GREENHOUSE GAS PROTOCOL WORLD RESOURCES INSTITUTE World Business Council for Sustainable Development

Greenhouse Gas Protocol Scope 3 TWG

Discussion Paper A.1

Scope 3, Inventory Quality

(Chapter 7, "Collecting Data" and *Technical Guidance*)

WORKING DRAFT: DO NOT CITE

This discussion paper intends to address issues concerning inventory quality, related to aspects of data quality, calculation methods, uncertainty, etc. This discussion paper has been provided to scope 3 Technical Working Group (TWG) to contribute to the update process of the *GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard* (2011) (referred to as the "*Scope 3 Standard"*) and *Corporate Value Chain (Scope 3) Accounting Scope 3 Technical Guidance* with potential application or relevance for the *Corporate Standard* and *Scope 2 Guidance*.

The objective of this discussion paper is to consolidate relevant information for consideration. This includes a summary of current GHG Protocol standard requirements and guidance, background information and context, key terms (as needed), a summary of the requirements and guidelines from other frameworks and programs (where relevant), references to relevant research and summaries thereof (where necessary), a summary of stakeholder feedback from the recent scope 3 stakeholder survey, an overview of options for consideration, and an analysis of these options according to the decision-making criteria specified by the GHG Protocol.

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Abstract

This discussion paper is intended for directional considerations for the Scope 3 Technical Working Group ("TWG") in the first phase of the scope 3 technical update process. This discussion paper considers inventory quality and inventory quality disclosure as one of the key issues for corporate GHG emissions accounting and reporting, and presents options for improvements.

Preparation of scope 3 inventories may be intended to meet different objectives, each of which may require different levels of inventory quality. Thus, different levels of inventory quality have their place in practice. However, users of reported GHG information need more clarity on the quality of inventories they use. Thus, inventory quality disclosure is a major focus.

Three general options (none of which are necessarily mutually exclusive) are outlined in this paper:

- Option 1. Improved implementation of current GHG Protocol requirements
- Option 2. Data quality scoring
- Option 3. Disaggregated reporting based on quality

For each option, the paper provides a description of the option, considerations for developments and decisions, example(s), implications for other aspects of revisions, discussion points, and decision-making criteria assessment.

Key terms

Glossary

Term	Definition
Activity data	A quantitative measure of a level of activity that results in GHG emissions. Activity data is multiplied by an emissions factor to derive the GHG emissions associated with a process or an operation. Examples of activity data include kilowatt-hours of electricity used, quantity of fuel used, output of a process, hours equipment is operated, distance traveled, and floor area of a building
Allocation	The process of partitioning GHG emissions from a single facility or other system (e.g., vehicle, business unit, corporation) among its various outputs.
Cradle-to-gate	All emissions that occur in the life cycle of purchased products, up to the point of receipt by the reporting company (excluding emissions from sources that are owned or controlled by the reporting company)
Economic allocation	Allocating the emissions of an activity based on the market value of each output/product
Extrapolated data	Data from a similar process or activity that is used as a stand-in for the given process or activity, and has been customized to be more representative of the given process or activity.
First party assurance	Person(s) from within the reporting company but independent of the GHG inventory process conducts internal assurance. (Also called "self-" or "internal-assurance.")
Level of assurance	Refers to the degree of confidence stakeholders can have over the information in the inventory report.
Life cycle assessment	Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.
Material misstatement	Individual or aggregate errors, omissions and misrepresentations that significantly impact the GHG inventory results and could influence a user's decisions.
Materiality	Concept that individual or the aggregation of errors, omissions and misrepresentations could affect the GHG inventory and could influence the intended users' decisions.
Physical allocation	Allocating the emissions of an activity based on an underlying physical relationship between the multiple inputs/outputs and the quantity of emissions generated.
Primary data	Data from specific activities within a company's value chain.
Process	A set of interrelated or interacting activities that transforms or transports a product.

Product	Any good or service
Proxy data	Data from a similar process or activity that is used as a stand-in for the given process or activity without being customized to be more representative of the given process or activity.
Secondary data	Data that is not from specific activities within a company's value chain.
Third party assurance	Person(s) from an organization independent of the GHG inventory process conducts third party assurance. (Also called "external assurance.")
Uncertainty	1. Quantitative definition: Measurement that characterizes the dispersion of values that could reasonably be attributed to a parameter. 2. Qualitative definition: A general and imprecise term that refers to the lack of certainty in data and methodology choices, such as the application of non-representative factors or methods, incomplete data on sources and sinks, lack of transparency etc.

Source: GHG Protocol *Scope 3 Standard*

Abbreviations

CSRD	Corporate Sustainability Reporting Directive
DQ	Data quality
DQI	Data quality indicator
DQR	Data quality rating
EC	European Commission
EEIO	Environmental-Extended Input-Output
EPA	Environmental Protection Agency
ESRS	European Sustainability Reporting Standard
GHG	Greenhouse gas
IFRS	International Financial Reporting Standards
LCA	Life cycle assessment
PACT	Partnership for Carbon Transparency
PCAF	Partnership for Carbon Accounting Financials
PCF	Product carbon footprint
PEF/OEF	Product Environmental Footprint / Organisational Environmental Footprint
SBTi	Science Based Targets Initiative
TfS	Together for Sustainability

1. Background information and context

Data quality of scope 3 emissions is cited as a challenge in scope 3 GHG emissions accounting and reporting. A stakeholder survey conducted by SBTi and published in 2023[1] provides an overview of the challenges that companies face for scope 3 accounting and reporting in the context of target setting. This survey covered 230 organizations across geographies and sectors[2].

Limited access to reliable data, and therefore quality and actionability of inventories, was identified by the survey respondents as a key barrier to developing robust baselines (identified by 85% of respondents), tracking the impact of decarbonization (58%), and achieving targets (59%). Both access to supplier-specific emission factors (emissions data) and supplier-specific activity data were identified as challenging. Moreover, supplier-specific emission factors (emissions data), when available and/or provided, often exhibit poor data quality and are therefore not reliable. The majority of respondents (57%) understandably see reducing the procurement budget as the only decarbonization action if a spend based method is used for accounting.

The survey showed predominant use of activity-based and spend-based methods for calculation of scope 3 emissions. Only 6% of respondents use supplier-specific emissions factors, which while provided by suppliers are said to "typically combine measured emissions from supplier operations and estimated emissions from a suppliers' upstream value chain". Most respondents indicated to source their emissions factors from publicly available databases with approximately half to also deploy privately held emissions factor data.

[1] SBTi "Catalyzing Value Chain Decarbonization: Corporate Survey Results" (2023), SBTi-The-Scope-3-challenge-survey-results.pdf (sciencebasedtargets.org)

[2] Note that this sample exhibited inherent sampling bias as 85% of surveyed companies either had a validated science-based target or were committed to setting a target with the SBTi. This reflects a particular purpose, objective, and audience for said surveyed companies' scope 3 inventories. This sample of companies may exhibit more advanced data management practices than most users of the GHG Protocol *Scope 3 Standard*. Further, based on the SBTi Monitoring Report 2023, this sample size may reflect input from approximately, exclusively, corporations and not that of small-to-medium-sized enterprises (SMEs).

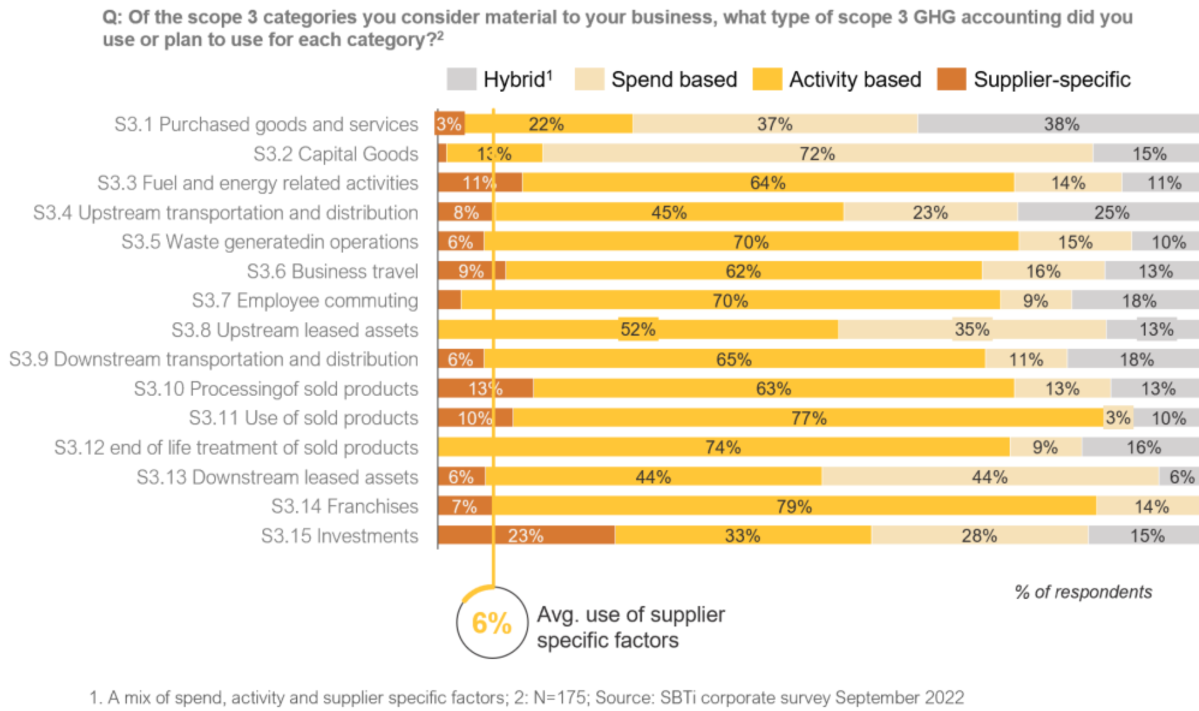

Figure 1. Type of emission factors used for base year reporting, count of entries

Source: SBTi 2023, p.14.[3]

As a follow up to the unveiled challenges, a discussion paper issued by SBTi in 2024[4], considers options to enhance scope 3 target setting by prioritizing action on the most climate-relevant activities within the value chain. In this context, the SBTi warns that "implementing prioritization may require a high-quality emissions inventory and much more granular understanding of emissions sources" (p. 31). The paper emphasizes the need for improvements.

Similar findings are presented in a study commissioned by WRI in 2022[5], based on a sample of CDP reports submitted by companies and made available for public disclosure, focusing on calculation methods. This report found that this sample of companies predominantly uses secondary data for accounting and reporting scope 3 emissions (82%), while less than half of reported scope 3 inventories underwent some level of verification.

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[3] SBTi "Catalyzing Value Chain Decarbonization: Corporate Survey Results" (2023), [SBTi-The-Scope-3-challenge-survey-results.pdf (sciencebasedtargets.org)]

[4] Aligning corporate value chains to global climate goals. SBTi Research: Scope 3 Discussion Paper; [SBTi Aligning Corporate Value Chains Scope 3 Discussion Paper (sciencebasedtargets.org)]

[5] Lloyd, S.M., Hadziosmanovic, M., Rahimi, K. Scope 1 and Scope 3 Literature Review and Practice Analysis, 2022

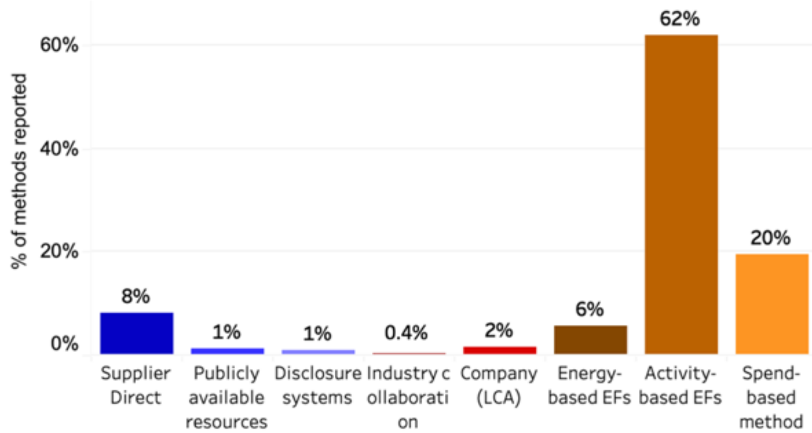

Figure 2. calculation methods identified for CDP reporting (cat. 1-6, 8) by manufacturing and service companies in the sample, count of entries (copied from (WRI 2022[6], p. 64).

