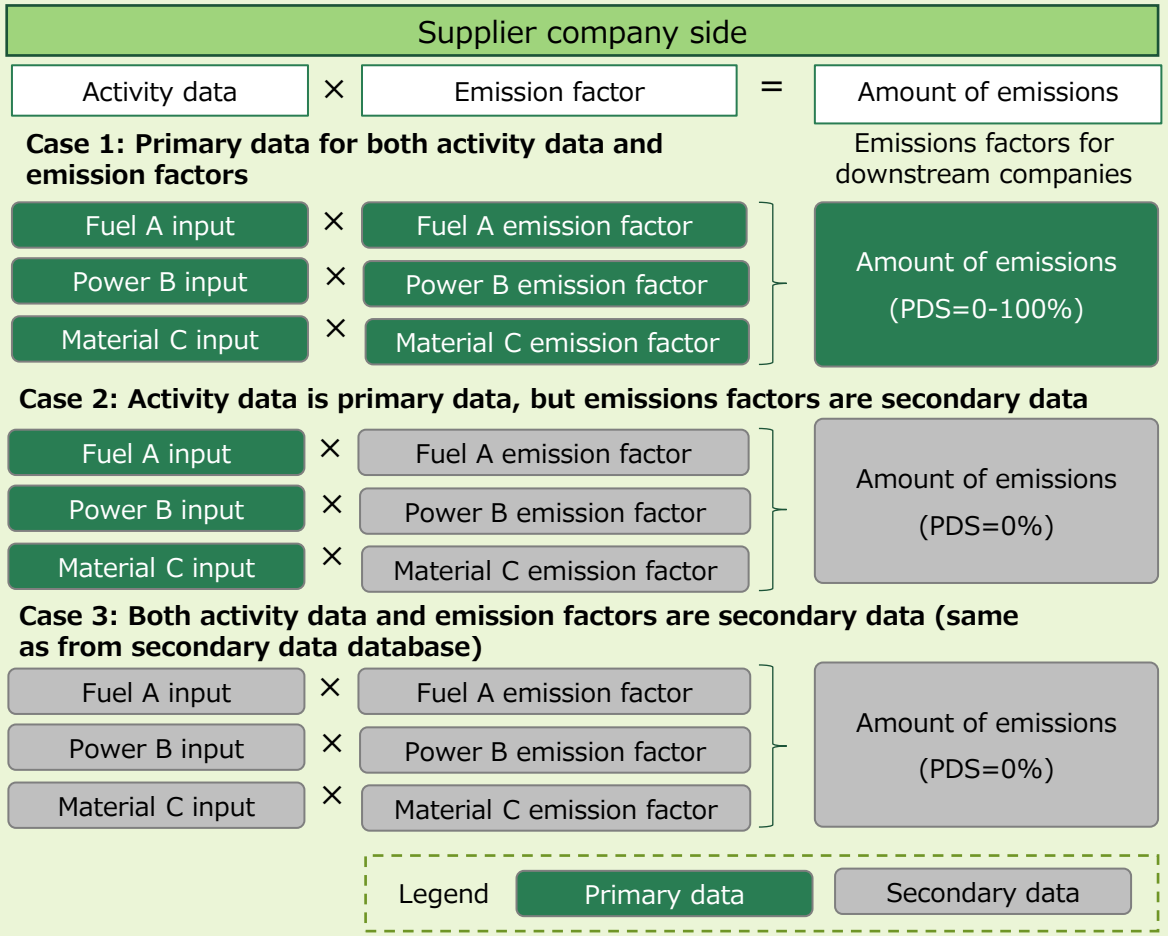
Figure 1-4-14 Five data quality assessment indicators

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

SWG discussion: (4) PDS limitations

- As will be discussed later in Section 2-2-8 (1), in the calculation of the primary data share (PDS), this document follows the Pathfinder Framework in taking the position that the calculated CO2 data (emissions) can be regarded as primary data only if both the activity data and emission factors are primary data.
- However, some members of the SWG, while acknowledging the usefulness of this concept, also pointed out that caution should be exercised when using it.
  - What is useful is that, in order for CO2 data to be considered primary data, not only the amount of activity but also the emission factors must be primary data, so that in order to increase the PDS, supplier companies are more inclined to seek CO2 data based on primary data from supplier companies further upstream (from Case 2 to Case 1, as shown in the figure).
  - The problem is that even if the CO2 data was provided by supplier companies, if the emission factors used in the calculation are secondary data, the PDS will be 0 (Case 2 in the figure).
  - The Pathfinder Framework identifies CO2 data provided by suppliers as a primary emission factor for downstream companies. However, in the above situation, even for the primary data emission unit, the PDS is 0%. There is no numerical difference between the PDS and Case 3 in the figure where both the the amount of activity and the emission factors are secondary data.
  - Furthermore, if the PDS can be 0% even for the primary data emission factor, even for Case 1, there could be cases where the PDS of the calculated emission amount is 0%.
- Case 2 is clearly superior to Case 3 in terms of showing the actual emissions specific to the supplier company. However, the PDS cannot show the difference between them. Furthermore, while Case 1 is the best case, even then the PDS may be 0%, which is the same as in Cases 2 and 3. These points must be understood as PDS limitations.

Figure 1-4-15 Limitations of PDS as as indicators



Source: Created by Mizuho Research & Technologies

Adoption of the cradle-to-gate method

1 -4 -6. Adoption of the cradle-to-gate method

(1) What is the cradle-to-gate method?

- To achieve the ideal form in “1-4-4. Cover emissions right up to the top of supply chain,” this document adopts, in principle, the cradle-to-gate method as the CO2 data calculation method implemented by suppliers, as in the PACT Pathfinder Framework.
- Using this approach, CO2 data is calculated from cradle (resource extraction) to gate (factory gate).
- Other methods include the cradle-to-grave method and the gate-to-gate method, which only covers emissions from a company’s own direct activities from the reception of materials from suppliers to the company’s factory gate.
- Normally, the cradle-to-grave method is assumed in product life cycle assessment. However, in the calculation and exchange of CO2 data in the supply chain, since the CO2 data after shipment is calculated by the downstream company, the supplier company is responsible for the calculation within the scope of gate-to-gate or cradle-to-gate.
- The cradle-to-gate method is adopted over gate-to-gate because, when the gate-to-gate method is used, if any one supplier does not participate in CO2 data calculation and sharing, emissions up to the top of the supply chain will not be covered.

* Even if the gate-to-gate method is adopted, it does not apply if downstream operator calculations complement emissions from the upstream activities of the supplier. See Section 1-4-6.

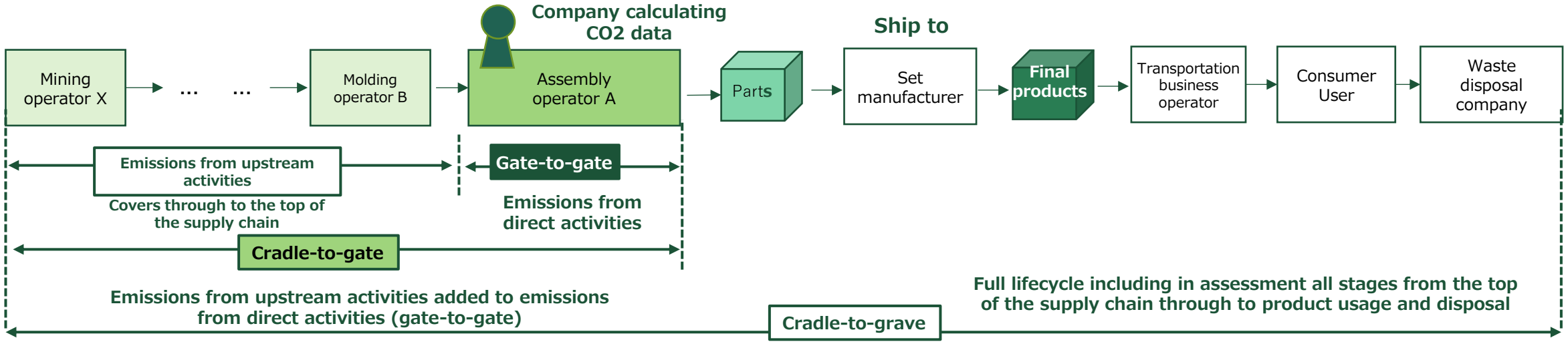


Figure 1-4-16 Cradle-to-gate and other systems

Source: Created by Mizuho Research & Technologies

Advantages of the cradle-to-gate method (Emissions coverage to top of supply chain)

(2) Advantages of the cradle-to-gate method

- The cradle-to-gate (C-to-G) approach ensures that suppliers participating in the calculation and sharing of CO2 data will always cover right through to the top of the supplier chain.
- This is because the supplier company takes on the responsibility for calculating C-to-G emissions comprising the following components:
  - **Gate-to-gate (G-to-G) emissions from their own direct activities**
  - **Emissions from upstream activities through to the top of the supply chain** (in the absence of upstream data, calculated using secondary data)
- Figure 1-4-17 illustrates this idea using a simple unbranched supply chain consisting of four tiers. In addition to G-to-G emissions, companies in each tier also calculate emissions from upstream emission activities using secondary data. Even if some upstream companies do not participate in the data calculation, their emissions will be covered through to the top of the supply chain.
- It can also be seen from the figure that if companies in all tiers engage in CO2 data calculation and downstream sharing, the C-to-G emissions data calculated and provided by the lowest tier supplier will be the sum of the G-to-G emissions calculated by each supplier. The more companies calculate and share CO2 data, the more downstream C-to-G emissions reflect their actual emissions and efforts to reduce them.

- Assumes a supply chain with Tier 4 as the most upstream.
- If companies in each tier calculate and share their C-to-G emissions, emissions will be covered up to the top of the supply chain even if some companies do not participate in the data calculation.

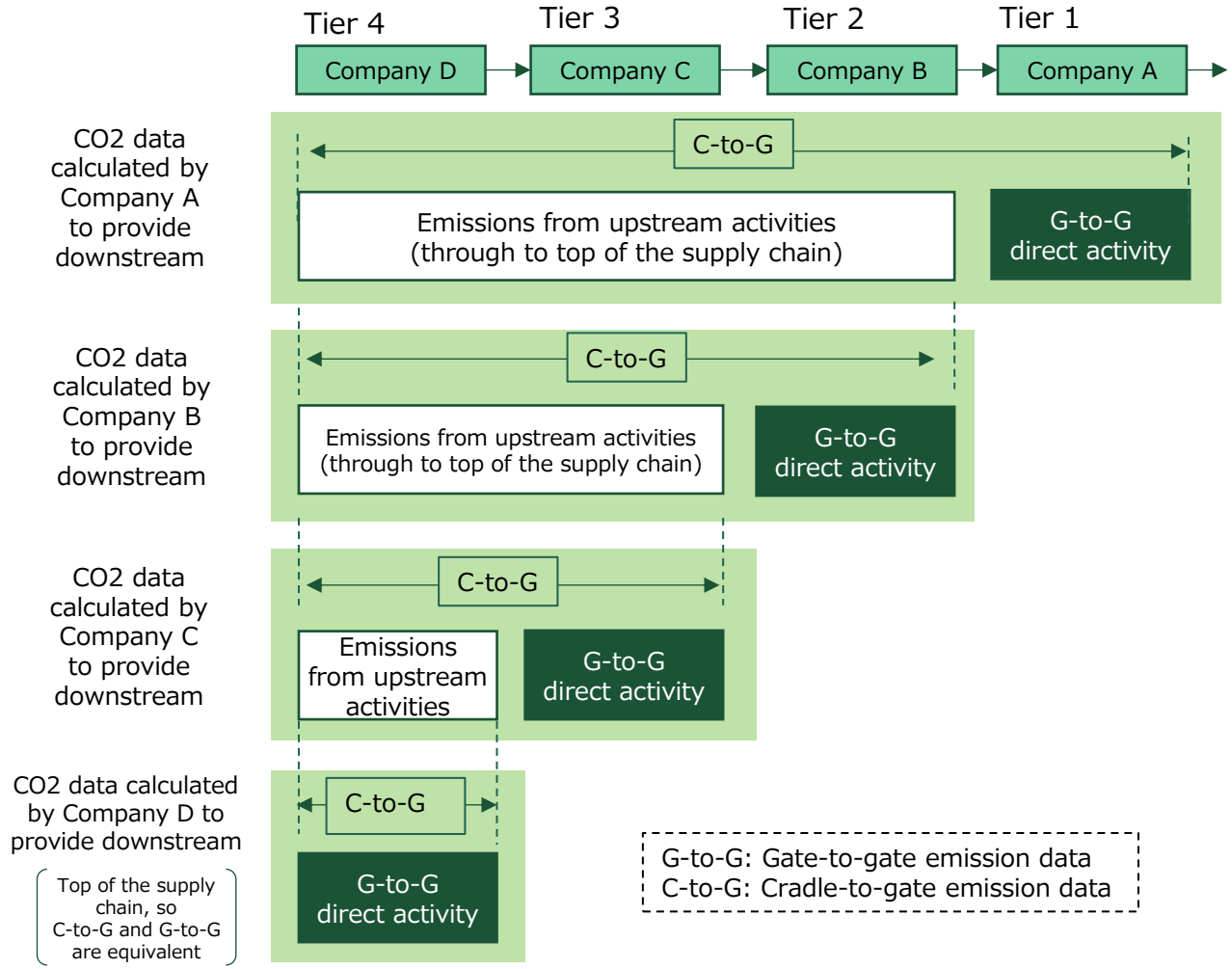


Figure 1-4-17 CO2 data structure in the C-to-G method

Source: Created by Mizuho Research & Technologies

Cradle-to-gate CO2 data calculation

(3) Cradle-to-gate CO2 data calculation

- As shown on the previous page, with the cradle-to-gate (C-to-G) method, gate-to-gate (G-to-G) emissions from direct activities and emissions from upstream activities need to be calculated. All of these are calculated by activity data × emission factor.
- The calculation concept is shown in Figure 1-4-18. In the past, a supply chain without branches was adopted for simplification purposes, but here we present a more realistic branched supply chain (with multiple inputs) as a model.
- In cases whereby secondary data are used for emission factors in calculating the activity data × emission factor shown under "Emissions from upstream activities" at the lower left of the figure, the calculation method is that noted on the previous page, i.e., "in the absence of upstream data, calculations using secondary data."
- Naturally, the secondary data emission factor used here should cover emissions up to the top of the supply chain. Section 2-2-6 notes which database should be used for the secondary data emission factor.

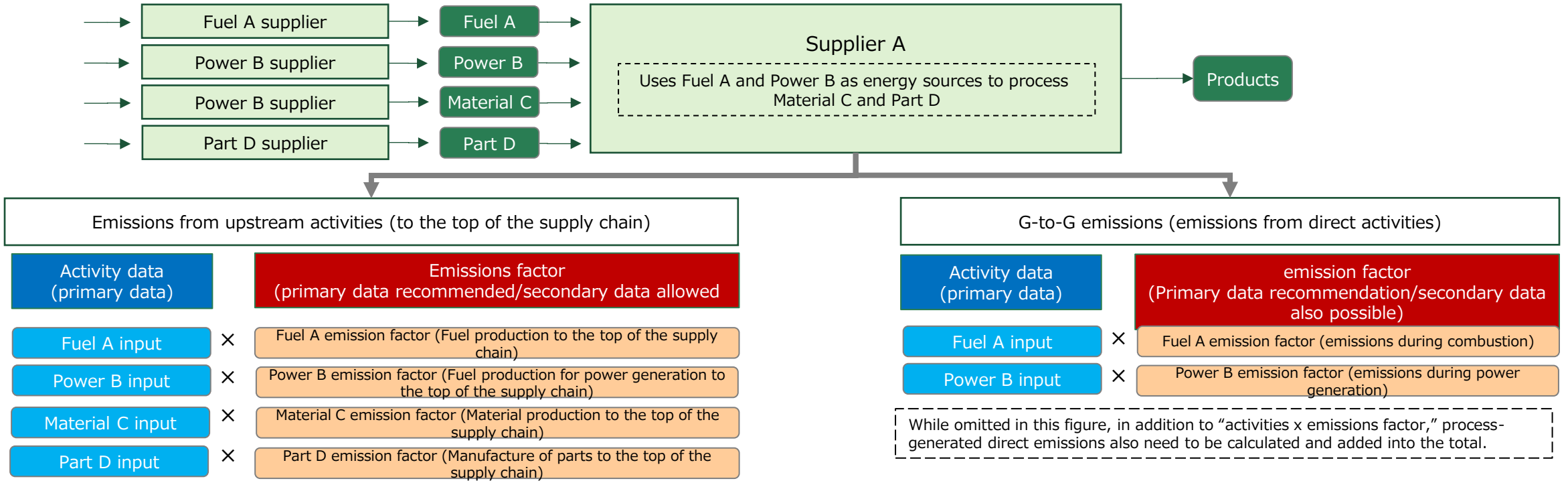


Figure 1-4-18 Calculation of G-to-G emissions using the C-to-G method and emissions from upstream activities

Source: Created by Mizuho Research & Technologies

When suppliers can only usine the gate-to-gate method

(4) Getting started with the gate-to-gate approach

- Although this document uses the C-to-G method as its premise for calculating CO2 data, the Methodology SWG pointed out that the calculation of emissions from upstream activities required by this method is difficult, particularly for companies and SMEs that are addressing CO2 data calculation for the first time.
- Therefore, this document allows companies that cannot comply with the C-to-G method to calculate CO2 data using the gate-to-gate (G-to-G) method.
- However, since G-to-G CO2 data does not include emissions upstream from the supplier, downstream companies using the data cannot cover emissions upstream in the supply chain. Since Scope 3 Category 1 is calculated up to the top of the supply chain, Category 1 is not correctly calculated when G-to-G emissions data provided by suppliers is taken as the emission factor.
- Therefore, when downstream companies use G-toG CO2 data provided by supplier companies to calculate Scope 3 Category 1 emissions, they must calculate and supplement emissions from upstream activities by proxy. Specifically, this means calculating emissions from upstream activities as shown Figure 1-4-18.

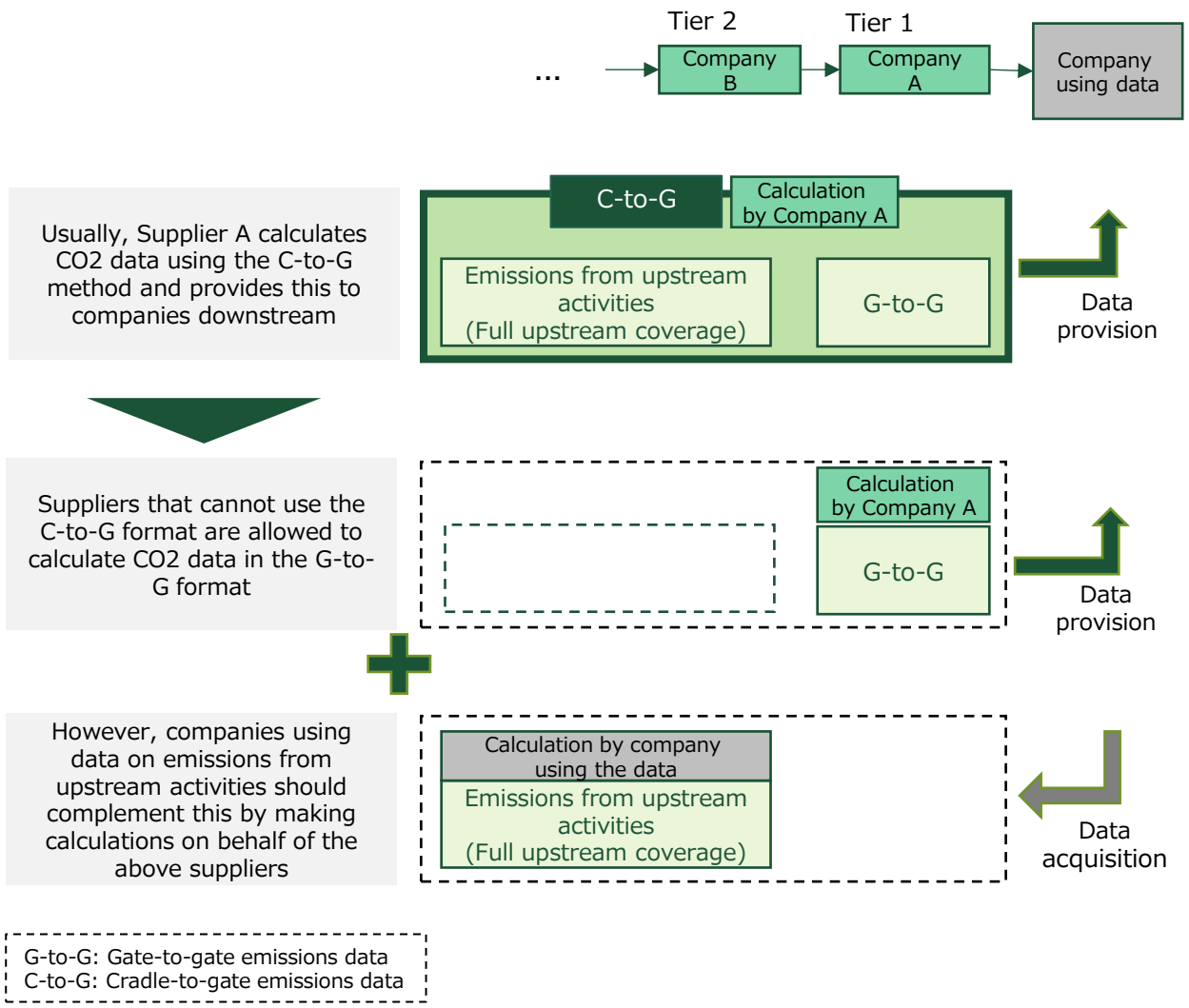


Figure 1-4-19 Cradle-to-gate method not supported

Source: Created by Mizuho Research & Technologies

SWG discussion: (5) Possibilities and issues with the G-to-G method

- While the G-to-G method creates the issue of retroactive data disruption, the idea of each company uploading its own G-to-G emissions data to the network and aggregating that data in some form is compatible with digital technology. In addition, unlike the C-to-G method, there is no need to calculate emissions from upstream activities and the burden on suppliers is limited. Some in the SWG felt that the G-to-G system should become the mainstream in future.
- On the other hand, it was also pointed out that the accumulation of G-to-G data on the network carries an inherent risk of leakage of confidential information from suppliers.
- In order to add Tier 2 companies' data to the Tier 1 data in the G-to-G method (Figure 1-4-20), it is necessary for Tier 1 to identify which companies are designated as Tier 2 and to what extent they purchase products and services—that is, to provide highly confidential information on transactions to the network and thus risk the leakage of confidential information.
- In this regard, the upstream emissions data which the C-to-G approach provides to downstream companies comprises only the results of C-to-G emissions calculations and does not disclose trade information, so it has an advantage in terms of confidentiality.
- However, with the emergence of regulations such as the EU Sustainable Batteries Regulation that require the presentation of traceability information in the supply chain, there may be a limit to a C-to-G method that does not retain traceability information for upstream supplier companies.
- Although the G-to-G method was not adopted here, it may be reconsidered in the future if a strong regulatory requirement for traceability emerges.

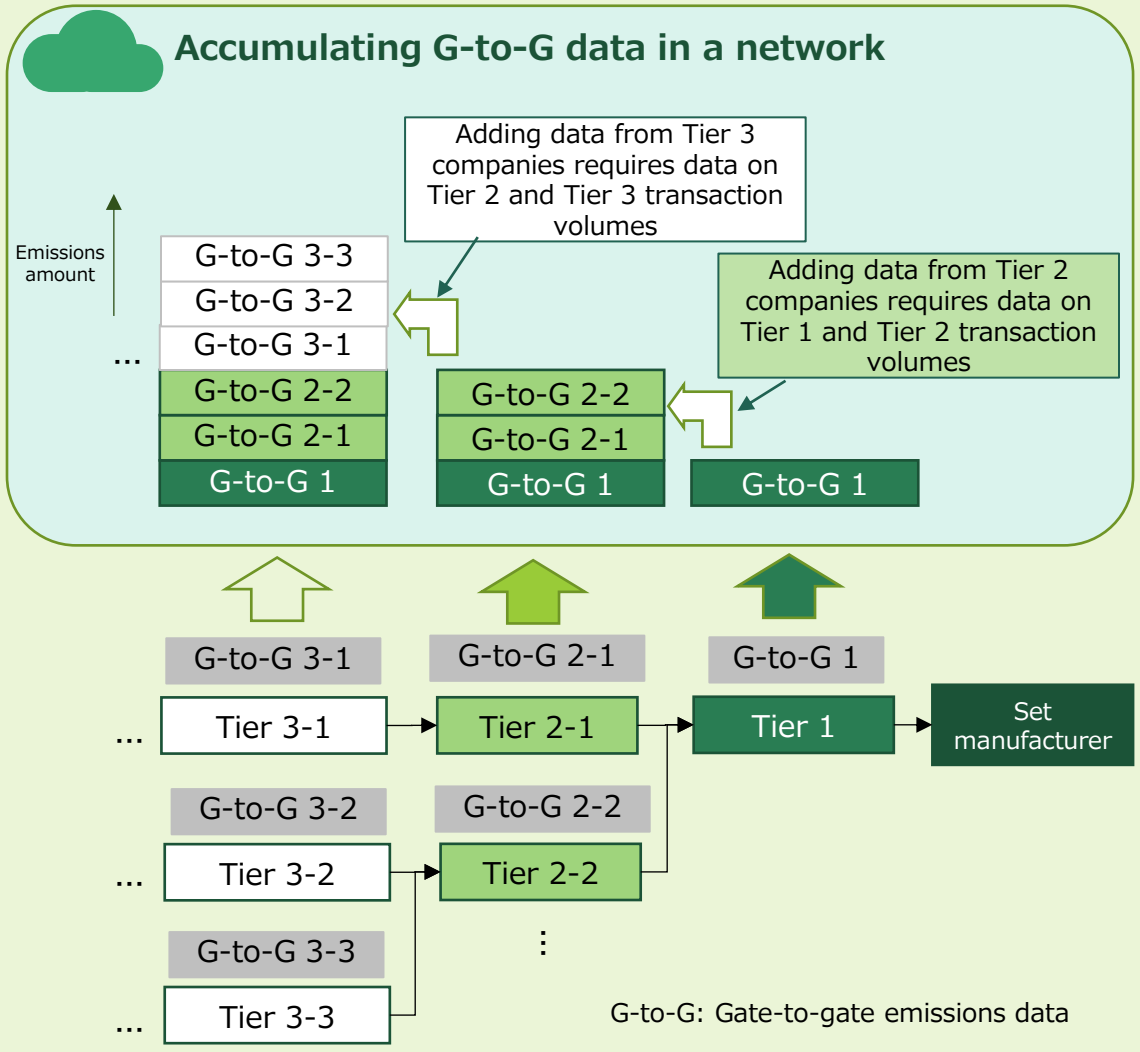


Figure 1-4-20 Gate-to-gate method and data confidentiality issues

Source: Created by Mizuho Research & Technologies

Coexistence with existing methodologies and standards

1-4-7. Coexistence with existing methodologies and standards

(1) Pathfinder Framework approach

- In 1-4, it was noted that clarification was needed as to how the CO2 data calculation method described in this document would coexist with existing methodologies and standards and what the division of roles would be. To achieve this vision, this document follows the PACT Pathfinder Framework concept.
- PACT notes that the Pathfinder Framework method of calculating CO2 data must be read in conjunction with existing methodologies and standards for product carbon footprint assessment. In other words, the Pathfinder Framework is positioned as a document that complements existing methodological standards.
- Those existing methodologies and standards are classified into the following three categories, with their relationship to the Pathfinder Framework as shown in the table below.
  (1) Product-specific rules
  (2) Sector-specific rules
  (3) Cross-sectoral standards
- The approach of Pathfinder Framework v2 can be summarized as follows:

> - **Where product-specific and sector-specific rules exist, their application shall always be prioritized for PCF calculation, subject to a certain degree of consistency with the Pathfinder Framework**
> - **Where generic cross-sectoral standards are used, priority shall be given to Pathfinder Framework requirements**

- This document too adopts this approach for Product-based calculations (see Section 2-2).

	Product-specific rules	Sector-specific rules	Cross-sectoral standards
Hierarchy	1	2	3
Outline	Carbon footprint calculation rules for specific product categories	Carbon footprint calculation rules for specific sectors	Generic standards for carbon footprint calculation, not limited to a specific product category or sector
Rules (Example)	PEFCR (Product Environment Footprint Category Rules) PCR (Product Category Rules)	Together for Sustainability (Product carbon footprint guidelines for the chemical industry)	ISO 14067:2018 GHG Protocol Product Standard
Requirements for claiming compliance with Pathfinder Framework	Product-specific rules that meet Pathfinder Framework certification criteria can be used independently*	Sector-specific rules that conform to the Pathfinder Framework recommended. Highlight any aspects not fully in alignment.	If there are differences, prioritize Pathfinder Framework requirements

* Pathfinder Framework qualification criteria (safeguards) for product-specific rules are noted in Section 2-2-2.

Figure 1-4-21 Relationship between Pathfinder Framework and existing methodologies

Source: Created by Mizuho Research & Technologies based on Pathfinder Framework v2

Product-specific and sector-specific rules in Japan

(2) Product-specific and sector-specific rules in Japan

- When applying the Pathfinder Framework v2 approach shown in Figure 1-4-21 in Japan, it is necessary to determine whether the application of product-specific rules and sector-specific rules developed in Japan will be prioritized over the Pathfinder Framework.
- This requires consultation with PACT and national organizations (described below), and a conclusion has not yet been reached.
- Product-specific rules and sector-specific rules prioritized over the Pathfinder Framework v2 and the Product-based calculations in this document will be disclosed as discussions progress.

■ Product-specific rules

- One set of product-specific rules in Japan is the set of PCRs in the SuMPO Environmental Label Program operated by the Japan Sustainable Management Organization (SuMPO).
- The SWG has started discussions with SuMPO, but we have come to share the view that a lengthy discussion is necessary on how the SuMPO Environmental Label Program PCRs will be positioned in relation to the Pathfinder Framework and the CO2 Visualization Framework.
- Consultations with SuMPO will continue. We will also review and discuss with PACT how to certify product-specific rules prioritized over the Pathfinder Framework.

■ Sector-specific rules

- Sector-specific rules in Japan include the Guidelines for Calculating the Carbon Footprint of Products in the Chemical Industry (published in March 2023).
- Industry rules based on the METI/MoE Carbon Footprint Guidelines are being developed.
- Pathfinder Framework v2 requires sector-specific rules to be developed based on ISO and the GHG Protocol, etc., but does not provide specific criteria for determining compliance.
- We will continue to confirm and discuss with PACT the criteria for determining which sector-specific rules will be prioritized over the Pathfinder Framework, like the Together for Sustainability PCF guidelines already approved by PACT.

Relationship to cross-sectoral standards widely used in Japan

(3) Relationship to cross-sectoral standards widely used in Japan

- Pathfinder Framework v2 gives ISO 14067:2018 and the GHG Protocol Product Standard as representative cross-sectoral standards, (Figure 1-4-21). In Japan, the ISO standard is frequently referenced.
- The METI/MoE Carbon Footprint Guidelines and the separate Carbon Footprints Practical Guide, both of which are expected to be referenced more and more by Japanese companies in the future, also fall under the heading of cross-sectoral standards.
- When companies that have conducted CO2 data calculations using these cross-sectoral standards claim compliance with the Pathfinder Framework, they need to apply the methodologies in the Pathfinder Framework and Section 2-2 of this document to determine the methodological differences in calculation and sharing (data provision).
- The handling of product-specific rules, sector-specific rules, and cross-sectoral standards developed in Japan is shown in Figure 1-4-22.
- The main differences between the main cross-sectoral standards and Pathfinder Framework v2 and this document are shown in Figure 1-4-20. Differences from the METI/MoE Carbon Footprint Guidelines are described separately in the Appendix at the end of this document.

	Product-specific rules	Sector-specific rules	Cross-sectoral standards
Hierarchy	1 →	2 →	3
Outline	Carbon footprint calculation rules for specific product categories	Carbon footprint calculation rules for specific industries	Generic standards for carbon footprint calculation, not limited to a specific product category or industry
Rules (Example)	PEFCR (Product Environment Footprint Category Rules) PCR (Product Category Rules)	Together for Sustainability (Product carbon footprint guidelines for the chemical industry)	ISO 14067:2018 GHG Protocol Product Standard
Handling of calculation rules developed in Japan	TBD (Discussions underway with SuMPO regarding the handling of the set of PCRs under of the SuMPO Environmental Label Program)	TBD (Plans to hold discussions with PACT on approval of carbon footprint calculation rules developed by domestic industry associations)	METI/MoE Carbon Footprint Guidelines and the Carbon Footprints Practical Guide positioned as cross-sectoral standards
Requirements for claiming compliance with Pathfinder Framework	Product-specific rules that meet Pathfinder Framework certification criteria can be used independently*	Sector-specific rules that conform to the Pathfinder Framework recommended. Indicate where not fully compliant.	If there are differences, prioritize Pathfinder Framework requirements

Figure 1-4-22 Relationship between calculation rules developed in Japan and the Pathfinder Framework (Addition to Figure 1-4-19)

* Pathfinder Framework qualification criteria (safeguards) for product-specific rules are noted in Section 2-2-2.

Source: Created by Mizuho Research & Technologies based on Pathfinder Framework v2

Differences between Pathfinder Framework and major cross-sectoral standards

- The differences between the main cross-sectoral standards (ISO 14067:2018 and the GHG Protocol Product Standard) and the Pathfinder Framework v2 and the Product-based calculation methodology shown in Section 2-2 of this document are summarized below.
- When companies that have conducted CO2 data calculations using cross-sectoral standards claim compliance with the Pathfinder Framework, they need to apply the methodology in the Pathfinder Framework and Section 2-2 to the methodological differences in calculation and sharing (data provision).

	Cross-sectoral standards (ISO 14067:2018 and GHG Protocol Product Standard)	Pathfinder Framework v2 and Section 2-2 Product-based calculation methodology
Boundary setting	Cradle-to-grave principle	Cradle-to-gate
Method of allocating emissions related to recycling	In the case of the GHG Protocol: Open loop recycling: Recycled content method* Closed-loop recycling: Closed-loop approximation method*	Only applicable to recycled content method*
Upstream emissions from transportation fuel production	Need for calculation judged according to materiality	Calculation required
Available secondary data databases	None specified	Database safeguards and databases fulfilling said safeguards indicated
Exemption rule (cutoff rule)	Criteria for exemption (cut-off) not specified	Less than 1% per process and less than 5% cumulatively of total emissions
Data quality assessment	In the case of the GHG Protocol: For five indicators: technological representativeness, temporal representativeness, geographical representativeness, completeness, and reliability Four-point scale (Very good>Good>Fair>Poor)	Three-point scale (Good>Fair>Poor) for five indicators: technological representativeness, temporal representativeness, geographical representativeness, completeness, and reliability

* Further details of the recycled content method and the closed-loop approximation method are given in Section 2-2-5 (3).

Figure 1-4-23 Methodological differences between cross-sectoral standards and Pathfinder Framework v2 and Section 2-2

Source: Created by Mizuho Research & Technologies based on ISO 14067:2018, GHG Protocol "Product Standard," and Pathfinder Framework v2

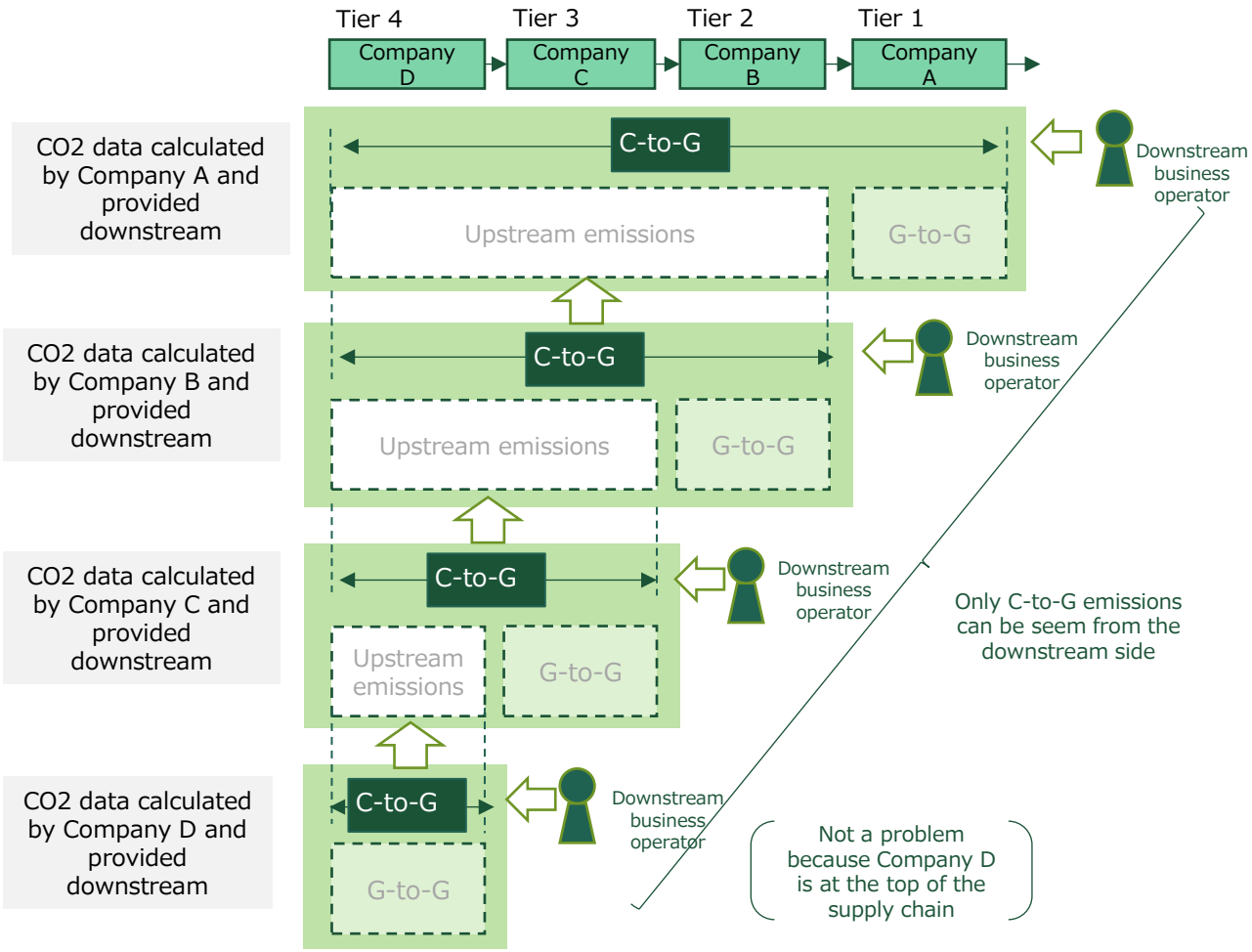
Limitations of the cradle-to-gate method

1-4-8. Additional measures for analysing emissions upstream in the supply chain

(1) Limitations of the cradle-to-gate method

- While “Ideal Form: 6. Allow some level of data analysis" in this document requires the protection of supplier companies’ confidential information, it also suggests that companies using data should be able to analyze to some extent the emission structure and potential for emissions reduction upstream in the supply chain.
- Following in the footsteps of the Pathfinder Framework, the C-to-G approach employed in this document is well suited to protecting the confidential information of supplier companies but less suited to data analysis.
- This is because even if multiple suppliers provide CO2 data based on primary data, that data is aggregated into one value which data users cannot analyze.
- The structure of C-to-G CO2 data is shown in Figures 1-4-16 and 1-4-17, which illustrate the internal calculation structure (G-to-G + upstream emissions) when compiling C-to-G emissions data.
- However, only the calculated C-to-G emissions data is actually provided to downstream companies, and downstream data users cannot perform “hot spot analysis” to identify large emission sources.
- This limitation in terms of data analysis is a challenge posed by the C-to-G approach.

- As in Figure 1-4-17, assumes a supply chain in which Tier 4 is at the top.
- Example of a situation in which a C-to-G data exchange is performed



G-to-G: Gate-to-gate emission data; C-to-G: Cradle-to-gate emission data

Figure 1-4-24 Limitations of the cradle-to-gate method

Source: Created by Mizuho Research & Technologies

Gate-to-gate combination for upstream emission structure analysis

(2) Using the gate-to-gate method

- In order to solve the problem presented on the previous page of being unable to break down C-to-G data, this document introduces a method based on the C-to-G method that adds in G-to-G data provision.
- Specifically, when a supplier provides C-to-G data to downstream entities, it provides (i) its own G-to-G emissions data and (ii) C-to-G emissions data provided by upstream suppliers, withholding company names (Figure 1-4-25).
- As presented in 1-4-5, the G-to-G emission data to be provided is only the output information (emissions, etc.) for CO2 data calculation and does not include input information (consumption of raw materials, etc.).
- Also, the upstream emission data is the sum of the upstream emissions of the supplier as a whole, and no individual emission data prior to the total sum is presented. For example, in Figure 1-4-25, Company C's C-to-G emission data is provided to Company B, but Company B only provides upstream emission data (the sum of emissions from Company C and Company D) to Company A, and Company C's G-to-G emission data is not visible to Company A.
- Downstream operators will be able to identify Tier 1 suppliers with particularly high G-to-G emissions and encourage them to reduce them (supplier engagement). It is also possible to take the approach of requesting Tier 1 suppliers with particularly large upstream emissions to encourage upstream suppliers to reduce their emissions (Figure 1-4-26).
- This document identifies this G-to-G combination method as a recommendation.

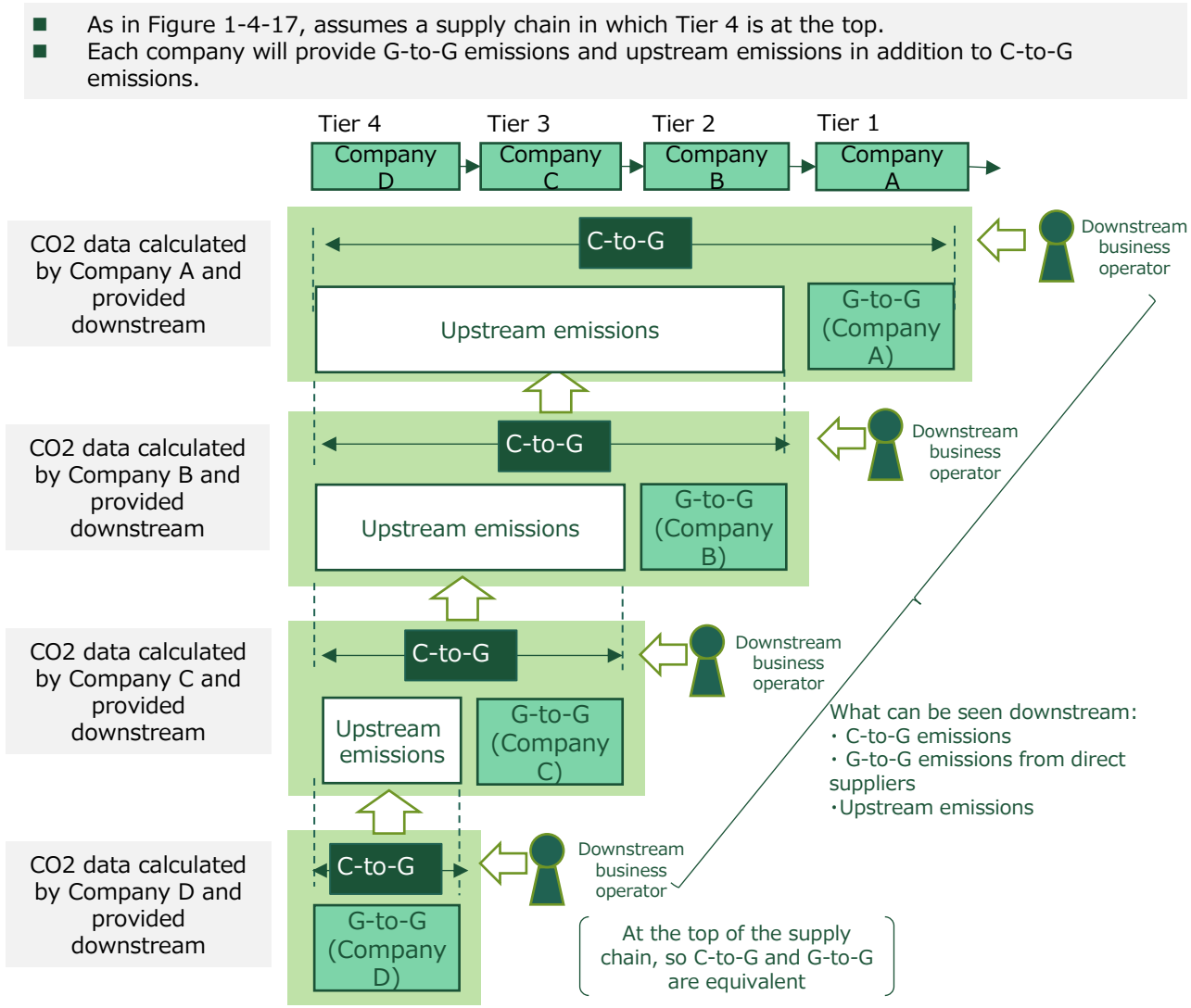


Figure 1-4-25 Cradle-to-Gate method + Gate-to-Gate method

Source: Created by Mizuho Research & Technologies

Illustration: G-to-G combination method and supplier engagement

- This page demonstrates how the G-to-G combination method is utilized in supplier engagement.
- Assume that Set Manufacturer X procures Parts A, B, and C from three Tier 1 suppliers—Aa, Ab, and Ac—as shown on the right. Assume that Company X is in a situation where it is considering which supplier to choose and what request to make as supplier engagement for reducing Scope 3 Category 1 emissions.
- Engagement suppliers can be selected based on the scale of the C-to-G emissions data for the parts they supply. Priority is given to suppliers that provide parts with high C-to-G emissions. (In this section, the total amount of emissions related to the parts obtained by multiplying the procurement amount, rather than the emissions of the parts alone, is the subject of consideration. This is what is shown in the figure on the right.)
- If Parts A and B have relatively large C-to-G emissions and Part C has relatively small C-to-G emissions, then Aa and Ab will be given priority for engagement.
- Company X will next consider the content of the reduction request to Companies Aa and Ab. At this time, G-to-G data will be utilized.
- Supplier Aa whose C-to-G emission data consists of G-to-G emission data and upstream emission data, the former of which is larger, is requested to reduce its own G-to-G emissions. Supplier Ab, whose upstream emission data is the the larger, will be asked to request cuts from their upstream suppliers.
- In response to the request to make reduction requests to its upstream suppliers, Supplier Ab will implement the same approach to its upstream suppliers as X did, and it is expected that this repetition will lead to reduction requests reaching hot spots in the supply chain.

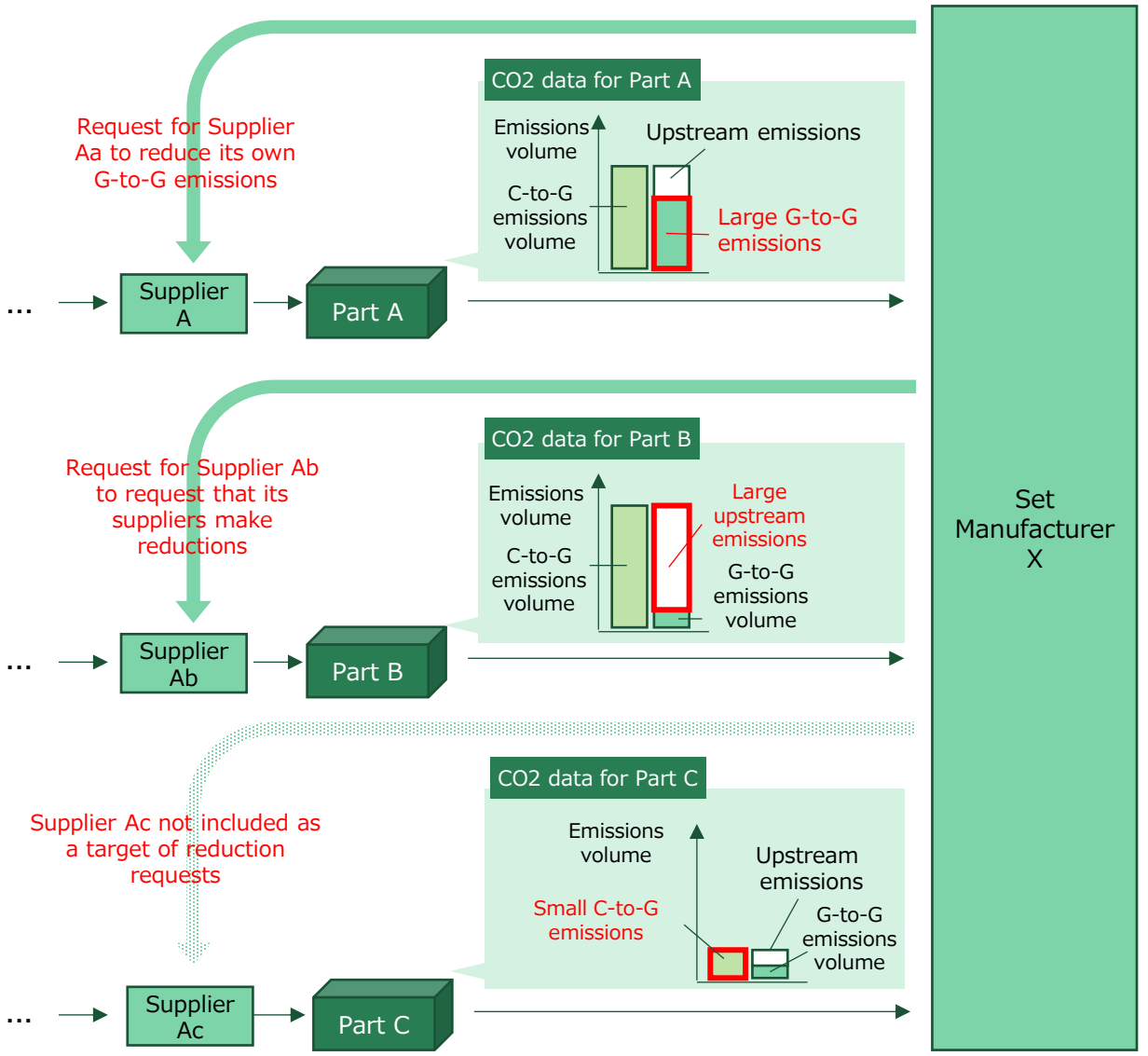


Figure 1-4-26 G-to-G combination method and supplier engagement

Source: Created by Mizuho Research & Technologies

SWG discussion: (6) Another G-to-G combination method not adopted (1/2)

- There are two possible G-to-G combination methods: Method (A), in which suppliers which calculate and provide CO2 data provide only their own G-to-G emissions data downstream; and Method (B), in which they also provide G-to-G emissions data provided from upstream;
- This document adopted (A) but also considered (B). For future discussion, the content of considerations on (B) is recorded below.
- The advantage of (B) is that downstream operators can understand the G-to-G emissions of not only the direct supplier (Tier 1) but also upstream suppliers (Tier 2 and Tier3, etc.) (Figure 1-4-27).
- The difficulty with (B) is that it requires a mechanism to identify where multiple G-to-G emissions data from upstream suppliers is located in the supply chain tree.
- As such a mechanism, the SWG devised a numbering rule whereby each supplier assigns a number to its direct supplier and provides G-to-G emissions data downstream with these numbers attached (Figure 1-4-28). Based on the principle that no input information is provided downstream (1-4-5), supplier names are not communicated.
- However, this method also places a burden on suppliers and does not resolve the problem of the increasing complexity of data exchange. Some SWG members also suggested that if companies had to go to such lengths, it would be better to formally obtain traceability. The SWG consequently decided not to adopt Method (B).

