Calculation Guidance for Scope 3 Emissions in the Rechargeable Battery Industry

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Ministry of Environment

KEITI Korea Environmental Industry & Technology Institute

Introduction

As the urgency intensifies globally to address climate change and transition to low-carbon societies, major economic powers, such as the European Union (EU) and the United States (US), have announced plans to establish and mandate disclosure standards for environmental, social, and governance (ESG) practices, while also strengthening various environmental regulations. In June 2023, the International Sustainability Standards Board (ISSB), operating under the International Financial Reporting Standards (IFRS) Foundation, released the final drafts of two key disclosure standards: General Sustainability-Related Disclosures (IFRS S1) and Climate-related Disclosures (IFRS S2). This move advances the international standardization of sustainability reporting. Concurrently, both the EU and the US Securities and Exchange Commission (SEC) have finalized their respective ESG disclosure standards and established timelines for their implementation.

ESG disclosures increasingly emphasize climate-related information, particularly the calculation of greenhouse gas (GHG) emissions. The scope of these required disclosures often extends beyond the reporting entity's direct operations to include emissions across the entire value chain. While the US SEC recently excluded scope 3 emissions from its initial climate disclosure proposal, both the European Sustainability Reporting Standard (ESRS) and the IFRS Sustainability Disclosure Standard include scope 3 emissions. This evolving regulatory landscape underscores the growing importance for Korean companies to prepare for reporting scope 3 emissions.

In response to these developments, the Korean Ministry of Environment has initiated the development of a document series titled *"Calculation Guidance for Scope 3 Emissions."* This initiative aims to assist companies in efficiently calculating carbon emissions across their entire supply chains, enabling them to meet emerging regulatory requirements in a timely manner.

The development of this guidance stemmed from the recognition that, although the GHG Protocol-proposed by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI), is an internationally accepted calculation guideline, Korean companies

require a methodology tailored to the specific characteristics of each industry for practical implementation. Accordingly, we prioritized industries among Korea's 15 major export sectors that urgently require support due to ESG and environmental regulatory challenges. Given the recent introduction of the EU Battery Regulation, a consensus emerged that the rechargeable battery industry requires immediate attention. As a result, he current document, *"Calculation Guidance for Scope 3 Emissions in the Rechargeable Battery Industry"* was developed as the first in this series of industry-specific guidelines.

The calculation methodology in the guidance is based on two key components of the internationally recognized GHG Protocol: the *Corporate Value Chain (Scope 3) Accounting and Reporting Standard* and the *Technical Guidance for Calculating Scope 3 Emissions*. It also incorporates the requirements outlined in the EU Battery Directive. To enhance its practical applicability, the guidance provides specific examples of calculations for each emissions category as defined by the GHG Protocol. While primarily designed for rechargeable battery companies, these examples can benefit businesses across various other industries in their emissions-reporting efforts.

Building on the guidance for the rechargeable battery sector, the Ministry of Environment plans to expand its calculation guidance regarding scope 3 emissions to other key export industries. This initiative aims to assist Korean exporters in responding promptly and effectively to international environmental regulations.

Achieving net-zero goals hinges on companies gaining a thorough understanding of their entire supply chain, accurately calculating their GHG emissions, and ultimately establishing and implementing robust carbon reduction targets. We anticipate that this guidance will help companies take a significant step toward these crucial objectives.

Note: This guidance is current as of December 31, 2024. It may be updated to reflect future changes in domestic and international sustainability disclosure standards, as well as related laws and regulations.

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I

Significance of Scope 3

01 Definition of Scope 3

GHG emissions are broadly categorized into direct and indirect emissions, determined by the organizational and operational boundaries of the reporting entity. Direct GHG emissions come from sources owned or controlled by the reporting entity, while indirect GHG emissions result from the entity's activities but occur at sources not owned or controlled by the reporting entity. To ensure that GHG emissions are calculated and reported without double counting or omission, GHG emissions are further categorized into three scopes: scope 1 covers all direct emissions, while scope 2 and scope 3 include indirect emissions([Reference 1]).

[Reference 1]

Definitions of scope 1, scope 2, and scope 3

- Scope 1 (direct emissions)
  - Direct GHG emissions originating from sources owned or controlled by the entity
  - Examples: Emissions from combustion in entity-owned or controlled boilers, furnaces, or motor vehicles
- Scope 2 (indirect emissions)
  - Indirect GHG emissions resulting from the generation of purchased electricity, steam, heating, or cooling consumed by the entity
  - Examples: Emissions from the production of electricity, steam, or heat consumed by the entity in its operations
- Scope 3 (indirect emissions)
  - All other indirect GHG emissions arising from the reporting entity's value chain that are not included in scope 2, including both upstream and downstream emissions.
  - Examples: Emissions from the production of purchased goods and services; emissions associated with employee business travel and commuting; emissions from the transportation and distribution of purchased products.

Scope 3 refers to all indirect GHG emissions that arise from sources not owned or directly controlled by the reporting entity and, instead, result from its business activities within the value chain. In other words, scope 3 encompasses indirect emissions that are not within scope 2. Such emissions may include those associated with the extraction and production of purchased goods, transportation-related activities (such as the transport of purchased materials, goods, and fuels, employee

business travel and commuting, the transport of sold products, and waste transport), electricity-related activities not included in scope 1 or scope 2, and emissions from leased assets and franchised operations.

Scope 3 emissions are further classified into 15 detailed categories as defined by the GHG Protocol, which are broadly divided into upstream and downstream emissions (refer to "02. Classifying Emission Source Categories" under "II. Building a Scope 3 Greenhouse Gas Inventory"). Upstream emissions refer to indirect GHG emissions resulting from the goods and services purchased or acquired by the reporting entity, covering emissions that occur until the point where the purchased goods are received. Downstream emissions, on the other hand, refer to indirect GHG emissions that occur during the distribution, storage, use, and disposal of sold goods and services. This category encompasses emissions that arise after control of the goods has been transferred from the reporting entity to other companies or consumers.

02 The Need for Calculating Scope 3 Emissions

As climate change and environmental issues have become critical global concerns, the demand for mandatory corporate climate disclosures has increased steadily. This shift is driven by governments, regulatory bodies, and international initiatives, requiring entities to assess and transparently disclose their environmental impacts. A key component of this disclosure is calculating each entity's carbon footprint to understand its environmental impact. Including this information as part of a disclosure is becoming increasingly necessary. As major global sustainability disclosure standards, regulations, and frameworks evolve to include scope 3 emissions in their assessments and disclosures, the need for calculating scope 3 emissions becomes more critical than ever.

Calculating scope 3 emissions is crucial for entities aiming to reduce their carbon footprint across the entire value chain and manage risks proactively amid the transition to net zero. For most entities, scope 3 emissions, which encompass the complete lifecycle of activities across their value chain, typically represent the largest share of total GHG emissions across scope 1, scope 2, and scope 3. Unlike scope 1 and scope 2 emissions, which are generally within the direct control of the reporting entity, scope 3 emissions are more complex. Therefore, the focus should not solely be on the absolute magnitude of scope 3 emissions but rather on continuous efforts to reduce them through engagement with key stakeholders across the value chain. This involves collaborating with suppliers and partners to implement sustainable practices, such as adopting sustainable packaging, transitioning to low-emission transport modes, and promoting product take-back and recycling programs. Effective communication and cooperation throughout the supply chain are crucial to optimizing processes and achieving meaningful emission reductions over time.

1. Global Sustainability Disclosure Standards: ESRS, SEC, ISSB

As the demand for mandatory disclosure and standardization of ESG information continues to grow, corporate sustainability disclosure standards are being consolidated through key frameworks, including the European Sustainability Reporting Standards (ESRS) developed by the European Financial Reporting Advisory Group (EFRAG), the US SEC's climate disclosure requirements[1)], and the IFRS's ISSB disclosure standards[2)] ([Reference 1]). Although disclosure requirements vary across these standards, the ESRS mandates the calculation and disclosure of a reporting entity's scope 3 emissions based on materiality assessments. Similarly, the ISSB specifically requires scope 3 emissions to be included when absolute GHG emissions are reported.

1) US Securities and Exchange Commission (SEC), The Enhancement and Standardization of Climate-Related Disclosures for Investors.

2) International Sustainability Standards Board (ISSB), Sustainability Disclosure Standards.

[Reference 1]

Overview of key global sustainability disclosure standards

Disclosure standards	EU ESRS	U.S. SEC Regulation	IFRS ISSB
Overview	• Consists of two general standards (ESRS 1, ESRS 2) and 10 topical standards (ESRS E1–E5, ESRS S1–S4, ESRS G1)	• Climate information disclosure is required for SEC-listed companies • Consists of general climate disclosures (Items 1500–1503 and 1506 under Regulations S-K), GHG emissions disclosures (Items 1504–1505 under Regulations S-K), and disclosures on the impact on financial statements (Articles 14-01 and 14-02 under Regulations S-X)	• Global disclosure standards for information about sustainability • Consists of general principles for sustainability topics (S1) and climate-related disclosures (S2), with S2 further divided into cross-industry and industry-based disclosure requirements
Reporting entities	• Companies subject to the EU Non-financial Reporting Directive (NFRD) • Large companies or corporate groups within the EU • EU-listed small and medium-sized enterprises (excluding micro-enterprises) • Non-EU companies with net turnover in the EU exceeding EUR 150 million or those with at least one subsidiary or branch in the EU	• SEC-listed companies	• Companies reporting general-purpose financial statements in participating countries
Reporting scope and framework	• Consolidated entity-based disclosure, including subsidiaries • Adherence to the Task Force on Climate-Related Financial Disclosures (TCFD) framework, with reporting based on its four pillars: governance, strategy, risk management, and metrics and targets		
Disclosure topics	• Encompasses environmental, social, and governance (ESG) aspects • Follows the standards for each specific topic	• Limited to climate-related risks and opportunities that have a financial impact on the company • Sets the materiality threshold at 1% of net asset value	• Covers all topics related to sustainability risks and opportunities • No materiality threshold is specified.
Materiality criteria	• A multi-stakeholder perspective with environmental and social concerns, beyond a financial viewpoint • Double materiality	• Financial (investor) perspective	• Financial (investor) perspective

1) According to the EU ESRS guidelines, an entity must report scope 1 and scope 2 emissions separately for the entire organization over which it has operational control. It is also required to disclose its total scope 3 emissions along with emissions from key categories, identified through value chain and materiality assessments[3]. Any exclusions of scope 3 categories must be explicitly justified. The calculation of scope 3 emissions follows the GHG Protocol Accounting and Reporting Standard.

3) A materiality assessment is a process or methodology that companies or organizations use to identify and prioritize the most significant social and environmental factors affecting their business. For instance, materiality may be evaluated based on how certain information might influence investors' decision-making.

- According to the detailed guidelines, an entity must report its emissions based on both financial and operational control. For wholly owned subsidiaries, 100% of their scope 1, scope 2, and scope 3 emissions are included in the entity's declaration. These must be separated from the emissions of joint ventures, associates, and non-consolidated subsidiaries, with distinctions made based on operational control. Furthermore, the reporting entity must disclose the proportion of emissions calculated using primary data, specify the methodologies employed for emissions calculation, and list any calculation tools used in the process.

2) A reporting entity presenting a disclosure under ISSB S2 is required to calculate emissions for the seven GHGs[4]. It must disclose scope 1 and scope 2 emissions separately and follow the GHG Protocol's methodology (e.g., equity method and control) for both consolidated and non-consolidated entities. Additionally, the entity must disclose its total scope 3 emissions, explain the exclusion of any categories, and provide emissions data for key categories.

- The detailed guidelines stipulate that scope 3 disclosures must incorporate a Measurement Framework for Reliable Emission Calculation. This framework should employ reliable measurement approaches, input factors, and assumptions to calculate scope 3 emissions. Companies are advised to prioritize data based on the characteristics of the identified sources to ensure the use of the most accurate and verifiable information available.

3) The recently finalized US SEC climate disclosure standards have exempted reporting entities from the requirement to calculate and disclose scope 3 emissions. In contrast, major global sustainability disclosure standards that mandate the calculation of scope 3 emissions have established detailed requirements, using the GHG Protocol as a core framework. Consequently, reporting entities need to calculate, report, and manage scope 3 GHG emissions at a level that meets the requirements of both the GHG Protocol and global sustainability disclosure regulations. By doing so, they can leverage long-term market-based incentives, reduce business risks, and identify opportunities to gain a sustainable competitive advantage.

4) Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).

2. Other Regulations and Initiatives: EU Battery Regulation

The 2023 EU Battery Regulation[5], targeting the rechargeable battery sector, mandates product-level reporting of carbon footprint information. This includes electric vehicle batteries and rechargeable industrial batteries with a 2 kWh or greater internal storage capacity. The reporting entity must report GHG emissions following a mandatory system boundary, based on a lifecycle assessment (LCA) of their products. ([Reference 2]). The regulation requires primary data to be used for emissions calculations of key battery components in line with specific calculation principles. For other aspects, entities may use secondary data conforming to the European Commission Product Environmental Footprint (EC PEF) standard.

[Reference 2]

System Boundaries for Carbon Footprint Reporting under the EU Battery Regulation

Life cycle stage	Processes involved in calculating emissions
Raw material acquisition and pre-processing	Emissions from the extraction and processing of critical component materials, such as battery cells and other electrical/electronic parts, excluding primary materials
Main product production	Emissions from assembling battery cells and electrical/electronic components
Processing	Emissions from battery assembly during vehicle or mechanical equipment manufacturing are excluded due to their negligible impact
Distribution	Emissions from transport to the point of sale
Use	Excluded since it is not under direct control; may be disclosed as an exception if the battery design significantly affects use-phase emissions (non-negligible contribution)
End of life and recycling	Emissions from collection, dismantling, and recycling

The EU battery regulation's detailed implementation will begin with mandatory product-level carbon footprint declarations in February 2025. Subsequently, regulations governing product-level emissions calculation and reporting will be revised and strengthened. Starting in August 2026, the carbon footprint performance class requirements will

5) European Parliament, Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC (2023).

become compulsory, requiring individual batteries to be labeled with their respective carbon footprint performance class.
In addition, by February 2028, the regulation will enforce maximum carbon thresholds for product-level carbon footprints. Products exceeding these thresholds will face sales restrictions. Consequently, reporting entities in the rechargeable battery industry must prioritize calculating and managing their products' carbon footprints, including scope 3 emissions, to comply with the regulations required by the EU battery market.

3. Other Regulations and Initiatives: Carbon Disclosure Project

The Carbon Disclosure Project (CDP) classifies capital goods companies as those supplying critical products and services to end markets, such as power generation, construction, transportation, and industry. It defines relevant business sectors as batteries (including secondary cells), electrical equipment, industrial equipment, and renewable energy equipment. The CDP emphasizes that although capital goods companies typically have relatively low scope 1 and scope 2 emissions, their scope 3 emissions may be significant, primarily due to the downstream use of their products and services. The guidance for the companies in the capital goods sector recommends setting both overall and product-level scope 3 targets, with a particular focus on category 11 (Use of Sold Products), given its substantial impact on end-use goods. Therefore, to effectively disclose and meet scope 3 targets, a reporting entity in this sector needs to implement advanced measurement and management practices for emissions from the use of their products.

II

Building a Scope 3 Greenhouse Gas Inventory

01 Setting Organizational Boundaries

Business operations vary in their legal and organizational structures, and their reporting is typically structured for financial accounting purposes. For GHG emissions reporting, entities shall also define organizational boundaries. To accurately reflect their GHG inventory, it is essential for the reporting entity to select an approach for consolidating GHG emissions and then consistently apply the chosen approach.

To set organizational boundaries for GHG emissions reporting, the reporting entity may use one of the following three approaches ([Reference 1], [Reference 2]):

- Equity share approach
- Control approaches:
  - Financial control approach
  - Operational control approach

Specifically, the reporting entity shall choose one of these organizational boundary approaches—the equity share approach, the financial control approach, or the operational control approach—and record and report their consolidated GHG data accordingly. if a company exercises full control over its operations, its organizational boundary remains consistent regardless of the chosen approach. For joint operations, the boundary and resulting emissions may vary based on the chosen approach. In both cases, the approach can affect how emissions are categorized when operational boundaries are set.

[Reference 1]

Emission scope by organizational boundary approach*

Organizational boundary setting / Asset type		Equity share approach	Financial control approach	Operational control approach	
				With operational control	Without operational control
Consolidated group	Subsidiaries (>50%)	The scope 1, 2, and 3 data of the related entity is included in the parent entity's scope 1, 2, and 3 data in proportion to its equity share.	100% of the subsidiary's scope 1, 2, and 3 data is included in the parent entity's scope 1, 2, and 3 data	100% of the scope 1, 2, and 3 data of the subsidiary, associate company, joint venture, or investor is included in the parent entity's scope 1, 2, and 3 data	The parent entity's data for scope 3 category 15 includes any related entity's data in proportion to its equity share. (Applicable only if the related entity's scope 3 emissions are of significant magnitude.)
	Joint operation		The scope 1, 2, and 3 data of the joint operation is included in the parent entity's scope 1, 2, and 3 data in proportion to its equity share.		
Unconsolidated group	Joint venture/ associate company (20%–50%)		The parent entity's data for scope 3 category 15 includes any related entity's data in proportion to its equity share.** (Applicable only if the related entity's scope 3 emissions are of significant magnitude.)		
	Non-equity method investor (<20%)		The parent entity's data for scope 3 category 15 includes any investor's scope 1 and scope 2 data in proportion to its equity share.** (Applicable only if the related entity's scope 3 is of relevant magnitude.)		

Note: * This table is based on interpretations of the GHG Protocol and IFRS S1 and S2 as of December 2023. However, due to inconsistencies regarding organizational boundaries in the GHG Protocol and other disclosure standards (such as IFRS), some aspects remain unclear. The table may be updated in the future as the GHG Protocol is revised.

** To avoid double counting, emissions that overlap across scope 3 categories are accounted for in only one category. While the GHG Protocol does not specify a priority for determining categories, it requires that the basis for these determinations be documented.

[Reference 2]

Industries required to use the financial control approach according to IFRS S2 industry-based guidance

The IFRS S1 (General Requirements for Disclosure of Sustainability-related Financial Information) and S2 (Climate-related Disclosures) standards do not prescribe a specific approach for setting organizational boundaries. However, the industry-based guidance (IBG) for IFRS S2 requires using the financial control approach for reporting consolidated GHG emission data in certain industries when disclosing GHG emissions. The industries for which the IBG requires the financial control approach are as follows:

[Reference 2]

Industries required to use the financial control approach according to IFRS S2 industry-based guidance

No.	IFRS S2 annex	Sustainable Industry Classification System (SICS) industry
1	7 (EM-CO)	Coal operations
2	8 (EM-CM)	Construction materials
3	9 (EM-IS)	Iron & steel producers
4	10 (EM-MM)	Metals & mining
5	11 (EM-EP)	Oil & gas—exploration and production
6	12 (EM-MD)	Oil & gas—midstream
7	13 (EM-RM)	Oil & gas—refining and marketing
8	20 (FB-AG)	Agricultural products
9	22 (FB-FR)	Food retailers & distributors
10	23 (FB-MP)	Meat, poultry, & dairy
11	32 (IF-EU)	Electric utilities & power generators
12	38 (IF-WM)	Waste management
13	43 (RR-PP)	Pulp & paper products
14	47 (RT-CH)	Chemicals
15	48 (RT-CP)	Containers & packaging
16	57 (TC-SC)	Semiconductors
17	60 (TR-AF)	Air freight & logistics
18	61 (TR-AL)	Airlines
19	65 (TR-CL)	Cruise lines
20	66 (TR-MT)	Marine transportation
21	67 (TR-RA)	Rail transportation
22	68 (TR-RO)	Road transportation

Note: For industries where GHG emissions are not a disclosure requirement, the IBG, like IFRS S2, does not mandate the use of any specific approach.

Each reporting entity shall clearly define its organizational boundaries in accordance with the chosen approach, review the GHG emissions reporting scope (scope 1, scope 2, or scope 3) for each asset type and emission source, and ensure that emissions are neither double counted nor omitted. Specifically, the reporting entity shall report direct GHG emissions from sources it owns or controls under scope 1; indirect GHG emissions from the generation of purchased electricity (whether directly purchased and consumed by the entity or used within its organizational boundary), as well as steam, heating, and cooling, under scope 2; and all other indirect GHG emissions occurring in the value chain that are not included in scope 2 under scope 3 ([Reference 3]).

[Reference 3]

Examples of emission reporting by using different organizational boundary approaches

Example 1

If a reporting entity sets its organizational boundary using the financial control approach and sources raw materials from a subsidiary engaged in raw material production:

- Since the reporting entity has financial control over the subsidiary, 100% of the subsidiary's scope 1 and scope 2 emissions are included in the reporting entity's scope 1 and scope 2 emissions, as the subsidiary is part of the consolidated entity.
- The emissions from fuel and electricity used by the subsidiary for raw material production are included in the reporting entity's scope 1 and scope 2 emissions. Consequently, these emissions are accounted for in the reporting entity's scope 3 category 1 data (purchased goods and services) to avoid double counting upstream emissions from products purchased or acquired during the reporting year.

Example 2

If a reporting entity sets its organizational boundary using the equity share approach and disposes of products it has sold through an associate company (40% equity share):

- The reporting entity owns an equity share but does not manage the associate company. It has ownership of the risks and benefits from the associate's operations proportional to its equity share. Therefore, 40% of the associate company's scope 1, 2, and 3 emissions are included in the reporting entity's corresponding scope 1, 2, and 3 emissions.
- The emissions from fuel and electricity used by the associate company to dispose of the sold products are included in the reporting entity's scope 1 and scope 2 emissions. Consequently, these emissions are accounted for in the reporting entity's scope 3 category 12 data (end-of-life treatment of sold products) to avoid double-counting emissions arising from the disposal and treatment of products sold by the reporting entity during the reporting year.

1. Equity Share Approach

Under the equity share approach, an entity accounts for GHG emissions according to its equity share in the operation. The equity share reflects economic interest, which is the extent of rights the entity has to the risks and rewards associated with that operation. Typically, the economic risks and rewards align with the reporting entity's ownership percentage in the operation. However, where this is not the case, the equity share may be adjusted to reflect the actual percentage of economic rights derived from the operation. Setting the equity share to reflect the percentage of economic interest is required, regardless of the status of legal ownership. This approach is consistent with international financial reporting standards. Therefore, the personnel managing the GHG inventory may need to consult with their accounting or legal colleagues to ensure that the appropriate equity share is applied for each joint operation.

2. Control Approach

Under the control approach, an entity includes 100% of the GHG emissions from the operations it controls in its GHG emissions data. However, it does not account for GHG emissions from operations

in which it has an ownership interest but no control. Control can be defined in either financial or operational terms. When using a control approach to consolidate GHG emissions, the reporting entity shall choose between operational and financial control criteria.

1) Financial control approach

A reporting entity that follows the financial control approach is considered able to direct the financial and operational policies of the operations it controls, which allows it to gain economic benefits from these activities. Consequently, the economic substance of the relationship between the reporting entity and an operation takes precedence over their legal ownership status. As a result, the entity may have financial control over an operation even if it holds less than a 50% interest in that operation.

2) Operational control approach

A reporting entity that follows the operational control approach is considered to have operational control over an activity if it has full authority to introduce and implement policies, either directly or through one of its subsidiaries. Specifically, if the reporting entity or one of its subsidiaries operates a facility, it is assumed to have this authority to implement relevant operating policies and can therefore choose the operational control approach for reporting GHG emissions. Under this approach, the reporting entity accounts for and reports 100% of the GHG emissions from operations it controls. However, operational control does not necessarily imply full authority over all decisions. For example, major capital investments may require approval from all partners with joint financial control.

3. Consolidation at Multiple Levels

All levels of an organization shall follow the same consolidation policy to ensure consistent data when consolidating GHG emissions across the organization. The parent entity's management shall first decide on an approach for setting organizational boundaries (i.e., equity share, financial control, or operational control) and then develop a consolidation policy. The chosen approach shall be applied consistently across all sub-levels of the organization.

02 Classifying Emission Source Categories

Scope 3 emissions encompass all indirect emissions, excluding scope 1 and scope 2 emissions, that occur within the value chain of the reporting entity. The reporting entity shall calculate scope 3 emissions according to its established organizational and operational boundaries, including the following items:

- Report the aggregated GHG emissions (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3) from all scope 3 activities within the organizational and operational boundaries.
- Exclude from scope 3 any biological CO_2 emissions from the value chain (e.g., CO_2 emissions from biomass combustion) and GHG removals such as biological carbon sequestration, which can be reported separately (e.g., in a corporate disclosure report).

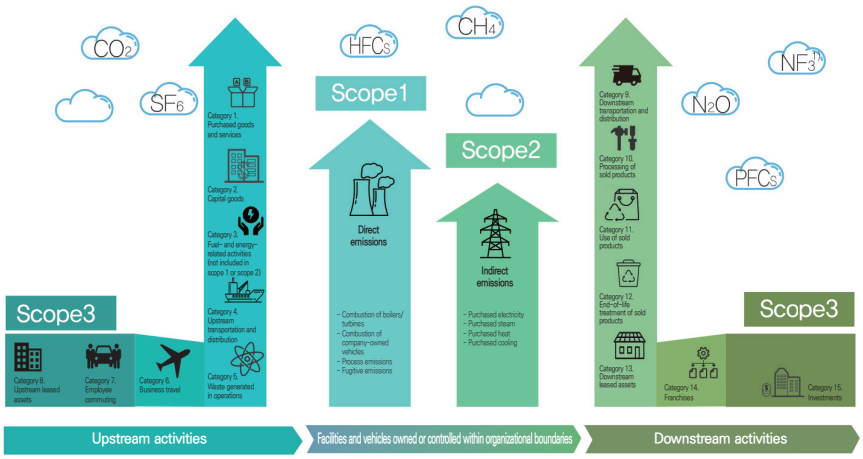
The reporting entity should strive for completeness in GHG accounting. However, it may not be feasible to account for all scope 3 emissions, and some categories may not be applicable in certain situations (e.g., when no leased assets or franchises are present). In such cases, the reporting entity should report "zero" emissions or "not applicable" for the relevant categories. Additionally, if certain data constraints or other limitations make it impossible to estimate emissions (e.g., difficulties in data collection), the corresponding scope 3 activities may be excluded from reporting. However, any exclusions should be disclosed and justified, along with a plan to improve data collection and estimation in the future.

As a general principle, activities that are likely to contribute significantly to scope 3 emissions shall not be excluded. The reporting entity's scope 3 inventory shall accurately reflect its GHG emissions to meet the needs of both internal and external stakeholders. The following criteria shall be used to determine which data to report:

- (Size) Activities that significantly impact the entity's total estimated scope 3 emissions
- (Influence) Activities where the entity undertakes or influences potential emissions reductions

- (Risk) Activities that contribute to the entity's GHG risk exposure
- (Stakeholders) Activities deemed critical by key stakeholders
- (Outsourcing) Activities outsourced by the reporting entity that are typically performed in-house by other companies in the reporting entity's sector
- (Sector-specific guidance) Activities identified as critical by sector-specific guidance, if available
- (Other) Activities that meet additional criteria developed by the entity or industry sector to determine relevance

Furthermore, the reporting entity shall define and categorize all relevant scope 3 activities across the value chain. As shown in the figure below, the entity shall distinguish and report emissions across 15 categories based on the definitions and characteristics of each scope 3 category ([Reference 1]).