Overview of challenges in scope 3 accounting, collected during the recent meeting of the independent group of corporate users of the *Scope 3 Standard* Scope 3 Peer Group, (Scope 3 Peer Group, 2024[7]) shows that data management and calculation methods are among top 5 topics posing highest challenges for Scope 3 managers, highlighting the following points in particular:

- Collecting high-quality supplier emissions data
- Validating and ensuring accuracy of primary data
- Standardizing methodologies for data collection
- Using data for actionable insights and progress measurement
- Improving Scope 3 accounting methods

Further discussions within the group bring up the need for solutions relevant for work of accounting standards (ibid):

- Standardization of data quality and calculation methods to advance accuracy, consistency, and transparency
- Harmonization of requirements to allow for cross-functional use of data (e.g. for use for CBAM)
- Guidance on the efficient transition from spend-based to activity data accounting
- More guidance on how to collect, track, and validate scope 3 data
- Consider prioritization of activities between data collection and decarbonization efforts

Shrimali (2022)[8] attributes low consistency of scope 3 emissions to different data sources and estimation methods, noting that data from commercial data providers is highly inconsistent, with correlations as low as 1. He further notes the complication of the situation through lack of transparency in scope 3 category coverage, and argues that whatever data quality is taken, each approach results in producing data that is unreliable to some degree. Shrimali notes the first challenge on the way to improvements to be answering how to combine data of different reliability.

[6] Lloyd, S.M., Hadziosmanovic, M., Rahimi, K. Scope 1 and Scope 3 Literature Review and Practice Analysis, 2022
[7] Scope 3 Peer Group "The Scope 3 Strategy Day", 2024. [Demographics (squarespace.com)]
[8] Shrimali, Gireesh. "Scope 3 emissions: measurement and management." The Journal of Impact and ESG Investing 3, no. 1 (2022): 31-54.

2. Summary of Stakeholder Feedback

Between November 2022 and March 2023, the public was invited to provide feedback on the current suite of corporate standards and guidance, including the *Scope 3 Standard* and *Technical Guidance*, and provide suggestions for either maintaining current practices or developing updates and new or additional guidance.

Approximately 350 individuals and/or organizations submitted feedback through the Scope 3 stakeholder survey, from all regions of the world and types of organizations. Refer to the Detailed Survey Summary and Proposals Summary for further detail on feedback and proposals received from stakeholders. Feedback related to, specifically, inventory quality and related topics is summarized below.

2.1 Disclosure related feedback

Some respondents asserted that the GHG Protocol should communicate more caution that scope 3 inventory results can be unreliable and incomparable, depending on data quality. Some respondents cautioned that varying levels of data quality often go undisclosed and undistinguished, including due to differing calculation methods, data inputs, assurance levels, and/or non-conformance. Several asserted that this can compromise GHG inventory accuracy and relevance.

2.2 Practical challenges

Respondents expressed that the limited availability of supplier-specific emissions and activity data, and paywalled secondary emission factors for purchased products, remains one of the biggest challenges to scope 3 GHG emissions accounting and reporting. Several respondents noted that value chain entities exhibit varying levels of adoption, capacity, data management protocols, levels of verification, and data quality.

Data management, including collecting activity data, allocating emissions data, keeping records, exchanging data, reviewing supplier-specific emissions data, and integrating various workflows for auditing and control, was a commonly mentioned challenge for respondents. Several respondents recommended developing tools and templates for collecting and transferring supplier-specific data to improve the reliability and accuracy of value chain emissions data. Some asserted that standardization is necessary for interoperability and efficient data exchange between autonomous software solutions.

Respondents described the constraints and challenges faced by both SMEs and large-cap enterprises. SMEs face acute capacity and cost constraints. Third-party manufacturers do not often feasibly prioritize data collection for SME clients. Large-cap businesses face complex supply chains and data management challenges. Despite the internal capacity and budget to perform data collection, some argue that the sheer scale and complexity of data management cannot be overcome absent market-wide adoption of GHG accounting and reporting. Adoption would necessitate enhanced standardization to bring down the cost of data management. A few respondents asserted that organizations cannot feasibly implement GHG accounting using supplier-specific data absent regulation mandating and enforcing controls to ensure that inputs and results are reliable, accurate, complete, and consistent.

2.3 Input data related

Respondents requested data quality guidance in the context of using specific calculation methods. Many cautioned that too many companies are relying on approximations due to data limitations. A few respondents asserted that permitting the use of secondary data undermines attempts at holding companies accountable.

Many respondents requested support in sourcing, verifying, calculating, and using emission factors. Some asserted that the optionality in the *Scope 3 Standard* and the limited consistency in selecting emission factors negatively affects adoption of GHG accounting and the reliability of GHG inventory results. Some asserted that the absence of a uniform database of emission factors coupled with this optionality is a major contributing factor that undermines the cross-comparability of GHG inventories internally and between companies.

Several respondents pointed out that emission factors often include multiple assumptions (e.g., scope and boundary, functional unit, allocations, global warming potential values, etc.) with implications for consistency. Some identified various business activities for which secondary LCA emission factors are needed and acknowledged differing needs by various industries and companies.[9]

Some respondents expressed uncertainty regarding what information is needed from suppliers to verify their supplier-specific emissions or activity data. Many suppliers providing supplier-specific emissions data suffer "survey fatigue" submitting data and information in accordance with multiple climate disclosure programs. Some respondents recommend coordinating data compilation requirements and information templates between various climate programs and disclosure frameworks.

Data access also influenced some respondents' position on encouraging the use of primary data versus making scope 3 disclosure mandatory[10].

2.4 Balance between accuracy, completeness, and action

Some respondents expressed the need to balance flexibility with accuracy, including balancing efforts to improve data quality and "perfect" measures versus informing decisions to act. Several respondents requested more guidance on using industry estimates, secondary data, and proxies, in the context of improving calculation methodologies — as companies integrate hybrid methods for supply chain measures.

Several respondents requested guidance on prioritizing data collection for significant sources. Some respondents expressed concern that a reporting company's capacity to influence emissions sources varies significantly and is often not aligned with the most significant emissions sources, for example, for manufacturers of fashion, apparel, beauty or electronics products, for which direct and indirect emissions in use of sold products may account for most product life cycle emissions. Some asserted that the potential disconnect between emissions vs. capacity to influence may misdirect efforts and resources.

Others identified that emission factor granularity is necessary to improve the completeness and relevance of scope 3 inventories. Some respondents asserted that brand-specific product-level

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[9] Products and business activities include raw materials (including industry-specific), intermediate products (pre-processed materials, components), precursor manufacturing (sometimes termed pre-processing), land-use change (LUC), deforestation, animal- and plant-based fibrous materials, rail, transportation, and oil and gas.

[10] Consideration of mandatory Scope 3 calculation and disclosure for Corporate Standard compliance is considered in the Corporate Standard update workstream

emission factors are needed to supplement aggregated data, and that this would help the market assess climate action and performance. At the same time, it was asserted that calculation methods relying on secondary data are less reliable or accurate than results that rely on combustion emission factors and primary data. They recommended mandating or encouraging the use of primary data.

Others asserted that currently available emission factors, via public and paywalled life cycle inventory (LCI) databases, are sufficient for companies to identify hotspots and to inform decarbonization activities and capital allocation. Other respondents asserted that the *Scope 3 Standard* should not require the development of primary data nor audit-quality data, in recognition of the inherent uncertainties in emissions estimates that must unavoidably use secondary data. Some asserted that companies should prioritize setting and achieving climate goals rather than focusing on measurement goals. They asserted that primary data provides limited new or uniquely actionable information for companies in terms of prioritizing mitigation and decarbonization activities, especially absent regulations that internalize the price of carbon.

2.5 Requirements for data quality

Respondents requested guidance on data quality improvements, data hierarchies, and provided feedback on restricting versus encouraging data quality improvements over time. Many respondents requested guidance concerning improving GHG inventory reliability and identified the need for clearer guidance on the type and quality of data needed for different purposes, including internal benchmarking versus external performance metrics and claims. Some asserted that improving data quality should be required, not just encouraged. A few asserted that the *Scope 3 Standard* needs to increase the use of primary data based on actual production systems to drive investment in empirically validated solutions. However, others stated that improving accuracy should be mandated by external programs, disclosures frameworks, and government agencies and legislators, rather than GHG Protocol.

2.6 Calculation methods

There was criticism of the spend-based method. Respondents recommended either removing it entirely, phasing it out (e.g., over 3 years), limiting its use (e.g., exclusively for hotspot identification or for immaterial categories), keeping it as a proxy method, or extending and specifying its use for all scope 3 categories.

Some respondents asserted that emissions results quantified using the spend-based method are inaccurate and therefore not good measures of emissions. Inventories using spend-based calculations do not, they asserted, meet the accounting requirements of accuracy and relevance. Some asserted that the spend-based method does not provide reliable information to inform decarbonization. Others asserted that unreliable results misrepresent a reporting entity's indirect emissions and are misleading without transparent methodological disclosures.[11]

Several factors were noted as affecting the method's unreliability and potentially large margin of error, including non-industry-specific factors, generic categories, uneven data availability, long time-lags in updates, regional variability, and using inconsistent financial line-items. In addition, it was noted that the spend-based method is not reliable for tracking or differentiating value

[11] (*Scope 3 Standard*, p. 121) states that reporting companies "**shall**" publicly report "separately by scope 3 category… a description of the types and sources of data… methodologies, allocation methods, and assumptions" relied upon and "the percentage of emissions calculated using [primary] data obtained from suppliers or other value chain partners".

chain performance. For example, a company that pays a higher price for high-quality components or materials may calculate higher GHG emissions when using generic environmentally-extended input output (EEIO) emission factors.

Most respondents who raised the topic of the spend-based method requested that the GHG Protocol limit its use and/or provide more guidance on how to use it effectively. Some respondents requested that the *Scope 3 Standard* and the *Product Standard* be revised to focus on accounting for emissions using primary value chain data from suppliers. Arguments were made in support of moving away from the spend-based method to encourage the use of primary data and to move the market in the direction of improving the cross-comparability of GHG inventory results between companies, rather than all companies reporting "industry average" emissions which are undifferentiated. Counter to this, some respondents cautioned against restricting the spend-based method due to the absence of reliable or cost-effective data and management tools necessary to quantify emissions using other methods. It was argued that removing the spend-based method would make compliance impossible for many reporting companies.

2.7 Uncertainty

Generally, some respondents asserted that users of the *Scope 3 Standard* need more prescriptive guidelines to reduce uncertainty and to fill in data gaps. This includes guidance on optionality, emission factor uniformity, parameter selection, and data quality, all of which make normative uncertainty measures difficult if not impossible. Some asserted that the GHG Protocol should focus on improving disclosure designations for companies to set or determine uncertainty thresholds. Others assert that uncertainty thresholds should distinguish upstream versus downstream estimates as each generally has different levels of uncertainty and/or "risk profiles". Some asserted that upstream and downstream estimation uncertainty should not be conflated. Some respondents requested that the GHG Protocol provide tools to assess the robustness and/or uncertainty of reported scope 3 emissions, especially with rapid adoption and as data quality improves.

3. Current GHG Protocol requirements and guidance

3.1 Accounting and reporting principles

The *Scope 3 Standard* includes the following requirement (p. 23):

- GHG accounting and reporting of a scope 3 inventory **shall** be based on the following principles: relevance, completeness, consistency, transparency, and accuracy.

Guidance on applying the relevance principle to data quality is included in chapter 4 and 7, such as:

- Companies should use the principle of relevance as a guide when selecting data sources.
- Companies should collect data of sufficient quality to ensure that the inventory is relevant (i.e., that it appropriately reflects the GHG emissions of the company and serves the decision-making needs of users). Selection of data sources depends on a company's individual business goals. More information on relevance and data collection is provided in chapter 7. (p. 24)

3.2 Calculation methods

The *Scope 3 Standard* specifies two quantification methods: direct measurement and calculation (see Figure 3 below). Direct measurement can be done, for example, using continuous emissions monitors (CEMS) that measure the concentration and flow-rate of gases exiting exhaust pipes. Table 7.1 and 7.2 of the Standard (Figure 3) provide a general calculation formula and types of data used.

Table [7.1] Quantification methods

Quantification method	*Description*	*Relevant data types*
Direct measurement	Quantification of GHG emissions using direct monitoring, mass balance or stoichiometry **GHG = Emissions Data x GWP**	Direct emissions data
Calculation	Quantification of GHG emissions by multiplying activity data by an emission factor **GHG = Activity Data x Emission Factor x GWP**	Activity data Emission factors

Table [7.2] Examples of activity data and emission factors

Examples of activity data	*Examples of emission factors*
• Liters of fuel consumed	• kg CO_2 emitted per liter of fuel consumed
• Kilowatt-hours of electricity consumed	• kg CO_2 emitted per kWh of electricity consumed
• Kilograms of material consumed	• kg PFC emitted per kg of material consumed
• Kilometers of distance traveled	• t CO_2 emitted per kilometer traveled
• Hours of time operated	• kg SF_6 emitted per hour of time operated
• Square meters of area occupied	• g N_2O emitted per square meter of area
• Kilograms of waste generated	• g CH_4 emitted per kg of waste generated
• Kilograms of product sold	• kg HFC emitted per kg of product sold
• Quantity of money spent	• kg CO_2 emitted per unit of currency spent

Figure 3. Calculation formula and types of data

In practice, the types of data used has an impact on the typology of calculation methods. Multiple calculation methods and formulas are itemized in the *Technical Guidance for Calculating Scope 3 Emissions* for each scope 3 category, ranked in order of specificity, including guidance for emission factor selection. Appendix D (p. 162-182) of the *Technical Guidance* aggregates the formulae possible/listed for use per category. Table 1 summarizes the calculation methods listed in Appendix D.