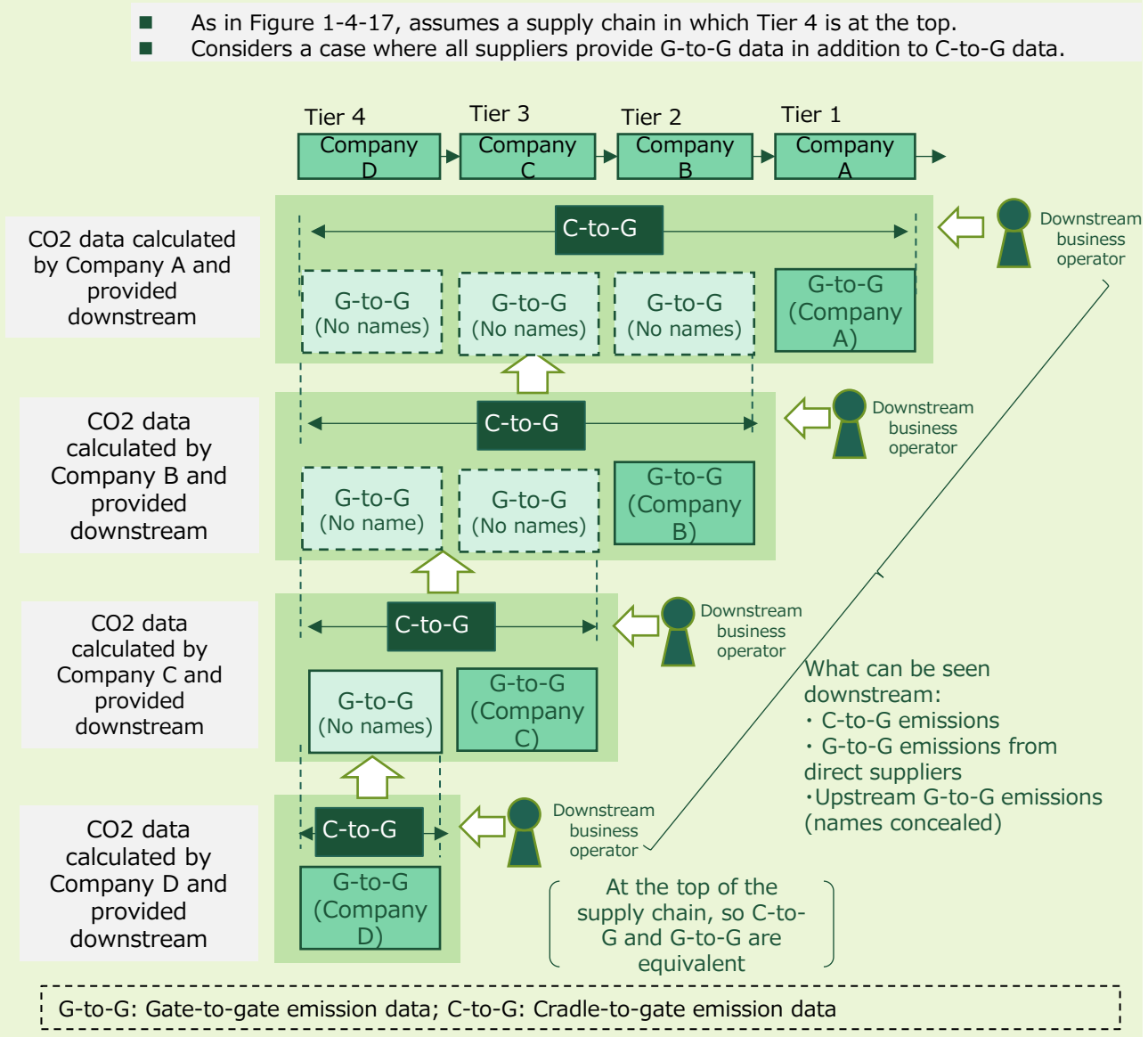


Figure 1-4-27 C-to-G method + G-to-G method

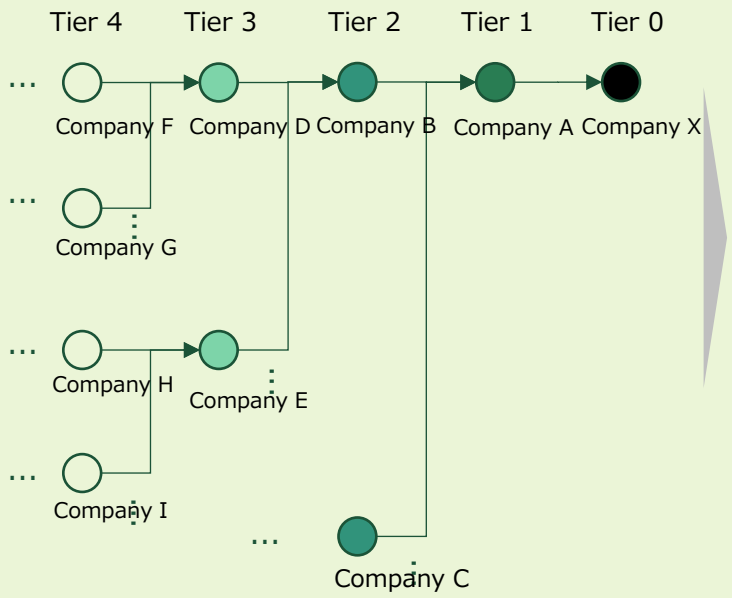
Source: Created by Mizuho Research & Technologies

SWG discussion: (6) Another G-to-G combination method not adopted (2/2)

- In order to implement the G-to-G combination method B (G-to-G emission data provided from upstream is also provided downstream), a mechanism is required to identify where multiple G-to-G emission data provided by upstream suppliers is located in the supply chain tree.
- As such a mechanism, the SWG examined a numbering system whereby each supplier numbers its direct supplier (Tier 1) and provides this number downstream attached to G-to-G emission data. This is done by each tier of suppliers, resulting in each set of G-to-G emission data being accompanied by a number and a hierarchical structure indicating its position in the supply chain.
- However, this numbering system too places a burden on suppliers and does not resolve the problem of the increasing complexity of data exchange, so the SWG decided not to adopt it.

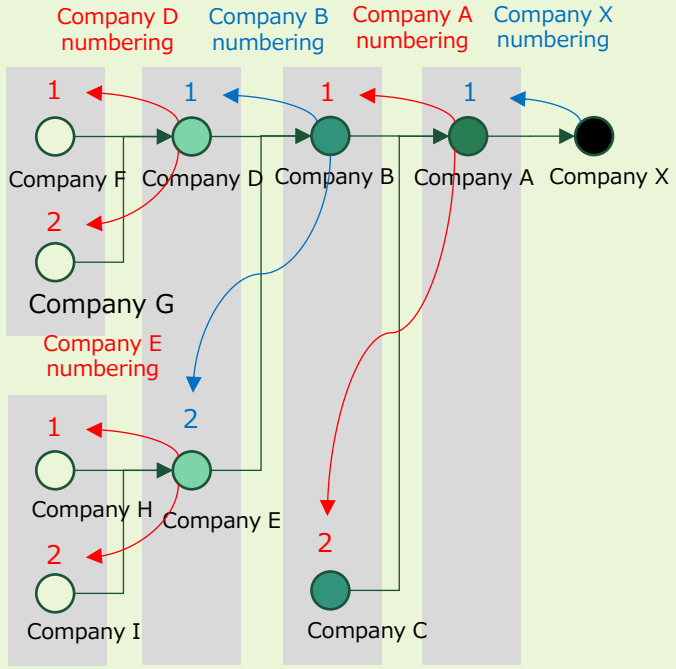
Branching supply chain model

The diagram models a branching supply chain.



Numbering of upstream suppliers

Each supplier numbers its direct upstream suppliers (only suppliers that provide G-to-G emission data can do so) and provides that number downstream.



Number of each supplier visible to Company X

Downstream operators can see the number attached to each tier for each supplier, which shows the branching structure of the supply chain and the location of each supplier.

Examples:
- Company D is identified as Tier 3 because of the number attached by Tier 2.
- Because Company B has the same number attached by Tier 0 as Company A, it can be seen that A is an upstream supplier.

	No. attached by Tier 0	No. attached by Tier 1	No. attached by Tier 2	No. attached by Tier 3
Company A	1	—	—	—
Company B	1	1	—	—
Company C	1	2	—	—
Company D	1	1	1	—
CompanyE	1	1	2	—
Company F	1	1	1	1
Company G	1	1	1	2
Company H	1	1	2	1
Company I	1	1	2	2

Source: Created by Mizuho Research & Technologies

Figure 1-4-28 Reproducing the supply chain structure by numbering upstream suppliers

CO2 visualization roadmap

1-5. CO2 visualization roadmap

- In addition to delineating the goals of CO2 calculation and sharing, the SWG discussed the importance of considering a transitional stage based on the current situation. Specifically, the following three points were raised.
  - Advances in CO2 data calculation methods
  - Expansion of tiers linked with primary data
  - Evolution of data collection methods within companies

1-5-1. Advances in CO2 data calculation methods

- As already indicated, Product-based calculation is prioritized over Organization-based calculation in CO2 data calculation, and when it comes to Product-based calculation, the application of calculation methods based on the Pathfinder Framework is recommended.
- However, depending on the current state of the company working on CO2 data calculations, the route to Pathfinder Framework-compliant calculations will vary.

(1) Companies that have already implemented some form of Product-based calculation

- Companies that have already implemented some form of Product-based calculation will first need to share the results of their current calculation with downstream operators in line with the data disclosure elements described in Section 3 of this document.
- After participating in data exchange over the supply chain, they will likely transition to the Pathfinder Framework-based CO2 data calculation methodology described in Section 2-2.

(2) Companies that have already implemented some form of Organization-based calculation

- Companies that have already implemented some form of Organization-based calculation (i.e., calculation of CO2 data for each product and transaction using Scope 1, 2, and 3 emissions) will first work to provide data to downstream companies in line with the data disclosure elements described in Section 3 of this document.
- Subsequent transition is recommended, however, to a calculation method with higher data quality (appropriate process subdivision and allocation) as described in 2-3 and to Product-based calculation as described in 2-2.

(3) Companies that have not yet begun calculating CO2 data

- For companies that have not yet started to calculate CO2 data, there are two approaches.
- One is first to calculate the Scope 1, 2, and 3 emissions of the company as an organization, then proceed to Organization-based calculation, using that data to participate in data exchange within the supply chain. The company would then consider moving to Product-based calculation in line with the wishes of downstream companies.
- The other is to undertake Product-based calculation from the outset. In so doing, it would be best to calculate CO2 data in compliance with the Pathfinder Framework noted in Section 2.2, but where this is difficult, the company could begin with G-to-G calculation (see 1-4-6 (4)). However, if a downstream company uses this data for its own Scope 3 calculations, it must calculate and supplement emissions from upstream activities.

CO2 visualization roadmap

1-5-2. Expansion of tiers connected by primary data

- At the beginning of this section, Figure 1-1-2 presented an image of all players in the supply chain calculating and exchanging CO2 data, and this is certainly the end-goal.
- In reality, most companies have yet to receive CO2 data based on primary data from direct suppliers (Tier 1), so their first step in the transition period will be to exchange data with Tier 1.
- Next, it will be important to aim for a situation where CO2 data can be collected based on primary data from Tier 2 and 3 upstream suppliers via Tier 1.
- Once connections have been created at the various points in the supply chain to exchange data over two or three tiers, these connections will connect with each other, leading to a stage in which data linkage progresses dramatically.

1-5-3. Evolution of data collection methods within companies

- Based on the theme of using digital technology for CO2 visualization, the Green x Digital Consortium Visualization WG has discussed the ideal image of automated and real-time data collection and CO2 data calculation using sensors.
- However, in our survey of existing standards, it was confirmed that even PACT's Pathfinder Framework, which is at the forefront of this work, is still at the stage of reaffirming the traditional LCA approach of identifying the annual average value of activity data by sorting out the existing LCA methodology and standards for calculating CO2 data. It has not yet reached the stage of examining automated and real-time data collection.
- Instead, some SWG members argued that data collection from each in-house system/database (environmental management system, procurement database, etc.) is necessary to calculate CO2 data in the cradle-to-gate method of Product-based calculation in accordance with the Pathfinder Framework, and that it is more important to build a mechanism utilizing digital technology for collection and aggregation.
- Therefore, as a roadmap for CO2 visualization, it will be important to promote cooperation with multiple systems and databases within a company using digital technology to calculate CO2 data, while promoting automated and real-time data collection on production lines, etc.
- In the future, real-time data collected by sensors will flow into companies' internal data connection platforms.

CO2 visualization roadmap

1-5-4. Creating a roadmap for CO2 visualization

- The CO2 visualization roadmap shown in Figure 1-5-1 draws on discussions to date, prepared from the three perspectives of progress in CO2 data calculation methods, expansion of tiers linked by primary data, and evolution in data collection methods within companies.
- We hope that this will serve as a reference for progress in the efforts of each company.

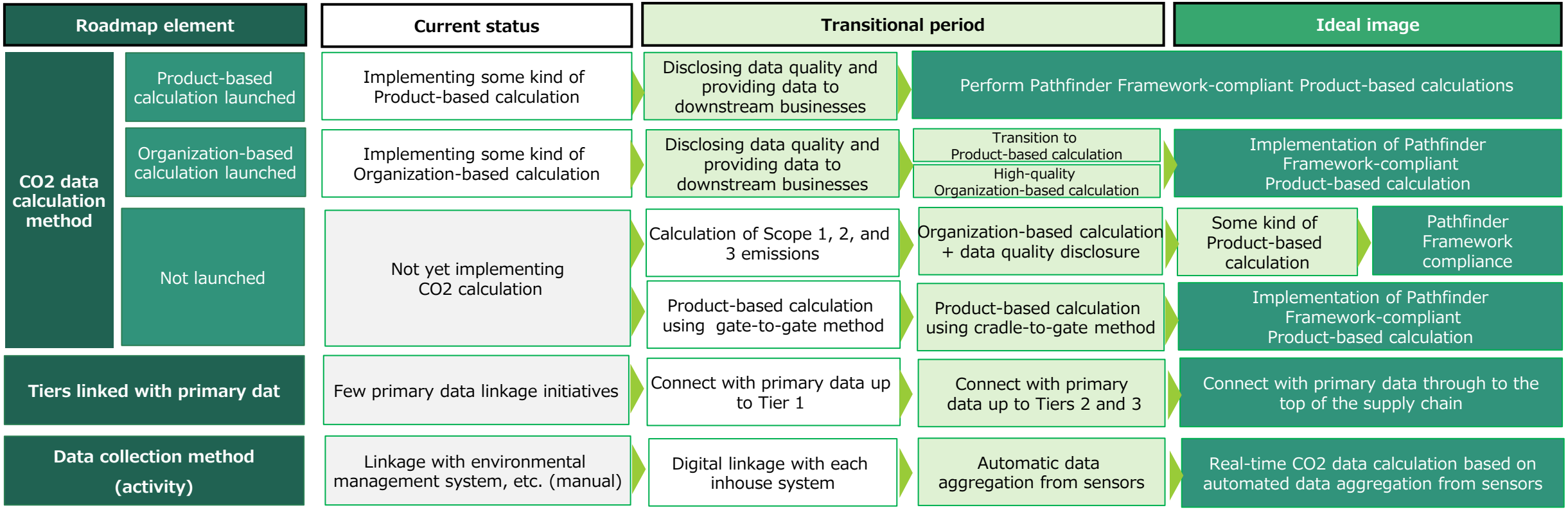


Figure 1-5-1 Road map for CO2 visualization progress

Source: Created by Mizuho Research & Technologies

It should be noted that, as stated above in 1-1-5, "CO2" or "CO2 data" in this Roadmap (1) refers to the CO2 equivalent of greenhouse gas emissions (expressed as kg-CO2e, etc.) as defined by the IPCC, and is not limited only to CO2 emissions; and (2) the life cycle boundary for calculating emissions is, in principle, cradle-to-gate unless otherwise specified.

2. CO2 data calculation methods

Two CO2 data calculation methods

2-1. Two CO2 data calculation methods

- This chapter presents the Green x Digital Consortium's recommended calculation methods for CO2 data provided by supplier companies for downstream companies to calculate Scope 3 Category 1 emissions.
- As shown in 1-4-2, calculation methods are presented for two types of calculation: calculation based on product data (Product-based calculation) and calculation based on organizational data (Organization-based calculation).

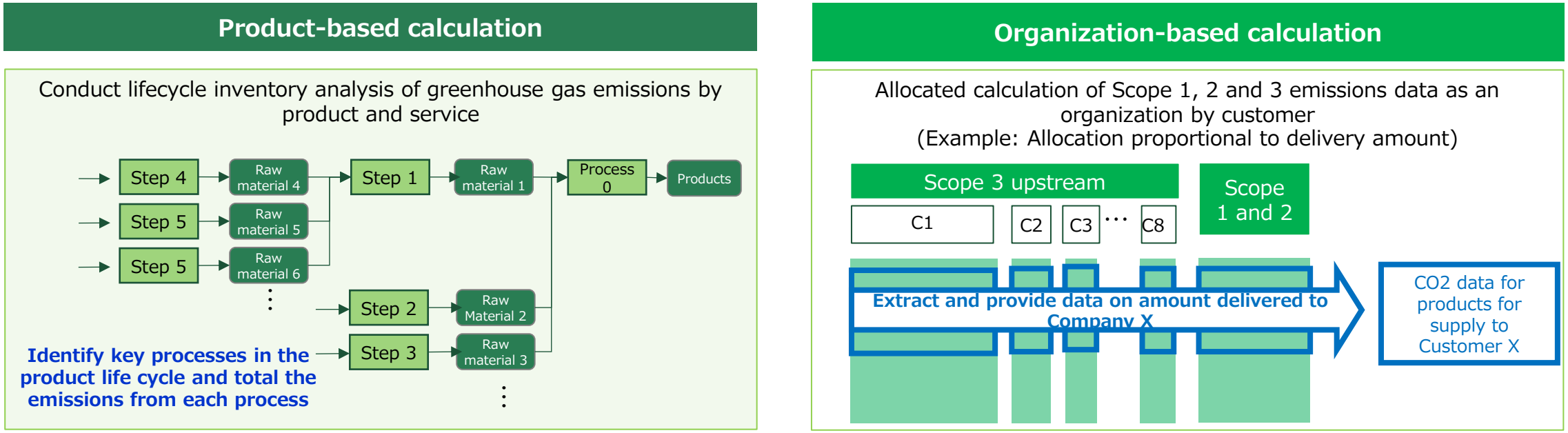


Figure 2-1-1 Overview of Product-based calculation and Organization-based calculation (Excerpt from Figure 1-4-4)

Source: Created by Mizuho Research & Technologies

Two CO2 data calculation methods

2-1-1. Product-based calculation

- Product-based calculation methods that comply with PACT's Pathfinder Framework are presented in 2-2 in order to realize internationally acceptable calculation methods and data quality.
- We aim to achieve a situation whereby, by following this document, companies can state that they have made calculations in accordance with the Pathfinder Framework. We are currently coordinating Edition 2 with PACT toward receiving approval for alignment with the Pathfinder Framework.

2-1-2. Organization-based calculation

- For Organization-based calculation, guidance for calculating CO2 data based on the level of data management in the digital age is presented in 2-3 based on Chapter 8 of the GHG Protocol Scope 3 Standard.
- Because this document takes the position of recommending a gradual shift from Organization-based calculation to Product-based calculation (1-4-2), the methodology of Organization-based calculation is positioned as a recommendation to improve data quality.

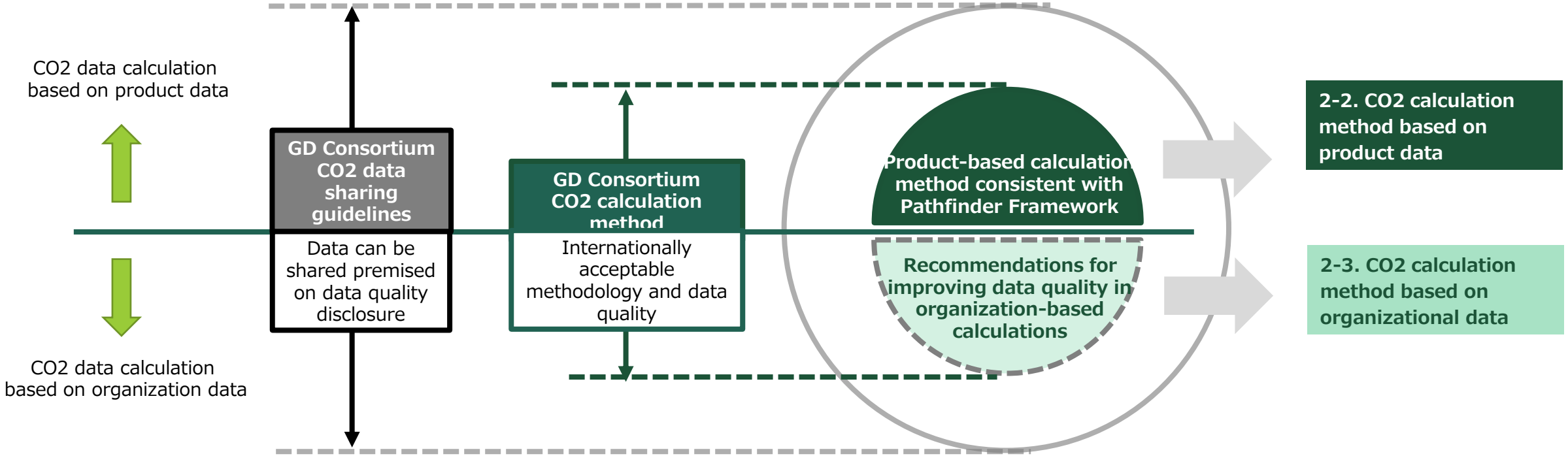


Figure 2-1-2 Positioning in this document of the Product-based and Organization-based calculation methods (Figure 1-4-9)

Source: Created by Mizuho Research & Technologies

Mixing of CO2 data calculation methods (1/2)

2-1-3. Relationship between the two CO2 data calculation methods

(1) Application priority

- As noted in 1-4-2, this document affirms the following position regarding the order of priority of Product-based and Organization-based calculations:
  - ① In view of the fact that Organization-based calculation of CO2 data is widely implemented in practice, companies may calculate and share such data to the extent that they explicitly state that it has not been produced through Product-based calculation.
  - ② However, we consider Organization-based calculation to be a provisional method and recommend a gradual transition to Product-based calculation.

(2) Mixing calculation methods

- Allowing the application of Organization-based calculation creates an issue that does not arise in the Pathfinder Framework: whether to allow a mixture of CO2 data from Organization-based calculation and from Product-based calculation.
- First, in Organization-based calculations, the use of CO2 data from Product-based calculations in the calculation of emissions from upstream activities is unproblematic. The application of CO2 data from Product-based calculation in the calculation of Scope 3 emissions, as organizational data is permitted under the GHC Protocol Scope 3 Standard.
- However, problems do arise when CO2 data from Organization-based calculation is used to calculate emissions from upstream activities calculated at product level.
- In general, Organization-based calculation includes calculation to assign organizational data to target products by allocation calculation, so calculation results are often mixed with data related to products other than the target products. Compared to Product-based calculations, which utilize data directly related to the target product or service, data for the target product tends to be less specific.
- As noted in Section 2-3 of this document, the DQRs for organization-based calcuation are less stringent than for Product-based calcuation.
- Therefore, it could be considered more appropriate to use secondary data generated through the Product-based calculation approach than CO2 data produced through Organization-based calculation, which is likely to remain at that level.
- However, one view is that the CO2 data from Organization-based calculation is superior to the secondary data produced through the Product-based calculation approach in that it reflects the actual situation of the supplier.
- Based on SWG discussion, this document handles this issue as follows: (PTO)

Mixing of CO2 data calculation methods (2/2)

(2) Mixing of calculation methods (continued)

a. The use of Organization-based CO2 data for the Product-based calculation of emissions from upstream activities is conditionally permitted under two conditions:

b. Condition 1: That Organization-based CO2 data shall be treated as non-primary data (PDS=0) in Product-based calculation.

c. Condition 2: The DQR status of the Organization-based calculation shall be ND ("No data to report").

- In other words, while it is permissible to use Organization-based CO2 data for the Product-based calculation of emissions from upstream activities, this will not be treated in the same way as Product-based CO2 data in terms of the PDS and DQRs.
- In this document, we have adopted the policy of not introducing PDS as a data disclosure element for Organization-based calculations (see 2-3-2 (6)). At present, Organization-based CO2 data is exchanged without a PDS. Downstream operators performing Product-based calculation will supply and receive this data with the PDS as 0.
- In addition, despite the first condition that Organization-based data be treated as non-primary data, in the data hierarchy for Product-based calculation shown in 2-2-6, it is positioned as secondary data if secondary data requirements can be met, and as proxy data if they can't.

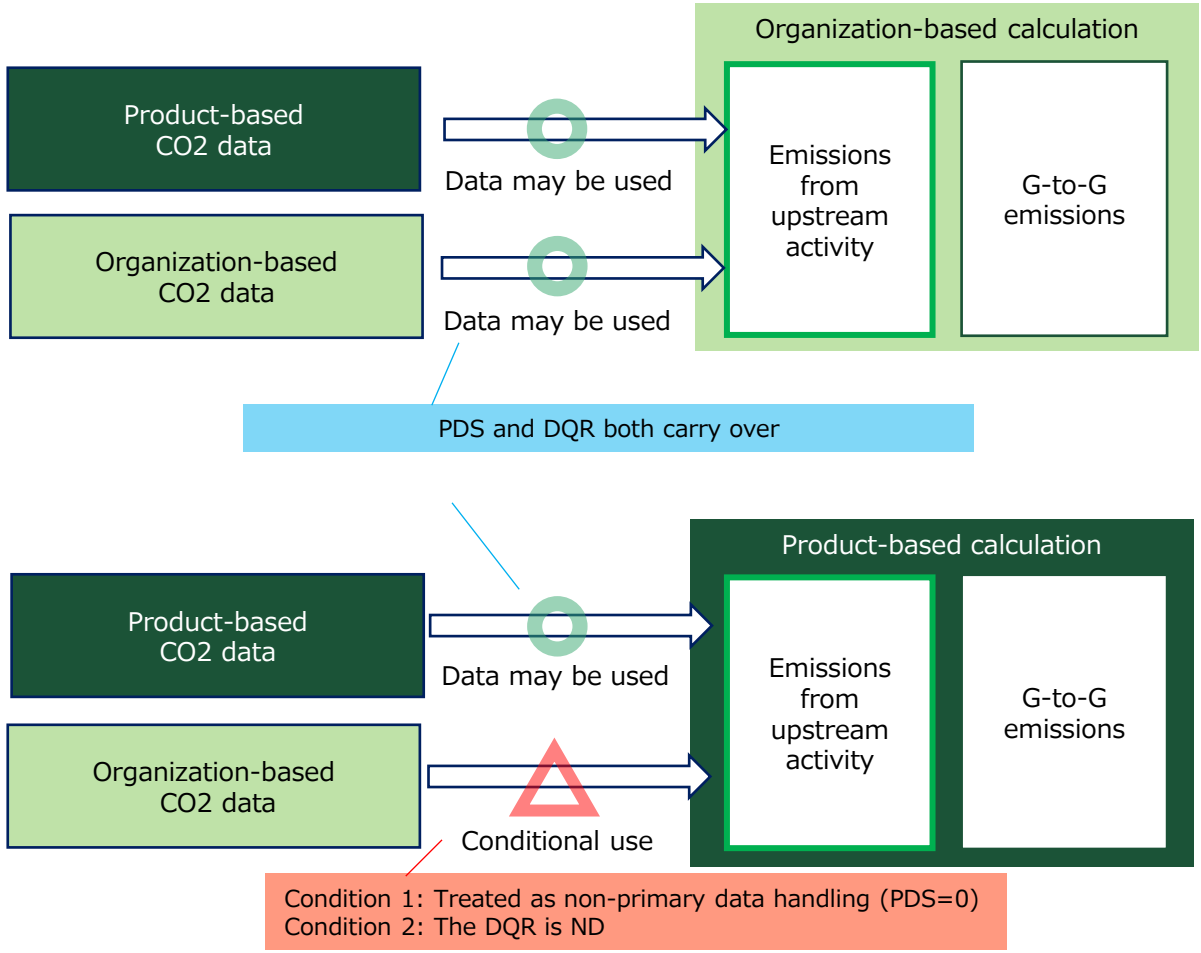


Figure 2-1-3 Approach when Product-based and Organization-based calculations are mixed

Source: Created by Mizuho Research & Technologies

For gate-to-gate only

2-1-4. For gate-to-gate only

- As previously noted in 1-4-6 (4), this document allows companies that cannot comply with the cradle-to-gate method to calculate CO2 data using the gate-to-gate method.

  - **The Product-based calculation shown in 2-2 will be a gate-to-gate method calculation if it is calculated for direct activities.**

  - **The Organization-based calculation shown in 2-3 is a gate-to-gate calculation if the allocation target is only Scope 1 and 2 emissions.**

- However, since gate-to-gate CO2 data does not include emissions upstream from the supplier, downstream companies using the data cannot cover emissions upstream in the supply chain. Downstream operators using that data are required to understand and utilize the imperfections of boundaries.
- Ideally, downstream entities using the G-to-G data should calculate emissions from the upstream activities of the supplier on their behalf.

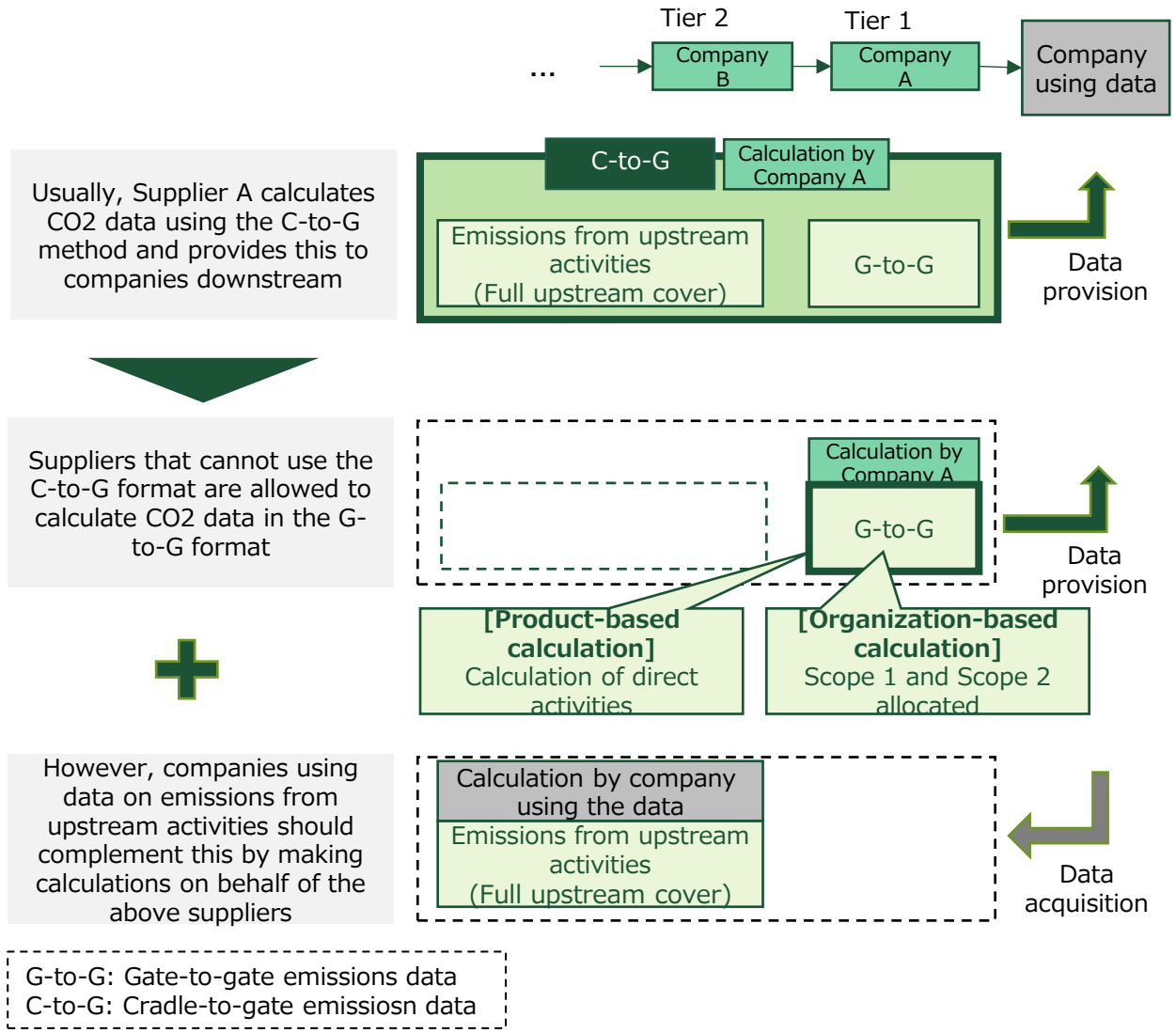


Figure 2-1-4 When companies cannot use the cradle-to-gate method (Figure 1-4-19)

Source: Created by Mizuho Research & Technologies

Requirements for the calculation and sharing methods described in this document

2-1-5. Requirements for the calculation and sharing methods described in this document

- The requirements for the CO2 data calculation and sharing method described in this document are as follows.
- “Shall”:
  Indicates which rules need to be followed
- “Should”:
  Indicates which rules are recommendations
- “May”:
  Indicates an option that is permissible or allowable

- The level of requirement depends on the CO2 calculation and sharing method.
  - Product-based calculations are given as “shall,” “should,” or “may.”
  - Organization-based calculations are presented as “should” or “may” because they are permitted from an inclusive perspective.
  - Responses to disclosure elements when sharing calculation results are shown as either "shall" or "should" in both Product-based and Organization-based calculations.

Requirement level	Product-based calculation	Organization-based calculation	Response to data disclosure elements
“Shall”	✓		✓
"Should"	✓	✓	✓
“May"	✓	✓	

Figure 2-1-5 Requirements for calculation and sharing methods

PCF notation

2-1-6. Adoption of PCF notation

- Where this document has thus far referred to Product-based C-to-G GHG emissions as Product-based CO2 data, henceforth we will follow the Pathfinder Framework in referring to this as the Product Carbon Footprint (PCF).
- This is because Product-based CO2 data accords with the PCF. In Japan, the PCF is often called the Carbon Footprint of Products (CFP) in line with ISO 14067:2018. Note that these terms denote exactly the same concept.
- Although many researchers use PCF as an abbreviation for Partial Carbon Footprint, PCF in this document is used only as an abbreviation for Product Carbon Footprint.
- organization-based CO2 data, on the other hand, is not always disaggregated as far as emissions data for individual product units, but rather often compiled as data per annual transaction volume (transaction value). In addition, when the data is exchanged as emission data per product unit, this does not comply with ISO 14067:2018 and other standards for carbon footprint calculation. (Where it can be considered compliant, it will be positioned in this document as Product-based data.)
- Therefore, as it is not necessarily appropriate to call organization-based CO2 data the PCF, this document will continue to use the term organization-based CO2 data.

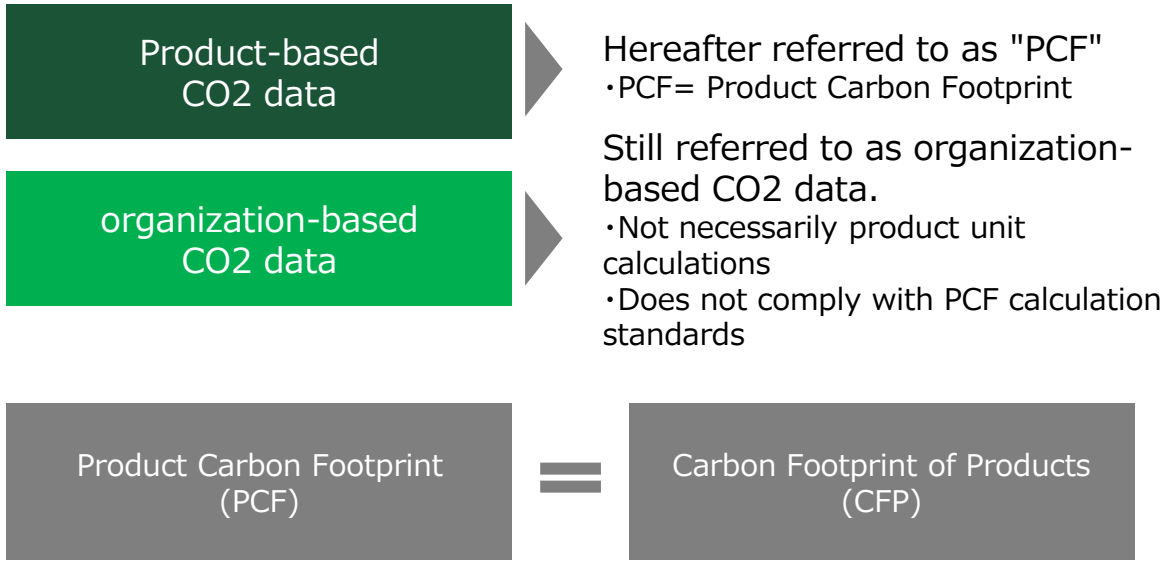


Figure 2-1-6 Use of the term PCF

2. CO2 data calculation methods

2-2. Product-based calculation method

Structure of methodological explanation of Product-based calculation

2-2. Product-based calculation method

- Section 2-2 presents the Green x Digital Consortium's Product-based calculation method, which, as noted earlier, is based on Pathfinder Framework v2. Pathfinder Framework requirements are explained, along with guidance to help Japanese companies apply the framework within Japan's institutional and data environment.

- The explanation is organized as follows.
  - 2-2-1: Pathfinder Framework v2 requirements
  - 2-2-2 to 2-2-8: Green x Digital Consortium rules
- This section explains how CO2 data is calculated. It corresponds to Section 3 (Emissions accounting) and Section 4 (Data integrity) in the Pathfinder Framework v2 (details shown on the right).

- The remaining sections of the Pathfinder Framework v2 correspond to the framework in this document as follows:
  - Section 5: Assurance and verification → Chapter 4: Verification of CO2 data
  - Section 6: Data exchange → Chapter 3: CO2 data sharing methods

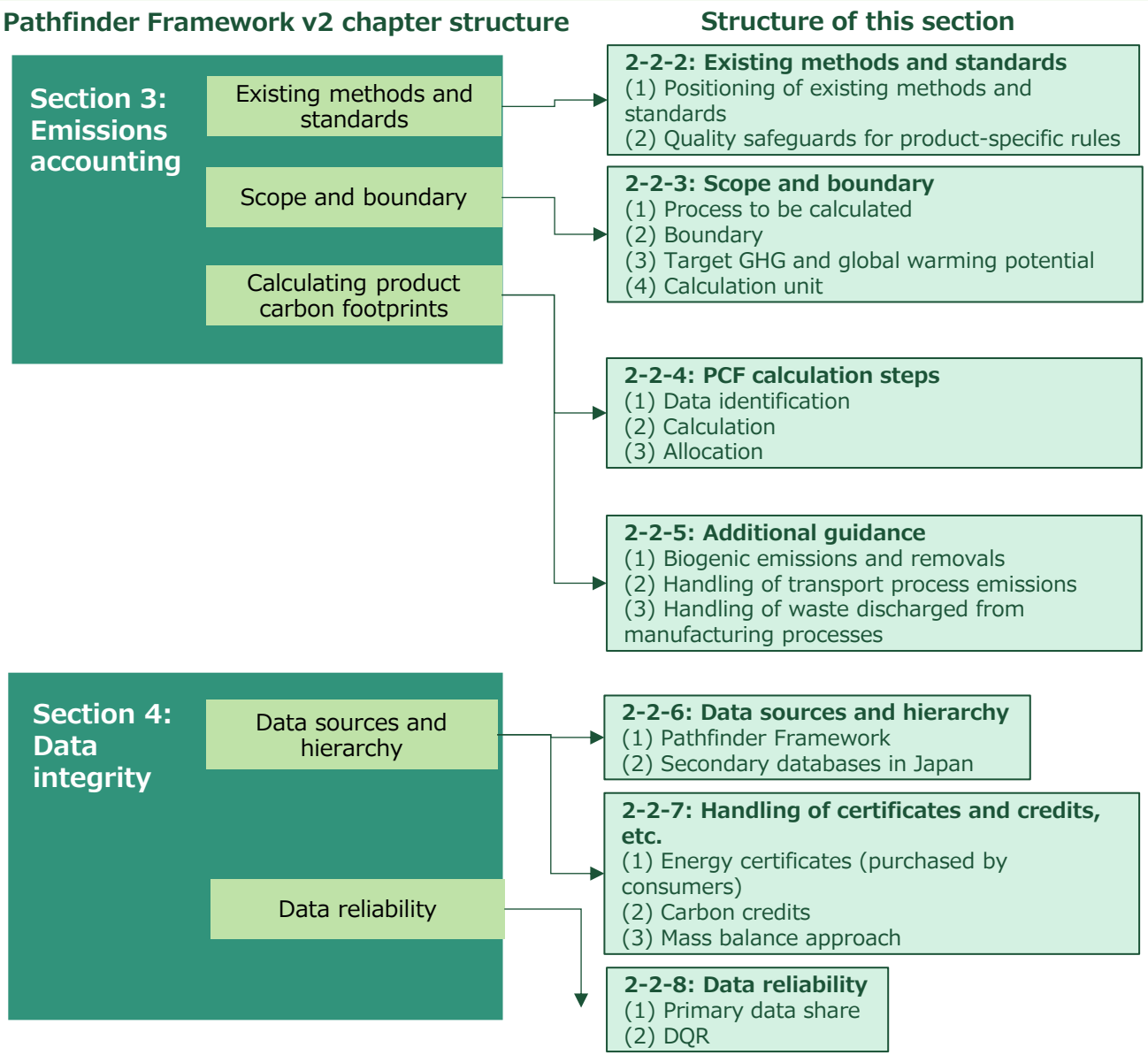


Figure 2-2-1 Correspondence between Pathfinder Framework v2 and this section

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

Overview of Pathfinder Framework v2 requirements (1)

2-2-1. Overview of Pathfinder Framework requirements

- Pathfinder Framework v2 requirements are as below.
- The Product-based calculation methodology presented in this section also requires parties calculating CO2 data to comply with the Pathfinder Framework requirements.
- However, in order for Japanese companies to comply with the requirements of the Pathfinder Framework, interpretation and explanation based on Japan's unique institutional environment and data environment are required. This is provided in Sections 2-2-2 to 2-2-8.

(1) Existing methods and standards	• The Pathfinder Framework shall be read in conjunction with existing methods and standards for the assessment of PCFs. • PCRs or sector-specific rules shall be prioritized for the calculation and allocation of PCFs. • PCRs shall only be considered valid if they comply with the Pathfinder Framework's quality safeguards. • If multiple PCRs are applicable, companies shall follow the PCR hierarchy laid out by the Pathfinder Framework. • Where no regulations or product- or sector-specific rules exist, companies shall follow the Pathfinder Framework requirements. • For elements not specifically addressed by the Pathfinder • Framework, the PCF calculation shall be compliant with the sector-agnostic standards.

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

Overview of Pathfinder Framework v2 requirements (2)

(2) Scope and boundary

- Companies shall account for all GHGs identified within the GHG Protocol.
- Their respective 100-year global warming potential (including carbon feedbacks) shall be derived from the latest (IPCC) Assessment
- Companies shall report cradle-to-gate PCF, comprising all upstream stages of the product life cycle up to the reporting company's gate (including upstream transportation), excluding downstream emissions from product use and end-of-life
- PCFs shall be exchanged upstream to downstream, providing kg of CO2e per unit of analysis.

(3) Guidance for PCFs

Accounting for product GHG emissions

- All attributable processes shall be identified.
- Companies shall collect relevant activity data and emission factors based on identified attributable processes.
- Manufacturing of production equipment, buildings and other capital goods, business travel by personnel, travel to and from work by personnel, and research and development activities should not be included within the boundaries of the PCF, unless materially significant.
- Companies shall be able to exclude individual attributable processes representing less than 1% of the total cradle-to-gate PCF.
- In aggregate, exclusions shall represent less than 5% of the total cradle-to-gate PCF emissions.
- If necessary: Allocation of emissions to outputs should follow the allocation hierarchy of the Pathfinder Framework.

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

Overview of Pathfinder Framework v2 requirements (3)

(3) Guidance for PCFs

Additional guidance

[Biogenic emissions and removals]

- Biogenic emissions and removals associated with the following shall be calculated and included as part of the “PCF (incl. biogenic emissions and removals)” metric from 2025 onwards:

—Direct land-use change (dLUC)

—Land-management-related changes (including land carbon pools and other non-CO2 emissions related to land management)

—Other biogenic GHG emissions not covered in dLUC and land management

—Biogenic CO2 withdrawals

- The biogenic carbon content in the product (mass of carbon) shall be calculated and reported separately as part of the data exchange form.
- GHG emissions associated with iLUC emissions may be calculated and reported separately as part of the data exchange form. iLUC emissions shall not be included as part of the PCF.
- To support transparency, all of the metrics shall also be reported separately, regardless of whether they are included in the PCF or not.

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

Overview of Pathfinder Framework v2 requirements (4)

(3) Guidance for PCFs

Additional guidance

[Transportation emissions]

- Upstream and direct transportation emissions within the cradle-to-gate boundary, including storage, shall be calculated and included in the PCF.
- Only transportation emissions relating to the fuel—also known as well-to-wheel emissions—and the energy consumed by storage facilities shall be included (i.e., the manufacturing of the vehicles used for the transport of goods shall not be included).

[Waste treatment and recycling emissions]

- All production emissions shall be allocated to the outputs with economic value, rather than to the waste or recyclable material itself
- Emissions resulting from waste treatment as part of the production process shall be calculated and included in the PCF of the company that manufactured the product and generated the waste.
- Emissions from the end-of-life stage of the products shall not be included in the PCF boundary.
- Since the Pathfinder Framework's boundary is cradle-to-gate, the "recycled content" method should be used for the allocation of emissions from recycling materials and energy recovery.

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

Overview of Pathfinder Framework v2 requirements (5)

(4) Data sources and hierarchy	• Pathfinder Framework definitions shall be used by companies to determine the nature of activity data and emissions. • Activity data that is used to calculate PCF shall be company-specific. • Secondary emission factors used shall be compliant with Pathfinder Framework safeguards. • Companies may use proxy data to bridge minor data gaps.
(5) Data reliability	• Companies shall either assess the primary data share (PDS) or the data quality of the PCF until 2025; after 2025, both KPIs shall be calculated and exchanged. • If calculated, the PDS shall be based on both the nature of the activity data and the emission factors used. • If calculated, the data quality ratings (DQRs) shall use the Framework's data quality assessment matrix, excluding any inputs representing less than 5% of the total PCF.
(6) Assurance and verification	• Verification of the PCF shall be done by an independent third party following the considerations laid out in the Pathfinder Framework's roadmap.

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

Overview of Pathfinder Framework v2 requirements (6)

(7) Data exchange	• Data owners shall exchange their cradle-to-gate PCFs alongside a set of minimum required data elements listed by the Pathfinder Framework downstream in the value chain.
(8) Connecting through technology	• Companies that have calculated their PCFs should exchange these using the Pathfinder Network.
(9) Incorporating Product-based data into Scope 3 calculations	• Companies should incorporate PCFs into their corporate Scope 3 footprints by multiplying the PCFs provided by suppliers with the number of product units purchased from them.

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

Relationship to existing methods and standards

2-2-2: Relationship to existing methods and standards

Pathfinder Framework requirements

- The Pathfinder Framework shall be read in conjunction with existing methods and standards for PCF assessment.
- PCRs or sector-specific rules shall be prioritized for the calculation and allocation of PCFs.
- PCRs shall only be considered valid if they comply with the Pathfinder Framework's quality safeguards.
- If multiple PCRs are applicable, companies shall follow the PCR hierarchy laid out by the Pathfinder Framework.
- Where no regulations or product- or sector-specific rules exist, companies shall follow the Pathfinder Framework requirements.

- For elements not specifically addressed by the Pathfinder Framework, the PCF calculation shall be compliant with the sector-agnostic standards

(1) Relationship to existing methods and standards

- As noted in 1-4-7, the Pathfinder Framework is intended to be used in conjunction with existing methodologies and standards and sets out a hierarchy for the application of existing methodologies and standards (see Figure 2-2-2).
- PCRs or sector-specific rules shall be prioritized over the Pathfinder Framework for the calculation and allocation of PCFs.
- Where no regulations or product- or sector-specific rules exist, companies shall follow the Pathfinder Framework requirements.
- The GD Consortium's Product-based calculation in this section also adopts this approach.

	Product-specific rules	Sector-specific rules	Cross-sectoral standards
Hierarchy	1 →	2 →	3
Outline	Carbon footprint calculation rules for specific product categories	Carbon footprint calculation rules for specific sectors	Generic standards for carbon footprint calculation, not limited to a specific product category or sector
Rule (Example)	PEFCR (Product Environment Footprint Category Rules) PCR (Product Category Rules)	Together for Sustainability (Product carbon footprint guidelines for the chemical industry)	ISO 14067:2018 GHG Protocol Product Standard
Requirements for claiming compliance with Pathfinder Framework	Product-specific rules that meet Pathfinder Framework certification criteria can be used independently*	Sector-specific rules that align to the Pathfinder Framework recommended. Highlight any aspects not fully in alignment.	If there are differences, prioritize Pathfinder Framework requirements

Figure 2-2-2 Relationship between Pathfinder Framework and existing methodologies (Figure 1-4-21)

Source: Created by Mizuho Research & Technologies based on Pathfinder Framework v2

Product-specific rules in Japan

(2) Existing methods and standards in Japan

- In order to identify the hierarchy of existing methods and standards shown in Figure 2-2-2 for Product-based calculations, we need to specify what constitutes existing methods and standards in Japan.
- This has already been outlined in 1-4-7, but is presented again below.

① Product-specific rules in Japan

- One set of product-specific rules in Japan is the set of PCRs in the SuMPO Environmental Label Program operated by the Japan Sustainable Management Organization (SuMPO).
- After consultations with SuMPO, we have reached the view that ongoing consultations will be needed on how the SuMPO EPD PCRs will be positioned in relation to the Pathfinder Framework and the CO2 Visualization Framework.

- There are consequently no product-specific rules specific to Japan at present that should be take precedence over the Pathfinder Framework and the Product-based calculation covered in this section.

- Consultations with SuMPO will continue.

Reference: PACT quality safeguards for product-specific rules

- Pathfinder Framework v2 states that product-specific rules must meet the following quality safeguards:

a. PCRs shall be developed in accordance with the ISO 14000 series or other cross-sectoral guidance to be considered an eligible PCR.
b. PCRs shall be developed through a multistakeholder process and independently peer reviewed
c. PCRs shall be reviewed at least every five years.
d. PCRs shall be applicable to the geography where the product is being marketed or produced.

- The above are important requirements to be met by product-specific rules, but they are only external and do not go into methodology.
- Therefore, even product-specific rules that meet these requirements may not be consistent with the calculation methodology proposed by the Pathfinder Framework, which assumes cradle-to-gate data exchange in the supply chain.
- The SWG discussed whether product-specific rules should have methodological similarities to the Pathfinder Framework in addition to the quality safeguards described above.
- We plan to exchange views with PACT on this point.

Sector-specific rules and cross-sectoral standards in Japan

(2) Existing methods and standards in Japan

② Sector-specific rules in Japan

- Sector-specific rules must be applied to PCF calculation second in order of priority after product-specific rules.
- In Japan, there are sector-specific rules such as the Guidelines for Calculating the Carbon Footprint of Products in the Chemical Industry (March 2023). In the future, sectoral rules are expected to be developed based on the METI/Moe Carbon Footprint Guidelines.
- On the other hand, Pathfinder Framework v2 requires sector-specific rules to be developed based on ISO and the GHG Protocol, etc., but does not provide specific criteria for determining compliance.
- We will continue to confirm and consult with PACT on the criteria for determining which sector-specific rules should be given precedence over the Pathfinder Framework, as in the Together for Sustainability PCF guidelines already approved by PACT.

- There are consequently no sector-specific rules specific to Japan at present that should be given precedence over the Pathfinder Framework and the Product-based calculation covered in this section.

③ Cross-sectoral standards in Japan

- ISO 14067:2018 and the GHG Protocol Product Standard are prominent cross-sectoral standards for PCF calculation. In Japan, the former is often referred to.
- The METI/MoE Carbon Footprint Guidelines and Carbon Footprints Practical Guide were released in May 2023. The Carbon Footprint Guidelines are also a cross-sectoral standard in the sense that they provide a general methodology for PCF without specifying a particular industry.
- Companies that use these cross-sectoral standards to calculate CO2 data must comply with the Pathfinder Framework. In the case of methodological differences in calculation and sharing (data provision), the methodology of the Pathfinder Framework and Section 2-2 of this document must be applied.

Illustration: Relationship to existing methods and standards

- It is assumed that the Product-based calculation methodology in this section, as well as the Pathfinder Framework v2, will be used in conjunction with existing PCF calculation methods and standards.
- The hierarchy for applying existing calculation methods and standards is product-specific rules > sector-specific rules > cross-sectoral standards.
- Product-specific and sector-specific rules have precedence over the Pathfinder Framework and the Product-based calculation methodology in this section. However, in Japan, approval of product-specific rules and sector-specific rules requires consultation with national organizations and PACT, which remains pending.
- The METI/MoE Carbon Footprint Guidelines are a type of cross-sectoral standard.

	Product-specific rules	Sector-specific rules	Cross-sectoral standards
Hierarchy	1 →	2 →	3
Outline	Product category-specific carbon footprint calculation rule	Sector-specific carbon footprint calculation rule	Not limited to a specific product category or industry General Standard for Carbon Footprint Calculation
Rule (Example)	PEFCR (Product Environment Footprint Category Rules) PCR (Product Category Rules)	Together for Sustainability Product Carbon Footprint Guidelines for the Chemical Industry	ISO 14067:2018, GHG Protocol Product Standard
Handling of calculation rules developed in Japan	TBD (Discussions underway with SuMPO regarding the handling of the set of PCRs under of the SuMPO Environmental Label Program)	TBD (Plans to hold discussions with PACT on approval of carbon footprint calculation rules developed by domestic industry associations)	METI/MoE Carbon Footprint Guidelines and the Carbon Footprints Practical Guide positioned as cross-sectoral standards
Requirements for claiming compliance with Pathfinder Framework	Product-specific rules that meet Pathfinder Framework certification criteria can be used independently*	Sector-specific rules that align to the Pathfinder Framework recommended. Highlight any aspects not fully in alignment.	If there are differences, prioritize Pathfinder Framework requirements

* The Pathfinder Framework's safeguards for product-specific rules are as noted earlier in this section.