[Reference 1]

Description of scope 3 categories

Category		Category description	Remarks
1	Purchased goods and services	• All upstream emissions from goods and services purchased by the reporting entity that are not already covered in categories 2–8. – Emissions from raw material extraction, manufacturing, assembly, processing, and waste treatment related to purchased goods and services (these are the supplier's own scope 1 and 2 emissions). – Any changes in land use resulting from the production of these purchased goods and services. – Other upstream activities that occur before the acquisition of these goods or services by the reporting entity.	
2	Capital goods	• Emissions from raw material extraction, production, and transportation of capital goods purchased by the reporting entity. – Examples include equipment, machinery, buildings, facilities, and land used as capital goods.	* To avoid double counting or omitting data in category 1 (purchased goods and services), entities should categorize capital goods consistently based on their characteristics (e.g., accounting standards).
3	Fuel– and energy–related activities (not included in scope 1 or scope 2)	• Emissions associated with the production of purchased fuels and energy consumed by the reporting entity during the reporting year that are not already accounted for in scope 1 or scope 2. Divided into four types: A. Upstream emissions of purchased fuels B. Upstream emissions of purchased electricity C. Transmission and distribution (T&D) losses D. Generation of purchased electricity that is sold to end users (reported by a utility company or energy retailer only)	
4	Upstream transportation and distribution	• Emissions from upstream transportation and distribution of vehicles not owned or controlled by the reporting entity (excluding fuels covered in category 3). – Emissions from the transportation and distribution of products purchased by the reporting entity, which occur between a company's tier 1 suppliers and its own operations. – Transportation and distribution services purchased by the reporting entity, including both inbound and outbound logistics (outbound logistics are considered upstream emissions since they are services purchased by the reporting entity).	
5	Waste generated in operations	• Emissions from waste disposal and treatment generated in facilities not owned or controlled by the reporting entity. – Emissions calculated from waste disposal methods, such as landfill, recycling, incineration, composting, waste–to–energy (WtE), and wastewater treatment. – The scope 1 and scope 2 emissions of waste management suppliers that occur during disposal or treatment.	* Emissions from waste treatment at facilities owned or controlled by the reporting entity are accounted for in scope 1 and scope 2.
6	Business travel	• Emissions from employee business travel in vehicles not owned or operated by the reporting entity. – Optional: Emissions from hotel stays during business travel. – The scope 1 and scope 2 emissions of transportation providers that occur while the vehicles are used.	* Emissions from employee business travel in vehicles owned by the reporting entity are accounted for in scope 1 and scope 2. * Emissions from leased vehicles are accounted for in category 8 (upstream leased assets). * Optional: Emissions from accommodation stays.
7	Employee commuting	• Emissions from employees commuting in vehicles not owned or operated by the reporting entity. – Optional: emissions from teleworking (e.g., employees working remotely) – The scope 1 and scope 2 emissions of employees and transportation providers that occur while the vehicles are used.	

8	Upstream leased assets	• Emissions from the operation of assets leased by the reporting entity (lessee) during the reporting year that are not included in the lessee's scope 1 or scope 2. – The scope 1 and scope 2 emissions of the lessors (e.g., vehicles, facilities) that occur during the reporting entity's operation of leased assets.	* Emissions from upstream leased assets not recognized as assets under the entity's accounting procedures, and thus not included in scope 1 and scope 2, should be reported.
9	Downstream transportation and distribution	• Emissions from the transportation and distribution of sold products in vehicles and facilities not owned or operated by the reporting entity. – Emissions from storage in warehouses, distribution centers, and retail facilities not owned or operated by the reporting entity, as well as transportation and distribution between the reporting entity and retailers, if not paid for by the reporting entity.	* Third-party outbound transportation and distribution services are accounted for in category 4 (upstream transportation and distribution).
10	Processing of sold products	• Downstream emissions from the processing of intermediate products sold by the reporting entity to downstream companies. – Emissions only from intermediate products that require further processing, transformation, or incorporation into other products before final use.	
11	Use of sold products	• Emissions from the end use of goods and services sold by the reporting entity. – The scope 1 and scope 2 emissions of end users that occur from the use of goods and services. – Emissions from the direct-use phase are categorized as 1) products that directly consume energy (fuel or electricity) and 2) products that contain or form GHGs that are emitted during use. – Optional: Emissions from the indirect-use phase of sold products.	* Entities may optionally include the indirect use-phase emissions of sold intermediate products based on the final product's lifecycle.
12	End-of-life treatment of sold products	• Downstream emissions from the waste disposal and treatment of products sold by the reporting entity at the end of their life in the reporting year. – Emissions calculated by waste disposal methods, such as landfill, recycling, incineration, composting, waste to energy, and wastewater treatment. – The scope 1 and scope 2 emissions of waste management companies that occur during disposal or treatment of sold products.	* Emissions from waste disposal and treatment at facilities owned and controlled by the reporting entity are accounted for in scope 1 and scope 2.
13	Downstream leased assets	• Emissions from the operation of assets owned by the reporting entity (lessor) and leased to other entities in the reporting year that are not included in the lessor's scope 1 or scope 2. – The scope 1 and scope 2 emissions of lessees that occur during the operation of leased assets.	* Emissions from downstream leased assets not recognized as assets under the entity's accounting procedures, and thus not included in scope 1 or scope 2, should be reported separately.
14	Franchises	• Emissions from the operation of franchises by the reporting entity (as franchisor). – The scope 1 and scope 2 emissions of franchisees that occur during the operation of franchises.	
15	Investments	• Emissions from the reporting entity's operation of investments. – Equity investments: The scope 1 and scope 2 emissions excluded by the reporting entity's scope 1 and scope 2 due to the organizational boundary setting, are accounted for proportional to the equity share. – Debt investments: These are applicable if the use of proceeds from debt investments held by the reporting entity, such as corporate bonds or convertible bonds, can be tracked. – Project finance: The scope 1 and scope 2 emissions from financed projects are included. The total projected lifetime emissions should be reported in the initial year that the project is financed.	* The scope of investment activities may vary depending on how the reporting entity defines its organizational boundaries.

03 Collecting Activity Data by Emission Source

According to its established organizational boundaries, the reporting entity should identify which activities to include within scope 3 and collect the data necessary to calculate total scope 3 emissions. Collecting scope 3 emissions data is likely to require broader engagement within the reporting entity compared to scope 1 and scope 2 emissions data. The entity may need to involve several internal departments, such as procurement, energy, manufacturing, marketing, research and development, product design, logistics, and accounting. Additionally, cooperation with external suppliers and partners may be necessary.

1. Prioritizing Data Collection

The reporting entity may use various approaches to identify and prioritize activities for data collection ([Reference 1]). The most rigorous approach involves using initial GHG estimation (or screening) methods to determine significant GHG emissions by prioritizing them from largest to smallest based on the quantitative scale of emissions. This quantitative approach provides the most accurate understanding of the relative magnitudes of scope 3 emissions across different activities, allowing entities to establish priorities based on their expected GHG emissions.

[Reference 1]

Guidance for prioritizing data collection activities

- Prioritizing activities based on the magnitude of GHG emissions
- Prioritizing activities based on financial spend or revenue
- Prioritizing activities based on assessments of the most significant risks and opportunities in the value chain. These could include activities that:
  - The entity has influence over
  - Contribute to the entity's risk exposure
  - Are deemed critical by stakeholders
  - Are identified as significant in sector-specific guidance
  - Meet any additional criteria developed by the entity or industry sector
- Prioritizing activities for which more accurate data may be obtained easily

Depending on the circumstances, the reporting entity may choose to rely on less accurate data for emission activities where the emissions are expected to be negligible or acquiring accurate data is difficult. In such cases, the reporting entity should strive to improve by establishing strategies and data management plans to gradually obtain more accurate data.

2. Quantification Methods and Data Types

Two main methods exist for quantifying GHG emissions. The first method is direct measurement which involves monitoring or using stoichiometric calculations, applying the formula: ((Emission data) × (GWP[6])). The second method is calculation, which involves multiplying an activity data value by an emission factor and a GWP value ([Reference 2]), using the formula ((activity data) × (emission factor) × (GWP)). These two methods require different types of data. In practice, calculation is the most commonly used method for quantifying scope 3 emissions. For the calculation method, two types of data are required: activity data and emission factors.

[Reference 2]

Considerations when setting values for GWP

- The reporting entity should convert GHG emissions data into the standardized metric of carbon dioxide equivalent (CO_2e) based on the GWP for each GHG.
- The reporting entity should use the most recent GWP values published by the Intergovernmental Panel on Climate Change (IPCC). Although the reporting entity may choose GWP values appropriate for its specific circumstances, it is important to use such values consistently across inventories. Additionally, the reporting entity is required to disclose the source of the GWP values used to calculate the inventory.
- [Reference 2–1] lists the GWP values for the seven GHGs[7] as provided in the IPCC's second, fourth, fifth, and sixth assessment reports and approved for use under the GHG Protocol.

6) Global warming potential (GWP) is an index that indicates the extent to which one unit of a specific GHG contributes to global warming while it remains in the atmosphere. It is used to compare and assess the relative warming effects of different GHGs.

7) Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).

[Reference 2]

Considerations when setting values for GWP

- The GHG Protocol requires using consistent 100-year GWP values from the IPCC across scope 1, 2, and 3 inventories. Reports should use the most recent GWP values. To maintain consistency, a reporting entity that has already developed scope 1 and scope 2 GHG inventories should use the same GWP values for scope 3. However, entities that have not yet developed a corporate GHG inventory[8] should use the most recent GWP values available.

[Reference 2-1]

GWP values for GHGs (partial list)

GHG		GWP			
		IPCC Second Assessment Report (SAR)	IPCC Fourth Assessment Report (AR4)	IPCC Fifth Assessment Report (AR5)	IPCC Sixth Assessment Report (AR6)
Carbon dioxide (CO_2)		1	1	1	1
Methane (CH_4)		21	25	28	27.9
Nitrous oxide (N_2O)		310	298	265	273
Hydrofluorocarbons (HFCs)	HFC-23	11,700	14,800	12,400	14,600
	HFC-32	650	675	677	771
	HFC-41	150	-	116	135
	HFC-43-10mee	1,300	1,640	1,650	1,600
	HFC-125	2,800	3,500	3,170	3,740
	HFC-134	1,000	-	1,120	1,260
	HFC-134a	1,300	1,430	1,300	1,530
	HFC-143	300	-	328	364
	HFC-143a	3,800	4,470	4,800	5,810
	HFC-152a	140	124	138	164
	HFC-227ea	2,900	3,220	3,350	3,600
	HFC-236fa	6,300	9,810	8,060	8,690
	HFC-245ca	560	-	716	787
Perfluorocarbons (PFCs)	PFC-14	6,500	7,390	6,630	7,380
	PFC-116	9,200	12,200	16,100	12,400
	PFC-218	7,000	8,830	8,900	9,290
	PFC-31-10	7,000	8,860	9,200	10,000
	PFC-c318	8,700	10,300	9,540	10,200
	PFC-41-12	7,500	9,160	8,550	9,220
	PFC-51-14	7,400	9,300	7,910	8,620
Sulfur hexafluoride (SF_6)		23,900	22,800	23,500	25,200
Nitrogen trifluoride (NF_3)		-	17,200	16,100	17,400

8) The Korean Act on the Allocation and Trading of Greenhouse-Gas Emission Permits adopted its GWP values from the IPCC's SAR.

1) Activity data

Reporting entities collect and use activity data for calculating scope 3 emissions, which can be broadly categorized into primary data and secondary data ([Reference 3]).

Primary data refers to data provided by suppliers or other value chain partners that are directly related to the reporting entity's specific activities. This data may consist primarily of key activity data or emissions data closely related to the activities of these suppliers or partners.

Secondary data serves as supplemental data and includes industry-average data (e.g., from published databases, government statistics, literature studies, and industry associations), financial data, proxy data, and other generic data. In some cases, the reporting entity may use specific data from one activity to estimate emissions for another activity in the value chain. This type of data, which serves as a proxy rather than being directly related to actual emissions, is classified as secondary data because it is not directly relevant to the activity for which the emissions are calculated.

[Reference 3]

Examples of primary and secondary data by scope 3 category

Category		Primary data	Secondary data
1	Purchased goods and services	Product-level cradle-to-gate GHG data from suppliers, calculated using site-specific data	Industry-average emission factors per material consumed from lifecycle inventory databases
2	Capital goods	Product-level cradle-to-gate GHG data from suppliers, calculated using site-specific data	Industry-average emission factors per material consumed from lifecycle inventory databases
3	Fuel- and energy-related activities (not included in scope 1 or scope 2)	Entity-specific data on upstream emissions (e.g., extraction of fuels)	National average data on upstream emissions (e.g., from a lifecycle inventory database)
4	Upstream transportation and distribution	Activity-specific energy use or emissions data from third-party transportation and distribution suppliers	Estimated distance traveled based on industry-average data
5	Waste generated in operations	Site-specific emissions data from waste management companies	Estimated metric tonnes of waste generated based on industry-average data
6	Business travel	Activity-specific data from transportation suppliers (e.g., airlines)	Estimated distance traveled based on industry-average data
7	Employee commuting	Specific distance traveled and mode of transport data collected from employees	Estimated distance traveled based on industry-average data
8	Upstream leased assets	Site-specific energy use data collected by utility bills or meters	Estimated emissions based on industry-average data, such as energy use per square meter by building type
9	Downstream transportation and distribution	Activity-specific energy use or emissions data from third-party transportation and distribution partners	Estimated distance traveled based on industry-average data
10	Processing of sold products	Site-specific energy use or emissions from downstream value-chain partners	Estimated distance traveled based on industry-average data
11	Use of sold products	Specific data collected from consumers	Estimated energy used based on national average statistics on product use
12	End-of-life treatment of sold products	Specific data collected from waste management providers on emissions rates or energy use	Estimated disposal rates or energy use based on national average statistics
13	Downstream leased assets	Site-specific energy use data collected by utility bills or meters	Estimated emissions based on industry-average data such as energy use per square meter by building type
14	Franchises	Site-specific energy use data collected by utility bills or meters	Estimated emissions based on industry-average data such as energy use per square meter by building type
15	Investments	Site-specific energy use or emissions data from investee companies	Estimated emissions based on industry-average data

2) Emission factors

When calculating scope 3 emissions, the reporting entity should select appropriate emission factors based on its reporting activities and the characteristics of the aggregated data for each category. If using internally developed emission factors such as site-specific emission factors is not feasible, the reporting entity may consult reputable third-party emission factor databases to select emission factors that reflect its specific characteristics for inventory calculation and reporting. Emission factors are structured according to the unit of activity data. Examples of commonly used emission factor units include the following:

- $kgCO_2$ emitted per kg, L, or m^3 of fuel consumed
- $kgCO_2$ emitted per kWh of electricity consumed
- $kgCO_2$ emitted per kg of material consumed
- tCO_2 emitted per km traveled
- $kgCO_2$ emitted per hour of operation
- $kgCO_2$ emitted per kg of product sold
- $kgCO_2$ emitted per USD or KRW of currency spent
- gCH_4 emitted per kg of waste generated
- gN_2O emitted per m^2 of area

2)-1. Third-party emission factor resources

Third-party resources may support a reporting entity in collecting GHG inventory data related to its product lifecycles and value chain (scope 3). However, before using information from such spreadsheets and databases to calculate actual emissions, the reporting entity should consider the principles of relevance, completeness, consistency, transparency, and accuracy. It should then evaluate and select the highest quality data within the context of its business goals.
Examples of third-party resources[9] include the following:

9) All third-party resources provided as examples take CO_2 and GHGs into account.

Resource name	Country	Relevant organizations	Free/ Paid	Overview and characteristics	Link
Emissions Intensity Database	Japan	Ministry of the Environment	Free	• The Ministry of the Environment, Japan, provides a database that allows users to select emission factors corresponding to each scope 3 category for calculating supply chain emissions. • This database is utilized by companies, governments, and research institutions to make environmental decisions and develop sustainable economic and environmental policies based on environmental assessment and carbon footprint data.	https://ghg-santeikohyo.env.go.jp/calc
GHG Emission Factors Hub, provided via Scope 3 Inventory Guidance	US	Environmental Protection Agency	Free	• The US government, recognizing the significance of scope 3 emissions quantification, has developed and provided a comprehensive supply-chain emission factor spreadsheet that encompasses all goods and services categories within the US economy. • The emission factors for US goods and services are based on the US Environmentally Extended Input-Output model.	https://www.epa.gov/climateleadership/ghg-emission-factors-hub
Supply Chain Greenhouse Gas Emission Factors	UK	Department for Energy Security and Net Zero; Department for Business, Energy, and Industrial Strategy	Free	• These annual spreadsheets, based on the UK input-output tables, provide various GHG emissions data, including upstream emissions for products consumed in the UK. • They support corporations that disclose environmental impact information required by investors and shareholders.	https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting
US Life Cycle Inventory Database	US	National Renewable Energy Laboratory	Free	• This database covers a wide range of sectors in the US, with data on frequently used materials, products, and processes. • It is available via website access and as JSON-LD files.	https://www.nrel.gov/lci/
The Australian Life Cycle Inventory Database	Australia	Australian Life Cycle Assessment Society	Free	• This database covers various industries in Australia, providing authoritative, comprehensive, and transparent environmental information on a wide range of products and services within the country. • The data is available as Excel files and as a SimaProDB snapshot.	https://auslci.com.au/index.php/Ho
Inventory Database for Environmental Analysis (IDEA)	Japan	National Institute of Advanced Industrial Science and Technology; Japan Environmental Management Association for Industry	Paid	• This database has been developed with the goal of achieving high comprehensiveness, completeness, representativeness, and transparency. • It includes data related to all products in the non-manufacturing, manufacturing, electric power, urban gas, and water supply and sewage sectors. However, in the processing sector, it is somewhat less comprehensive for certain items.	https://riss.aist.go.jp/idealab/
Ecoinvent Database	Switzerland	Ecoinvent Association	Paid	• This database covers various countries and industries, is widely used in Europe and the US, and is highly regarded for its reliability, having undergone review by multiple experts. • The data is available in website access and as Excel and EcoSpold v2 XML files.	https://support.ecoinvent.org/database

Resource name	Country	Relevant organizations	Free/ Paid	Overview and characteristics	Link
Sphera LCA for Experts (LCA FE)	US*	Sphera	Paid	• This database covers a wide range of industries. Users can select the industries they need and install the software accordingly. • However, additional programming work would be required to use the emission factors.	https://lcadatabase.sphera.com/
Comprehensive Environmental Data Archive (CEDA)	US	Watershed (VitalMetrics Group)	Paid	• Based on the US input-output tables, this database provides various statistical data as source material. • It is highly regarded for its reliability, having undergone multiple validations and consistency analyses. • However, a separate license and consultation with the support team are required to use the emission factors.	https://watershed.com/solutions/ceda
LCI Database	Korea	Korea Environmental Industry & Technology Institute (KEITI)	Free	• This database, which covers various industries in Korea, is based on the Korean Life Cycle Inventory (LCI) Databases developed in accordance with ISO-14044 procedures. It is used for environmental impact assessments of products. • The data is available via website access and as Excel and PDF files.	https://ecosq.or.kr/websquare.do#w2xPath=/ui/cer/ic/oh/ICOH110M01.xml&valVl=tabs3&menuSn=20018500
Environmental Product Declaration Assessment Factors	Korea	KEITI	Free	• This database provides values that quantify environmental impacts per unit of raw material and energy production, transportation methods, and waste treatment methods. It covers categories such as resource footprint, carbon footprint, and ozone layer impact.	https://ecosq.or.kr/websquare.do#w2xPath=/ui/cer/ic/oh/ICOH110M01.xml&valVl=tabs3&menuSn=20018500
National GHG Emission and Removal Factors	Korea	Ministry of Environment	Free	• This database of emission factors was developed to compile national GHG inventories. It is used to quantify GHG emissions or removals per unit of national activity for emission sources and sinks.	https://www.gir.go.kr/home/index.do?menuId=36

Note: Germany's PE International initially developed the GaBi Database, which was later acquired by Sphera.

2)-2. Methods for using Korean emission factor databases

In Korea, three key national emission factor databases are used: the National Life Cycle Inventory (LCI) Database, Environmental Product Declaration Evaluation Factors, and National GHG Emission and Removal Factors. To improve the accuracy of emissions calculations based on domestic activity data, reporting entities should use emission factors that correspond to the same geographic location as their business activities (e.g., Korea). However, before using relevant Korean databases, reporting entities should consider the principles of relevance, completeness, consistency, transparency, and accuracy, just as they would when selecting third-party databases. They should strive to select high-quality data that is relevant to their business goals.

(1) Utilization of National Lifecycle Inventory (LCI) Database

Overview

The National LCI Database (LCI DB) is a collection of data regarding the inputs and outputs involved in the entire product system, from the extraction of raw materials to the production, transportation, distribution, use, and disposal of a product per functional unit. This resource offers fundamental information for conducting lifecycle assessments (LCAs) of products. It includes lists of energy and mineral resources extracted from the environment, as well as air emissions, waterborne effluents, and waste outputs to the environment. When a product's carbon footprint is calculated, which quantifies the impact of GHG emissions such as carbon dioxide on global climate change, air emissions data from the LCI DB is utilized. Given its relevance, the reporting entity can use the national LCI database to determine scope 3 emissions by ensuring alignment with their business activities in terms of system boundaries and processes.

Example of utilization

To calculate emissions for the incineration of general waste under category 5 (waste generated in operations) using the LCI DB, the following method may be applied:

(Example assumption) The entity generates 2,000 kg of general waste per month. The LCI DB provides the following emission factors for general waste incineration—CO_2: 120.79, CH_4: 0.085259, and N_2O: 0.00080584.

Calculation methodology	Disposal method basis	Σ ((Amount of waste generated) × (Emission factor by waste type and disposal method))
Activity data	Amount of general waste generated	2,000 (kg/month)
Emission factor*	Emission factor for general waste incineration**	= Σ ((Emission factor per kg from the LCI Database of each GHG) ×(GWP of each GHG***)) = (120.79 ×1) + (0.085259 ×27.9) + (0.00080584 ×273) = 123.3887204 ($kgCO_2e/kg$)
Emissions from general waste incineration	= 2,000 (kg/month) ×123.3887204 ($kgCO_2e/kg$) = 246,777.4408 ($kgCO_2e$/month)	

Note: * The emission factor was derived from the LCI DB entry for general waste incineration. See additional explanation below.
** CO_2, CH_4, and N_2O are three of the seven GHGs emitted during general waste incineration.
*** The most recent GWP values from the IPCC's AR6 were used.

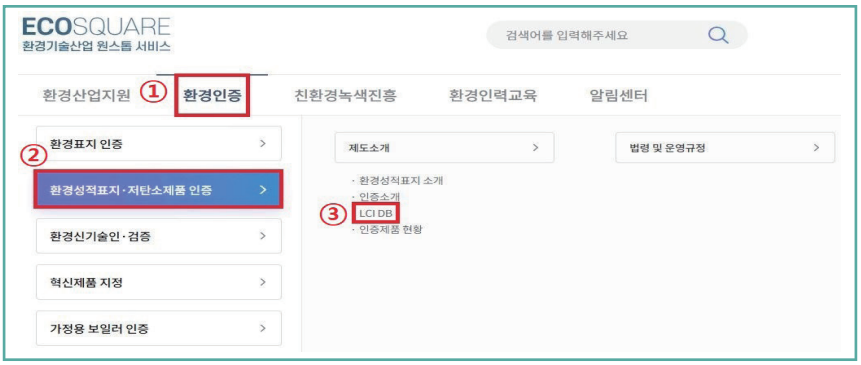
If the reporting entity can obtain activity data on general waste incineration, it can calculate the relevant emissions under category 5 using the methodology for disposal method–based calculation specified in the GHG Protocol. The necessary emission factors, categorized by waste type and disposal method, can be derived from the LCI DB for general waste incineration.

Additional explanation

When calculating scope 3 emissions using the LCI DB, the first step is to convert its input and output data into emission factors for the specific GHGs being measured. The following five-step example demonstrates the process of deriving emission factors for plastic incineration.

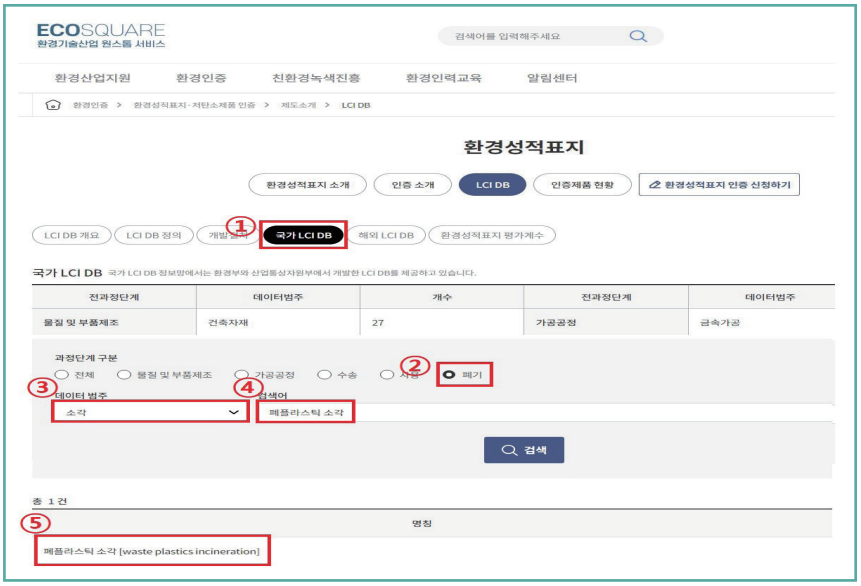
Step 1.

Access KEITI's Environmental Technology Industry One-Stop Service, EcoSquare (www.ecosq.or.kr) ⟹ ① Select "환경인증" (Environmental Certification) from the main menu options ⟹ ② From the dropdown menu, select "환경성적표지·저탄소제품 인증" (Environmental Product Declaration · Low Carbon Product Certification) ⟹ ③ In the "제도소개" (System Introduction) section, select "LCI DB" (formerly Environmental Product Declaration, www.greenproduct.go.kr/epd).



Step 2.

① Select "국가 LCI DB" (National LCI DB) on the LCI DB page ⟹ ② Select "폐기" (Disposal) from the dropdown menu in the 과정단계 구분 (process stage) section ⟹ ③ Choose "소각" (Incineration) from the 데이터 범주 (data category) dropdown ⟹ ④ Enter "폐플라스틱 소각" (waste plastics incineration) in the 검색어 (search) field and submit the search ⟹ ⑤ Choose "폐플라스틱 소각" (waste plastics incineration) from the search results.



Step 3.

① On the detail page for “폐플라스틱 소각” (waste plastics incineration), select the Excel file option in the “LCI DB 보기” (LCI DB view) section to download the file.

Step 4.

In the waste plastics incineration LCI DB Excel file: ① Select the “투입물 및 산출물” (Inputs and Outputs) sheet ➡ ② Focus on the rows where column B (방향/Direction) shows OUTPUT, column C (그룹/Group) shows Emission, and column D (환경/Environment) shows Air; then identify the emission values for GHGs in column K (값/unit value). (Note: values may only be available for some of the seven GHGs. In this example, the emission values for CO_2, CH_4, and N_2O can be confirmed.)

Step 5.

Multiply the identified GHG emission values by the GWP value for each gas, then sum them to derive the GHG emission factor for waste plastics incineration.

Example : Calculation method for the gate-to-grave emission factor for waste plastics incineration

GHG	GWP**	Air emission in LCI DB (kg)	Emission factor* ($kgCO_2e/kg$)
CO_2	1	2.809853933	2.809853933
CH_4	27.9	−3.63196E−05	−0.001013316
N_2O	273	−2.97337E−07	−8.11731E−05
Total			2.808759444

Note: * By multiplying the GWP value corresponding to each GHG by the air emission value in the LCI DB, the gate-to-grave emission factor for waste plastics incineration can be calculated to be approximately 2.81 $kgCO_2e/kg$. In other words, (emission factor) = (2.809853933 × 1) + (−3.63196E−05 × 27.9) + (−2.97337E−07 × 273) = 2.808759444 ≒ 2.81 [$kgCO_2e/kg$].