Table 1. Calculation methods and data types

Category	Calculation methods				
	Method 1	**Method 2**	**Method 3**	**Method 4**	**Method 5**
Category 1	Supplier-specific	Hybrid[12]	Average-data	Spend-based	
Category 2	Supplier-specific	Hybrid[1]	Average-data	Spend-based	
Category 3	Supplier-specific	Average-data			
Category 4[13]	Fuel-based	Site-specific	Distance-based	Average-data	Spend-based
Category 5	Supplier-specific	Waste-type-specific	Average-data		
Category 6	Fuel-based	Distance-based	Spend-based		
Category 7	Fuel-based	Distance-based	Average-data		
Category 8	Asset-specific	Lessor-specific	Average-data		
Category 9[2]	Fuel-based	Site-specific	Distance-based	Average-data	Spend-based
Category 10	Site-specific	Average-data			
Category 11[14]	Fuel-/electricity-based[15]	Fuels/Feed-stocks[16]	Contained/forming[17]	Average-data	
Category 12	Waste-type-specific[18]				
Category 13	Asset-specific	Lessee-specific	Average-data		
Category 14	Franchise-specific	Average-data			
Category 15	Investment-specific[19]	Project-specific[20]	Average-data		

Calculation methodologies are summarized based on calculation method classifications from the *Technical Guidance* (Appendix D, p. 162-182). Note: This figure presents a summary of calculation methods only; readers should refer to the *Scope 3 Technical Guidance* and Appendix D therein for calculation guidance to ensure *Scope 3 Standard* conformance. Calculation methods are color-coded based on the activity data and/or emission factor data type for which

[12] Including "where supplier-specific activity data is available for all activities associated with producing the purchased goods" or "where only allocated scope 1 and 2 emissions and waste data are available from supplier" (*Scope 3 Technical Guidance*, p. 164).
[13] For both upstream and downstream transportation and distribution (category 4 and category 9), the fuel-based method, distance-based method, and spend-based method are specified for calculating emissions from transportation, while the site-specific method and average-data method are specified for calculating emissions from distribution.
[14] Not that calculation methods for category 11 are itemized separately for Direct Use-Phase Emissions vs. Indirect Use-Phase Emissions.
[15] Specifically: "Products that directly…" and/or "indirectly consume energy (fuels or electricity) during use" (*Scope 3 Technical Guidance*, p. 177-178).
[16] The Fuels and Feed-stocks method is only itemized for Direct Use-Phase Emissions.
[17] Specifically: "Greenhouse gases and products that contain or form greenhouse gases that are emitted during use" and/or "Intermediate products that directly consume energy (fuels or electricity) during use" (*Scope 3 Technical Guidance*, p. 177).
[18] Relying on "Average waste treatment specific emission factors based upon all waste disposal types" (*Scope 3 Technical Guidance*, p. 179).
[19] The investment-specific method is specified for calculating emissions from equity investments.
[20] The project-specific method is specified for calculating emissions from project finance and from debt investments with known use of proceeds.

they are specified: primary, hybrid, average/secondary (in some cases, some primary data may specify alternative formulas that use secondary data) and spend-based separately.

The *Technical Guidance* provides decision trees to select calculation methods, including:

- Figure 1.2 (p. 23) for purchased goods and services (category 1)
- Figure 4.1 (p. 51) for upstream transportation and distribution (category 4)
- Figure 5.2 (p. 73) for waste generated in operations (category 5)
- Figure 6.1 (p. 82) for business travel (category 6)
- Figure 7.1 (p. 88) for employee commuting (category 7)
- Figure 8.1 (p. 95) for upstream leased assets (category 8)[21]
- Figure 10.1 (p. 107) for processing of sold products (category 10)
- Figure 15.1 (p. 141) for equity investments (category 15)
- Figure 15.2 (p. 147) for debt investments (category 15)

Calculation methods are prioritized based on the specificity of data inputs (i.e., activity-data or spend-based data and associated emission factors). One of the conditions of the preference of supplier-specific and/or the hybrid calculation method for purchased goods and services (category 1) is that suppliers are be able to provide allocated scope 1 and scope 2 data of sufficient quality, that most appropriately reflects the GHG emissions of the company, supports the company's business goals for conducting the GHG inventory, and serves the decision-making needs of users (Figure 1.2 of the *Technical Guidance*, p.23). The spend-based method is itemized in decision trees in Figure 1.2 (for category 1), Figure 4.1 (for category 4), and Figure 6.1 (for category 6).

3.3 Data Quality

Section 7.1 of the *Scope 3 Standard* (p. 65-67) provides guidance for prioritizing data collection efforts. It states that "companies should prioritize data collection efforts on the scope 3 activities that are expected to have the most significant GHG emissions, offer the most significant GHG reduction opportunities, and are most relevant to the company's business goals. Collecting higher quality data for priority activities allows companies to focus resources on the most significant GHG emissions in the value chain, more effectively set reduction targets, and track and demonstrate GHG reductions over time." Further, "companies may use a combination of approaches and criteria to identify priority activities. For example, companies may seek higher quality data for all activities that are significant, activities that present larger risks and opportunities in the value chain, or activities for which more accurate data can be readily obtained" (p. 65). The Standard specifically provides an overview of prioritizing activities based on the magnitude of the GHG emissions (with an initial screening), and on financial spend or revenue.

Section 7.2 of the *Scope 3 Standard* provides an overview of quantification methods and data types, including guidance on activity data and emission factors. The calculation method relies on the basic formula:

Activity data x Emission factor x GWP value

Activity data includes inputs such as material weight, fuel/liquid volume, electric energy, chemical energy, distance traveled, weight-distance freighted, gross floor area, number

[21] Note that Figure 8.1 does not specify the spend-based method.

of products, and amount of money spent or earned. Emission factors are given as expressed mass of GHG emitted per unit of activity data. Energy emission factors are further categorized into combustion emission factors and life cycle emission factors.

The quality of a scope 3 inventory "depends on the quality of the data used to calculate emissions" (*Scope 3 Standard*, p. 74), including emission factors, GWPs, and activity data. Companies are required to report a description of the types and sources of data used to calculate emissions, and the percentage of emissions calculated using data obtained from value chain partners.

The *Scope 3 Standard* provides guidance on data quality in section 7.3, "Guidance for selecting data" (p. 74-77). When choosing data sources, companies should seek the highest quality (most representative) data available and reasonably obtainable. Data quality is defined by:

- Technology representativeness
- Time representativeness
- Geography representativeness
- Completeness
- Reliability

Example data quality indicators are provided with scoring from Poor to Very good.

Data typology in Section 7.2 considers:

- Primary data – data from specific activities within a company's value chain
- Secondary data –data that is not from specific activities within a company's value chain

Both activity data and emission factors can be primary or secondary data. Although it is not necessarily true, usually it is presumed that primary data is more representative than secondary data.

"In general, companies should collect high quality, primary data for high priority activities (see section 7.1). **To most effectively track performance, companies should use primary data collected from suppliers and other value chain partners** [emphasis added] for scope 3 activities targeted for achieving GHG reductions." (*Scope 3 Standard*, p. 74)

Table 7.5 compares the advantages and disadvantages of primary data and secondary data (*Scope 3 Standard*, p. 74).

"In some cases, primary data may not be available or may not be of sufficient quality. In such cases, **secondary data may be of higher quality than the available primary data for a given activity** [emphasis added]. Data selection depends on business goals. If the company's main goal is to **set GHG reduction targets, track performance** [emphasis added] from specific operations within the value chain, or engage suppliers, the company should **select primary data** [emphasis added]. If the company's main goal is to **understand the relative magnitude** [emphasis added] of various scope 3 activities, identify hot spots, and prioritize efforts in primary data collection, the company should **select secondary data** [emphasis added]. In general, companies should collect secondary data for:

- Activities not prioritized based on initial estimation methods or other criteria (see section 7.1)
- Activities for which primary data is not available (e.g., where a value chain partner is unable to provide data)

- Activities for which the quality of secondary data is higher than primary data (e.g., when a value chain partner is unable to provide data of sufficient quality)

Companies are required to report a description of the types and sources of data (including activity data, emission factors, and GWP values) used to calculate emissions, and the percentage of emissions calculated using data obtained from suppliers or other value chain partners (see chapter 11)."

(*Scope 3 Standard*, p. 75)

Supplier data is further ranked by the level of specificity (level of aggregation in data collection):

- Product-level
- Activity-, process-, or production line-level
- Facility-level
- Business unit-level
- Corporate-level

Product-level data is said to be more precise. The accuracy and representativity is seen to be declining with extending the level of aggregation. (*Scope 3 Standard*, p. 79)

With regard to the secondary data, the Standard states that companies should prioritize databases and publications that are internationally recognized, provided by national governments, or peer-reviewed. Proxy data may be used to fill data gaps. For guidance on collecting secondary data, including using proxy data to fill data gaps, refer to p. 83 in Chapter 7 of the *Scope 3 Standard*.

Section 7.6 (*Scope 3 Standard*, p. 84) provides guidance on data improves and states that "companies should seek to improve the data quality" of its GHG inventories over time, "by replacing lower quality data with higher quality data as it becomes available." Further, the *Scope 3 Standard* recommends focusing on high-emitting activities (hotspots) and includes Appendix B on uncertainty guidance.

Appendix C, Data Management Plan, of the *Scope 3 Standard* presents guidance on maintaining a data management plan which documents internal quality assurance and quality control (p. 132-137).

3.4 Use of monetary indicators and measures

Monetary measures are specified in the *Scope 3 Standard* as tools for:

- Prioritizing or identifying potential emission hotspots (*Scope 3 Standard*, p. 66);
- Allocating GHG emissions (e.g., revenue-based economic allocations (Box 8.2, *Scope 3 Standard*, p. 91); or
- Creating GHG-intensity targets and other performance metrics (e.g., emissions per unit of revenue) (Table 9.3, *Scope 3 Standard*, p. 102).

Building on the emissions calculations for activity prioritization and hotspot analysis, spend-based emissions calculation methods are listed among the calculation methods specified in the *Technical Guidance* (summarized in Appendix D).

Box 7.1 of the *Scope 3 Standard* (p. 66) introduces the concept of EEIO models and resulting emission factors for the context of the standard and specifies that EEIO data is particularly useful in screening emission sources when prioritizing data collection efforts.

The *Technical Guidance* categorizes EEIO as secondary data and lists the following advantages and disadvantages of EEIO data in the introduction (p. 17):

Table 2. Advantages and disadvantages of EEIO

Advantages	Disadvantages
• Comprehensive coverage of the entire economy (i.e., no emissions sources are excluded from the system boundary) • Simplicity of method and application • Time and cost savings as data requirements are less onerous than in a process-based approach	• Broad sector averages may not represent nuances of unique processes and products, especially for non-homogenous sectors • Assumption of linear attribution between monetary and environmental flows provides only indicative results (i.e., EEIO models cannot distinguish between products of different monetary value within a single sector) • Lacks specificity and accuracy of process-based approaches • Difficult to measure and demonstrate results of reduction efforts • EEIO databases are generally limited to a specific geographic region, (e.g., United States) and are not available in some world regions.

The *Technical Guidance* introduces various spend-based methods, listing it as the last priority method. E.g. for Purchased goods and services, p. 33:

> "If the supplier-specific method, hybrid method, and average-data method are not feasible (e.g., due to data limitations), companies should apply the average spend-based method by collecting data on the economic value of purchased goods and services and multiplying them by the relevant EEIO emission factors."

The spend-based method is further characterized as effective for screening purposes, however also as having high levels of uncertainty (p. 65). It is allowed to combine spend-based calculations with other methods when calculating emissions within one category.

Spend-based formulas are provided as an option for some, but not all, scope 3 categories, in Appendix D of the *Technical Guidance* (p. 162-182) (summarized in Table 1).

Regarding prioritization, the *Scope 3 Standard* says: "Companies should use caution in prioritizing activities based on financial contribution, because spend and revenue may not correlate well with emissions. For example, some activities have a high market value, but have relatively low emissions. Conversely, some activities have a low market value, but have relatively high emissions. As a result, companies should also prioritize activities that do not contribute significantly to financial spend or revenue but are expected to have a significant GHG impact" (*Scope 3 Standard*, p. 66).

Economic allocation is considered in detail among the allocation methods in Chapter 8 (Allocating Emissions), as a method usually less appropriate compared to the physical allocation method. This is due to the higher possibility of yielding misleading estimates (p. 95 of the *Scope 3 Standard*). The *Scope 3 Standard* however emphasizes that a company should choose the most appropriate allocation method, which best reflects the causal relationship between the production of the product and the resulting emissions. Page 95 of the Standard in particular lists situations where economic allocation is expected to be more representative.

Regarding performance metrics, the *Corporate Standard* specifies that revenue-based metrics "must be recalculated for changes in product prices and product mix, as well as inflation" (*Corporate Standard*, Box 4, p. 76).