Figure 2-2-3 Relationship between Product-based calculation in this section and existing methodologies in the Pathfinder Framework (Figure 1-4-22)

Source: Created by Mizuho Research & Technologies based on Pathfinder Framework v2

Processes to be calculated: Attributable processes

2-2-3: Scope and boundary

Pathfinder Framework requirements

- Companies shall account for all GHGs identified within the GHG Protocol
- Their respective 100-year global warming potential (including carbon feedbacks) shall be derived from the latest IPCC Assessment Report publication
- Companies shall report cradle-to-gate PCF, comprising all upstream stages of the product life cycle up to the reporting company's gate (including upstream transportation), excluding downstream emissions from product use and end-of-life
- PCFs shall be exchanged upstream to downstream, providing kg of CO2e per unit of analysis

(1) Attributable LCA approach and attributable processes

- The Pathfinder Framework v2 uses the attributional LCA approach as the premise for the above requirements.
- The attributional LCA approach is a method that attempts to identify the environmental impacts that occur in relation to the product life cycle. Specifically, the approach is to identify the processes attributable to the product and evaluate the environmental impact of each process.
- Pathfinder Framework v2 defines attributable processes as any processes associated with services, materials, or energy flows that become, make, or carry a product throughout its life cycle (Appendix-1). Figure 2-2-4 illustrates this approach.
- The Green x Digital Consortium's Product-based calculation adopts the same approach.
- See 2-2-4 for a practical approach to identifying attributable processes.

Attributable LCA approach

Identify attributable processes for target products and assess the environmental impact of each process

Attributable process

Services, raw materials and energy flows related to:

Becoming a product	E.g. raw material manufacturing and transportation processes
Making a product	E.g. product manufacturing process energy inputs
Carrying a product	E.g. product transportation energy inputs

Figure 2-2-4 Attributable LCA approach and attributable processes

Source: Created by Mizuho Research & Technologies based on Pathfinder Framework v2

Target greenhouse gases and global warming potential

(2) GHG and global warming potential

① Greenhouse gases

- The first element in the Pathfinder Framework requirements identifies the GHGs to be included in the PCF calculation.
- Pathfinder Framework v2 calculates the GHGs as identified within the GHG Protocol titled “Required Greenhouse Gases in Inventories.”
- As of March 2024, the target GHGs are as follows:
  - CO2 (carbon dioxide)
  - CH4 (methane)
  - N2O (nitrous oxide)
  - HFCs (hydrofluorocarbons)
  - PFCs (perfluorocarbons)
  - SF6 (sulfur hexafluoride)
  - NF3 (nitrogen trifluoride)
- The Green x Digital Consortium’s Product-based calculation also adopts this approach.

② Global Warming Potential (GWP)

- The second element of the requirements identifies the Global Warming Potential (GWP) to be applied.
- GWP is a coefficient that indicates how many times greater the greenhouse effect of an GHG is than that of carbon dioxide.
- Pathfinder Framework v2 requires that this is expressed in terms of the 100-year GWP and is derived from the latest version of the IPCC Assessment Report publication.
- The Green x Digital Consortium’s Product-based calculation also adopts this approach.
- However, where the usable secondary data emission factor introduced in the following section meets the safeguards set out in Pathfinder Framework v2, it is not necessary to confirm the application of the GWP from the latest IPCC report.
- On the other hand, if GHG emissions other than CO2 can be ascertained, application of the GWP from the latest IPCC report shall be mandatory.

Cradle-to-gate boundary

(3) Boundary

- The third element in the requirements specifies the boundary of the PCF calculation.
- Pathfinder Framework v2 defines the PCF calculation boundary as a “cradle-to-gate PCF, comprising all upstream stages of the product life cycle up to the reporting company’s gate (including upstream transportation), excluding downstream emissions from product use and end-of-life."
- The reporting company's gate refers to the gate of the company shipping the product, not the company receiving it.
- It is important to note that, unlike the conventional method of PCF calculation, it does not include product use or end-of-life after shipment. The requirements are based on the idea that the downstream companies that receive the products and CO2 data will calculate the emissions after shipment.
- Emissions after shipment that are outside the boundary include emissions from shipment logistics from the shipping gate to the customer. This is accounted for by the downstream companies that receive the products as emissions from procurement logistics.
- However, in practice, there are many cases where companies on the shipping side calculate the emissions from shipping logistics (downstream procurement logistics). In this case, the shipping company calculates and provides the emissions from procurement logistics for the downstream company but provides separate data from the cradle-to-gate PCF.
- The same can be said for the emissions from the procurement logistics of reporting companies. This point is summarized again in 2-2-5 (2).

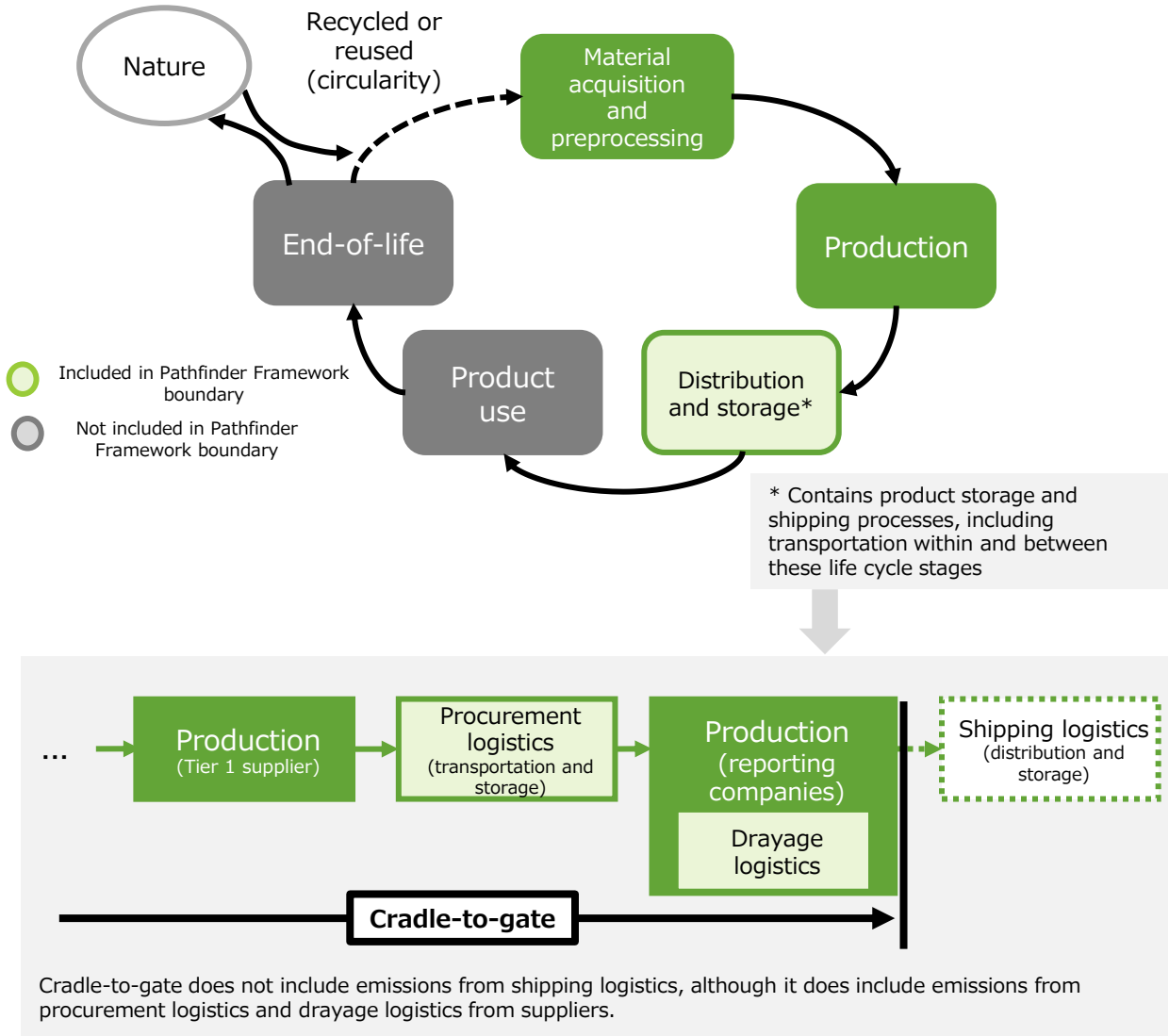


Figure 2-2-5 PCF calculation scope and bounday in the Pathfinder Framework

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

Unit of analysis: “Declared unit”

(4) Unit of analysis

① Adoption of a “declared unit” approach

- The fourth element in the requirements specifies the PCF unit of calculation.
- Pathfinder Framework v2 requires that the final PCF inventory results be disclosed as kg-CO2e per unit of analysis.
- In life cycle assessment (LCA), which is the basis of PCF methodology, it is common to define calculation and display units in terms of functional units. A functional unit is a quantified reference unit that represents the performance of a product system and is an effective unit quantity for comparative evaluation of different product systems performing the same function.
- However, in terms of the Pathfinder Framework goal of exchanging CO2 data from upstream to downstream in the supply chain, many PCF calculations are for intermediate products. Comparative evaluation of different product systems performing the same function is rarely carried out at the intermediate product stage. In practice, priority should be given to obtaining emission data for the procured product itself, and it is important to obtain emission data for the procured product per unit volume.
- Pathfinder Framework v2 identifies “declared unit” as the unit of procurement per unit of volume for the product. The Product-based calculation methodology in this section also adopts this approach.

② Types of declared unit

- Pathfinder Framework v2 adopts the following as declared units:

  L, kg, m3, kWh, MJ, tkm, m2

- The Green x Digital Consortium’s Product-based calculation also adopts this approach.

③ Conversion to "per unit" using product quantity

- As of version 2.0, published in January 2023, the Pathfinder Framework does not include “piece” as a declared unit.*

> * Although it is expected that “piece" will be added as a declared unit in future versions of the Pathfinder Framework this document also excludes piece as a declared unit. This document will be updated in response to Pathfinder Framework updates on this issue.

- For many products, it is easier to visualize PCF content using the unit “piece” rather than “per kg”, as is the case for types of part, and how to display the PCF for products that are usually counted in pieces instead in declared units is an important issue.
- Pathfinder Framework v2 addresses this challenge by introducing the metric of product quantity.
- The product quantity is the quantity of the declared unit contained in the product to which the PCF refers. For example, in the case of parts with a mass of 5kg per piece, the declared unit is given as “kg” and the product quantity is given as “5”.

Conversion to "per unit" using product quantity

③ Conversion to "per unit" using product quantity (continued)

- Using this concept of product quantity, a PCF expressed in terms of "per kg" can be converted to "per unit." Examples are given below.

- Taking the example from the previous page, if we take parts with a mass of 5kg per piece, the declared unit of the part is "kg" and the product quantity is “5”.
- Suppose that the PCF of this part is "20 kg-CO2e per unit.“*

*In practice, when PCFs are calculated, it is common for products (parts, etc.) that are counted by unit to have their emissions calculated on a per-unit basis.

- At this time, the PCF per declared unit is “4 kg-CO2e/kg”. This is because "PCF per piece 20 kg-CO2 e" is divided by "mass per piece 5 kg" (20÷5=4).
- As a result, the data provided to downstream operators is:
  - Declared unit kg
  - PCF per declared unit 4(kg-CO2/kg)
  - Product quantity 5 (kg/piece)
- If the downstream operator is counting the parts in question by "units" and also wants to convert the PCF to "per unit," the PCF per unit can be obtained by multiplying "PCF per declared unit" by "product quantity" (below).

4 (kg-CO2e/kg) x 5 (kg/unit) =20 (kg-CO2e/unit)

Handling of PCF data for parts with a mass of 5 kg per unit and a PCF of 20kg-CO2e

Per unit PCF calculation	**20** kg-CO2e / Pieces (= **5 kg**) **PCF value per unit** **Product quantity** **Declared unit**
Conversion to PCF per declared unit	**20** kg-CO2e**/5 kg** **= 4** kg-CO2e/**kg** **PCF value per kg declared**
Data exchange using declared units	■ Declared unit kg ■ PCF per declared unit 4(kg-CO2/kg) ■ Product quantity 5 (kg/unit)
Conversion to PCF per unit (as necessary)	**4** kg-CO2e/**kg** **kg/** **=20 kg-CO2e /**

Figure 2-2-6 Examples of use of declared unit and product quantity in data exchange

Source: Created by Mizuho Research & Technologies

PCF calculation steps

2-2-4. PCF calculation steps

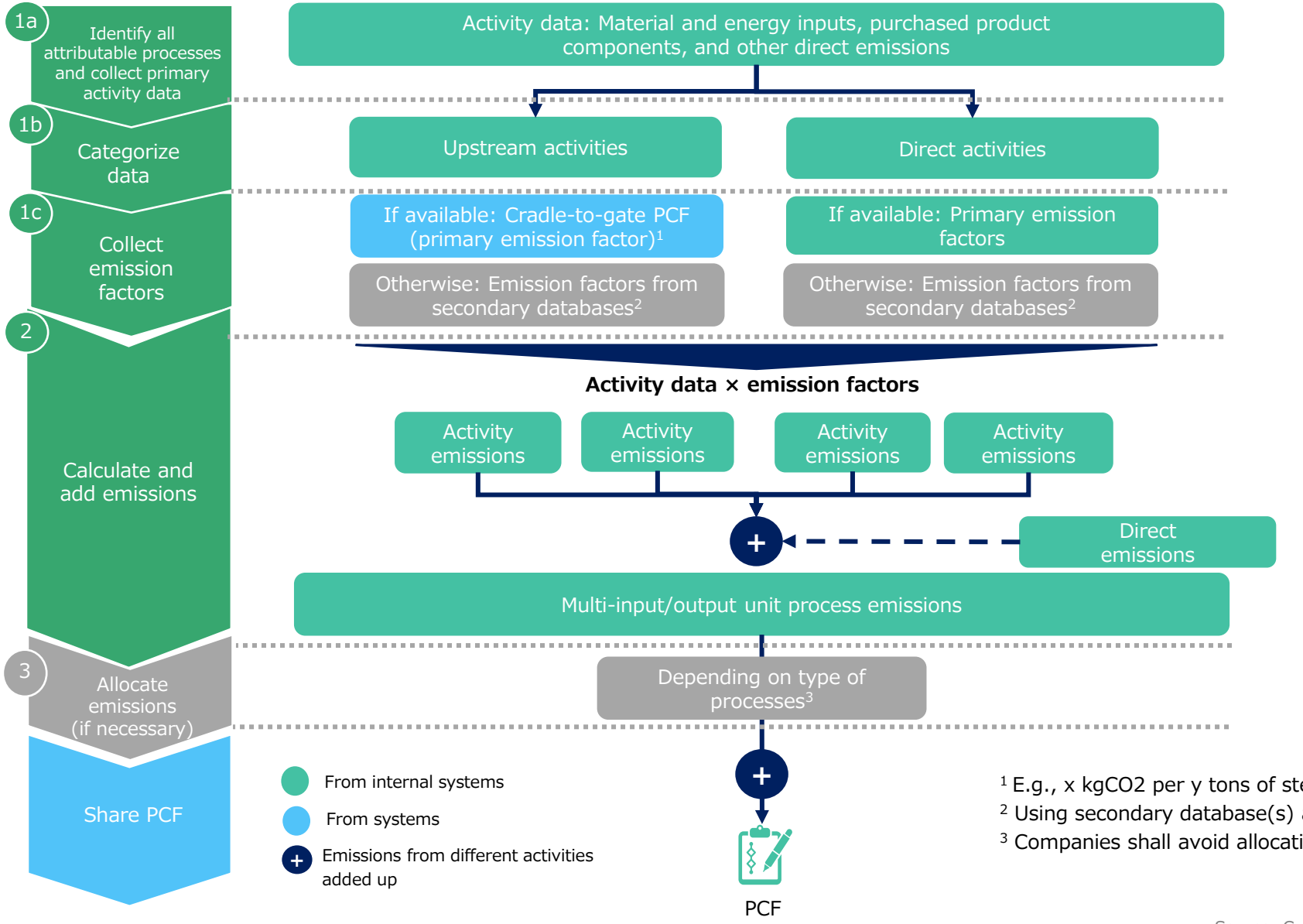
Pathfinder Framework requirements

- All attributable processes shall be identified
- Companies shall collect relevant activity data and emission factors based on identified attributable processes
- Manufacturing of production equipment, buildings and other capital goods, business travel by personnel, travel to and from work by personnel, and research and development activities should not be included within the boundaries of the PCF, unless materially significant
- Companies shall be able to exclude individual attributable processes representing less than 1% of the total cradle-to-gate PCF
- In aggregate, exclusions shall represent less than 5% of the total cradle-to-gate PCF emissions
- If necessary: allocation of emissions to outputs should follow the Pathfinder Framework allocation hierarchy

- The following steps are used in the calculation of a PCF in the Pathfinder Framework (see Figure 2-2-7):
  - Step 1: Data identification
    - 1a Identify all attributable processes and collect primary activity data
    - 1b Categorize data
    - 1c Collect emission factors
  - Step2: Calculation
  - Step: 3 Allocation

- The Green x Digital Consortium's Product-based calculation also adopts the same approach.
- The first five requirements in the Pathfinder Framework relate to the data identification in Step 1. The sixth requirement relates to the allocation noted in Step 3.
- The Green x Digital Consortium's Product-based calculation also adopts these requirements.
- Hereafter, this section describes the PCF calculation methodology in Pathfinder Framework v2 from Steps 1 to 3 and provides additional guidance for the Green x Digital Consortium's Product-based calculation.

Overview of steps for PCF calculation



[1] E.g., x kgCO2 per y tons of steel.
[2] Using secondary database(s) according to agreed guidelines
[3] Companies shall avoid allocation whenever possible

Figure 2-2-7 Steps for PCF calculation in Pathfinder Framework v2

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

Identifying attributable processes (Step 1a)

(1) Step 1: Data identification

① Step 1a: Identify all attributable processes and collect primary activity data

- The first step in PCF calculation (Step 1a) is to identify all attributable processes and collect primary activity data.
- As noted above in 2-2-3 (1), attributable processes are any processes associated with services, materials, or energy flows that become, make, or carry a product throughout its life cycle.
- The following description is based on the description in Pathfinder Framework v2.

■ Attributable processes at the “becoming a product’ stage

- The attributable process at the “becoming a product’ stage—which is the main process—is the upstream manufacturing of raw material and part inputs.
- The upstream manufacturing process for raw materials and parts is actually a combined manufacturing and transportation process by multiple suppliers (i.e. a supply chain). However, at this stage, the company performing the PCF calculation needs to know the elements and quantities of raw materials and parts procured. It does not have to study the structure of upstream combined processes and break them down into discrete processes.

■ Attributable processes at the “making a product” stage

- The main processes at this stage are:
  - Production of the fuel that goes into the manufacturing process
  - Supply of power and steam, etc., to the manufacturing process
  - Direct GHG emissions from the manufacturing process (other than fuel combustion; CO2 and methane produced and emitted from chemical reactions, refrigerant leakage, etc.)
  - Treatment of waste generated from the manufacturing process
- Pathfinder Framework v2 does not explicitly address the handling of manufacturing processes for inputs that are not part of the product (submaterials and consumables). For the purposes of this document, these are considered to be attributable processes at the "making a product" stage. However, in many cases, it is possible to exclude them using the exemption rule described in 2-2-4 (3) below.

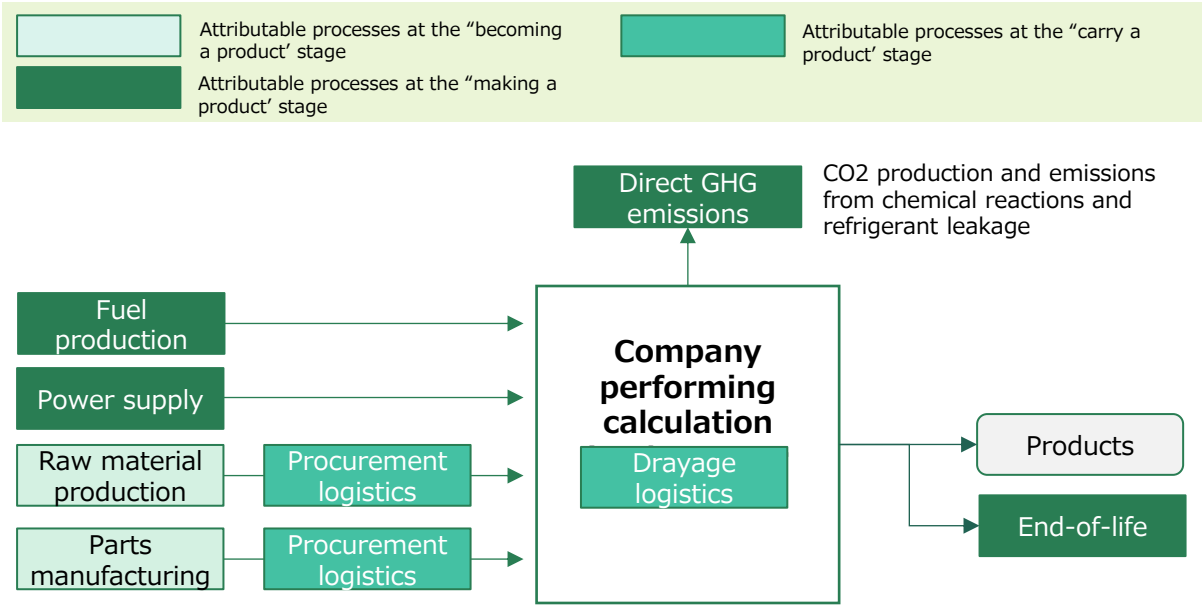


Figure 2-2-8 Example of processes attributable to manufacturing

Source: Created by Mizuho Research & Technologies

Excluding non-attributable processes (Step 1a)

■ Attributable processes at the “carry a product” stage

- The main attributable processes at the “carry a product” stage are procurement logistics and drayage logistics.
- Shipping logistics are not subject to cradle-to-gate PCF calculation because emissions occur after the shipment gate.
- In addition, the logistics for a direct supplier (Tier) to procure raw materials, etc. from an upstream supplier (Tier 2) conceptually belong to the “carry a product" stage. However, since this will be included in the PCF data provided by the supplier, it is not considered necessary to grasp it in practice.

■ Specifying non-attributable processes

- Although we have identified representative attributable processes, Pathfinder Framework v2 also specifies the following as processes to be excluded from calculation (non-attributable processes, so to speak):
  - Manufacturing of production equipment, buildings and other capital goods
  - Business travel by personnel
  - Travel to and from work by personnel
  - Research and development activities
- Pathfinder Framework v2 says these processes should be excluded from the calculation unless they are "materially significant" to the target product. Therefore, when excluding non-attributable processes from the calculation, it is not necessary to justify the exclusion.
- Of course, these processes should be included in the PCF calculation if they are “materially significant.” No quantitative criteria for material significance are provided in the Framework, and it is reasonable to assume that the criteria are left to the PCF assessor. (In discussions with PACT side, it was suggested that, similar to the exemption rule described in 2-2 -4 (3) below, a process may be considered materially significant if the overall PCF is affected by 5%, but this is not prescriptive.)

Collecting primary data (Step 1a)

■ Primary data collection

- After identifying all the attributable processes cradle-to-gate, the primary data for each process is collected.
- This primary data c is activity data. (Collection of primary data for emission factors from suppliers will be handled in Step 1b below.)
- Figure 2-2-9 shows examples of the collection of activity data in Pathfinder Framework v2.
- The activity data amounts shown here are larger than usual “per product” figures and should be regarded as more representative of activity data collection by an organization, which is the original data before conversion to activity data per product.
- In practice, the next step is conversion to "per product" (product quantity × per declared unit) or "per declared unit".

	Examples of activity data collected
Material inputs	10 tons of steel, 300 kg of aluminum
Energy inputs (purchased electricity, etc.)	100 kWh
Purchased materials or feedstocks	Chemical component, unit, amount
Inbound transport and storage-related inputs	10 km transport of 10 kg of chemical components from supplier to manufacturing site in a diesel-fueled truck
Production waste and treatment	10 kg of cardboard waste sent to landfill
Other	CO2 formed during the production process

Figure 2-2-9 Examples of primary data (activity data) collected

Source: Created by Mizuho Research & Technologies based on Pathfinder Framework v2

Categorizing data (Step 1b)

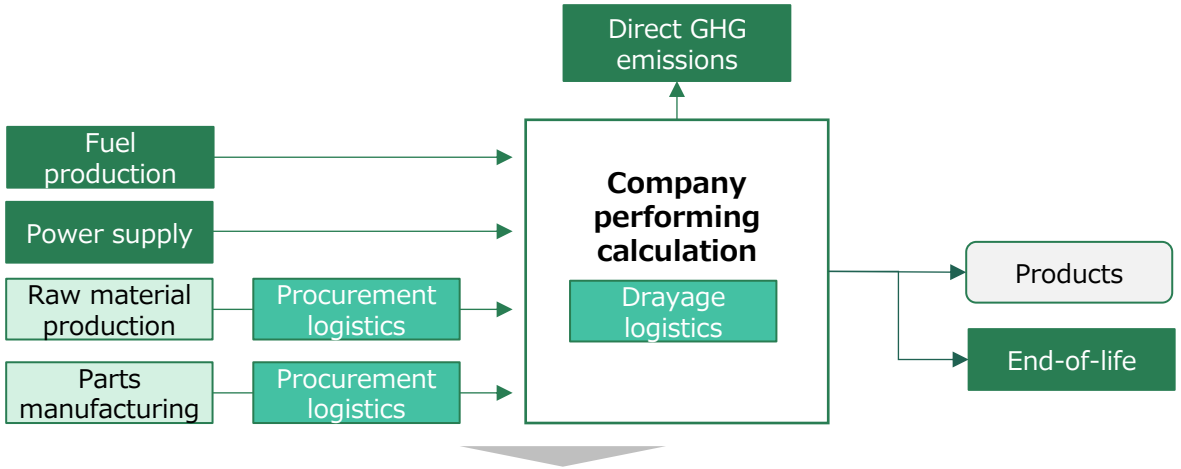
② Step 1b: Data categorization

- After identifying all the attributable processes and collecting activity data for each process, in Step 1b, Pathfinder Framework v2 categorizes the collected activity data as follows:
  - Data used to calculate emissions from upstream activities
  - Data used to calculate direct activity emissions
- Based on discussions with PACT, this document categorizes upstream activities and direct activities as shown in Figure 2-2-10.

- It should be noted that only the activity data collected on fuel production and power supply are used to calculate emissions for both upstream activities and direct activities.
  - Fuel production activities = fuel purchases are used to calculate emissions from both direct fuel combustion and upstream fuel production.
  - Power supply activities = power purchases are used to calculate emissions during power generation, which are considered to be emissions from direct activities, and to calculate emissions from upstream production of fuel for power generation.

Figure 2-2-10 Categorization of activity data

■ Categorizes activity data as it relates to the company performing the PCF calculation as shown in Figure 2-2-8



Process	Activity data	Use in calculating emissions	
		Upstream activities	Direct activities
Fuel production	Fuel input	✓ (Fuel production)	✓ (Fuel combustion)
Power supply	Power input	✓ (Upstream emissions from power generation)	✓ (Emissions from power generation)
Raw materials and parts manufacturing	Input of raw materials and parts	✓	
Procurement logistics	Ton-km, etc.	✓	
Drayage logistics	Fuel consumption, etc.		✓
Direct GHG emissions	Amount of emissions		✓
End-of-life	Outsourced amount		✓

Source: Created by Mizuho Research & Technologies in consultation with PACT

Collecting emission factors (Step 1c)

③ Step 1c: Collecting emission factors

Next, the emission factors for each type of activity data are collected.

- Collect supplier-specific primary data emission factors where possible. The primary data emission factor here must be the cradle-to-gate PCF data generated on the supplier side from the top of the supply chain to the shipping gate. Even if gate-to-gate emissions data is provided, it cannot be used for PCF calculations.
- If primary data cannot be obtained, secondary data on emission factors is collected. This shall be collected from a secondary database conforming to the safeguards described later.
- For direct GHG emissions from manufacturing processes, use the 100 year GWP value from the most recent IPCC report as the characterization factor.
- This framework has developed rules for calculating PCF using Organization-based calculation (see 2-3). If the cradle-to-gate data provided by the upstream supplier is based on Organization-based calculation, it will be treated as non-primary data.
- The concepts of primary data, secondary data, and alternative data for emission factors will be discussed in 2-2-6.

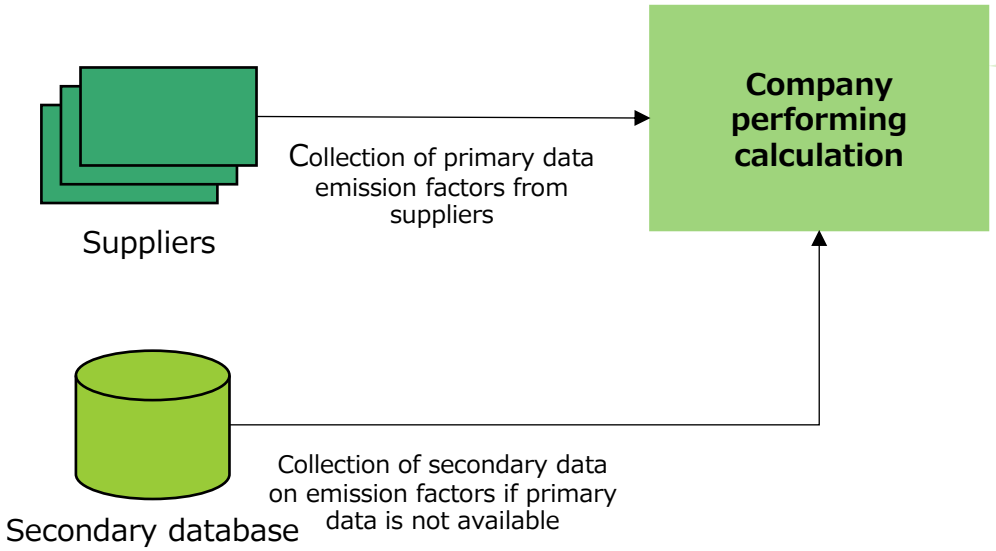


Figure 2-2-11 Collection and classification of emission factors

Collect emission factors for each type of activity data

Process	Activity data (Example)	Emission factors collected (Example)	
		Upstream activities	Direct activities
Fuel production	Fuel input	Fuel production emission factor	Fuel combustion emission factor
Power supply	Power input	Power generation upstream emission factor	Power generation emission factor
Raw materials and parts manufacturing	Input of raw materials and parts	Raw materials and parts manufacturing emission factor	
Procurement logistics	Ton-km, etc.	Emission factor per tonne	
Drayage logistics	Fuel consumption, etc.		Fuel combustion emission factor
Direct GHG emissions	Amount of emissions		GWP
End-of-life	Outsourced amount		Waste treatment emission factor

Source: Mizuho Research & Technologies and Aenergy Creation

Calculation of emissions (Step 2)

(2) Step 2: Calculation

- After data identification (Step 1), the next step is the calculation of emissions using the collected data. GHG emissions resulting from each process are derived by multiplying the amount of activity by the emission factor. Emissions are calculated for upstream and direct activities, respectively. An image of the calculation is shown in Figures 2-2-12 and 2-2-13.
- If there are direct GHG emissions from a process, these are converted to CO2 data by multiplying the emissions by a characterization factor and adding them to the emissions associated with the particular activity.
- Direct GHG emissions include leaked refrigerants, CO2 and methane produced from chemical reactions of processes, etc. However, GHG emissions do not necessarily have to be measured.
- Pathfinder Framework v2 allows estimation of direct GHG emissions based on stoichiometry. For CO2 and methane produced from chemical reactions, GHG emissions may be estimated from the amount of material input and stoichiometry.
  - Example:CO2 generation from cement production (CaCO3→CaO+CO2) is estimated from limestone input based on the relationship between 1 mol of CO2 generated from 1 mol of limestone.

Upstream activities

	Activity data		Emission factor		Amount of emissions
Fuel	Fuel consumption	×	Cradle-to-gate emission factor (upstream activities for fuel production)	=	Emissions from upstream fuel activities
Power	Power consumption	×	Cradle-to-gate emission factor (upstream activities for fuel for power generation)	=	Emissions from upstream power activities
Raw material	Raw material consumption	×	Cradle-to-gate emission factor (raw material production)	=	Emissions from raw matetrial manufacturing
Transport	Transport volume	×	Transport process emission factor for transport process from supplier to company	=	Emissions from suppliers to the company

Direct activities

	Activity data		Emission factor		Amount of emissions
Fuel	Fuel consumption	×	Fuel combustion emission factor	=	Fuel combustion emissions
Power	Power consumption	×	Emission factor at time of power generation	=	Emissions from electricity
Waste	Amount of waste produced	×	Waste disposal emission factor	=	Emissions from waste disposal
	Activity data		**Characterization factor**		**Amount of emissions**
Direct GHGs	Amount of direct production GHG emissions	×	GWP	=	CO2 equivalent of direct GHG emissions

Source: Mizuho Research & Technologies and Aenergy Creation

Figure 2-2-12 PCF calculation method

Illustration: Example of PCF calculation

Emission factor is supplier-specific primary or secondary data

Direct activities

Amount of activity					Emission factor		Source of emission factor		Amount of emissions	
Fuel	Heavy oil A	1	L	×	2.75	kg-CO2e/L	Act on Promotion of Global Warming Countermeasures	=	2.75	kg-CO2e
	Hydrogen (Company A)	0.1	Nm3	×	0	kg-CO2e/Nm3	Emission factor provided by Company A	=	0	kg-CO2e
Purchased energy	Power (Company B)	15	kWh	×	0.443	kg-CO2e/kWh	Emission factors by power company Company B-adjusted emission factor (residue)	=	6.65	kg-CO2e
Waste	Sludge	2	Kg	×	0.216	kg-CO2e/kg	Domestic emission factor database	=	0.432	kg-CO2e
Direct emission	Methane	0.02	kg-CH4	×	29.8	kg-CO2e/kg-CH4	IPCC AR6	=	0.596	kg-CO2e
							Total		**10.4**	**kg-CO2e**

Upstream activities

Amount of activity					Emission factor		Source of emission factor		Amount of emissions	
Raw material・Components	Aluminum	5	kg	×	10	kg-CO2e/kg	Secondary data database	=	50	kg-CO2e
	Recycled resin (Company C)	3	kg	×	1.5	kg-CO2e/kg	PCF provided by Company C	=	4.5	kg-CO2e
	Plain steel	2	kg	×	2	kg-CO2e/kg	Secondary data database	=	4	kg-CO2e
	Motor (Company D)	1	kg	×	3	kg-CO2e/kg	PCF provided by Company D	=	3	kg-CO2e
Fuel	Heavy oil A	1	L	×	0.4	kg-CO2e/L	Secondary data database	=	0.4	kg-CO2e
	Hydrogen (Company A)	0.1	Nm3	×	0.2	kg-CO2e/Nm3	Upstream emission factor provided by Company A	=	0.02	kg-CO2e
Purchased energy	Power (Company B)	15	kWh	×	0.03	kg-CO2e/kWh	Primary upstream emission factor provided by Company B	=	0.45	kg-CO2e
Transport	Truck transport (Company E)	2	tkm	×	0.5	kg-CO2e/tkm	Domestic emission factor database	=	1	kg-CO2e
							Total		**63.4**	**kg-CO2e**

Figure 2-2-13 Example of PCF calculation

*Total rounded to one decimal place

Source: Mizuho Research & Technologies and Aenergy Creation

Applying exemption rules (Cut-off rules)

(3) Exemption rules (cutoff rules)

- Before proceeding to Step 3: Allocation, we will explain the exemption rules indicated as the fourth and fifth requirements.
- In Japan, exemption rules are often called “cut-off rules” based on ISO 14067:2018, etc. Since the names are different but the idea is the same, this document will refer primarily to cut-off rules.
- Companies should seek to incorporate all attributable cradle-to-gate processes into their PCF. However, there are instances where the lack of data availability or the effort and resources required to calculate certain attributable processes can far outweigh their overall GHG contribution to the PCF.
- Pathfinder Framework v2 states that in such cases, companies can exclude the processes if they disclose and justify these, based on their degree of significance to the final PCF..
- The specific provisions are as follows:

> - **Companies shall only be able to exclude individual attributable processes representing less than 1 percent of the total cradle-to-gate PCF.**
> - **In aggregate, the sum of excluded processes shall be less than 5 percent of the total estimated cradle-to-gate PCF emissions**

- In practice, companies can conduct an initial screening of the product to identify all attributable processes and their contribution to the total PCF. If no activity or emission factor data is available, they can make conservative estimates.
- Then, the exemption shall be made subject to confirmation that: (1) emissions from individual attributable processes to be excluded represent less than 1 percent of the total cradle-to-gate PCF; and
- (2) total emissions from all the attributable processes to be excluded represent less than 5 percent of the total cradle-to-gate PCF.

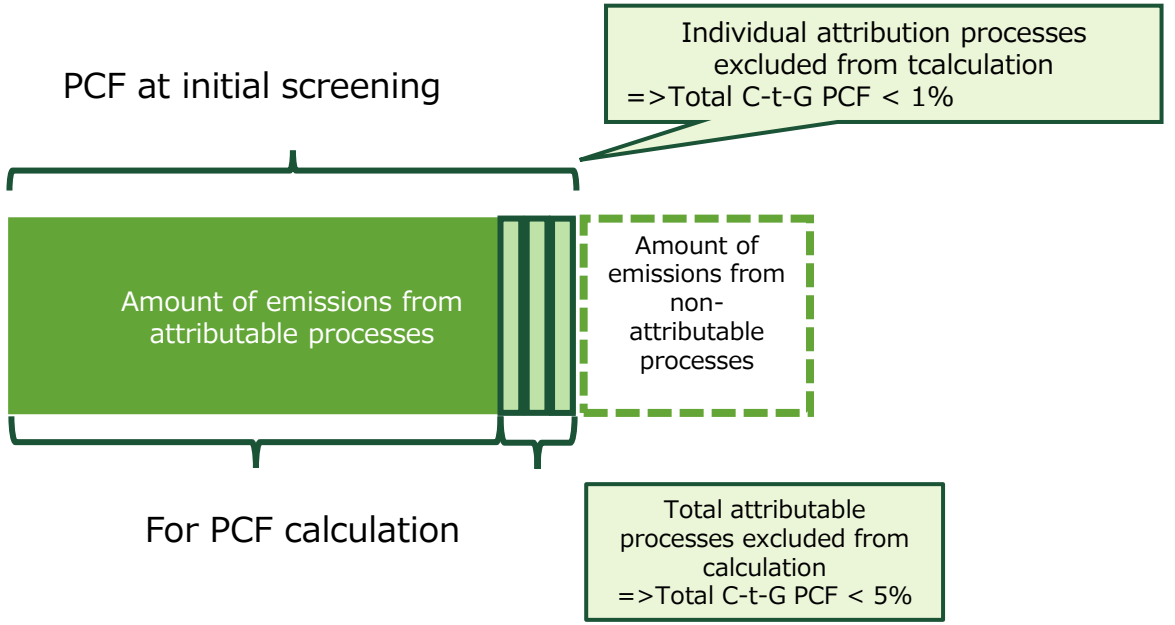


Figure 2-2-14 Relationship between attributable processes and exclusion ratios

Source: Created by Mizuho Research & Technologies

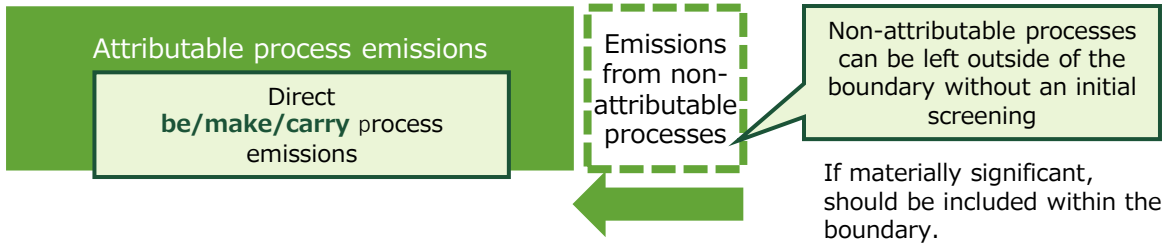
Candidates for application of cut-off rules

(3) Exemption rules (Cut-off rules) (continued)

- As mentioned above, Pathfinder Framework v2 identifies only (1) manufacturing of production equipment, buildings and other capital goods, (2) business travel/travel to and from work by personnel, and (3) R&D activities as non-attributable processes, so an initial screening of other indirect activities needs to be conducted to consider whether to exclude them in light of the cut-off rules (Figure 2-2-16).
- In the initial screening, only the approximate scale of emissions from the pertinent activities needs to be ascertained, so an estimation method may be used. Ensure that this is not an underestimate.
- Processes that are often excluded through application of the cutoff rules in PCF calculations include:
  - Sales and marketing department activities
  - Administration department activities
  - Air conditioning and lighting at production sites
  - Storage of raw materials and products
  - Wastewater treatment
  - Treatment of air pollutants
  - Production of secondary materials
  - Manufacture and transport of containers and packaging and transport materials used in the procurement of raw materials
  - Packaging materials for product shipment

A) Leave non-attributable processes outside of the boundary

(Only manufacturing equipment, buildings, and other capital goods; employee travel/commuting; and R & D activities)



B) Apply cut-off rules to attributable processes

Conduct Review B) for indirect activities other than A)

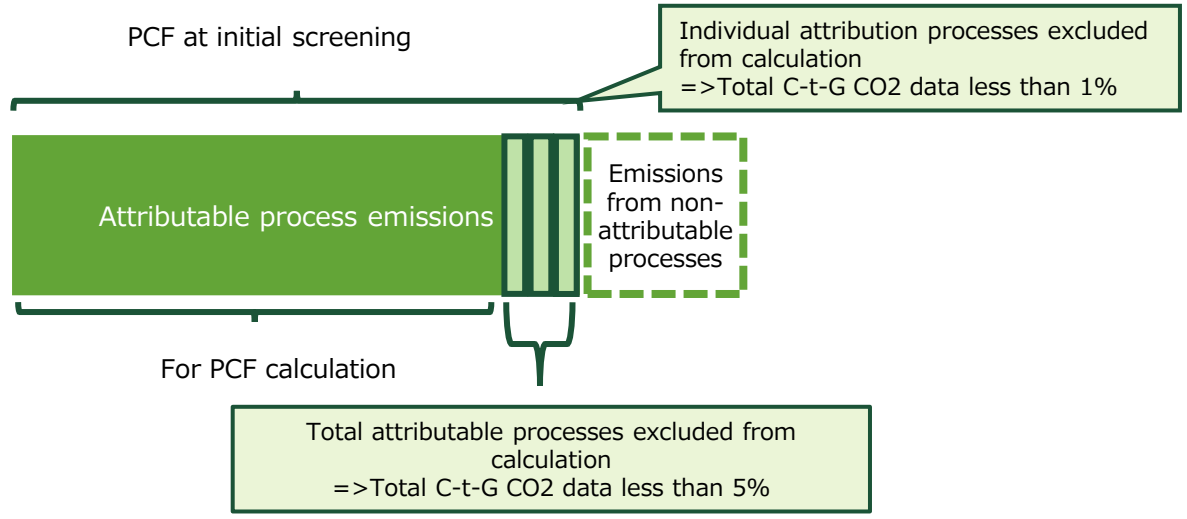


Figure 2-2-15 Non-attributable processes and processes excluded by cut-off rules

Source: Created by Mizuho Research & Technologies

Illustration: Steps 1-2 in PCF calculation

■ The PCF calculation steps are illustrated based on the explanations in Steps 1a, 1b, 1c, and 2.

1a) Identify all attributable processes and collect primary activity data

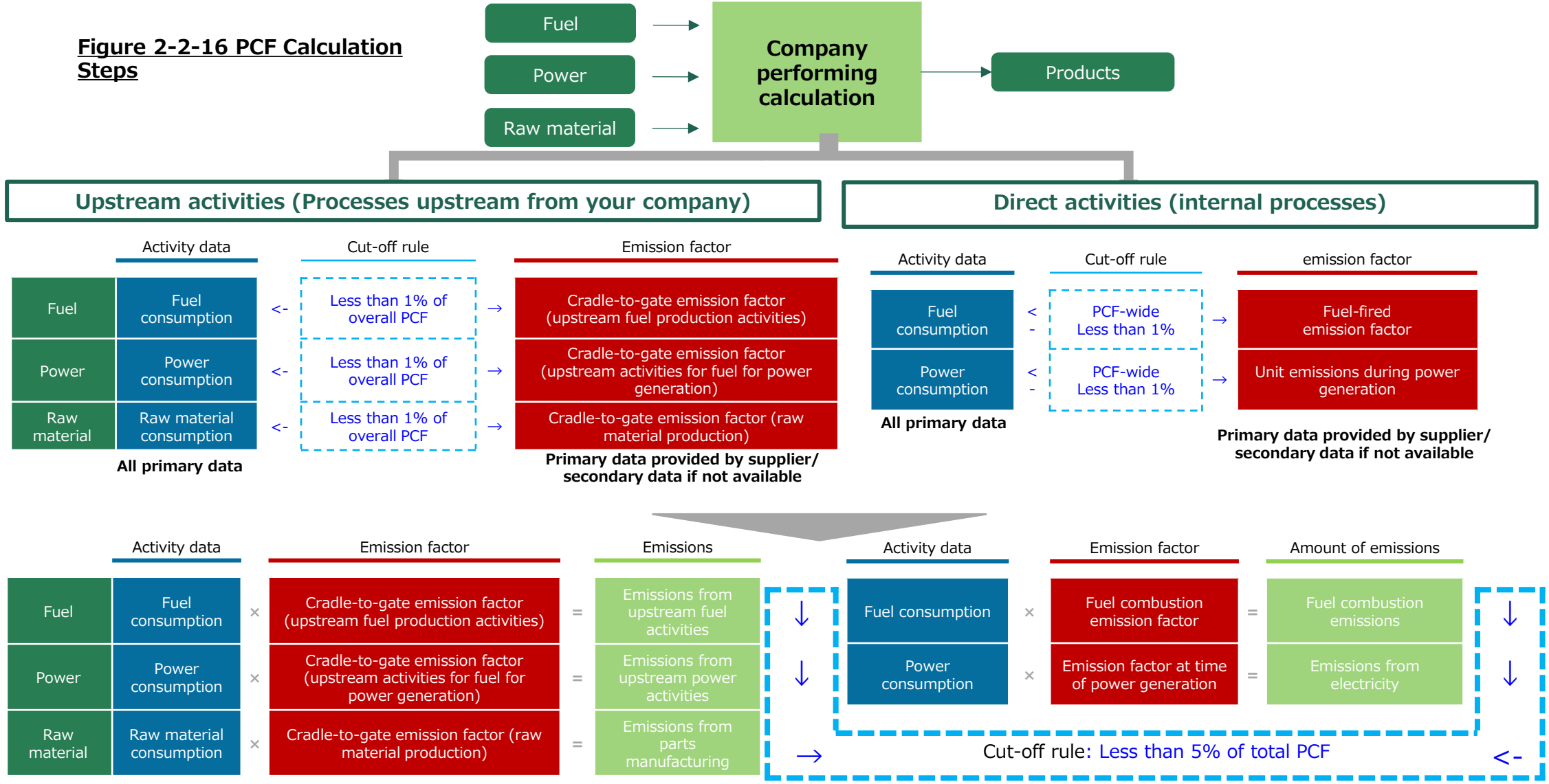
1b) Categorize the collected activities into upstream and direct activities

1c) Collect emission factors

2) Calculate emissions

Although omitted in this figure, direct GHG emissions from processes other than transport and waste emissions and "activity data × emission factor" must be calculated and totaled.

Figure 2-2-16 PCF Calculation Steps



Source: Created by Mizuho Research & Technologies and Brother Industries

Allocation (Step 3)

(4) Step 3: Allocation

- Allocation means splitting multi-input/output processes into single output unit processes by using physical, economic, or other criteria to partition the emissions between the product system being studied (also known as the studied product) and one or more other product systems (also known as co-products).
- For example, suppose that a production site manufactures Product 1 on Production Line 1 and Product 2 on Production Line 2, but does not know GHG emissions on a line-by-line basis, only on a site-wide basis. To calculate emissions from the production of Product 1, the total emissions of the production site are divided by some index (ratio of total number of products, production value ratio, production weight ratio, etc.) to make the appropriate allocation.

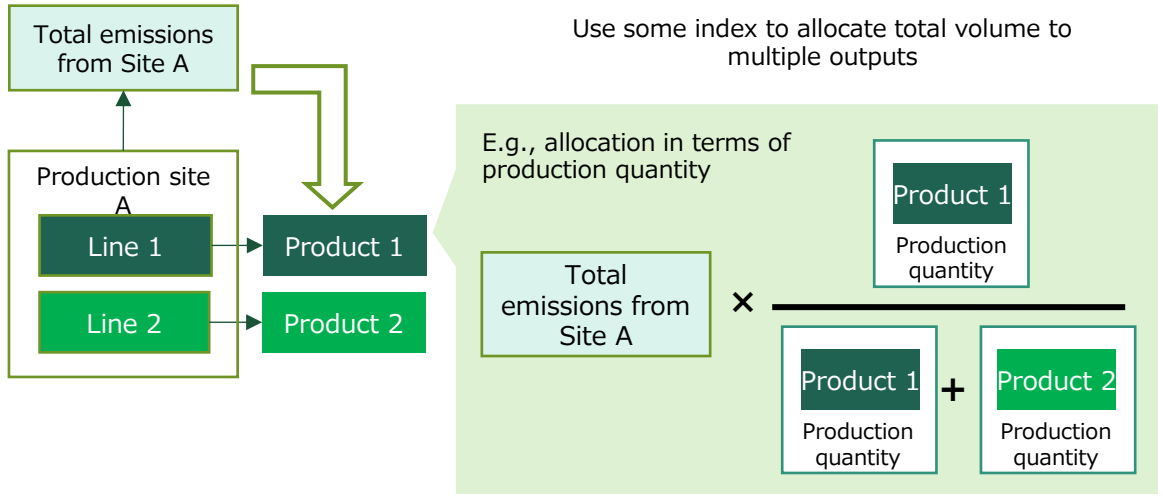


Figure 2-2-17 Image of allocation calculation

Source: Created by Mizuho Research & Technologies

- Pathfinder Framework v2 states that "allocation shall be avoided whenever possible" but may be used where unavoidable.
- The sixth requirement states: "If necessary: allocation of missions to outputs should follow the Pathfinder Framework allocation hierarchy."
- The Pathfinder Framework allocation hierarchy is shown in Figures 2-2-18 and 2-2-19.

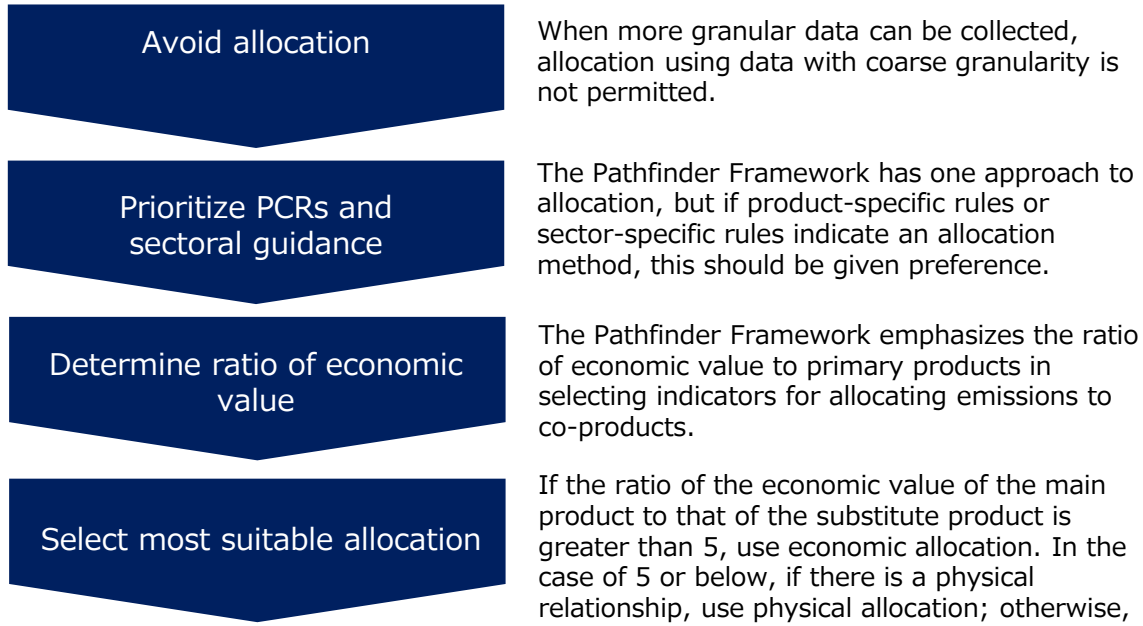


Figure 2-2-18 Pathfinder Framework allocation hierarchy

Source: Created by Mizuho Research & Technologies based on Pathfinder Framework v2

Illustration: Pathfinder Framework allocation hierarchy (Decision-making tree)

- The concept explained on the previous page is presented here in the form of a decision tree.
- ISO 14067:2018, etc., prioritize physical allocation over economic allocation, but the Pathfinder Framework may prioritize economic allocation if there is a large difference in economic value between outputs.