** The GWP values used in this example are based on the most recent values provided in the IPCC's AR6.

(2) Utilization of environmental product declaration assessment factors

Overview

The Environmental Product Declaration (EPD) assessment factors quantify the environmental impact per unit of raw material according to its energy production, transportation methods, and waste treatment methods.[11] These factors are categorized into various environmental impact metrics, such as resource footprint, carbon footprint, and ozone layer impact.[12] The carbon footprint metric quantifies the impact when GHGs, such as carbon dioxide, are released into the atmosphere and contribute to global climate change.[13] Therefore, after its suitability is assessed, this metric can be utilized by the reporting entity to calculate scope 3 emissions.

Example of utilization

To calculate emissions from the incineration of general waste under category 5 (waste generated in operations) using carbon footprint information from the EPD assessment factors, the following method may be used.

10) Korea Environmental Industry & Technology Institute, "Environmental Product Declaration Assessment Factors," https://ecosq.or.kr/websquare.do#w2xPath=/ui/cer/ic/oh/ICOH110M01.xml&valVl=tabs1&menuSn=20018000 (accessed on October 24, 2024).

11) Korea Environmental Industry & Technology Institute, "Definition of LCI DB," https://www.greenproduct.go.kr/epd/lci/lciIntro01.do (accessed on September 22, 2023).

12) Ministry of Environment, "Public Notice on Comprehensive Revision of the Environmental Product Declaration Guidelines," 2021.03.30, https://me.go.kr/home/web/policy_data/read.do?pagerOffset=0&maxPageItems=10&maxIndexPages=10&searchKey=&searchValue=&menuId=10260&orgCd=&condition.code=A1&condition.deleteYn=N&seq=7688 (assessed on October 24, 2024).

If the reporting entity can obtain activity data on household waste incineration, they can calculate emissions under category 5 using the methodology for disposal method–based calculation specified in the GHG Protocol. The necessary emission factors, categorized by waste type and disposal method, can be derived from the carbon footprint assessment factors in the EPD for household waste incineration.

Calculation methodology	Disposal method basis	Σ ((Amount of waste generated) × (Emission factor by waste type and disposal method))
Activity data	Amount of general waste generated	5,000 (kg/month)
Emission factor	Carbon footprint for general waste incineration	1.18168730881208 ($kgCO_2e/kg$)
Emissions from general waste incineration	= 5,000 (kg/month) ×1.18168730881208 ($kgCO_2e/kg$) = 5,908.4365440604 ($kgCO_2e$/month)	

Additional explanation: considerations for application

EPD assessment factors are quantified values representing the environmental impact per unit of raw materials, energy production, transportation methods, and waste treatment methods, based on the national LCI database. Differences in results may occur depending on the categorization and characterization methods used. Therefore, when a reporting entity intends to use carbon footprint information from the EPD assessment factors for calculating scope 3 emissions, it should first verify the original source (i.e., the LCI DB) and determine its suitability for use.

- Carbon footprint information from the EPD assessment factors includes gases beyond the seven GHGs covered by the Kyoto Protocol (e.g., carbon monoxide [CO], chlorofluorocarbons [CFCs]). Therefore, when using the carbon footprint as an emission factor to calculate emissions, the reporting entity should consider the possibility of discrepancies compared to the actual emissions.

- Reporting entities that intend to measure only the seven GHGs can derive emission factors directly from the LCI DB and use them to calculate scope 3 emissions. However, before deciding to use this information, they should determine whether the processes and system boundaries of the LCI DB are appropriate for their specific circumstances.

(3) Utilization of National GHG Emission and Removal Factors

Overview

The national GHG emission and removal factors are designed to quantify the GHG emissions or removals per unit of activity at the national level for compiling national GHG inventories.[13] Since these factors are used to calculate GHG emissions and removals by governments, businesses, and other entities, they can be applied for scope 3 emissions calculation, provided that the reporting entity evaluates the suitability of these factors based on its emission activities and the available activity data.

Example of utilization

To calculate emissions under category 7 (employee commuting) for employees commuting in compact passenger vehicles powered by liquefied petroleum gas (LPG), the following method may be applied using the national GHG emission factors.

Calculation methodology	Distance basis	Σ ((Travel distance per transport mode [km]) × (Emission factor for the transport mode))	
Activity data	Survey-based commuting data	Fuel and vehicle types: LPG, compact car Average speed: 60 km/h Average round-trip commuting distance per employee per day under these conditions: 20 km	
Emissions*	Emission for the given fuel type, vehicle type, and range of speed	CO_2 emissions	= 989.9413 × (speed [km/h]) ^ (−0.5937) = 87.0805264423241 [gCO_2/km]
		CH_4 emissions	= 0.0114 × (speed [km/h]) ^ (−0.7073) = 0.000629822935753512 (gCH_4/km) = 0.0132262816508238 (gCO_2e/km)
		N_2O emissions	= −0.0001 + 0.0217/(speed [km/h]) = 0.000261666666666667 (gN_2O/km) = 0.0811166666666668 (gCO_2e/km)
		Total	= 87.1748693906416 (gCO_2e/km)
Emissions from commuting for one employee under these conditions	= 20 [km/day] ×87.1748693906416 (gCO_2e/km) = 1,743.49738781283 (gCO_2e/day]		

Note: * The emission factors were derived from the national GHG emission and removal factors approved in 2021 for the road transport sector. While it is most accurate to calculate the emission factors by dividing them into ranges of speed below and above 65.4 km/h, the calculation can still be performed using the average speed over the total distance if only that data is available. However, this approach may result in somewhat reduced accuracy.

* For the range of speed below 65.4 km/h, the emission factor formulas for compact cars using LPG, as specified in the road transport section of the 2021 approved national GHG emission and removal factors (y: emissions [g/km], x: speed [km/h]), are as follows:
- CO_2 emission factor: y = 989.9413 × (x^ (−0.5937))
- CH_4 emission factor: y = 0.0114 × (x^ (−0.7073))
- N_2O emission factor: y = −0.0001 + 0.0217/x

13) Greenhouse Gas Inventory and Research Center of Korea, "Development and Verification Guidelines of the National Greenhouse Gas Emission and Removal Factors (2020)," (2020.12), p. 4.

Additional explanation: considerations for application

If the reporting entity can obtain activity data on employee commuting, including fuel type, vehicle type, travel distance, and travel speed, it can calculate emissions under category 7 using the distance-based calculation methodology specified in the GHG Protocol. The necessary emission factors for the transport mode may be derived using the emission factor formulas from the national GHG emission and removal factors.

if exact activity data matching the national GHG emission factors is unavailable, similar activity data may be used; however, it is important to note that this may result in less accurate emissions calculations.

For the "road transport" category in the National GHG Emission and Removal Factors, the emission factor formulas vary depending on vehicle type, fuel type, travel speed, and travel distance within specific speed intervals.. Therefore, detailed activity data are necessary for determining the most accurate emission factor. If obtaining detailed activity data on travel distance by speed interval and average speed proves challenging, an alternative approach is to use average travel distance and average speed, which may reduce accuracy but still provide a reasonable estimate.

3. Selecting Data

The quality of the scope 3 inventory depends on the quality of the data used to calculate GHG emissions. Reporting entities should collect data of sufficient quality ([Reference 4]) to ensure that the inventory accurately represents the entity's GHG emissions, aligns with its business objectives, and meets the decision-making needs of both internal and external users.

[Reference 4]

Guidance for collecting data of sufficient quality

- Appropriately reflects the GHG emissions of the reporting entity
- Meets the decision-making needs of internal and external users of the reporting entity
- Supports the business goals for managing the GHG inventory of the reporting entity

(refer to section 7.3 of the GHG Protocol Scope 3 Standard.)

In general, a reporting entity should collect high-quality primary data for high-priority activities. To most effectively track performance, the reporting entity should use primary data collected from suppliers and other value chain partners particularly for scope 3 activities where GHG reductions are targeted. However, in some cases, primary data may be unavailable or of insufficient quality. In such cases, secondary data may be of higher quality than the primary data available for a given activity.

Data selection may also align with the entity's business goals. If a primary goal of the reporting entity is to set GHG reduction targets, track performance from specific operations within the value chain, or engage with suppliers, the entity should collect primary data. If the entity's primary goal is to understand the relative magnitude of various scope 3 activities, identify hot spots, and prioritize efforts in primary data collection, the entity should collect and use secondary data ([Reference 5]). The reporting entity is required to compile a description of the types and sources of data used to calculate emissions (including activity data, emission factors, and GWP values), and the percentage of emissions calculated using data obtained from suppliers or other value chain partners.

[Reference 5]

Guidance for collecting secondary data

- Activities not prioritized based on initial estimation methods or other criteria
- Activities for which primary data is not available
  (e.g., when a value chain partner is unable to provide data)
- Activities for which secondary data is of higher quality than primary data
  (e.g., when a value chain partner is unable to provide data of sufficient quality)

1) Data quality indicators and evaluation

The GHG Protocol describes indicators of data quality in terms of how representative the data is (with respect to technology, time, and geography) and how well the data is measured (completeness and reliability) ([Reference 6]). The reporting entity should select the data that is most representative of the relevant technology, time period, and geographic scope; most complete; and most reliable. It should also determine the most useful method for evaluating and applying indicators

of data quality. To ensure transparency and avoid misinterpretation of data, the reporting entity is required to compile a description of the quality of its reported emissions data.

Alternatively, the reporting entity may choose to adopt a qualitative approach to assess the quality indicators of its direct emissions data, activity data, and emission factors ([Reference 7]).

[Reference 6]

Data quality indicators

Indicator	Description
Technological representativeness	The degree to which the dataset reflects the actual technologies used
Temporal representativeness	The degree to which the dataset reflects the actual timespan (e.g., year) or duration of the activity
Geographical representativeness	The degree to which the dataset reflects the actual geographic location of the activity (e.g., country or site)
Completeness	The degree to which the data is statistically representative of the relevant activity (e.g., the percentage of locations for which data is available and used, and the extent to which the data cover seasonal and other normal fluctuations).
Reliability	The degree to which the sources, data collection methods, and verification procedures used to obtain the data are dependable

Note: GHG Protocol; adapted from B.P. Weidema and M.S. Wesnaes, "Data quality management for life cycle inventories—an example of using data quality indicators," Journal of Cleaner Production 4 no. 3-4 (1996): 167-174.

[Reference 7]

Example of criteria for evaluating indicators of data quality

Score	Technological representativeness	Temporal representativeness	Geographical representativeness	Completeness	Reliability
Very good	Data generated using the same technology	Data with less than 3 years of difference	Data from the same area	Data from all relevant sites over an adequate time period to even out normal fluctuations	Verified data based on measurements
Good	Data generated using a similar yet different technology	Data with less than 6 years of difference	Data from a similar area	Data from more than 50% of sites for an adequate time period to even out normal fluctuations	Verified data based partly on assumptions, or non-verified data based on measurements
Fair	Data generated using a different technology	Data with less than 10 years of difference	Data from a different area	Data from less than 50% of sites for an adequate time period to even out normal fluctuations, or more than 50% of sites but for a shorter time period	Non-verified data based partly on assumptions or a qualified estimate (e.g., by a sector expert)
Poor	Data where the technology is unknown	Data with more than 10 years of difference or of unknown age	Data from an unknown area	Data from less than 50% of sites for a shorter time period or representativeness is unknown	Non-qualified estimate

Note: GHG Protocol; adapted from B.P. Weidema and M.S. Wesnaes, "Data quality management for life cycle inventories—an example of using data quality indicators," Journal of Cleaner Production 4 no. 3-4 (1996): 167-174.

2) Additional applications of data quality ratings

Under the EU's *Rules for the calculation of the Carbon Footprint of Electric Vehicle Batteries (CFB-EV) +*, data quality is assessed using a data quality rating (DQR) system. This system categorizes data into five quality ratings: 1 (excellent) 〉 2 (very good) 〉 3 (good) 〉 4 (fair) 〉 5 (poor). The evaluation criteria focus on three quality indicators, which are also used in the GHG Protocol—time-related representativeness (TiR), technological representativeness (TeR), and geographical representativeness (GeR) [Reference 6]. However, the CFB-EV rules differ from the GHG Protocol by providing a quantitative (numeric) approach to evaluating these indicators. The reporting entity may refer to both the GHG Protocol and CFB-EV rules to choose a data quality evaluation method that best suits its internal data characteristics [Reference 8].

[Reference 8]

DQR indicators in CFB-EV

Quality rating	TiR dataset	TeR dataset	GeR datasets
1	The dataset/CFB's *reference year* falls within the time validity of the secondary dataset	The modeled technology is exactly the same as the one in scope of the dataset or CFB.	The modeled process takes place in the country for which the dataset or CFB is valid.
2	The reference year of the dataset or CFB dataset is at maximum 2 years beyond the time validity of the secondary dataset.	The modeled technologies are included in the mix of technologies in scope of the dataset or CFB.	The modeled process takes place in the geographical region (e.g., Europe, Asia, North America, Africa) for which the dataset or CFB is valid.
3	The "reference year" of the dataset or CFB is maximum 3 years beyond the time validity of the secondary dataset.	The modeled technologies are only partly included in the scope of the dataset or CFB.	The modeled process takes place in one of the geographical regions for which the dataset or CFB is valid, or the dataset covers several regions (e.g., global—GLO).
4	The reference year of the dataset or CFB is maximum 4 years beyond the time validity of the secondary dataset.	The modeled technologies are similar (i.e., technological proxy) to those included in the scope of the dataset or CFB.	The modeled process takes place in a country that is not included in the geographical region(s) for which the dataset or CFB is valid, but it is estimated that there are sufficient similarities based on expert judgment.
5	The reference year of the dataset or CFB is more than 4 years beyond the time validity of the secondary dataset.	The modeled technologies are different from those included in the scope of the dataset or CFB.	The modeled process takes place in a different country from the one for which the dataset or CFB is valid.

Note: Data quality rating (DQR): 1 (excellent), 2 (very good), 3 (good), 4 (fair), 5 (poor).

In CFB–EV, the method to quantify data based on the three DQR indicators (TeR, TiR, GeR) involves calculating a weighted average of each DQR indicator according to their absolute contribution to the carbon footprint. The final DQR score is then calculated using the formula (TeR + TiR + GeR)/3. The detailed evaluation method is as follows:

- Evaluate all secondary datasets based on the three DQR criteria, namely TeR, TiR, and GeR. The values of each criterion shall be assigned based on [Reference 8].

- Calculate the absolute value of the carbon footprint of each process by multiplying the absolute carbon footprint of the dataset by the corresponding activity data. (For example, if a process consumes 3 kWh of electricity and the dataset modeling the electricity consumption has a carbon footprint of 0.6 $kgCO_2e/kWh$, the absolute carbon footprint for the process is calculated as: 3 kWh x 0.6 $kgCO_2e$/kWh.)

- Calculate the carbon footprint contribution (in %) of each process. This contribution is determined by dividing the absolute CFP of the process by the sum of all absolute values. Absolute values are used to ensure all contributions are positive, and the sum is equivalent to the overall carbon footprint if no negative values are present.

- Calculate the weighted average value for each DQR criterion. (For example, he weighted average of TeR is calculated by applying the carbon footprint contribution of each individual dataset as the weight for averaging.)

- Finally, calculate the DQR score using the following formula (TeR + TiR + GeR)/3.

The CFB–EV rules define the most representative secondary dataset by prioritizing TeR as the primary criterion and GeR as the secondary criterion. If a secondary dataset with TeR is available, the one with the highest TeR shall be used as most representative. However, if the dataset with the highest TeR is not selected, a dataset with DQR ≤ 2 may be chosen as an alternative. Conversely, if no secondary dataset with TeR is available, either a dataset with DQR ≤ 3 shall be used, or a dataset deemed representative based on various information sources shall be selected.

4. Collecting Primary Data

Primary activity data may be obtained through various methods, such as meter readings, purchase records, utility bills, direct monitoring, and other approaches for collecting the necessary data from specific activities in the entity's value chain. Where possible, the reporting entity should collect energy or emissions data from suppliers and other value chain partners to obtain site-specific data for high-priority scope 3 activities. To facilitate this, the reporting entity should identify the relevant suppliers to request GHG data. These suppliers may include contract manufacturers, raw material and parts suppliers, capital equipment suppliers, fuel suppliers, third-party logistics providers, waste management companies, and other entities that provide goods or services to the reporting entity.

The reporting entity should engage first with relevant tier 1 suppliers. Tier 1 suppliers are the companies with which the reporting entity has purchase orders for goods or services (e.g., raw materials, parts, or components). Since tier 1 suppliers have contractual obligations with the reporting entity, this provides the necessary leverage to request GHG inventory data. Additionally, where relevant, the reporting entity may seek GHG emissions data from tier 2 suppliers (N-tier suppliers). Tier 2 suppliers are those with which tier 1 suppliers have purchase orders for goods or services. If the data is not collected from specific suppliers or is incomplete ([Reference 9]), secondary data may be used to calculate emissions for the activities involved. To achieve this goal, the reporting entity may develop its own policy to establish criteria for selecting relevant suppliers for primary data collection.

The reporting entity is required to declare the percentage of emissions calculated using data obtained from suppliers or other value chain partners. However, not all relevant suppliers will be able to provide GHG inventory data. In such cases, the reporting entity should encourage these suppliers to develop GHG inventories in the future, and it may work towards increasing supplier participation in public GHG emissions reporting.

[Reference 9]

Challenges and guidance for collecting primary data from value chain partners

Challenges	Guidance
Large number of suppliers	– Target the most relevant suppliers based on spend and/or anticipated emissions impact – Target suppliers with which the reporting entity has a high degree of influence (e.g., contract manufacturers or suppliers where the reporting entity accounts for a significant share of the supplier's total sales)
Lack of supplier familiarity with GHG inventories and accounting practices	– Target suppliers with prior experience in developing GHG inventories – Identify the correct subject-matter expert in the supplier's organization – Explain the business value of investing in GHG accounting and management – Request data that suppliers have already collected, such as energy-use data, and prioritize requesting activity data rather than emissions data to minimize errors – Provide clear instructions and guidance with the data request – Provide training, support, and follow-up
Lack of supplier capacity and resources for tracking data	– Make the data request as straightforward as possible – Use a simple, user-friendly, standardized data template or questionnaire – Provide a clear list of the data required and where to find them (e.g., utility bills) – Use an automated online data collection system to streamline data entry – Consider using a third-party database to collect data – Leverage resources from suppliers' trade associations – Coordinate the GHG data request with other requests – Follow up with suppliers
Lack of transparency regarding the quality of supplier data	– Request documentation on the methodology and data sources used, as well as inclusions, exclusions, assumptions, etc. – Minimize errors by requesting activity data (e.g., kWh electricity used, kg of fuels used) and calculating the GHG emissions separately – Consider engaging third-party assurance
Confidentiality concerns of suppliers	– Protect suppliers' confidential and proprietary information (e.g., through nondisclosure agreements or firewalls) – To avoid requiring confidential details, request third-party assurance of supplier data instead of direct submission of detailed activity data
Language barriers	– Translate the questionnaire and communications into local languages

Note: GHG Protocol..

5. Collecting Secondary Data and Filling Data Gaps

The reporting entity will engage in a repetitive process of data collection, quality assessment, and continuous improvement. When selecting data sources, the reporting entity should first assess their data quality by applying the relevant indicators. Once it has collected the data, it should use the same data quality assessment approach to review the quality of the inventory.

In the initial years of scope 3 data collection, a reporting entity may need to rely on relatively low-quality data due to limited availability. However, over time, entities should prioritize improving the overall quality of their inventory by replacing lower-quality data with higher-quality data. Furthermore, entities that report relatively high emissions are required to compile a description of data quality when reporting scope 3 emissions to ensure transparency and avoid potential misinterpretation.

04 GHG Emissions Accounting and Methodologies for Application

1. GHG Emissions Accounting

When accounting for scope 3 emissions, the reporting entity is required to adhere to standard calculation methods and follow the five GHG Protocol principles—relevance, completeness, consistency, transparency, and accuracy—to establish and assure the scope 3 inventory ([Reference 1]).

[Reference 1]

The five principles of GHG emissions accounting

Principle	Guidance
Relevance	– Ensure the GHG inventory appropriately reflects the GHG emissions of the entity and serves the decision-making needs of users – both internal and external to the entity.
Completeness	– Account for and report on all GHG emission sources and activities within the inventory boundary. – In cases where the entity is unable to account for and report all GHG emission sources and activities (e.g., due to data limitations or other constraints), all exclusions shall be documented and justified.
Consistency	– Use consistent calculation methods to enable users to monitor and track GHG emissions trends. – However, when consistency is compromised (e.g., inclusion of previously excluded activities, other changes affecting emission estimates and data), these changes must be transparently documented and justified, and the base year emissions may need to be recalculated.
Transparency	– Disclose all relevant information about the construction of the GHG inventory in a clear, factual, neutral, and understandable manner, including procedures, assumptions, applied calculation methods and data sources with appropriate references, and limitations. – Information based on clear documentation (i.e., an audit trail) should be recorded, compiled, and analyzed in a way that enables internal reviewers and external assurance providers to attest to its credibility. Specific exclusions shall be clearly identified and justified.
Accuracy	– Ensure that the quantification of GHG emissions is systematically aligned as closely as possible with actual emissions. (Ensure that the reported emissions are neither overestimated nor underestimated, compared to the actual emissions.) – Reduce uncertainties as far as practicable, and ensure the data is sufficiently accurate to meet decision-making needs.

In practice, the reporting entity may encounter trade-offs among these five principles when compiling a scope 3 inventory. For example, an entity may use relatively less accurate data to achieve a more complete scope 3 inventory, which could compromise overall accuracy. Conversely, achieving the most accurate scope 3 inventory may require excluding activities with lower data accuracy, and this approach may result in an inventory that is less complete overall.

Therefore, the reporting entity should balance trade-offs among these principles relative to its specific business goals. Though trade-offs between accuracy and completeness may exist, the entity should strive to improve both the accuracy and completeness of the reported emissions data over time through efforts to enhance overall data quality, thereby minimizing these trade-offs.

The reporting entity should calculate emissions for each scope 3 category in accordance with these five principles. The calculation methods and emission factors applicable to each category can be found in Chapter II, 3.2 (Quantification Methods and Data Types) and Chapter III (Scope 3 Calculation Methodology by Category), which the entity may refer to when calculating its inventories for reporting purposes.

2. Methodologies for Application

When applying category-specific calculation methods, the reporting entity may use commonly applicable methodologies to calculate more accurate emissions for each category. Representative methodologies include allocation and sampling techniques. Allocation refers to the process of partitioning GHG emissions from a single facility or other system (e.g., activity, vehicle, production line, or business unit) among its various outputs or targets. Meanwhile, in statistics and data analysis, sampling refers to the process of selecting and applying specific data values from the entire dataset.

1) Allocation

When a reporting entity uses primary data from suppliers or other value chain partners to calculate scope 3 emissions, it may apply the allocation method to estimate emissions. Similarly, when the reporting entity provides primary data to its customers, those customers can also use the allocation method to estimate their own scope 3 emissions ([Reference 2]).

Allocation is necessary when:

- A single facility or other type of system produces multiple outputs.
- Emissions are quantified only for the facility or system as a whole.
- Emissions from the facility or other systems need to be allocated to (or divided among) the various outputs.

Allocation is not necessary when:

- A facility or other type of system produces only one output.
- Emissions from producing each output are separately quantified.
- Allocation is not typically necessary when secondary data is used to calculate scope 3 emissions.

[Reference 2]

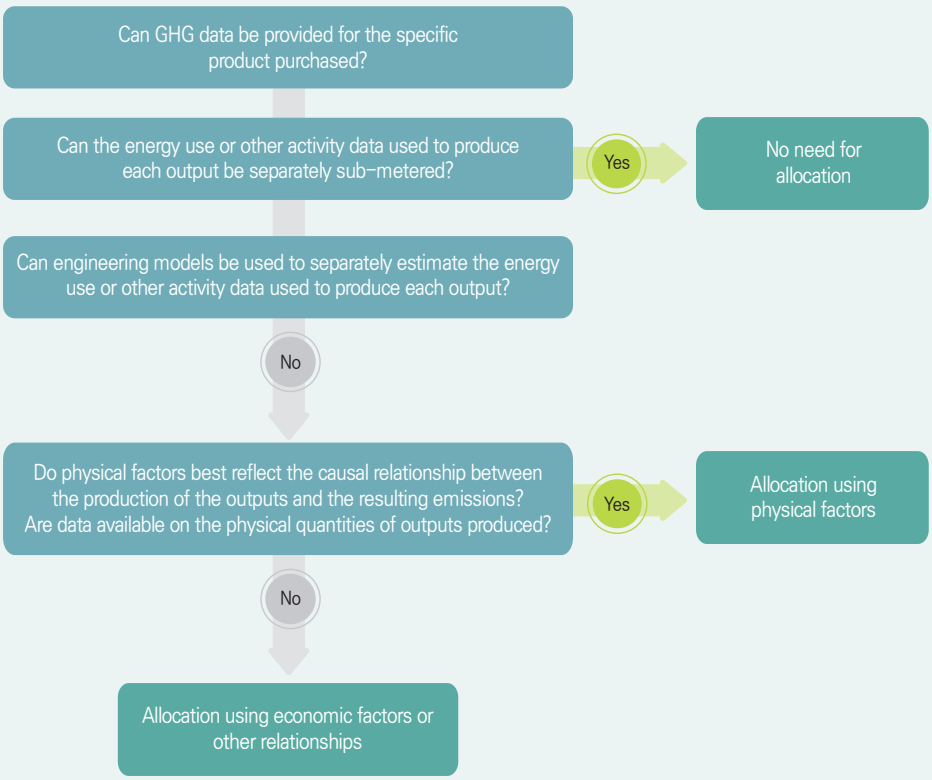
Allocation examples and guidance by scope 3 category

	Category	Examples of allocation data	Guidance
1	Purchased goods and services	Site-specific energy use or emissions data from suppliers	Physical or economic allocation
2	Capital goods	Site-specific energy use or emissions data from capital goods suppliers	Physical or economic allocation
3	Fuel- and energy-related activities (not included in scope 1 or scope 2)	Entity-specific data on upstream emissions (e.g., extraction of fuels) and actual power purchase data for purchased power	Physical allocation (energy)
4	Upstream transportation and distribution	Activity-specific energy use or emissions data from third-party transportation and distribution suppliers (for shared vehicles), and physical allocation for shared facilities (based on volume or area)	Physical allocation for shared vehicles (mass or volume)
5	Waste generated in operations	Site-specific emissions data from waste management companies	Physical or economic allocation
6	Business travel	Activity-specific emissions data from transportation suppliers (e.g., airlines)	Physical allocation for shared vehicles (area)
7	Employee commuting	Specific distance traveled and mode of transport collected from employees	Physical allocation for shared vehicles (area)
8	Upstream leased assets	Site-specific energy use data collected by utility bills or meters	Physical allocation for shared facilities (area or volume)
9	Downstream transportation and distribution	Activity-specific energy use or emissions data from third-party transportation and distribution partners (for shared vehicles), and physical allocation for shared facilities (volume or area)	Physical allocation for shared vehicles (mass or volume)
10	Processing of sold products	Site-specific energy use or emissions from downstream value chain partners	Physical or economic allocation
11	Use of sold products	Specific data collected from consumers	Physical allocation, where applicable
12	End-of-life treatment of sold products	Specific data collected from waste management providers on emissions rates or energy use	Physical allocation, where applicable
13	Downstream leased assets	Site-specific energy use data collected by utility bills or meters	Physical allocation for shared facilities (area or volume)
14	Franchises	Site-specific energy use data collected by utility bills or meters	Physical allocation for shared facilities (area or volume)
15	Investments	Site-specific energy use or emissions data	Economic allocation based on the entity's proportional share of equity or debt in the investee company

When a reporting entity chooses to apply the allocation method, it should use a consistent allocation factor for allocating emissions across the entire facility or system. The total of the allocated emissions for each output should match the overall emissions from the system. However, allocation may introduce uncertainty into the entity's emission estimates, particularly when an activity or facility produces a diverse range of products with varying contributions to GHG emissions. Therefore, the reporting entity should avoid or minimize allocation when using primary data to calculate scope 3 emissions ([Reference 3]).