3.5 Uncertainty

Scope 3 Standard defines uncertainty as an indicator of how well the data represents the process in the inventory (p. 116). It is closely related to the principle of accuracy. Uncertainty is relevant to improving data quality over time (p. 84) and assurance (p. 118).

The guidance notices that "higher uncertainty for scope 3 calculations is acceptable as long as the data quality of the inventory is sufficient to support the company's goals and ensures that the scope 3 inventory is relevant (i.e., the inventory appropriately reflects the GHG emissions of the company, and serves the decision-making needs of users, both internal and external to the company)." (p.75)

Appendix B in the *Scope 3 Standard* (Uncertainty in Scope 3 Emissions) provides guidance on parameter uncertainty (p. 129), scenario uncertainty (p. 130), and modeling uncertainty (p. 131). Parameter uncertainty in itself is then considered as single parameter uncertainty and propagated (combined) parameter uncertainty (p. 127).

Types of Uncertainty	*Sources*
Parameter Uncertainty	• Direct emissions data • Activity data • Emission factor data • Global warming potential (GWP) values
Scenario Uncertainty	• Methodological choices
Model Uncertainty	• Model limitations

Figure 4. Types of uncertainty considered in the Scope 3 Standard (Table B.1)

Appendix B notes the possibility of quantitative and qualitative uncertainty assessment. It additionally lists possible quantification methods for parameter uncertainty (p. 128):

- Measurement uncertainty (represented by standard deviations)
- Data quality indicators
- Default uncertainty parameters defined for specific activities or industry data and reported in literature sources or elsewhere
- Probability distributions in databases or other data sources for data they contain
- Other approaches reported by literature

The *Scope 3 Standard* lists reporting of information on inventory uncertainty as optional (p. 120, 122). The reporting in that case would include causes of uncertainty, description of the level of uncertainty (qualitative or quantitative), and efforts to address uncertainty if it is high.

4. Other frameworks and programs (requirements and guidance)

Two main categories of external frameworks were considered for this chapter:

- Major standards or frameworks for environmental life cycle analysis (LCA)
- Mandatory and voluntary disclosure frameworks.[22]

Inclusion of LCA standards and frameworks is due to the close connection between LCA and Scope 3 accounting, both taking life cycle perspective and looking at value chains systems. "The GHG Protocol Scope 3 Standard and GHG Protocol Product Standard both take a value chain or life cycle approach to GHG accounting and were developed simultaneously. The Scope 3 Standard accounts for value chain emissions at the corporate level, while the Product Standard accounts for life cycle emissions at the individual product level. Together with the Corporate Standard, the three standards provide a comprehensive approach to value chain GHG measurement and management." (*Scope 3 Standard*, p. 8). Life cycle assessment as a framework for assessing environmental impacts, has been in use of data quality assessment for decades.

All considered frameworks set up certain expectations and descriptive guidance on data quality. For example, specifying and listing the dimensions for data quality assessment, including requiring data to be as representative as possible, requiring data quality disclosures, and providing prioritization guidance within a data quality dimension.

Several additional approaches can be found in the considered frameworks, often combined with each other:

1. **Pre-screening** or estimating the significance of all categories (European Sustainability Reporting Standards (ESRS), Science Based Targets initiative's (SBTi) Corporate Net-Zero Standard).
2. **Scoring**, i.e. using pedigree matrices to score data and calculate an aggregated score:
    a. Scoring of input data (Product Environmental Footprint / Organisational Environmental Footprint (PEF/OEF); EPA Guidance on Data Quality Assessment for Life Cycle Inventory Data. Version 1)
    b. Scoring of resulting emissions data (the Global GHG Accounting and Reporting Standard of the Partnership for Carbon Accounting Financials (PCAF); CDP; Partnership for Carbon Transparency (PACT), Together for Sustainability (TfS))
3. **Minimum requirements**, i.e. setting well-defined minimum requirements for the data used (PEF/OEF)
4. Directly **connecting data quality to the type or source of data** (TfS, PACT, International Financial Institutions Guideline for a Harmonised Approach to Greenhouse Gas accounting, arguably CDP, IPCC Guidelines). Although in all considered cases, the connection is described as a guiding principle rather than a ready-to-use rule.

[22] No complete and comprehensive overview is claimed in this review.

5. Tiered approach to data registration (A proto-standard for carbon accounting and auditing using the E-liability method)
6. **Share of primary data KPI** (PACT, TfS)

The sections below present the requirements of each of the above frameworks in more detail.

4.1 ISO 14064-1:2018

ISO 14064-1:2018, *Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals* categorizes data into primary (including site specific) and secondary data, and requires a reporting organization to "determine and document the characteristics for each relevant data used for quantification" (6.2.2).

Selection, collection and use of data

Annex C of the standard provides guidance on the selection, collection and use of data for direct emissions. It specifies "primary or secondary data (depending on who has originally collected it) and site-specific or not site-specific (depending on if it has been obtained from the original source or sink)" (p. 25). Site-specific data (which ISO defines as a type of primary data) is usually characterized as being of higher quality than secondary data. The Guidance on data selection and collection used for quantification (C.3) states that "The characteristics of the data might be chosen by the company in accordance with pre-existing company practice, industry practice, best practice, interested party requirements, or might be mandated by regulatory schemes". Organizations should use primary activity data or underlying data, and should use secondary data when no site-specific activity data is available. Further, it specifies that: "Secondary data and primary data that are not site-specific data should only be used for inputs where the collection of site-specific data is not practicable, or for processes of minor importance, and may include literature data (e.g. default emission factors), calculated data, estimates or other representative data." (p.29). No guidance on data quality for indirect emissions calculations is given.

The standard provides guidance on GHG information management in chapter 8, focusing on the need to meet the principles on a generic level. It does not provide a hierarchy for data quality (e.g., the quality of estimates, assessments, or calculations).

Calculation methods

ISO 14064-1:2018 provides quantification approaches (i.e., calculation methods) like the GHG Protocol *Scope 3 Standard*, specifically: (i) measurement or (ii) modelling (i.e., calculation). The standard requires organizations to "explain and document the justification for the selection or development of the model" (p. 10), including characteristics like accuracy, reproducibility, uncertainty, and consistency with the intended use, etc.

Annex C provides further guidance for model selection based on the quantitative and qualitative aspects of its data inputs: accuracy, frequency, timeliness, completeness, control, and validity. The guidance leaves room for costs and feasibility considerations in justification of the chosen methods.

ISO 14064-1:2018 further requires organizations to assess the uncertainty associated with the quantification approaches but does not specify a required methodology. Further, where "quantitative estimation of uncertainty is not possible or cost effective, it shall be justified and a qualitative assessment shall be conducted" (p. 13).

4.2 IFRS

In consideration of inventory quantification, IFRS predominantly refers to methods and approaches provided in the GHG Protocol corporate standards suite. Other methods are possible with justification, referring to local regulatory requirements.

Data quality

The standard requires an entity to use reasonable and supportable information, and "use a measurement approach, inputs and assumptions that result in a faithful representation of this measurement" (B38). Reporting entities are required to prioritize inputs and assumptions using the following characteristics (listed in no particular order):

(a) data based on direct measurement

(b) data from specific activities within the entity's value chain

(c) timely data that faithfully represents the jurisdiction of, and the technology used for, the value chain activity and its greenhouse gas emissions

(d) data that has been verified

The standard acknowledges the trade-offs posed by the quantification of scope 3 emissions, which requires judgement:

> *For example, an entity might need to consider the trade-offs between timely data and data that is more representative of the jurisdiction and technology used for the value chain activity and its emissions. More recent data might provide less detail about the specific activity, including the technology that was used in the value chain and the location of that activity. On the other hand, older data that is published infrequently might be considered more representative of the specific activity and its greenhouse gas emissions"* (B42).

Further, types of data in the value chain are given as primary and secondary[23] (or a combination of both). Due to assumed higher representativity of primary data, entities are required to prioritize the use of primary data (obtained directly from activities in the value chain). When it comes to secondary data, entities are said to prioritize based on *technological representativity (B50), geographical representativity (B51), temporal representativity (B52)*. Entities also are said to prioritize *data that have been verified* (B53-B54). However, no hierarchical framework or decision tree for points of prioritization is given.

When reporting scope 3 emissions, an entity shall disclose the extent to which the inventory is measured using primary data versus using inputs that are verified.

Calculation method:

[23] B48 of the IFRS S2 Climate-related Disclosures (June 2023) define Primary data as data provided by suppliers or other entities in the value chain related to specific activities in an entity's value chain. B49 defines Secondary data as data that is not
obtained directly from specific activities within an entity's value chain

IFRS S2 stipulates two methods to quantify scope 3 emissions: direct measurement and estimation (the latter is classified as "calculation" by the GHG Protocol *Scope 3 Standard*). Further, IFRS S2 explains that, while direct measurement, "in theory, provides the most accurate evidence," however, IFRS "expect[s] that Scope 3 greenhouse gas emissions data will include estimation due to the challenges associated with direct measurement…" (B43 and B44, IFRS S2, p. 34).

4.3 ESRS E1

AR 39 of the ESRS E1 stipulates that undertakings shall "disclose the methodologies, significant assumptions and emissions factors used to calculate or measure GHG emissions accompanied by the reasons why they were chosen, and provide a reference or link to any calculation tools used", while referring to the GHG Protocol Corporate Standard, EU 2021/2279 or ISO14064-1:2018 for principles, requirements and guidance, and requires to use most recent IPCC GWP values.

The standard does however require a reporting entity to screen its total scope 3 (indirect) emissions for all 15 categories according to the GHG Protocol or the ISO 14064-1 using appropriate estimates. (AR46)

Moreover, the standard requires entities to disclose the extent to which the emissions are measured using inputs from specific activities within the value chain, and disclose the percentage of emissions calculated using primary data obtained from value chain partners. (AR46)

4.4 PCAF

PCAF acknowledges that, "to date, the comparability, coverage, transparency, and reliability of scope 3 data still varies greatly per sector and data source" (PCAF, Part A, 2022, p.50[24]), and emissions data availability and quality vary in assuredness, specificity, and other variables. However, for quantifying financed emissions, PCAF requires financial institutions to use the highest available quality data and improve data quality over time. Moreover, PCAF states that data limitations should not deter from taking the first steps toward inventories preparation.

Emissions data types are considered based on the type of financing or investment in question but, generally, can be classified based on the quantification method (with the exception that verified vs. unverified emissions can rely on all calculation methods specified by the GHG Protocol):

1. Actual or reported emissions of an investee (either verified or unverified in accordance with the GHG Protocol for, specifically, listed equity, corporate bonds, business loans, unlisted equity, and project finance)
2. Physical activity-based emissions from the investee (e.g. energy consumption, material production volumes, floor area, vehicle model, etc.) and supplier-specific or average emission factors

[24] PCAF (2022). The Global GHG Accounting and Reporting Standard Part A: Financed Emissions. Second Edition.

3. Economic activity-based emissions using revenue-based (with or without asset turnover rations) and asset or economic activity-based calculation methods, relying on monetary emission factors

Data quality is further assessed in scoring system 1-5, where 1 is the highest quality and 5 is the lowest quality data. Each type of investment, facilitated or insured emissions considered in the PCAF guidance, have prescriptive guidance on assigning 1 – 5 (Annex 10.1 of the Guidance part A, Annex 1 of part B, Annex 2 of part C). The emissions data types above are organized in order of data quality score, with actual or reported emissions having the best (highest) quality score of 1 or 2 (depending on the asset type) and economic activity-based emissions having the worst (lowest) quality score of 4 or 5 (depending on the calculation type). The most recent available data should be used, including a mention of the data source, reporting period, or publication date.

The score should be assigned to each evaluated financed, facilitated or insured emission item, and a weighted-average data quality score calculated. Companies should publish a weighted score by outstanding amount or should explain why they are unable to do so. When scope 3 is included in calculation, the data quality score shall be reported separately from that of Scope 1 and 2.

The guidance (p. 128 of Part A) prescribes financial institutions to disclose whether data is verified and to what level, as well as to move towards verification to at least a level of limited assurance over time.

4.5 CDP

Questions 7.73 to 7.73.4 of Module 7 of the CDP questionnaire (optional) provide insights into the data relations considered by the framework. The questionnaire intends to assist members of CDP in sharing emissions data. However, the framework presented in the questions leaves a lot to the user of the information with regards to the decisions and interpretations.

A reporting entity is first asked for the LCA framework used for calculations, and then asked to provide the data on the emissions calculated, associated with certain products supplied to certain customers. The emissions are to be reported by life cycle stage or scope of LCA (a sum of stages), specifying the scope of GHG included (scope 1, 2, 3). Given the scoping and system boundary differences between the GHG Protocol corporate standard suite framework and LCA frameworks, the user of such information might be left in uncertainty on which emissions are reported and whether and how they can be used. The CDP questionnaire additionally asks to provide the level of data (primary, secondary, or mix), open answer text for data quality clarification, and verification status.