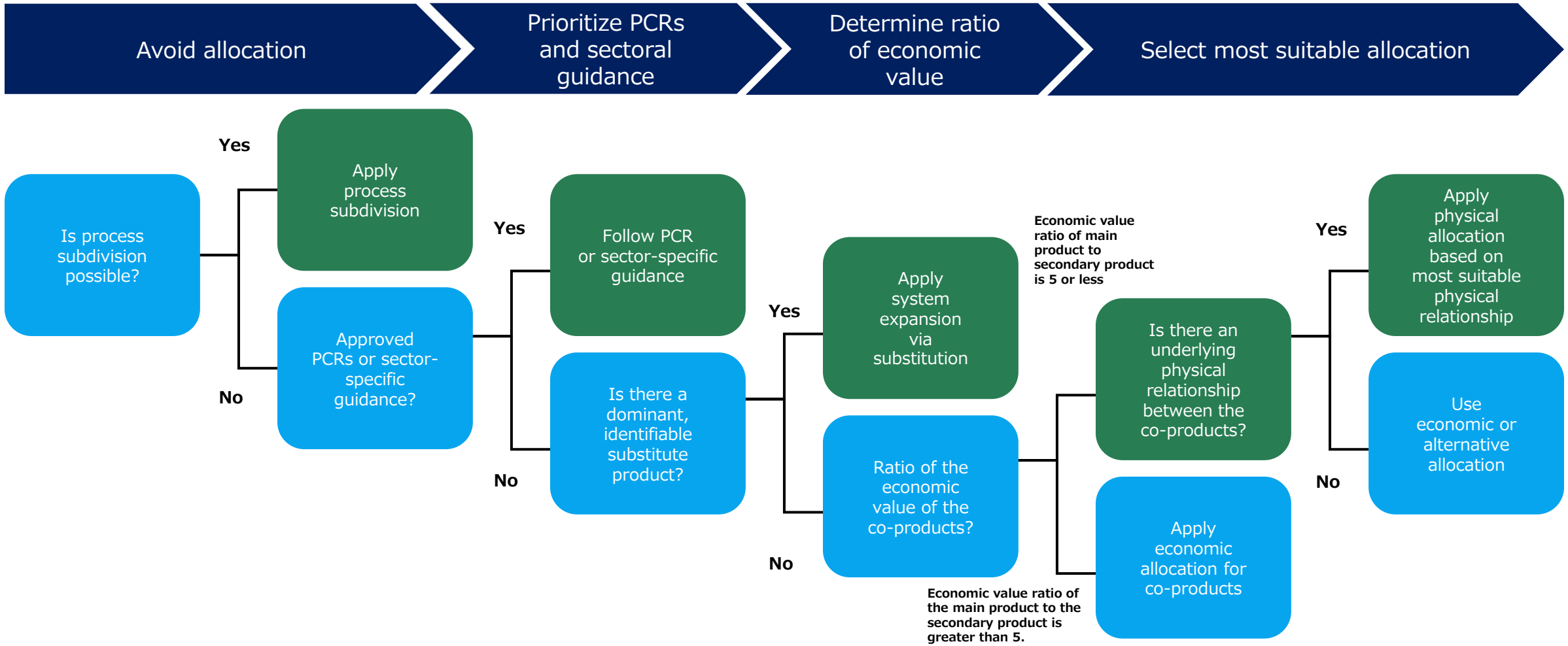


Figure 2-2-19 Pathfinder Framework decision-making tree to consistently implement ISO and GHG Protocol allocation rules

Source: Developed by Mizuho Research & Technologies and Sustech based on Pathfinder Framework v2

Requirements for biogenic emissions and removals

2-2-5. Additional guidance on PCF calculations

- Pathfinder Framework v2 provides additional guidance for PCF calculations in relation to:
  (1) Accounting for biogenic emissions and removals
  (2) Accounting for transportation and distribution emissions
  (3) Accounting for waste treatment and recycling emissions

- Below we introduce and explain each of these, along with additional guidance for the Green x Digital Consortium Product-based calculation.

(1) Biogenic emissions and removals

Pathfinder Framework requirements

- Biogenic emissions and removals associated with the following shall be calculated and included as part of the “PCF (incl. biogenic emissions and removals)” metric from 2025 onwards:
  - — Direct land-use change (dLUC)
  - — Land-management-related changes (including land carbon pools and other non-CO2 emissions related to land management)
  - — Other biogenic GHG emissions not covered in dLUC and land management
  - — Biogenic CO2 withdrawals
- The biogenic carbon content of the product (mass of carbon) shall be calculated and reported separately as part of the data exchange form
- GHG emissions associated with indirect land-use change (iLUC) emissions may be calculated and reported separately as part of the data exchange form. iLUC emissions shall not be included as part of the PCF.
- To support transparency, all of the metrics above shall also be reported separately whether they are included in the PCF or not.

- Biogenic emissions and removals have been regarded as an important theme in PCF calculations due to the expectations vested in "nature-based solutions" that utilize photosynthesis carried out by organisms as a means of achieving net-zero emissions.
- Pathfinder Framework v2 also provides additional guidance on how to handle biogenic emissions and removals in the calculation of cradle-to-gate PCFs exchanged over the supply chain.
- The first requirement sets 2025 as the first year for mandatory reporting of the “PCF (incl. biogenic emissions and removals)”. Pathfinder Framework v2 was announced in January 2023, giving companies 2 years to prepare.
- The following pages introduce the biogenic emissions and removals included in PCF calculations.

Items to be considered in terms of biogenic emissions and removals

A) Direct land use change (dLUC)

- Emissions resulting from recent (i.e., previous 20 years) carbon stock loss due to land conversion directly on the area of land under consideration.
- In the case of no value chain and/or data traceability to account for dLUC, companies shall account for sLUC emissions as a proxy for dLUC.

B) Land management GHG emissions or removals

- It covers GHGs generated from land management activities and land during the production of food, feed, fiber and other biological products.
- Land management emissions and removals include all land carbon pools—i.e., soil organic carbon, dead organic matter, and biomass carbon stocks—as well as other non-CO2 emissions related to land management.
- Non-CO2 sources related to land management GHG emissions include:
  - CH4 and N2O emissions from livestock, including emissions from enteric CH4 fermentation and manure management
  - Non-biogenic CO2 and N2O emissions from agricultural soils and inputs, including fertilizers, pesticides, and herbicides
  - CH4 and N2O emissions from biomass burning and fires
  - CH4 emissions from rice production
  - Other CH4, N2O, non-biogenic CO2, HFCs, and PFCs emissions, including emissions from on-site fuel and energy consumption, fuel combustion, air conditioning and refrigerant use, on-site waste or wastewater management, and indirect emissions from purchased energy.

C) Other biogenic emissions

- All other biogenic GHG emissions associated with product manufacturing and transport that are not included above.

D) Biogenic carbon

- Carbon derived from living organisms or biological processes, but not fossilized materials or fossil sources..

E) Biogenic CO2 withdrawal

- Biogenic carbon content converted into CO2e.

F) Indirect land use change (iLUC)

- A recent (i.e., previous 20 years) carbon stock loss due to land conversion on land not owned or controlled by the company or in its supply chain, induced by change in demand for products produced or sourced by the company.

Items to be considered in terms of biogenic emissions and removals

- The treatment of each of the elements shown on the previous page in the PCF calculation is shown below.

	Unit	Included in PCF	Reported separately	Mandatory
dLUC emissions	kg-CO2e	Yes	Yes	Yes, from 2025
Land management GHG emissions or removals	kg-CO2e	Yes	Yes	Yes, from 2025
Other biogenic emissions	kg-CO2e	Yes	Yes	Yes, from 2025
Biogenic carbon content	kg	No	Yes	Yes, from 2025
Biogenic CO2 withdrawal	kg-CO2e	Yes	Yes	Yes, from 2025
iLUC	kg-CO2e	No	Yes	No

Figure 2-2-20 Treatment of biogenic emissions and removals

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

- As stated in the second requirement, biogenic carbon content is not included in the PCF calculation because it is not yet a GHG emission, but it does need to be passed on to downstream operators in the data exchange.
- This allows for an assessment of the origin (biogenic or fossil) of carbon content when it is released into the atmosphere as a GHG at some stage downstream in the supply chain.
- The third requirement states that iLUC emissions shall not be included as part of the PCF.
- The fourth requirement states that all of the metrics above shall also be reported separately whether they are included in the PCF or not (Figure 2-2-20).

■ Recycling biomass materials

- As described below, the Pathfinder Framework v2 and the Product-based calculation in this document adopt the “recycled content” method for the allocation of emissions from recycling materials.
- This method stipulates that (a) emissions up to the stage of preparation for recycling (recovery) should be included as waste emissions and (b) emissions from the post-recovery recycled material manufacturing process should be included in the emissions of the company using the recycled materials.
- The “recycled content” method also applies in cases where biomass materials and materials derived from waste biomass. However, Pathfinder Framework v2 does not specifically describe how to deal with biogenic carbon removals or biogenic carbon content.
- The following approaches are adopted as interim measures in this document:
  - **Biogenic carbon removals shall not be passed on to the users of recycled materials**
  - **The biogenic carbon content shall be reported to the users of recycled materials**
- If explicit provisions and guidance are introduced in the Pathfinder Framework in the future, these will be followed.

Accounting for transportation emissions

(2) Accounting for transportation emissions

Pathfinder Framework requirements

- Upstream and direct transportation emissions within the cradle-to-gate boundary, including storage, shall be calculated and include in the PCF
- Only transportation emissions relating to the fuel—also known as well-to-wheel emissions—and the energy consumed by storage facilities shall be included (i.e., the manufacturing of the vehicles used for the transport of goods shall not be included).

- Pathfinder Framework v2 mandates that all significant upstream and direct transportation emissions within the cradle-to-gate boundary—i.e., transportation and storage emissions related to a company's direct activities and distribution activities between tiers in the supply chain relating to the PCF—shall be accounted for.
- However, as explained in Step 1a in 2-2-4, it can be considered that the elements covered in practice are procurement logistics from Tier 1 suppliers and transportation and storage processes in drayage logistics prior to shipment.
  - Procurement logistics and drayage logistics for Tier 1 suppliers are included in the cradle-to-gate PCF data provided by the supplier
- As noted in the second requirement, emissions from not just transport but also storage processes must be included, as well as the life cycle emissions (well-to-wheel) of fuels used in transport.
- The mandatory calculation of well-to-wheel emissions was based on the awareness that, due to the widespread use of electric vehicles and carbon-neutral fuels, it will become impossible to grasp the actual status of emissions from vehicle movement. (Emissions from power generation are important for electric vehicles, and emissions from fuel production and transportation are important for carbon-neutral fuels.)
- On the other hand, emissions related to construction of vehicle transportation equipment and emissions related to maintenance of infrastructure for transportation services (e.g., road or port infrastructure) are outside the boundary.

Storage	Emissions related to the energy consumed by the storage facilities
Fuel life cycle emissions (well-to-wheel)	Emissions related to well-to-tank (upstream fuel production and transportation) and tank-to-wheel (fuel combustion)
Vehicle construction	Emissions related to construction of vehicle transportation equipment
Infrastructure construction and maintenance	Emissions related to maintenance of infrastructure for transportation services (e.g., road or port infrastructure)

Included in Pathfinder Framework boundary

Not included in Pathfinder Framework boundary

Figure 2-2-21 Boundary of calculation for transportation emissions

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

Illustration: Accounting for transport process emissions

- The Pathfinder Framework calculates all significant upstream and direct transportation emissions within the cradle-to-gate boundary.
- For emissions related to transportation, emissions data calculated based on the Guidelines for CO2 Visualization in Logistics developed by the Logistics SWG can be converted into product units (see next page).

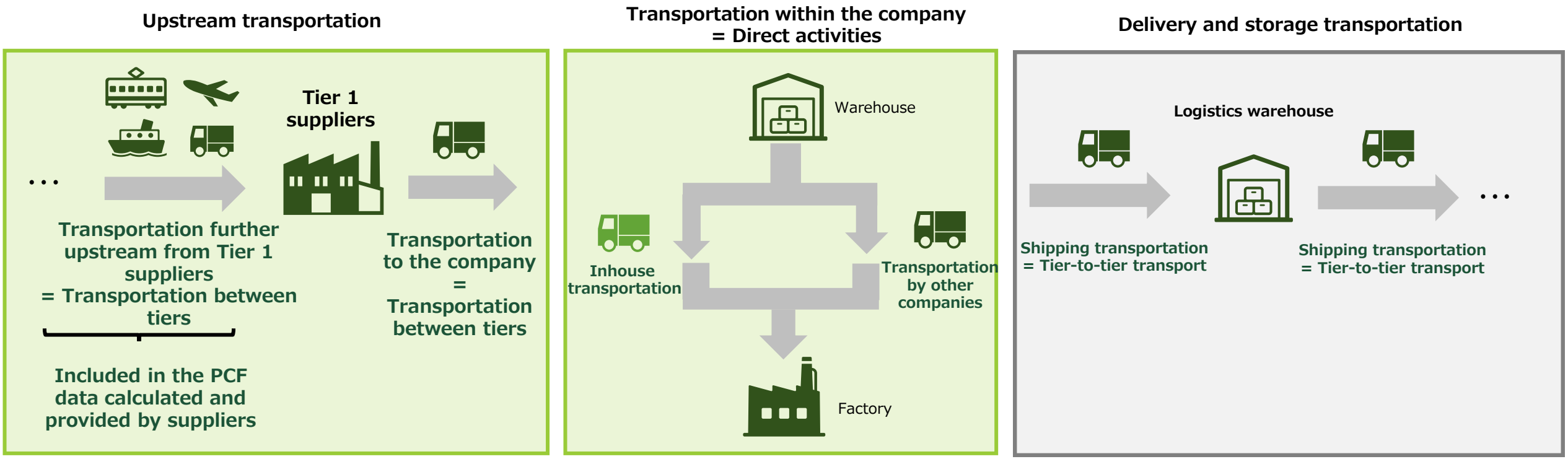


Figure 2-2-22 Concept of transportation targeted in transport process emissions

Source: Created by Mizuho Research & Technologies

Accounting for storage and transport emissions

① Accounting for storage emissions

- Storage facility emissions are calculated by multiplying the percentage of the total area that is covered by the reference product with the total energy consumption of the storage facility.
- Should no information be available on the total energy usage of the facilities, companies may use industry benchmarks based on the site's total floor area.

$$\text{GHG emissionsstorage} = \frac{\text{Area}_{\text{product}}}{\text{Area}_{\text{storage site}}} \times \text{Energy consumption}_{\text{site}} \times \text{Emission factor}_{\text{Energy type}}$$

② Accounting for transport emissions

- Calculation of product transportation emissions depends on the availability of data on fuel consumption, mass, distance, and load factor.
- Figure 2-2-23 shows how Pathfinder Framework v2 chooses the method for calculating transport emissions.
- The prevalent unit of measure used for calculationand exchange of logistics emissions is ton-km, reflecting the mass of the shipment (in tons) and distance transported.
- The Pathfinder Framework v2 refers to the Global Logistics Emissions Council (GLEC) Framework and GHG Protocol standards for further guidance.

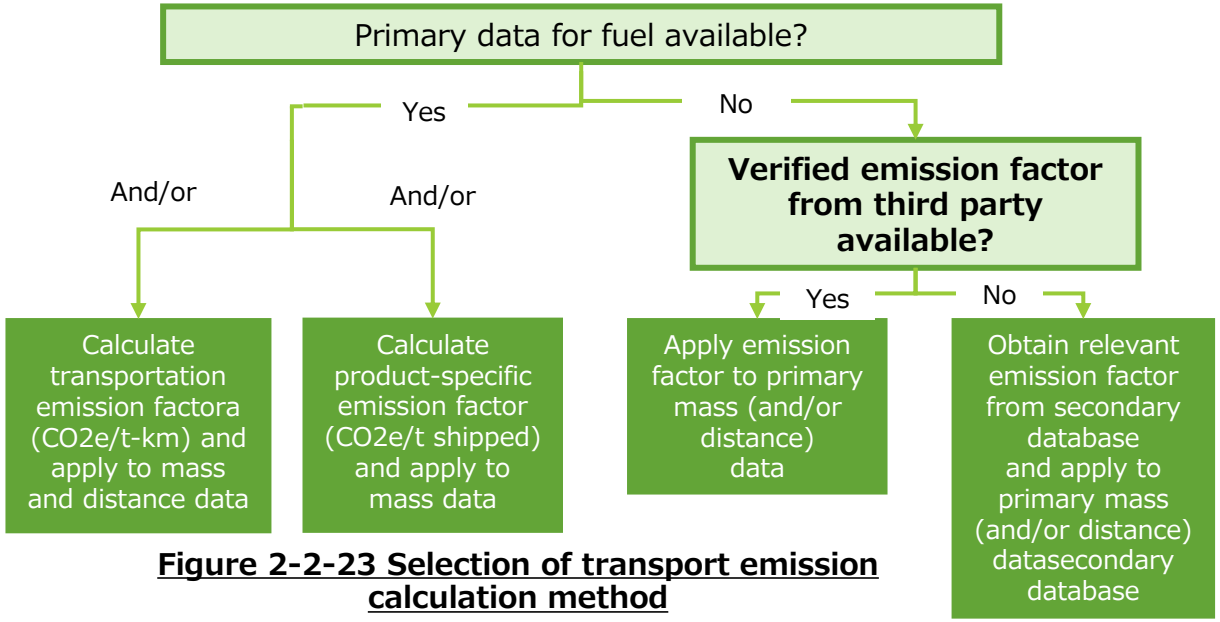


Figure 2-2-23 Selection of transport emission calculation method

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

- This is how Pathfinder Framework v2 calculates storage and transport emissions.
- In addition, the GxD Consortium Logistics SWG is developing detailed guidelines for the calculation of storage and transportation emissions (Guidelines for CO2 Visualization in Logistics). This guidance will be consistent with the GLEC framework.
- However, it does not assume that emissions are provided on a product-by-product basis, so conversion to a product-by-product basis is required to calculate PCF (Figure 2-2-24 on the next page).

Illustration: Calculation of logistics emissions per product unit

- In the Guidelines for CO2 Visualization in Logistics under preparation by the Logistics SWG, logistics companies will present a method for calculating total emissions for the entire transportation chain (all transportation processes from shipper to consignee).
- Logistics companies' calculations of emissions per product are considered optional. This is because, in many cases, it is not the logistics (site) operator who can ascertain the product unit of the cargo but the shipper of the cargo.
- Therefore, the shipper will convert the emissions of the entire transportation chain (all transportation processes from the shipper to the consignee) obtained from the logistics (site) operators into product units.
- Here, the product unit means not only the unit but also the measurement unit such as the weight (kg) or capacity (L, m^3) which is determined by the properties of the cargo and corresponds to the product quantity × the declared unit introduced in 2-2-3.
- In order to calculate emissions on a product-by-product basis, the total transportation chain emissions of the target cargo (received from the logistics operator) must be divided by the product-by-product value.

$$\text{Emissions per product unit [kgCO}_2\text{e]} = \frac{emissions\ per\ transport\ chain[kgCO_2e]}{number\ of\ product\ units}$$

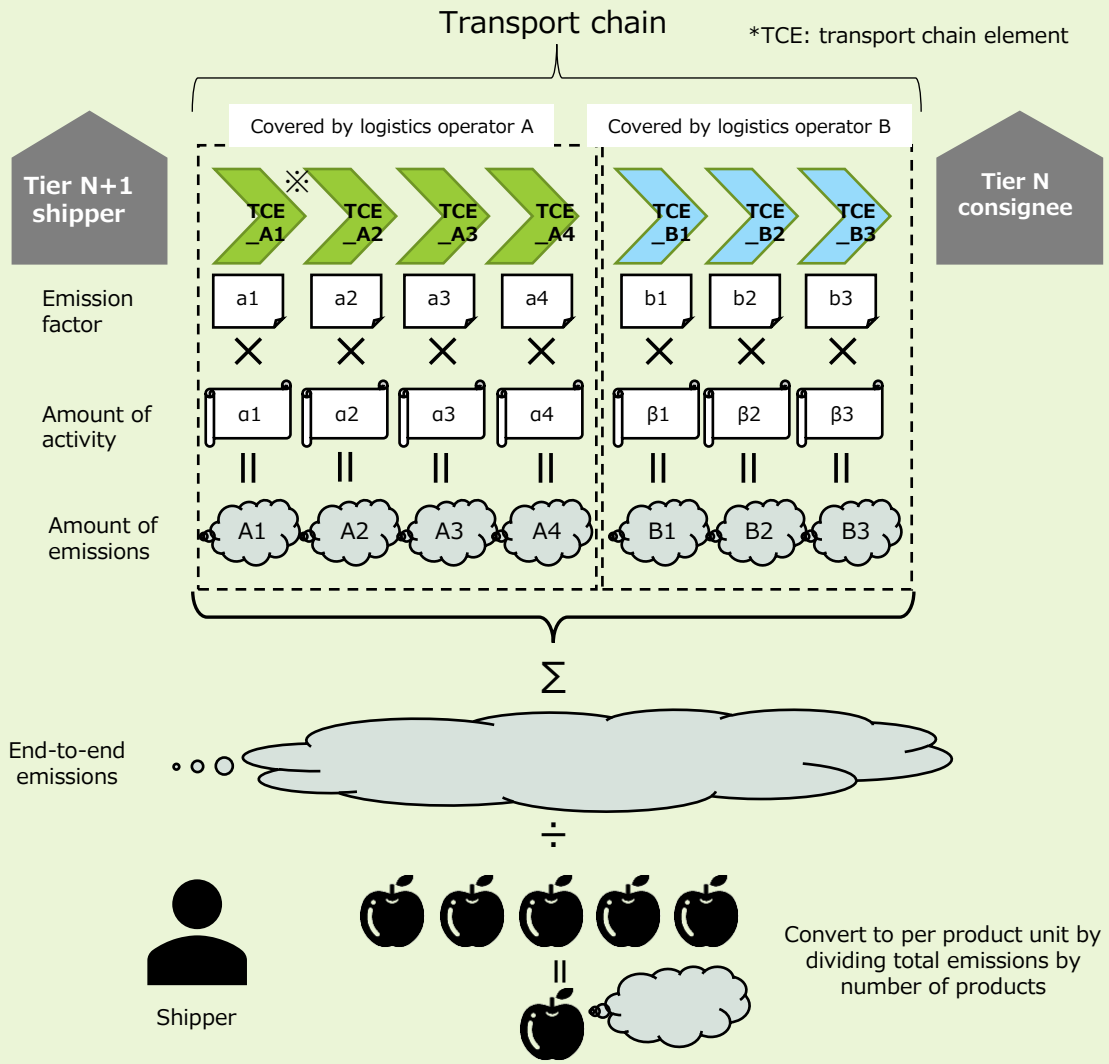


Figure 2-2-24 Framework for calculating product-unit emissions

Source: Created by Mizuho Research & Technologies based on the Guidelines for CO2 Visualization in Logistics

Waste treatment and recycling emissions

(3) Waste treatment and recycling emissions

Pathfinder Framework requirements

- All production emissions shall be allocated to the outputs with economic value, rather than to the waste or recyclable material itself
- Emissions resulting from waste treatment as part of the production process shall be calculated and included in the PCF of the company that manufactured the product and generated the waste
- Emissions from the end-of-life stage of the products shall not be included in the PCF boundary
- Since the Pathfinder Framework's boundary is cradle-to-gate, the "recycled content" method should be used for the allocation of emissions from recycling materials and energy recovery

- The first requirement prohibits the allocation of emissions from manufacturing processes between output products and waste. According to the allocation hierarchy in 2-2-4, such allocations should not be made, but this requirement was added as a reminder.
- The second requires that emissions from the treatment of waste generated by a manufacturing process be included in the PCF of the product output from the manufacturing process. This concept is presented in Step 1a in 2-2-4, and this requirement is the basis for it.
- The third requires that emissions from the end-of-life stage when the product is disposed of after shipment not be included in the PCF. This idea has also been presented in the cradle-to-gate boundary discussion in 2-2-3.
- The fourth requirement specifies the handling of emissions and effects associated with waste recycling, which is the first reference to this.

① Waste recycling

- There are three approaches to accounting for waste treatment and recycling emissions:
  A) Accounted for by the company that generated the waste
  B) Accounted for by the company using the recycled materials/energy
  C) Shared by both
- Pathfinder Framework v2 recommends the "recycled content" method (B) as a suitable concept for the cradle-to-gate boundary (continued on the next page).

Recycled content method

① Waste recycling (continued)

- The recycled content method shall be as follows:
  - The amount of waste discharged up to the stage of preparation for recycling (recovery) shall be subject to calculation by the waste discharging side.
  - The amount discharged from the recycling material manufacturing process after recovery is subject to calculation on the recycling material utilization side.

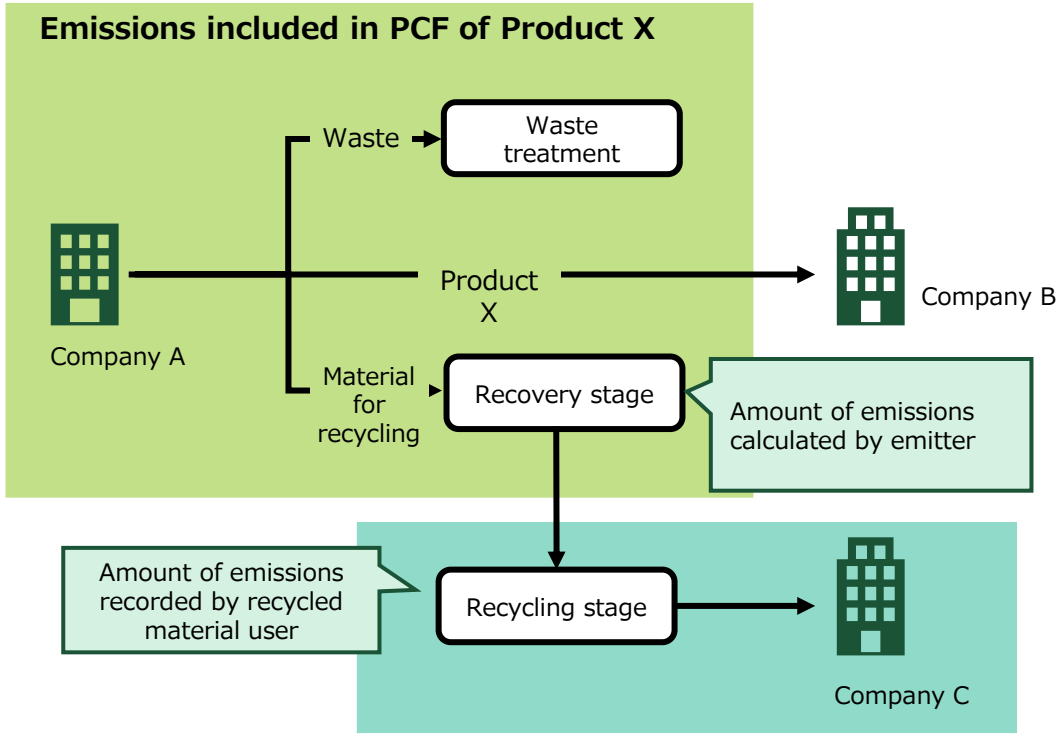


Figure 2-2-25 Recycled content method

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

- Pathfinder Framework v2 states that the recycled content method should also be used for energy recovery.
- The application of the recycled content method is a recommendation, and the use of other methods is not prohibited, but Pathfinder Framework v2 states that if other methods are used, this should be communicated during data exchange.
- Pathfinder Framework v2 recommends the recycled content method because it is suitable for the cradle-to-gate boundary.
  - The cradle-to-gate boundary can capture the effect of choosing recycled materials (recycled materials often have lower cradle-to-gate emissions than new materials) as a reduction in upstream activity emissions.
  - However, since the amount of emissions after shipment is outside the boundary, the reduction effect of recycling after disposal of the product (e.g., reduction of new material use materials in society) cannot be recorded. Therefore, the closed-loop approximation method, which aims to account for this effect, cannot be applied (Figure 2-2-26).
- The following benefits have also been noted:
  - It is applicable even if the supply chain is complex.
  - The secondary data emission unit is also calculated using the recycled content method, making it easy to obtain data.
  - Consistent with Scope 3 calculation (does not include avoided emissions not allowed in Scope 3 calculation)

Reference: Explanation of closed loop approximation method

- The “closed loop approximation method” (also called “0-100”) is another typical method alongside the recycling inclusion method.
- The concept of closed-loop approximation is as follows:
  - Even if recycled materials are actually included in the raw materials input, the environmental impact is calculated assuming that all the raw materials are new.
  - Account for 100% of the environmental impact of the recycling process and the indirect environmental impact reduction effect of recycling at the post-use processing stage (on the recycled material generation side)
  - Instead of accounting for all emissions before used products are recycled into recycled materials, new material inputs can be deducted by the amount of recycled materials obtained from the recycling process.

- Since the calculation method assumes a closed loop recycling route, the raw materials input at the raw material procurement stage and the recycled materials obtained by recycling must have the same quality.
- The Pathfinder Framework and the GxD Consortium envisage the exchange of CO2 data from upstream to downstream in the supply chain on a cradle-to-gate basis, which is why applying the closed-loop method would be difficult, since upstream entities would not have visibility over the waste treatment processes at the end of life stage of materials, and would therefore struggle to include the load reduction effect retroactively upstream in the closed loop approximation method.
- Closed loop approximation is often considered an option for cradle-to-grave full-life carbon footprints* but this is why it is not recommended in the Pathfinder Framework.

* For example, in the GHG Protocol Product Standard and the MET/MoE Carbon Footprint Guidelines.

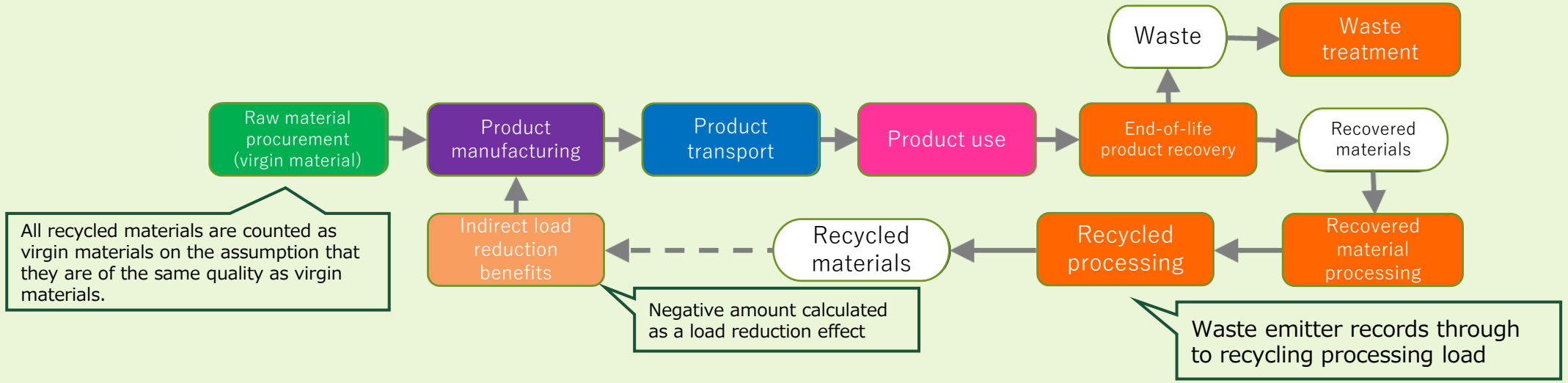


Figure 2-2-26 Closed loop approximation

Source: Created by Mizuho Research & Technologies from the GHG Protocol Product Standard

Accounting for waste treatment emissions

② Accounting for waste treatment emissions

■ Waste treated by the company that generates it

- Calculate using primary activity data on waste type, composition, and type of waste treatment activity (incineration or landfill).
- Companies may use waste treatment emission factors calculated based on internal primary data. However, internal emission factors should be verified by an independent auditor.
- If no primary emission factors are available, emission factors derived from accepted secondary sources can be employed.

■ Generated waste sent to a third party for waste treatment

- Waste treatment facilities should calculate their waste treatment emissions, develop emission factors, and verify and communicate these to the company that generated the waste in instances where the waste is not recycled (or to the company making use of the recycled material in instances where it is).
- The waste treatment facility may share primary data with the company that generated the waste. This involves collecting certified emissions data from waste treatment companies and allocating the corresponding emissions to the products in question.
- If companies do not have access to primary data from waste treatment facilities, they shall estimate waste treatment emissions using primary activity data on the waste type and composition and secondary emission factors according to the type of waste treatment and disposal.

Reference: Linking production waste and the PCF

- The amount of waste generated during production and the amount sent for external processing are often identified and managed on a site-by-site basis rather than organized in relation to individual products. However, Pathfinder Framework v2 requires emissions from the treatment of waste generated during production to be included in PCF calculations, so the amount of waste generated during production and the amount of waste treated need to be linked to the PDF.
- In the GxD Consortium PoC project (2022-June 2023), the following two methods were presented as examples of linking methods.

A) Top-down approach (allocation from total)

- Method of allocating the amount of waste generated and treated throughout the site to products produced at the site

B) Bottom-up approach (utilizing loss ratio)

- Utilize product-specific loss ratios measured for cost accounting, etc., a method that assumes that the losses go straight to waste

- Please regard these as potential methods of linking production waste and the PCF. Which method is more appropriate, or whether a third or fourth method exists, will need to be considered on a case-by-case basis.

Defining the data hierarchy

2-2-6. Data sources and hierarchy

Pathfinder Framework requirements

- Pathfinder Framework definitions shall be used by companies to determine the nature of activity data and emissions
- Activity data that is used to calculate PCF shall be company-specific
- Secondary emission factors used shall be compliant with Pathfinder Framework safeguards
- Companies may use proxy data to bridge minor data gaps

- Pathfinder Framework v2 specifies definitions and hierarchies for activity data, emissions factors, and emissions data. The GxD Consortium Product-based calculation takes the same approach.
- Pathfinder Framework v2 provisions are described below, along with additional guidance on their application in Japan.

(1) Defining the data hierarchy

① Define the data hierarchy

- For a PCF calculation to take place, two types of data are required: activity data and emission factors. Both of these can be derived from different sources, which the Pathfinder Framework guidance categorizes into primary, secondary, and proxy data (Figure 2-2-27).
- The Pathfinder Framework recommends that companies directly measure GHG emissions or calculate GHG emissions based on both primary activity data and emission factors (“best case”).

Data type	Activity data	Emission factor	Example
Primary	Site- or supplier-specific data directly measured, collected, or calculated	Calculated based on company-owned primary activity data or provided by a supplier for a process under their control	Direct GHG combustion emissions or well-characterized emission factors based on stoichiometry
Secondary	Data not directly collected, measured, or calculated based on specific company production data	Emission factors derived from secondary sources	Default factors, regional industry averages, literature studies, government statistics, financial data, and environmentally extended input-output databases
Proxy	Extrapolated, scaled-up, or customized data. Data from similar processes used as a stand-in for a specific process, e.g., based on geography, outdated data		Customizing amount of material consumed by a process from another product’s life cycle Using electricity grid emission factors from one region for another region with similar generation mix

Figure 2-2-27 Data type definitions

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

Hierarchy in the combination of activity data × emission factors

② Select primary data

- Companies shall prioritize the collection of primary activity and emissions data (Figure 2-2-28).
- In some cases, further polishing and aggregating of the data may be required to refine the emissions estimate.
- Modeling tools are often used to estimate GHG emissions. The results of a model that uses primary data as an input are also considered primary data.

③ Select secondary data

< Activity data >

- Activity data used to calculate Product-based GHG emissions shall always be company-specific.
- However, the Pathfinder Framework acknowledges that there may be instances where company-specific process-based data may not be available (e.g., where there is no traceability in the value chain).
- In these instances, companies may resort to using spend-based data and EEIO emission factors for their PCF calculations (“worst case”), bearing in mind this will reflect negatively in their data quality assessment scores.

The principle is that activity data is primary data

Priority is given to primary data for emission factors. Use of the PCFs provided by suppliers is recommended for raw materials.

	Activity data source		Emission factor source	
Data type	**Energy[a]**	**Material**	**Energy**	**Material**
Best case	In-house/process-based data		For on-site production: in-house/primary For purchased electricity: supplier-specific or via a certification mechanism (e.g., guarantees of origin) For other purchased energy: supplier-specific or well-characterized emission factors based on stoichiometry	Supplier-specific (e.g., via Pathfinder Network)
Best case[b]	In-house/process-based data		Secondary process-based sources	
worst case	In-house/spend data		EEIO databases and data proxies	

a: Electricity, heating/cooling, steam.
b: Prevalent approach in practice.

Figure 2-2-28 Data hierarchy for activity data and emission factors

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

Available secondary data emission factors

< Data on emission factors>

- To ensure the use of verified and credible secondary emission factors while still allowing for flexibility in the data sources used, the Pathfinder Framework defines a series of safeguards that secondary emission factors shall comply with if they are to be used for the calculation of PCFs (Figure 2-2-29).

1. Documentation	• Data included in the secondary emission factor shall be validated in line with globally recognized LCA principles.* • The emission factor source should ensure transparency by providing information on key methodological (i.e., LCA modeling approach, aggregation and allocation approach, if any) and data (time period, geography, technology, representativeness) elements.
2. Management and maintenance	• If life cycle inventory databases are used, they shall be periodically maintained and updated with the latest data sets.
3. Choice of modeling	• The modeling of the secondary emission factor shall be consistent with the methodological principles of the Framework (e.g., attributional approach).

* More information on validation of databases can be found in Section 2.3 of the Global Guidance for Life Cycle Assessment Databases (2011).

Figure 2-2-29 Safeguards for secondary data emission factor

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

- Databases of secondary data emission units accepted under Pathfinder Framework v2 are shown in Figure 2-2-30. These databases have been verified for safeguard compliance and do not need to be checked again.

- Databases not listed in Figure 2-2-30 can also be used for PCF calculations if the safeguard compliance in Figure 2-2-29 is confirmed.

Database	Sector	Link
Ecoinvent	All	https://ecoinvent.org/
GaBi (thinkstep)	All	https://gabi.sphera.com/international/databases
GLEC database	Transportation	
Official national emission factor databases	All	Example:US EPA Database https://cfpub.epa.gov/ghgdata/inventoryexplorer/
PEF	All	https://www.openlca.org/product-environmental-footprints-pefs-in-openlca/
UNEP Global LCA Data Access Network	All	https://www.globallcadataaccess.org/

Figure 2-2-30 Examples of secondary emission factor databases accepted under the Pathfinder Framework

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

Positioning of secondary data emission factor databases in Japan

(2) Positioning of secondary data emission factor databases in Japan

- What would happen if the provisions of Pathfinder Framework v2 regarding secondary data emission factors (safeguards, available databases) were applied to secondary data emission factor databases in Japan?
- The thinking behind the GxD Consortium Product-based calculation methodology is described below.

① IDEA

- The National Institute of Advanced Industrial Science and Technology's "IDEA" (Inventory Database for Environmental Analysis) is one of the most widely used secondary data emission factor databases in Japan.
- IDEA is included in the UNEP Global LCA Date Access Network (https://www.globallcadataaccess.org/search) in Figure 2-2-30 and is therefore considered a database certified as usable by Pathfinder Framework v2.

② SHK (accounting, reporting and disclosure) scheme emission factors

- The SHK scheme for GHG emissions accounting, reporting and disclosure (which takes the first letter of the Japanese terms for accounting, reporting, and disclosure) under the Act on Promotion of Global Warming Countermeasures provides a range of emission factors (secondary data emission factors in the terminology of this document) to support GHG emissions calculation by companies, and these are used by many Japanese companies.
- SHK emission factors fit the definition of an official national emissions factor database in Figure 2-2-30, so they are considered to be part of a database certified as usable by Pathfinder Framework v2.
- However, there are caveats when using the SHK scheme's secondary data emission factors for fuel and electricity for PCF calculations based on Pathfinder Framework v2 and the GxD Consortium Product-based calculation:

- The secondary data emission factor for fuel and power under the SHK scheme does not include upstream emissions.

- The secondary data emission factor for power in the SHK scheme adopts a different approach to the application of certificates and credits from Pathfinder Framework v2.

- There are many types of secondary data emission factors for power in the SHK scheme, and the choice must be made in line with Pathfinder Framework v2.

- This document lays out conditions for using emission factors from the SHK scheme in product-level calculation (see overleaf).

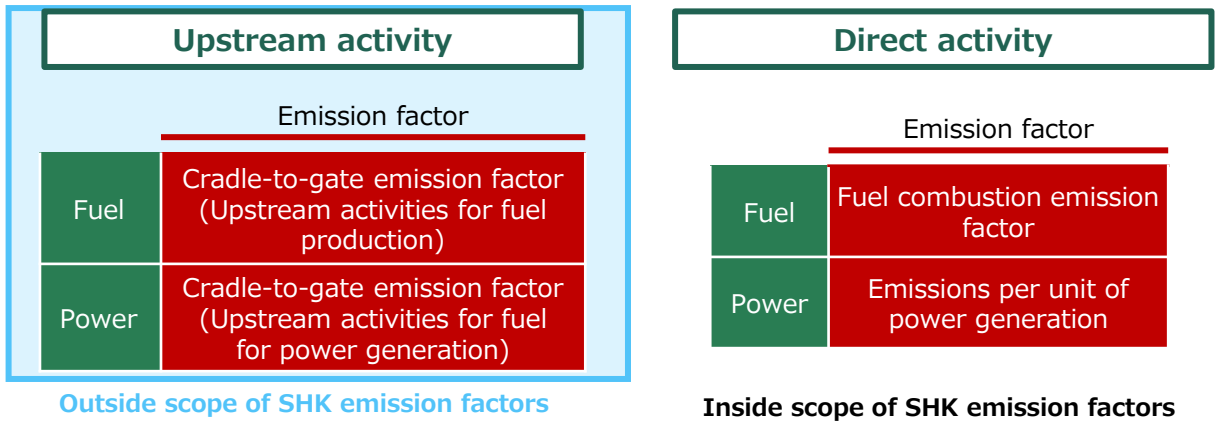
Caveats when using secondary data emission factors in the SHK scheme (1)

② SHK scheme emission factors (continued)

■ Caveat 1: Upstream emissions not included

- The first point to note is that the SHK scheme's secondary data emission factor for fuel and electricity covers only combustion and power generation and does not include upstream emissions.
- Both Pathfinder Framework v2 and the Product-based calculation methodology in this document include emissions from upstream activities (such as fuel manufacturing processes) of fuel and power purchased within the boundary (Figure 2-2-12).
- Therefore, when using the fuel and power emission factors in the SHK scheme, it is necessary to either (a) supplement the upstream activity emissions or (b) confirm that the upstream emissions can be excluded in light of the cutoff rule and use the current SHK emission factors.

Figure 2-2-31 Boundary of fuel and power emission factors in SHK scheme



Source: Mizuho Research & Technologies and Aenergy Creation

- At present, a realistic method for complementing emissions from upstream activities would be to specify the type of fuel and, in the case of power, the type of generated fuel to be extracted from the power supply structure of the purchase menu, and then refer to the emission data for the production stage of the fuel from secondary data emission factors such as IDEA.
- Emissions from upstream activities of fossil fuels, such as coal, heavy oil, diesel oil, gasoline, and city gas, tend to be relatively small relative to emissions during combustion, so it is expected that they can be excluded in many cases by applying the cut-off rules.
- On the other hand, carbon-neutral fuels such as hydrogen and ammonia have zero emissions during combustion, while upstream emissions may reach a certain level depending on the production method. With regard to these fuels and the power generated from their generation, it is assumed that emissions from upstream activities cannot be excluded in some cases.
- METI is also developing a guide for obtaining fuel and power emission factors that comply with the Carbon Footprint Guidelines, which will include the calculation of emissions from upstream activities. Once the guide is published, it should be much easier to complement upstream emissions.Companies implementing Product-based calculation should also refer to this when complementing upstream emissions.

Caveats when using secondary data emission factors in the SHK scheme (2)

② SHK scheme emission factors (continued)

■ Caveat 2: The application method for certificates and credits is unique to Japan.

- The second point to note is that the SHK scheme allows adjustment of power emission factors (emission factors of power companies) using certificates and credits, and the application concept differs from Pathfinder Framework v2.
- There are two specific differences:
  - A) Factor adjustment using offset credits is allowed
  - B) When using energy attribute certificates such as non-fossil certificates for factor adjustment, a slightly different formula to the GHG Protocol is adopted.
- The GHG Protocol Scope 3 Standard and Product Standard on which the Pathfinder Framework is based do not allow offset credits to be applied (Issue A).

	GHG Protocol Scope 2 Guidance	Power company emission factors under the SHK scheme
Offset credit	• No	• Yes
Method of calculating emission factors when energy attribute certificates are used	• **Apply certificate attributes (emission factor attributes) to that power in units of power**	• Adjust emission factor by applying a corresponding reduction amount to the amount of power-derived emissions

Figure 2-2-32 Differences between the GHG Protocol and the SHK scheme for power emissions factors

Source: Created by Mizuho Research & Technologies

- In addition, where the GHG Protocol Scope 2 guidance applies the attributes of certificates (emission factor attributes) to purchased power by unit of power consumption (kWh), in the SHK scheme, the reduction effect of the application of the certificate (difference from the national average coefficient) is converted into t-CO2 and subtracted from emissions from power generation (Issue B).
- PACT assumes compliance with the GHG Protocol for power emission factors. To enable the use of emission factors for purchased electricity under the SHK scheme for Product-based calculation, the manner in which differences from the GHG Protocol are handled becomes important. This document accordingly adopts the following approach on this point:

– Given that power emission factors under the SHK scheme are noted by CDP-Worldwide Japan as not identical to the GHG Protocol Scope 2 guidance approach but still acceptable to account for Scope 2 emissions, they are interpreted as being emission factors consistent with the GHG Protocol to some extent, and may consequently be used for Product-based calculation.

– Where emission factors that are highly compliant with the GHG Protocol can be obtained,* it is recommended that these be applied with priority over SHK scheme factors.

*The guide being developed by METI for obtaining fuel and power emission factors that comply with the Carbon Footprint Guidelines will recommend a method similar to the GHG Protocol for offsets and energy attribute certificates.

Caveats when using secondary data emission factors in the SHK scheme (3)

② SHK scheme emission factors (continued)

■ Caveat 3: Factor selection required

- The third point to be noted is that the SHK scheme presents power emission factors in multiple ways, so companies must select the appropriate option.
- At the present time (March 2024), the SHK scheme provides two emission factor units (emission factors by power companies): a basic factor and an adjusted factor. A new basic factor is also under consideration.

Basic emission factor	• Emission factor based on the power supply structure of power supplied by a retail power utility before environmental value transactions such as non-fossil certificates are reflected
Adjusted emission factor	• The basic emission factor reflects the trading of environmental values such as non-fossil certificates. Also reflects factor adjustment with offset credits.
New basic emission factor (Under review)	• The basic emission factor reflects the trading of environmental values such as non-fossil certificates. Factor adjustment by offset credit is not included.

Figure 2-2-33 Power emissions factors under the SHK scheme

Source: Created by Mizuho Research & Technologies based on Appendix 3 of the 7th Meeting of the Review Committee on Calculation Methods for the Greenhouse Gas Emissions Accounting, Reporting and Disclosure System

- The selection of multiple power emission factors provided by the SHK scheme is in accordance with GHG Protocol Scope 2 emission calculation practices accepted in Japan's CDP reporting.
  - Currently, Japanese companies use "national average emission factors" to account for the location-based Scope 2 emissions and "adjusted emission factors" by retail power provider to account for the market-based Scope 2 emissions
  - Regarding adjustment emission factors, CDP Worldwide-Japan noted that they are not identical to "contract-based emission factor" compliant with GHG protocol but still acceptable to account for market-based emissions.
    (In addition, given the issue noted in (A) on the previous page, eliminating factor adjustment using offset credits is recommended.)
- Pathfinder Framework v2 makes no direct reference to the relationship between location-based or market-based emission factors in Scope 2 accounting and primary or secondary emission factors for purchased electricity in PCF quantification. However, based on the data type definitions it gives in Table 5 (Figure 2-2-27 in this document), the "adjusted emission factor" for each retail power utility corresponding to the market standard equates to primary data, and the "national average emission factor" for the government statistics corresponding to the location standard equates to secondary data.
- This document adopts the same correspondence.

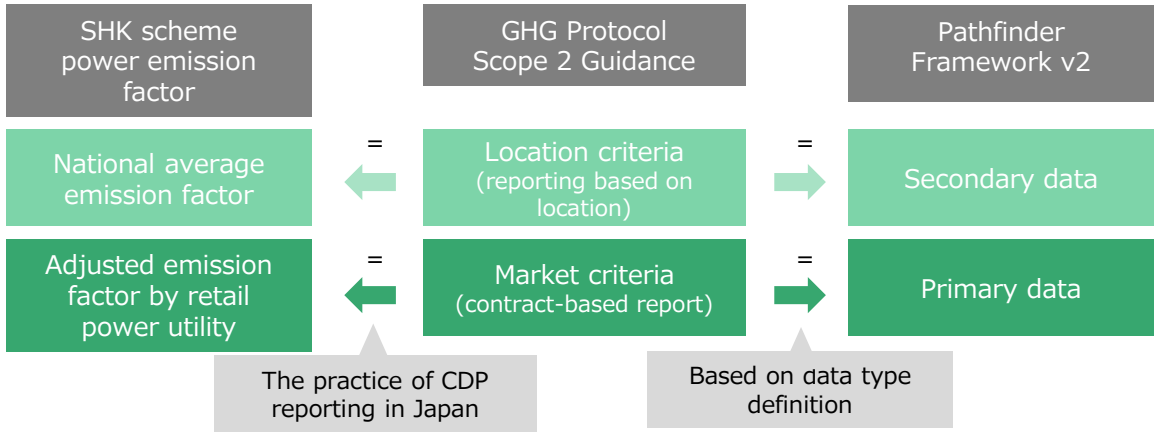


Figure 2-2-34 Correspondence between SHK scheme power emission factor, the GHG Protocol, and Pathfinder Framework v2

Source: CDP Worldwide-Japan document, based on Pathfinder Framework v2. Creating Mizuho Research & Technologies

Positioning of "3EID"

② SHK scheme emission factors (continued)

■ Caveat 3: Factor selection required

- It should be noted that the new basic emission factor under consideration may be regarded as an emission factor with a high degree of compliance with the GHG Protocol in terms of eliminating factor adjustment by offset credits.
- Regarding this matter, this document's policy will be determined based on whether the new basic emission factor will be recommended in Japanese business's CDP reporting as more GHG protocol-aligned emission factors.

③ 3EID

- 3EID (Data Book for Environmental Impact Units Based on Input-Output Tables) is an emission unit database based on Input-Output Tables developed and operated by the National Institute for Environmental Studies. It is a type of EEIO (Environmentally-Extended Input-Output, Enhanced Input-Output Model).
- It is also registered in the Ministry of the Environment's "Emissions Factor Database for Calculation of Greenhouse Gas Emissions of Organizations through Supply Chains" and is widely used to calculate Scope 3 emissions by Japanese companies.
- Pathfinder Framework v2 positions EEIO in the data hierarchy as the worst case, on a par with proxy data (Figure 2-2-28).
- It is possible to apply the 3EID in PCF calculation, but it should be noted that this will sit lower in the data hierarchy than secondary data based on process data such as IDEA.

Handling of energy attribute certificates (purchased from consumer companies)

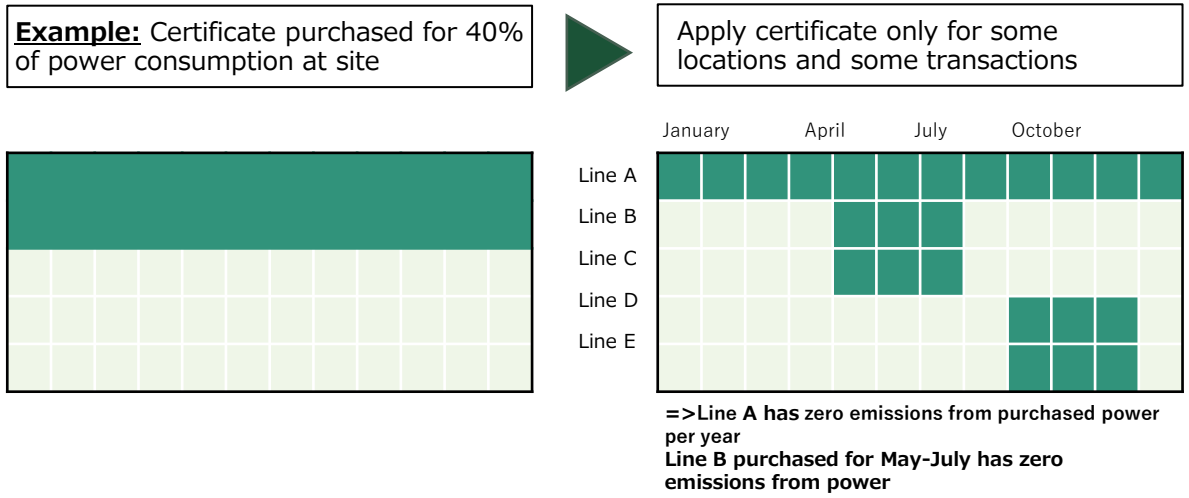
2-2-7. Handling of certificates and credits, etc.