[Reference 3]

Decision tree for selecting the allocation approach



2) Sampling

If a reporting entity needs to collect a large quantity of data for a particular scope 3 category but finds it impractical or impossible to collect the data from each individual activity, it may use appropriate sampling techniques. This allows the entity to extrapolate data from a representative sample of activities within the category. Additionally, activities can be grouped into similar categories to facilitate data collection and emission estimation.

When sampling and grouping may be necessary:

- Calculating emissions by grouping buildings by type or floor area, or vehicles by type
- Calculating emissions associated with employee commuting (category 7) by extrapolating data from a representative sample of employees
- For entities with multiple distribution channels, calculating emissions associated with transportation and distribution (categories 4 and 9)

The use of sampling and choice of a specific sampling method by a reporting entity aims to optimize the trade-off between cost of measurement and accurately representing all emission sources. The reporting entity may use a sampling method ([Reference 4]) that aligns with its business goals and is appropriate for each specific emissions activity.

[Reference 4]

Sampling methods

Sampling method	Description
Simple random sampling	– With an appropriate sample size, simple random sampling creates a representative view of the entire dataset. – Constructing the sample is relatively straightforward; however, if the total number of activities is too large, the process may become cumbersome.
Systematic sampling	– Systematic sampling involves randomly selecting the first item to sample and then selecting subsequent activities at regular intervals to achieve the desired sample size. – It is simple to implement and guarantees even sampling without clustering; however, if the dataset has a periodic pattern, sampling bias could occur.
Stratified sampling	– Stratified sampling initially groups the dataset's activities into categories with similar characteristics, followed by random sampling within these groups. – It may improve precision due to less variability within groups,reducing the necessary sample size and saving time and money; however, identifying appropriate variables and forming relevant groups may be difficult and complex.

Note: GHG Protocol.

In all sampling activities, determining the sample size is fundamental ([Reference 5]). When determining the sample size for estimating emissions through sampling, the reporting entity should consider several factors, including the significance of GHG emissions from the source, the size of the population, the variability of the emission sources, and the necessary degree of precision.

[Reference 5]

Sample size determination

Determination method	Description
Using the sample size of a similar inventory	– The reporting entity may refer to similar inventories for guidance on appropriate sample size and sampling techniques; however, when using this approach, entities should justify the similarity and appropriateness for comparison.
Using online calculators	– Online calculators offer a quick and easy way to assess sample size. Such websites include: ① http://www.research-advisors.com/tools/SampleSize.htm (Provides a downloadable spreadsheet to calculate the necessary sample size with customizable sampling criteria.) ② www.surveysystem.com/sscalc.htm (Provides an interactive online calculator with fixed options for confidence level.)
Using published tables	– Many published tables provide the necessary sample size for specific criteria, such as precision, confidence levels, and variability for a given population size. (Reporting entities should refer to standard statistics texts or search online for a table matching their specific sampling criteria.)
Using formulas	– Formulas for calculating sample size are available in all standard statistics and sampling textbooks as well as online. The reporting entity may find it advantageous to consult these formulas to ensure confidence in determining the appropriate sample size.

Note: GHG Protocol.

When a normal distribution is assumed during the sampling process, increasing the sample size is likely to reduce sampling error. However, it is important to recognize that all measurements contain some level of uncertainty. The reporting entity should estimate uncertainty[14] for the parts of the assessment that are significant to its organization.

An estimate of uncertainty should include both precision from random error and bias from systematic error. A commonly accepted standard level of confidence regarding uncertainty is a "95% confidence level. For example, if the uncertainty level is ±5% for an emissions estimate of 100 tonnes CO_2e, the true value is likely to lie between 95 and 105 tonnes with 95% confidence.

Variability refers to the degree of difference among activities within a dataset. A more heterogeneous (more variable) dataset will require a larger sample size. Generally, the maximum level of variability is "50%," and a conservative estimate of variability is often represented by "0.5" in many cases.

14) This concept involves evaluating how accurate a particular measurement or assessment is and understanding the degree of uncertainty involved.

05 Assurance and Reporting

1. Assurance

Assurance refers to the level of confidence that the inventory is complete, accurate, consistent, transparent, relevant, and free from material misstatements. Assuring scope 3 inventory results can provide a variety of benefits, including:

- Enhanced reliability of reported information, which serves as the basis for senior management's reduction targets and related decisions.
- Improved internal accounting and reporting practices (e.g., data collection, calculation, and internal reporting systems), as well as support for learning and knowledge transfer.
- Improved efficiency in subsequent inventory update processes.
- Increased stakeholder confidence in the reported information.

Thoroughly documenting the assurance process is a crucial step in preparing for assurance. Three key parties are involved in the assurance process:

- The reporting entity seeking assurance
- Stakeholders using the inventory report
- The assurance provider(s)
- Assurance is classified into two types: first-party assurance (internal providers) and third-party assurance (external providers).
- The type of assurance is distinguished by the level of independence maintained by the assurance providers from the reporting entity's inventory process ([Reference 1]).

[Reference 1]

Types of assurance

Type of assurance	Description	Independence mechanism
First-party assurance	Person(s) from within the reporting entity, but independent of the GHG inventory process, conduct internal assurance	Different lines of reporting
Third-party assurance	Person(s) from an organization independent of the scope 3 inventory process conduct third-party assurance	Different business entity from the reporting entity

Both first party and third-party assurance providers should follow similar procedures and processes, including:

- Planning and scoping (e.g., identifying risks and material misstatements)
- Identifying emission sources included in the scope 3 inventory
- Performing the assurance process (e.g., gathering evidence, performing analytics)
- Evaluating results
- Determining and reporting conclusions

For external stakeholders, third-party assurance is likely to increase the credibility of the GHG inventory. Inherently, assurance provided by a third party offers a higher degree of objectivity and independence. However, first-party assurance can also provide confidence in the reliability of the inventory report and serve as a valuable learning experience for the reporting entity before engaging in third-party assurance. In such cases, a reporting entity undergoing first-party assurance should report how potential conflicts of interest were avoided during the assurance process.

When conducting the assurance process, the reporting entity should choose between limited or reasonable assurance, based on the components of the audit (e.g., assertions, subject matter, criteria, evidence, standards, and opinions) ([Reference 2]). The level of assurance indicates the degree of confidence stakeholders can have in the assurance report. Additionally, the level of assurance requested by the reporting entity will determine the rigor of the assurance process and the volume of evidence required. The highest level of assurance that can be provided is reasonable assurance. However, since it is practically impossible to test 100% of all inputs to a GHG inventory, it is important to note that "absolute assurance" cannot be provided.

[Reference 2]

Offering limited or reasonable assurance opinions

Assurance opinion	Nature of the opinion	Example wording
Limited assurance	Negative opinion	"Based on our review, we are not aware of any material modifications that should be made to the entity's assertion that their scope 3 inventory is in conformance with the requirements of the GHG Protocol Scope 3 Standard."
Reasonable assurance	Positive opinion	"In our opinion, the reporting entity's assertion of their scope 3 emissions by category, as reported in the inventory report, is fairly stated, in all material respects, and is in conformance with the GHG Protocol Scope 3 Standard."

2. Reporting

The reporting entity shall present information based on the principles of relevance, accuracy, completeness, consistency, and transparency through a credible GHG emissions report. The report should be based on the best available data and transparently disclose any limitations.

1) Required information

The GHG Protocol specifies that reporting entities shall publicly disclose the following information:

- A scope 1 and scope 2 emissions report in conformance with the GHG Protocol Corporate Standard.
- Total scope 3 emissions reported separately by scope 3 category.
- For each scope 3 category, total emissions of GHGs (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, and NF_3) reported in metric tonnes of CO_2–equivalent, excluding biogenic CO_2 emissions and independent of any GHG trades, such as purchases, sales, or transfers of offsets or allowances.
- A list of scope 3 categories and activities included in the inventory.
- A list of scope 3 categories or activities excluded from the inventory with justification of their exclusion.
- Once a base year has been established: the year chosen as the scope 3 base year, the rationale for choosing it, the base year emissions recalculation policy, scope 3 emissions by category in the base year consistent with that policy, and appropriate context for any significant emissions changes that triggered base year emissions recalculations.
- For each scope 3 category, any biogenic CO_2 emissions, reported separately.
- For each scope 3 category, a description of the types and sources of data used to calculate emissions, including activity data, emission factors, and GWP values, and a description of the data quality of reported emissions data.
- For each scope 3 category, a description of the methodologies, allocation methods, and assumptions used to calculate scope 3 emissions.
- For each scope 3 category, the percentage of emissions calculated using data obtained from suppliers or other value chain partners.

2) Optional information

Reporting entities should incorporate into their GHG emissions report, when applicable, the following additional points:

- Emissions data further subdivided where it would add relevance and transparency (e.g., by business unit, facility, country, source type, or activity type).
- Emissions data further disaggregated within scope 3 categories where it would add relevance and transparency (e.g., reporting by different types of purchased materials within category 1, or different types of sold products within category 11).
- Emissions from scope 3 activities not included in the list of scope 3 categories (e.g., transportation of attendees to events), reported separately (e.g., in an "other" scope 3 category).
- Emissions of GHGs reported in metric tonnes of each individual gas.
- Emissions of any GHGs other than CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, and NF_3 whose 100-year GWP values have been identified by the IPCC, to the extent they are emitted in the entity's value chain (e.g., CFCs, HCFCs, NOx, etc.), and a list of any additional GHGs included in the inventory.
- Historic scope 3 that have previously occurred, reported separately from future scope 3 emissions expected to stem from the reporting entity's activities in the reporting year (e.g., from waste generated in operations, the use of sold products, or the end-of-life treatment of sold products).
- Qualitative information about emission sources that have not been quantified.
- Information on any GHG sequestration or removals, reported separately from scope 1, scope 2, and scope 3 emissions.
- Information on project-based GHG reductions calculated using the project method (e.g., using the GHG Protocol for Project Accounting), reported separately from scope 1, scope 2, and scope 3 emissions.
- Information on avoided emissions (e.g., from the use of sold products), reported separately from scope 1, scope 2, and scope 3 emissions.
- Quantitative assessments of data quality.
- Information on inventory uncertainty (e.g., information on the causes and magnitude of uncertainties in emission estimates) and an outline of policies in place to improve inventory quality.
- The type of assurance performed (first or third party), the relevant competencies of the assurance provider(s), and the opinion issued by the assurance provider.
- Relevant performance indicators and intensity ratios.
- Information on the entity's GHG management and reduction activities, including scope 3 reduction targets, supplier engagement strategies, product GHG reduction initiatives, etc.
- Information on supplier/partner engagement and performance.

- Information on product performance.
- A description of performance measured against internal and external benchmarks.
- Information on purchases of GHG reduction instruments, such as emissions allowances and offsets, from outside the inventory boundary.
- Information on reductions at sources within the inventory boundary that have been sold or transferred as offsets to a third party.
- Information on any contractual provisions addressing GHG-related risks or obligations.
- Information on the causes of emissions changes that did not trigger a scope 3 base-year emissions recalculation.
- GHG emissions data for all years between the scope 3 base year and the reporting year (including details of and reasons for recalculations, if appropriate).
- Additional explanations that provide context for interpreting the data.

III

Calculation Methodology by Category

01 Category 1 (Purchased Goods and Services)

1. Definition

Category 1 includes the cradle-to-gate emissions ([Reference 2]) of purchased or acquired goods and services ([Reference 1]) by the reporting entity in the reporting year. It includes emissions from all upstream activities not included in other upstream categories, from category 2 (capital goods) to category 8 (upstream leased assets). In other words, it covers all emissions that occur throughout the life cycle of the goods purchased by the reporting entity until they reach the point of receipt.

[Reference 1]

Examples of entity purchases

- Production-related procurement (direct procurement):
  - ① Raw materials
  - ② Intermediate goods
    - Purchased for processing, transformation, or inclusion in other products
    - Examples: materials, components, parts
  - ③ Final goods
    - Purchased for resale
    - Only for retail and distribution companies
  - ④ Capital goods (included in category 2)
    - Used by entities to manufacture products, provide services, and sell, store, and deliver products
    - Examples: plants, assets, equipment
- Non-production-related procurement (indirect procurement):
  - ① Operations resource management
    - Products used in work environments, such as offices
    - Examples: office supplies, office furniture, computers, IT support, consulting services, cleaning and landscaping services
  - ② Maintenance, repairs, and operations
    - Products used in manufacturing settings
    - Examples: spare parts, replacement parts

[Reference 2]

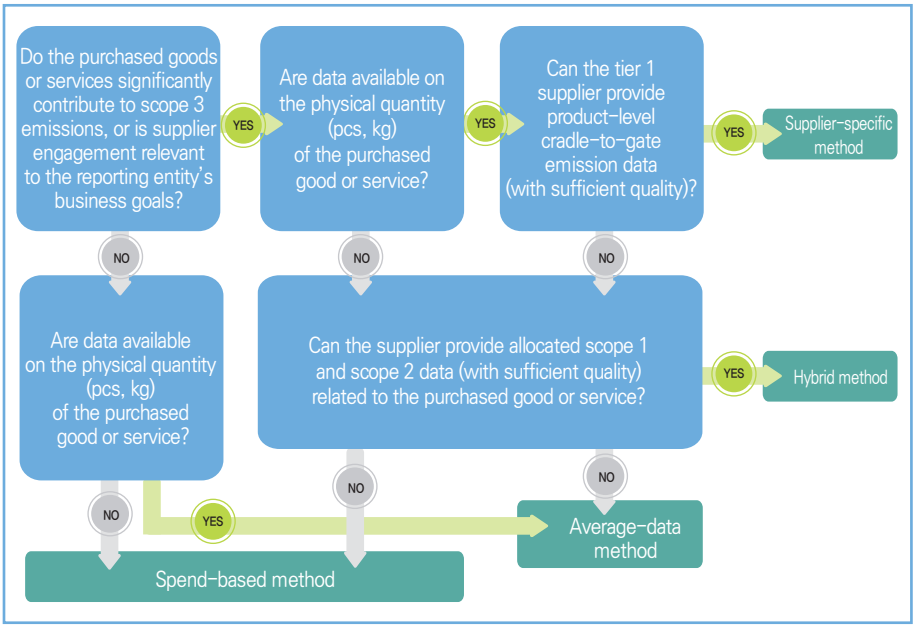
Examples of products' upstream (cradle-to-gate) emission activities

- Extraction of raw materials
- Manufacturing, production, and processing
- Electricity consumed during upstream activities
- Disposal or treatment of waste generated by upstream activities and land use
- Transportation of materials and products between suppliers
- Other activities performed prior to the product's acquisition by the reporting entity

2. Calculation Methodology

Four methods may be used to calculate emissions from category 1 (purchased goods and services): the supplier-specific, hybrid, average-data, and spend-based methods. The applicable method may vary depending on the level of data available to the reporting entity (e.g., data with sufficient quality). They may be determined as shown in the following diagram ([Reference 3]).

1) Decision tree



[Reference 3]

Determining the calculation method based on the level of collected data

The supplier-specific and hybrid methods can yield more specific results for individual suppliers than the average-data and spend-based methods. However, these methods may not accurately reflect product-specific contributions to the reporting entity's scope 3 emissions, and the collected data from a reporting entity's actual suppliers may be less accurate than industry-average data for certain products. Therefore, the reporting entity should identify the specificity and accuracy of the data and select the appropriate calculation method for reporting emission values in category 1.

2) Calculation formulas and descriptions

Classification		Calculation formula	Description
a	Supplier-specific method	Σ((quantity of goods purchased) × (supplier-specific product emission factor))	Collect product-level cradle-to-gate emission factors for the purchased goods and services from suppliers.
b	Hybrid method	Σ(emission sum across quantities of materials input) + Σ(emission sum across transport of materials input to tier 1 or tier 2 suppliers) + Σ(emission sum across production of purchased goods/services) + Σ(emission sum across waste outputs by tier 1 supplier)	If some of the supplier-specific activity data are unavailable, secondary and primary data are combined to calculate emissions.
c	Average-data method	Σ((mass or unit of purchased good or service) × (emission factor of purchased good or service per unit of mass or reference unit))	Collect data on the mass of goods and services (e.g., kg or other relevant units), and multiply by a secondary emission factor (e.g., average emissions per unit of goods or services) to estimate the emissions of the goods and services.
d	Spend-based method	Σ((value of purchased good or service) × (emission factor of purchased good or service per unit of economic value))	Collect data on the economic value of purchased goods and services, and multiply by the relevant secondary emission factor (e.g., average emissions per monetary value of the goods).

3. Calculation Examples by Methodology[15)]

a. Supplier-specific method

- Company A, a rechargeable battery manufacturer, purchases raw materials for batteries from its suppliers B, C, and D. Using its internal IT system, Company A is able to determine the quantities of each purchased product. Additionally, Company A collects product-specific emission factors from the supplier for the purchased products.

15) All activity data and emission factors are for illustrative purposes only and do not represent actual data.

Purchased item	Quantity of goods purchased (kg)	Supplier	Supplier-specific emission factor ($kgCO_2e/kg$)
Cathode	200,000	Supplier B	1.25
Anode	600,000	Supplier C	0.75
Separator	200,000	Supplier D	1.40

- Therefore, using the supplier-specific method, the total emissions of the goods purchased by rechargeable battery manufacturer A are calculated as follows:

Σ (quantities of good purchased (kg) × supplier-specific emission factor of purchased good or service ($kgCO_2e/kg$))

= (200,000 × 1.25) + (600,000 × 0.75) + (200,000 × 1.40)
= 980,000 $kgCO_2e$

b. Hybrid method (1)

- Company A, a rechargeable battery manufacturer, utilizes cases purchased from supplier B to sell its final rechargeable battery products.

- Company A collected information on Company B's scope 1 and scope 2 emissions, and waste generated, relating to the goods purchased from Company B. Additionally, Company A collected information on input quantities of Company B's raw materials corresponding to the goods purchased by Company A, as well as on the transportation of these raw materials. The representative emission factors for each raw material were obtained by referencing the LCI DB. To calculate emissions from natural gas consumption, Company B converted the units of natural gas consumed from Nm^3 to kg. Furthermore, Company B collected the net calorific value of the natural gas using the conversion standard for its calorific value (enforcement rule of the Energy Act) and its emission factors (National GHG Emission and Removal Factors, approved in 2021). The activity data and emission factors investigated are as follows:

Company B's fuels consumed	Quantity of fuels consumed	Emission factor	Net calorific value
Electricity	5,000 kWh	0.5 kg CO_2e/kWh	Not applicable
Natural gas	2,500 kg	15.281 tC/TJ	49.4 MJ/kg

Company B's disposal method	Disposal quantity (kg)	Emission factors ($kgCO_2e/kg$)
Landfill	100	0.5

Company B's purchased raw materials	Quantity of raw materials purchased (kg)	Emission factor ($kgCO_2e/kg$)
Aluminum	5,000	7.0
Plastics	2,500	5.0
Chemical substance X	500	2.0

Company B's purchased raw materials	Transportation distance (km)	Emission factor ($kgCO_2e/kg{\cdot}km$ or $kgCO_2e/tonne{\cdot}km$)
Aluminum	1,000	0.01
Plastics	2,500	0.02
Chemical substance X	800	0.05

– Therefore, using the hybrid method, the total emissions of the goods purchased by rechargeable battery manufacturer A may be calculated as follows:

① Σ (Company B's scope 1 and scope 2 emissions relating to purchased good ($kgCO_2e$))

= (Company B's scope 1 and scope 2 emissions from electricity consumption) + (Company B's scope 1 and scope 2 emissions from natural gas consumption)
= (quantity of electricity consumed × electricity emission factor) + (quantity of natural gas consumed × calorific value of natural gas × carbon emission factor × 44/12[16])
= (5,000 × 0.5) + (2,500 × 49.4 × 15.281/1,000,000[17] × 44/12 × 1,000[18])
= 2,500 + 6,920
= 9,420 $kgCO_2e$

② Σ (mass or value of raw-material inputs used by Company B relating to purchased good (kg or USD) × emission factor for the corresponding material ($kgCO_2e$/kg or $kgCO_2e$/USD))

= (5,000 × 7.0) + (2,500 × 5.0) + (500 × 2.0)
= 48,500 $kgCO_2e$

③ Σ (Distance of transport of raw material inputs to Company B (km) × mass of raw material input (kg) × vehicle-specific emission factor ($kgCO_2e$/kg/km))

= (5,000 × 1,000 × 0.01) + (2,500 × 2,500 × 0.02) + (500 × 800 × 0.05)
= 195,000 $kgCO_2e$

④ Σ (mass of waste generated by Company B relating to purchased good (landfill transfer weight) (kg)) × emission factor for the landfill waste ($kgCO_2e$/kg))

= 100 × 0.5
= 50 $kgCO_2e$

⑤ Sum of the above-mentioned values

9,420 + 48,500 + 195,000 + 50
= 252,970 $kgCO_2e$

b. Hybrid method (2)

– If rechargeable battery manufacturer A only has allocated data for scope 1, scope 2, and waste, the upstream emissions may be calculated using the number of cases purchased from Company B and the case-specific emission factors from the LCI DB.

– In this scenario, Company A collected information on Company B's scope 1 and scope 2 emissions and waste generated relating to the goods purchased from Company B.

16) A factor to convert carbon-based emissions to carbon dioxide-based emissions ($kgCO_2$/kgC).
17) A factor to unify units of MJ for natural gas net calorific value and TJ for emission factor.
18) A factor to convert tCO_2e to $kgCO_2e$.

Additionally, Company A collected the number of cases purchased from Company B through its internal IT system. Furthermore, the cases' representative emission factors were obtained by referencing the LCI DB. To calculate the emissions from its natural gas consumption, Company B converted the units of natural gas consumed from N m^3 to kg and collected the net calorific value of the natural gas using the conversion standard for its calorific value (enforcement rule of the Energy Act) and its emission factors (National GHG Emission and Removal Factors, approved in 2021). The activity data and emission factors investigated are as follows:

Company B's fuels consumed	Quantity of fuels consumed	Emission factor	Net calorific value
Electricity	5,000 kWh	0.5 kg CO_2e/kWh	Not applicable
Natural gas	2,500 kg	15.281 tC/TJ	49.4 MJ/kg

Company B's disposal method	Disposal quantity (kg)	Emission factors ($kgCO_2e$/kg)
Landfill	100	0.5

Number of cases purchased	Case cradle-to-gate process emission factor ($kgCO_2e$/quantity)	Case cradle-to-gate process emission factor ($kgCO_2e$/quantity) (excluding scope 1 and scope 2 emissions and emissions from waste associated with final producer)
12,000	6	5.6

- Therefore, using the hybrid method, the total emissions of the goods purchased by rechargeable battery manufacturer A may be calculated as follows:

① Σ (Company B's scope 1 and scope 2 emissions relating to purchased good ($kgCO_2e$))

= (Company B's scope 1 and scope 2 emissions from electricity consumption) + (Company B's scope 1 and scope 2 emissions from natural gas consumption)
= (quantity of electricity consumed × electricity emission factor) + (quantity of natural gas consumed × calorific value of natural gas × carbon emission factor × 44/12[19])
= (5,000 × 0.5) + (2,500 × 49.4 × 15.281/1,000,000[20] × 44/12 × 1,000[21])
= 2,500 + 6,920
= 9,420 $kgCO_2e$

② Σ (mass of waste generated by Company B relating to purchased good (landfill transfer mass) (kg)) × emission factor for landfill waste ($kgCO_2e$/kg))

= 100 × 0.5
= 50 $kgCO_2e$

③ Σ (mass (kg), quantity, or cost of purchased goods or services × emission factor of purchased good, excluding the producer's scope 1 and scope 2 emissions ($kgCO_2e$/kg, units, or dollars))

= 12,000 ×5.6
= 67,200 $kgCO_2e$ (refers to all other upstream emissions)

19) A factor to convert carbon-based emissions to carbon dioxide-based emissions ($kgCO_2$/kgC).
20) A factor to unify units of MJ for natural gas net calorific value and TJ for emission factor.
21) A factor to convert tCO_2e to $kgCO_2e$.

④ Sum of the above-mentioned values

9,420 + 50 + 67,200
= 76,670 $kgCO_2e$

c. Average-data method & d. Spend-based method

- Rechargeable battery manufacturer A purchases more than 1,000 components and raw materials to manufacture various competitive products. Instead of collecting data from all suppliers and allocating emissions among each of the 1,000 individual products, Company A classifies the purchased goods into Group 1 or Group 2 based on the type of data available (mass or expenditure data) for each product.

  [Group 1] Raw materials for battery cells: Mass data (average value)
  [Group 2] Raw materials for pole plates of batteries: Expenditure data

- Company A calculated the final values by extrapolating the primary data collected through its IT system to derive the purchase quantities (kg) for Group 1 products. It calculated the expenditure data of Group 2 using its enterprise resource planning system.

- Company A applied a process-based cradle-to-gate upstream emission factor to Group 1 and an environmentally extended input-output (EEIO)-based upstream emission factor to Group 2. The collected data is summarized as follows:

[Group 1] Purchased item	Purchased quantity (kg)	Emission factor ($kgCO_2e$/kg)
Cathode	400	20
Anode	200	5
Separator	500	3
Electrolyte	100	8
[Group 2] Purchased item	**Purchase cost (KRW)**	**Emission factor ($kgCO_2e$/KRW)**
Cathode active material	7,000,000	0.25
Anode active material	7,000,000	0.1
Conductive additive	250,000	0.4
Binder	980,000	0.8

- Therefore, the total emissions of the goods purchased by Company A using average-data and spend-based methods may be calculated as follows:

Σ((quantities of goods purchased (kg) × purchase cost (KRW)) × (emission factor per purchased product ($kgCO_2e$/kg or $kgCO_2e$/KRW))
= Σ((quantities of good purchased (kg) × (emission factor per purchased product ($kgCO_2e$/kg)) + Σ((purchase cost (KRW)) × (emission factor per purchased product ($kgCO_2e$/KRW))

= (400 × 20) + (200 × 5) + (500 × 3) + (100 × 8)
+ (7,000,000 × 0.25) + (7,000,000 × 0.1) + (250,000 × 0.4) + (980,000 × 0.8)
= 3,345,300 $kgCO_2e$

4. Matters to Be Considered on Application

(Calculation complement) If the reporting entity cannot acquire primary data-based upstream emissions from its nth suppliers, it should complement the final emission calculation by using secondary data to apply the average-data or spend-based methods.

(Definition distinction) Emissions from capital goods should be reported as part of category 2 (capital goods) rather than category 1 (purchased goods and services). Capital goods are final goods that are not immediately consumed or further processed by the reporting entity and, instead, are used in their current form by the reporting entity to manufacture products, provide services, or sell, store, and deliver products. Intermediate goods are production inputs that require further processing, transformation, or inclusion in other goods or services before use by the end customer, in which case they should be analyzed as part of category 1.