Outside of the questionnaire (i.e. not reflected in the CDP scores or in a company's disclosure) CDP ranks quality of the reported data (inventory-level) on a scale from 1 to 7, with 7 being the most reliable, and 1 being the least reliable. Total emissions data quality is estimated as a weighted score and is calculated based on the revenue activity split of the company (CDP and

PCAF, 2023[25]). Since 2022, CDP and PCAF claim alignment on the data quality scoring through a correspondence matrix (ibid).

4.6 SBTi

SBTi Corporate Net-Zero Standard, v.1.2, provides general requirements for data quality in inventory. 4.2.1 of the standard (p.22) states that "Companies should select data that is the most complete, reliable, and representative in terms of technology, time, and geography. Companies should collect high-quality primary data from suppliers and other value chain partners for scope 3 activities deemed most relevant and targeted for GHG reductions. Secondary data is permissible but it is better suited for scope 3 categories that are not significant in magnitude as it limits a company's ability to track performance". In fact, SBTi's own study confirms that the vast majority of companies estimate value chain emissions using secondary data (e.g. average emission factors from databases)[26]. Emission factors must be representative of the corresponding activities and be country-specific as a minimum (SBTi Corporate Net-Zero Standard, v.1.2, p.23).

For calculation methodologies in the Scope 3 inventory, the SBTi standard refers to the GHG Protocol *Scope 3 Standard* and *Technical Guidance*. However, on page twenty-three of the Net-Zero Standard, a high-level screening based on secondary financial data is emphasized as a first step. Finally, SBTi states that, over time, target-setting organizations should develop complete inventories and improve data quality, with focus on high-impact categories (SBTi Corporate Net-Zero Standard, v.1.2, p.23).

SBTi stipulates several reporting requirements for organizations (SBTi Corporate Net-Zero Standard, v.1.2, D.3.1):

- "Companies must report all emissions scopes (1, 2 and 3) and all scope 3 categories, including those that do not fall within a target boundary.
- Companies must disclose what the reporting period is and should clarify what the choice of year type is (i.e., calendar year or financial year).
- Any exclusions from the inventory (scope 1, 2 or 3) must be described, estimated and disclosed.
- For scope 3 categories that are considered negligible, companies should report an estimate (either in tons of CO2 equivalent or percentage of total scope 3 emissions).
- Companies should report the type of data used, data sources, methodologies and assumptions used to determine the GHG emissions data. For example, for scope 3 emissions, companies should disclose which portions of the reported emissions data come from primary data (i.e., data obtained from suppliers or value chain partners) versus other data sources, such as average emission factors.
- Companies should describe their plans for improving the accuracy of their GHG inventory data over time e.g., including a greater percentage of primary data in their scope 3 inventories.

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[25]CDP and PCAF The importance of data quality in the journey toward decarbonization, 2023 [Importance_of_data_quality_21.6_Final.pdf (cdp.net)]

[26] Aligning corporate value chains to global climate goals. SBTi Research: Scope 3 Discussion Paper, p.20

- If relevant, the Forest, Land and Agriculture (FLAG) inventory and non-FLAG inventory must be reported separately.
- Companies must disclose their GHG inventory for the base year and current reporting year. They may also disclose GHG inventories for the intervening years between the base year and reporting year to show the trend in emissions over time."

Companies should also "report on how they plan to bridge data gaps, exclusions and improve data quality. Companies should quantify and provide the level of uncertainty that has been introduced by use of estimates or averages, where possible". (D.3.2)

4.7 International Financial Institutions Guideline for a Harmonised Approach to Greenhouse Gas Accounting

In 2021, the International Financial Institutions (IFIs) Technical Working Group on GHG Accounting released the version 02.0 of its Guideline for a Harmonised Approach to Greenhouse Gas Accounting[27].
Its goal is to increase consistency and comparability across IFIs, as well as clarity of data for the users.

The Guideline specifies a tiered approach to data sources to address completeness and data gaps. There are three tiers which are determined and ranked based on the level of complexity (as cited from the source, p.8):

> "Tier 1 – Country-specific activity data and default emission factors. Sectoral emission factors from sector guidance or country emission factors from credible sources, e.g., GHG national inventories;
>
> Tier 2 – Organisation-level GHG data. This can include publicly disclosed GHG data, e.g. audited data under ISO 14064, data reported to the Carbon Disclosure Project (CDP), and sustainability reports of the investee;
>
> Tier 3 – Project-level activity data and emission factors. This can include historical records of electricity consumption, fuel use, and fugitive emissions; estimates from the feasibility study; and specific factors, e.g., net calorific value."

This tiered approach serves as a kind of data quality hierarchy to guide preparers in data selection, but is not used in reporting of the emissions. Based on the examples, provided in the Annex of the document, IFIs are not expected to disclose data on the tier of data used.

4.8 IPCC Guidelines for National Greenhouse Gas Inventories

In 2019 the IPCC published refinements to the 2006 Guidelines for National Greenhouse Gas Inventories[28]. Volume 1 of the Guidelines, General Guidance and Reporting, contains several chapters relevant for considerations of the input data quality and calculation methods.

Chapter 2 of the Volume concerns data collection. The chapter presents approaches to data collection, and provides detailed guidance on data management, data sourcing, measurement methods, differences between data of different origin, data applicability to particular situations,

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[27] IFI TWG – AHG-003. International Financial Institutions Guideline for a Harmonised Approach to Greenhouse Gas Accounting. V.02.0., 2021.
[28] See Vol 1. At Publications - IPCC-TFI (iges.or.jp)

etc. Data quality for facility data (industrial facility-level data) is considered with regards to reaching comparability, consistency, accuracy, transparency, and completeness (Table 2.4, vol. 1, p. 2.34). Table 2.5 of Vol. 1 Chapter 2, specifies potential facility GHG reporting requirements.

Chapter 2 also advises identification of key categories through screening procedures and expert judgment, to be able to focus resources on those. Identification of key categories is then considered in Chapter 4.

Methodologies for quantification of emissions is considered in a tiered approach:

- Tier 1 – the most basic estimation
- Tier 2 – intermediate
- Tier 3 – most demanding

Volumes 2 through 5 of the Guidelines are dedicated to specific source areas of emissions: Energy, Industrial Processes and Product Use, Agriculture , Forestry and other Land Use, and Waste. Each of the volumes provide the specific applicable tier 1, 2, and 3 methods, as well as worksheets for tier 1 estimations.

It is always possible to provide a Tier 1 estimate for every category, as sectoral volumes contain default Tier 1 emission factors and parameters that can be used. It is good practice to use Tier 2 or 3 methods for key categories, for which additional data collection is needed.

Reporting guidance provided by the Guidance's Chapter 8 of Vol.1 requires to disclose the factors, activity data, assumptions and methodologies used to the level of facilitation of reproducible results. Transparency is suggested to be ensured, among other, through completing the worksheets for Tier 1 methods, and provision of additional documentation in case of using higher tier methods. The provided quantitative templates do not reflect the tiered approach.

4.9 California Senate Bill No. 253

SB 253, Approved by the Governor on October 07, 2023, and filed with Secretary of State on October 07, 2023 provides additions to the Health and Safety Code, relating to greenhouse gases.

SEC. 2 adds a Section 38532 (c)(A)(ii) to the Health and Safety Code, requiring reporting entities to measure and report its emissions (including scope 3) in conformance with the Greenhouse Gas Protocol standards and guidance. The article specifically states the requirement to follow "guidance for scope 3 emissions calculations that detail acceptable use of both primary and secondary data sources, including the use of industry average data, proxy data, and other generic data in its scope 3 emissions calculations."

Moreover, the bill provides an additional section 38532 (c) (B) requiring the publicly disclosed information be comprehensive, understandable and accessible: "a reporting entity's public disclosure maximizes access for consumers, investors, and other stakeholders to comprehensive and detailed greenhouse gas emissions data across scopes 1, 2, and 3 emissions, as defined by this section, and is made in a manner that is easily understandable and accessible."

4.10 SEC 17 CFR 210, 229, 230, 232, 239, and 249

The United States Securities and Exchange Commission's (SEC) The Enhancement and Standardization of Climate-Related Disclosures for Investors Rule, finalized in March 2024, will require an estimated 4,000 publicly-traded companies in the US to disclose information on climate-related risks and opportunities.

Although the original proposition was suggesting reporting of scope 3 emissions when material and/or when entities have respective scope 3 targets, the comments received questioned this recommendation, with the main arguments referring to unreliability of scope 3 data and additional burdens of assessment. The final ruling (F.3) does not require measurement and reporting of Scope 3 emissions (it remains voluntary) and puts measure and reporting of Scope 1 and 2 emissions subject to materiality, necessary to provide investors with information for informed investment and voting decisions.

Regarding the quality of the presented data, the final ruling will require entities to describe the methodology, significant inputs, and significant assumptions used to calculate the disclosed GHG emissions, "in a manner that best fits with their particular facts and circumstances" (p. 251). Specifically, a brief description[29] is required to state the protocol or standard used, the calculation approach, the type and source of emission factors, and any calculation tools used. Entities may use reasonable estimates, as long as they describe the underlying assumptions and reasons for using the estimates.

4.11 E-liabilities proto-standard

A proto-standard for carbon accounting and auditing using the E-liability method[30] was published to further develop and support e-liabilities approach in 2024.

Principle 1 of the proto-standard states that "An entity, […], shall record on its environmental ledger all material, direct emissions of GHGs using direct measurement or calculation." Principle 3 states that "Except where immaterial, an entity shall record on its environmental ledgers the emissions embedded in all acquired units of goods and services as reported by its suppliers upon legal economic transfer." Principle 5 states "In cases where suppliers do not provide the emissions data described in principle 3, the purchasing entity will record on its environmental ledgers the embedded emissions of the acquired inputs at the maximum applicable value of the emissions distribution for the input's product category as described across generally accepted data sources." Following principles 2, 4 and 6, all these ledger points must be verified to the reasonableness standard.

Based on the proposed implementation, this approach presents separate registration of the data of different origins. Moreover, the Implementation Guidance of the proto-standard mentions use of estimates in the ledgers in case of future expected emissions (e.g. from waste disposal), prescribing adjustment of the numbers when the realized emissions are obtained. This procedure implies that the proto-standard developers see the estimates as data of different nature. As the update of the number is required, estimates speculatively are data of lower quality.

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[29] "in sufficient detail for a reasonable investor to understand" (SEC 17, p. 253)
[30] Ramanna, K. et al. A proto-standard for carbon accounting and auditing using the E-liability method v. 1.5.4, The E-liability Institute, 2024

That being said, the Implementation Guidance of the proto-standard states that data quality is generally out of consideration: "either the information is material, in which case it must be measured or calculated to a level of accuracy that can be verified to the reasonableness standard, or the information is immaterial, separately and in aggregate, and thus need not be included" (p.19). Thus, companies are not required to report any data quality indicators. Over the phase-in period the guidance acknowledges a possibility of complementary data quality indicators without further clarifications.

4.12 LCA frameworks

All widely spread LCA frameworks include the requirement for data quality and data quality analysis. The basis traditionally is laid in ISO14040/44 standards, summarized in two main points:

1. Data used in LCA shall be considered in view of its quality as of Time related coverage, Geographical coverage, Technology coverage, Precision, Completeness, Representativeness, Consistency, Reproducibility, Sources of the data, Uncertainty of the information
2. Goal and scope of an analysis shall dictate the required data quality level, to be established by practitioners within the study, and assessed and reported as a part of it.

When it comes to calculation methods, all LCA frameworks refer to the standard of elementary flows accounting (inventory) and their follow up characterization through use of emission factors, developed under different models, depending on a type of impact (e.g. climate change, eutrophication, ionizing radiation), and an assessment model (e.g. IPCC AR5, IPCC AR6). In the following framework considerations only data quality assessment will be addressed as relevant and additional information to this paper.

4.12.1 GHG Protocol Product Standard

Published in 2011, the *Product Life Cycle Accounting and Reporting Standard* (*Product Standard*) applies to life cycle GHG inventories of products.

The Standard requires companies to assess the data quality of activity data, emission factors, and/or direct emissions data by using the data quality indicators of technological representativeness, geographical representativeness, temporal representativeness, completeness, and reliability. The guidance refers to the qualitative scoring matrix that is described in the *Scope 3 Standard* as an example.

Companies should create a data management plan and follow a 7-step approach in data collection and assessment. They may conduct data screening and use it to prioritize data collection resources to ensure effectiveness.

For significant processes, companies shall report a descriptive statement on the data sources, the data quality, and any efforts taken to improve data quality.

4.12.2 PEF/OEF

The Product Environmental Footprint and Organisation Environmental Footprint methods (PEF/OEF) are life cycle assessment-based methods developed by the Joint Research Centre for the European Commission. In 2021 the latest version of the method was adopted by the

Commission in the Commission Recommendation (EU) 2021/2279 of 15 December 2021. PEF/OEF framework offers one of the most elaborate data quality assessment frameworks in LCA analysis.