- Although this section does not correspond to a chapter of the Pathfinder Framework, below is an explanation of three elements which companies should take into consideration in terms of environmental value in their PCF calculation and data exchange:
  - Energy attribute certificates (purchased from consumer companies)
  - Carbon credits
  - Mass balance approach

(1) Energy attribute certificates (purchased from consumer companies)

- Some energy attribute certificates, such as FIT non-fossil certificates, allow a consumer company to adjust its own emissions factor for power purchased directly and separately. A energy attribute certificate that is purchased in a form that is not bundled with such power is called an unbundled certificate.
- As described above in 2-2-6 (2) (2), this document does not require conversion to the GHG Protocol method (applied to purchased power in units of kWh, which is the attribute of the certificate) in the case of the power emission factor under the SHK scheme but rather allows the SHK method (applied by converting the reduction effect of applying the certificate into t-CO2).
- On the other hand, the method of application of the unbundled certificate on the consumer side can be selected. Therefore, it is mandatory to apply the GHG Protocol. That is, it is obligatory to apply the certificate attribute (emission factor attribute) to purchased power in units of power (kWh).
- At this time, the emission factor when the unbundled certificate is applied is positioned as primary data (because it is the emission factor specific to the purchased power).
  - This arrangement follows the concept of Table 6 in Pathfinder Framework v2 (Figure 2-2-28 of this document).
- Unbundled certificates purchased by a company can also be applied together to specific locations and specific manufacturing lines. However, the same energy attribute certificate shall not be applied twice at this time.
- The reason for limiting certificates that can be applied together to specific lines and products to unbundled certificates is that the amount of certificates included in power menus purchased from retail electric utilities is difficult for consumer companies to grasp and difficult for third parties to verify.

Figure 2-2-35 Applying unbundled certificates together



Source: Created by Mizuho Research & Technologies

Handling of carbon credits

(2) Handling of carbon credits

- Pathfinder Framework v2 is not designed to be used to quantify GHG savings from offsets for carbon credit accounting. Offsets due to carbon credits are also excluded from the Product-based calculation in this section.
- However, if the data provider applies carbon credits, the amount of carbon credits used may be provided as reference information in addition to the unapplied product emissions.
- It should be noted that current carbon credits are mainly based on the baseline-and-credit system, which is often referred to as "offset credit."
- In the baseline-and-credit system, the difference between the emissions in scenarios that did not occur due to non-implementation of initiatives called the baseline and the actual emissions after implementation of initiatives is credited. This difference is not the actual actual reduction amount (e.g., the difference between the past actual emission amount and the current actual emission amount) and is therefore excluded from the calculation of PCF and Scope 1, 2, and 3 emissions based on the accumulation of actual value.
- In the future, however, there will be carbon credits for removing GHGs from the atmosphere. These carbon credits are proof of performance and their inclusion may be allowed in calculations of PCF and Scope 1, 2 and 3 emissions.
- It is anticipated that the treatment of carbon credits for removal will be reflected in the Pathfinder Framework after being specified in the Land Sector and Removals Guidance currently under development.
- The inclusion of carbon removal will help to reflect the idea of carbon credits when the Pathfinder Framework is revised.

	Cross-product category rules			Product category specific rules		
	PACT Pathfinder Framework	GHG Protocol Product Standard	ISO 14067:2018	PEFCR IT equipment	SuMPO PCR	EPD international PCR
Handling of carbon credits	• Not designed to use offsets	• Offsets not covered by the product lifecycle inventory	• Carbon offsets must not be included	• No mention if offsetting by carbon offset, etc., may be included	• Offsetting by carbon offset, etc. shall not be included	• No mention if offsetting by carbon offset, etc., may be included

Figure 2-2-36 Handling of carbon credits

Source: Compiled by Mizuho Research & Technologies based on various documents

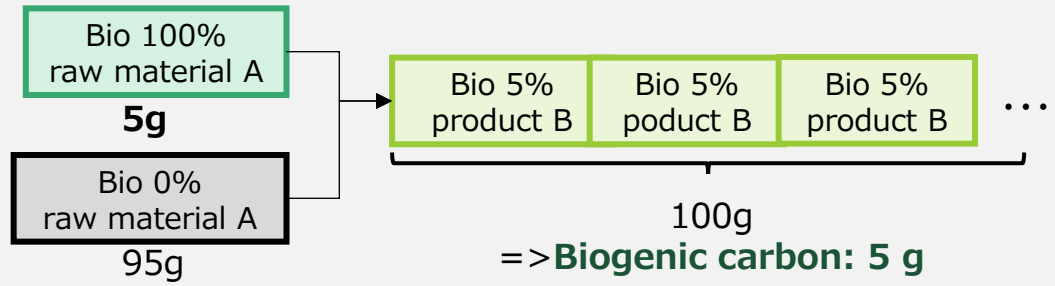
Mass balance approach

(3) Concept of the mass balance approach

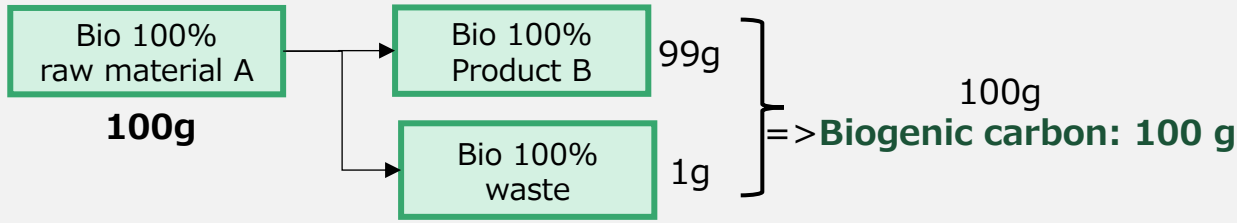
- The Pathfinder Framework does not define a mass balance approach such as mixing biomass and non-biomass feedstocks and assigning biomass feedstock by weight to specific products of a product.
- Therefore, we have followed Pathfinder Framework v2 in not adopting a mass balance approach in our Product-based calculation.

< Mass balance approach >

- When biomass raw materials are used, biogenic carbon is distributed by weight.



- Biogenic carbon is also allocated to by-products and waste.



- The mass balance approach distributes biogenic carbon by weight to specific products.

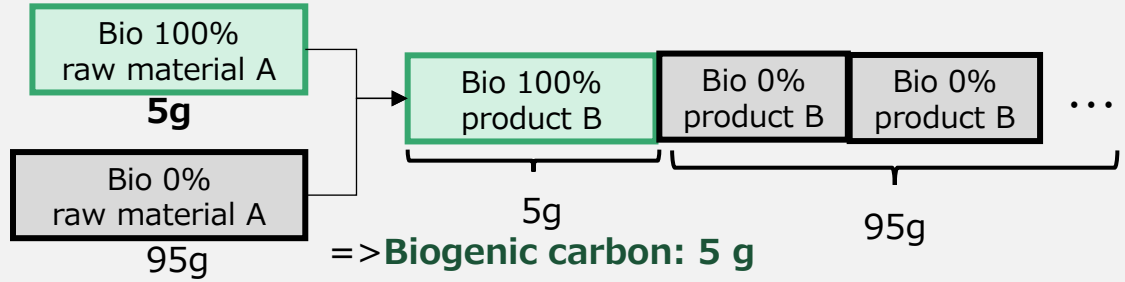


Figure 2-2-37 Mass balance approach

Source: Created by Mizuho Research & Technologies

Introduction of primary data share and data quality ratings

2-2-8. Data reliability

Pathfinder Framework requirements

- Companies shall either assess the primary data share (PDS) or the data quality of the PCF until 2025; after 2025, both KPIs shall be calculated and exchanged
- If calculated, the PDS shall be based on both the nature of the activity data and the emission factors used
- If calculated, the data quality ratings (DQRs) shall use the Framework's data quality assessment matrix, excluding any inputs representing less than 5% of the total PCF

- Pathfinder Framework v2 introduces the following indicators to increase the use of primary data to track, report and improve data quality:

- Primary data share (PDS):
  Percentage of PCF emissions that were calculated using primary activity and emissions data

- Data quality ratings (DQRs):
  Quantitative score for five data quality indicators based on the data quality matrix

- Pathfinder Framework v2 also notes that:
  - Initially, companies shall calculate and report, as part of PCF data exchange, on at least one of the above metrics.
  - From 2025, both metrics shall be reported by companies.
- The idea is to ensure a fuller picture of both the quality of the PCFs and the amount of primary data being used to calculate them.
- The Product-based calculation in this section also introduces the same definitions and adopts the same requirements for PDS and DQRs.
- The provisions of Pathfinder Framework v2 for these two indicators are described below, along with additional guidance from the GxD Consortium on their application in Japan.

PDS calculation method

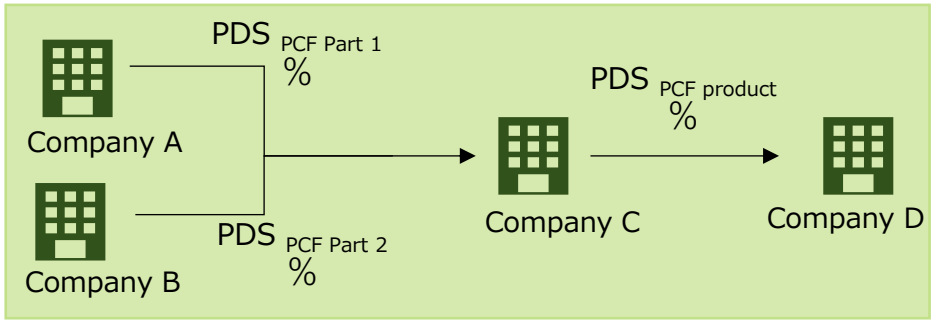
(1) Primary data share

- To create visibility on the share of primary data in PCF calculations, the PDS in each data set should be determined and exchanged across the value chain.
- This can be done by calculating the percentage of the total GHG emissions (CO2e) that is derived using primary data.
- The supplier's individual PDS for all inputs received is multiplied by the respective emission ratio (%) of the product's output to PCF, and the sum is calculated to be the downstream shared PDS.

$$\frac{\text{Part of PCF based on primary data (CO2e)}}{\text{PCF (CO2e)}} = PDS_{PCF}(\%)$$

- Companies are encouraged to include an explanation on primary data sharing with a view to helping to increase the amount of primary data flowing through their systems and to assist each other in ensuring a more accurate PCF.

- In the following pages, as representative examples of PCF calculations, we will illustrate how the PDS is calculated in Japan's data environment based on calculations of emissions from fuel combustion, power use, and raw material procurement.



PDS $_{\text{PCF product}}$ = (PDS $_{\text{PCF part 1}}$ x emissions to PCF ratio (%)) + (PDS $_{\text{PCF part 2}}$ x emissions to PCF ratio (%))

Weighted PDS components, %

Source: Created by Mizuho Research & Technologies from Pathfinder Framework v2

	Amount of emissions	Percentage of emissions	PDS	Nature of the data
Part 1	4 kg-CO2e	40%	0 %	Secondary data
Part 2	3 kg-CO2e	30%	40%	Supplier-supplied PCF
Fuel 3	2 kg-CO2e	20%	0%	Secondary data
Power 4	1 kg-CO2e	10%	100%	Primary data

Product PDS 22% =
40%X0%+30%X40%+20%X0%+10%X100%

Figure 2-2-38 Calculation method and example of PDS calculation

Source: Created by Mizuho Research & Technologies

Illustration: Calculation of primary data on emissions from fuel combustion

- Emissions from fuel use are also considered primary data if both combustion use (activity) and the fuel combustion emission factor are primary data.
- For the fuel combustion emission factor, the emission factors in databases such as the SHK list and IDEA are considered as secondary data because they are calculated as the average nationwide value. Therefore, emissions calculated using these data are treated as secondary data even if the activity data is primary data.
- The primary data are the emission factors provided by suppliers and the factor calculated per unit (kg or m3) by specifying the amount of carbon contained from the fuel composition information and assuming that the total amount of CO2 is generated by combustion. At present, however, there are very limited cases in Japan where fuel suppliers provide combustion emission factors specific to the fuel they sell.
- The PDS is determined by the activity data and emission factor. The activity data is treated as 1 if it is primary data, 0 if it is not primary data such as secondary data, and the PDS is calculated by multiplying it by the PDS of the emission factor. In the case where the primary unit of emission is secondary data as in Case 3, since the PDS is 0%, the PDS of the emission amount is also considered as 0%.

		Activity data		Emission factor		Amount of emissions	PDS
Fuel		Fuel consumption	×	Emission factor at time of fuel combustion	=	Fuel combustion emissions	PDS
	Case 1	Primary data	×	Primary data (fuel-specific value provided by supplier)	=	Primary data	1× PDS unit of fuel combustion emissions
	Case 2	Primary data	×	**Primary data (emission factor calculated from fuel-specific carbon content)**	=	**Primary data**	**1× PDS per unit of fuel combustion emissions**
	Case 3	Primary data	×	**Secondary data (databases such as SHK scheme and IDEA)**	=	**Secondary data**	**0%**

Figure 2-2-39 Approach to primary data in calculating fuel combustion emissions

Source: Created by Mizuho Research & Technologies

Illustration: Calculation of primary data on emissions from power use

- Emissions from power use are also considered primary data if both power use (activity data) and the emissions factor from fuel combustion are primary data.
- Because the SHK scheme's national average factor and the factors from databases like IDEA are national averages, they are considered secondary data. The factor at time of power generation specific to the procured power is considered primary data. This includes the factor by power company under the SHK scheme. However, since the concept of PDS differs by type, it is summarized in the table below.
- In the case of a zero-emission menu such as renewable energy, the primary data is 100% because the secondary data does not enter, but since the emission amount is 0, the result is PDS = 0%.
- If secondary fuel data is used in the calculation of emissions from thermal power generation included in the power menu, this part is treated as secondary data (PDS = 0%). If primary fuel data is used, that portion is treated as primary data.
- Unbundled certificates are treated as primary data. However, since the emission amount is 0, PDS = 0% as in the renewable energy menu.

Power		Power consumption	×	Emission factor at time of power generation	=	Emissions from power	PDS
	Case 1	Primary data	×	**Primary data (factor by menu for emission factors by power utilities under SHK scheme: renewable energy/zero emission menu)**	=	**Primary data**	**0% (because emissions = 0)**
	Case 2	Primary data	×	**Factor by menu for emission factors by power utilities under SHK scheme: includes thermal power generation**	=	**Primary data**	**1× PDS per unit of power generation (Primary data on fuel combustion in thermal power generation)**
							0% (Secondary data on fuel combustion in thermal power generation)
	Case 3	Primary data	×	**Primary data (Unbundled certificates)**	=	**Primary data**	**0% (because emissions = 0)**
	Case 4	Primary data	×	**Secondary data (nationwide average factor in SHK scheme, IDEA)**	=	**Secondary data**	**0%**

Figure 2-2-40 Approach to primary data in calculating emissions from power use

Source: Created by Mizuho Research & Technologies

Illustration: Approach to primary data on emissions from raw material production

- For raw materials, emissions are calculated using cradle-to-gate emission factors.
- In the case of a cradle-to-gate PCF with emission factors provided by suppliers, the PDS of the emissions is determined according to the the PDS used in calculating the PCF.
- In order to identify the PDS in downstream companies' PCF calculations, suppliers need to provide PDSs.
- If the cradle-to-gate emission factor is used in an LCA database such as IDEA, the emission amount is secondary data.

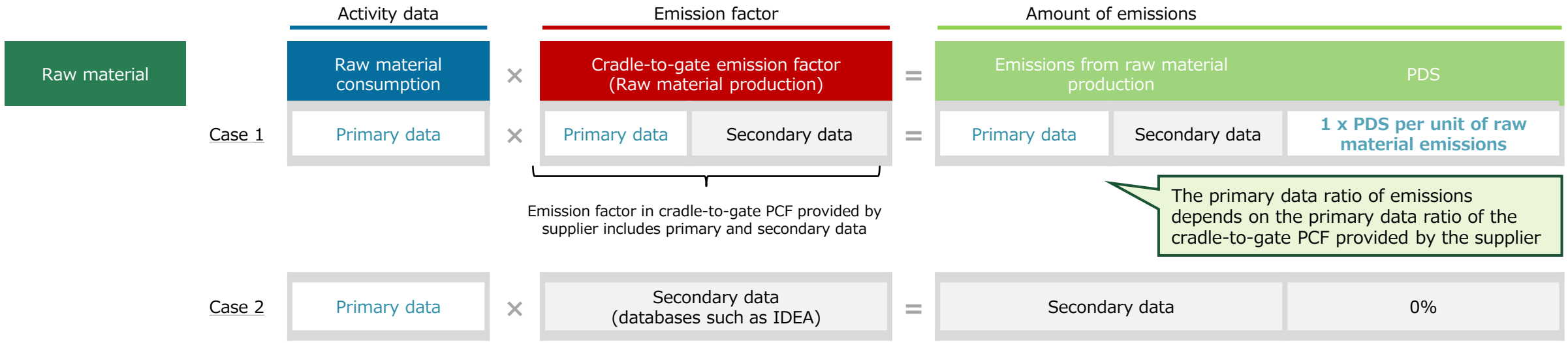


Figure 2-2-41 Approach to primary data in calculation of raw material production emissions

Source: Created by Mizuho Research & Technologies

Five data quality assessment indicators

(2) Data quality assessment

- Pathfinder Framework v2 identifies the significance of Data Quality Ratings (DQRs) as follows:
  - With companies able to calculate their PCFs using several data types, DQRs provide data users with a better understanding of the overall integrity of the data and the resulting PCF.
  - Understanding the quality of the data allows companies to identify key secondary data sources that should be improved or replaced with primary data in order for companies to be able to track the impact of emissions reduction plans more accurately.
- Once the GHG calculations for the PCF have been completed, the company undergoing data quality assessment shall calculate a DQR for the following five indicators:
  - Technological representativeness: The degree to which the data reflects the actual technology(ies) used in the process
  - Geographical representativeness: The degree to which the data reflects the actual geographic location of the processes within the inventory boundary (e.g., country or region)
  - Temporal representativeness: The degree to which the data reflects the actual time (e.g., year) or age of the process
  - Completeness: The degree to which the data is statistically representative of the process sites
  - Reliability: The level of confidence in the sources, data collection methods, and verification procedures used to obtain the data are dependable.
- The quality levels against which each indicator shall be assessed are 1— Good, 2—Fair, and 3—Poor.
- This matrix shall be used by companies to derive quantitative DQRs for each of the indicators. Companies shall include in the assessment any contribution that represents at least 5 percent of the overall PCF.

	Data quality indicators	1—Good	2—Fair	3—Poor
Factor indicator	Technological representative-ness	Same technology	Similar technology (based on secondary data sources)	Different or unknown technology
	Temporal representative-ness	Same reporting year	Less than 5 years old	More than 5 years old
	Geographic representative -ness	Same country or country subdivision	iSame region or subregion	Global or unknown
Indicator of amount of activity	Completeness	Activity data collected for all relevant sites for specified period	Activity data collected for <50% of sites for specified period or >50% of sites for shorter period	Activity data collected for <50% of sites for shorter time period or unknown
	Reliability	Measured activity data	Activity data partly based on assumptions	Financial data or nonqualified estimate

Figure 2-2-42 Data quality matrix for Pathfinder Framework v2

Source: Created by Mizuho Research & Technologies and Sustech based on Pathfinder Framework v2

Data quality assessment method

(2) Data quality assessment (continued)

- To facilitate clarity and transparency, companies shall report the ratings of each data quality indicator separately.
- No integration across data quality indicators.
- If a company produces the studied product in more than one site, it shall define the DQRs using the weighted average of production volumes of the respective sites.
- The contributions of the different PCF components (i.e., material and energy inputs) to the final DQRs are determined via a weighted average based on their emissions contribution to the total PCF.

$$\text{DQR}_{\text{index}} = (\text{DQR}_{\text{part 1}}) + (\text{DQR}_{\text{part 2}}) + (\text{DQR}_{\text{part 3}}) \times \frac{PCF_{part\,1}}{PCF_{total}} \times \frac{PCF_{part\,2}}{PCF_{total}} \times \frac{PCF_{part\,3}}{PCF_{total}}$$

Data quality indicators	Part 1	Part 2	Part 3	Total DQR
GHG contribution to total PCF	**25%**	**30%**	**45%**	**100%**
Technological representativeness	2	1	1	1.25
Geographical representativeness	1	3	1	1.60
Temporal representativeness	2	3	3	2.75
Completeness	1	1	1	1.00
Reliability	2	3	2	2.30

Figure 2-2-43 Example of data quality assessment

Source: Created by Mizuho Research & Technologies based on Pathfinder Framework v2

SWG discussion: (7) Difference between Pathfinder Framework and existing LCA (1/3)

- The PCF calculation in the cradle-to-gate boundary presented by the Pathfinder Framework differs in some respects from the existing LCA and carbon footprint calculations based on the full life cycle (cradle-to-grave). The SWG discussed and identified the gaps.
- This discussion is presented here as an appendix because it may be helpful to study existing LCA/CFP when calculating a Pathfinder cradle-to-gate PCF for the first time.

① Calculation steps

- While the PCF calculation steps are described briefly in the Pathfinder Framework, the overall organization of the Pathfinder Framework is similar to the carbon footprint approach.
- For example, the figure on the right shows a comparison with the calculation steps in the GHG Protocol Product Standard as an existing LCA calculation method.
- Because the Pathfinder Framework clarifies the setting of prerequisites, the calculation steps are limited to a few elements.
- Pathfinder Framework v2 identifies uncertainty analysis as a data disclosure element but does not require that it be performed (see 3-2). Therefore, there is no mention of the method of implementation. This may be because the Pathfinder Framework prioritizes the use of primary data and does not assume low-uncertainty data collection.
- Existing standards should be consulted when performing uncertainty analysis.
- Uncertainty analysis is not required, but the quality of the PCF data needs to be evaluated (see 2-2 -8).

Product Standard	Pathfinder Framework v2
Defining Business Goals (Chapter 2)	No description of calculation steps because these are automated
Principles of Product Life Cycle GHG Accounting and Reporting (Chapter 4)	
Fundamentals of Product Life Cycle GHG Accounting (Chapter 5)	
Establishing the Scope of a Product Inventory (Chapter 6)	Disclosure on a declared unit basis and not stated in calculation steps
Boundary Setting (Chapter 7)	Defined as cradle-to-gate in the Pathfinder Framework, not included in calculation steps
Collecting Data and Assessing Data Quality (Chapter 8)	Calculation Step (1) Data Identification
Allocation (Chapter 9)	Calculation Step (1) Data Identification, Calculation Step (3) Allocation
Assessing Uncertainty (Chapter 10)	None: Uncertainty analysis is not mandatory, but data quality should be assessed
Calculating Inventory Results (Chapter 11)	Calculation Step (2) Calculation
Assurance	Pathfinder Framework also defines implementation separately
Reporting	PCF must be shared downstream

Figure 2-2-44 Comparison of PCF calculation steps in existing LCA (Product Standard) and the Pathfinder Framework

Source: Created by Mizuho Research & Technologies

SWG Discussion: (7) Difference between Pathfinder Framework and existing LCA (2/3)

② Data collection method for each process

- The existing LCA and Pathfinder Framework differ in how they retrospectively collect activity data for upstream processes.

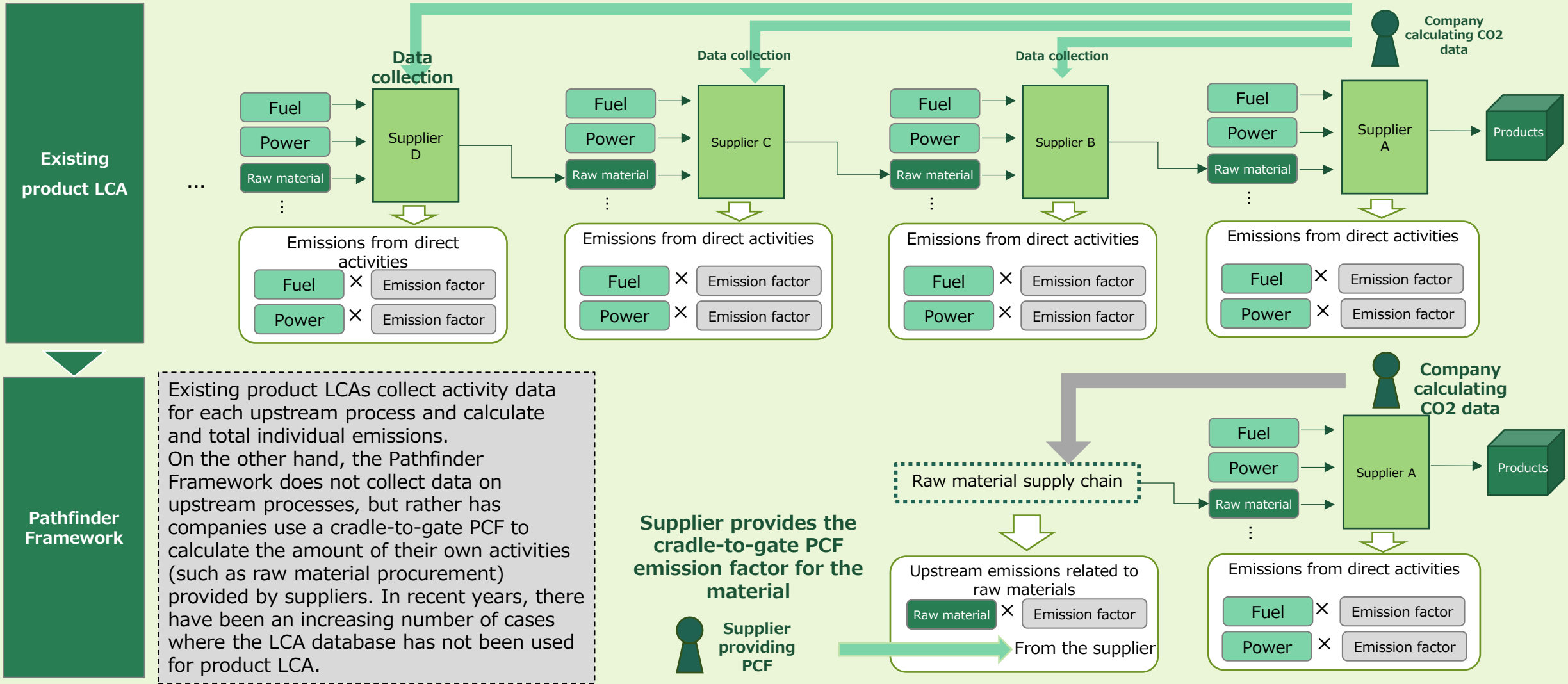


Figure 2-2-45 Differences between existing LCA and Pathfinder Framework approaches to primary data collection

Source: Created by Mizuho Research & Technologies

SWG discussion: (7) Difference between Pathfinder Framework and existing LCA (3/3)

③ Coexistence of LCA with data exchange in the Pathfinder Framework

In ① and ②, we confirmed the differences between LCA and the Pathfinder Framework, but they can be said to be equivalent to Product-based calculation of cradle-to-gate emissions.

- The Pathfinder Framework is designed to pass the cradle-to-gate PCF downstream from the supplier. This cradle-to-gate PCF does not necessarily have to be calculated according to the Pathfinder Framework, and it can be used even if it is calculated with the LCA method.
- Both LCA- and Pathfinder Framework-based emissions factor can be used, and they coexist (see figure on the right).
- However, among the differences between LCA and the Pathfinder Framework is the information passed downstream (see “3. CO2 data sharing method”).
- A secondary database may be used for the calculation.

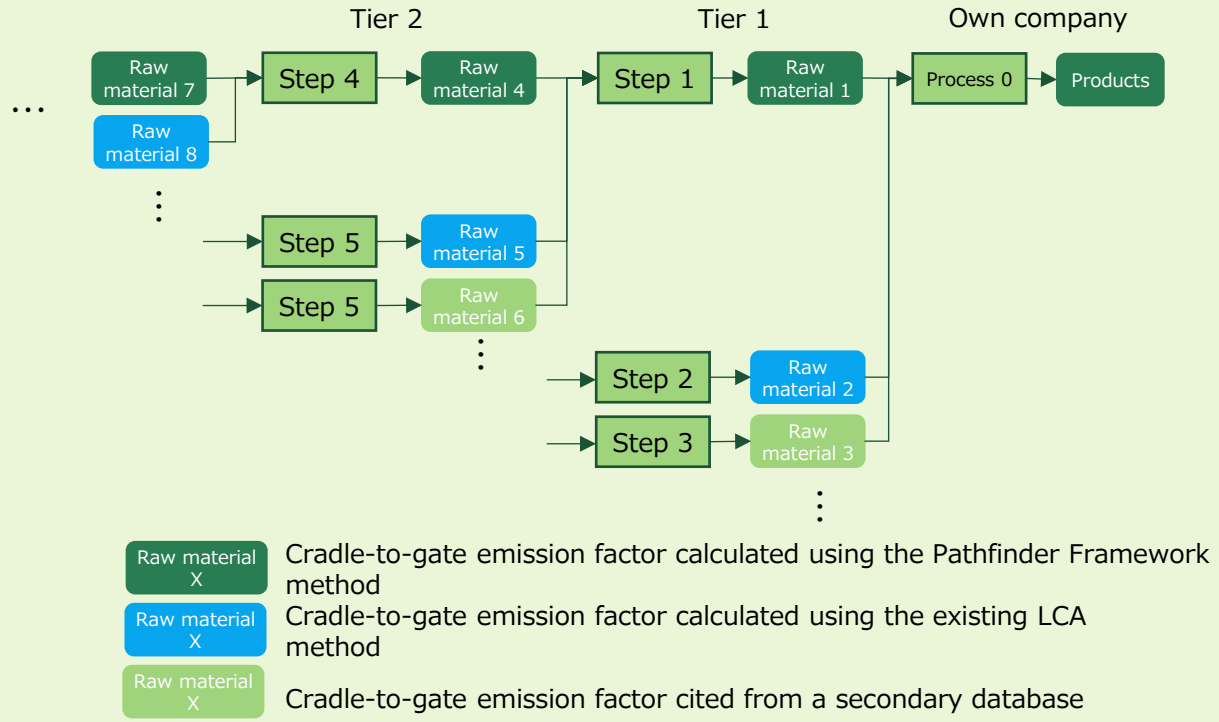


Figure 2-2-46 Coexistence of LCA with Pathfinder Framework in PCF calculation

Source: Created by Mizuho Research & Technologies

2. CO2 data calculation method

2-3. Organization-based calculation method

Positioning of Organization-based calculation

2-3. Organization-based calculation method

2-3-1. Positioning of Organization-based calculation

- The Green x Digital Consortium aims to eventually link data at the product level, but considering the current situation in which it is difficult for all companies to support Product-based calculations, the Consortium will allow Organization-based calculations in the transitional period.
- The GHG Protocol Scope 3 Standard allows suppliers to provide suppliers with CO2 data, including primary data, by calculating and reporting the portion of their Scope 1, 2, and 3 emissions attributable to activities targeted at a particular supplier (Chapter 8).
- The Green x Digital Consortium follows this approach and positions it as the basic concept of Organization-based calculation. In other words, Organization-based calculation comprises allocating the results of Scope 1, 2, and 3 emissions calculations by customer (or byproduct delivered to each customer).
- Companies that have not been able to calculate their Scope 1, 2, and 3 emissions must first calculate these using the Ministry of the Environment's materials on supply chain emissions calculation before engaging in Organization-based calculation. (The next page presents the flow of the calculation of Scope 1, 2, and 3 emissions and examples of data used for Scope 3 calculation.)

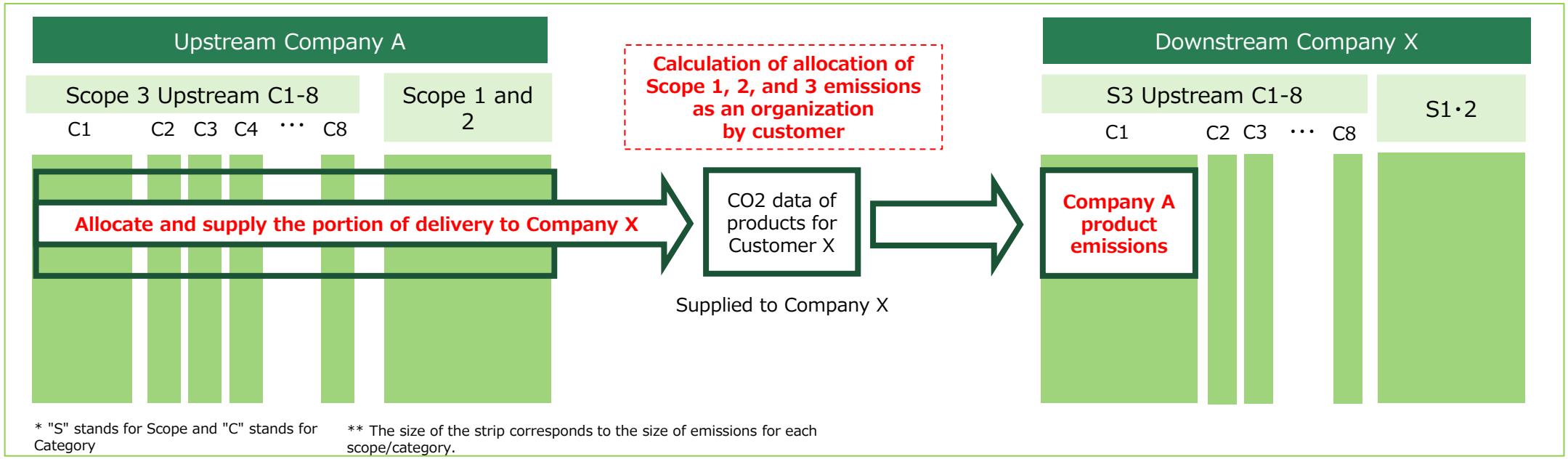


Figure 2-3-1 Organization-based calculation

Source: Created by Mizuho Research & Technologies

Reference: Outline of calculation method for Scope 1, 2 and 3 emissions

- Companies that have not been able to calculate Scope 1, 2, and 3 emissions need to calculate these using the Ministry of the Environment's materials on supply chain emissions calculation prior to conducting Organization-based calculations.
- This section presents an excerpt from the calculation method, showing the flow of calculation of Scope 1, 2, and 3 emissions (supply chain emissions) and examples of data used for Scope 3 calculation.

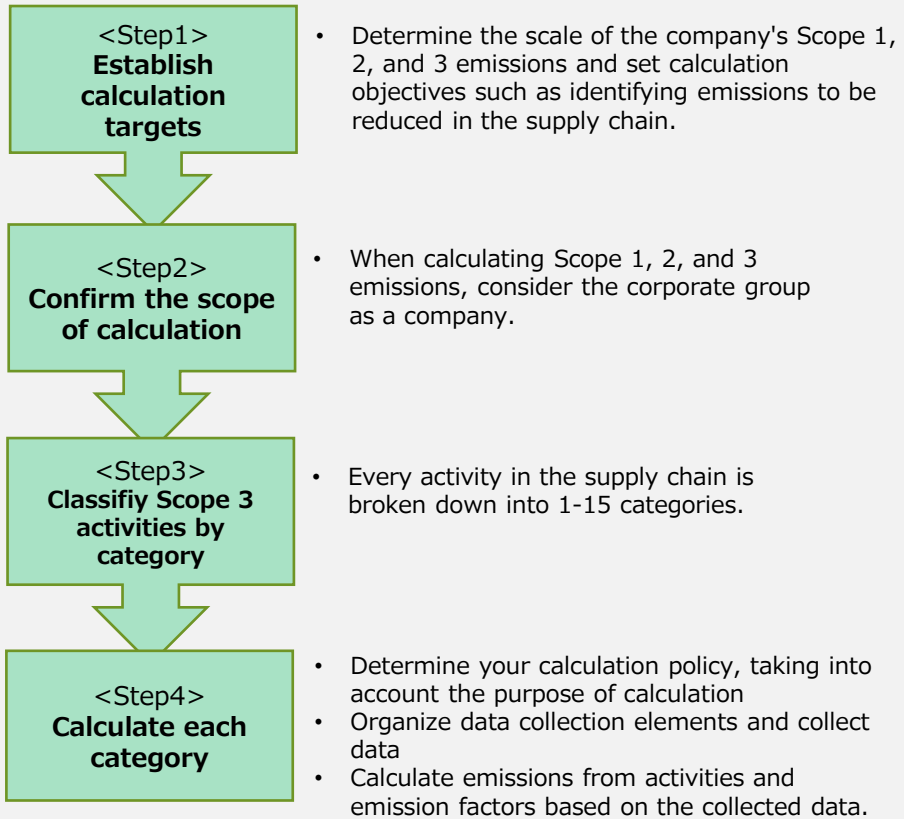


Figure 2-3-2 Flow of Scope 3 emission calculations

Scope 3 Category		Applicable activities (examples)	Emission factor (example)
1	Purchased products and services	• Procurement of raw materials, outsourcing of packaging, procurement of consumables	• Emissions per quantity
2	Capital goods	• Expansion of production facilities	• Emission factor per capital goods price by capital formation sector
3	Fuel and energy activities not included in Scopes 1 and 2	• Upstream processes for the fuel being procured (mining, refining, etc.) • Upstream power procurement (mining and refining fuel used for power generation)	• Emission factor by procurement volume by fuel and energy type
4	Transportation and delivery (upstream)	• Procurement logistics, lhorizontal flow, shipping distribution (where the company is the shipper)	• Emission factor by means of transport
5	Waste from business	• Transport and treatment of waste (excluding valuable waste) outside the company	• Emission factor at the time of treatment by type of waste
6	Business trips	• Employee travel	• Emission factor per travel expense
7	Employee commuting	• Employee commuting	• Emission factor per commuting allowance payment
8	Leased assets (upstream)	• Operation of leased assets held by the company	• Emission factor by energy type
9	Transportation and distribution (downstream)	• Shipping transportation (after the shipper's own transportation), storage in warehouses, retail sales	• Emission factor by means of transport
10	Processing of sold products	• Processing of intermediate products by business operators	• Emission factor by energy type
11	Use of sold products	• Use of the product by the user	• Emission factor of energy used during operation
12	Disposal of sold products	• Product transportation and disposal at the time of disposal by the user	• Emission factor at the time of treatment for each type of waste
13	Leased assets (downstream)	• Operation of leased assets owned by the company as a lessor and leased to others	• Emission factor by energy type
14	Franchise	• Activities that fall under Scope 1 and 2 of the franchisees organized by the company	• Emission factor by energy type
15	Investment	• Investments in stocks, bonds, and project finance	• Emission factor per share of the investee (annual Scope 1 and 2 emissions/total number of shares issued by the investee)

Figure 2-3-3 Scope 3: Activities and emission factors by category

Source: Compiled from the Ministry of the Environment and Mizuho Research & Technologies, "Calculation and Reduction of Supply Chain Emissions"

Methodology of Organization-based calculation

2-3-2. Methodology of calculation

- Today, it is possible to collect data using sensors and to manage it in a precise manner using digital technology.
- In other words, with Organization-based calculation:
  - it has become possible not only to make rough calculations for the allocation of the whole corporate group's total Scope 1, 2, and 3 emissions; but also to
  - calculate the amount of emissions from specific group companies and sites that manufacture specific products.
- In light of this situation, the Green x Digital Consortium proposes a more detailed calculation method based on the Scope 3 Standard allocation method.
- During the transitional period, the results of Product-based and Organization-based calculations are expected to be mixed in the supply chain. Since the results of the Organization-based calculation are regarded as substitutes for the results of the Product-based calculation, it is necessary to adopt the Pathfinder Framework and the provisions for Product-based calculation as part of the Organization-based calculation to bring the two approaches to calculation as close as possible.
- In light of the above, this section presents the Green x Digital Consortium's methodology for Organization-based calculation of the following elements.

(1) Scope 1, 2, and 3 data review
Presents points to consider when using Scope 1, 2, and 3 emissions data for Organization-based calculations

(2) Boundary
Presents the Consortium's approach to boundary-setting in Organization-based calculation based on the Pathfinder Framework's cradle-to-gate formula and the attributional LCA approach

(3) Allocation
Proposes a method for making more detailed calculations by collecting detailed activity data (process subdivision) based on Chapter 8: Allocating Emissions in the Scope 3 Standard

(4) Declared unit
Provides options for declared units in Organization-based calculation (by customer and by product)

(5) Handling of credit and energy attribute certificates
Presents the results of discussion on the feasibility of applying purchased energy attribute certificates and carbon credits in addition to the results of Organization-based calculation to achieve low carbon emissions

(6) Indicators of data reliability
Presents an Organization-based calculation methodology for PDS and DQRs, which are indicators of the reliability of the calculated PCF

Scope 1, 2, and 3 data review (1/2)

(1) Review Scope 1, 2, and 3 data

- Organization-based calculation calculates emissions by customer and product by allocating Scope 1, 2 and 3 emissions already calculated.
- However, the Scope 1, 2, and 3 emissions used as the basis for calculating emissions at the organizational level are not calculated for the purpose of understanding emissions by customer and product. Therefore, it is desirable to review the purpose and boundary of the calculation (i.e., what emissions are excluded) in advance when using the data for provision to customers.
- The main points to note are as follows.

■ Confirm excluded emissions

- Some emissions may be excluded from Scope 1, 2, and 3 calculations.
- Whether or not the excluded emissions include emissions that are important to products and services for the customer providing the CO2 data determines whether Organization-based calculation can calculate appropriate CO2 data for that customer(see Figure 1-4-6).
- It is recommended that emissions excluded from Scope 1, 2, and 3 calculations be identified prior to any allocation calculationss.

■ Review Scope 2 calculation method

- Scope 2 emissions are calculated using two approaches—location-based and market-based—based on the GHG Protocol Scope 2 Guidance.
- The guidance states that when providing a portion of Scope 2 emissions to downstream entities, emissions data calculated using either approach may be provided, but the approach used should be communicated (Appendix B).
- It is advisable to consider whether to allocate Scope 2 emissions on a location-based or market-based basis before implementing Organization-based calculation.

■ Confirm IDEA license used to calculate Scope 3 emissions

- IDEAv2 (for calculating supply chain greenhouse gas emissions) can be used free of charge by companies that have obtained permission from the Ministry of the Environment to calculate Scope 3 emissions.
- However, the MOE’s IDEAv2 may be used only for the purpose of calculating an organization’s own Scope 3 emissions and Organization-based calculations may not be conducted using the Scope 3 emissions calculation results and supplied to customers as CO2 data.
- If Scope 3 emissions are calculated using IDEAv2, the Scope 3 emissions must be updated by replacing the emission factor with data based on the paid version of IDEA, etc., to avoid violation of the IDEA license before Organization-based calculation is performed.

Scope 1, 2, and 3 data review (2/2)

(1) Review Scope 1, 2, and 3 data (continued)

■ Verify conformance with Pathfinder Framework requirements

- As noted above, organization-based emissions calculations too should be conducted to the greatest extent possible using a methodology similar to the Pathfinder Framework and the Product-based calculation described in this document.
- Therefore, it is important to check whether any part of the Scope 1, 2, and 3 emissions data used in Organization-based calculation was calculated using a methodology not consistent with the Pathfinder Framework or the Product-based calculation methodology.
- Figure 1-4-23 can be used to assist this review. It summarizes the key differences between the Pathfinder Framework v2, ISO 14067:2018, and the GHG Protocol Product Standard. Despite differences in the targeted organizations and products, the Scope 3 Standard, in principle, adopts the same approach as the Product Standard in its methodology for estimating GHG emissions. Therefore, many of the differences shown in the figure can be seen as differences between the methodology of Scope 1, 2 and 3 emissions calculation and that of Pathfinder Framework v2.
- Typical examples are shown on the right.
- These elements should be revised in line with the Pathfinder Framework concept, taking into account the status of your company’s handling of Scope 1, 2 and 3 emissions calculations.

[Allocation method for recycling-related emissions]

- The recycled content method is recommended for Scope 3 Category 5 calculation, while use of the closed-loop approximation method is also permitted (see 2-2-5 (3) for more on the two methods). Pathfinder Framework v2 states the application of the recycled content method is a recommendation (should).
- Companies should check whether they are using the closed-loop approximation method in their calculation of Scope 3 emissions.

[Upstream emissions from transportation fuel production]

- Upstream emissions from transportation fuel production are not included in the minimum boundary of Scope 3 Category 4, so this emission might not be counted in Scope 3 emissions. Pathfinder Framework v2, on the other hand, requires this emission to be included in the boundary.
- In calculating Scope 3 emissions, companies should check how upstream emissions from transportation fuel production are handled.

[Secondary data databases that can be used]

- While the Scope 3 Standard does not set requirements for secondary data databases to be used, Pathfinder Framework v2 specifies examples of databases that may be used (Figure 2-2-30) and safeguards.
- In calculating Scope 3 emissions, companies should check whether they are databases not permitted by Pathfinder Framework v2.

Boundary (1) Cradle-to-gate in the Scope 1, 2 and 3 framework

(2) Boundary

① Cradle-to-gate in the Scope 1, 2 and 3 framework

- This document, like the Pathfinder Framework, in principle adopts the cradle-to-gate method as the CO2 data calculation method to be implemented by supplier companiesn.
- The cradle-to-gate method is also adopted for Organization-based calculation.
- The correspondence between the Scope 1, 2 and 3 framework used to calculate an organization's emissions and cradle-to-gate is as follows:

  - Scope 1 and 2 correspond to gate-to-gate
  - Scope 3 upstream (Categories 1-8) corresponds to emissions from upstream activities

- Therefore, in Organization-based calculations, emissions data for the upstream portion of Scope 1 and 2 and Scope 3 upstream (Categories 1-8) are allocated to each customer using the procedure described below. (Category 4 is where the company excludes the shipper's outbound logistics.)
- However, if all of Scope 1 and 2 and the upstream categories (1-8) of Scope 3 are included in the boundary in Organization-based calculation, the boundary will be different from the Product-based calculation. The extent to which boundaries are included will be described later in (2) Determination of Scope 1, 2 and 3 boundaries.

Scope 1: Direct emissions of greenhouse gases by business (fuel combustion and industrial processes)
Scope 2: Indirect emissions from the use of electricity, heat and steam supplied by other companies
Scope 3: Indirect emissions other than Scope 1 and Scope 2 (emissions by other companies related to business activities)

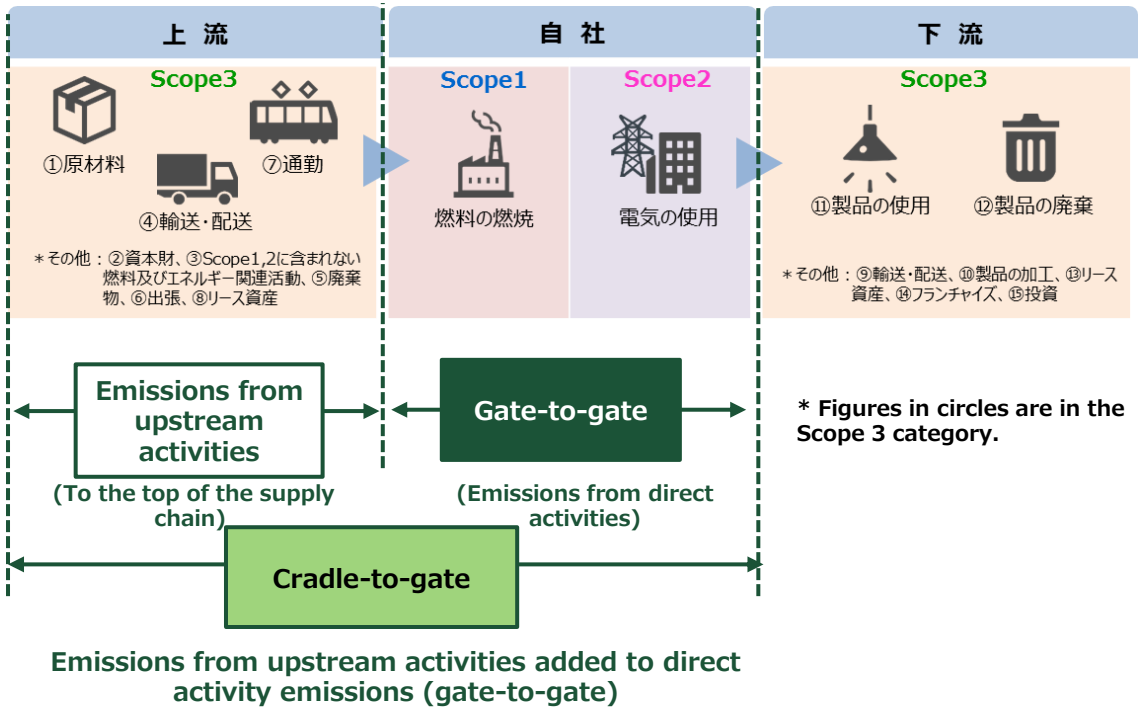


Figure 2-3-4 Correspondence between Scope 1, 2, and 3 and cradle-to-gate

Source: Created by Mizuho Research & Technologies based on the Ministry of the Environment/Mizuho Research & Technologies "Towards Calculation and Reduction of Supply Chain Emissions"

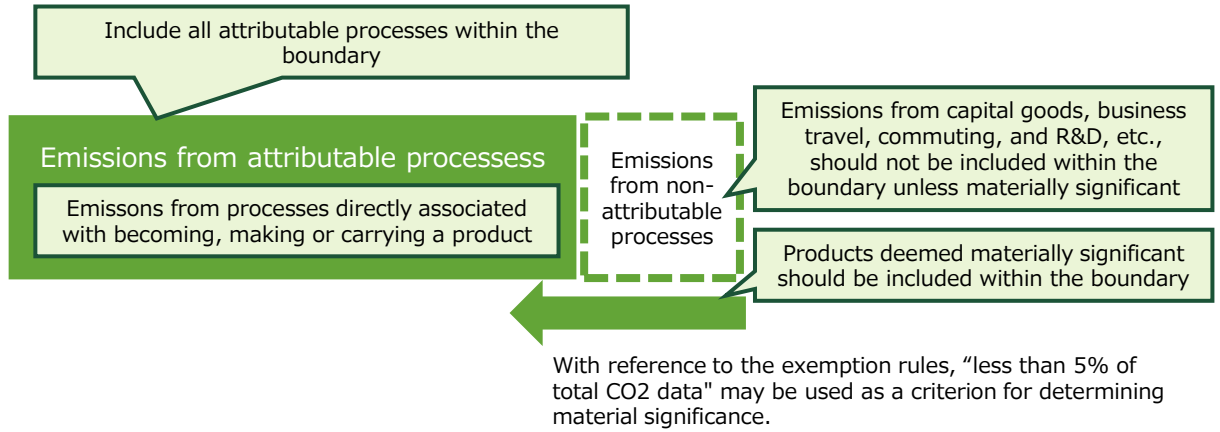
Boundary (2) Determination of Scope 1, 2 and 3 boundaries

(2) Boundary

② Determination of Scope 1, 2 and 3 boundaries

- The Pathfinder Framework is based on an attributional LCA approach, whereby all attributable processes (any processes associated with services, materials, or energy flows that become, make, or carry a product throughout its life cycle) must be included within the PCF boundary to calculate emissions. Conversely, non-attributable processes that are not related to product manufacturing (manufacturing of production equipment, buildings and other capital goods, business travel by personnel, travel to and from work by personnel, and research and development activities) are indirect activities and should consequently not be included within the boundary unless materially significant.
- In addition, Pathfinder Framework v2 introduced exemption rules (cut-off rules) that allow the exclusion of individual attributable processes deemed insignificant because they represent less than 1 percent of the total cradle-to-gate PCF, as long as the sum of excluded processes in aggregate is less than 5 percent of the total estimated cradle-to-gate PCF emissions.
- The boundary for Product-based calculation observes the same approach to non-attributable processes as Pathfinder Framework v2 (see Sections 2-2-4 (1) (1) ① and 2-2-4 (3)).
- Organization-based calculation also adopts this approach, with processes that are deemed to to constitute insignificant indirect activities excluded from the calculation. However, products deemed materially significant should be included within the boundary.

A) Non-attributable processes lie outside of the PCF boundary



B) Application of exemption rules to attributable processes

See Figure 2-2-14

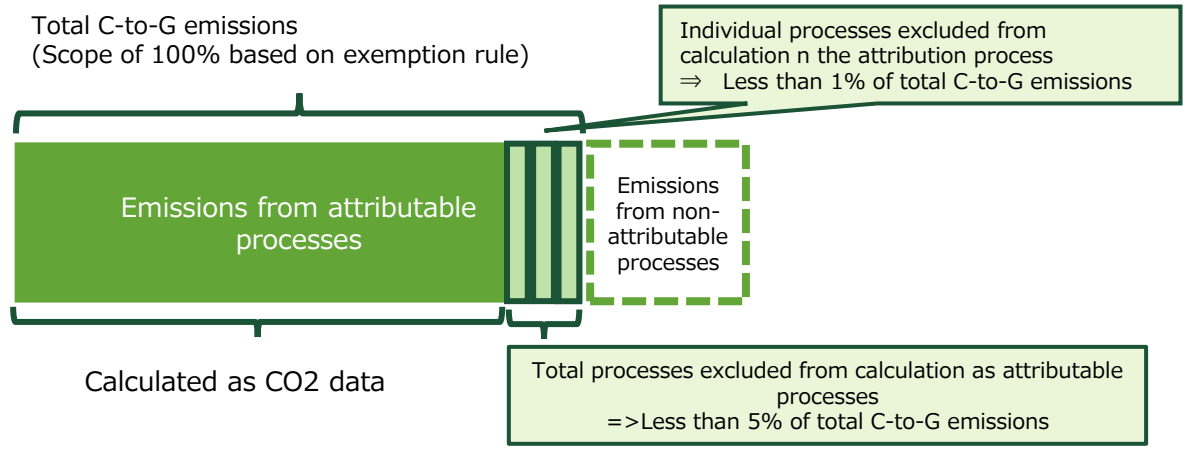


Figure 2 -3 -5 Approach to Boundaries and Calculation Targets in Organizational Basis Calculation

Source: Created by Mizuho Research & Technologies

Boundary (2) Determination of Scope 1, 2 and 3 boundaries

(2) Boundary

② Determination of Scope 1, 2 and 3 boundaries (continued)

- Applying the concept on the previous page specifically to Scope 1, 2, and 3 emissions, Scope 3 Categories 2, 6, 7, and 8 are generally considered to be non-attributable processes. Each of these may also be included within the boundary if deemed significant, but should not be included otherwise.
- Scope 1, Scope 2, and the remaining Scope 3 categories are attributable processes. It may be determined on a case-by-case basis based on the cut-off rules that some or all of these processes are indirect activities and should can consequently be excluded from calculation. (One example is Scope 2 office building lighting.)
- However, the above does not apply where PCR, etc., deem that indirect activities should be included within the boundary.