02 Category 2 (Capital Goods)

1. Definition

Category 2 includes all upstream (cradle-to-gate) emissions from the production of capital goods purchased or acquired by the reporting entity in the reporting year. Capital goods refer to long-lived final products used by the company to manufacture products, provide services, or sell, store, and deliver products. In financial accounting, capital goods are treated as fixed assets (property, plant, and equipment). Examples of capital goods include equipment, machinery, buildings, facilities, and vehicles. However, emissions from the use of capital goods by the reporting entity, rather than upstream emissions, are accounted for under scope 1 and 2, not scope 3.

2. Calculation Methodology

The calculation methodology is the same for category 1 (purchased goods and services) and category 2 (capital goods). For guidance on calculating category 2 emissions, see the guidance in section 1.2 regarding category 1.

3. Calculation Examples by Methodology

The calculation examples by methodology are the same for category 1 (purchased goods and services) and category 2 (capital goods). For guidance on calculating category 2 emissions, see the guidance in section 1.3 regarding category 1.

4. Matters to Be Considered on Application

(Definition distinction) In some cases, it may be ambiguous whether certain purchased goods fall under capital goods (reported in category 2) or purchased goods or services (reported in category 1). The reporting entity should follow its own financial accounting procedures to determine whether to account for these goods as capital goods or as purchased goods or services. It should avoid double-counting emissions under both category 1 and category 2.

(Additional reporting) The reporting entity should clarify that the emissions from capital goods may fluctuate from year to year. Unlike in financial accounting, where assets typically depreciate over their lifetime, scope 3 requires that emissions from the production of capital goods be reported in the year of acquisition, without depreciation, discounting, or spreading them across future years. If major capital investments occur irregularly (e.g., once every few years), the reporting entity should acknowledge that the emissions from capital goods may be highly volatile from year to year and explain relevant matters. Because investments in facility infrastructure, such as the establishment or expansion of factories, are implemented proactively in the rechargeable battery industry, the reporting entity should report emissions from capital goods with in-depth consideration of their emissions in the reporting year as well as potential year-to-year volatility.

03 Category 3
(Fuel- and Energy-Related Activities Not Included in Scope 1 or Scope 2)

1. Definition

Category 3 includes emissions related to the production of fuels and energy that are purchased and consumed by the reporting entity in the reporting year and that are not included in scope 1 or scope 2. Depending on the entity's activities, they are categorized into four types: upstream emissions of purchased fuels, upstream emissions of purchased electricity, transmission and distribution (T&D) losses, and the generation of purchased electricity that is sold to end users. The emissions from all activities pertinent to the reporting entity are summed to calculate its scope 3 emissions in category 3.

- Among fuel- and energy-related emission activities, the category includes the following four types:

1) Upstream emissions of purchased fuels (activity A)
- Emissions from extraction, production, and transportation of fuels consumed by the reporting entity
- Applicable to the end users of fuels (e.g., mining of coal, refining of gasoline, transmission and distribution of natural gas, or production of biofuels)

2) Upstream emissions of purchased electricity (activity B)
- Emissions from the extraction, production, and transportation of fuels consumed to generate electricity, steam, heating, and cooling that are consumed by the reporting entity
- Applicable to the end users of electricity, steam, heating, and cooling (e.g., mining of coal, refining of fuels, or extraction of natural gas)

3) T&D losses (activity C)
- Emissions from the generation (upstream activities and combustion) of electricity, steam, heating, and cooling lost in a T&D system and reported by end users
- Applicable to the end users of electricity, steam, heating, and cooling

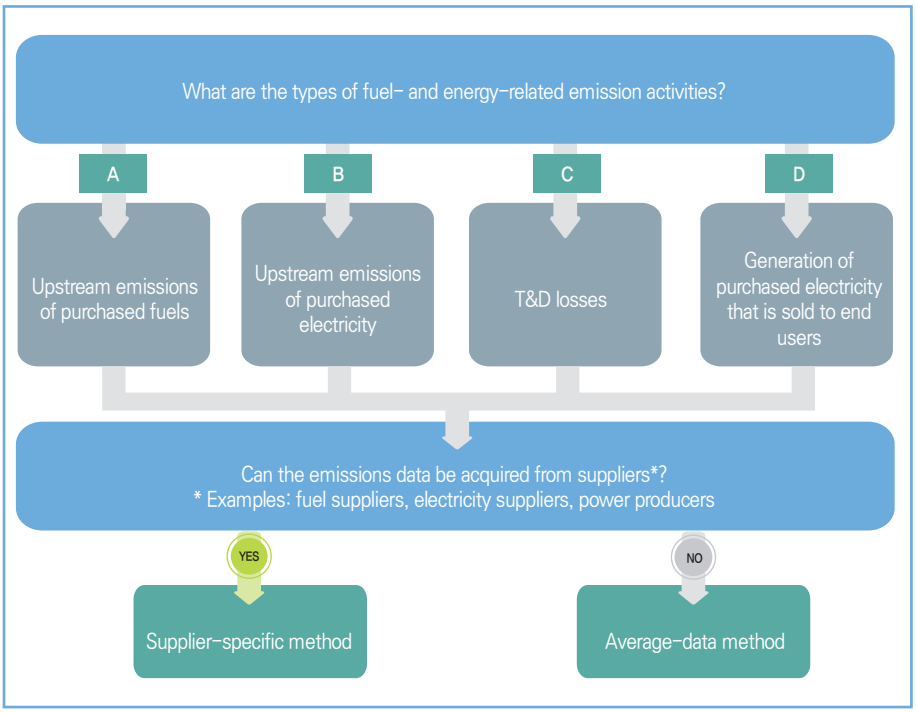
4) Generation of purchased electricity that is sold to end users (activity D)

- Emissions from the production (upstream activities and combustion) of electricity, steam, heating, and cooling that are purchased by the reporting entity and sold to end users, and reported by utility companies or energy retailers
- Includes activities especially relevant for utility companies that purchase wholesale electricity supplied by independent power producers for resale to their customers

2. Calculation Methodology

Two methods may be used to calculate the emissions from category 3 (Fuel- and Energy-Related Activities Not Included in Scope 1 or Scope 2): the supplier-specific and average-data methods. Although the methodology is the same, the calculation formulas vary for each activity type (A, B, C, and D). The applicable method may vary depending on the level of data available to the reporting entity. The method may be determined as shown in the following diagram.

1) Decision tree



2) Calculation formulas and descriptions

Classification	Calculation formula			Description
Activity A	Σ((fuel consumed) × (upstream fuel emission factor)) (upstream emission factor = (life-cycle emission factor)-(fuel-combustion emission factor))	a	Supplier-specific method	Collect upstream data from fuel suppliers regarding the fuels consumed by the reporting entity to estimate emissions. (Since emissions from fuel combustion fall under scope 1, the life-cycle emission factors excluding them are applied.)
		b	Average-data method	Apply secondary emission factors (e.g., industry-average data) for upstream emissions per unit of the reporting entity's fuel consumption to estimate emissions.
Activity B	Σ((electricity, steam, heating, or cooling consumed) × (upstream electricity, steam, heating, or cooling emission factor)) (upstream emission factor = (life-cycle emission factor) – ((fuel combustion + T&D) emission factor))	a	Supplier-specific method	Collect upstream data from electricity suppliers regarding the electricity consumed by the reporting entity to estimate emissions. (T&D losses should be excluded from the upstream emission factor only if they have already been included in the life-cycle emission factor. Additionally, because emissions from fuel combustion fall under scope 2, life-cycle emission factors excluding them are applied.)
		b	Average-data method	Apply secondary emission factors (e.g., industry average) for upstream emissions per unit of the reporting entity's electricity consumption to estimate emissions.
Activity C	(activity B calculation formula) × (T&D loss rate) (includes fuel combustion emissions)	a	Supplier-specific method	Collect T&D loss rate data from electricity suppliers for the reporting entity's grid consumption to estimate emissions. (Utility companies that own T&D systems report these as scope 1 and scope 2 emissions.)
		b	Average-data method	Apply an average T&D loss rate (e.g., national, regional, or global average) to estimate emissions.
Activity D	Σ((electricity, steam, heating, or cooling purchased for resale) × (electricity, steam, heating, or cooling emission factor))	a	Supplier-specific method	Collect GHG emissions data from power producers that have generated the purchased electricity to estimate emissions.
		b	Average-data method	Apply the average grid emission rate to estimate emissions.

3. Calculation Examples by Methodology[22)]

a. Supplier-specific method & b. Average-data method (activities A-D)

- Company A, a rechargeable battery manufacturer, operates five corporations in five countries.
- Company A purchases electricity to operate its corporations and district heating in several of these countries.
- Company A collected primary data on all electricity purchased through its energy tracking system. It used an average-data method to collect the emission factors for the extraction, production, and transportation of fuels consumed to generate electricity and heating, for the combustion of electricity and heating, and for its T&D losses. Here, the upstream emission factor is the life-cycle emission factor that excludes fuel combustion and T&D emission factors. The primary data and emission factors are as follows:

Country	Primary data		Average data			
	Electricity purchased (kWh)	District heating purchased (kWh)	Upstream emission factor of purchased electricity ($kgCO_2e$/kWh)	Electricity/ heating combustion emission factor ($kgCO_2e$/kWh)	T&D loss rate (%)	Upstream emission factor of purchased heating ($kgCO_2e$/kWh)
Australia	500,000	N/A	0.12	0.8 (electricity)	10 (electricity)	N/A
Canada	600,000	50,000	0.10	0.4 (electricity) 0.15 (heating)	13 (electricity) 5 (heating)	0.05
India	400,000	N/A	0.15	0.8 (electricity)	15 (electricity)	N/A
USA	5,500,000	N/A	0.10	0.5 (electricity)	10 (electricity)	N/A
Türkiye	200,000	N/A	0.05	0.4 (electricity)	12 (electricity)	N/A

22) All activity data and emission factors are for illustrative purposes only and do not represent actual data.

– Therefore, based on the data collected, the total emissions for rechargeable battery manufacturer A from fuel- and energy-related activities not included in scope 1 or scope 2 are calculated as follows:

① Upstream emissions of purchased electricity (activity B)

= Σ (purchased electricity per country (kWh) × upstream emission factor of electricity purchased per country ($kgCO_2e$/kWh))
= (500,000 × 0.12) + (600,000 × 0.10) + (400,000 × 0.15) + (5,500,000 ×0.10) + (200,000 × 0.05)
= 740,000 $kgCO_2e$

② Life-cycle emissions from T&D losses of electricity/heating (activity C)

= Σ (purchased electricity or heating per country (kWh)) × upstream emission factor of electricity or heating purchased per country ($kgCO_2e$/kWh) × T&D loss rate (%))
= (500,000 × 0.8 × 0.1) + (600,000 × 0.4 × 0.13) + (50,000 × 0.15 × 0.05) + (400,000 × 0.8 × 0.15) + (5,500,000 × 0.5 × 0.1) + (200,000 × 0.4 × 0.12)
= 404,175 $kgCO_2e$

③ Upstream emissions of purchased heating (activity B)

= Σ (purchased heating per country (kWh) × upstream emission factor of heating purchased per country ($kgCO_2e$/kWh))
= 50,000 × 0.05
= 2,500 $kgCO_2e$

④ Sum of the above-mentioned values

740,000 + 404,175 + 2,500
= 1,146,675 $kgCO_2e$

4. Matters to Be Considered on Application

(Category distinction) The reporting entity should select transparent, disaggregated emission factors that allow separate accounting of emissions from electricity generation in scope 2 and non-generation activities related to electricity in scope 3.

(Data collection) To avoid double-counting emissions, the reporting entity should review whether T&D losses are already accounted for in the electricity-related emission factors it might use. The process endpoints regarding electricity-related emission factors may vary depending on the calculation entity's location and jurisdiction (e.g., overseas operations). For example, in Korea, the LCI DB defines the technical scope of electricity generation as a cradle-to-gate process, that is, from the acquisition of raw materials to product manufacturing. Therefore, the reporting entity should verify the definitions of relevant emission factors to ensure accuracy.

04 Category 4 (Upstream Transportation and Distribution)

1. Definition

Category 4 includes emissions from the transportation and distribution of products purchased or acquired by the reporting entity in the reporting year. It refers to transportation activities that use vehicles and facilities not owned or operated by the reporting entity and third-party transportation and distribution services purchased by the reporting entity ([Reference 1]). It includes scope 1 and scope 2 emissions from third-party transportation and distribution service providers.

[Reference 1]

Examples of emissions from upstream transportation and distribution activities

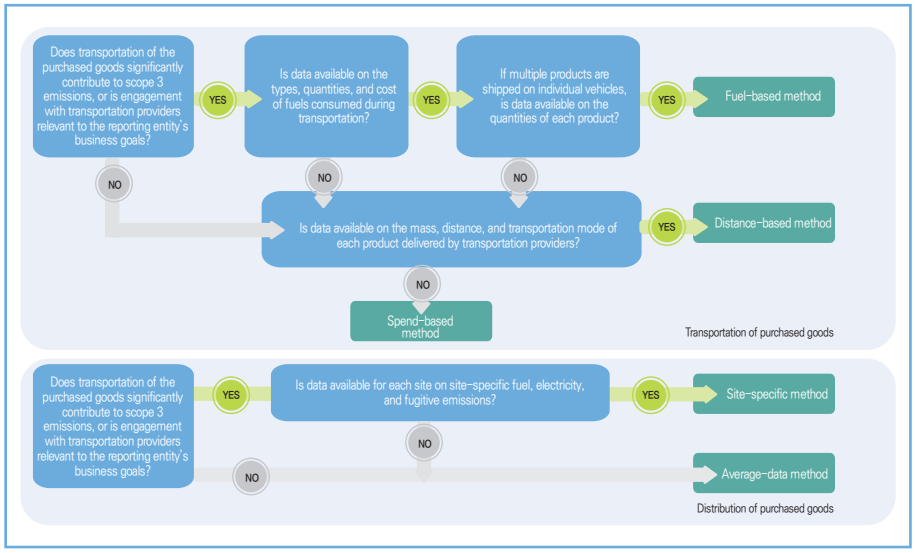
- Transportation and distribution between tier 1 suppliers and their own operations (e.g., air, rail, road, or marine transport)
- Third-party transportation and distribution among the reporting entity's own facilities (e.g., air, rail, road, or marine transport)
- Storage of purchased products in warehouses, distribution centers, and retail facilities

Logistically, transportation and distribution activities to sell the reporting entity's products generate downstream emissions, but they should be classified as upstream transportation and distribution emission activities if the reporting entity has purchased this service.

2. Calculation Methodology

Category 4 (upstream transportation and distribution) emissions are categorized into upstream transportation and upstream distribution, depending on the reporting entity's activities. Three methods (the fuel-based, distance-based, and spend-based methods) may be used to calculate emissions from upstream transportation, while two methods (the supplier-specific and average-data methods) may be used to calculate emissions from upstream distribution. The applicable method may vary depending on the level of data available to the reporting entity. They may be determined as shown in the following diagram.

1) Decision tree



2) Calculation formulas and descriptions

Classification			Calculation formula	Description
Transportation	a	Fuel-based method	Σ((quantity of fuel consumed) × (fuel emission factor)) + Σ((quantity of electricity consumed) × (electrical grid emission factor)) + Σ((quantity of refrigerant leakage) × (refrigerant emission factor)) (optional) + Σ((quantity of fuel consumed from unladen vehicle) × (emission factor for fuel)) ((quantity of fuel consumed from unladen vehicle) = (average efficiency of unladen vehicle) × (total distance traveled by unladen vehicle))	Determine the amount of fuel consumed (i.e. scope 1 and scope 2 emissions of transportation providers) and apply the fuel type's appropriate emission factor to calculate emissions. Additional energy consumption and fugitive emissions are also considered. The reporting entity may optionally include emissions from unladen backhaul. However, if the vehicle is not dedicated solely to transporting products purchased by the reporting entity, the reporting entity's emissions may be estimated by extrapolating only a portion of the total emissions with a reasonable method. If fuel data is not available, they may be supplemented by fuel expenditures or distance traveled ([Reference 2]).
	b	Distance-based method	Σ((mass of goods purchased) × (distance traveled by vehicle type in transport steps) × (emission factor of transport mode or vehicle type))	Determine the mass, distance, transport modes, and vehicle types, and apply the appropriate emission factor for the transport mode or vehicle type (the reporting entity's average fuel consumption, average utilization rate, average size, mass, or volume of products and vehicles, and their associated GHG emissions) to calculate emissions ([Reference 3]).
	c	Spend-based method	Σ((amount spent on transportation by type) × (EEIO emission factors per unit of economic value))	Determine the amount spent for each transport mode or vehicle type and apply the relevant EEIO emission factors to calculate emissions.
Distribution	d	Site-specific method	Σ((quantity of fuel consumed) × (fuel emission factor)) + Σ((quantity of electricity consumed) × (electrical grid emission factor)) + Σ((quantity of refrigerant leakage) × (refrigerant emission factor)) (Emissions are allocated based on the volume that the reporting entity's products occupy within storage facilities, and then the allocations across all storage facilities are summed.)	Collect fuel and energy data for each storage facility (e.g., warehouses, distribution centers) according to their specific distribution activities, and apply the appropriate emission factor to calculate emissions. However, if any storage facilities are not dedicated solely to storing the reporting entity's products, the reporting entity's emissions may be estimated by extrapolating only a portion of the total emissions with a reasonable method.
	e	Average-data method	Σ((volume of stored products) × (average number of days stored) × (emission factor for storage facility))	Estimate activity-specific emissions based on the average data (e.g., average emissions per warehousing capacity) for each distribution activity.

[Reference 2]

Fuel data estimation methods when fuel data are not available

- If fuel data is not available but the reporting entity wants to calculate emissions using the fuel-based method, the final emission calculation may be supplemented using the following formulas.
- Calculating the quantity of fuel consumed from fuel expenditure: sum by fuel type, Σ(total fuel expenditure (e.g., KRW) / average fuel price (e.g., KRW/liter))
- Calculating the quantity of fuel consumed from distance traveled: sum across transport steps, Σ(total distance traveled (e.g., km) × fuel efficiency of vehicle (e.g., liter/km)

[Reference 3]

Emission factors in the distance-based method

- For the distance-based method, the emission factors are typically indicated as gram or kilogram of CO_2e per tonne-km or TEU-km of products transported
- Tonne-km: a measurement unit representing 1 tonne of products traveling one kilometer
- TEU[23]-km: a measurement unit representing one 20-foot container of products traveling 1 kilometer

3. Calculation Examples by Methodology[24]

a. Fuel-based method (Transportation)

- Company A, a rechargeable battery manufacturer, is supplied with batteries from production entities B, C, and D. The batteries are transported by a freight transportation service provider.
- To calculate emissions from the upstream transportation of the produced batteries, for each production entity, Company A collected the following activity data and emission factors for the fuel consumed, as well as for refrigerant leakage during battery transportation from the freight transportation service provider.

Entity	Quantity of fuel consumed (liter, kWh for electric vehicles, or mass of refrigerant leakage (kg))	Fuel/refrigerant type	Emission factor ($kgCO_2e$/liter for fuels, $kgCO_2e$/kWh for electricity, $kgCO_2e$/kg for refrigerants)
B	3,000	Electric vehicle	0.7
C	80,000	Diesel	3
D	90,000	Diesel	3
D	50	Refrigerant R410a	2,000

23) Twenty-foot equivalent unit: A unit based on the size of a 20-foot standard container that is used to compare capacity between transport modes.

24) All activity data and emission factors are for illustrative purposes only and do not represent actual data.

– Therefore, using the fuel-based method, the emissions from the upstream transportation of batteries for rechargeable battery manufacturer A are calculated as follows:

① Sum across fuel types:
Σ (quantity of fuel consumed (liters) × emission factor for the fuel ($kgCO_2e$/liter))

= (quantity of diesel consumed × emission factor for diesel)
= (80,000 + 90,000) × 3
= 510,000 $kgCO_2e$

② Sum across electrical grid regions:
Σ (quantity of electricity consumed (kWh) × emission factor for the electrical grid ($kgCO_2e$/kWh))

= 3,000 × 0.7
= 2,100 $kgCO_2e$

③ Sum across refrigerant and air-conditioning types:
Σ (quantity of refrigerant leakage (kg) × GWP of the refrigerant ($kgCO_2e$/kg))

= 50 × 2,000
= 100,000 $kgCO_2e$

④ Sum of the above-mentioned values

510,000 + 2,100 + 100,000
= 612,100 $kgCO_2e$

b. Distance-based method (Transportation)

– Company A, a rechargeable battery manufacturer, is supplied with basic goods from its suppliers B, C, and D.

– Company A calculated the total distance traveled for the transportation of the basic goods and collected information on the vehicle type from its suppliers. In addition, Company A collected relevant emission factors from its life-cycle database. The activity data and emissions factors collected are as follows:

Supplier	Mass of products transported (tonnes)	Distance traveled (km)	Transport mode or vehicle type	Emission factor ($kgCO_2e$/tonne-km)
B	2	2,000	Truck (rigid, 〉3.5-7.5 tons)	0.2
C	1	3,000	Air (long haul)	1
D	6	4,000	Container 2,000- 2,999 TEU	0.05

– Therefore, using the distance-based method, the emissions from the upstream transportation of basic goods for rechargeable battery manufacturer A are calculated as follows:

① Emissions from road transport

= Σ(mass of purchased goods (tonnes) × distance traveled in road transport (km) × vehicle-specific emission factor ($kgCO_2e$/tonne-km))
= 2 × 2,000 × 0.2
= 800 $kgCO_2e$

② Emissions from air transport

= Σ(mass of purchased goods (tonnes)) × distance traveled in air transport (km) × vehicle-specific emission factor ($kgCO_2e$/tonne-km))
= 1 × 3,000 × 1.0
= 3,000 $kgCO_2e$

③ Emissions from marine transport

= Σ(mass of purchased goods (tonnes) × (distance traveled in marine transport (km) × vehicle-specific emission factor ($kgCO_2e$/tonne-km))
= 6 × 4,000 × 0.05
= 1,200 $kgCO_2e$

④ Sum of the abovementioned values

emissions from road transport + emissions from air transport + emissions from marine transport
= 800 + 3,000 + 1,200
= 5,000 $kgCO_2e$

c. Spend-based method (Transportation)

– Company A, an electrolyte manufacturer, produces electrolytes in China and is supplied with raw materials from suppliers B, C, and D.

– To calculate emissions from the upstream transportation of the produced electrolyte, Company A collected information from its internal financial accounting system regarding the total amount spent on raw material transportation and the types of vehicles used by its suppliers. In addition, Company A collected relevant emission factors through the relevant EEIO databases ([Reference 4]). The activity data and emission factors collected are as follows:

Supplier	Expenditure (USD)	Transport mode or vehicle type	EEIO emission factor ($kgCO_2e$/USD)
B	20,000	Truck (rigid, 〉3.5–7.5 tonnes)	0.04
C	30,000	Air (long haul)	0.15
D	40,000	Container 2,000– 2,999 TEU	0.05

– Therefore, using the spend-based method, emissions from the upstream transportation of electrolytes for electrolyte manufacturer A are calculated as follows:

① Emissions from road transport

= Σ (amount spent on road transport leg (USD) × EEIO emission factor of transport mode or vehicle type ($kgCO_2e$/USD))
= 20,000 × 0.04
= 800 $kgCO_2e$

② Emissions from air transport

= Σ (amount spent on air transport leg (USD) × EEIO emission factor of transport mode or aircraft type ($kgCO_2e$/USD))
= 30,000 × 0.15
= 4,500 $kgCO_2e$

③ Emissions from marine transport

= Σ (amount spent on marine transport leg (USD) × EEIO emission factor of transport mode or vessel type ($kgCO_2e$/USD))
= 40,000 × 0.05
= 2,000 $kgCO_2e$

④ Sum of the abovementioned values

emissions from road transport + emissions from air transport + emissions from marine transport
= 800 + 4,500 + 2,000
= 7,300 $kgCO_2e$

[Reference 4]

EEIO model

- EEIO models estimate energy consumption and GHG emissions resulting from the production and upstream supply-chain activities of various sectors and products within an economy. EEIO models are derived by allocating national GHG emissions to groups of finished products based on the economic flow between industry sectors.
- The derived EEIO emission factors can be used to estimate GHG emissions for a specific industry or product category.
- EEIO data are particularly useful in screening emission sources to be prioritized for data collection.

d. Site-specific method (Distribution)

- Company A, a rechargeable battery manufacturer, places its rechargeable batteries produced for sale in two US-based distribution centers for short-term storage (one month) before distributing them to customers in the US with whom it has pre-arranged supply contracts.
- Company A collected data from its distribution center suppliers regarding fuel and electricity consumption for the reporting year, as well as the total capacity (e.g., volume) of the distribution facilities used to store its products. In addition, Company A collected relevant emission factors from the relevant databases. The activity data and emissions factors collected are as follows:

Distribution center	Electricity consumed (kWh)	Electricity emission factor ($kgCO_2e/kWh$)	Natural gas consumed (kg)	Natural gas emission factor ($kgCO_2e/kg$)	Total volume of Company A's goods in storage (m^3)	Total volume of goods stored in distribution centers (m^3)
X	10,000	0.8	1,000	0.25	100	400
Y	15,000	0.8	2,000	0.25	200	800

- Therefore, using the site-specific method, emissions from the upstream distribution of batteries for rechargeable battery manufacturer A are calculated as follows:

① Emissions from distribution center X

= ((fuel consumed (kg) × fuel emission factor ($kgCO_2e/kg$)) + (electricity consumed (kWh) × electricity emission factor ($kgCO_2e/kWh$))) × (total volume of Company A's products in storage (m^3) / total volume of products stored in distribution centers (m^3)) × 1 month/12 months
= ((10,000 × 0.8) + (1,000 × 0.25)) × (100/400) × (1/12)
= 171.875 $kgCO_2e$

② Emissions from distribution center Y

= ((fuel consumed (kg) × fuel emission factor ($kgCO_2e/kg$)) + (electricity consumed (kWh) × electricity emission factor ($kgCO_2e/kWh$))) × (total volume of Company A's products in storage (m^3) / total volume of products stored in distribution centers (m^3)) × 1 month/12 months
= ((15,000 × 0.8) + (2,000 × 0.25)) × (200 / 800) × (1/12)
= 260.4166667 $kgCO_2e$

③ Sum of the above-mentioned values

emissions from distribution center X + emissions from distribution center Y
= 171.875 + 260.4166667
= 432.2916667 $kgCO_2e$

e. Average-data method (Distribution)

- Company A, a rechargeable battery manufacturer, stores the rechargeable batteries it produces in two distribution centers with short-term leases and distributes them to its sales entities.
- Company A collected data on the total capacity (e.g., volume) of the distribution centers from their lease contracts and average storage days of goods from its internal system. In addition, Company A collected the average emission factors regarding the warehousing capacity of the distribution centers from research papers. The activity data and emissions factors collected are as follows:

Distribution centers	Total volume of stored goods (m^3)	Average days stored (days)	Emission factors of distribution centers ($kgCO_2e/m^3/day$)
X	4,000	2	0.01
Y	4,000	2	0.02

- Therefore, using the average-data method, the emissions from the upstream distribution of batteries for rechargeable battery manufacturer A are calculated as follows:

Emissions from upstream distribution

= Σ (volume of stored goods (m^3) × number of days stored (days) × emission factor of distribution facility ($kgCO_2e/m^3/day$))
= (4,000 × 2 × 0.01) + (4,000 × 2 × 0.02)
= 80 + 160
= 240 $kgCO_2e$

4. Matters to Be Considered on Application

(Definition distinction) The reporting entity should calculate emissions for certain transportation and distribution activities by clearly separating them into upstream (category 4) and downstream (category 9) activities. All inbound and outbound transportation and distribution[25] services purchased by the reporting entity are upstream activities, whereas outbound transportation and distribution services not purchased by the reporting entity are downstream activities. Therefore, the reporting entity should establish accurate definitions of upstream and downstream transportation and distribution activities and manage the relevant data internally.