In the framework, only activity data is considered for collection, and shall include all known inputs and outputs for the processes (including direct emissions). Secondary data in the framework is integrated on the level of elementary flows (i.e. not an emission factor by an inventory of resource use and emissions attributed to a considered process throughout the value chain in the scope). Emission (characterization) factors are to be derived from the Environmental Footprint (EF) method (as of 2024, EF3.1) per elementary flow.

Activity data is considered in two types:

- Company-specific data, and
- Secondary data

In order to qualify for use, activity data shall meet the minimum requirements of completeness, methodological appropriateness, and consistency, and three quality aspects: documentation, nomenclature, and review.

Four quality criteria of the data: technological, geographical, time-related representativeness, and precision, shall be subject to scoring. The detailed process is presented in the Commission Recommendation (EU) 2021/2279, Chapter 4.6 of Annex 1. The summary below provides highlights of the process:

- The scoring is done for each of the four indicators on a scale 1 to 5 (1 the best, 5 the worst)
- For a newly developed dataset most relevant inputs and outputs are identified as those contributing at least 80% of the total impact. These inputs and outputs (activity data and elementary flows) are then considered for Data Quality Rating (DQR).
- For newly developed datasets activity data and elementary flows are considered to be complete company-specific data, and assessed on the scale 1 to 5 in all four dimensions. Technological and geographical representativity cannot be worse than 2; Precision and time-related representativeness cannot be worse than 3.
- Technological representativity (TeR), Time representativity (TiR), Geographical representativity (GeR) and Precision (P) indicators of the newly developed dataset are calculated separately as the weighted average of the most-relevant activity data and direct elementary flows.
- The DQR score is calculated as simple average of the four indicators.
- Secondary datasets connected to the one in development are assessed on the scale 1 to 5 in only technological, geographical, and time-related representativeness. It presumes re-calculating the DQR of the EF compliant dataset calculated by the data provider, when it is used in the modelling of most-relevant processes
- For the study (the product in consideration of LCA), DQR for each of the four TeR, TiR, GeR and P is calculated separately as a weighted average of the most relevant processes/flows.
- The total score is calculated as a simple average of the four TeR, TiR, GeR and P.

While conducting an EF study, practitioners must define the need for company specific data and DQR re-assessment of secondary datasets based on their relative contribution and commissioner's (product manufacturer's) ability to access company/supplier-specific data.

4.12.3 Together for Sustainability (TfS)

Together for Sustainability (TfS) is an industry initiative driven by chemical procurement specialists to address sustainability in value chains. In 2022 TfS published its first Product Carbon Footprint (PCF) Guideline specifying PCF calculations. The Guideline is currently on its 2.1 version and included in the initiative's Scope 3 Program. The guideline specifies the PCF modelling and gives guidance on the calculations used for reporting of Scope 3 category 1.

Data is categorized in activity data and emission factors, with explanation of the categorization. In data exchange and management, the guideline requires transparent information on data including attributes of the material and energy. It also requires strategic clustering (e.g. based on a profile) and prioritization (based on magnitude) in data collection. Companies are mandated to update and improve data each year. Emissions shall be calculated from at least 80% (by volume, weight, or spend) of purchased goods and services, with the other 20% allowed to be extrapolated.

In its interpretation of the GHG Protocol Scope 3 Standard requirements, the TfS guideline explicitly states that supplier-specific values are always preferred <u>if data quality allows</u> (p. 16). For emission factors specifically, the guideline provides a hierarchy based on sourcing, including allocated organizational footprint as an option (Figure 5).

Definition	EEIO	Industry average LCA	Specific PCF	Supplier PCF	Hybrid	OCF*
Description	Sector/ country/global emission factors mapped against purchasing volumes	Product industry average data from LCA databases	Modelled dataset that is more granular for technology or geography than industry average	PCF data per product collected from the specific supplier	Supplier specific allocated OCF for Scope 1&2 and supplier activity data and average EF data for suppliers' Scope 3.	Supplier specific OCF for Scopes 1, 2, 3 (per EUR or physical units or as abs CO_2 emissions)
Pre-condition	Understanding of corporate spend, currencies, and inflation rates Access to an input/output model	Physical data available Consistent base of LCA data	Detailed knowledge on supply chain incl. physical data PCF data on product level	Willingness of the supplier to share data per product also for baseline	Willingness of the supplier to share inventory data per product (material amounts)	Availability of OCF and purchasing volume data or physical data
Application	Base inventory Hotspot analysis (country, material group contribution)	Broad product portfolio	Capture emission reductions through generic reductions	Measurement of supplier performance Tracking progress to climate goals	General supplier performance	General supplier performance
Source Activity Data	Purchasing records (+ price adjustment)	Reporting company's ERP system BoM	Reporting companies ERP system, BoM	Reporting companies ERP system, BoM	Supplier data	Reporting company's procurement or ERP system
Source Emission Factors	Environmen-tally extended Input Output model	LCA database Literature or data on demand	Reporting company or consultancy sector/product specific model and average LCA data	Supplier PCF based on primary data collection	OCF data for Tier 1 supplier and average LCA/PCF data for upstream of Tier 1 supplier	Sustainability report CDP report
Pros	Complete and consistent inventory for all products Good regional coverage	Relatively detailed product differentiation Annual differentiation Easy to access	Detailed product differentiation Annual differentiation	Exact product differentiation	Supplier specific performance Annual update possible Compromise with respect to effort and data accuracy	Supplier specific performance Annual update possible Easy and fast to calculate

Definition	EEIO	Industry average LCA	Specific PCF	Supplier PCF	Hybrid	OCF*
Cons	Only coarse product differentiation Time lag of statistical data with the risk of outdated data when used closely before the next update (Inaccuracies due to price and currency effects) No standardization of EEIO models No supplier-specific information	Physical activity data often not complete EF data not available for all products and countries Limited comparability with base-year emission due to methodological updates Temporal representative-ness Cost of LCA databases No exact supplier-specific information	Availability of physical activity data Uncertainty in calculation No exact supplier-specific information	Physical activity data often not complete Big effort for data generation, validation and collection, if manually done No annual update, if manually done Limited availability Low traceability if no detailed documentation is available	Large effort for data collection Limited precision Challenging to validate	Inaccuracies and low comparability due to methodological differences (Scope 3) and allocation In case of monetary units sensitive to price and currency effects
Conclusion	Very basic approach. Limitations with regard to accuracy & supplier performance measurement	Basic approach but the more specific the product portfolio the less data are available	Data only available for limited product categories	Highest accuracy with big effort incl. dependency from supplier However, the effort can be reduced by automating and implementing IT tools for calculating and sharing PCF and PCF data	Medium effort incl. dependency from supplier	Basic approach. Only applicable in case of homogenous product portfolio of the supplier

*** OCF = Organizational Carbon Footprint**

Figure 5. TfS emission factors sourcing, TfS 2024

The TfS Guideline then provides a decision tree for identification of a suitable data selection and calculation method (Figure 6).

Figure 4.5 Decision tree to select emission factor data (Note: In accordance with chapter 5.2.2 of this guideline, PCFs have a validity period of up to five years and shall be updated before the end of the validity period has been reached.)

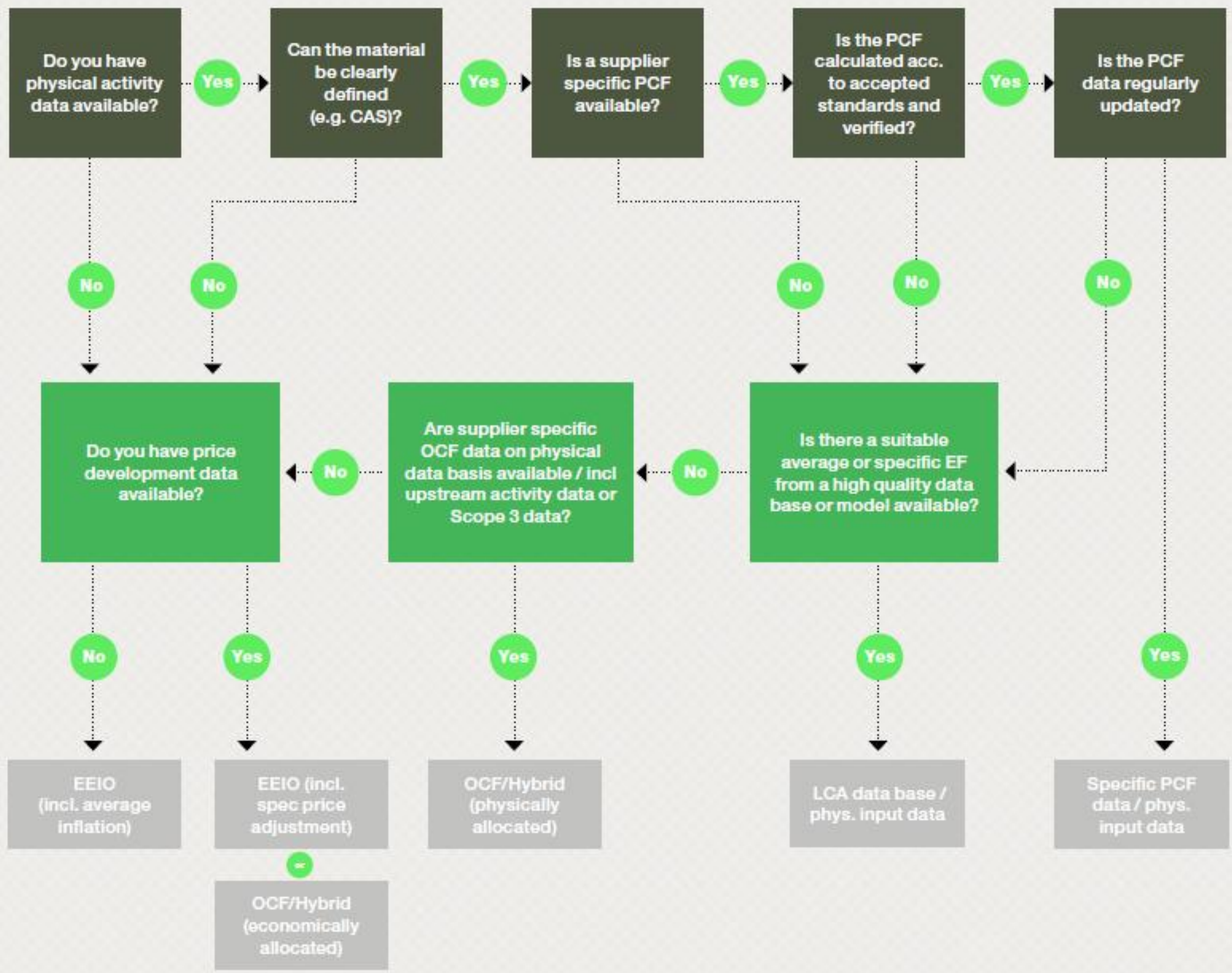

Figure 6. TfS calculation methods decision tree

Data quality considerations for product carbon footprint in the TfS Guideline are given from two perspectives:

1. *Share of primary data (PDS)* – a percentage of the total GHG impact that is derived by using primary data in the cradle-to-gate system (referenced to the PACT framework – see more details below)
2. *Data quality rating (DQR)*, conducted for activity data, emission factors, and/or direct emissions data by using the data quality indicators, during data collection. DQR is performed using a 3-grade score across 5 indicators: Technological representativeness, Geographical representativeness, Temporal representativeness, Completeness, and Reliability. The pedigree matrix is references as one from the PACT methodology (Figure 9). A process' DQR score is calculated as a simple average of the 5 indicators. The PCF's

total DQR is calculated as a weighted average of the input and unit process scores, where footprint contribution is used for weighting.

4.12.4 PACT

Partnership for Carbon Transparency (PACT) was established as a project within WBCSD by several members of the council, with the aim of addressing challenges in Scope 3 data transparency. In 2023, PACT published methodology guidance for conducting LCA for data exchange within the project[31].

Like the PEF framework, the PACT methodology distinguishes activity data and emission factors as different types of data, and categorizes them by data source into primary, secondary, and proxy data.

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

Figure 7. Data typology and definitions in the PACT methodology, PACT 2023

[31] Pathfinder Framework: Guidance for the Accounting and Exchange of Product Life Cycle Emissions, 2023

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

Figure 8. Data quality hierarchy in PACT methodology, PACT 2023

In addition to a formalized typology, the methodology also provides a hierarchy of different data types (Figure 8), effectively stating that the source defines data quality, proclaiming primary data to be the best case, and encouraging companies to use primary data for both activity data and emission factors. However, the methodology states that "In some cases, further polishing and aggregating the [*primary*] data may be required to refine the emissions estimate. Algorithms may be used to fill in the missing data, or data aggregation may be required to dampen the effect of revisions, turnarounds, or other atypical production conditions." (p. 36)

Regarding secondary data, the methodology acknowledges the need for it, but highlights the impacts of its use on data quality, and sets up a list of minimum requirements that address documentation and transparency on methodology, maintenance of the used datasets, and consistency of the background methodology with the PACT modelling methodology.