- When calculating and sharing the DQR noted in Section (6) ②, we recommended that companies confirm the DQR for each process when determining which processes to include in the calculation.

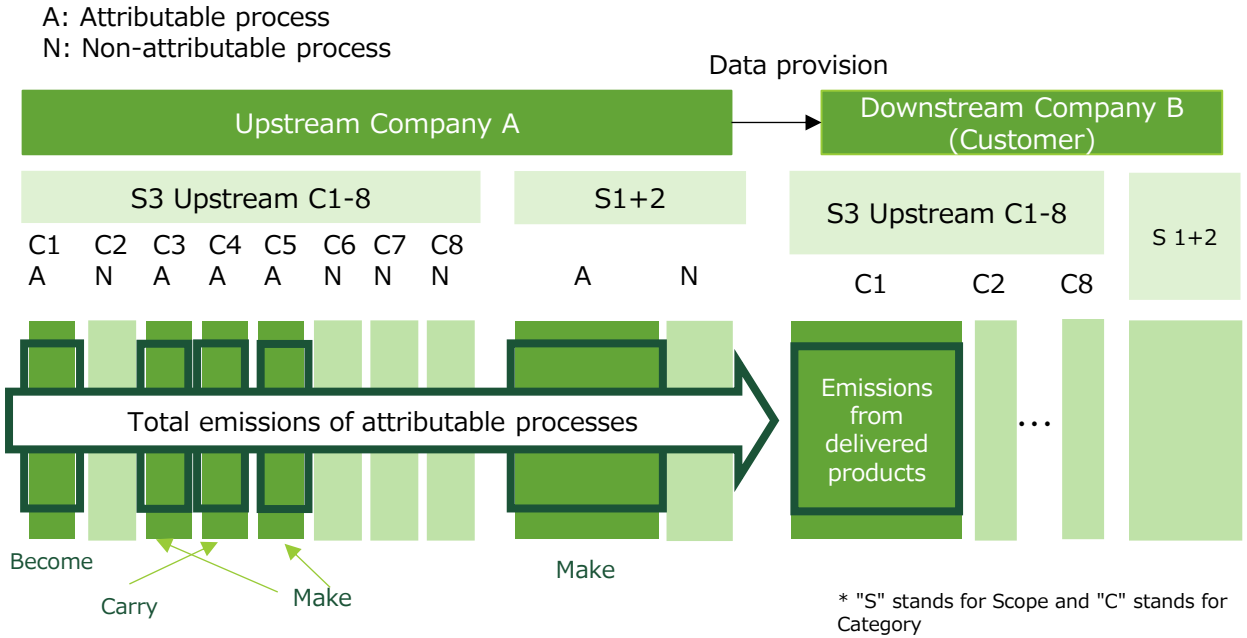


Figure 2-3-6 Relationship between attributable processes and Scope 1, 2, and 3 emissions

Source: Created by Mizuho Research & Technologies

Allocation

(3) Allocation

- Currently, Chapter 8: Allocation, of the GHG Protocol Scope 3 Standard is the only document that can be called guidance for an Organization-based calculation methodology (see 1-4-3 (2) in this document). Therefore, the allocation calculation methodology here is based on Chapter 8 of the Scope 3 Standard. (Although Pathfinder Framework v2 provides its own allocation decision tree, which t differs from the decision tree in Figure 2-3-7, we will continue to reference the Scope 3 Standard GHG Protocol for our Organization-based calculation.)
- Section 8 of the Scope 3 Standard divides the allocation procedure into two stages: avoiding and minimizing allocation and performing allocation.

- **First, to avoid and minimize allocation, companies will collect more detailed activity data (process subdivision) and try to avoid or minimize allocation if possible.**
- **If allocation is still unavoidable, it will be performed.**

- The advance of digitization has made process subdivision easier, so as an allocation methodology in Organization-based calculation, we show how to (1) avoid and minimize allocation and (2) perform allocation when process subdivision is carried out.

- However, as noted in Section 2-1-2, in light of the Green x Digital Consortium's positioning of Organization-based calculation, the methodology presented here should be regarded as a recommendation for improving data quality.

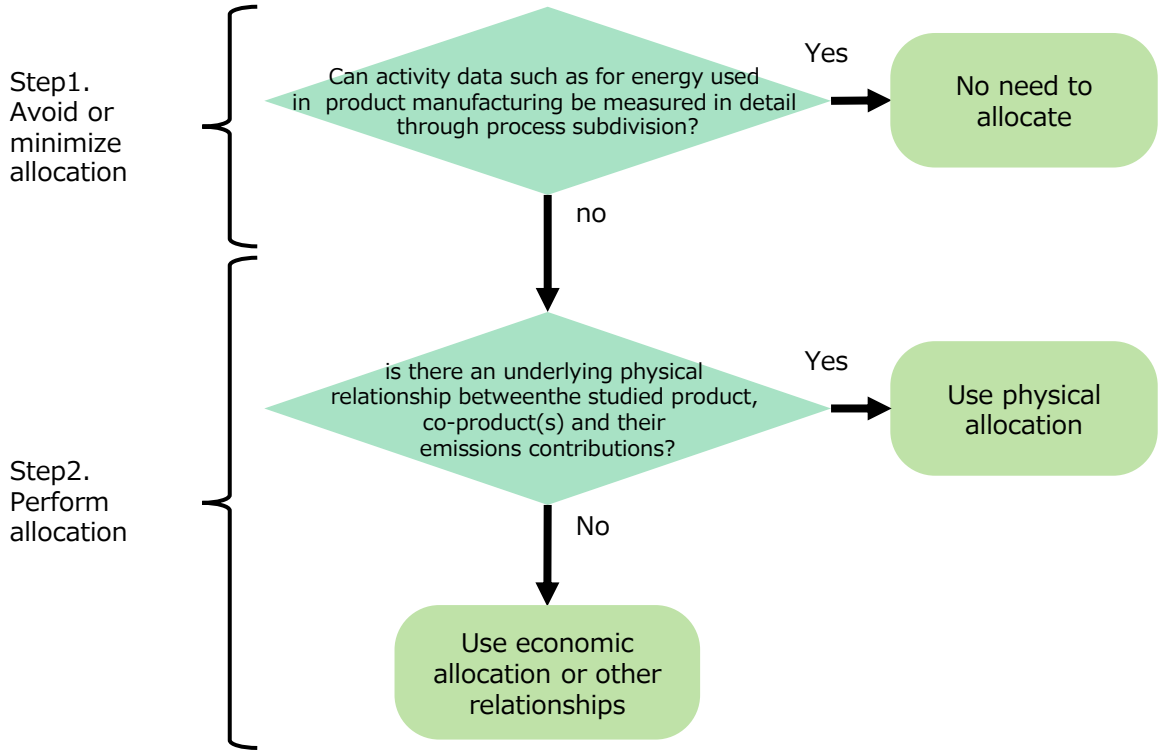


Figure 2-3-7 Scope 3 Standard allocation decision tree

Source: Produced by Mizuho Research & Technologies from Scope 3 Standard GHG Protocol

Avoiding and minimizing allocation (Process subdivision)

(3) Allocation

① Avoiding and minimizing allocation (Process subdivision)

- Allocation is a calculation method that divides the emissions of a facility or system among the various outputs thereof.
- Therefore, if the amount of emissions from one output among multiple output is to be obtained through an allocation calculation, the emissions data for other output will be mixed in.
- Consequently, the Scope 3 standard, like the Product-based calculation standard, recommends that allocation be avoided whenever possible:

> - Allocation is necessary in situations where there is at least one common process that has multiple valuable products as inputs or outputs and for which it is not possible to collect data at the individual input or output level.
> - However, more detailed data should be collected and companies should avoid or minimize allocations wherever possible by, for example, using process subdivision to measure activity data such as energy use.
>
> (Scope 3 Standard 8)

- Process subdivision is the act of dividing the common process that produces multiple outputs into sub-processes corresponding to individual products.
- For example, in the case of an organization with multiple manufacturing sites, the common process might be the production activities of the entire organization (the sum of the production of multiple sites), and the sub-processes might be the production activities of each site.
  - It is also possible to define the production activities of the entire site as common processes and the production activities of each production line within the site as sub-processes.
- At this time, the accuracy of calculation results will differ significantly if the emissions from the common process (total production of multiple sites) are allocated to all products of multiple sites and if the emissions from the sub-processes (production of each site) are allocated to the products of each site (as illustrated in Figure 2-3-8 on the next page).
- Following the Scope 3 Standard 8 at left, this document also recommends the following in organizational-level calculation:

> - To improve the accuracy of calculation results, process subdivision should be performed prior to the allocation calculation and organizations (companies, facilities, production lines, etc.) that are not related to the products for a certain business partner should be excluded from the emissions covered under the allocation calculation.

Illustration: How process subdivision affects allocation

- Assumes a situation in which Product A1 emissions are calculated using Organization-based calculation. Product A1 is assumed to be manufactured only at the company's site (Site 1).
- Left figure: No process subdivision: Product A1 emissions are calculated based on Scope 1, 2, and 3 emissions data for the entire organization.
  In other words, emissions of fuel and raw materials, etc., that are not directly related to the production of Product A1 are also used to calculate Product A1 emissions.
- Right figure: Process subdivision. Accuracy in calculating Product A1 emissions through allocation improved by more pinpointing of the amount of activities related to the production of Product A1.

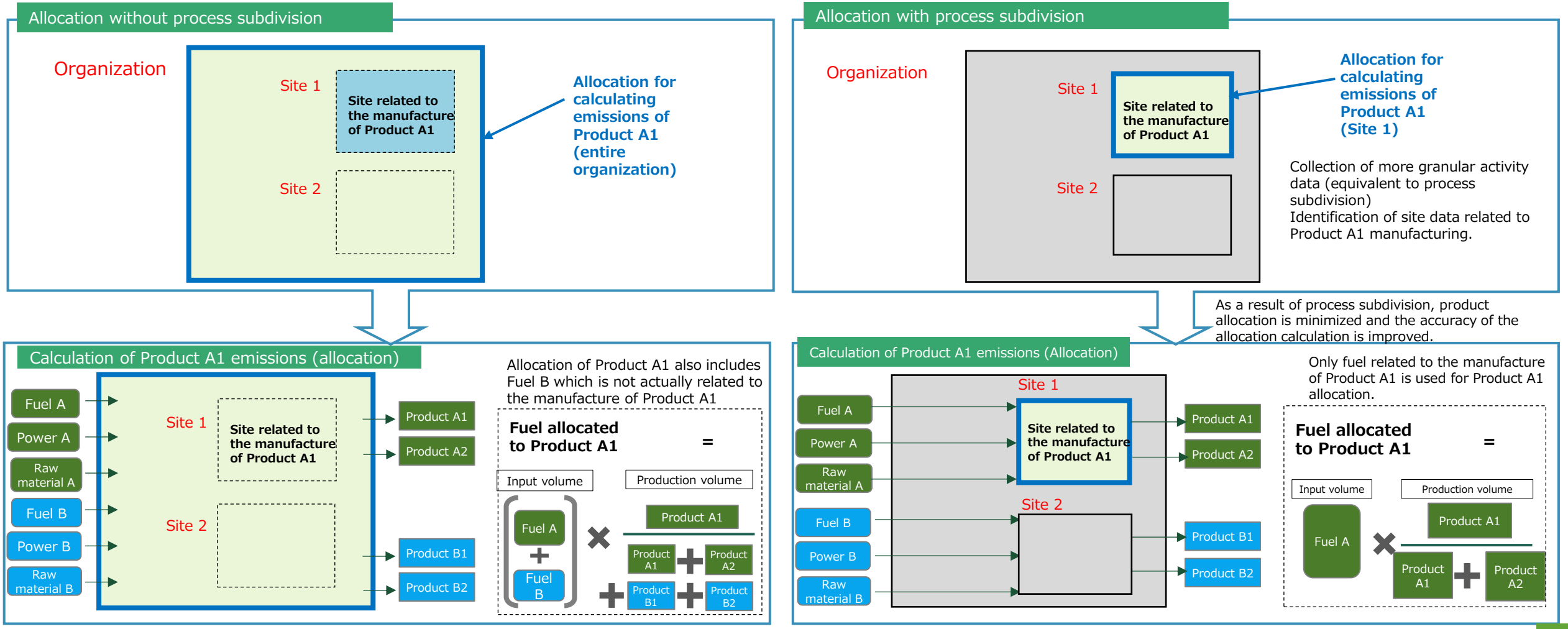


Figure 2-3-8 Process subdivision to avoid and minimize allocation

Source: Created by Mizuho Research & Technologies

Performance of allocation

(3) Allocation

② Performance of allocation

- This document uses the recommendations of the Scope 3 Standard in performing allocation calculations:

> - If avoiding allocation is not possible, companies should first determine total facility or system emissions, then determine the most appropriate method and factor for allocating emissions.
> - Companies should select the allocation approach that best reflects the causal relationship between the production of the outputs and the resulting emissions; results in the most accurate and credible emissions estimates; best supports effective decision-making and GHG reduction activities; and otherwise adheres to the principles of relevance, accuracy, completeness, consistency and transparency.
> - Companies may use a combination of different allocation methods and factors to estimate emissions from the various activities in the Scope 3 inventory. However, for each individual facility or system, a single, consistent allocation factor should be used to allocate emissions throughout the facility or system.
> - The sum of the allocated emissions for each output of a system should equal 100 percent of emissions from the system. The use of multiple allocation methods for a single system can result in over-counting or under-counting of total emissions from the system.
>
> (Scope 3 Standard Chapter 8)

- This document organizes the recommendations of the Scope 3 Standard into three areas:

> - **Factors used for allocation should best reflect the causal relationship between product manufacturing and emissions.**
> - **The factor used for allocation should be one consistent factor (e.g., production volume, production value) for each allocation calculation.**
> - **The sum of the results of the allocation and the total amount before the allocation should match.**

- Consistency in the factors used for allocation only needs to be ensured by allocation calculation.
- For example, if process subdivision yields emissions for Sites A and B, respectively, and allocations are performed for the products of each site, there is no need to use the same allocation factor for Sites A and B.

Declared units in Organization-based calculation: Yen also allowed

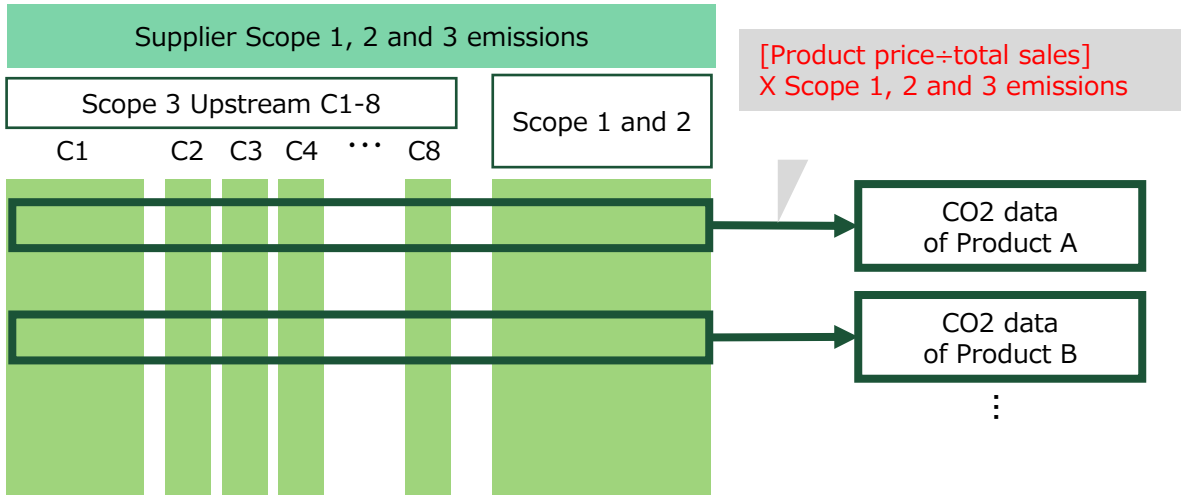
(4) Declared units

- As with Product-based calculation, Organization-based calculation uses declared units to present CO2 data. However, caution should be exercised in the application of declared units in Organization-based calculation, as there are unique challenges that differ from those in Product-based calculation.

① Include the currency unit "yen" in the declared unit

- As described above in 2-2-3 (4), the declared units used in Product-based calculations are L, kg, m3, kWh, MJ, tkm and m2.
- For Organization-based calculation, the currency unit "yen" is added.
- This is because “yen” is often used as a factor for allocating Scope 1, 2 and 3 emissions calculated as an organization to specific products or transactions with specific customers.
- Specifically, the yen is used as the allocation factor when the following calculations are performed:
  - If the allocation is to a specific product, multiply Scope 1, 2, and 3 emissions by product price (yen)/total sales (yen)
  - In the case of allocation to transactions with specific customers, Scope 1, 2, and 3 emissions are multiplied by the amount delivered to the customer/total sales.
- The Pathfinder Framework does not include currency as a declared unit. Note that the use of the declared unit “yen" is permitted only when applying this document's Organization-based calculation methodology.

■ Calculation of allocation to specific products



■ Calculation of allocation to transactions with specific customers

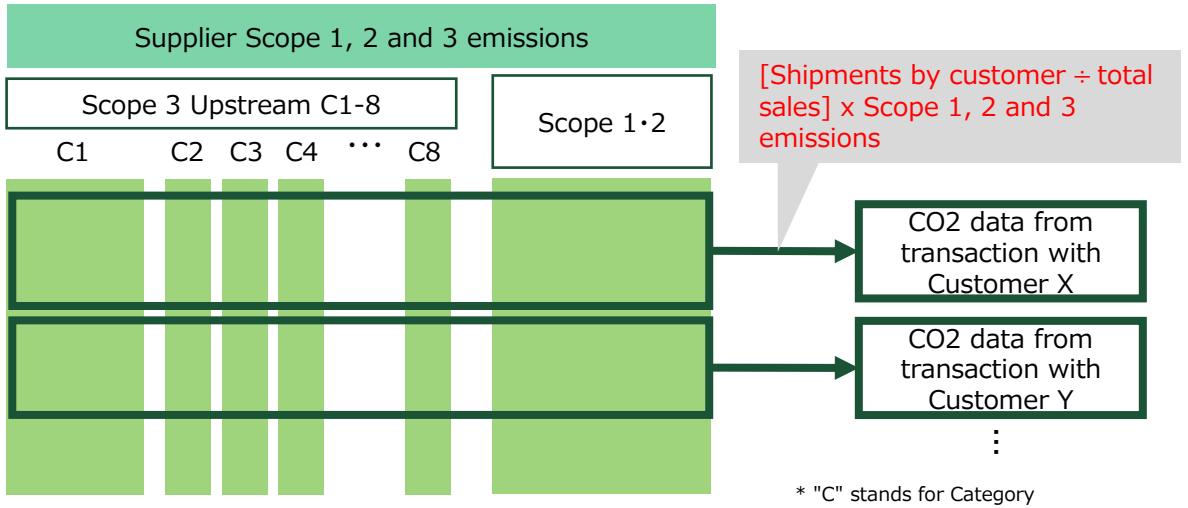


Figure 2-3-9 Yen may appear in allocation calculations in Organization-based calculation

Source: Created by Mizuho Research & Technologies

Declared units in Organization-based calculation: Expansion of concept of product quantity (1/2)

(4) Declared units

② Applying the concept of product quantity to transaction quantity

- Organization-based calculation applies an extended version of the concept of product quantity used as a set with declared units.
- In Product-based calculation, "product quantity" is defined as "the amount of a declared unit contained in a product referred to in the PCF" (see 2-2-3 (4)). The PCF corresponds to Product-based CO2 data.
- For example, when CO2 data for a product weighing 5 kg per unit (20 kg-CO2e per unit) is expressed per declared unit “kg”, the product quantity” is “5”. By multiplying the CO2 data expressed per kg by the product quantity, the unit quantity of the product can be converted into CO2 data per unit.

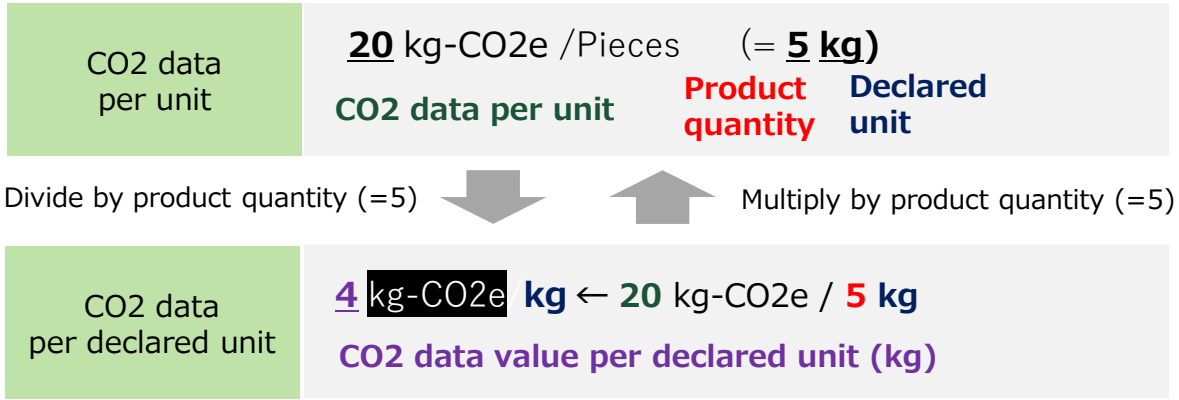


Figure 2-3-10 Product quantity in Product-based calculation

Source: Created by Mizuho Research & Technologies

- In Organization-based calculation, CO2 data is calculated in units of specific products, but CO2 data is often calculated in units of transactions with specific customers (Figure 2-3-9).
- In the case of the former (CO2 data calculated in units of specified products):
  The definition of "product quantity" in Product-based calculation can be applied as is.
- For example, if CO2 data (1kg-CO2e) for a product costing 1000 yen per unit is expressed per declared unit of yen, the product quantity is 1000. By multiplying the CO2 data expressed per yen by product quantity, the unit quantity of the product can be converted to CO2 data per unit.

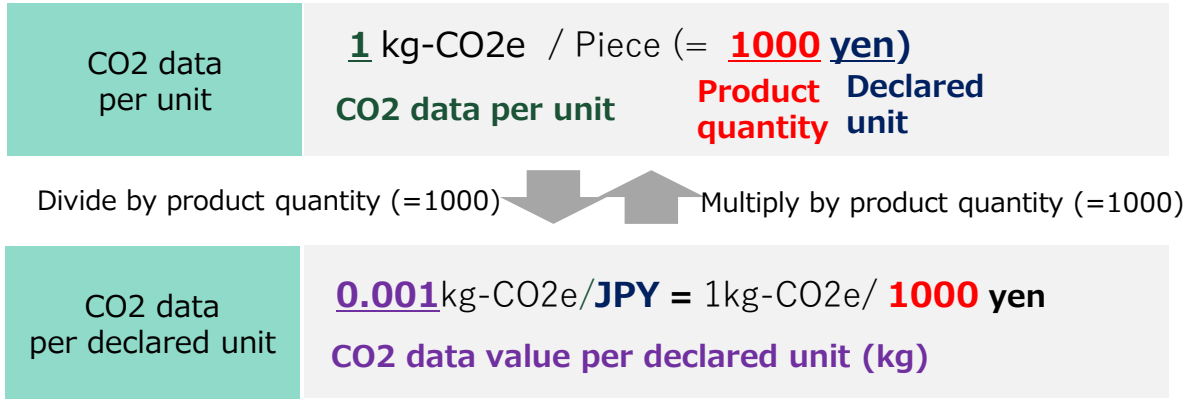


Figure 2-3-11 Product quantity in Organization-based calculation (1) Calculation on a per product basis

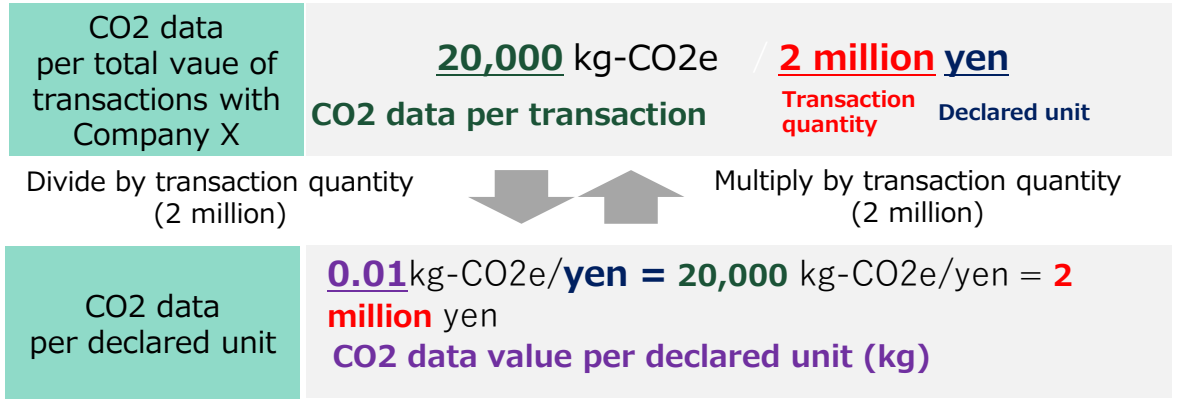
Source: Created by Mizuho Research & Technologies

Declared units in Organization-based calculation: Expansion of concept of product quantity (1/2)

(4) Declared units

② Applying the concept of product quantity to transaction quantity (continued)

- In the latter case (CO2 data calculated in units of transactions with specified customers):
  The concept of "product quantity" is extended to transaction quantity (transaction value).
- Assume the following fictitious case:
  - Assume Supplier A with sales of 10 million yen (10 million yen) and Scope 1, 2, and 3 emissions (Scope 3 upstream only) of 100,000kg-CO2e (100,000kg-CO2e)
  - Company A delivers 100 elements of various products to Customer X, and the total amount of transactions reached 2 million yen (2 million yen) per year.
  - Company A was asked by Company X for CO2 data corresponding to its own (Company X) procurement activities.
  - Company A gave up using Product-based calculation to calculate CO2 data for each of its 100 products and opted to use Organization-based calculation to calculate CO2 data in units of the total value of transactions with Company X.
- At this time, in the Organization-based calculation, the CO2 data can be calculated in units of the total quantity of transactions with Company X by multiplying the Scope 1, 2, and 3 emissions of Company A by the “total quantity of transactions with Company X ÷ total sales”: 100,000 kg-CO2e/company-wide × 2 million yen/Total quantity of transactions with Company X ÷10 million yen/Company =20,000 kg - Total quantity of transactions with CO2e/X
- The CO2 data value per total transaction quantity (2 million yen) with Company X is calculated as 20,000 kg-CO2e. However, in order to show the CO2 data value per yen declared unit during data exchange, it is necessary to divide by 2 million, which is the transaction volume in yen units to make 0.01 kg-CO2e/yen (20,000 ÷2 million). In addition, when the CO2 data value per yen unit is returned to the value per total transaction quantity, it is multiplied by 2 million, which is the transaction quantity in yen units.
- In this calculation, 2 million, which is the volume traded in yen units, plays the same role as product quantity on the previous page. The introduction of a new index called transaction quantity in addition to product quantity will complicate data exchange, so product quantity will be replaced with transaction quantity when exchanging CO2 data on transaction basis.



*The data disclosure element for “transaction quantity" in the figure is not a new figure but rather substituted for "product quantity”

Figure 2-3-12: Product quantity in Organization-based calculation ② Calculation by transaction unit

Source: Created by Mizuho Research & Technologies

Handling of credits and energy attribute certificates

(5) Handling of credits and energy attribute certificates

- The procedure for calculating CO2 emissions data for delivery destinations from Scope 1, 2, and 3 emissions data by process subdivision and allocation calculation has been presented in (3) above.
- SWG members discussed the possibility of applying additional purchased electricity certificates and carbon credits to the CO2 data obtained from Organization-based calculations to reduce carbon emissions.
- In light of the GHG Protocol standards and guidance related to Organization-based calculation, this document presents an approach to credit and energy attribute certificate processing that does not violate the rules.

① Handling of carbon credits

- Current GHG protocol provisions do not permit reductions in Scope 1, 2 and 3 emissions using carbon credits.
- Therefore, even if carbon credits are applied (amortized) to the CO2 data in the Organization-based calculation and offset, the effect is not reflected in the Scope 3 calculation of the downstream company that received the data. It can be concluded that the application (amortization) of carbon credits is ineffective for the purpose of contributing to the reduction of Scope 3 emissions by downstream businesses.
- The GHG Protocol is currently reviewing its rules, but the draft GHG Protocol Land Sector Carbon Removal guidance has already indicated the same policy regarding the handling of carbon credits.
- We will continue to closely monitor trends in the GHG Protocol in relation to the handling of carbon credits and update this in the Organization-based calculation as appropriate.

② Handling of energy attribute certificates

- Energy attribute certificates are allowed to be used when the GHG Protocol's Scope 2 Guidance uses a market-based approach to calculate Scope 2 emissions. The Scope 2 Guidance states that when providing Scope 2 emissions data to recipients, emissions data calculated using either the location-based approach or the market-based approach may be provided.
- From the above, it can be concluded that energy attribute certificates can be reflected in the CO2 data provided to the customer by:

a. Adopting a market-based approach and reflecting energy attribute certificates in the company's Scope 2 emissions calculation results;

b. Disclosing the use of the market approach to suppliers; and

c. Supplying the allocation results for Scope 2 emissions data.

Handling of credits and energy attribute certificates

(5) Handling of credits and energy attribute certificates

② Handling of energy attribute certificates (continued)

- The method shown on the previous page is a general method for applying energy attribute certificates. However, SWG members also discussed whether or not the following energy attribute certificates can be applied.

  - **The GHG Protocol takes the view that the reduction effect of emissions from energy attribute certificates is achieved by overwriting the attributes of purchased power with attributes such as renewable energy power held by the certificate side (Scope 2 Guidance). In many cases, power contracts are made on a site basis, and the minimum unit for overwriting power attributes by energy attribute certificates is also often on a site basis.**
  - **In the application of certificates of electricity at each site, is it possible to achieve 100% renewable energy by applying them only to electricity supplied to specific production lines or products manufactured at certain times?**

- The GHG Protocol does not provide explicit guidance on the applicability of such certificates. The Pathfinder Framework also makes no mention of this issue.
- In the PoC phase of this project, we tested the above based on the preliminary proposal which we made in Edition 1.0. Based on the fact that no negative opinions or improvemen suggestions were raised during PoC testing, we have adopted the policy of allowing the application of energy attribute certificates for power input to specific production lines or products manufactured at a given time in accordance with the Edition 1.0 proposal as follows:

- **Allow the intensive application of energy attribute certificates for power input to specific production lines or products manufactured at a given time.**
- **However, there shall be no double counting of energy attribute certificates and the total number of certificates applied shall be equal to the total number of certificates procured.**
- **Only unbundled certificates (purchased separately from actual power) purchased directly by consumer companies can be used for this process.**

*The reason why certificates that can be applied intensively to specific lines and products are limited to unbundled certificates (certificates purchased separately from actual power) is because the amount of energy attribute certificates included in the electricity menu purchased from retail electricity providers is difficult for consumer companies to understand and for third parties to verify.

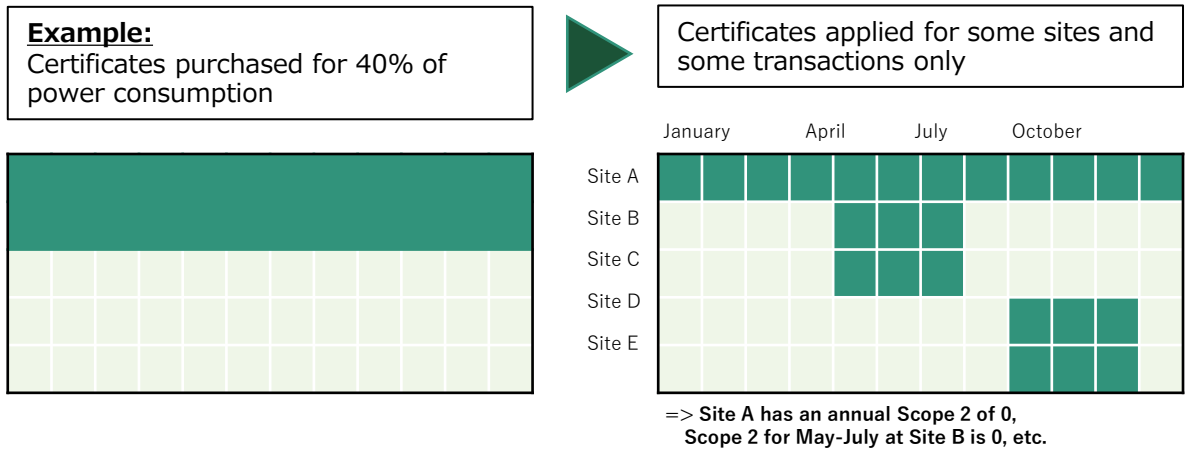


Figure 2-3-13 Application of certificates to some sites and periods

Source: Created by Mizuho Research & Technologies

SWG Discussion: (8) Cases in which double counting of certificates is easily overlooked

- This document permits the application of unbundled certificates to certain production lines and products, provided that double counting is strictly prohibited.
- However, SWG members pointed out that there are cases where double counting is easily overlooked, and suggested that awareness had to be raised in this regard.
- One such case is where supplier companies perform both Product-based and Organization-based calculations.
- For example, if one customer specifies Product-based calculation and another specifies Organization-based calculation, the same supplier will use Product-based calculation and Organization-based calculation depending on the customer.
- In such a case, information management concerning the application of certificates is likely to be complicated. Even if dual counting within the scope of Product-based calculation or within the scope of Organization-based calculation is avoided, there may be cases where certificates are used in both Product-based and Organization-based calculation.
- To prevent such double counting, a procedure could be established, for example, in which certificates are first applied to Product-based calculation and the remaining certificates are applied to Organization-based calculation.
- In any case, it must be understood that simply checking for double counting within one calculation method is not sufficient to prevent double counting, so proper procedures need to be established.

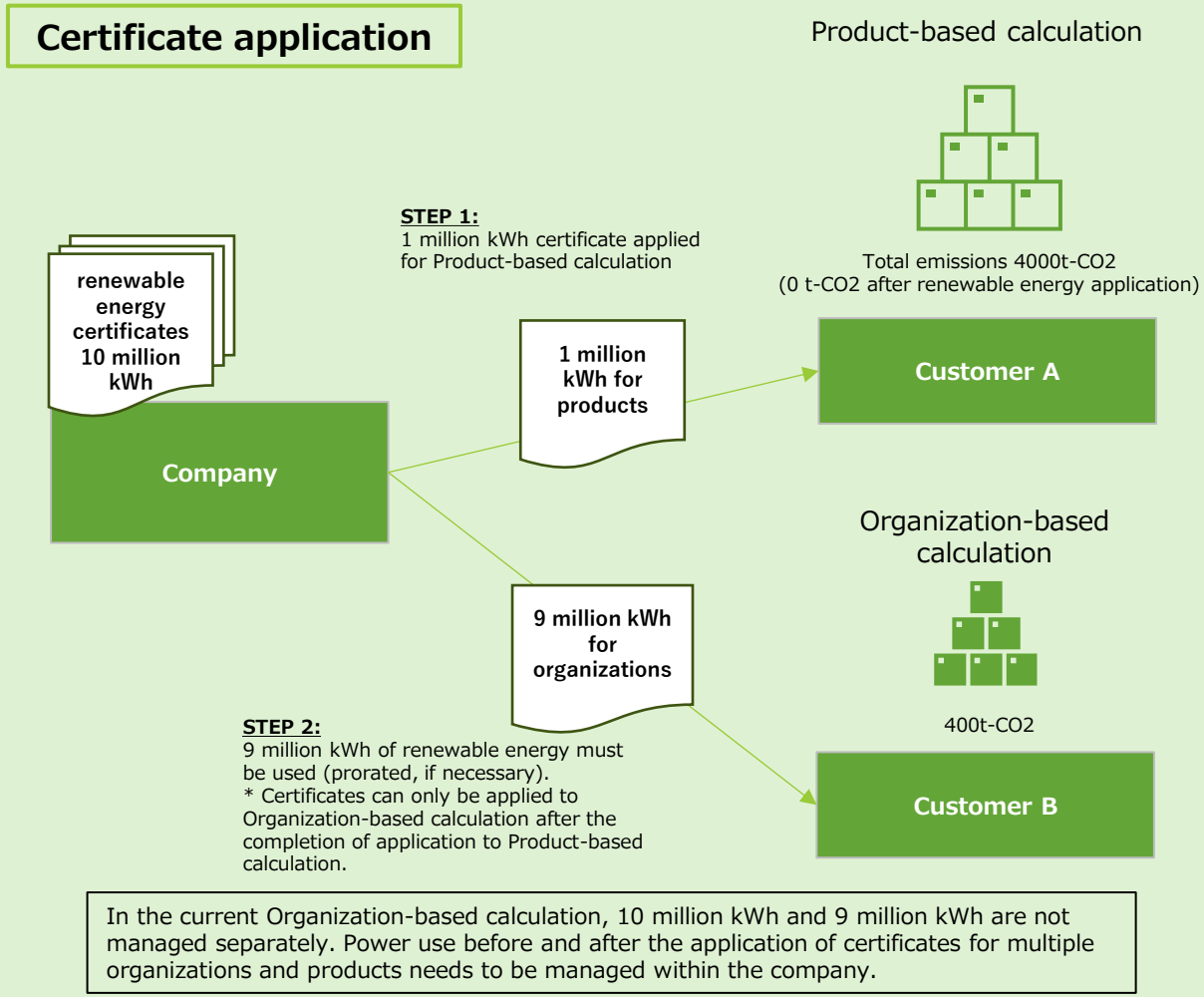


Figure 2-3-14 Example of a procedure for preventing double counting of certificates when both Product-based and Organization-based calculations are both used

Source: Mizuho Research & Technologies and NTT Data Group

Postponement of adoption of PDS

(6) Data reliability indicators

- Indicators such as primary data share (PDS) and data quality ratings (DQR) were introduced for Product-based calculation to indicate the data quality of CO2 data (2-2-8).
- Organization-based calculation adopts the following policy for these indicators:

> - PDS will not be adopted at this time.
> - DQR calculation and sharing is recommended, and an approach will also be introduced to address issues specific to Organization-based calculations.

① Postponement of adoption of PDS

- When an organization calculates Scope 1, 2, and 3 emissions, it can calculate the PDS using the same calculation method as Pathfinder Framework v2 and Product-based calculation in this document.
- However, some companies use a PDS calculation method that differs from that of the Pathfinder Framework. Some companies deem acquired emission data to be 100% primary data because it is provided by a specific supplier in the CDP reporting and others. This departs from the Pathfinder Framework method (Figure 1-4-15), which has a PDS of 0 in some cases even for data provided by suppliers.
- It is expected that there will be some resistance on the part of companies to pursuing the Pathfinder Framework method in place of the alternative method which is currently the mainstream. Even if both methods are acceptable, the PDS values differ depending on which method is adopted, making it difficult for data users to interpret and utilize them.
- In addition, for Organization-based calculation, the results of the calculation of the PDS differ depending on the choice of calculation method, even for the same transaction or product. In the case of Figure 2-3-15, it is possible to increase the PDS value by avoiding process subdivision.
- Given the above, it would be premature to introduce PDS into Organization-based calculation at present. We will wait for progress in international considerations on PDS calculation methods.

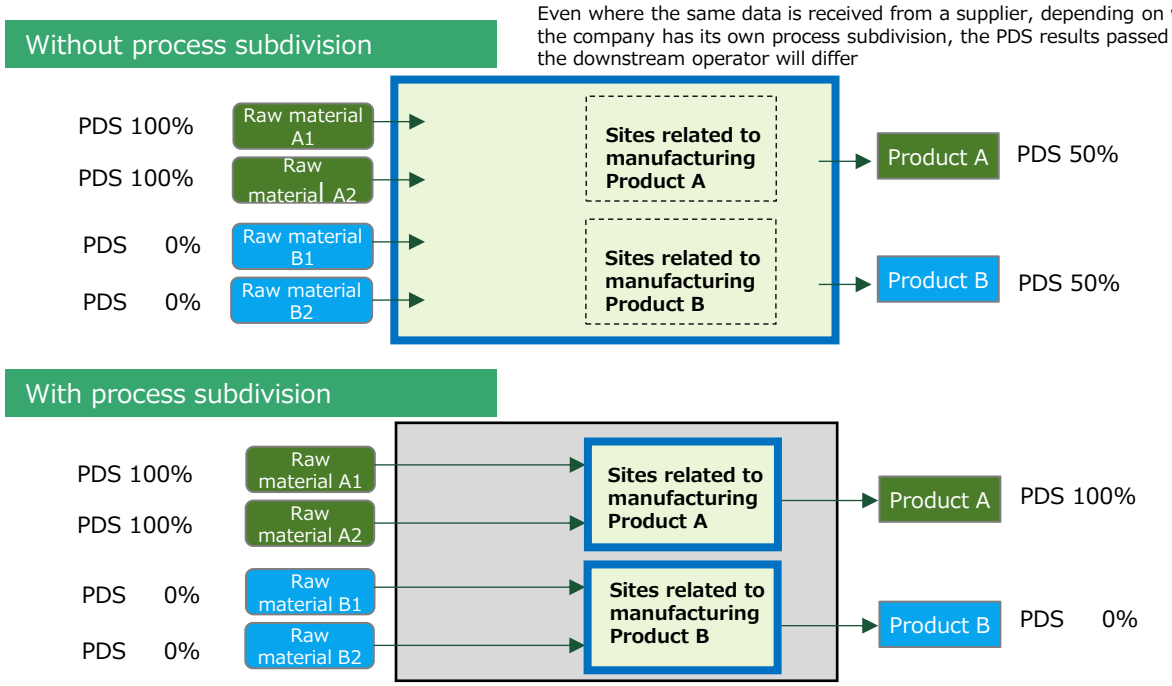


Figure 2-3-15 Effect of process subdivision on PDS calculation

Source: Created by Mizuho Research & Technologies

DQR for Organization-based calculation (1/2)

(6) Data reliability indicators

(2) DQR calculation and sharing

- For the DQR, Organization-based calculation will also introduce the the Pathfinder Framework method for indicators and evaluation criteria.
- This is because, while there is another DQR method, it is not as popular as the alternative PDS method. We also want to avoid the mixing of the two methods in disclosure.
- The DQR indicators and evaluation criteria adopted are shown in Figure 2-3-16.
- As noted above in Section 2-2-8 (2), the emission factor indicators are technological representativeness, temporal representativeness, and geographic representativeness, while integrity and reliability are indicators for amount of activity.
- Like the Pathfinder Framework, Product-based calculation defines DQR calculation and sharing as a requirement, while Organization-based calculation defines it as a recommendation.
- The concept of addressing issues specific to Organization-based calculation is described on the next page.

	Data quality indicators	1—Good	2—Fair	3—Poor
Factor indicator	Technical representative-ness	Same technology	Similar technology (based on secondary data sources)	Different or unknown technology
	Temporal representative-ness	Same reporting year	Less than 5 years old	More than 5 years old
	Geographic representative-ness	Same country or country subdivision	Same region or subregion	Global or unknown
Indicator of amount of activity	Completeness	Activity data collected for all relevant sites for specified period	Activity data collected for <50% of sites for specified period or >50% of sites for shorter period	Activity data collected for <50% of sites for shorter time period or unknown
	Reliability	Measured activity data	Activity data partly based on assumptions	Financial data or nonqualified estimate

Source: Developed by Mizuho Research & Technologies and Sustech based on Pathfinder Framework v2

Figure 2-3-16 Data quality matrix for Pathfinder Framework v2 (Figure 2-2-42)

DQR for Organization-based calculation (2/2)

(6) Data reliability indicators

② DQR calculation and sharing (continued)

- The problem with introducing DQR into Organization-based calculation is that decisions need to be made on:
  (a) Whether the DQR at the time of calculation of will be retained
  (a) Whether reevaluation will be carried out from the viewpoint of the products and transactions to be calculated.
- In Organization-based calculation, Scope 1, 2, and 3 emissions are allocated to a specific product or transaction through an allocation calculation, but this allocation calculation results in the inclusion of emissions data not directly related to the target product or transaction.
- When calculating Scope 1, 2, and 3 emissions as an organization, DQR is highly regarded if the production data for the products manufactured by the company is appropriately collected. However, DQR (technological representativeness, etc.) will be underestimated if it is evaluated as the mixed data for the CO2 data for target products and transactions (see Figure 2-3-17).
- Although it would be best to replace the DQR with a product/transaction perspective rather than an organization perspective through allocation, this is likely to be an extremely onerous process. We have accordingly taken the position that DQR need not be replaced with a product/transaction perspective rather than an organization perspective.
- Based on the above considerations, the DQR calculation method for calculation based on organizational data is shown in Figure 2-3-18.

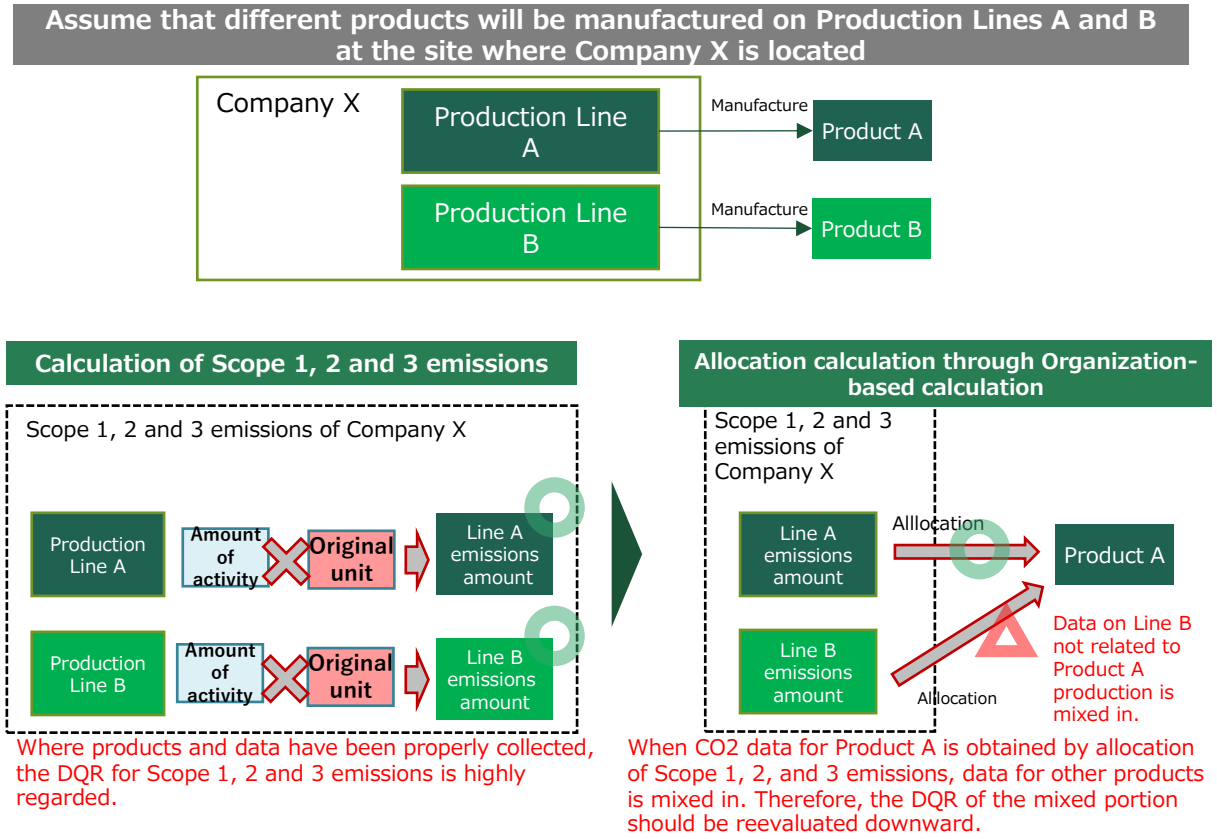


Figure 2-3-17 Replacement of DQR arising from allocation calculation

Source: Created by Mizuho Research & Technologies

Illustration: DQR calculation method in Organization-based calculation

■ The DQR calculation method in Organization-based calculation has five indicators, but in this figure, it is expressed as one indicator for simplified representation.)

Step 1: Set boundary

① Three levels of quality assessment of activities and emissions factors for all processes for Scope 1, 2 and 3 emissions included in the boundary

*"S" stands for Scope and "C" stands for Category

Scope 3 Upstream C1-8

C1 (Category 1) | C2 | C3 | C4 | C5 | C6 | C7 | C8

Manufacturing process	Amount of emissions	DQR
Raw material A	1,500	1
Raw material B	200	1
…	…	…
Raw material Z	500	1

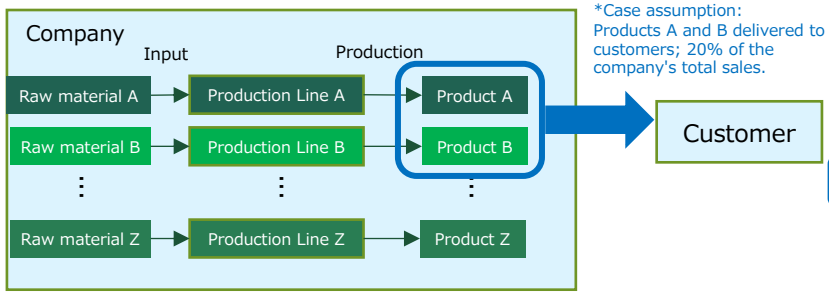
Scope 1 and 2

S1 | S2

Manufacturing process	Amount of emissions	DQR
Power (JP)	2,000	1
Power (US)	3,000	1
Power (EU)	500	2

Step 2: Allocate by transaction value, etc.* and calculate DQR

② Allocate (determine the amount of emissions after allocation for each process)
Some processes not involved in customer transactions will also be mixed in, but none of the DQR values by process will be revised after allocation.



③ Calculate the DQR for CO2 data using a weighted average based on contribution to emissions.

Scope 3 Upstream C1-8

C1 (Category 1) | C2 | C3 | C4 | C5 | C6 | C7 | C8

Manufacturing process	Amount of emissions	DQR
Raw material A	300	1
Raw material B	40	1
…	…	…
Raw material Z	100	1

Scope 1 and 2

S1 | S2

Manufacturing process	Amount of emissions	DQR
Power (JP)	400	1
Power (US)	600	1
Power (EU)	100	2

Allocate 20% of emissions to customers accounting for 20% of sales

Product Z data not related to customer transactions is mixed in, but DQR is not updated

Calculate DQR for CO2 data using a weighted average based on contribution to emissions

DQR (CO2 data)

Figure 2-3-18 DQR calculation based on organizational data

Source: Created by Mizuho Research & Technologies

Indirect data quality assessment by allocation level

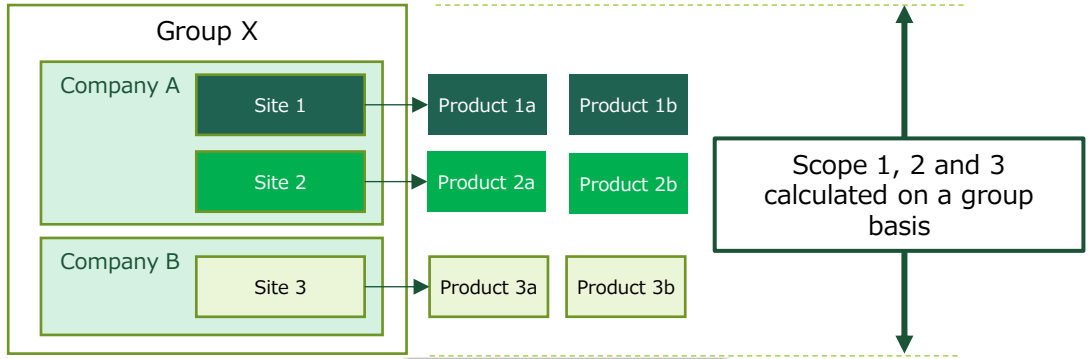
(6) Data reliability indicators

③ Indirect data quality assessment by allocation level

- In this document, "allocation level" is introduced as an additional disclosure element for downstream operators to estimate the data quality of CO2 data in Organization-based calculations.
- In the FY 2022-2023 PoC project, many companies commented that, in order to estimate the quality of CO2 data in Organization-based calculation, they needed to know to what extent process subdivision was carried out and, conversely, to what extent a coarse allocation calculation was made.
- In Organization-based calculation, Scope 1, 2 and 3 emissions as an organization are allocated to specific products and transactions through process subdivision and allocation calculations.
  There is a big difference in reliability between a calculation that subdivides Scope 1, 2, and 3 emissions into processes by production site and allocates site emissions by site production amount (value), and a calculation that allocates the Scope 1, 2, and 3 emissions of the entire group by the production (sales) of the entire group.
- To clarify this, businesses that choose Organization-based calculation are required to disclose the allocation level (group, company, site, building, etc.) (see 3-2-2 below).