25) Since the service was purchased to support outbound logistics, it is classified and calculated as upstream even though it is an outbound T&D activity.

05 Category 5 (Waste Generated in Operations)

1. Definition

Category 5 includes emissions from the third-party disposal and treatment of waste that is generated in the operations owned or controlled by the reporting company in the reporting year ([Reference 1]). It includes all future emissions that are expected to occur due to waste generated in the reporting year. These can be derived from scope 1 and scope 2 emissions of third-party waste treatment providers not owned or operated by the reporting entity.

[Reference 1]

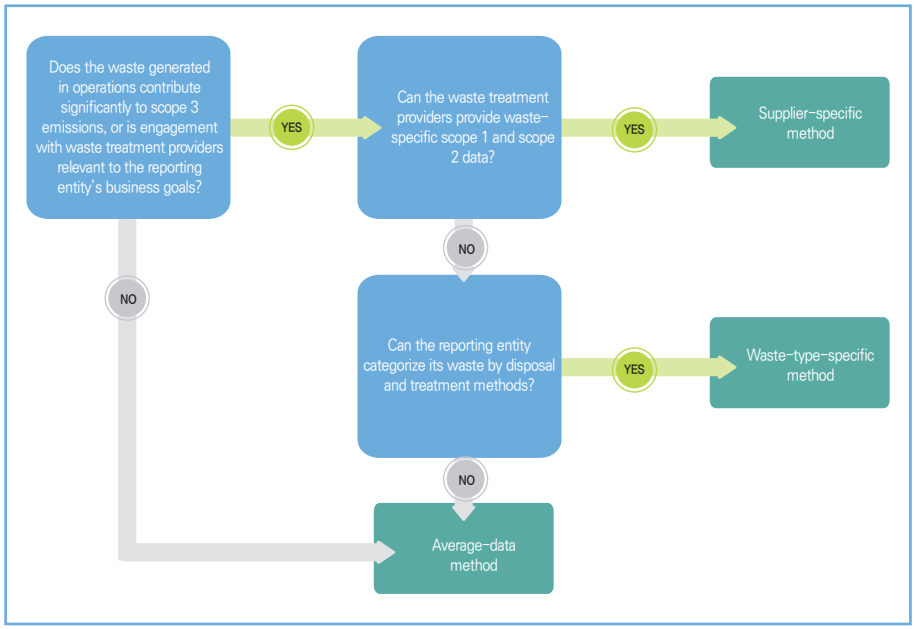
Examples of waste disposal and treatment activities

- Landfill
- Recovery for recycling
- Composting
- WtE to generate electricity
- (Optional) Emissions from the transportation of waste

2. Calculation Methodology

Three methods may be used to calculate emissions from category 5 (waste generated in operations): the supplier-specific, waste-type - specific, and average-data methods. The applicable method may vary depending on the level of data available to the reporting entity. They may be determined as shown in the following diagram.

1) Decision tree



2) Calculation formulas and descriptions

Classification		Calculation formula	Description
a	Supplier-specific method	Σ ((scope 1 emissions from a waste treatment provider for waste allocated to the reporting entity) + (scope 2 emissions from a waste treatment provider for waste allocated to the reporting entity))	Collect scope 1 and scope 2 emission data of the waste treatment provider for waste allocated to the reporting entity, and sum the emissions from all waste treatment methods of the reporting entity.
b	Waste-type-specific method	Σ ((mass of waste generated) × (emission factor for waste type and treatment method))	Estimate emissions by distinguishing among waste types and waste disposal methods and applying waste type-specific and waste treatment-specific emission factor. Emissions from the transportation of waste may be included in the emission factors.
c	Average-data method	Σ ((total mass of waste) × (proportion of waste by treatment method (%)) × (emission factor by treatment method))	Estimate emissions based on the mass of waste generated, the proportion of waste by each treatment method, and the average emission factor.

3. Calculation Examples by Methodology[26)]

a. Supplier-specific method

- Company A, a rechargeable battery manufacturer, works with two waste treatment providers B and C to dispose of waste generated at its production entities in Korea and the US, respectively.
- The waste treatment providers measure their GHG emissions. Company A collected scope 1 and scope 2 emissions from providers B and C for waste allocated to Company A in the reporting year. The collected emission data are as follows:

Entity	Location	Allocated scope 1 emissions ($kgCO_2e$)	Allocated scope 2 emissions ($kgCO_2e$)
B	Korea	4,000	5,600
C	USA	12,000	13,200

- Therefore, using the supplier-specific method, the total emissions from waste generated amid rechargeable battery manufacturer A's operations in the reporting year are calculated as follows:

Σ (scope 1 emissions from waste treatment providers for waste allocated to the reporting entity ($kgCO_2e$) + scope 2 emissions from waste treatment providers for waste allocated to the reporting entity ($kgCO_2e$))

= (4,000 + 12,000) + (5,600 + 13,200)
= 34,800 $kgCO_2e$

b. Waste-type-specific method

- Company A, a rechargeable battery manufacturer, generates various types of waste during the process of manufacturing rechargeable batteries. Through its waste management system, it investigated the types of waste, the mass of the generated waste by type, waste treatment methods, and each type's emission factors as follows.

Waste type	Waste generated	Waste treatment method	Emission factor by waste type and treatment method
Plastic	2,000 t	Landfill	40 $kgCO_2e/t$
Plastic	5,000 t	Incineration with energy recovery	2 $kgCO_2e/t$
Waste liquid from lithium	4,000 m^3	Recycling	10 $kgCO_2e/m^3$
Steel scrap	5,000 t	Recycling	0.5 $kgCO_2e/t$
Iron scrap	1,000 t	Recycling	1.25 $kgCO_2e/t$

26) All activity data and emission factors are for illustrative purposes only and do not represent actual data.

– Therefore, using the waste-type-specific method, the total emissions from waste generated amid rechargeable battery manufacturer A's operations in the reporting year are calculated as follows:

Σ (mass of waste generated (tonne or m^3) × emission factor by waste type and treatment method ($kgCO_2e$/tonne or m^3))

= (2,000 × 40) + (5,000 × 2) + (4,000 × 10) + (5,000 × 0.5) + (1,000 × 1.25)
= 133,750 $kgCO_2e$

c. Average-data method

– Company A, a rechargeable battery manufacturer, generates a large amount of waste during the process of manufacturing rechargeable batteries. It investigated data on the average waste type and average treatment proportion by type from a national public data system, as well as the emission factors by waste treatment method from a national inventory, as follows.

Total waste generated (tonnes)	Waste treatment method	Proportion (%)	Emission factor by treatment method ($kgCO_2e$/tonne)
40	Landfill	35	300
	Incineration with energy recovery	5	0
	Recycling	60	10

– Therefore, using the average-data method, the total emissions from the waste generated amid rechargeable battery manufacturer A's operations in the reporting year are calculated as follows:

Σ (total mass of waste (tonnes) × proportion of waste by treatment method (%) × emission factor by treatment method ($kgCO_2e$/tonne))

= (40 × 0.35 × 300) + (40 × 0.05 × 0) + (40 × 0.6 × 10)
= 4,440 $kgCO_2e$

4. Matters to Be Considered on Application

(Category distinction) As it is anticipated that more rechargeable battery manufacturers will integrate battery disposal and recycling companies as subsidiaries, the reporting entity should separate the emissions from battery disposal and recycling companies according to their type or the organizational boundaries and report these emissions without double counting or omissions. In other words, the reporting entity's scope 3 emissions should only include scope 1 and scope 2 emissions from the disposal and treatment of waste at facilities owned or operated by third parties, while emissions from disposal at facilities owned or controlled by the reporting entity should be reported under its scope 1 or scope 2, respectively.

06 Category 6 (Business Travel)

1. Definition

Category 6 includes emissions from the movement of employees for the reporting entity's business-related activities (hereinafter referred to as "business travel") in vehicles (e.g., airplanes, trains, buses, or automobiles) that are owned or operated by third parties ([Reference 1]). It includes scope 1 and scope 2 emissions from companies that provide transportation for business travel (e.g., airlines or national railroads). However, this category excludes emissions from business travel that uses vehicles owned or operated by the reporting entity.

[Reference 1]

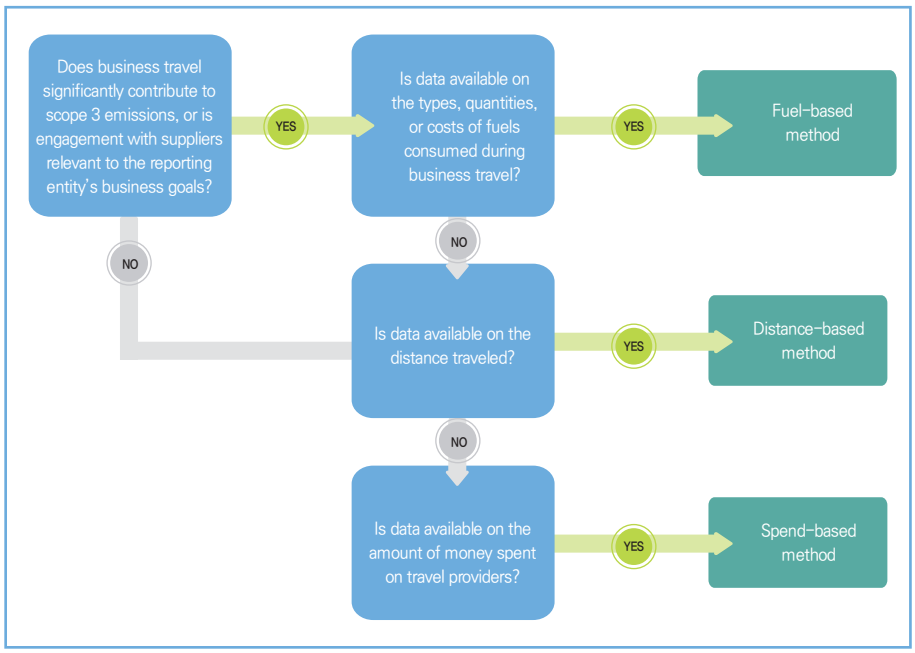
Examples of business travel emissions

- Air travel
- Rail travel
- Bus travel
- Automobile travel
  (e.g., business travel in rental cars or employee-owned vehicles)
- (Optional) Business travelers' hotel stays

2. Calculation Methodology

Three methods may be used to calculate emissions from category 6 (business travel): the fuel-based, distance-based, and spend-based methods. The applicable method may vary depending on the level of data available to the reporting entity. They may be determined as shown in the following diagram.

1) Decision tree



2) Calculation formulas and descriptions

Classification		Calculation formula	Description
a	Fuel-based method	Σ((quantity of fuel consumed) × (fuel emission factor)) + Σ((quantity of electricity consumed) × (electrical grid emission factor)) + Σ((quantity of refrigerant leakage) × (refrigerant emission factor))	Determine the quantities of fuels consumed during business travel and apply the appropriate emission factor for each fuel. This means the scope 1 and scope 2 emissions of the transportation providers. If fuel data is not available, the quantities of fuel consumed can be estimated from the fuel expenditures or distance traveled ([Reference 2]).
b	Distance-based method	Σ((distance traveled by vehicle type) × (vehicle-specific emission factor))	Determine the distance and vehicle type, and apply the appropriate emission factor for the vehicle. Calculate emissions based on the distance traveled and the transport mode.
c	Spend-based method	Σ((amount spent on transportation by type) × (EEIO emission factors per unit of economic value))	Determine the amount spent for each transport mode or vehicle type, and apply the relevant EEIO emission factors. Calculate emissions based on the type of business travel or the amount spent on each type of transportation.

[Reference 2]

Fuel data estimation methods when fuel data are not available

- If fuel data is not available but the reporting entity wants to calculate emissions using the fuel-based method, the final emission calculation can be supplemented using the following formulas.
- Calculating the quantity of fuel consumed from fuel expenditure: sum by fuel type, Σ(total fuel expenditure (e.g., USD) / average fuel price (e.g., USD/liter))
- Calculating the quantity of fuel consumed from the distance traveled: sum by transport steps, Σ(total distance traveled (e.g., km) × fuel efficiency of the vehicle (e.g., liter/km)

3. Calculation Examples by Methodology[27)]

a. Fuel-based method

The calculation methodology is the same as for category 4 (upstream transportation and distribution). For guidance on calculating emissions using the fuel-based method, see the guidance in section 4.3.a (fuel-based method) regarding category 4.

b. Distance-based method

- Every year, Company A, a rechargeable battery manufacturer, sends groups of experts to industry conferences in the UK (Group 1), Australia (Group 2), and the US (Group 3).
- To calculate emissions from business travel, Company A collected activity data on the distance traveled and the vehicle type from employee surveys, travel agencies, and transportation companies (rental car agencies) as follows. It is assumed that each member of the group who traveled to the same country incurred the same amount of business travel activities.

Group	Number of employees	Location	Car type	Average employees per vehicle	Distance (km)	Emission factor per vehicle type ($kmCO_2e$/vehicle-km)
Group 1	10	UK	Hybrid	2	50	1
Group 2	20	Australia	Gasoline vehicle	2	200	2
Group 3	100	USA	Four-wheel-drive vehicle	3	100	4

Group	Flight type	Distance (km)	Emission factor of aircraft ($kmCO_2e$/passenger-km)
Group 1	Short haul (flights less than 3 hours in length)	10,000	5
Group 2	Medium haul (flights 3 to 6 hours in length)	15,000	6
Group 3	Long haul (journeys with wide-bodied aircraft that fly long distances, typically more than 6.5 hours)	12,000	5

- Therefore, using the distance-based method, the total emissions from rechargeable battery manufacturer A's business travel in the reporting year are calculated as follows:

① Emissions from road travel

= Σ (distance traveled by vehicle type (vehicle-km or passenger-km) × vehicle-specific emission factor ($kgCO_2e$/vehicle-km or $kgCO_2e$/passenger-km))
= (10/2 × 50 × 1) + (20/2 × 200 × 2) + (100/3 × 100 × 4)
= 17,583.33 $kgCO_2e$

27) All activity data and emission factors are for illustrative purposes only and do not represent actual data.

② Emissions from air travel

= Σ (distance traveled by aircraft type (aircraft-km or passenger-km)
× aircraft-specific emission factor ($kgCO_2e$/aircraft-km or $kgCO_2e$/passenger-km))
= (10 × 10,000 × 5) + (20 × 15,000 × 6) + (100 × 12,000 × 5)
= 8,300,000 $kgCO_2e$

③ Sum of the above-mentioned values

17,583.33 + 8,300,000
= 8,317,583.33 $kgCO_2e$

c. Spend-based method

The calculation methodology is the same as for category 4 (upstream transportation and distribution), but some activity data capture the amount spent by type and mode of business travel. For guidance on calculating emissions using the spend-based method, see the guidance in section 4.3.c (spend-based method) regarding category 4.

4. Matters to Be Considered on Application

(Data collection) Depending on the destination of the business travel, transport emission factors vary, and the transport mode may have a significant impact on emissions. Therefore, when using the distance-based method, the reporting entity should collect detailed activity data, including the actual countries visited and the transport mode, and reflect it in the final calculation to improve the calculation's accuracy.

07 Category 7 (Employee Commuting)

1. Definition

Category 7 includes emissions from the commuting activities of employees between their homes and workplaces using transportation not owned or operated by the reporting entity ([Reference 1]). It includes scope 1 and scope 2 emissions from employees ([Reference 2]) and third-party transportation providers.

[Reference 1]

Examples of commuting emissions	• Automobile travel • Bus travel • Rail travel • Air travel • Other modes of transportation (e.g., subway, bicycle, walking) • (Optional) teleworking of employees

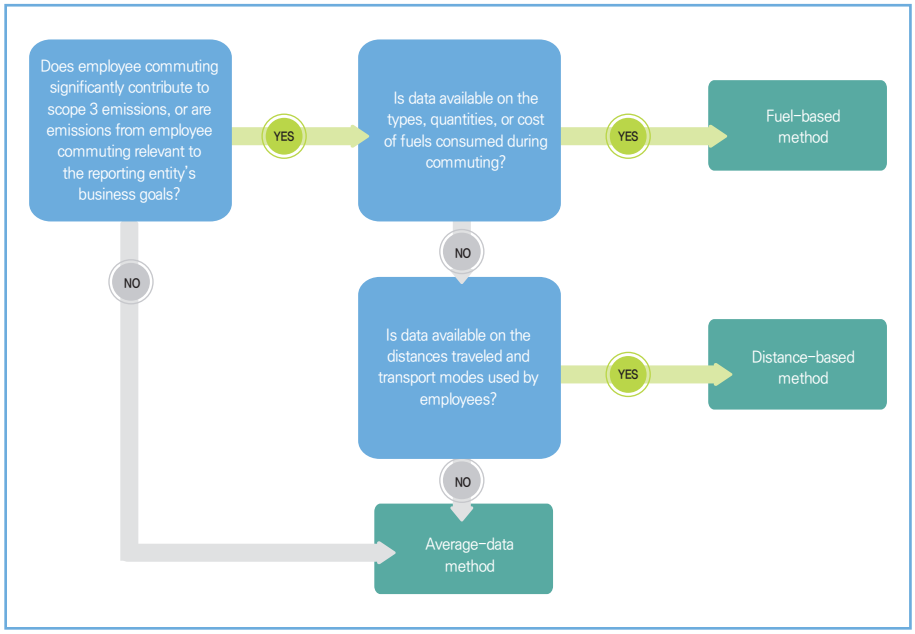
[Reference 2]

Scope of employees	• Employees of businesses and facilities owned, operated, or leased by the reporting entity • (Optional) Employees of other related entities of the reporting entity (e.g., franchises or outsourced entities) • (Optional) Other individuals who are not employees of the reporting entity, such as consultants and contract workers, but who commute to facilities owned or operated by the reporting entity

2. Calculation Methodology

Three methods may be used to calculate emissions from category 7 (employee commuting): the fuel-based, distance-based, and average-data methods. The applicable method may vary depending on the level of data available to the reporting entity. They may be determined as shown in the following diagram.

1) Decision tree



2) Calculation formulas and descriptions

Classification		Calculation formula	Description
a	**Fuel-based method**	Σ((quantity of fuel consumed) × (fuel emission factor)) + Σ((quantity of electricity consumed) × (electrical grid emission factor)) + Σ((quantity of refrigerant leakage) × (refrigerant emission factor))	Determine the quantities of fuels consumed while employees commute and apply the appropriate emission factor for the fuel. For public transportation, if the vehicle is not dedicated solely to transporting the reporting entity's employees, the reporting entity's emissions may be estimated by reflecting only a portion of the total emissions of public transportation with a reasonable method.
b	**Distance-based method**	Σ((distance traveled by vehicle type) × (vehicle-specific emission factor))	Collect data on commuting patterns (e.g., distance traveled and types of vehicles used) from the entity's employees, and apply the appropriate emission factor for the transport mode. If it is difficult to collect commuting data from all employees, appropriate sample techniques may be used to estimate patterns.
c	**Average-data method**	Σ((number of employees by transport mode) × (roundtrip commuting distance) × (commuting days per year) × (emission factor of transport mode))	Estimate emissions from employee commuting based on average data regarding employee commuting.

3. Calculation Examples by Methodology[28)]

a. Fuel-based method

The calculation methodology is the same as for category 4 (upstream T&D). For guidance on calculating emissions using the fuel-based method, see the guidance in section 4.3.a (fuel-based method) regarding category 4. However, if the fuel-based method is used to calculate emissions from public transportation commuting, emissions from public transportation should be allocated to the employees.

b. Distance-based method

- Company A, a small-sized rechargeable battery manufacturer, has three employees in the human resources department of its overseas sales entity who work for 48 weeks per year.
- To calculate emissions from employee commuting, Company A collected employee commuting profiles through a survey ([Reference 3]). The activity data and emissions factors collected are as follows:

Employee	Subway commuting days per week	Commuting distance by subway (one way, km)	Subway emission factor ($kgCO_2e$/passenger-km)	Automobile commuting days per week	Commuting distance by automobile (one way, km)	Automobile emission factor ($kgCO_2e$/vehicle-km)
Employee A	5	10	0.1	0	N/A	N/A
Employee B	4	10	0.1	1	15	0.2
Employee C	0	N/A	N/A	5	20	0.2

- Therefore, using the distance-based method, the total emissions from commuting of the human resources employees of rechargeable battery manufacturer A's overseas sales entity in the reporting year are calculated as follows:

① Total distance traveled by subway

= Σ (one-way commuting distance by subway (km) × 2 × commuting days per week × commuting weeks per year)
= (10 km × 2 times/day × 5 days × 48 weeks) + (10 km × 2 times/day × 4 days × 48 weeks)
= 8,640 km

② Total distance traveled by automobile

= Σ (one-way commuting distance by automobile (km) × 2 × commuting days per week × commuting weeks per year)
= (15 km × 2 times/day × 1 day × 48 weeks) + (20 km × 2 times/day × 5 days × 48 weeks)
= 11,040 km

28) All activity data and emission factors are for illustrative purposes only and do not represent actual data.

③ Sum of the above-mentioned values

= Σ (total distance traveled by vehicle type (vehicle-km or passenger-km) × vehicle-specific emission factor ($kgCO_2e$/vehicle-km or $kgCO_2e$/passenger-km))
= (8,640 × 0.1) + (11,040 × 0.2)
= 3,072 $kgCO_2e$

[Reference 3]

Examples of data to be collected through employee surveys

- Distance traveled daily by employees or location of residence and office
- The number of days per week that employees use different vehicle types (e.g., subway, automobile, bus, train, bicycle)
- The number of commuting days per week and working days per year
  (For multinational companies) Residence and working regions of employees, since transport emission factors may vary depending on regional locations
- Whether there is a significant car-pooling scheme in operation, the proportion of employees using the scheme and the average occupancy per vehicle.
- if applicable, the amount of energy used from teleworking (e.g., kWh of gas, electricity consumed)

c. Average-data method

- Company A, a rechargeable battery manufacturer located in Germany, has more than 10,000 employees.
- Company A determined the employees' commuting distance and transport mode by referring to information on average commuting methods and commuting distances from the Federal Ministry for Digital and Transport, Germany. According to national statistics, German workers work an average of 235 days per year, and it was assumed that transportation was not shared among employees. The activity data and emission factors investigated based on the national statistics are as follows.

Transport mode	Percentage of employees commuting by transport mode (%)	Average commuting distance (one way, km)	Emission factor ($kgCO_2e$/vehicle-km or $kgCO_2e$/passenger-km)
Subway	50	10	0.1
Automobile	30	15	0.2
Foot	15	1	0.0
Bus	5	5	0.1

– Therefore, using the average-data method, the total emissions from commuting of rechargeable battery manufacturer A's employees in the reporting year are calculated as follows:

① Emissions from subway commuting

= (total number of employees × percentage of subway commuters × one-way distance of subway commuting (km) × 2 × working days per year) × subway emission factor ($kgCO_2e$/vehicle-km or $kgCO_2e$/passenger-km)
= (10,000 × 50% × 10 × 2 × 235) × 0.1
= 2,350,000 $kgCO_2e$

② Emissions from automobile commuting

= (total number of employees × percentage of automobile commuters × one-way distance of automobile commuting (km) × 2 × working days per year) × automobile emission factor ($kgCO_2e$/vehicle-km or $kgCO_2e$/passenger-km)
= (10,000 × 30% × 15 × 2 × 235) × 0.2
= 4,230,000 $kgCO_2e$

③ Emissions from commuting on foot

= (total number of employees × percentage of pedestrian commuters × one-way distance of pedestrian commuting (km) × 2 × working days per year) × pedestrian emission factor ($kgCO_2e$/vehicle-km or $kgCO_2e$/passenger-km)
= (10,000 × 15% × 1 × 2 × 235) × 0.0
= 0 $kgCO_2e$

④ Emissions from bus commuting

= (total number of employees × percentage of bus commuters × one-way distance of bus commuting (km) × 2 × working days per year) × emission factor ($kgCO_2e$/vehicle-km or $kgCO_2e$/passenger-km)
= (10,000 × 5% × 5 × 2 × 235) × 0.1
= 117,500 $kgCO_2e$

⑤ Sum of the above-mentioned values

2,350,000 + 4,230,000 + 0 + 117,500
= 6,697,500 $kgCO_2e$

4. Matters to Be Considered on Application

(Data collection) When the reporting entity optionally calculates emissions from employee telecommuting, it should first establish baseline[29] emissions and only consider and account for additional emissions due specifically to telecommuting (e.g., energy consumed for air conditioning to create a comfortable environment). Emissions from teleworking are calculated by multiplying the energy consumption by the emission factor for the energy source used.

(Category distinction) For commuting-related emissions from commuter buses provided by the reporting entity, emissions should be reported separately for buses owned and operated by the reporting entity and for those owned and operated by third parties. If the buses are owned by the reporting entity, the emissions are reported in scope 1 and scope 2 because the reporting entity uses purchased fuels and electricity directly to operate the buses. If the buses are owned by a third party, the third party's scope 1 and scope 2 emissions from operating commuter buses dedicated solely to the reporting entity's commuting activities are reported in the reporting entity's scope 3 category 7 (employee commuting).

29) A baseline is a hypothetical scenario of GHG emissions that would have occurred in the absence of GHG projects or reduction activities. For category 7 (employee commuting), examples of baseline emissions include energy consumption from operating computers and monitors.

08 Category 8 (Upstream Leased Assets)

1. Definition

Category 8 includes emissions from the operation of assets that are leased from other entities by the reporting entity in the reporting year and not included in the reporting entity's scope 1 or scope 2 inventories ([Reference 1]). This category is applicable only to reporting entities that operate leased assets. The calculation of emissions from leased assets may vary depending on the type of lease and the consolidation approach (i.e., equity share, financial control, or operational control) used to define the reporting entity's organizational boundaries.

[Reference 1]

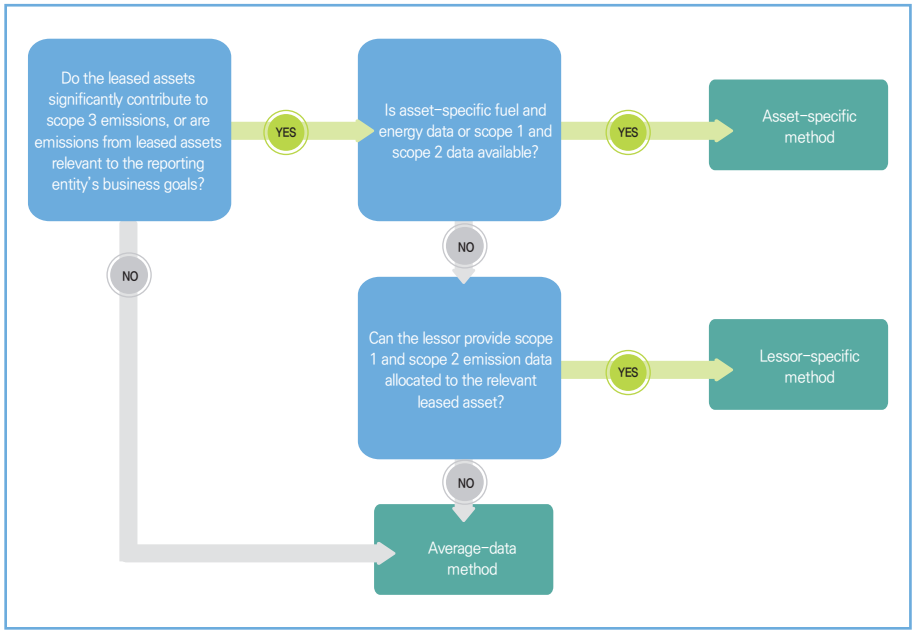
Examples of upstream leased asset emissions

- Lessors' scope 1 and scope 2 emissions (e.g., emissions from energy consumption, emissions from transportation and distribution) during the operation of assets (e.g., vehicles, facilities) leased by the reporting entity and not included in the reporting entity's scope 1 or scope 2
- (Optional) Life-cycle emissions related to the manufacturing or construction of the leased assets

2. Calculation Methodology

Three methods may be used to calculate emissions from category 8 (upstream leased assets): the asset-specific, lessor-specific, and average-data method. The applicable method may vary depending on the data available to the reporting entity. They may be determined as shown in the following diagram.