Data quality disclosure then is addressed from two perspectives:

1. *Primary data share (PDS)*: calculated proportion (percentage) of the total GHG emissions that is derived using primary data. To be accounted as primary data, both activity data and emission factors used shall be compliant with primary data definitions. With data transfer from one tier in a value chain to another, PDS rolls up as a weighted average of the PDSs reported by suppliers. For transparency reasons, PDS shall be reported downstream together with the product carbon footprint (PCF) data.
2. *Data quality assessment*. The methodology offers a 3-degree pedigree matrix for data quality assessment in 5 dimensions: technological representativeness, temporal representativeness, geographical representativeness, completeness, and reliability (Figure 9).

To calculate the PCF's data quality score, practitioners shall assign a score to each PCF component (cited as input energy and materials[32]) in each dimension, and calculate the respective DQ score for each dimension as a weighted average, taking components contribution to the overall PCF for weighting. It is unclear how the elementary flows or outputs are to be included into consideration, or how to make DQ assessment for secondary data in cases of differences between activity data and emission factors.

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

Figure 9. DQA in the PACT methodology, PACT 2023

4.12.5 EPA LCA Data Quality Assessment Guidance

In 2016 EPA published a guidance for data quality assessment of unit processes in LCA[33]. The guidance is based on a 5-degree pedigree matrix, considering seven different dimensions: flow reliability, process review, process completeness, as well as representativeness in temporal correlation, geographical correlation, technological correlation, and data collection methods. The assessment framework presumed a scoring matrix as presented in Figure 10. In this framework, process review seems to become a new dimension of assessment, while completeness is split into process [flow] completeness and data collection method as market coverage.

[32] Companies shall include in the assessment any contribution that represents at least 5 percent of the overall PCF.
[33] Guidance on Data Quality Assessment for Life Cycle Inventory Data. Version 1. EPA/600/R-16/096 June 2016. https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=528687

Highest score ← → Lowest score

Indicator		1	2	3	4	5 (default)
Flow reliability		Verified[1] data based on measurements	Verified data based on a calculation **or** non-verified data based on measurements	Non-verified data based on a calculation	Documented estimate	Undocumented estimate
Flow Representativeness	**Temporal correlation**	Less than 3 years of difference[2]	Less than 6 years of difference	Less than 10 years of difference	Less than 15 years of difference	Age of data unknown or more than 15 years
	Geographical correlation	Data from same resolution **and** same area of study	Within one level of resolution **and** a related area of study[3]	Within two levels of resolution **and** a related area of study	Outside of two levels of resolution **but** a related area of study	From a different or unknown area of study
	Technological correlation	All technology categories[4] are equivalent	**Three** of the technology categories are equivalent	**Two** of the technology categories are equivalent	**One** of the technology categories is equivalent	**None** of the technology categories are equivalent
	Data collection methods	Representative data from >80% of the relevant market[5], over an adequate period[6]	Representative data from 60-79% of the relevant market , over an adequate period **or** representative data from >80% of the relevant market, over a shorter period of time	Representative data from 40-59% of the relevant market, over an adequate period **or** representative data from 60-79% of the relevant market, over a shorter period of time	Representative data from <40% of the relevant market, over an adequate period of time **or** representative data from 40-59% of the relevant market, over a shorter period of time	Unknown **or** data from a small number of sites **and** from shorter periods
Process review		Documented reviews by a minimum of two types[1] of third party reviewers	Documented reviews by a minimum of two types of reviewers, with one being a third party	Documented review by a third party reviewer	Documented review by an internal reviewer	No documented review
Process completeness		>80% of determined flows have been evaluated and given a value	60-79% of determined flows have been evaluated and given a value	40-59% of determined flows have been evaluated and given a value	<40% of determined flows have been evaluated and given a value	Process completeness not scored

Figure 10. EPA LCA unit process scoring matrix, EPA 2016

For a given process, all indicators should always be completed. However, their importance for interpretation of the results are situationally dependent and left to a practitioner's judgment.

Interestingly, the Guidance instructs to score the default (lowest) score "5" to data for which primary data sources are unavailable (e.g. older data sets where the original documentation is untraceable) and recommends that in those situations "it is better to qualitatively discuss the data quality than to attempt to score an unknown source".

4.13 Other approaches

GHG Protocol Quantitative Inventory Uncertainty

A short paper issued by the GHG Protocol on the Quantification of Inventory Uncertainty[34] focusses on single parameter uncertainty applied to direct emissions data, activity data, emission factors, and GWP factors. It distinguishes the following approaches:

- Measured uncertainty (represented by standard deviations);
- The pedigree matrix approach, based on data quality indicators (DQIs) ;
- Default uncertainties for specific activities or sector data (reported in various literature);
- Probability distributions from commercial databases;
- Uncertainty factors reported in literature; and
- Other approaches reported by literature.

The paper describes several ways of reporting quantitative uncertainty, including qualitative descriptions of uncertainty source as well as quantitative depictions, such as error bars, histograms, etc.

5. Summary of Relevant Research

5.1 Inventory quality fit for inventory objectives

Wang and Strong (1996)[35] denote that there are several dimensions to data quality. While intrinsic data quality highlights that that data have quality in their own right, and representational and accessibility data quality refers to the role of the system of operation, c*ontextual data quality* signifies that data quality must be contextualized with the task and objective. This is done by multiple referenced frameworks, including the GHG Protocol *Scope 3 Standard*. The objective or use of a scope 3 inventory often determines or dictates the necessary or recommended data quality. Thus, a conversation on inventory quality shall incorporate the considerations of the task: objective of the inventory in the first place.

Following the GHG Protocol's Corporate Standard and Scope 3 Standard, compiling a corporate carbon emissions inventory may pursue the following objectives:

- Identify GHG-related risks in the value chain
- Identify new market opportunities
- Inform investment and procurement decisions
- Identify GHG "hot spots" and prioritize reduction efforts across the value chain
- Set scope 3 GHG reduction targets
- Quantify and report GHG performance over time
- Partner with suppliers, customers, and other companies in the value chain to achieve GHG reductions
- Expand GHG accountability, transparency, and management in the supply chain
- Enable greater transparency on companies' efforts to engage suppliers

[34] Microsoft Word - Quantitative Uncertainty Guidance_final.docx (ghgprotocol.org)

[35] Wang, R. Y., & Strong, D. M. (1996). Beyond Accuracy: What Data Quality Means to Data Consumers. *Journal of Management Information Systems*, *12*(4), 5–33. https://doi.org/10.1080/07421222.1996.11518099

- Reduce energy use, costs, and risks in the supply chain and avoid future costs related to energy and emissions
- Reduce costs through improved supply chain efficiency and reduction of material, resource, and energy use
- Improve corporate reputation and accountability through public disclosure
- Meet needs of stakeholders (e.g., investors, customers, civil society, governments), enhance stakeholder reputation
- Improve stakeholder relationships through public disclosure of GHG emissions, progress toward GHG targets, and demonstration of environmental stewardship
- Participate in government- and NGO-led GHG reporting and management programs to disclose GHG-related information
- Participating in GHG markets (*Corporate Standard*)
- Participating in mandatory disclosure programs (*Corporate Standard*)

While some of the objectives can be achieved with a data of limited quality (e.g. hotspot identification, high-level risk identification, partially mandatory disclosure etc.), some objectives require higher accuracy of inventory to be effective. *From that perspective, a required minimum inventory quality shall be adequate to the goals and objectives of inventory creation.*

Thus, formalize the list of objectives of Scope 3 inventory, and defining desirable minimum level of inventory quality required to meet different objectives, becomes one of the core tasks for the upcoming revision. *The following table is to be updated with the results of the TWG work.*

Table 3. Scope 3 inventory objectives and (potential) minimum inventory quality required.

Objective type	Minimum inventory quality required
Identify GHG-related risks in the value chain	Limited quality
Identify new market opportunities	Limited quality
Inform investment and procurement decisions	Mid- to high-quality
Identify GHG "hot spots" and prioritize reduction efforts across the value chain	Limited quality
Set scope 3 GHG reduction targets	Mid- to high-quality
Quantify and report GHG performance over time	Set by the respective reporting standard or program; as a minimum – limited quality is sufficient
Partner with suppliers, customers, and other companies in the value chain to achieve GHG reductions	Mid- to high-quality
Expand GHG accountability, transparency, and management in the supply chain	Mid- to high-quality
Enable greater transparency on companies' efforts to engage suppliers	Limited to mid-quality, trajectory for quality improvement
Reduce energy use, costs, and risks in the supply chain and avoid future costs related to energy and emissions	High quality
Reduce costs through improved supply chain efficiency and reduction of material, resource, and energy use	Mid- to high-quality

Objective type	Minimum inventory quality required
Improve corporate reputation and accountability through public disclosure	Limited to mid-quality
Meet needs of stakeholders (e.g., investors, customers, civil society, governments), enhance stakeholder reputation	Mid- to high-quality
Improve stakeholder relationships through public disclosure of GHG emissions, progress toward GHG targets, and demonstration of environmental stewardship	Limited to mid-quality, trajectory for quality improvement
Participate in government- and NGO-led GHG reporting and management programs to disclose GHG-related information	Set by the respective reporting standard or program; as a minimum – limited quality is sufficient
Participating in GHG markets [Corporate Standard]	High quality
Participating in mandatory disclosure programs [Corporate Standard]	
Other objectives	To be defined by the user

Given that organizations may be pursuing different objectives in their practice of scope 3 inventory accounting, one could fairly assume that each inventory quality has its own place in general practice. Score 3 Standard postulates that "Data selection depends on business goals" (p.75). It would be suggested to additionally specify in the standard revision that targeted inventory quality should depend on the goals and objectives of organization and its carbon footprint strategy. Internal and external stakeholders however need to be supported in interpretation of the information, thus it is assumed to focus the effort on the inventory quality disclosure.

5.2 Data typology and terminology in practice

The GHG Protocol *Scope 3 Standard* presents data typology and terminology as follows:

Role in emissions quantification (table 7.1 of the standard):

- Emissions data (measured)
- Activity data
- Emission factor
- Global warming potential (GWP) value

Data source:

- Primary - Data from specific activities within a company's value chain
- Secondary - Data that is not from specific activities within a company's value chain

Level of specificity in aggregation (table 7.7 of the Standard):

- Product-level data – cradle-to-gate GHG emissions for the product of interest
- Activity, process-, or production line-level data – GHG emissions and/or activity data for the activities, processes, or production lines that produce product of interest

- Facility-level data – GHG emissions and/or activity data for the facilities or operations that produce the product of interest
- Business unit-level data – GHG emissions and/or activity data for the business units that produce the product of interest
- Corporate-level data – GHG emissions and/or activity data for the entire corporation

The *Scope 3 Standard* and the *Technical Guidance* however introduce other terminology in relation of data and calculation methods. The largest attention is given to terms of calculation methods, often named after the source or type of data they are using (e.g, supplier-specific, hybrid, average data, spend-based, fuel-specific, distance-specific, etc.) as itemized in Appendix D of the *Technical Guidance*.

Table 4. Examples of correspondence between data types

Role in calculations	**Source**	**Specificity**	**Examples scope 1+2**
Activity data	Primary	Supplier-specific	Electricity meter data
		Average	Electricity consumption based on floor area, extrapolated from the supplier's facilities Fuel consumption per t-km of transportation service, average for the supplier Electricity consumption allocated to 1 kg of product based on the total mass of different product produced
	Secondary	Supplier specific	NA
		Average	Electricity consumption based on floor area and statistics of energy consumption per m^2 in the region for the type and use of building
Emission factor	Primary	Supplier-specific	Emissions measured for burning specific fuel in the supplier's turbine
		Average	Emissions of an average fuel burned in the supplier's turbine
	Secondary	Supplier-specific	Emissions from burning specific fuel in the model of the turbine the supplier uses
		Average	Average emissions of burning fuels in a turbine

*Note that the presented classification omits the specificity of aggregation.

When a supplier communicates total emissions associated with the purchased product or service, and the emissions are not measured, activity data shall be multiplied by emissions data (emission factor). If a supplier uses secondary emission factors from life cycle inventory (LCI) databases that rely on different boundaries, GWPs, etc., then a supplier's resulting supplier-specific emission data may house a mix of data types. This calculation would often lead to a mix of the data types in the resulting inventoried (GHG emissions) value that a downstream client would be unable to parse.

When scope 3 calculations require more than scope 1 and 2 emissions from suppliers and include other upstream (cradle-to-gate) and/or downstream activities, purely primary supplier-specific data becomes nearly impossible. For example, a tier 1 supplier may be unable to source primary data from their vendors (the reporting company's tier 2 vendors), and so on. Alternatively, a reporting company may be unable to collect primary data from final customers using its sold products. While activity data can be collected, average data would at some level of detail find its place in the inventory, and at least some emission factors will at some or another point be sourced from secondary sources.