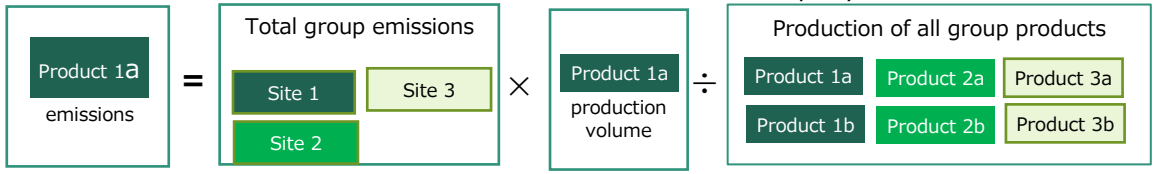
- In summary, **Organization-based calculations measure the quality of CO2 data by considering both the allocation level and each DQR indicator**.

■ **Group X, which manufactures six kinds of products, consists of Companies A and B and Sites 1, 2 and 3.**



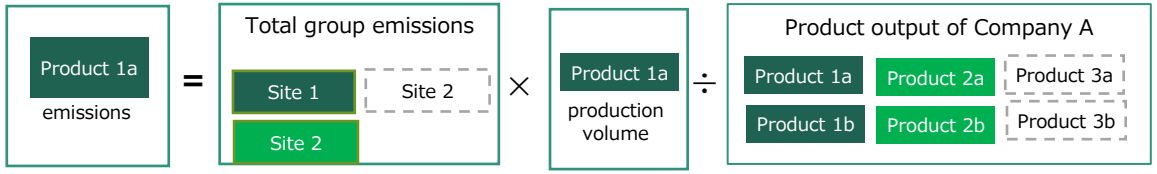
1. Allocation level: By group

Emissions from other companies within the group and other sites within the company are mixed in.



2. Allocation level: By company

Emissions from other sites within the company are mixed in.



3. Allocation level: By site

Emissions of other products from the same site are mixed in.

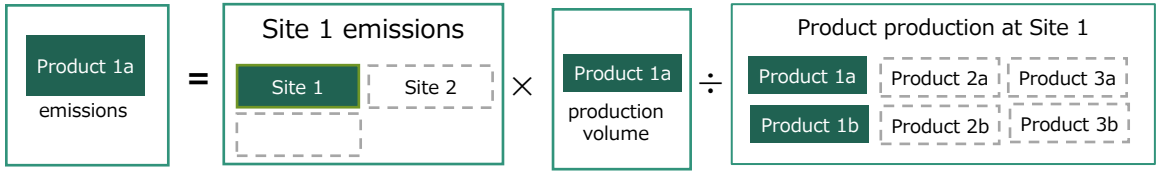


Figure 2-3-19 Allocation levels

Source: Created by Mizuho Research & Technologies

Handling of DQR, etc., when used for Product-based upstream emission calculations

- **(6) Data reliability indicators**

④ Handling when used to calculate upstream emissions from Product-based calculations

- As noted in 2-1-3 (2), this document specifies the treatment of PDS/DQR when CO2 data from Organization-based calculations is used to calculate upstream emissions from Product-based calculations by downstream operators.
- TThe use of organization-based CO2 data for the Product-based calculation of emissions from upstream activities is permitted under two conditions:
- Condition 1: That organization-based CO2 data shall be treated as non-primary data (PDS=0) in Product-based calculation.
- Condition 2: The DQR status of the Organization-based calculation shall be ND (“No data to report”).

- It should be noted that the above processing is carried out by the downstream business operator giving and receiving CO2 data, and is not something that the suppliers calculating and providing CO2 data need to think about.

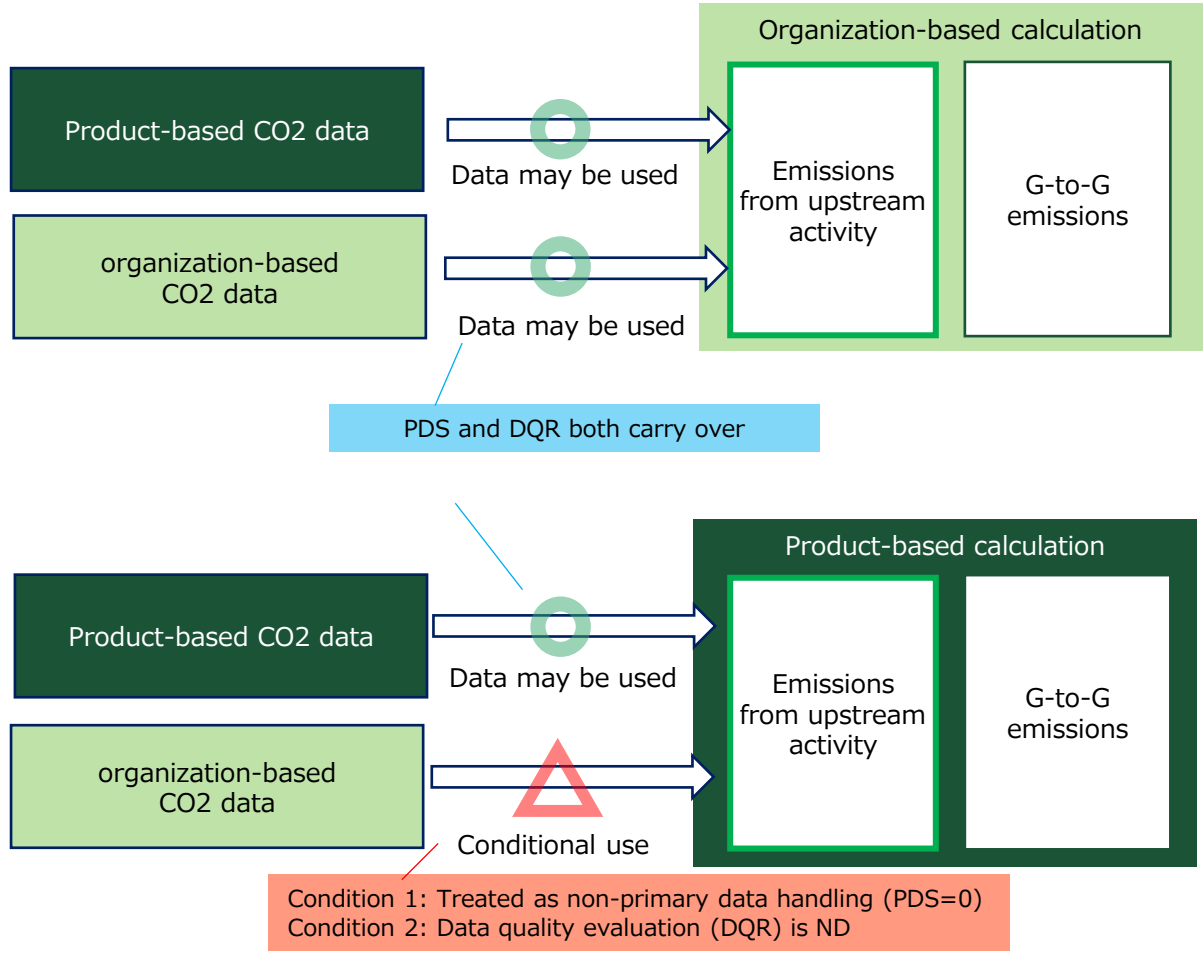


Figure 2-3-20 Approach when Product-based and Organization-based calculations are mixed (Figure 2-1 -3)

Source: Created by Mizuho Research & Technologies

3. CO2 data sharing method

Positioning and configuration of data disclosure elements

3-1. CO2 data sharing

3-1-1. Positioning of data disclosure elements in this document

- This section presents information (data disclosure elements) that suppliers disclose when sharing data with suppliers.
- Consistent with the Product-based methodology in this document, the PACT Pathfinder Framework is paired with the Pathfinder Network, and the technical requirements are presented in the Pathfinder Network. Technical specifications and details can be found in the Pathfinder Network Technical Specifications, which include information on data elements, API, and licenses for data sharing.
- The GD Consortium Visualization WG set up a Tech Specifications SWG in conjunction with the Methodology SWG (see 1-1) to examine CO2 data exchange formats and cooperation methods using digital technology.
- The data disclosure elements presented in this document (CO2 Visualization Framework v2) are intended to present the necessary elements for data sharing. For the digital technology format and specifications, please refer to the Data Format Linkage SWG study.
- This document is intended to be widely used for social implementation, but may be updated as appropriate in response to methodological revisions in the overseas frameworks of partners.

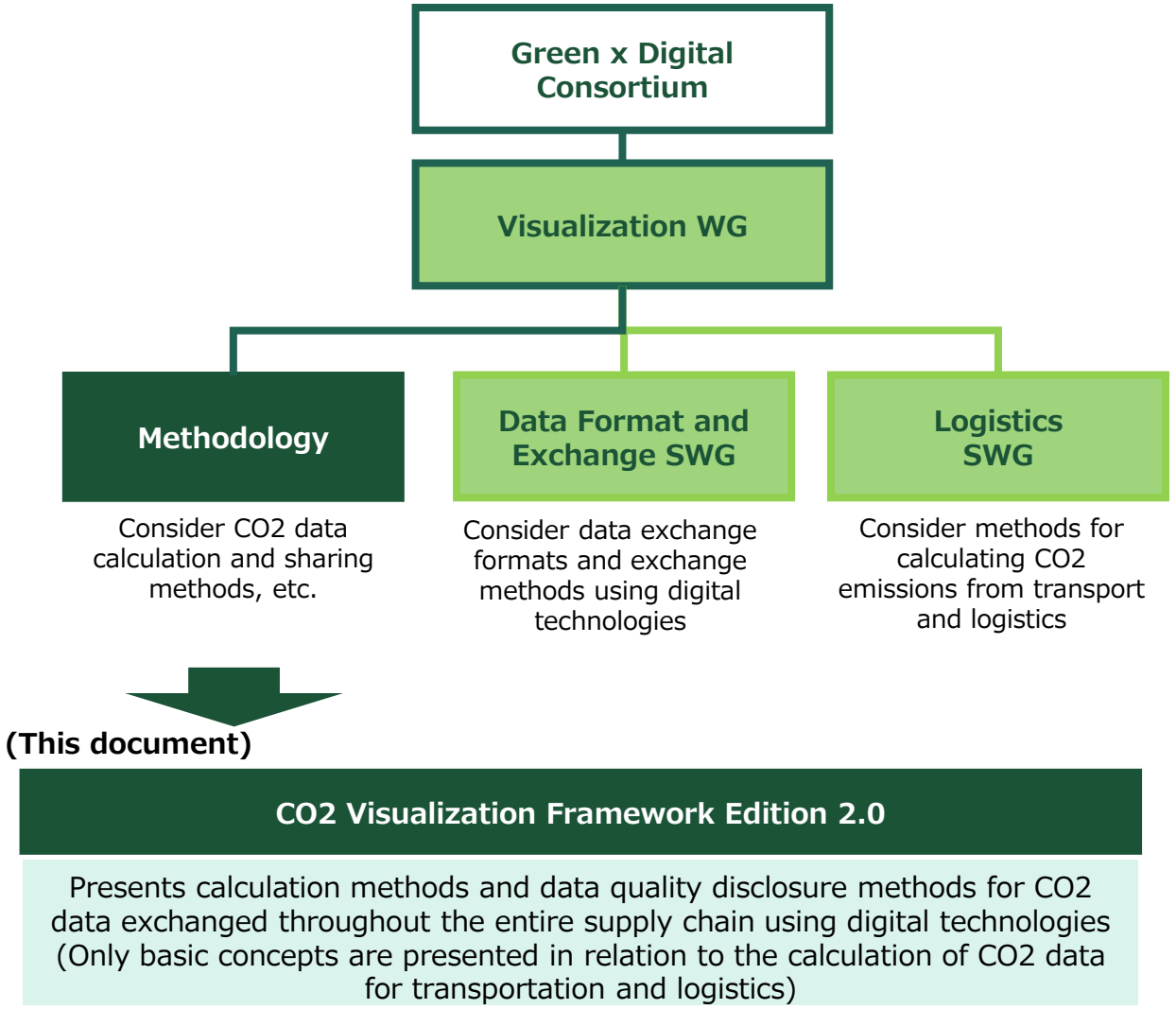


Figure 1-1-1 Positioning of the Methodology SWG and this document

Source: Created by Mizuho Research & Technologies

Process of preparing data disclosure elements

3-1-2. Process of preparing data disclosure elements

- This document aims to develop methods for calculating CO2 data consistent with international frameworks/platforms. Product-based calculations are consistent with PACT Pathfinder Framework v2.
- Pathfinder Framework v2 lists elements where data sharing is desired in 6.1 Required elements for data exchange and Appendix B: PCF Questionnaire.
- The Product-based data disclosure elements in this document are based on the mandatory elements in Pathfinder Network Technical Specifications for PCF Data Exchange (Version 2.1.0) based on Pathfinder Framework v2 (January 2023).
  - Pathfinder Network Technical Specifications for PCF Data Exchange (Version 2.1.0; the current version of the specifications) was selected as the basis for this document as the most appropriate choice in terms of technical alignment with PACT toward social implementation.
- Necessary elements were also added based on the results of the FY 2022-2023 PoC project and the METI/MoE Carbon Footprint Guidelines.
- The data disclosure elements for Organization-based calculation were established based on SWG discussion based on elements in Product-based calculation.
- In addition, the SWG suggested that as many disclosure elements as possible should be set from the viewpoint of data analysis. However, the Visualization WG and the Data Format and Exchange SWG noted (a) the burden this would place on the data provider (data input side) and (b) the burden it would also place on the system implementation side, as well as the feasibility thereof. Consequently, we ultimately decided to present the minimum necessary elements for data sharing.

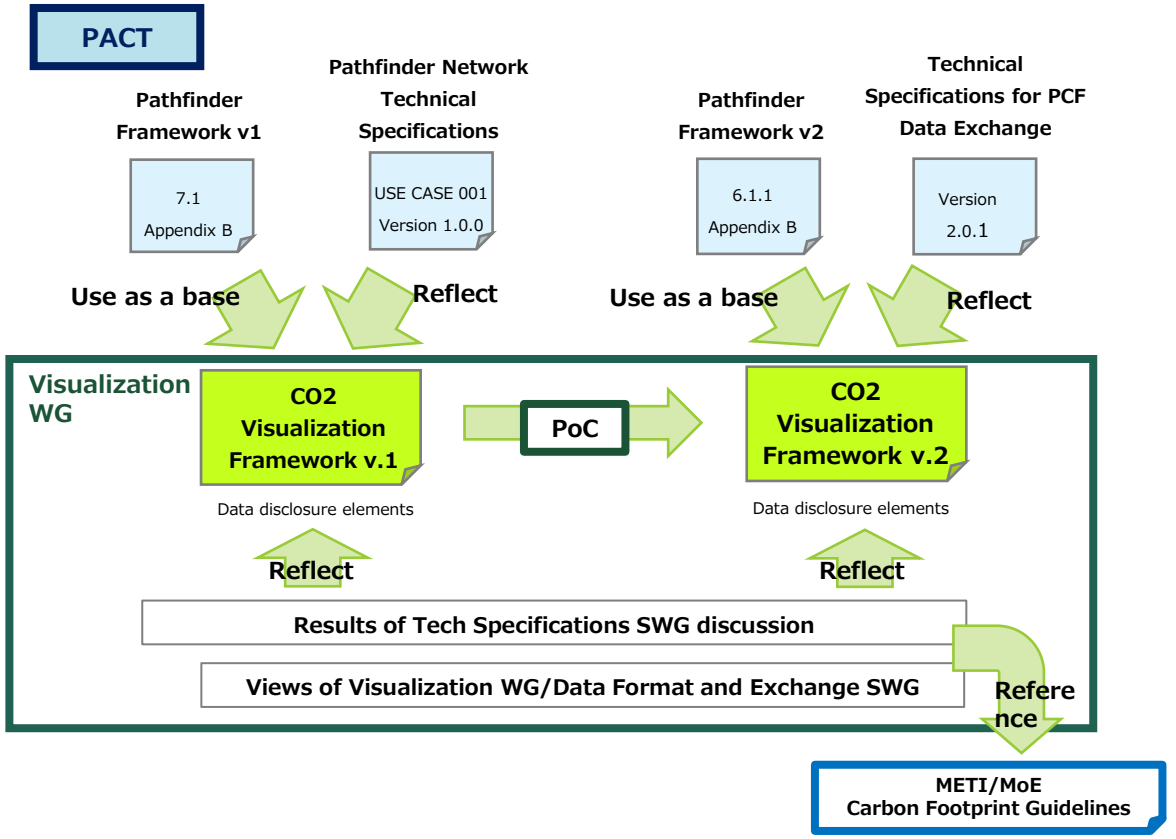


Figure 3-1-2 Process of preparing data disclosure elements

Source: Mizuho Research & Technologies and NTT Data Group

Composition of data disclosure elements

3-1-3. Composition of data disclosure elements

- The composition of the data disclosure elements is as follows:

(1) Basic information

- Set of elements for disclosing company information or information on the product itself

(2) Calculation conditions

- Set of elements for disclosing the prerequisite information for CO2 data calculation
- Standards referenced, declared unit, boundary, allocation method, etc.

(3) Calculation results

- Set of elements to disclose CO2 data calculation results and other relevant information
- Relevant information: Gate-to-gate emission data provided in conjunction with cradle-to-gate emission data and certificates used

(4) Data quality

- Set of elements for disclosing information related to the data quality of the CO2 data
- Comprises Primary Data Share and Data Quality Rating.

- Please note that the above structure is intended to help users understand this document, and differs from the arrangement and order of the Tech Specs toward Data Exchange (Version 2.0).

Specific data disclosure elements are presented in 3-2.

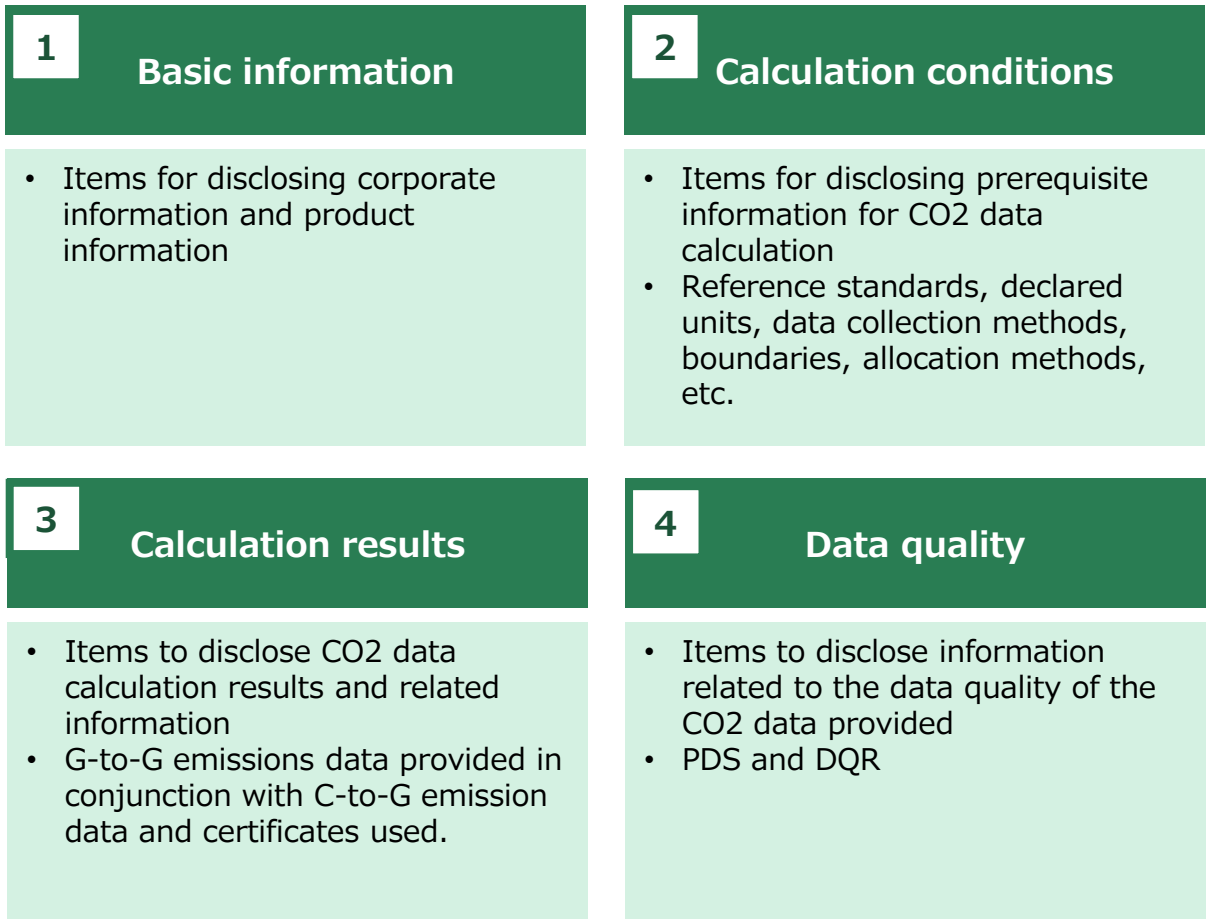


Figure 3-1-3 Composition of data disclosure elements

Source: Created by Mizuho Research & Technologies

Notes on input: (1) Disclosure elements vary by calculation method

3-1-4. Notes on input of data disclosure elements

(1) Selection and description of data disclosure elements that vary by calculation method

- This document permits the sharing of CO2 data calculated using two calculation methods: Product-based calculation and Organization-based calculation. The existence of two calculation methods gives rise to the following typologies of data disclosure elements:
  - Type a: Same elements, same description method
  - Type b: Same elements, different description methods
  - Type c: Items required for only one calculation method
- For example, the company name must always be disclosed regardless of the calculation method, and the description method is the same (Type a).
- On the other hand, the boundary needs to be disclosed in both calculation methods, but the description method differs. For Product-based calculation, the processes included in the boundary are noted. For Organization-based calculation, since Scope 1, 2 and 3 emission data are assumed, the scope and categories included in the boundary can also be noted (Type b).
- Data model specification version is an element that needs to be stated only for Product-based calculation. This is because the entry lists the version of the Pathfinder Framework referenced and is therefore not relevant to Organization-based calculation, a calculation method not based on the Pathfinder Framework (Type c).
- The company entering the data should select the appropriate disclosure elements and the method for describing them in accordance with the calculation method chosen.

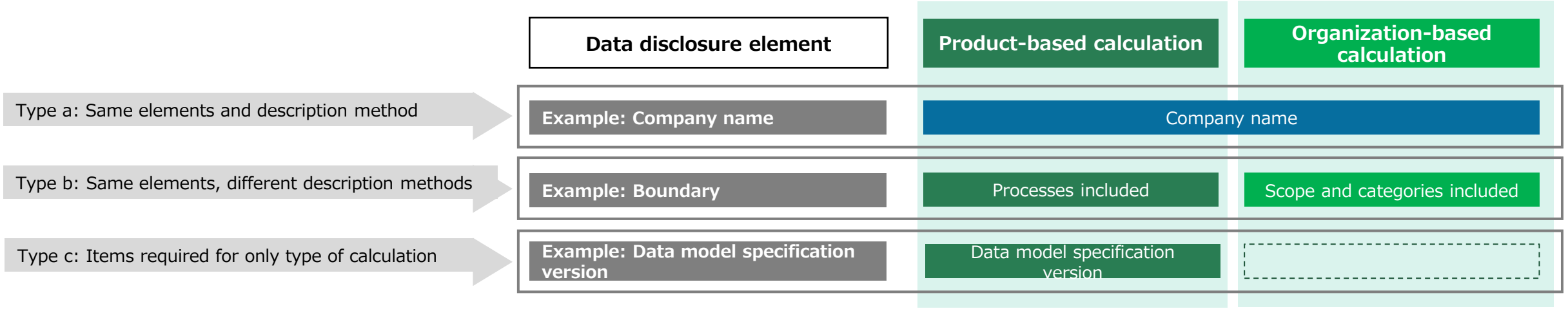


Figure 3-1-4 Calculation methods and data disclosure elements

Source: Created by Mizuho Research & Technologies

Notes on input: (2) Distinguishing between Product-based and Organization-based calculation

3-1-4. Notes on input of data disclosure elements

(2) Distinguishing between Product-based and Organization-based calculation

As described in 1-4-2 (4), the distinction between Product-based and Organization-based calculation is based on the type of methodology and standards referenced.

- Specifically, the party inputting the data must:
  - Determine whether the methodology and standards referenced in CO2 data calculation pertain to Product-based or Organization-based calculation;
  - Determine whether the calculation method they themselves have used was a Product-based or Organization-based calculation; and
  - In terms of data disclosure, (i) enter Product-based or Organization-based calculation in the data disclosure field "Calculation method," and (ii) as a means of determining which method was used, enter the methodology and standards underpinning the calculation iin the data disclosure field “Standards referenced.” (This field is divided into two types: “Cross-sectoral," which is mandatory, and "Product or sector-specific," which is optional.)
- The relationship between the various standards and guidance used for CO2 calculation and Product-based and Organization-based calculation is shown in Figure 3-1-5. If the methodology followed is unknown, it shall be deemed Organization-based calculation.
- The reason for adopting such a roundabout approach to distinguishing between Product-based and Organization-based calculation is that, as shown in Section 1, “SWG Discussion: (2),” there are cases in practice in which the boundary between the two calculation methods is blurred, and it was decided to introduce types of calculation methodologies and standards as criteria.
- Consistency between the calculation method and the standards referenced is evaluated by the downstream operator using the data.

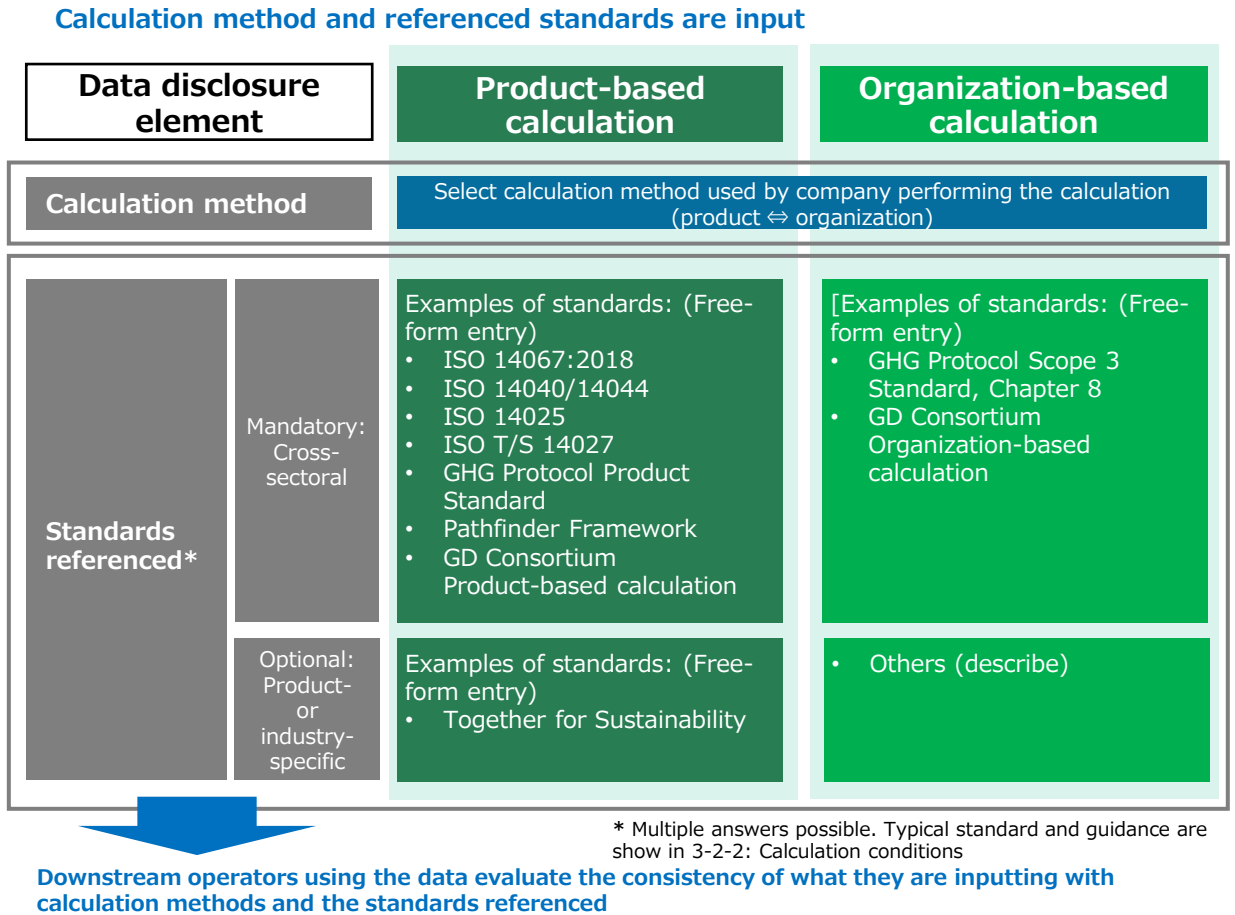


Figure 3-1-5 Input and evaluation of Product-based and Organization-based calculation

Source: Created by Mizuho Research & Technologies

Notes on input: (3) Data disclosure requirements are phased

3-1-4. Notes on input of data disclosure elements

(3) Data disclosure requirement levels

- Each of the data disclosure element groups shown in 3-2 onward indicates the disclosure requirement level.
- There are three levels: M, R, and O.
  - "M": Mandatory
  - "R": Recommended (optional but should be made whenever possible)
  - "O": Optional

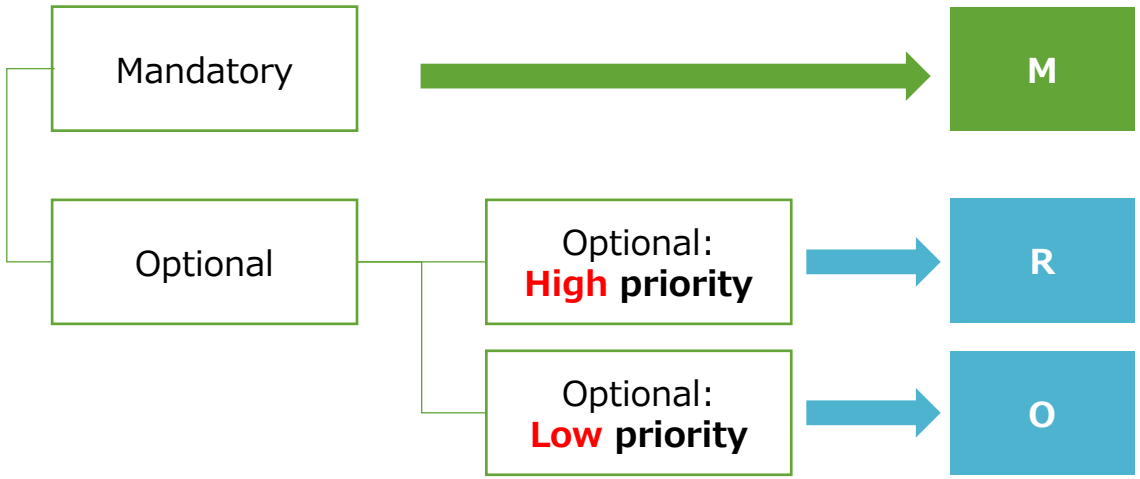


Figure 3-1-6 Data disclosure requirements

Source: Created by Mizuho Research & Technologies

- There may be situations in which it is not possible to disclose an element marked "M". In such cases, it is also permissible to exchange data as long as it is specified that the disclosure is made in circumstances that do not permit the disclosure of mandatory elements.*

> * As noted in 4-2-1 (4), Pathfinder Framework v2 requires companies to meet third-party assurance and verification requirements, but also states that if a company is unable to meet these requirements before exchanging the data, the company may still exchange it through the Pathfinder Network, provided that it makes transparent to what extent the assurance requirements were fulfilled or not. (Pathfinder Framework v2, page 53).

- Assurance and verification requirements include addressing the requirements of the Pathfinder Framework, which of course includes addressing the minimum data elements required.
- In other words, Pathfinder Framework v2 too specifies elements that must be disclosed but also recognizes that in reality there will be elements that cannot be disclosed and permits data exchange on the condition that incomplete compliance is specified.
- This document takes the same view.

Data disclosure elements (Basic information 1/2)

3-2. Data disclosure elements

- Hereafter, we will present specific data disclosure elements in terms of basic information, calculation conditions, calculation results, and data quality. The name of the data disclosure element basically equates to the element name in Tech Specs toward Data Exchange v.2.
- The necessary information is shown for each element (in other words, what data needs to be collected and ascertained). Please refer to the the explanation in Tech Specs toward Data Exchange v.2 regarding the specific input method for each element, etc.

3-2-1. Basic information

Data disclosure element		GD Consortium specification	Calculation method	Request level (M, R, O)	Description
Corporate information	Company name	-	Both	M	Company name
	Company ID	-	Both	M	Company ID that uniquely identifies that company, such as its DUNS Number, ISIN, or ticker code
Product information	Product name	-	Both	M*	Product name
	Product ID	-	Both	M*	Product ID
	Product category (CPC code)	-	Both	M*	Product category (CPC Code)
	Framework edition	○	Both	M	• Edition of the referenced CO2 Visualization Famework • When this document is referred to, Edition 2.0
	Data model spec version	-	Product base	M	• Referenced version of Pathfinder Framework • When exchanging CO2 data from Product-based calculations with overseas companies, Pathfinder Framework version information is also provided. • When this document is referred to, Version 2.0
	Product description	-	Both	M*	Product description
	Comment	-	Both	M	Comments that encourage interpretation and evaluation outside of the product description
	Digitally recorded signature	-	Both	O	Digital signature covering all CO2 data

* "O" if the CO2 data provided is "transaction unit" rather than "product unit" in Organization-based calculation (see 2-3-2(4) (2) of this document)

Data disclosure elements (Basic information 2/2)

3-2-1. Basic information (continued)

Data disclosure element	GD Consortium specification	Calculation method	Request level (M, R, O)	Description
Data generation time	-	Both	M	Datetime of data generation
Data ID	-	Both	M	ID to identify the created data
Data version (revision no.)	-	Both	M	Version of the data created
Data update time	-	Both	M	Date and time the data was updated

Data disclosure elements (Calculation conditions 1/5)

3-2-2. Calculation conditions

Data disclosure element	GD Consortium specification	Calculation method	Request level (M, R, O)	Description
Standards referenced (cross-sectoral)	-	Both	M	• Standards and guidance referenced Typical standards and guidance are listed below (other standards and guidance can also be entered): <Product-based calculation> • ISO 14067:2018, ISO 14040/14044, ISO 14025, ISO T/S 14027 • GHG Protocol Product Standard • Pathfinder Framework v2 • METI/Moe Carbon Footprint Guidelines • CO2 Visualization Framework Product-based calculation (2-2) <Organization-based calculation> • GHG Protocol Scope 3 Standard • CO2 Visualization Framework Organization-based calculation (2 -3)
Standards referenced (product- or sector-specific)	-	Both	O	• Standards and guidance referenced Typical standards and guidance are listed below (other standards and guidance can also be entered): <Product-based calculation> • PEFCR, PCR • Together for Sustainability, Plastic Europe, GLEC, RMI (Steel sector)
Calculation method	○	Both	M	• Calculation method adopted (Product-based or Organization-based calculation)
Methodology for calculation of biogenic carbon	-	Both	O (M as of 2025)	• Name of the methodology referred to in calculating emissions and biogenic carbon removals • Until 2025, enter the methodology used only if the data provided includes emissions or removals of biogenic carbon

Data disclosure elements (Calculation conditions 2/5)

3-2-2. Calculation conditions (Continued)

Data disclosure element	GD Consortium specification	Calculation method	Request level (M, R, O)	Description
Declared unit	-	Both	M	• Display unit of CO2 data* • When CO2 data is displayed as “XX kg-CO2e/kg," "kg" corresponds to the declared unit • For Product-based calculation, "kg," "L," "m3," "kWh," "MJ," "tkm" and "m2" can be selected. • In addition to the above, "yen" can be selected for Organization-based calculation.
Product quantity (Quantity per declared unit)	-	Both	M	• The unit quantity of products and transactions subject to CO2 data calculation, expressed as the declared unit quantity* • Example 1: When CO2 data for a product weighing 5 kg per unit is displayed in declared units =kg, the product quantity is 5. • Example 2: When CO2 data for a transaction of 1 million yen is displayed in declared units = yen, the product volume is 1 million. *In the case of Example 2, "transaction amount" is easier to understand, but increasing the number of disclosure elements also increases the complexity. "Product quantity" shall be used in conjunction with “transaction amount." Also indicate this in the "Product quantity: Description column" below.
Product quantity: Description field	○	Both	R	• Space to add a description of "product quantity" and "declared unit" • Example 1: "For a product weighing 5 kg per unit, the declared unit was set to kg, so the product quantity was set to 5." • Example 2: “With regard to the 1 million yen transaction, the declared unit was yen, so the product quantity was set at 1 million." • Where the currency unit (yen, dollar, etc.) is used as the declared unit in Organization-based calculation, it is difficult to distinguish between product unit CO2 data and transaction unit CO2 data, so this should be explained in this column.

*For application of the declared units and product quantity, see:
- 2-2-3 (4) for Product-based calculation
- 2-3-2 (4) for Organization-based calculation

Data disclosure items (Calculation conditions 3/5)

3-2-2. Calculation conditions (continued)

Data disclosure element		GD Consortium specification	Calculation method	Request level (M, R, O)	Description
Boundary	Description of the target process	-	Product-based	M	• Enter processes included in the PCF calculation • Processes that are attributable processes and that were not cut off by application of the exemption rule
	Calculation category	○	organization-based	R	• Scope and category of CO2 data • If some scopes or categories are excluded (e.g., Scope 2 office building lighting), this can also be entered.
Exemption rules (cutoff rules) applied	Cutoff:%	-	Both	M	• Total emissions resulting from attributable processes that are excluded from CO2 data calculation due to the application of the exemption rules • Enter as the ratio when cradle-to-gate CO2 data is set to 100%
	Cutoff: Explanation	-	Both	M	• Describe attributable processes that are excluded from CO2 data calculation and the reasons for the exclusion.
Data sources	IPCC version of the GWP characterization factor	-	Both	M	• Version of the IPCC report from which the GWP used originated (100 year value)
	Secondary data emission factor	-	Both	R	• Information about secondary data sources, such as the database used • Example: IDEA vX.X
Data collection period	Data collection period	-	Both	M	Period of data collection
Geographic scope of data collection	Geographic scope of data collection	-	Both	M	Geographic area where data was collected

Data disclosure elements (Calculation conditions 4/5)

3-2-2. Calculation conditions (continued)

Data disclosure element		GD Consortium specification	Calculation method	Request level (M, R, O)	Description
Allocation of Product-based calculations	Allocation rules	-	Product-based	O	• Standard used for allocation in Product-based calculation • If the allocation hierarchy in 2-2-4 (4) of this document is followed, then write “Pathfinder Framework v2 allocation hierarchy"
Allocation of Organization-based calculations	Allocation level: Scope 1	○	organization-based	M	• Allocation level in Organization-based calculation CO2 data calculation • For example, if the total emissions of the entire organization are allocated by the total output of the entire organization, etc., enter "Organization level"; if the emissions of each production site are allocated by the total output of the sites, etc., by process subdivision, enter "Site level."
	Allocation level: Scope 2	○	organization-based	M	• Same as above.
	Allocation level: Scope 3	○	organization-based	M	• The entry concept the same as for Scope 1 and Scope 2. • If the allocation level varies by category, indicate the allocation level for the category that accounts for the majority of emissions • Allocation levels for other categories can be entered in the description field.
	Allocation level: Description field	○	organization-based	O	• Free-form entry for further description of “allocation level" • For example, if the level of allocation differs between Scope 3 categories, the level not included in Scope 3 can be entered here.

Data disclosure elements (Calculation conditions 5/5)

3-2-2. Calculation conditions (continued)

Data disclosure element		GD Consortium specification	Calculation method	Request level (M, R, O)	Description
Allocation of Organization-based calculations (continued)	Allocation metric: Scope 1	○	organization-based	M	• Include the metrics used to allocate Scope 1 emissions E.g. physical metrics (weight, amount, etc.), economic metrics (production)
	Allocation metric: Scope 2	○	organization-based	M	• Include the metrics used to allocate Scope 2 emissions E.g. physical metrics (weight, amount, etc.), economic metrics (production)
	Allocation metric: Scope 3	○	Organization-level	M	• The data entry concept is the same as for Scope 1 and Scope 2. E.g. physical metrics (weight, amount, etc.), economic metrics (production) • If the allocation metrics differ by category, indicate the allocation metrics for the category that accounts for the majority of emissions • Allocation metrics for other categories can be entered in the description field.
	Allocation metric: Description field	○	Organization-level	O	• Free-form entry for further description of allocation metrics • If the allocation metrics differ between Scope 3 categories, allocation metrics used for the categories that could not be filled out in Allocation metrics: Scope 3 can be entered here.

Data disclosure elements (Calculation results 1/5)

3-2-3. Calculation results

Data disclosure element		GD Consortium specification	Calculation method	Request level (M, R, O)	Description
CO2e emissions per cradle-to-gate declared unit (total emissions)	① Total emissions (excluding biogenic emissions and removals)	-	Both	M	• Carbon emissions per declared unit (kg-CO2e) • Biogenic emissions and removals are not included (excluding (10), (11), (12) and (13) below). • Many of the currently reported product carbon footprints (PCF, CFP) fall under this heading
	② Total emissions (including biogenic emissions and removals)	-	Both	O (M from 2025)	• Carbon emissions per declared unit (kg-CO2e) • Includes biogenic emissions and removals (including (3), (4), (5) and (6) below) • From 2025, when calculation of biogenic emissions and removals will become a requirement, calculation of (2) including biogenic emissions and removals will also be required in addition to (1).

Data disclosure elements (Calculation results 2/5)

3-2-3. Calculation results (continued)

Data disclosure element		GD Consortium specification	Calculation method	Request level (M, R, O)	Description
CO2e emissions per cradle-to-gate declared unit (related to biogenic emissions and removals)	③ Emissions from direct land-use change	-	Both	O (M from 2025)	• Emissions from land-use change owned and controlled by the disclosing company or in the supply chain (kg-CO2e) • Calculation required from 2025
	④ Emissions or removals from land management	-	Both	O (M from 2025)	• Amount absorbed and removed due to land management changes (kg-CO2e) • Calculation required from 2025
	⑤ Other biogenic carbon emissions	-	Both	O (M from 2025)	• All biogenic carbon emissions from ③ and ④ related to the manufacture and transport of products not included in (7) (kg-CO2e) • Calculation required from 2025
	⑥ Amount of biogenic carbon removal	-	Product-based	O (M from 2025)	• Amount of biogenic carbon removals from products in declared units (kg-CO2e) • Calculation required from 2025
	⑦ Emissions from indirect land-use change	-	Both	O	• Emissions from land-use change not owned or controlled by the disclosing company and not in the supply chain (kg-CO2e) • Not included in CO2 data, but reported separately

Data disclosure elements (Calculation results 3/5)

3-2-3. Calculation results (continued)

Data disclosure element		GD Consortium specification	Calculation method	Request level (M, R, O)	Description
Other data related to CO2e emissions per cradle-to-gate declared unit	⑧ Emissions from fossil fuels	-	Both	M	① Direct emissions (kg-CO2e) from use (fossil fuel combustion, etc.), fugitive emissions, and process emissions within total emissions
	⑨ Carbon content from fossil fuels	-	Product-based	M	• Carbon mass derived from fossil fuels per declared unit included in the product (kg-C) • This element was not initially required in carbon footprint calculation, but was introduced in conjunction with (10) in order to evaluate emissions from disposal by incineration of procured products by downstream businesses. • For the time being, is it realistic to use stoichiometric calculations based on a composition formula? If CO2 data exchange within the supply chain becomes widespread, it will be possible to respond by leveraging information provided by upstream suppliers.
	⑩ Biogenic carbon content	-	Product-based	M	• Biogenic carbon mass per declared unit included in the product (kg-C) • This element was not initially required in carbon footprint calculation, but was introduced in conjunction with (9) in order to evaluate the emissions from disposal by incineration of procured products by downstream businesses. • For the time being, is it realistic to use stoichiometric calculations based on a composition formula? If CO2 data exchange within the supply chain becomes widespread, it will be possible to respond by leveraging information provided by upstream suppliers.
	⑪ Emissions from aircraft engines	-	Both	O	CO2 emissions of aircraft engines related to product transport (kg-CO2e)
	⑫ Flag for packaging emissions	-	Both	M	Indicate whether carbon emissions from packaging are included
	⑬ Product packaging emissions	-	Both	O	Carbon emissions from packaging (kg-CO2e)

Reference: Handling the various data disclosure elements related to emissions

- The data disclosure elements related to emissions introduced in this section are relisted below:
(Bold: Items that must be disclosed as of March 2024)
  - **① Total emissions (not including biogenic emissions and removals)**
  - ② Total emissions (including biogenic emissions and removals)
  - ③ Emissions from direct land-use change
  - ④ Emissions or removals from land management
  - ⑤ Other biogenic carbon emissions
  - ⑥ Amount of biogenic removal
  - ⑦ Emissions from indirect land-use change
  - **⑧ Emissions from fossil fuels**
  - **⑨ Carbon content from fossil fuels**
  - **⑩ Biogenic carbon content**
  - ⑪ Emissions from aircraft engines
  - **⑫ Flag for packaging emissions**
  - ⑬ Emissions resulting from product packaging

- Many readers may have been surprised by the number of data disclosure elements related to emissions and the presence of unfamiliar data disclosure elements ((2)-(13)).
- Many of these elements were introduced by the Pathfinder Framework and ISO 14067, which required this document to follow suit.
- In regards to the difficulties envisaged in dealing with the list on the left, note that companies are not yet required to perform these calculations, and that it will become easier as data exchange in the supply chain advances.
- For example, data disclosure elements (2) -(7) in relation to biogenic emissions and removals and land use start to be addressed in 2025. In addition, significant land-use emissions and removals occur at the very top of the supply chain, and in an era when data is provided by upstream suppliers, the difficulty of responding will be reduced.
- New elements such as data elements (9) and (10) can also be passed downstream if data is provided by upstream suppliers that manufacture materials and components.
- Of the data disclosure elements required at present, (1) and (8)are already being calculated as part of the calculation of product carbon footprints and Scope 1, 2, and 3 emissions.
- ⑨ and ⑩ are new data disclosure elements that have already become requirements, but companies can engage in data exchange even if they do not address these elemenst as long as they clearly indicate this. Companies struggling to address these elements might therefore choose to engage in data exchange without addressing them until data is provided by upstream suppliers.

Data disclosure items (Calculation results 4/5)

3-2-3. Calculation results (continued)

Data disclosure element		GD Consortium specification	Calculation method	Request level (M, R, O)	Description
Supplementary information on calculation results	Amount of certificates used (including J-credits derived from renewable energy)	○	Both	R	Use of unbundled certificates per declared unit (kWh)
	Type of certificate (including J-credits derived from renewable energy)	○	Both	R	State the type of certificate used < Input examples in Japan > • Non-fossil certificates (with a renewable energy designation) • Green power certificates • J Credit (renewable energy generation) < Input example overseas > • GO, US-REC, I-REC, Indian REC, Korean REC, Australian REC, NZREC, REGO, TIGR, T-REC
	Explanation of uncertainty assessment	-	Both	O	Include the results of the assessment, the main factors, and a qualitative description of the assessment.

Data disclosure items (Calculation results 5/5)

3-2-3. Calculation results (continued)

Data disclosure element		GD Consortium specification	Calculation method	Request level (M, R, O)	Description
CO2e emissions per gate-to-gate declared unit (Total emissions)	Gate-to-gate emissions (excluding biogenic emissions and removals)	○	Both	R	• (1) Total emissions (not including biogenic emissions and removals) from the company's gate-to-gate boundary (kg-CO2e) • Gate-to-gate CO2 data in addition to cradle-to-gate for upstream emission structure analysis (see 1-4-8), if available • Or, if a business operator that cannot follow the cradle-to-gate method is forced to calculate and provide data using the gate-to-gate method (see 1-4-6 (4) of this document), put that in this field. • If a downstream operator uses gate-to-gate emission data provided by a supplier that is unable to follow the cradle-to-gate method for its Scope 3 calculation, it must supplement that supplier's upstream emissions.
	Gate-to-gate emissions (including biogenic emissions and removals)	○			• (2) Total emissions (including biogenic emissions and removals) from the company's gate-to-gate boundary (kg-CO2e) • Gate-to-gate CO2 data in addition to cradle-to-gate for upstream emission structure analysis (see 1-4-8), if available • Or, if a business operator that cannot follow the cradle-to-gate method is forced to calculate and provide data using the gate-to-gate method (see 1-4-6 (4) of this document), put that in this field. • If a downstream operator uses gate-to-gate emission data provided by a supplier that is unable to follow the cradle-to-gate method for its Scope 3 calculation, it must supplement that supplier's upstream emissions.

Data disclosure elements (Data quality 1/2)

3-2-4. Data quality

Data disclosure element		GD Consortium specification	Calculation method	Request level (M, R, O)	Description
Primary data share	Primary data share	-	Product-based	M	Primary data shareo of CO2 data provided
Data Quality Rating	% coverage	-	Product-based	O (M from 2025)	Percentage of CO2 data subjected to data quality assessment
			organization-based	O	
	Technological representativeness	-	Product-based	O (M from 2025)	Technological representativeness of emission factor based on data quality matrix
			organization-based	O	
	Temporal representativeness	-	Product-based	O (M from 2025)	Temporal representativeness of emission factor based on data quality matrix
			organization-based	O	
	Geographical representativeness	-	Product-based	O (M from 2025)	Geographical representativeness of emission factor based on data quality matrix
			organization-based	O	
	Completeness	-	Product-based	O (M from 2025)	Completeness of activity based on data quality matrix
			organization-based	O	
	Reliability	-	Product-based	O (M from 2025)	Reliability of activity based on data quality matrix
			organization-based	O	

Data disclosure elements (Data quality 2/2)

3-2-4. Data quality (continued)

Data disclosure element		GD Consortium specification	Calculation method	Request level (M, R, O)	Description
Assurance and verification	Assurance or verification conducted	–	Both	R	• Answer Yes/No to assurance/verification by third party • answer the following regarding assurance/verification content
	Coverage*	–	Both	O	• Level of emissions data assured/verified • Organization level, product series level, PCF calculation system level, individual product level (for Organization-based calculation, the transaction level can also be stated)
	Assurance level*	–	Both	O	• Limited or reasonable assurance
	Assurance boundary*	–	Both	O	• Is the boundary gate-to-gate or cradle-to-gate?
	Assurance body*	–	Both	O	• Name of the party conducting the assurance/verification
	Date of implementation	–	Both	O	• Completion date of assurance/verification
	Rules and standards with which assurance is compliant	–	Both	O	• Rules and standards followed for assurance and verification
	Statement	–	Both	O	• Statement of assurance and verification • PDF attachment or electronic signature (in line with technical specifications)
	Additional comments	–	Both	O	• Additional comments on interpretation of assurance and verification

*See also the discussion in 4-2-1 on coverage, assurance level, assurance boundary and assurance provider.

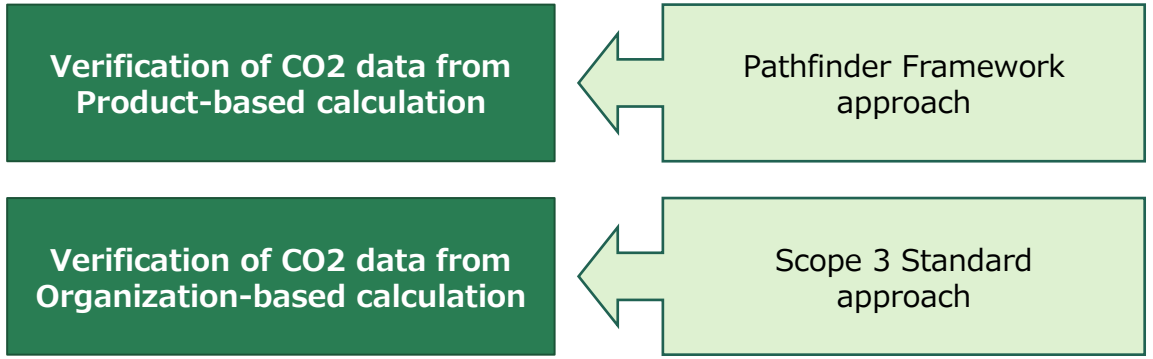
4. Assurance and verification of CO2 data

- Following Pathfinder Framework v2, the terms “assurance" and "verification" are used interchangeably throughout this document.

Assurance and verification of CO2 data

4-1. Assurance and verification of CO2 data

- With the advent of the era in which CO2 data is exchanged in supply chains using digital technologies, it is expected that third-party verification of data will gain increasing importance.
  - Companies that calculate CO2 data in accordance with the Pathfinder Framework, the international framework presented in Chapter 2-2 of this document, may wish to demonstrate to the public that their results are internationally acceptable. They will look to obtain third-party verification as an effective means of achieving this.
  - Downstream operators may also want to have assurance that the CO2 data they receive is calculated in accordance with authoritative methodologies and standards.
- This section addresses verification in relation to the CO2 data calculation and data sharing methods presented in this document in Section 2 and 3 respectively, examining both Product-based and Organization-based calculation.
- The basic approach of this document is that:
  - Verification of data from Product-based calculation will adopt the Pathfinder Framework approach.
  - Verification of data from Organization-based calculation will adopt the approach of the GHG Protocol Scope 3 Standard, which is the only standard that provides guidance on this methodology.