1) Decision tree



2) Calculation formulas and descriptions

Classification		Calculation formula	Description
a	**Asset-specific method**	(Σ((quantity of fuel consumed) × (fuel-specific emission factor)) + Σ((quantity of refrigerant leakage) × (refrigerant emission factor)) + (process emissions)) + (Σ((quantity of electricity, steam, heating, or cooling consumed) × (emission factor for electricity, steam, heating, or cooling))	Collect asset-specific fuel and energy data, or scope 1 and scope 2 emission data, from individual leased assets, and sum the emissions from all leased assets of the reporting entity. If the reporting entity leases assets for which the lessee does not measure energy consumption separately, the energy consumption can be estimated from the building's gross floor area and total energy consumption ([Reference 2]).
b	**Lessor-specific method**	Σ((scope 1 emissions of lessor) + (scope 2 emissions of lessor)) × ((area and volume of the leased asset) ÷ (total area and volume of lessor's assets)) (i.e., (formula a) × (the reporting entity's occupancy rate))	Collect scope 1 and scope 2 emissions from the lessor and estimate emissions from the relevant leased asset by reflecting only a portion of the total emissions with a reasonable method ([Reference 2]).
c	**Average-data method**	Σ((gross floor area per building type) × (average emission factor per building type)) or Σ((number of leased assets) × (average emissions per leased asset type))	If purchase records, utility bills, and meter readings regarding actual fuel or energy consumption are not available, emissions from each leased asset or groups of leased assets are estimated based on average statistics and secondary data (e.g., average emissions per asset type or square area), and emissions are summed from all leased assets of the reporting entity.

[Reference 2]

Estimation of the energy consumption of the reporting entity's leased assets if the lessee does not measure energy consumption separately per asset

- If a reporting entity leases an asset whose energy consumption is not measured separately by a lessee, the total energy consumption of the building may be allocated by reflecting the ratio of the reporting entity's leased asset area and occupancy rate to the gross floor area of the asset. Therefore, the energy consumption of the reporting entity's leased asset may be estimated using the following formula:
- (energy consumption of leased assets) = (reporting entity's leased asset area (m_2) / building's gross floor area (m_2)) × (building's occupancy rate (%)) × (total energy consumption of the building (kWh))

3. Calculation Examples by Methodology[30)]

a. Asset-specific method

- Company A, a rechargeable battery manufacturer, leases the entire floor of a building from Lessor B, covering an area of 200 m^2. The building has 10 floors with a gross floor area of 2,000 m^2 and an occupancy rate of 75%.
- Lessor B collected data on fuel consumption, electricity consumption, and fugitive emissions for the entire building in the reporting year. The activity data and emissions factors collected for the building are as follows:

Natural gas consumption (kg)	Natural gas emission factor ($kgCO_2e/kg$)	Electricity consumption (kWh)	Electricity emission factor ($kgCO_2e/kWh$)	Fugitive emissions (kg)	Emission factor for fugitive emissions ($kgCO_2e/kg$)
1,500	0.2	3,000	0.7	5	1,500

- Therefore, using the asset-specific method, the total emissions from leased assets of Company A in the reporting year are calculated as follows:

① Natural gas consumption allocated to Company A

= (reporting entity's area (m2) / building's gross floor area (m2)) × (building's occupancy rate (%))
× (building's total natural gas consumption (kg))
= (200 / (2,000 × 0.75)) × 1,500
= 200 kg

② Electricity consumption allocated to Company A

= (reporting entity's area (m^2) / building's gross floor area (m^2)) × (building's occupancy rate (%))
× (building's total electricity consumption (kWh))
= (200 / (2,000 × 0.75)) × 3,000
= 400 kWh

30) All activity data and emission factors are for illustrative purposes only and do not represent actual data.

③ Fugitive emissions allocated to Company A

= (reporting entity's area (m^2) / building's gross floor area (m^2)) × (building's occupancy rate (%))
× (building's total fugitive emissions (kg))
= (200 / (2,000 × 0.75)) × 5
= 0.67 kg

④ Sum of the above-mentioned values

emissions from natural gas consumption + emissions from electricity consumption + emissions from fugitive emissions
= (200 × 0.2) + (400 × 0.7) + (0.67 × 1,500)
= 1,325 $kgCO_2e$

b. Lessor-specific method

- Company A, a rechargeable battery manufacturer, sends a task force to Germany to investigate the feasibility of establishing a new business and leases a short-term workspace for the task force's use.
- The space leased by Company A is 360 m^2, and the building's gross floor area is 3,000 m^2. Company A collected scope 1 and scope 2 emission data from Lessor B for the entire building, which are 75 $kgCO_2e$ and 90 $kgCO_2e$, respectively.
- Therefore, using the lessor-specific method, the total emissions from Company A's leased assets in the reporting year are calculated as follows:

Σ((scope 1 emissions of lessor ($kgCO_2e$) + scope 2 emissions of lessor ($kgCO_2e$)) × (area and volume of the leased asset (m^2) ÷ total area and volume of the lessor's assets (m^2))

= (75 + 90) × (360 / 3,000)
= 19.8 $kgCO_2e$

c. Average-data method

- Company A, a rechargeable battery manufacturer, leases short-term warehouses for the temporary storage of the rechargeable batteries it produces in the US. Three warehouses were leased, and their combined gross floor area is 2,700 m^2.
- Company A could not collect data on electricity bills, or meter readings of fuel or energy, thus investigated US EPA data to identify an average emission factor of 0.36 $kgCO_2e/m^2$ for a similar building type.
- Therefore, using the average-data method, the total emissions from leased assets of Company A in the reporting year are calculated as follows:

Σ(gross floor area per building type (m^2) × average emission factor per building type ($kgCO_2e/m^2$))

= 2,700 × 0.36
= 972 $kgCO_2e$

4. Matters to Be Considered on Application

(Category and definition distinction) To ensure the completeness of its disclosures and avoid double counting or omissions, the reporting entity should assess upstream leased assets that are not included in scope 1 or scope 2, based on its asset accounting system. Leased assets recognized as assets are reported in scope 1 or scope 2, regardless of which approach is used for setting the reporting entity's organizational boundaries (i.e., equity share, financial control, or operational control). Leased assets not recognized as assets (e.g., short-term leases, leases of small capital assets) are reported in scope 3 category 8 (upstream leased assets) if the equity share or financial control approach is used to set the organizational boundary, and in scope 1 or scope 2 if the operational control approach is used.

09 Category 9 (Downstream Transportation and Distribution)

1. Definition

Category 9 includes emissions from the transportation and distribution of sold products in vehicles and facilities not owned or operated by the reporting entity in the reporting year ([Reference 1]). It includes emissions only from the transportation and distribution of products after the point of sale. A reporting entity that sells intermediate products should report emissions from the products' transportation and distribution between the point of sale and either its end customers or its business customers, if the intermediate products' end use is known or may reasonably be estimated.

[Reference 1]

Examples of downstream transportation and distribution emissions

- Storage of products for sale in warehouses, distribution centers, and retail facilities not owned or operated by the reporting entity
- Transportation and distribution between the reporting entity and retailers where the reporting entity does not pay for transportation (e.g., air, rail, road, or marine transportation)
- Transportation and distribution between retailers and customers (e.g., air, rail, road, or marine transportation)

Although T&D activities for the sake of selling the reporting entity's products would usually generate downstream T&D emissions, the emissions should be classified as upstream transportation and distribution emissions if the reporting entity has purchased the products.

2. Calculation Methodology

The calculation methodology is the same for category 4 (upstream transportation and distribution) and category 9 (downstream transportation and distribution). For guidance on calculating category 9 emissions, see the guidance in sections 4.2 and 4.3 regarding category 4.

3. Calculation Examples by Methodology

The calculation examples by methodology are the same for category 4 (upstream transportation and distribution) and category 9 (downstream transportation and distribution). For guidance on calculating category 9 emissions, see the guidance in section 4.3 regarding category 4.

4. Matters to Be Considered on Application

(Definition distinction) All inbound transportation and distribution and outbound transportation and distribution services purchased by the reporting entity are part of upstream activities (category 4) if the services have been purchased for shipping logistics, whereas outbound transportation and distribution services not purchased by the reporting entity are part of downstream activities (category 9). Therefore, the reporting entity should establish accurate definitions of upstream and downstream transportation and distribution activities and manage the relevant data internally when calculating emissions to ensure the completeness of its report.

10 Category 10 (Processing of Sold Products)

1. Definition

Category 10 includes emissions from the processing of sold intermediate products by third parties (e.g., manufacturers) subsequent to sale by the reporting entity and before their use by end customers. Intermediate products are products that require further processing, transformation, or inclusion in other products before use. Even if the end use of the intermediate products is unknown, their emissions should be reported if they may reasonably be estimated.

1) Determining the applicability to the rechargeable battery industry

The EU Battery Regulation[31] mandates reporting GHG emissions from the life cycle of batteries, including raw material extraction, production, consumption, and disposal based on a life-cycle assessment. It specifies that when the carbon footprint is calculated, emissions from the processing of batteries are excluded from the system boundary because they are considered negligible compared to emissions from production ([Reference 1]). Although the reporting entity should, in principle, report emissions completely for all applicable categories, a reporting entity that manufactures rechargeable batteries may choose not to declare category 10 emissions (processing of sold products) by citing the relevant provision of the EU Battery Regulation as a reason for exclusion. However, because the inclusion of the processing stage in the system boundary may change in the future as the the European Commission is expected to adopt a delegated act of the EU Battery Regulation (draft published for comment in April 2024), reporting entities that want to calculate emissions from the processing of sold products at this time may utilize the calculation method in the following section 10.2.

31) European Parliament, Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC (2023).

[Reference 1]

Reasons for excluding the disclosure of emissions from processing under the EU Battery Regulation[32)]

ANNEX II. CARBON FOOTPRINT – 4. System boundary (part)

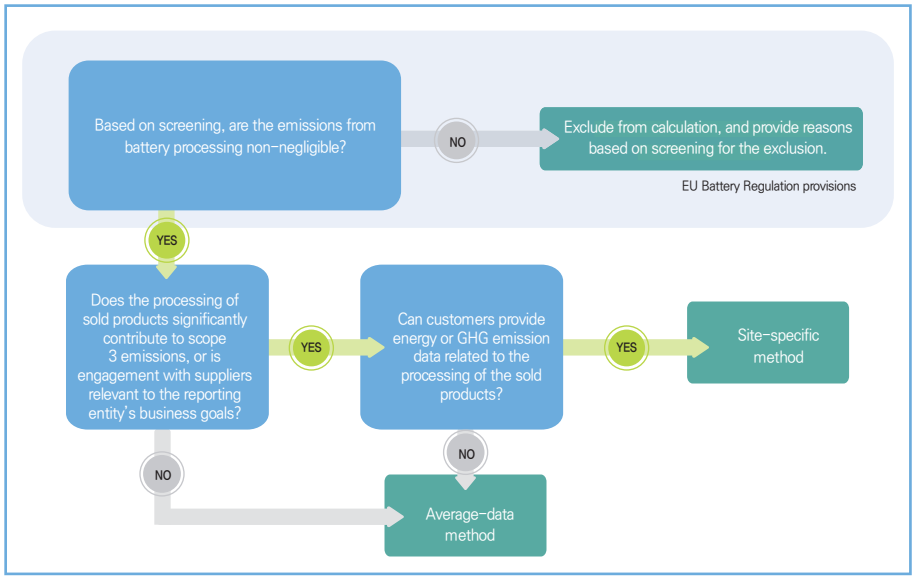
The following processes involved in the life-cycle stages shall be excluded from the system boundary:

- Manufacturing of equipment for the assembly and recycling of batteries, as carbon footprint impacts have been calculated as negligible in the PEFCRs for high specific energy rechargeable batteries for mobile applications;
- The battery assembly process using the original equipment manufacturer (OEM) system components; this process corresponds for the most part to mechanical assembly and is included inside the OEM equipment or vehicle assembly line; the consumption of energy and material for this specific process is negligible when compared to the manufacturing process of OEM components.

2. Calculation Methodology

Two methods may be used to calculate emissions from category 10 (processing of sold products): the site-specific and average-data method. The applicable method may vary depending on the level of data available to the reporting entity. The method may be determined as shown in the following diagram.

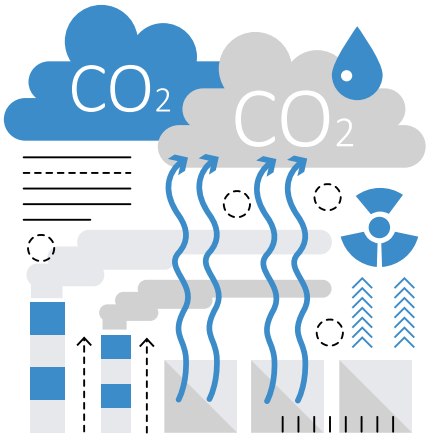
1) Decision tree



32) Same as above, p.86

2) Calculation formulas and descriptions

Classification		Calculation formula	Description
a	Site-specific method	Σ((quantity of fuel consumed) × (life-cycle emission factor for fuel)) + Σ((quantity of electricity consumed) × (life-cycle emission factor for electricity)) + Σ((quantity of refrigerant leakage) × (refrigerant emission factor)) + Σ(process emissions from processing of products) + Σ((mass of waste) × (waste emission factor))	Calculate emissions by collecting activity data and emission factors for each downstream process from the downstream suppliers that have sold intermediate products or collect downstream emission data calculated by each supplier. If the downstream process involves materials other than the intermediate products sold by the reporting entity, the reporting entity's emissions may be estimated by reflecting only a portion of the total emissions with a reasonable method.
b	Average-data method	Σ((mass of sold intermediate product) × (emission factor for the processing of sold products))	Collect data on the types of downstream processes required to process the sold intermediate products into final products and apply average emission factors from the relevant industry to estimate emissions.



11 Category 11 (Use of Sold Products)

1. Definition

This category includes emissions from the use by end users (e.g., business customers, individual customers) of goods and services sold by the reporting entity in the reporting year. It includes the scope 1 and scope 2 emissions of end use. Use-phase emissions are classified into direct use-phase emissions from products that consume energy directly and indirect use-phase emissions from products that consume energy indirectly ([Reference 1]). Category 11 includes all emissions that are expected to occur in the future from products sold in the reporting year. The reporting entity may optionally report the indirect use-phase emissions of its sold products, and it is encouraged to report such emissions if they are expected to be significant.

If the reporting entity sells intermediate products, it can report emissions if these may reasonably be estimated, even though the end use of the intermediate products is unknown. Calculating use-phase emissions of sold products requires product design specifications and assumptions about how the end users may use these products, and the reporting entity should report both its calculation methods and its assumptions.

[Reference 1]

Examples of the use-phase emissions of sold products

- Direct emissions from products that directly consume energy (fuels or electricity) during use
- Direct emissions from fuels and feedstocks (e.g., petroleum, natural gas, coal, biofuels, crude oil)
- Direct emissions from products that form or emit GHGs during use (e.g., CO_2, CH_4, N_2O, refrigeration and air-conditioning equipment, industrial gases, fire extinguishers, fertilizers)
- (Optional) Indirect emissions from sold products (including intermediate products) that indirectly consume energy (fuels or electricity) during use over their expected lifetime
- (Optional) Emissions from the maintenance of sold products

1) Determining the applicability to the rechargeable battery industry

The EU Battery Regulation[33] specifies that the use phase of a battery shall be excluded from the system boundary when calculating its carbon footprint because the manufacturer's battery design stage does not have a direct impact on the use-phase emissions of final products. However, it also states that emissions may be disclosed if the battery design exceptionally has a non-negligible contribution to the product's use-phase emissions ([Reference 2]).

In such cases, the latest version of the Product Environmental Footprint Category Rules (RECHARGE, 2024) may be used to calculate the carbon footprint.[34]

[Reference 3]

Reasons for reviewing the disclosure of use-phase emissions under the EU Battery Regulation[35]

ANNEX II. CARBON FOOTPRINT – 4. System boundary (partial)

The use phase shall be excluded from the life cycle carbon footprint calculations, as it is not under the direct influence of manufacturers except where it is demonstrated that choices made by battery manufacturers at the design stage can make a non-negligible contribution to that impact.

Although the reporting entity should, in principle, report emissions completely for all applicable categories, the reporting entity may choose not to disclose emissions based on the EU Battery Regulation or may conduct screening to determine whether each company's battery design significant impacts the use-phase emissions of the final products, and thus whether their emissions should be calculated.

33) European Parliament, Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC (2023).

34) The Product Environmental Footprint Category Rules (RECHARGE, 2024) propose considering energy consumption in the use phase of a battery as energy loss due to the energy efficiency of the battery cells over the lifetime of the application (e.g., EV, PHEV, e-mobility). The use-phase energy consumption can be calculated as the energy consumption of the final product over the battery's life cycle until its end of life (EoL), based on the energy loss due to battery efficiency and energy mix. Based on this, indirect GHG emissions for all energy losses expected to occur in the future from the products sold in the reporting year may be estimated and applied to category 11 (use of sold products).

Note: [quantity of use-phase energy consumption] = (energy loss due to battery efficiency) × (electricity emission factor)
= (application service energy) × (1 – (energy efficiency)) × (electricity emission factor)
= (application service energy) × (1 – (voltage efficiency) × (coulombic efficiency)) × (electricity emission factor)

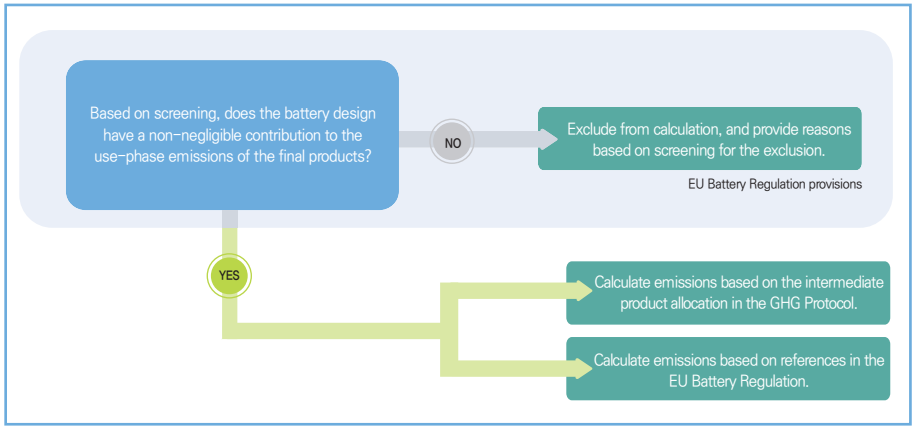
35) European Parliament, Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC (2023), p. 87.

However, because the inclusion of the use phase in the system boundary may change in the future as the the European Commission is expected to adopt a delegated act of the EU Battery Regulation (draft published for comment in April 2024), reporting entities that want to calculate emissions from the use of sold products or preemptively respond to the disclosure of category 11 emissions at this time may utilize the calculation method in the following section 11.2.

2. Calculation Methodology

If the battery design is identified through screening to have a non-negligible contribution to use-phase emissions, as shown in the diagram below, or if the indirect use-phase emissions of the sold intermediate products are significant, the reporting entity may calculate category 11 emissions (use of sold products) based on the calculation formula used for screening, or it may use an intermediate product allocation-based method from the following section.

1) Decision tree



2) Calculation formulas and descriptions

Classification		Calculation formula	Description
GHG Protocol	Intermediate product allocation-based method	Σ ((total intermediate products sold) × (lifetime uses of the final products sold) × (emissions per use of the sold intermediate products))	Identify the final products that are made from the intermediate products sold by the reporting entity, and consider the proportion of intermediate products sold per final product to allocate the use-phase emissions (based on the final goods) for the reporting entity. For further explanation of allocation, see "4.2.1. Allocation" in "II. Building a Scope 3 Greenhouse Gas Inventory" in this guide.

12 Category 12 (End-of-Life Treatment of Sold Products)

1. Definition

This category includes emissions from the EoL disposal and treatment of products that were sold by the reporting entity in the reporting year. It includes disposal emissions expected to occur in the future from all products sold in the reporting year.
Calculating emissions from the EoL treatment of sold products requires assumptions about how end users dispose of and treat the products. The reporting entity should report both its calculation methods and its assumptions. If the reporting entity sells intermediate products, it should report emissions from the disposal of the intermediate products, not their related final products.

2. Calculation Methodology

The calculation methodology is the same for category 5 (waste generated in operations) and category 12 (end-of-life treatment of sold products). The difference is that category 12 collects data on the total mass of sold intermediate product from the point of sale to their EoL treatment by end users, rather than the total mass of the waste generated in operations. For guidance on calculating category 12 emissions, see the guidance in section 5.2 regarding category 5.

Considering the characteristics of batteries, in addition to the three methods (supplier-specific, waste-type - specific, and average-data methods) described already for category 5, a fourth calculation method (d) may be presented based on the Rules for the calculation of the Carbon Footprint of Electric Vehicle Batteries (CFB-EV)[36], which specifies input material - specific and process-specific formulas ([Reference 1]). See section 12.4 for description of the methodology and the available basic data.

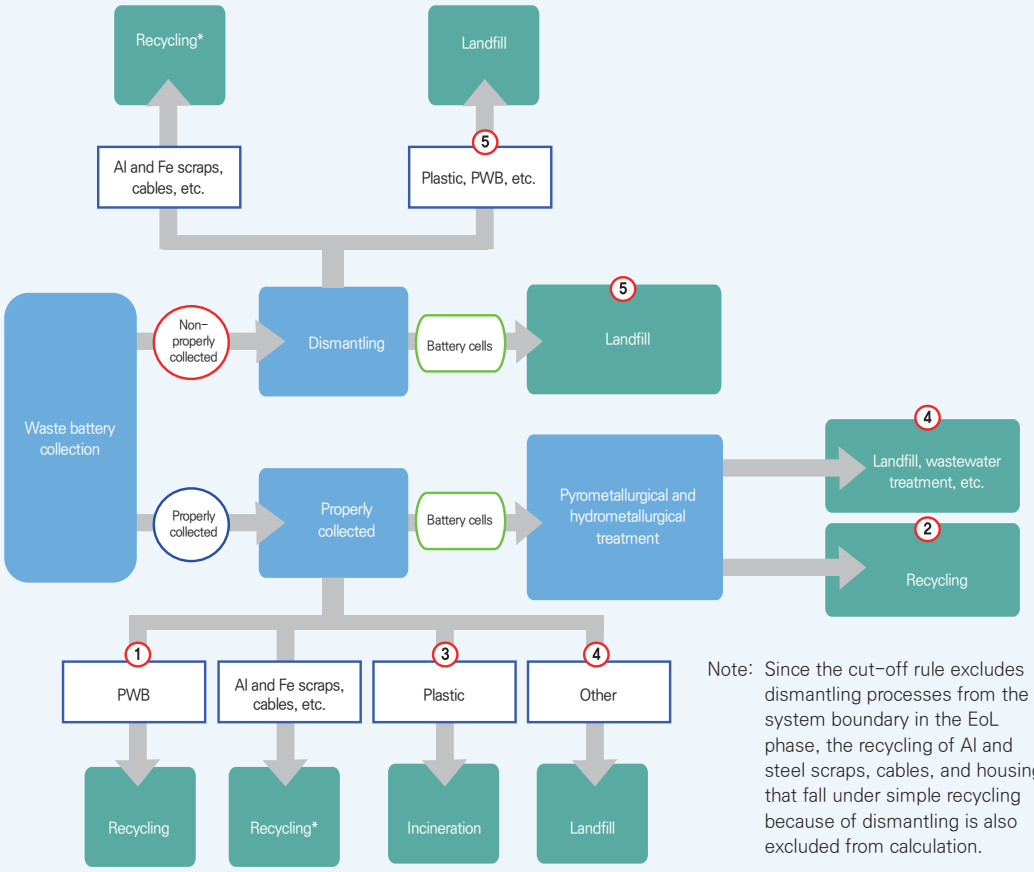
36) Joint Research Centre, Rules for the calculation of the Carbon Footprint of Electric Vehicle Batteries (CFB-EV) (2023).

Classification				Calculation formula	Description
d	Method based on Rules for the calculation of the Carbon Footprint of Electric Vehicle Batteries	Recycling	① Printed wiring board (PWB)	(PWB recycling emissions) − Σ(emission reductions contributed in the recycling process of secondary materials) = ((battery collection rate) × (1 − (PWB allocation factor)) × (emissions and resources consumed in the PWB recycling process)) − Σ ((1 − (material-specific allocation factor)) × (material-specific recycling yield) × (emissions from resources consumed in being treated as base materials rather than recycled) × ((acquired material quality) / (raw material quality)))	Estimate the emissions for the relevant recycling process by including the emission reduction contributions of recycled secondary materials (e.g., Cu, Au, Ag, Pd) to the PWB recycling emissions.
			② Battery Cell	(emissions from cell recycling) −Σ(emissions from secondary material emissions) −Σ(emission reductions contributed in the recycling process of secondary materials) = (battery collection rate) × (((1 − (battery-cell allocation factor) × (emissions and resources consumed in the cell recycling process)) + Σ((1 − (material-specific allocation factor)) × (material-specific recycling yield) × ((emissions from resources consumed to produce secondary materials) − (emissions from resources consumed in being treated as base materials rather than recycled) × ((acquired material quality) / (raw material quality))))	Estimate the emissions for the relevant recycling process by including the emission reduction contributions of recycled secondary materials to the emissions from recycling battery cells and secondary materials ((e.g., Cu, Ni, Co).
		Incineration	③ Plastic	Σ(emissions from resources (energy) consumed in converting dismantled plastic into energy) = (battery collection rate) × Σ ((1 − (energy recovery allocation factor)) × (energy recoverable material yield) × (emissions from resources consumed in the energy recovery process))	Estimate emissions from the process of incinerating plastic using emissions from the incineration and energy recovery of the dismantled plastic.
		EoL treatment	④ Properly collected	Σ(emissions from resources (energy) consumed in treating other materials not recycled within properly collected waste batteries) = (battery collection rate) × Σ((1 − (material-specific recycling yield (properly collected))) × (emissions from resources consumed in the disposal process))	Estimate emissions from the EoL treatment process using emissions from the disposal of other materials that are not recycled and dismantling of the properly collected battery waste.
			⑤ Non-properly collected	Σ(emissions from resources (energy) consumed in treating other materials not recycled within non-properly collected waste batteries) = (1-battery collection rate) × Σ((1 − (material-specific recycling yield (non-properly collected))) × (emissions from resources consumed in the disposal process))	Estimate emissions from the EoL treatment process with emissions from the disposal of other materials notbeing recycled from the dismantling of the non-properly collected battery waste.

Note: "Non-properly collected" refers to batteries that have not been collected in a suitable manner (e.g., discarded or not treated in a typical waste system).

[Reference 1]

Example of the phases in the default EoL process



Note: Since the cut-off rule excludes dismantling processes from the system boundary in the EoL phase, the recycling of Al and steel scraps, cables, and housing that fall under simple recycling because of dismantling is also excluded from calculation.

3. Calculation Examples by Methodology[37)]

The calculation examples by methodology are the same for category 5 (waste generated in operations) and category 12 (end-of-life treatment of sold products). For guidance on calculating category 12 emissions, see the guidance in section 5.3 regarding category 5.

4. Matters to Be Considered on Application

(Category distinction) Given that the tendency of rechargeable battery manufacturers to incorporate battery disposal and recycling companies as their subsidiaries are expected to increase in the future, the reporting entity should separate the emissions from battery disposal and recycling

37) All activity data and emission factors are for illustrative purposes only and do not represent actual data.

companies according to their type or organizational boundaries and report these emissions without double counting or omission. In other words, the reporting entity's scope 3 emissions should only include scope 1 and scope 2 emissions from the disposal and treatment of waste at facilities owned or operated by third parties, while emissions from disposal at facilities owned or controlled by the reporting entity should be reported in its scope 1 or scope 2, respectively.

(Rules for the calculation of the Carbon Footprint of Electric Vehicle Batteries) In accordance with Article 7 of the EU Battery Regulation,[38] which specifies that the carbon footprint of the EoL treatment of batteries should be calculated, the Rules for the calculation of the Carbon Footprint of Electric Vehicle Batteries (CFB-EV)[39] provide guidance for calculating the carbon footprint of electric-vehicle batteries. The carbon footprint measures the impact of carbon emitted throughout a product's life cycle. Based on the similarities to scope 3 emissions, category 12 emissions (end-of-life treatment of sold products) may be calculated by indirectly utilizing the Rules for the calculation of the Carbon Footprint of Electric Vehicle Batteries (CFB-EV).

(Utilizing secondary data in calculation) If battery EoL treatment providers do not manage historical information separately on waste batteries and data for calculating input material-specific and process-specific emissions, the feasibility of collecting primary data on emissions from disposal and treatment processes may be limited. Therefore, as shown in calculation method (d) in section 12.2 (Calculation Methodology) for category 12, it is proposed to use the Rules for the calculation of the Carbon Footprint of Electric Vehicle Batteries (CFB-EV) with the default scenarios and default values ([Reference 2], [Reference 3]) presented in this document for each waste-type-specific method (e.g., recycling, incineration, landfill) within the EoL-phase system boundary, as well as when evaluating criteria for selecting a suitable secondary dataset. However, this may be modified in the future as the European Commission is expected to adopt a delegated act for the EU Battery Regulation (draft published for comment in April 2024).

38) Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006 /66 /EC and amending Regulation (EU) No. 2019/1020 (2023).

39) Joint Research Centre, Rules for the calculation of the Carbon Footprint of Electric Vehicle Batteries (CFB-EV) (2023).

[Reference 2]

Default values of each item used in the default EoL phase

Classification	Material-specific allocation factor	Properly collected batteries		Non-properly collected batteries	
		Material-specific recycling yield	Quality of the acquired or raw material	Material-specific recycling yield	Quality of the acquired or raw material
Al metal (cell)	0.2	0	1	0	1
Cu metal (cell)	0.2	0.9	1	0	1
Fe metal (cell)	0.2	0	1	0	1
Au (PWB)	0.2	1.40E-05	1	0	1
Cu (PWB)	0.2	0.11	1	0	1
Ag (PWB)	0.2	9.77E-04	1	0	1
Pd (PWB)	0.2	9.31E-08	1	0	1
Co salts (cell)	0.2	0.9	0.8	0	0.8
Ni salts (cell)	0.2	0.9	0.8	0	N/A
Mn salts (cell)	0.2	0	0.8	0	N/A
Li salts (cell)	0.2	0	0.8	0	N/A
Other metal salts (cell)	0.2	0	0.8	0	N/A
Graphite (cathode active material), hard carbon (cell)	0.2	0	0.8	0	N/A
Other materials (cell)	0.5	0	0.8	0	N/A

[Reference 3]

Default activity data on the default battery-cell recycling process

Classification	Component	Unit	Default value	Specification or dataset
Pyrometallurgical treatment	Inputs			
	EoL battery cell	kg	1.00	From disassembly
	Electricity	kWh	1.00	Electricity mix
	Process heat	MJ	2.288	Thermal energy from natural gas
	Process heat	MJ	0.237	Thermal energy from diesel fuel
	Limestone, washed	kg	0.136	Limestone production, technology mix
	Silica sand	kg	0.119	Silica sand, production mix
	Quicklime (CaO)	kg	0.085	Quicklime production, technology mix
	Carbon black	kg	0.001	Carbon black production, technology mix
	Transport from the dissembling to the battery cell recycling plant	km	130	Transport by truck (>32 t, EURO 4)
	Transport from the dissembling to the battery cell recycling plant	km	240	Transport by train (average freight train)
	Transport from the dissembling to the battery cell recycling plant	km	270	Transport by ship (barge)

Classification	Component	Unit	Default value	Specification or dataset
Pyrometallurgical treatment	**Outputs**			
	Metal alloy	kg	0.209	Input to hydrometallurgical treatment
	Slag	kg	0.712	Landfill of inert slag
	Emissions	$kgCO_2e$	1.194	Direct process emissions (all greenhouse gases)
Hydrometallurgical treatment	**Inputs**			
	Metal alloy	kg	0.34	–
	Electricity	kWh	0.085	Electricity mix
	Process heat	MJ	1.847	Thermal energy from natural gas
	Hydrochloric acid (100%)	kg	0.017	HCl production, technology mix
	Hydrogen peroxide (100%)	kg	0.305	Hydrogen peroxide, production, technology mix
	Soda (sodium carbonate)	kg	0.017	Soda production, technology mix
	Sodium hydroxide (100%, caustic soda)	kg	0.458	Sodium hydroxide production, technology mix
	Sulfuric acid aq. (96%)	kg	0.881	Sulfuric acid aq. production, technology mix
	Water (tap water)	m^3	0.003	–
	Outputs			
	Recovered metals	kg	–	E.g., Al, Cu, Fe, stainless steel
	Recovered metal salts	kg	–	E.g., cobalt sulfate, nickel sulfate
	Wastewater	m^3	0.00864	Wastewater treatment, average

Note: The data in [Reference 2], [Reference 3] are based on the draft delegated acts of the EU Battery Regulation (published for comment in April 2024).

(System boundary of EoL process) When calculating the carbon footprint of batteries, the cut-off rules for the EoL-phase system boundary exclude the collection of the battery waste, pretreatment, battery dismantling, and transport of the battery. Therefore, the recycling of secondary materials extracted from Fe and Al scraps, cables, and housings that fall under simple recycling due to dismantling is also excluded from the calculation. However, this may be modified in the future as the European Commission is expected to adopt a delegated act for the EU Battery Regulation (draft published for comment in April 2024).

13 Category 13 (Downstream Leased Assets)

1. Definition

Category 13 includes emissions from the operation of assets that are owned by the reporting entity, leased to other entities in the reporting year, and not included in the reporting entity's scope 1 and scope 2 declarations ([Reference 1]). This category is applicable only to reporting entities that own leased assets and receive payments from lessees. The calculation of emissions from leased assets may vary depending on the type of lease and the consolidation approach (i.e., equity share, financial control, or operational control) used to define the reporting entity's organizational boundaries.

[Reference 1]

Examples of downstream leased asset emissions

- Lessees' scope 1 and scope 2 emissions (e.g., emissions from energy consumption) during the operation of assets that are owned by the reporting entity and leased to other entities
- (Optional) Life-cycle emissions related to the manufacturing or construction of the leased assets

2. Calculation Methodology

The calculation methodology is the same for category 8 (upstream leased assets) and category 13 (downstream leased assets). For guidance in calculating category 13 emissions, see the guidance in section 8.2 regarding category 8.

3. Calculation Examples by Methodology

The calculation examples by methodology are the same for category 8 (upstream leased assets) and category 13 (downstream leased assets). For guidance in calculating category 13 emissions, see the guidance in section 8.3 regarding category 8.

4. Matters to Be Considered on Application

(Category and definition distinction) To avoid duplicate calculations or omissions and to ensure the completeness of its disclosures, the reporting entity should review downstream leased assets not included in scope 1 or scope 2 based on its asset accounting system. In addition, if it is not meaningful to distinguish between products sold to customers (category 11) and products leased to customers (category 13), the reporting entity may account for products leased to customers and sold products in the same way and report them in category 11 (use of sold products). In this case, while ensuring that emissions are not double-counted, the reporting entity may calculate emissions by accounting for the total expected lifetime emissions of all relevant products leased to other entities in the reporting year.

14 Category 14 (Franchises)

1. Definition

Category 14 includes emissions from the reporting entity's operation of franchises in the reporting year that are not part of its scope 1 and scope 2 declarations ([Reference 1]). This category is applicable to reporting entities that operate franchises as franchisors, that grant licenses to other entities to sell or distribute its goods or services in return for payments, such as royalties for the use of trademarks. The category includes the franchises' scope 1 and scope 2 emissions. Reporting entities that operate franchises under license as franchisees should include emissions from operations under their control according to the consolidation approach in this category if they have not included those emissions in their scope 1 and scope 2 declarations.

[Reference 1]

Examples of franchise emissions

- Scope 1 and scope 2 emissions of franchises
- (Optional) Scope 3 emissions if purchases of a franchise's goods or services would result in significant upstream emissions

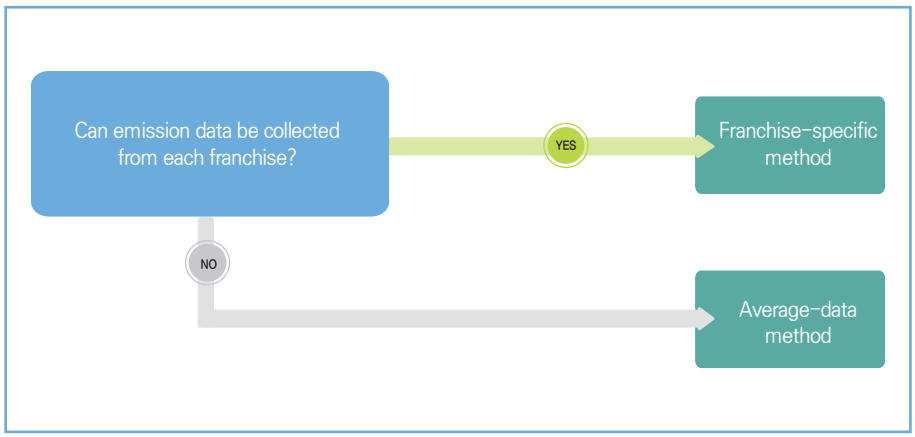
1) Determining the applicability to the rechargeable battery industry

Since this category is applicable to franchisors, it is not applicable to typical companies in the rechargeable battery manufacturing industry. However, if the reporting entity is a rechargeable battery manufacturer that operates franchises, the emissions from the franchises' operations are calculated and reported in this category based on the calculation methodology in section 14.2.

2. Calculation Methodology

Two methods may be used to calculate emissions from category 14 (franchises): the franchise-specific and average-data methods. The applicable method may vary depending on the level of data available to the reporting entity. The method may be determined as shown in the following diagram.

1) Decision tree



2) Calculation formulas and descriptions

Classification		Calculation formula	Description
a	Franchise-specific method	Σ (franchise's scope 1 and scope 2 emissions)	Collect scope 1 and scope 2 emission data from individual franchises and sum the emissions for all franchises of the reporting entity. If a franchise does not measure its emissions separately, emissions may be estimated from the franchise's total floor area and its asset-specific fuel and energy consumption. Additionally, if the number of franchises is large and collecting franchise-specific data is difficult, emissions may be calculated through appropriate sampling.
b	Average-data method	Σ ((building-specific total floor area) × (building-specific average emission factor))	Estimate emissions for a franchise or a group of franchises based on average statistics (e.g., average emissions per franchise type or square area), and sum the emissions for all franchises in the reporting entity.

15 Category 15 (Investments)

1. Definition

Category 15 includes emissions that are associated with the reporting entity's investments in the reporting year but are not included in the reporting entity's scope 1 and scope 2 declarations. The reporting entity's emissions are estimated from an investee's total scope 1 and scope 2 emissions and are proportional to the reporting entity's investment equity. If the investee's scope 3 emissions are significant or otherwise relevant compared to other emission sources, they may be included when estimating the reporting entity's emissions.

The investment activities included in this category may vary depending on the reporting entity's organizational boundaries. According to the four categories of financial investments and services (equity, debt, project finance, managed investments, and client services), they are divided into those for which GHG accounting is required and those for which it is optional. If accounting for GHGs is required, it is reported in this category. Cases with required and optional accounting for GHGs depending on the investment type are as follows:

- **(Required)** Cases for investments with required accounting of GHGs based on the investment type:

1) Equity investments

- If emissions from equity investments are not included in the reporting entity's scope 1 and scope 2 declarations because the reporting entity does not have control over the investee company, then scope 1 and scope 2 (and scope 3 if significant) emissions of equity investments in the reporting year are accounted for in scope 3 category 15 (investments), in proportion to the equity owned by the reporting entity.
- Equity investments in subsidiaries where the reporting entity has financial control, associate companies where the reporting entity has significant influence but no financial control, and joint ventures where partners have joint financial control.

2) Debt investments and project finance

- Scope 1 and scope 2 emissions from relevant projects in the reporting year are accounted for in scope 3 category 15 (investments), in proportion to the reporting entity's total investment cost. Emissions expected to occur over a project's lifetime are reported in the project's initial year of funding.
- Debt investments include corporate debt instruments (e.g., convertible bonds prior to conversion, bonds) or commercial loans, where the use of the proceeds is known. They are included in corporate debt holdings held in the reporting entity's portfolio.
- Project finance includes the long-term financing of projects by the reporting entity as either an equity investor (sponsor) or debt investor (financier).

- **(Optional)** Cases for investments with optional accounting of GHGs, based on the types of investments (report these in the reporting entity's scope 3 category 15):

1) Debt investments

- General debt-holding for corporate purposes (e.g., loans, bonds) in the reporting entity's portfolio, for which the use of proceeds is not specified.

2) Managed investments and client services

- Investments and services managed by the reporting entity on behalf of clients using the clients' capital.
- Investments and asset management services, such as stocks and bonds on behalf of clients, and financial advisory services for clients seeking assistance with mergers.

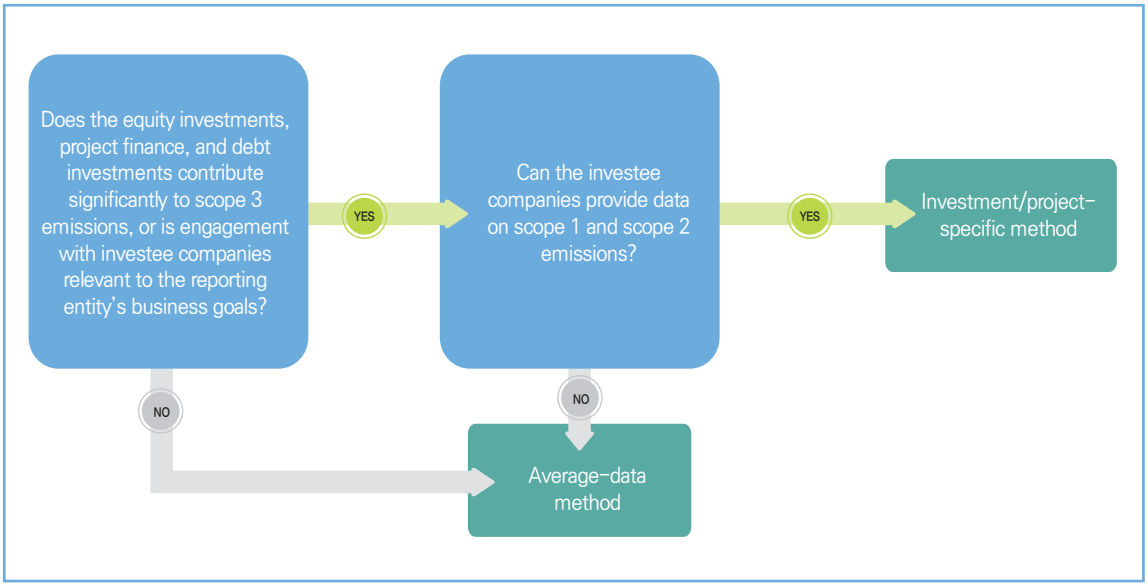
3) Other investments or financial services

- Other financial services (e.g., pension funds, retirement accounts, insurance contracts) not included in the above-mentioned four types of financial investments and services (equity investments, debt investments, project finance, and managed investments and client services)

2. Calculation Methodology

Two methods may be used to calculate emissions from category 15 (investments): the investment/project-specific and average-data methods. The applicable method may vary depending on the level of data available to the reporting entity. The method may be determined as shown in the following diagram.

1) Decision tree



2) Calculation formulas and descriptions

Classification			Calculation formula	Description
Equity investments	a	Investment/project-specific method	Σ((investee company's scope 1 and scope 2 emissions) × (share of equity))	Collect scope 1 and scope 2 emissions from the investee company. The reporting entity's emissions are estimated from only a portion of the investee company's total scope 1 and scope 2 emissions, in proportion to the reporting entity's investment equity.
	b	Average-data method	Σ((investee company's total revenue) × (emission factor for investee company's sector) × share of equity))	Estimate the investee company's scope 1 and scope 2 emissions based on its sales data and EEIO data for the relevant sector. The reporting entity's emissions are estimated from only a portion of the investee company's total scope 1 and scope 2 emissions, in proportion to the reporting entity's investment equity.
Project finance and debt investments	a	Investment/project-specific method	Σ((investee company's scope 1 and scope 2 emissions from the relevant project) × (share of equity))	Collect scope 1 and scope 2 emissions from the investee company. The reporting entity's emissions are estimated from only a portion of the investee company's total scope 1 and scope 2 emissions, in proportion to the reporting entity's investment equity regarding the relevant project.
	b	Average-data method	Σ((construction cost or project revenue in the reporting year) × (emission factor of relevant sector) × (investment share of total project costs))	Estimate investee company's scope 1 and scope 2 emissions based on EEIO data. The reporting entity's emissions are estimated from only a portion of the investee company's total scope 1 and scope 2 emissions, in proportion to the reporting entity's investment equity regarding the total project capital.

3. Calculation Examples by Methodology[40)]

a. Investment/project-specific method

(1) Equity investments

- Company A, a rechargeable battery manufacturer, has equity investments in three associate companies, X, Y, and Z.
- Company A uses the operational control approach to establish its organizational boundaries. Since it does not have operational control over the three associate companies, Company A should report the associate companies' scope 1 and scope 2 emissions in scope 3 category 15, in proportion to its equity share.
- Company A collected the GHG emissions of each associate company from their GHG inventory reports and obtained equity information related to the investments from the electronic disclosure system. In addition, based on Company A's materiality criteria, Company A determined that the associate companies' scope 3 emissions are not relevant compared to scope 1 and scope 2. The collected data is as follows:

Investment	Investment type	Investee company's scope 1 and scope 2 emissions in the reporting year (tonnes CO_2e)	Reporting entity's share of equity (%)
1	Equity investments in associate company X	120,000	40
2	Equity investments in associate company Y	200,000	25
3	Equity investments in associate company Z	1,600,000	30

- Therefore, using the investment-specific method, the total emissions from Company A's equity investments are calculated as follows:

Σ((investee company's scope 1 and scope 2 emissions) × (share of equity (%))

= (120,000 × 40%) + (200,000 × 25%) + (1,600,000 × 30%)
= 48,000 + 50,000 + 480,000
= 578,000 tonnes CO_2e

(2) Project finance and debt investments

- Company A, a rechargeable battery manufacturer, has debt investments in several public facilities and infrastructure companies for a project to construct a new power plant. Company A collected scope 1 and scope 2 emissions from its investee companies. The collected data is as follows:

Investee company	Investee company's scope 1 and scope 2 emissions (tonnes CO_2e)	Debt investment value (USD)	Total project costs (USD)	Reporting entity's share of equity (%)
1	200,000	1,000,000	20,000,000	5.00
2	10,000	5,000,000	50,000,000	10.00
3	250,000	3,000,000	60,000,000	5.00
4	30,000	10,000,000	90,000,000	11.11

40) All activity data and emission factors are for illustrative purposes only and do not represent actual data.

– Therefore, using the project-specific method, the total emissions from Company A's project finance and debt investments (where the use of the proceeds is known) are calculated as follows:

Σ((investee company's scope 1 and scope 2 emissions from the relevant project (tonnes CO_2e) × (share of equity (%))

= (200,000 × 0.05) + (10,000 × 0.1) + (250,000 × 0.05) + (30,000 × 0.1111)
= 10,000 + 1,000 + 12,500 + 3,333
= 26,833 tonnes CO_2e

b. Average-data method

(1) Equity investments

– Company A, a rechargeable battery manufacturer, has a portfolio of equity investments in dozens of companies located in different regions. However, since most of its investee companies have not completed their GHG inventories, Company A cannot collect their scope 1 and scope 2 emissions. Therefore, Company A wants to group its investments according to the investee companies' economic sectors and estimate emissions based on economic average values.

– Company A collected each investee company group's EEIO emission factors for each sector. Additionally, it collected the following information on the proportion of investments from an internal financial system and the investee companies' business reports.

Investee company	Investee company's total revenue (USD)	Reporting entity's share of equity (%)	Investee company sector	Investee company's revenue in the sector (%)	Sector's scope 1 and scope 2 emission factor ($kgCO_2e$/USD)
1	3,000,000	5	Cathode material supply	100	0.6
2	7,500,000	15	Separator R&D	100	0.5
3	1,150,000	20	Electrolyte R&D	100	3
4	5,500,000	10	Waste battery collection	60	2
			Waste battery disposal	40	1.5

– Therefore, using the average-data method, the total emissions from Company A's equity investments are calculated as follows:

Σ((investee company's total revenue (USD) × investee company's revenue in sector (%) × emission factor for investee company's sector ($kgCO_2e$/USD revenue)) × share of equity (%))

= (3,000,000 × 100% × 0.60) × 0.05 + (7,500,000 × 100% × 0.5) × 0.15 + (1,150,000 × 100% × 3) ×0.20 + ((5,500,000 × 60% × 2) + (5,500,000 × 40% × 1.5)) × 0.10
= 90,000 + 562,500 + 690,000 + 900,000
= 2,242,500 $kgCO_2e$

(2) Project finance and debt investments

- Company A, a rechargeable battery manufacturer, has debt investments in several public facilities and infrastructure companies for a project to construct a new R&D center. Company A conducts its initial calculation of scope 3 emissions in the reporting year, and due to time and resource constraints, it plans to cooperate with its investee companies starting the following year.
- Company A collected the following data from its internal data management system.

Project type	Project phase	Construction cost or project revenue in the reporting year (USD million)	Relevant EEIO sector	EEIO emission factor (scope 1 and scope 2 only) (tonnes CO_2e/ USD million)	Reporting entity's share of equity (%)
Road construction	Construction	20	Non-residential structures	310	7
Hospital construction	Construction	8	Non-residential commercial and medical structures	325	10
Cathode material manufacturing facilities	Operation	3	Cathode material plants	500	5
Coal-fired power plants	Operation	15	Power generation and supply	9,000	5

- Therefore, using the average-data method, the total emissions from Company A's project finance and debt investments (where the use of the proceeds is known) are calculated as follows:

Σ(construction cost or project revenue in the reporting year (USD million) × emission factor of relevant sector (tonnes CO_2e/USD million) × share of total project costs (%))

= ((20 × 310) × 0.07) + ((8 × 325) × 0.10) + ((3 × 500) × 0.05) + ((15 × 9,000) × 0.05)
= 434 + 260 + 75 + 6,750
= 7,519 tonnes CO_2e

4. Matters to Be Considered on Application

(Category distinction) Depending on the reporting entity's approach to setting its organizational boundaries, the reporting context for each investment activity may be scope 1, scope 2, or scope 3. Therefore, the reporting entity should refer to "01. Setting Organizational Boundaries" in "II. Building a Scope 3 Greenhouse Gas Inventory" in this guide to avoid duplicate calculations or omissions of investment-related emissions. That is, the reporting entity should review investments not included in scope 1 or scope 2 based on its asset accounting system to ensure the completeness of its disclosures. Additionally, if any entities are excluded from reporting based on a materiality assessment, the reporting entity should provide clear reasons.

[Reference 1]

Emission scope by organizational boundary approach*

Asset type \ Organizational boundary setting		Equity share approach	Financial control approach With operational control	Operational control approach	
				With operational control	Without operational control
Consolidated group	Subsidiaries (>50%)	The related entity's scope 1, 2, and 3 data are reflected in the parent entity's scope 1, 2, and 3 data, respectively, proportional to its equity share.	100% of the subsidiary's scope 1, 2, and 3 data is reflected in the parent entity's scope 1, 2, and 3 data, respectively.	100% of scope 1, 2, and 3 data of the subsidiary, associate company, joint venture, or investor is reflected in the parent entity's scope 1, 2, and 3 data, respectively	The scope 1 and 2 data of the related entity are reflected in the parent entity's scope 3 category 15, proportionate to its equity share. (Applicable only if the related entity's scope 3 is of relevant magnitude.)
	Joint operation		The joint operation's scope 1, 2, and 3 data are reflected in the parent entity's scope 1, 2, and 3 data, respectively, proportional to its equity share.		
Unconsolidated group	Joint venture/ associate company (20%–50%)		The parent entity's scope 1, 2, and 3 data subsumes any related entity's data proportional to its equity share.** (Applicable only if the related entity's scope 3 is of relevant magnitude.)		
	Non-equity method investor (<20%)		The parent entity's data for scope 3 category 15 subsume any investor's scope 1 and scope 2 data proportional to its equity share.** (Applicable only if the related entity's scope 3 is of relevant magnitude.)		

Note: * This table is based on interpretations of the GHG Protocol and IFRS S1 and S2 as of December 2023. However, due to inconsistencies regarding organizational boundaries in the GHG Protocol and other disclosure standards (such as IFRS), it is unclear how to interpret some aspects. The table may be updated in the future as the GHG Protocol is revised.

** To avoid double-counting, emissions that overlap across scope 3 categories are accounted for in only one category. The GHG Protocol does not specify a priority for determining categories, but it does require that the basis for these determinations be documented.

List of Abbreviations

CDP	Carbon Disclosure Project
CFB-EV	Carbon Footprint of Electric Vehicle Batteries
CO_2e	Carbon dioxide equivalent
DB	Database
DQR	Data quality rating
EC PEF	European Commission product environmental footprint
EEIO	Environmentally extended input-output
EoL	End of life
EPA	Environmental Protection Agency
ESRS	European Sustainability Reporting Standards
EU	European Union
EV	Electric vehicle
GeR	Geographical representativeness
GHG	Greenhouse gas
GWP	Global warming potential
IBG	Industry-based guidance
IFRS	International Financial Reporting Standards
ILCD	International Reference Life Cycle Data
IPCC	Intergovernmental Panel on Climate Change
ISSB	International Sustainability Standards Board
JSON-LD	JavaScript object notation for linked data
KEITI	Korea Environmental Industry and Technology Institute
KRW	Korean won
LCA	Life-cycle assessment
LCI	Life-cycle inventory
LPG	Liquefied petroleum gas
MOE	Ministry of Environment
PEFCRs	Product environmental footprint category rules
PHEV	Plug-in hybrid electric vehicle
PWB	Printed wiring board
R&D	Research and development

SEC	Securities and Exchange Commission
T&D	Transmission and distribution
TeR	Technological representativeness
TEU	Twenty–foot equivalent unit
TF	Task force
TiR	Time–related representativeness
US	United States
WtE	Waste–to–energy

Reference

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