4. Assurance and verification of CO2 data

4-2. Assurance and verification of CO2 data from Product-based calculations

Verification concepts in the Pathfinder Framework

4-2. Verification of CO2 data from Product-based calculations

- As noted above, CO2 data verification from Product-data based calculations follows the Pathfinder Framework approach.

4-2-1. Pathfinder Framework approach to verification

- This section introduces the approach to assurance and verification of PCF data in Pathfinder Framework v2 (PFv2; the current version at the time of this document's preparation) and outlines this document’s interpretation.
- Our conclusions are summarized in 4-2-2.

(1) No distinction between "assurance" and "verification"

- Although "assurance" and "verification" originally had different meanings, PFv2 uses these terms interchangeably in relation to PCF verification (p. 43).
- Following PFv2, this document uses assurance and verification interchangeably.

(2) The “how” of verification

- PFv2 defines the requirements and proposed outcomes of the assurance process (the “what” of assurance) but does not prescribe the assurance process itself (i.e., the “how) (p. 44).
- PFv2 requires assurance providers refer to additional assurance standards for the “how” of the process (p. 44), but does not provide examples of recommended standards.
- The policy adopted by PFv2 of requiring only "what" in terms of assurance is regarded as being based on the current situation in terms of the provision of assurance and verification. This document adopts the same approach for the same reason.

(3) The “what” of verification: (1) Mandatory third-party verification

- PFv2 requires that verification of the PCF shall be done by an independent third party (p. 15).
- At the same time, if a company is unable to meet the assurance and verification requirements as defined in PFv2 before exchanging data, the company may make the exchange through the Pathfinder Network, providing the company makes transparent to what extent the assurance requirements were fulfilled or not (p. 53).
- Although the above concept emerged for the first time in PFv2, it is consistent with the concept of balancing prescription and inclusiveness adopted in this document (see 1-4-1) and is consequently also adopted in this document.

Pathfinder Framework approach to verification

(4) The “what” of verification: (2) Compliance with the assurance Roadmap

- In addition to requiring third-party verification, PFv2 requires that this verification follows the considerations laid out in the Pathfinder Framework’s roadmap (p. 15).
- The PFv2 assurance roadmap comprises time horizons and assurance dimensions (Figure 4-2-1):
  - Time horizons
    - Short term: 2023–2025
    - Medium term: 2025-2030
    - Long term: 2030 onwards
  - Assurance dimensions
    - Coverage: Granularity of data to be assured
    - Conformance: Basis for the assurance
    - Boundary: Depth of the data to be assured
    - Level of assurance: Degree of confidence
    - Provider: Entity providing the assurance
    - Process cycle: Temporal validity of the assurance
    - Evidence: Guidance for consolidation
    - Application to SMEs: SME requirements
- The details of the assurance roadmap are shown in Figure 4-2-1 on the next page and in the explanations of assurance dimensions on subsequent pages.
- As shown in the illustrations and explanations below, the PFv2 assurance roadmap sets very high-level requirements, such as immediately requiring "reasonable assurance" (see below), and this places a substantial burden on companies calculating CO2 data.
- On the other hand, as previously noted, PFv2 allows data exchange through the Pathfinder Network providing the company makes transparent to what extent the assurance requirements were fulfilled or not (PFv2, p. 53).
- This document also adopts this concept, requiring compliance with the PFv2 assurance roadmap but also allowing companies to exchange data providing that they make transparent to what extent the assurance requirements were fulfilled or not.

Illustration: Assurance roadmap overview

- Pathfinder Framework v2 requires compliance with the following assurance roadmap for PCF assurance.
- Details of the requirements for each of the assurance dimensions are provided in the following pages.

Dimension	Short-term requirements (2023-2025)	Medium-term requirements (2025-2030)	Long-term requirements (2030 onwards)
Coverage Granularity of data to be assured	Corporate level	Representative product or PCF system	Representative product or PCF system
Conformance Basis for the assurance	Any recognized standard	PCR or sector-specific guidance, if followed If not, Pathfinder Framework	PCR or sector-specific guidance, if followed If not, Pathfinder Framework
Boundary Depth of the data to be assured	Gate-to-gate Scope 1 and 2 for corporate-level	Dradle-to-gate	Cradle-to-gate
Level Degree of confidence	Limited assurance	Limited assurance	Reasonable assurance
Provider Entity providing the assurance	Independent third party	Independent third party	Independent third party
Process cycle Temporal validity of the assurance	Annual	3 years or earlier if variance >10%	3 years or earlier if variance >10%
Evidence Guidance for consolidation	**Evidence pack guidance** Companies should use guidance around evidence consolidation to facilitate and streamline the assurance process (see below		
Application to SMEs SME requirements	**Phased-in approach for SMEs** All requirements above identically apply to SMEs but with a 2-year time lag to allow for capacity building		

Figure 4-2-1 Pathfinder Framework v2 assurance roadmap

Source: Created by Mizuho Research & Technologies and Zero Board from Pathfinder Framework v2

Assurance roadmap details: (1) Coverage (1/2)

(4) The "what" of verification: (2) Compliance with the assurance roadmap (continued)

- In the next pages, we provide details of the requirements for each assurance dimension.

① Coverage

PFv2 summary

- Coverage defines the type and level of GHG data to be assured (e.g., corporate level, product line level, or PCF level).

■ Short-term (2023-2025)

- Companies shall assure emissions data at the corporate level. Assurance on a more product-specific level, such as product line or product level, is desirable but not required.

■ Medium-term (2025-2030) and long-term (2030 onward)

- Companies shall assure PCFs are aligned with Pathfinder Framework requirements).
- When warranting multiple PCFs, there are ways to avoid having to get direct assurance for individual PCFs:
  - Option A: At the product-line level, where the PCF of a representative product is assured
  - Option B: By verifying the underlying methodology used by a system (e.g., software) for the purpose of PCF calculation
- Please note that companies may still need to verify specific PCFs at the product level if regulations or customers require it.

■ Steps for Options A and B

- PFv2 sets out the implementation steps for Options A and B as follows.

	Option A Product line assurance	Option B Verification of PCF calculation system
Step 1	Pick representative product (RP) by defining the product line it represents	Define what constitutes the PCF system
Step 2	Assure RP in accordance with PFv2 requirements	Assure whether the tool(s) calculate(s) company PCFs following PFv2 requirements
Step 3	Use assurance statement of RP as proof of verification for any product within product line, provided explanation on representativeness is given	Use assurance statement of PCF system as proof of calculation being aligned with Pathfinder Framework. Communicate data inputs have not been assured.

Figure 4-2-2 Two options for multiple PCF assurance

Source: Created by Mizuho Research & Technologies and Zero Board from Pathfinder Framework v2 5.3.3

Assurance roadmap details: (1) Coverage (2/2)

(4) The “what” of verification: (2) Compliance with the assurance roadmap (continued)

① Coverage (continued)

Explanation: Assurance for short-term corporate-level emissions

- PFv2 requires coverage to be assured at the corporate level in the short term and at the PCF level in the medium and long term. Based on the boundary description below, it is clear that the short-term corporate-level assurance refers to Scope 1 and Scope 2 emissions assurance.
- Given that Scope 1 and 2 emissions are often calculated before PCF calculation, assuring Scope 1 and 2 emissions prior to assurance on a PCF basis could be said to be the typical flow.
- The existence of a data collection and management system that can withstand the Scope 1 and 2 emission assurance process at the corporate level will also have a positive impact on the PCF calculation process and assessment of the reliability of the results.
- However, this does not mean that PCFs cannot be calculated or assured unless Scope 1 and 2 emissions are calculated or assured. In the short, medium, and long term, PCF assurance is possible if the company can engage in PCF calculation and provide information in accordance with the evidence pack (companies are not required to provide emission data or assurances for Scope 1 and 2 emissions, noted below). At this time, it is not necessary to assure Scope 1 and 2 emissions.

Explanation: Assurance for multiple PCFs

- PFv2 proposes a simplified method based on the idea that product-specific PCF assurance is not required when multiple PCFs have been assured.
- The proposed simplified method comprises of the following two types:

  – PCF assurance for a representative product is considered to assure the PCFs of other products in the same product series that share multiple similarities with the representative product. (Option A: Product line assurance)

  – Assurance that the PCF calculation system can perform calculations in accordance with PFv2 requirements is considered to constitute assurance of the calculations for multiple PCFs output by that system. (Option B: PCF calculation system assurance)

- Given that suppliers have been required to calculate PCFs for multiple of their products and provide them to downstream operators under assurance, the PFv2's approval of the above simplified methods is welcome.
- This document also recognizes these two simplified methods and recommends their application.

Assurance roadmap details: (2) Conformance

(4) The “what” of verification: (2) Compliance with the assurance roadmap (continued)

② Conformance

PFv2 summary

- The assurance process verifies whether emissions data output was calculated according to methodological rules. The conformance of the assurance defines adherence to which standard is verified, i.e., which methodological standards serves as the reference.

■ Short-term (2023-2025)

- Companies may use any recognized standard included in Appendix C (Figure 4-2-3) as the basis for corporate-level assurance.
- Companies wishing to go beyond the minimum coverage requirements of PFv2 guidance and assure on a product-specific level may use any of the recognized standards set out in Appendix C (Figure 4-2-3) as the basis for assurance.

■ Medium-term (2025-2030) and long-term (2030) onwards

- Companies should use the Pathfinder Framework as the methodological basis for assurance and verification.
- Please note that, in line with the standards hierarchy established in PFv2 Section 3.1 (2-2-2 in this document), companies may be required to calculate certain PCFs following PCR or sector-specific guidelines.
- In those cases, conformance with the PCR or sector specific methodology shall be followed. Conformance with PFv2 is encouraged, but not required.
- Any PCR or sector-specific methodology or standard used shall be publicly disclosed and referenced in the assurance and verification process as well as in the data exchange information to ensure downstream users of the information have a complete understanding of the conformance of the PCF.

Explanation

- Conformance provides the standards on which assurance and verification must be based.
- For the assurance and verification of short-term corporate-level emissions (equivalent to Scope 1 and 2), any of the standards in Figure 4-2-3 can be used. Specifically, the following standards may be referenced:
  - Organizational Environmental Footprint (OEF)
  - ISO 14064
  - GHG Protocol (Corporate Standard, Scope 2 Guidance, Scope 3 Standard)
- For the medium and long term, the hierarchy for application of calculation rules presented in 2-2-2 of this document is repeated, and there are no new requirements.

Key calculation standards recognized by the Pathfinder Framework

- Pathfinder Framework v2 summarizes key calculation standards of the European Commission, ISO, and GHG Protocol referenced in the development of the document as follows:

Publisher	Geographical focus	Corporate level	Product level	Specific to given sectors	Specific to given products
European Commission	EU	Organizational Environmental Footprint (OEF)	PEF	OEF Sector Rules (e.g. for retail)	PEFCR (e.g. for IT equipment)
ISO	Global	ISO 14064	ISO 14067 ISO 14040 ISO 14044	ISO 20915:2018 for steel products	PCR (e.g. ISO 22526 for biobased plastics)
GHG Protocol (WRI/WBCSD)	Global	Corporate, Scope 2 and Scope 3 standards	Product Life Cycle Standard	E.g., Agriculture Guidance Land Sector and Carbon Removal Guidance	PCRs (e.g. PCRs for concrete)

Figure 4-2-3 Calculation standards recognized by the Pathfinder Framework

Source: Created by Mizuho Research & Technologies and Zero Board from Pathfinder Framework v2

Assurance roadmap details: (3) Boundary

(4) The “what” of verification: (2) Compliance with the assurance roadmap (continued)

③ Boundary

PFv2 summary

- The boundary of the assurance and verification, as its name suggests, defines the boundary of life cycle stages included in the assurance processs.
- While the PCFs exchanged under the Pathfinder Framework are cradle-to-gate footprints, the boundary of the assurance and verification of the PCF can be broader, narrower, or equal to the boundary of the PCF.

■ Short-term (2023-2025)

- Companies shall assure their gate-to-gate emissions.
- This requirement is, in part, a consequence of the initial corporate-level coverage requirement (requiring the calculation of corporate-level emissions in the short term). Gate-to-gate emissions on the company level are considered to be equivalent to Scope 1 and Scope 2 emissions, as defined by the GHG Protocol.

■ Medium-term (2025-2030) and long-term (2030 onwards)

- Companies shall ensure that the entire cradle-to-gate footprint of PCFs has been verified, i.e., the entire footprint up to the point where it is passed on downstream

Source: Created by Mizuho Research & Technologies and Zero Board from Pathfinder Framework v2

Explanation

- Given the scope of the short-term assurance coverage (at corporate level) noted earlier, it can be seen that the gate-to-gate short-term coverage in the assurance roadmap in Figure 4-2-1 equates to the scope of Scope 1 and 2 of the GHG Protocol.
- However, as described above in the “Coverage” section, companies can assure PCFs if these are calculated in accordance with PFv2 requirements with information presented in accordance with the evidence pack (emission data and assurance for Scope 1 and 2 emissions do not have to be provided). At this time, assurance for Scope 1 and 2 emissions is not necessarily required.
- PFv2 proposes that the boundary for medium and long term assurance should be cradle-to-gate, following on from the requirements for PFv2 PCF calculation (a cradle-to-gate calculation boundary).

Assurance roadmap details: (4) Level of assurance

(4) The “what” of verification: (2) Compliance with the assurance roadmap (continued)

④ Level of assurance

(PFv2 summary)

- The level of assurance defines the degree of confidence in the assurance statement.

■ Short-term (2023-2025)

- Companies shall conduct limited assurance.

■ Medium-term (2025-2030)

- Companies shall conduct limited assurance.

■ Long-term (2030 onwards)

- Companies shall conduct reasonable assurance.

	Limited assurance	Reasonable assurance
Opinion statements	Negative “Nothing has come to our attention that the assurance statement does not conform with the Pathfinder Framework and contains material misstatements”	Positive “In our opinion the disclosure conforms with all Pathfinder requirements and is fairly stated in all material aspects”
Application	Commonly used for nonfinancial disclosures	Commonly used in financial disclosures
Process	Limited in scope—different or fewer checks than reasonable assurances)	Greater sampling at a greater depth and comprehensiveness

Figure 4-2-4 Assurance levels comparison

Source: Created by Mizuho Research & Technologies and Zero Board from Pathfinder Framework v2

[Explanation]

- PFv2 specifies that, with respect to the level of PCF assurance, limited assurance is acceptable in the short and medium term, but reasonable assurance is required in the long term.
- As shown in Figure 4-2-4, limited assurance guarantees that no inconsistencies with PFv2 or material misstatements have been found, which is simpler than reasonable assurance, whereby the disclosure is found to conform “with all Pathfinder requirements” and to be “fairly stated in all material aspects.”
- Traditionally, the GHG Protocol too has not gone so far as to call for reasonable assurance, which is used primarily in financial disclosures, although Scope 1, 2, and 3 assurances provide two levels of assurance: limited and reasonable.
- The fact that PFv2 requires the stricter “reasonable assurance” with the condition of "2030 onwards" means that the level of reliability required for PCF data will approach the reliability of financial disclosures in the long run.
- While this is a high-level requirement, we agree that reasonable assurance is appropriate as an assurance level to be realized in the long-term and accept it as an assurance requirement.

Assurance roadmap details: (5) Provider

(4) The “what” of verification: (2) Compliance with the assurance roadmap (continued)

⑤ Provider

PFv2 Summary

- The provider of the assurance is the entity that verifies the emissions data.
  - When the reporting company also performs the assurance, this is known as first-party assurance.
  - When a party other than the reporting company performs the assurance, this is known as third-party assurance.
- Companies shall choose an independent third party to conduct the verification process.
- While first-party quality controls and plausibility checks are encouraged, they do not suffice to fulfill the assurance requirements of this guidance.
- Companies may choose any qualified assurance provider, as long as the provider meets the expertise requirements to conduct an assurance engagement. Proof of such expertise may include previous assurance engagements around PCFs, sector-specific knowledge, and technical capabilities.
- Additional details on criteria to consider when selecting an assurance provider are as follows:

Requirements for choosing assurance providers

1. Expertise and experience
   - Proven experience conducting assurance engagements and applying assurance standards
   - Capabilities around LCA and carbon accounting, as shown by experience, educational qualifications, and tools used
2. Industry and sectoral knowledge
   - Understanding of the underlying industry that the PCF data to be assured belongs to
   - Understanding of business operations within the sector which the product or corporation belongs to
3. Credibility
   - Proof of no conflicts of interest between the assurance provider and reporting company
   - Proof of successful verification processesability
4. Capacity
   - Enough staff capacity to conduct the assurance engagement

Source: Created by Mizuho Research & Technologies and Zero Board from Pathfinder Framework v2

Explanation

- The term "self-declaration" no longer appears in PFv2 because third-party assurances are now mandatory.
- However, first-party PCF quality controls and plausibility checks are encouraged and, as noted earlier, data exchange of PCFs that do not fully meet PFv2 requirements is also permitted. During the transition period, there will be cases where PCF data that has only been subjected to first-party quality and plausibility checks will be exchanged.

Assurance roadmap details: (6) Process cycle

(4) The “what” of verification: (2) Compliance with the assurance roadmap (continued)

⑥ Process cycle

PFv2 summary

- The process cycle defines the validity period of the assurance statement.

■ Short-term (2023-2025)

- The assurance statement shall be valid for one year. Accordingly, companies shall renew the assurance annually.
- The requirement for an annual renewal of assurance on the corporate level aims to be aligned with regulatory requirements such as the EU’s Corporate Sustainability Disclosure Directive (CSRD) and the US Securities and Exchange Commission’s (SEC) proposed rules on nonfinancial disclosures.

■ Medium-term (2025-2030) and long-term (2030 onwards)

- The assurance statement shall be valid for a maximum of three years or until:
  - The underlying PCF of the representative product changes by more than 10 percent compared to the PCF that was previously assured, if the company chooses to assure on the product-line level.
  - The PCF system’s underlying methodology or system build has changed qualitatively. A qualitative change includes:
    - ✓ Relevant fixes or changes with the existing PCF system
    - ✓ Deployment of a different PCF system product (e.g., witch to a different vendor or change in product line of same vendor)
    - ✓ Changes to the data flows necessary for PCF calculation within the PCF system (e.g., when the type of digital input data has changed or when there is a qualitative change to other digital systems participating in PCF calculation)

Explanation

- The one-year validity period of the assurance statement for the short term has been increased to three years in the medium term and the long term because the coverage is different.
- Because the scope of the short-term assurance is Scope 1 and 2 emissions as a company, the assurance is expected to be updated annually in line with EU and US non-financial reporting rules (emissions are reported annually).
- Since a product’s cradle-to-gate PCF is covered by the assurance in the medium and long term, annual renewal of the calculation and assurance is impractical considering the burden on the company, and the PCF data of the product unit seems unlikely to change significantly every year, which is why PFv2 is considered to have set an assurance period of three years.
- The data quality assessment (2 -2-8 (2) of this document) regards the level of quality for emission factors calculated within five years as “fair" (midway between “good” and “poor”). This means that even if the PCF provided by the supplier is four to five years old, the quality will be rated as “fair." In other words, even a PCF whose three-year assurance has expired will receive a "fair" rating for five years.

Assurance roadmap details: (7) Evidence

(4) The “what” of verification: (2) Compliance with the assurance roadmap (continued)

⑦ Evidence

PFv2 Summary

■ Context and purpose

- The provision of standardized and relevant evidence to substantiate emissions claims and support the assurance process is the cornerstone of any verification and assurance process.
- This section is therefore meant to guide companies’ efforts to gather and organize the evidence that might be required in an assurance engagement.
- This guidance does not replace any guidance that assurers themselves may provide during the verification process and is not a blueprint for an assurance engagement. Rather, it is meant to help companies prepare for an assurance engagement ahead of time, speeding up and streamlining the assurance process.

■ Structure and dimensions

- The guidance around evidence is structured along three dimensions central to verifying Product-based emission disclosures:
  1) Data: Evidence around the required data elements, sources, and quality of data used in the calculations
  2) Methodology: Evidence around the calculation steps, results, and assumptions
  3) Governance: Evidence around the underlying processes used during the calculations, including how data was stored, how quality was ensured, and how risks were mitigated

- Each dimension contains five specific elements described in the assurance evidence pack described below, which constitute the assurance evidence pack for that dimension. Because the maturity of a company’s Product-based emissions reporting varies, the assurance evidence pack distinguishes between minimal and optional elements that may further clarify the assurance process.

■ Assumptions

- Companies should check to what extent the assumptions are applicable and, accordingly, to what extent this guidance may be relevant for their context.

■ Evidence pack

- A full version of the evidence pack, including the different dimensions and minimum and optional requirements, is described below.

Explanation

- The Assurance Roadmap (Figure 4-2-1) shows the short-, medium-, and long-term requirements by assurance dimension, but the actual requirements are shown only up to the process cycle (previous page), while the section on evidence lays out an “evidence pack" so that companies can collect and organize the evidence considered necessary for assurance.
- Figures 4-2-5 to 4-2-7 describe the content of the PFV2 evidence pack, together with this document's own discussion of what should be checked and from what perspective for each element of evidence.

Illustration: Assurance evidence pack (1) Data

- Pathfinder Framework v2 sets out the data required as evidence for assurance.

Assurance evidence pack (from Pathfinder Framework v2)				What should be checked and from what perspective (This document's approach)
Element	Description	Minimum	Optional	
Data collection	In order to perform a PCF calculation, companies are expected to identify all relevant GHG sources and map the activity data available for each	Inventory of all GHG sources and the relevant activity data broken down by site	N/A	Have any important attributable processes been overlooked?
Primary data source	Understanding which of the GHG sources have been calculated via primary data collection is considered key for the purpose of the Pathfinder Framework	Comprehensive list of all primary data sources used	Additional information on how and when the data was accessed	(For the purpose of understanding the contents of the PCF calculation, so there is no pass/fail judgment for this element alone.)
Secondary data source	Companies downstream want to ensure that secondary data used for the calculation comes from credible and globally recognized sources	Comprehensive list of all secondary data sources used	Additional information on how and when the data was accessed	Are you using a Pathfinder Framework-approved secondary data database?
Proxy data	Should primary and secondary data sources not cover the entirety of the studied PCF, proxy data can be used to fill in the gaps as long as this is documented transparently	List of proxy data used and rationale of application	Steps taken to ensure that proxy data used is minimized in the future	Are there unreasonable proxy data applications? For example, is primary and secondary data really not available? Is the proxy data really suitable for emissions estimation?
Data quality	As data quality shall only be assessed for GHG sources surpassing the defined 5% threshold, companies will need to give evidence of this exercise to ensure all material sources are covered in the assessment Companies will also need to give evidence of the data quality assessment statement	Results of materiality threshold assessment of PCF's GHG sources Overall data quality assessment statement	An individual data quality statement for each GHG source surpassing the materiality threshold	Are exemption rules (cutoff rules) applied correctly? (Since the data quality statement is also used to understand the quality of PCF data, no pass/fail judgment is made for this element alone.)

Figure 4-2-5 Assurance evidence pack (1) Data

Source: Created by Mizuho Research & Technologies and Zero Board from Pathfinder Framework v2

Illustration: Assurance evidence pack (2) Methodology

- Pathfinder Framework v2 sets out the evidence required for methodology in the evidence pack.

Assurance evidence pack (from Pathfinder Framework v2)				What should be checked and from what perspective (This document's approach)
Element	Description	Minimum	Optional	
Conformance	Standards followed will define the Framework requirements and thus the correctness of the steps taken by companies to calculate the PCF Companies will need to demonstrate alignment to Scope boundary conditions prescribed by the Framework	Comprehensive checklist of standard(s) requirements followed List of Scope boundary conditions (E.g., treatment of site waste disposal; upstream boundary of raw materials using recycled materials	N/A	When using PCR and sector rules, is the company compliant with those requirements? Has the company set a boundary which runs contrary to the Pathfinder Framework?
Calculation step	It is essential for companies to be able to produce a list of calculation steps taken to convert activity data into GHG emissions for each life cycle stage included in the system boundary of the PCF	Comprehensive list of calculation steps per life cycle stage (list of activity x emission factor)	N/A	Are there any omissions or duplications in the calculation steps? (The data collection list above is useful in this regard.)
Assumptions	List of assumptions used in calculation to ensure completeness of calculation	Comprehensive list of assumptions made at each stage	N/A	Have unreasonable assumptions have been made? (Decisions must be based on common sense.)
Allocation	Downstream companies will want to understand whether allocation has taken place, and if so, what approach was used	Description of allocation approach followed	Evidence to confirm avoided allocation	Is the allocation approach consistent with the Pathfinder Framework (see 2.2.4)?
Results	Results will allow verification parties to understand whether the calculation steps required by the standard have been completed accurately Ensures mass balance validation	Comprehensive list of all intermediate and final results		Is the calculation process correct? • Check by "activity data x emission factor" • Check double accounting at the time of statement application • Check PDS calculations • Check DQR calculations

Figure 4-2-6 Assurance evidence pack (2) Methodology

Source: Created by Mizuho Research & Technologies and Zero Board from Pathfinder Framework v2

[Illustration: Assurance evidence pack (3) Governance

- Pathfinder Framework v2 sets out the evidence required for governance in the evidence pack.

Assurance evidence pack (from Pathfinder Framework v2)				What should be checked and from what perspective (This document's approach)
Element	Description	Minimum	Options	
Data governance	In order to ensure replicability and facilitate knowledge transfer, companies should have in place a data governance plan mapping the data processes, ownership, and responsibilities, as well as documentation on the steps taken to consolidate and validate different data inputs, e.g., from different sites	Comprehensive map of all processes and responsibilities Comprehensive list of all data consolidation steps and rationale (e.g., data consolidation from multiple locations)	N/A	Confirmation (No pass/fail judgment for this element alone) Are there inconsistencies in any of the data consolidation steps?
Quality control	Internal mechanism in place to ensure quality control takes place and that responsibilities associated with it are clear	N/A	Comprehensive list of controls and responsibilities	Confirmation (No pass/fail judgment for this element alone)
Expertise	There is a need to ensure that the team employed to undergo the calculation process has sufficient expertise in the subject in order to minimize PCF misstatements	N/A	Total years of expertise within team employed to undergo PCF	Confirmation (No pass/fail judgment for this element alone)
Capacity	When asked, companies should be able to list internal and contracted team members (if any) responsible for the product footprint calculations	N/A	List of all responsible individuals	Confirmation (No pass/fail judgment for this element alone)
Risk management	Companies need to be able to identify potential shortcomings or pitfalls associated with the PCF calculation process in order to be able to address them	Comprehensive list of all risks and mitigation tactics	Progress on mitigation tactics employed	Confirmation (No pass/fail judgment for this element alone)

Figure 4-2-7 Assurance evidence pack (3) Governance

Source: Created by Mizuho Research & Technologies and Zero Board from Pathfinder Framework v2

Requirements for choosing assurance providers

(5) Requirements for choosing assurance providers

PFv2 does not include specific requirements around choosing an assurance provider but does suggest some criteria that may be used for selection.

Requirements for choosing assurance providers suggested by PFv2

① Expertise and experience

- Proven experience conducting assurance engagements and applying assurance standards
- Capabilities around LCA and carbon accounting, as shown by experience, educational qualifications, and tools used

② Industry and sectoral knowledge

- Understanding of the underlying industry that the PCF data to be assured belongs to
- Understanding of business operations within the sector which the product or corporation belongs to

③ Credibility

- Proof of no conflicts of interest between the assurance provider and reporting company
- Proof of successful verification processes

④ Capacity

- Enough staff capacity to conduct the assurance engagement
- It is the company's responsibility to ensure that requirements are met

- General elements are listed as conditions for selecting an assurance provider, but no specific criteria are provided.
- Although we believe that more specific criteria could be provided, given alignment with PFv2 and the shortage of PCF data assurance and verification providers, we will only recommend the PFv2 selection requirements.

Pathfinder Framework approach to verification

(6) Reporting

- PFv2 notes the following in relation to assurance statements and their use by companies:

[PFv2 assurance statement requirements]

In line with the GHG Product Standard, companies shall include the assurance statement in the emission disclosure.

- An assurance statement, at the minimum, shall include:
  - The assurer's assertion
  - The level of assurance
  - The assurance provider's name and the executing individuals
  - A summary of the assurance process and work performed
  - The relevant expertise of the assurer
  - Any potential conflicts of interest
  - The assurance standard applied, if any
  - A list of criteria that were evaluated to reach the assertion.
- The format of reporting will depend on the applicable requirements, particularly the coverage requirements.

[Company use of assurance statements as defined by PFv2]

- In the short term, companies shall report the assurance statement alongside the relevant emissions disclosure.
- In the medium and long term, companies shall need to share the assurance statement as a link in the data attributes or as an attachment to the relevant PCF being exchanged.
- In general, companies shall exchange information on the assurance itself through the Pathfinder Network. It is the company's responsibility to ensure that assurance-related information for each PCF exchanged through the Pathfinder Network is up to date and aligned with PFv2 requirements.

Concept of CO2 data verification in this document (1/2)

4-2-2. Concept of CO2 data verification in this document

- This section summarizes the approach of this document to the specific requirements and guidance for PFv2 presented in the preceding pages. Following PFv2, assurance and verification are used interchangeably in this document.

(1)What is required for verification?

- As with PFv2, this document does not specify to the “how” of the assurance process, just the “what” of the process (i.e., the requirements and proposed outcomes).

(2) Third-party verification required

- As with PFv2, this document requires that PCF assurance by a third party. At the same time, data exchange is permitted for PCFs that have not been verified by a third party, subject to disclosure that information related to data quality has not been verified.
- This is due to this document’s acceptance, consistent with our inclusiveness orientation, of the PFv2 position that “If a company is unable to meet the assurance and verification requirements as defined in this guidance before exchanging the data, the company may still exchange it through the Pathfinder Network.”
- How the reliability of PCF data is evaluated based on the presence or absence of third-party assurance is left to the judgment of the downstream company that sends or receives the data.

(3) Compliance with PFv2 assurance roadmap required

- This document also requires compliance with the PFv2 assurance roadmap (Figure 4-2-1). At the same time, PCF data that are not fully compliant with the roadmap will be allowed to be exchanged as long as this non-compliance is disclosed.
- Consistent with our inclusiveness orientation, this document accepts the PFv2 position that “If a company is unable to meet the assurance and verification requirements as defined in this guidance before exchanging the data, the company may still exchange it through the Pathfinder Network.”
- How the reliability of PCF data is evaluated based on the presence or absence of third-party assurance is left to the judgment of the downstream company exchanging the data.

- It should be noted that the short-term requirements for "coverage" and "boundary" (third-party verification of Scope 1 and 2 emissions) in the assurance roadmap are not required in situations where a company can obtain third-party PCF assurance by presenting information based on the assurance evidence pack after performing the PCF calculation.
- Where the purpose is only PCF assurance, this document takes the position that third-party assurance of Scope 1 and 2 emissions as an organization is not required (although desirable) as long as the necessary data have been compiled and third-party assurance of the PCF can be obtained.

Concept of CO2 data verification in this document (2/2)

4-2-2. Concept of CO2 data verification in this document (continued)

(4) Preparation of information in assurance evidence pack recommended

- The assurance evidence pack presented by PFv2 (Figures 4-2–5 to 4-2-7) is an effective list of information that companies should prepare for assurance and verification.
- This document also recommends the organization of information based on assurance evidence packs.

(5) Compliance with PFv2 requirements for choosing assurance providers recommended

- This document recommends following the PFv2 proposal on requirements for choosing assurance providers (4-2-1 (5)).

(6) Compliance with PFv2 assurance statement reporting format required

- This document requires compliance with the assurance statement reporting format presented by PFv2 (4-2-1 (6)).

4. Assurance and verification of CO2 data

4-3. Assurance and verification of CO2 data from Organization-based calculations

Verification of CO2 data from Organization-based calculations

4-3. Verification of CO2 data from Organization-based calculations

- Although this document recognizes Organization-based calculation data for the purpose of inclusiveness, CO2 data quality is as important as in Product-based calculations.
- There are differences in calculation methods between organization-based and Product-based calculations, and these differences are also relevant in relation to verification.
  - In Organization-based calculations, CO2 data is calculated (allocated) and shared based on Scope 1, 2, and 3 emissions. Scope 1, 2, and 3 emissions are important today as non-financial disclosure elements for companies and require third-party verification. For this reason, many companies have already verified Scope 1, 2, and 3 emissions.
  - Scope 1, 2, and 3 emissions verification is regarded as a corporate non-financial disclosure measure, and therefore is not subject to the verification required by this document. The verification required by this document is the appropriateness of the allocation for CO2 data-sharing.
  - However, it is also important to understand Scope 1, 2 and 3 emissions, which are a prerequisite for Organization-based calculations, in order to verify the appropriateness of the allocation.
- Based on the above, we propose the following requirements for CO2 data verification for Organization-based calculations:
  ① Understanding of Scope 1, 2 and 3 emissions as a premise
  ② Plausibility of process subdivision and allocation

4-3-1. Understanding of Scope 1, 2 and 3 emissions

- Scope 1, 2 and 3 emissions are not subject to verification in the CO2 data-sharing presented in this document, as they are intended to deepen understanding as premises and to lead to the formulation of reduction measures and supplier collaboration.
- Specific elements for understanding Scope 1, 2, and 3 emissions include reporting boundaries, calculation methods, emissions factors, and primary data utilization ratios.

Verification of CO2 data from Organization-based calculations: Plausibility of data subdivision and allocation

4-3-2. Verifying allocation plausibility

- Points (1) to (5) below are required to verify allocation plausibility.

(1) Plausibility of process subdivision

- "2-3-2. Organizational-level calculation method" recommends process subdivision as a means of avoiding or minimizing allocation.
- To avoid or minimize allocation, we envisage an approach that is limited to transaction-related scope by customer, with the plausibility of this approach to be confirmed.

(2) Does it contain a target category?

- The GHG Protocol Product Standard stipulates that non-attributable processes (indirect activities) fall outside the boundary (unless deemed to be product-related).
- In line with this concept, we suggest that in the Organization-based calculation presented in this document, emissions from indirect activities and other activities in the Scope 3 category that have low relevance to products destined for a customer should be excluded from the range of emissions used as the denominator for allocation to that customer.
- Check whether these activities are excluded for valid reasons based on relevance to customer transactions.

(3) Allocation indicators

- If a physical indicator reflects a causal relationship between product manufacturing and emissions, it is allocated using a physical indicator; otherwise, it is allocated using an economic or other indicator.
- Check whether allocation indicators have been determined in accordance with the concepts presented in "2-3-2. Organizational-level calculation method."

(4) Consistency of emissions before and after allocation

- In the case of allocation, emissions before and after allocation must be consistent.
- Check whether the total value of allocation results matches the total amount before allocation.

(5) Appropriateness of certificate allocation

- Check whether the certificate allocation has been done properly as shown in 2-3-2.
- Check for double counting.

Appendix

Appendix 1. Glossary

(1) Terms appearing in Japanese translation, katakana notation or mixed Japanese notation

Terminology	Definition
Green x Digital Consortium	A consortium established by JEITA in October 2021 to promote activities for the creation and implementation of new digital solutions that lead to the promotion of corporate carbon neutrality and changes in industry and society
Visualization WG	A Green x Digital Consortium working group (WG) considering mechanisms for visualizing CO2 emissions throughout the supply chain
Methodology SWG	A subworking group of the Visualization WG considering CO2 data calculation and sharing methods, etc., for the CO2 Visualization Framework
Data Format and Exchange SWG	A subworking group of the Visualization WG considering data exchange formats and exchange methods using digital technologies
Logistics SWG	A subworking group of the Visualization WG considering methods for calculating CO2 emissions from transport and logistics
CO2 Visualization Framework	Framework document for CO2 visualization released by the Green x Digital Consoritum that presents calculation and data quality disclosure methods for CO2 data exchanged throughout the supply chain using digital technology
CO2 data	In this document, in principle, cradle-to-gate greenhouse gas emissions data. Not limited to CO2, but refers to the CO2 equivalent of GHG as defined by the IPCC.
Life cycle	Consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to end-of-life
Life Cycle Assessment (LCA)	Compilation and evaluation of the inputs, outputs, and potential environmental impacts of a product throughout its entire life cycle.
Life cycle emissions	The sum of GHG emissions resulting from all stages of the life cycle of a product
Declared unit	A unit used to quantify and share GHG emissions. It is basically used in intermediate products because it is based on a unit that is easy to grasp objectively, such as mass. An additional concept is functional unit, which is the unit based on the function and performance of the studied product
Product quantity	The quantity of declared units in the product. For example, in the case of "parts with a mass of 5 kg per piece," the declared unit is indicated as "kg" and the product quantity is indicated as "5."
Inventory	A list of sources and sinks from which a particular substance has been released or removed over a period of time
Activity data	Quantitative measurement of activities related to GHG emissions or removals. Fuel and power consumption, component weight and procurement costs, etc.
Emission factor	GHG emissions per unit of activity. Although emission intensity has the same meaning, this document generally uses the term “emission factor.”
Global Warming Potential (GWP)	Factor for converting non-CO2 greenhouse gases into CO2 equivalent greenhouse effect

Appendix 1. Glossary

(1) Terms appearing in Japanese translation, katakana notation or mixed Japanese notation

Terminology	Definition
Unit process	The smallest unit in which input/output data is quantified
Attributable LCA approach	An LCA method that combines the environmental impacts of all attributable processes in the current life cycle and attributes them to the target product
Attributable process	Service, material, and energy flows that become the product, make the product, and carry the product through its life cycle
Non-attributable process	Processes that do not qualify as attributable processes and should be excluded from the calculation. Not used in the Pathfinder Framework, but introduced here to define a concept.
Boundary	Boundaries for calculating and reporting greenhouse gas emissions. In principle, this document is bounded by cradle-to-gate attributable processes.
Exemption rules (cutoff)	Provisions for excluding certain processes from calculations within the framework of the attributable process
Allocation	The process of partitioning GHG emissions from a single facility or other systems among its various outputs, in particular products
Process subdivision	A method of avoiding allocation by dividing a unit process into two or more finer processes and understanding the inputs and outputs for each process
Primary data	Site- or supplier-specific data related to specific activities within a company's value chain
Secondary data	Data not derived from specific activities within a company's value chain but rather from databases based on information sources such as averages and scientific reports
Proxy data	Data used to bridge data gaps in primary or secondary data
Primary data emission factors	Emission factors specific to each company provided by supplier companies, not industry averages taken from databases, etc.
Primary data share (PDS)	Percentage of PCF emissions that were calculated using primary activity and emissions data. The PDS is not necessarily 100%.
Data Quality Ratings (DQR)	A system to evaluate the quality of CO2 data by five indicators: technological representativeness, temporal representativeness, geographical representativeness, completeness, and reliability

Appendix-1. Glossary

(1) Terms appearing in Japanese translation, katakana notation or mixed Japanese notation

Terminology	Definition
Recycled content method	One means of reflecting recycling effects, premised on open-loop recycling, whereby the recycled materials are used in different products. The recycling effect and environmental burden are divided into pre- and post-recycling processes. This document stipulates that the recycled content method should be used to reflect the recycling effect.
Closed-loop approximation method	One means of reflecting recycling effects, premised on closed-loop recycling, whereby the materials are used again for the same product. The recycling effect and environmental burden are borne by the recycling processing side, with the whole product presumed to comprise virgin materials on the raw material procurement side.
SHK scheme under the Act on Promotion of Global Warming Countermeasures	System for GHG emissions accounting, reporting and disclosure whereby companies with substantial GHG emissions (“specified emitters”) have to calculate their GHG emissions and report them to the government
Emission factors by power company	Emission factors by power company and general transmission and distribution utility for reporting CO2 emissions associated with the use of power supplied by another party. Two types of emission factors, the basic emission factor and the adjusted emission factor, are disclosed. An SHK scheme concept.
Energy attribute certificate	A certificate enabling renewable electricity attribute information and value to be handled separately from actual power
Carbon credit	Measurement, Reporting, and Verification (MRV) is performed in relation to GHG reduction or removal projects to verify the difference between the envisaged amountss of emissions and removals against the actual amounts, which can then be traded among countries and companies, etc., as carbon credits
Offset	Application of carbon credits to offset GHG emissions from the reporting entity's entire organization or per product
Mass balance approach	In general, when a mixture of sustainable and non-sustainable raw materials (e.g., biomass and fossil-origin raw materials) is produced, a method of assigning sustainable characteristics to some products by weight. This document reserves the use of the mass balance approach for CO2 data calculation.
Biogenic carbon	Carbon derived from organisms and biological processes, as opposed to carbon from fossil fuel sources
Biogenic emissions	Amount of biogenic GHG emitted into the atmosphere, comprising land management (agriculture, etc.), land use change (deforestation, etc.), and others (biogenic waste disposal, etc.)
Biogenic removal	Amount of biogenic GHG removed from the atmosphere, comprising the mass of biogenic carbon contained in the product of the declared unit converted to kg-CO2e
Direct land use change (dLUC) emissions	A recent (i.e., previous 20 years) carbon stock loss due to land conversion directly on the area of land under consideration
Indirect land use change (iLUC) emissions	A recent (i.e., previous 20 years) carbon stock loss due to land conversion on land not owned or controlled by the company or in its supply chain, induced by change in demand for products produced or sourced by the company
Land management emissions	GHG emissions from sources that occur on land from land management activities and during production of food, feed, fiber, or other biogenic product(s)

Appendix 1. Glossary

(2) English terms

Terminology	Definition
CO2e	CO2 equivalent. Each type of greenhouse gas has a different magnitude of impact on global warming, and this is a common measure to uniformly represent them
CFP	Carbon Footprint of Products. Total amount of greenhouse gases generated over the life cycle of the product. Also called Product Carbon Footprint (PCF). ISO 14067 uses the CFP notation, and the Pathfinder Framework uses the PCF notation.
Cradle-to-gate	One type of boundary setting in the product lifecycle, stating with raw material extraction and other processes at the first stage of the product lifecycle
Gate-to-Gate	One type of boundary setting in the product lifecycle
GHGs	Greenhouse gases, including include CO2, CH4, N2O, HFCs, PFCs, SF6, and NF3
EEIO	Environmentally-Extended Input Output. An economic analysis model of inputs and outputs for each industry is applied to the evaluation of environmental impact, such as emission factor databasse based on input-output tables
PACT	Partnership for Carbon Transparency. An initiative established by WBCSD to enable cross-sectoral exchange of primary data on GHG emissions for Scope 3 transparency
Pathfinder Framework	Emission data calculation and exchange methodology issued by PACT
Pathfinder Network	An open network for the confidential and secure exchange of emissions data. A PACT initiative.
PCF	Product Carbon Footprint. Total amount of greenhouse gases generated over the life cycle of the product. Also called Carbon Footprint of Products (CFP). ISO 14067 uses the CFP notation, and the Pathfinder Framework uses the PCF notation. Although sometimes used as an abbreviation for Partial Carbon Footprint, PCF in this document refers only to Product Carbon Footprint.
PCR	Product Category Rule. Criteria for calculating PCF for the same commodity type.
PEFCR	Product Environmental Footprint Category Rules, rules on the environmental footprint (results of life cycle assessment covering not only GHG emissions but also various environmental impacts) by product category developed as part of the EU’s environmental footprint policy
SuMPO EPD	The Environmental Product Declaration program, which is operated by Japan's Sustainable Management Promotion Organization (SuMPO) and is the only program in Japan compliant with ISO14025. Called EcoLeaf prior to May 14, 2024.

Appendix 2. Alignment with METI/MoE Carbon Footprint Guidelines

- Clarification of necessary points of adjustment (recalculation, etc.) when a business that has calculated a CFP using the Carbon Footprint Guidelines (CFP Guidelines, released in May 2023) seeks to align with this document

No.	Alignment/ adjustment required	Issue	CFP Guidelines	Page	CO2 Visualization Framework	Page	Notable differences *	Necessary adjustments
1	Alignment	Allocation hierarchy	① Data Collection - V. Calculation method for allocation (1/3)	53	2-2-4. PCF calculation steps (4) Step 3 Allocation 2-3-2. Calculation methodology (3) Allocation	91 (Product) 137 (Organization)	The allocation hierarachy differs. The Product-based calculation inf the CO2 Visualization Framework Edition 2 uses the Pathfinder Framework decision tree and prioritizes economic allocation. For Organization-based calculation, physical indicators are prioritized (but only as recommended) in accordance with Chapter 8: Allocation, of the GHG Protocol Scope 3 Standard. The CFP Guidelines prioritize physical indicators.	If the allocation is based on physical indicators, based on CFP Guidelines, it is necessary to consider whether an allocation based on economic value is feasible.
2	Alignment/ partial adjustment required	Declared and functional units	① Calculation Unit (1/2)	28	2-2-3. Scope and boundary (4) Display units	77	The CO2 Visualization Framework Edition 2 requires that the final PCF inventory results be disclosed as kg-CO2e per declared unit. Most of the PCF calculations are for intermediate products, which must use declared rather than functional units. In the CFP Guidelines, the unit of calculation for CFP must be defined in functional units. However, if it is an intermediate product or difficult to define in a functional unit, it may be implemented in a declared unit.	If the calculation is performed on a functional basis based on the CFP Guidelines, it is necessary to perform the calculation on a declared unit basis, where the function is decomposed and related to the quantity.
3	Adjustment required	Cutoff rules	(a) Examination of cutoff criteria	34	2-2-4. PCF calculation steps (3) Exemption rules (cutoff rules)	88	The CO2 Visualization Famework Edition 2 refers to Pathfinder Framework v2 and provides quantitative provisions for cutoff. The CFP Guidelines state that "It is recommended that cutoff be avoided as much as possible," and there is no quantitative provision.	Based on the CFP guidelines, which prefer not to perform a cutoff, there is no problem if there is no cutoff. According to the CO2 visualization framework, if a cutoff is to be performed, detailed descriptions in accordance with the following cutoff contents are necessary: ・Ensure that the cutoff target is an individual attributable process that is less than 1% of the total amount of cradle-to-gate PCF. If 1% or higher, the process must be added for PCF. ・The sum of the excluded processes shall be less than 5% of the total amount of cradle-to-gate PCF. If 5% or higher, the process must be added for PCF.

* The above represents the Green x Digital Consortium's Methodology Sub-Working Group's analysis and interpretation of the is CFP Guidelines.

Appendix 2. Alignment with METI/MoE Carbon Footprint Guidelines

No.	Alignment/ adjustment required	Issue	CFP Guidelines	Page	CO2 Visualization Framework	Page	Notable differences *	Necessary adjustments
4	Alignment	Disclosure of information on renewable energy certificates	① Renewable energy certificates (1/5)	58･59	3-2. Data disclosure elements	166	CO2 Visualization Framework Edition 2 recommends disclosure of certificate usage and certificate type. The CFP Guidelines require specification of the type of renewable energy certificate, etc., in the calculation rules for each product (J-Credits, Non-fossil Certificates, etc.) Not only J-Credit (renewable power) but also J-Credit (renewable heat) can be used.	–
5	(Pending)	Application of the mass balance approach	P37 (2) Mass balance method P77 Carbon offset (1/2)	37･77	2-2-7. Market approach (3) Concept of the mass balance approach	114	Adoption of CO2 Visualization Framework Edition 2 is pending in line with Pathfinder Framework v2. The CFP Guidelines state that "If the mass balance method is used in CFP calculation, CO2 emissions must be appropriately assigned to products, taking into account the characteristics of the manufacturing process and referring to the mass balance model specified in ISO 22095."	(Pending)
6	Alignment	Biogenic carbon	③ Carbon from biomass (1/2)	38	2-2-5. Additional guidance on PCF calculation (1) Biogenic emissions and removals	93-95, 167	In CO2 Visualization Framework Edition 2, biogenic emissions and removals are listed as elements that need to be calculated after 2025. The CFP Guidelines state that "Biomass-derived GHG emissions and removals should be included in the CFP, and emissions and removals should be described so that they can be distinguished and understood. In addition, when providing cradle-to-gate CFPs to others, if the carbon content derived from biomass is calculated, the information must be provided separately as a figure different from the CFP."	–
7	(Pending)	Land use	④ Land use	40			CO2 Visualization Framework Edition 2 lists land management emissions and removals as elements that need to be calculated after 2025. However, as stated on page 167, even if it is difficult to comply with the mandatory disclosure items, it is permissible to exchange data by explicitly stating so. The CFP Guidelines do not describe land use separately. The CFP survey report is included separately.	The calculation should be made on an optional basis as an element that needs to be calculated after 2025.

* The above represents the Green x Digital Consortium's Methodology Sub-Working Group's analysis and interpretation of the is CFP Guidelines.

Appendix 2. Alignment with METI/MoE Carbon Footprint Guidelines

No.	Alignment/ adjustment required	Issue	CFP Guidelines	Pg	CO2 Visualization Framework	Pg	Notable differences	Necessary adjustments
8	(Pending)	Land use change	⑤ Land use change	41	2-2-5. Additional guidance on PCF calculation (1) Biogenic emissions and removals	93-95, 167	In CO2 Visualization Framework Edition 2, land-use change is added as an element that needs to be calculated after 2025. The CFP Guidelines do not describe land-use change separately.	The calculation should be made on an optional basis as an element that needs to be calculated after 2025.
9	Adjustment required	Internal verification	① Necessity of verification and subject (internal verification/third-party verification)	67	4-2. Verification of Product-based CO2 data	171	CO2 Visualization Framework Edition 2 adopts the concept introduced in PFv2 of requiring third-party verification but allowing data exchange without that verification as long as this is clearly disclosed. The CFP Guidelines state that either internal or third-party verification should be performed.	It is desirable to obtain assurances based on third-party verification.
10	Adjustment required	Temporal representat-iveness in data quality assessment	③ Data collection period (temporal boundary)	33	2-2-8. Data reliability (2) Data quality assessment	120	TCO2 Visualization Framework Edition 2 evaluates data collection for the same year as the reporting year. The CFP Guidelines recommend the collection of representative CFPs in consideration of changes in emissions due to seasonal fluctuations. Where there are short-term or long-term fluctuations, the average emissions of the process, taking both into account, are desirable.	For temporal representativeness, it is desirable to report data collected in the same year as the reporting year (good) or less than 5 years (fair), taking into account short- and long-term variations.

* The above represents the Green x Digital Consortium's Methodology Sub-Working Group's analysis and interpretation of the is CFP Guidelines.

Appendix 3. Contributions to the writing of this document (1) (Edition 1)

- As indicated in 1-1-2, this document was prepared with the cooperation of various members of the Methodology SWG.
- All SWG members (Figure 1-1-3) contributed to the preparation of this document through discussions at WG meetings.
- The table below also shows the companies that contributed to the writing of each section and additional work such as individual discussions and reviews.

Overall writing		Mizuho Research & Technologies
Discussion and review of full document		NTT Data Group, Brother Industries
Cooperation in discussion of the draft		Deloitte Tohmatsu Consulting, NEC
Cooperation in answering questionnaires		Kajima, Canon, Zero board, Deloitte Tohmatsu Consulting, Toshiba, Nitto Denko, NEC, Nomura Research Institute, Panasonic, Hitachi, Brother Industries, Mitsubishi Electric
Cooperation in the writing of individual parts	**2-2. Product-based calculation method**	Brother Industries
	2-3 Organization-based calculation method	Zeroboard
	3-2. Data disclosure elements	NTT DATA
	4-2. Verification of Product-based CO2 data	Asuene
	4-4. Verification of organization-based CO2 data	Zeroboard
Cooperation in investigation of existing standards	**GHG Protocol Product Standard**	Microsoft Japan
	PEFCR	Hitachi, Ltd.
	SuMPO PCR	Brother Industries
	EPD International PCR	Mizuho Research & Technologies
	ISO 14067:2018	Mizuho Research & Technologies
	PACT Pathfinder Framework v1	Mizuho Research & Technologies
	CDP Supply Chain Program	NTT DATA

Appendix 3. Contributions to the writing of this document (2) (Edition 2)

- Similarly, the update to Edition 2 was prepared with the cooperation of various members of the Methodology SWG (Figure 1-1-3), and all SWG members contributed to the preparation of this document through discussions at WG meetings.
- The companies that contributed to the writing of each section are shown in the table below.

		writer
1. Introduction		• Mizuho Research & Technologies (Overall)
2. CO2 data calculation method	**2-1. Two calculation methods**	• Mizuho Research & Technologies (Overall)
	2-2. Product-based CO2 calculation method	• Brother Industries (Handling of indirect activities) • Asuene (Calculation of end-of-life and process-derived emissions and upstream complementation of SHK factors) • Sustech (Allocation guidance, DQR commentary) • Mizuho Research and Technologies (Other)
	2-3. Organization-based CO2 calculation method	• Mizuho Research & Technologies (Overall)
3. CO2 data disclosure method		• NTT DATA (Correspondence with digital specifications) • Mizuho Research & Technologies (Consistency with Chapters 1 and 2)
4. Verification		• Zeroboard (Analysis of verification methods in Pathfinder Framework v2) • Mizuho Research & Technologies (Adoption or rejection in CO2 Visualization Framework)
Appendix		• NTT DATA (CFP Guideline analysis, glossary) • Mizuho Research & Technologies (Consistency with Chapters 1 to 3)

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