Practice overview and stakeholder feedback shows that the data-related terms may be confusing for users, leading to misunderstandings, misinterpretations and potential malpractices. For example, confusion that can occur in practice:

- Primary data and supplier-specific data are often confused by users;
- Data from value chain partners is often considered supplier-specific despite the fact that supplier-specific emissions data often relies on average- or spend-based calculations;
- While not listed in the *Scope 3 Standard* nor in the *Technical Guidance*, phrases such "spend-based data" and "activity-data method" appear in practice;
- While not listed in the *Scope 3 Standard* nor in the *Technical Guidance*, any combination of any types of calculation methods or data is called "hybrid" by users

A more rigid definition of terms related to data typology and data quality may be beneficial, including to differentiate language used for input data used for inventory calculation, calculation methods, and the resulting inventory.

5.3 Correlation between data type and quality

The *Scope 3 Standard* defines data quality through five indicators: Technology representativeness, Time representativeness, Geography representativeness, Completeness, Reliability. These indicators are adapted from B.P. Weidema and M.S. Wesnaes[36], the tap into the intrinsic data quality (by Wang and Strong[37]) and would correspond the most to accuracy and completeness principles of GHG accounting.

In consideration of choice of data to be used in inventory, one should prioritize quality of the data rather than its source. Data collection guidance is presented in Chapter 7 of the Standard. From the context of the *Scope 3 Standard* and the *Technical Guidance*, it is often assumed that primary data (supplier-specific data in particular) are of higher quality than secondary data, as well as activity-based data is superior to spend based data.

In practice there is a correlation stemming from the fact that achieving higher accuracy and representativity is more likely if the data is supplier specific. That is especially true for activity data. However, the correlation is not perfect as the quality of the data would also depend on the methods used to collect the data, possible errors and uncertainties, modelling choices, secondary sources and assumptions used, etc.

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[36] Weidema B.P., and Wesnaes M.S., "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

[37] Wang, R. Y., & Strong, D. M. (1996). Beyond Accuracy: What Data Quality Means to Data Consumers. *Journal of Management Information Systems*, *12*(4), 5–33. https://doi.org/10.1080/07421222.1996.11518099

Box 1.1 of the *Technical Guidance* emphasizes the difference between data accuracy and data specificity (*Figure 11*)

> Even though the supplier-specific and hybrid methods are more *specific* to the individual supplier than the average-data and spend-based methods, they may not produce results that are a more *accurate* reflection of the product's contribution to the reporting company's scope 3 emissions. In fact, data collected from a supplier may actually be less accurate than industry-average data for a particular product. Accuracy derives from the granularity of the emissions data, the reliability of the supplier's data sources, and which, if any, allocation techniques were used. The need to allocate the supplier's emissions to the specific products it sells to the company can add a considerable degree of uncertainty, depending on the allocation methods used (for more information on allocation, see chapter 8 of the *Scope 3 Standard*).

Figure 11. Box 1.1 of the Technical Guidance: Difference between data specificity and data accuracy

Table 5 demonstrates three hypothetical pairs of data types, as examples of convoluted connections between data type and data quality, and difficulties faced by preparers in making a judgement on optimal data point choice.

Table 5. Data type vs Data quality - missing correlation examples

Example	Data point 1	Data point 2	Take away message
Pair 1	Life cycle emission factor sourced from ecoinvent in an independent verified study (EF, secondary, product specific)	Unverified emission factor from the supplier, without the breakdown of the included GHG and background data used (EF, primary, product-specific)	Data point 2 (primary) does not provide enough information to judge its quality and accuracy, and likely to be of lower quality than the data point 1 (secondary)
Pair 2	Product specific emission LC factor sourced from ecoinvent in an independent verified study (EF, secondary, average, product specific)	Supplier specific scope 1+2 factor, with 50% upstream covered, allocated based on economic value (EF, supplier specific, corporate level data, incomplete, economic allocation)	Data point 1 and data point 2 have little ground to be compared in their quality due to principal differences in their origin
Pair 3	Emissions associated with consultancy services using EEIO emission factors from EXIOBASE and the paid amount (Activity: primary, supplier specific, economic; EF: secondary, EEIO)	Emissions calculated based on literature found average consultancy hour per a project and emissions per hour of desk work (Activity: secondary, low specificity assumption, physical; EF: secondary, high level assumption)	Data point 1 and data point 2 have little ground to be compared in their quality due to principal differences in their origin

6. Options Under Consideration

This section presents three main options for addressing data quality and calculation methods in the context of quantifying and reporting corporate scope 3 inventories.

The three main options are:

1. Improved implementation of current GHG Protocol requirements
2. Data quality scoring
3. Disaggregated reporting based on quality

Each option includes the following sub-sections:

1. Description (of the option/solution)
2. Considerations (developments and decisions to consider the option)
3. Example(s) (of the option/solution)
4. Implications (for the *Scope 3 Standard*)
5. Discussion point(s)
6. Decision-making criteria assessment

The implications of options are focused mainly on possibilities to impose requirements related to minimum data quality, data quality improvement, data transfer, and hot spot analysis ("hotspotting").

Discussion points are intended to outline the starting point for the discussion on to what degree the option satisfies the objectives of addressing the issue. The following suggested objectives are identified:

- Provide information on whether the inventory quality is fit for the intended use
- Provide information on the certainty of the reported emissions (indication of emissions size)
- Provide information on reliability of the inventory / category point as a basis for planning actions
- Provide information on reliability/certainty of achieved reductions / increases
- Evaluating the organization's stewardship and transparency efforts

The GHG Protocol decision-making criteria are provided in Annex A. Decision Making Criteria. The preliminary analysis presented for each option is intended to provide a starting point for the discussion within the TWG.

Option 1. Improved implementation of current GHG Protocol requirements

Description

In keeping the current GHG Protocol data quality requirements, the main possible instrument for making inventory quality more actionable and useful is to improve implementation of the requirements on inventory transparency.

Chapter 11 of the *Scope 3 Standard* lists the following reporting requirements related to data quality and inventory quality:

1. Required information
    a. A list of scope 3 categories and activities included in the inventory
    b. A list of scope 3 categories or activities excluded from the inventory with justification of their exclusion
    c. For each scope 3 category, a description of the types and sources of data, including activity data, emission factors and GWP values, used to calculate emissions, and a description of the data quality of reported emissions data
    d. For each scope 3 category, a description of the methodologies, allocation methods, and assumptions used to calculate scope 3 emissions
    e. For each scope 3 category, the percentage of emissions calculated using data obtained from suppliers or other value chain partners
2. Optional information
    a. Relevant disaggregation of the emissions data
    b. Emissions from scope 3 activities not included in the list of scope 3 categories, reported separately
    c. Qualitative information about emission sources not quantified
    d. Quantitative assessments of data quality
    e. 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

While the requirements are created to support transparency and usability of the reported information, the reporting requirements may not always be fulfilled by companies. This potentially could be due to:

1. Lack of the explicit and/or equal reporting requirement by some sustainability reporting frameworks used as the base of ESG reporting
2. Lack of clarity on the format of reporting

The first point can be addressed by engagement and dialogue with reporting frameworks on harmonization of requirements (currently out of scope of the TWG work).

The second point can be addressed through improved presentation of the reporting requirements and improvements to the scope 3 reporting template. The current version is available at: https://ghgprotocol.org/corporate-value-chain-scope-3-standard).

The current reporting template includes the following section related to methodologies and data used (Figure 12).

Part 4: Description of methodologies and data used

Scope	Methodologies used to calculate or measure emissions, providing a reference or link to any calculation tools used
Scope 1	
Scope 2	

Scope and category	Description of the types and sources of data used to calculate emissions	Description of the data quality of reported emissions	Description of the methodologies, allocation methods, and assumptions used to calculate emissions	Percentage of emissions calculated using data obtained from suppliers or other value chain partners
Upstream scope 3 emissions				
Category 1: Purchased goods and services				
Category 2: Capital goods				
Category 3: Fuel- and energy-related activities (not included in scope 1 or scope 2)				
Category 4: Upstream transportation and distribution				
Category 5: Waste generated in operations				
Category 6: Business travel				
Category 7: Employee commuting				
Category 8: Upstream leased assets				
Other				

Part 4: Description of scope 3 methodologies and data used (continued)

Scope and category	Description of the types and sources of data used to calculate emissions	Description of the data quality of reported emissions	Description of the methodologies, allocation methods, and assumptions used to calculate emissions	Percentage of emissions calculated using data obtained from suppliers or other value chain partners
Downstream scope 3 emissions				
Category 9: Downstream transportation and distribution				
Category 10: Processing of sold products				
Category 11: Use of sold products				
Category 12: End-of-life treatment of sold products				
Category 13: Downstream leased assets				
Category 14: Franchises				
Category 15: Investments[38]				
Other				

Figure 12. Current GHG Protocol reporting template

[38] If the reporting company is an initial sponsor or lender of a project, also account for the projected lifetime emissions of relevant projects financed during the reporting year and report those emissions separately from scope 3.

Considerations

In order to enhance the disclosure of inventory quality, the reporting requirements (listed above) can be edited. Several points could be addressed:

1. Visual: introducing a clearer presentation (every item is represented as a separate field or numerical item) ("kanban"-like)
2. Clarifications: provide a more detailed explanation, range, and/or examples of information required for reporting, in addition to the stated requirements
3. Options: provide multiple choice options where applicable

In order to provide clarifications, some of the definitions, typologies, and classifications may need an update.

Example

The following text presents an example of possible editorial changes to the reporting requirements.

"Required information. Companies shall publicly report the following information:

- 1.1. A list of scope 3 categories and activities included in the inventory
- 1.2. A list of scope 3 categories or activities excluded from the inventory with justification of their exclusion
- 1.3. For each scope 3 category, a description of the types and sources of data used to calculate emissions, including:
  - 1.3.1. activity data
  - 1.3.2. emission factors
  - 1.3.3. GWP values
- 1.4. For each scope 3 category, data quality of reported emissions data
- 1.5. For each scope 3 category, a description of:
  - 1.5.1. Quantification methods used to calculate scope 3 emissions
  - 1.5.2. Allocation methods used to calculate scope 3 emissions
  - 1.5.3. Assumptions used to calculate scope 3 emissions
- ~~1.6.~~ For each scope 3 category, the percentage of emissions calculated using data obtained from suppliers or other value chain partners
  - ~~1.6.1.~~ Alternative to consider: For each scope 3 category, the percentage of emissions calculated using supplier-specific data (or value-chain-partner-specific data) of sufficient quality. (Supplier-specific data is deemed to be of sufficient quality if it assessed to be of higher quality than average data).

The following are examples of possible updates that could be made to the reporting template to more effectively and transparently report on data quality.

Table 6. Possible template for data quality reporting for one scope 3 category

Category 1. Purchased goods and services

	Activity 1	**Activity 2**	**Activity 3**
Activity description			
Activity data			
Data type			
Data source			

Emission factor			
Data type			
Data source			
GWP applied			
Data quality			
Technological representativeness			
Geographical representativeness			
Temporal representativeness			
Completeness			
Reliability			
Calculation method(s)			
Allocation method(s)			
Assumptions used			
Percentage of emissions calculated with supplier specific data			
(Optional) uncertainty level			

*Note: a wide range of activities included into an inventory may limit feasibility of this variation of the template, and potentially the option.

Table 7. Possible template for reporting activities excluded from the inventory

Category	**Activities excluded (text)**	**Justification for exclusion (text)***	**Estimated emissions of the activity (t CO_2e)**
Category 1. Purchased goods and services			
Category 2. Capital goods			
Category 3. Fuel- and energy-related activities (not included in scope 1 or scope 2)			
Category 4. Upstream transportation and distribution			
Category 5. Waste generated in operations			
Category 6. Business travel			
Category 7. Employee commuting			
Category 8. Upstream leased assets			
Category 9. Downstream transportation and distribution			
Category 10. Processing of sold products			
Category 11. Use of sold products			
Category 12. End-of-life treatment of sold products			
Category 13. Downstream leased assets			

Category	**Activities excluded (text)**	**Justification for exclusion (text)***	**Estimated emissions of the activity (t CO_2e)**
Category 14. Franchises			
Category 15. Investments			

** Options to be defined in consultation with the Corporate Standard TWG*

Implications

Requirements

Consideration of the need and possibilities of imposing limitations on inventory quality is discussed in a different discussion paper. However, if a recommendation to impose a limitation is to be adopted, Option 1 technically allows for the following options:

a. Impose minimum data quality requirements
b. Impose limitations on certain data types and source (Spend activity data and/or EEIO; Inventory allocation for LC emissions)
c. Impose limitations on certain calculation methods (spend based method, average method)

Further a more rigid / refined definition of data types should be considered, as well as potential adoption of a data quality hierarchy.

Improvements

Consideration of the need and possibilities of imposing a requirement for improvement of inventory quality is discussed in a different discussion paper. However, if a recommendation to impose a such requirement is to be adopted, Option 1 technically allows for the requirement to increase or decrease the share of the inventory calculated on certain types of data or methods.

Data transfer

Implications for data transfer: supplier specific data request and consequent transfer needs to include data quality assessment.

Hot spot analysis (hotspotting)

In case of introduction of minimum requirements for limit or ban of certain data inputs or calculation methods, hotspotting can be defined through the use of the limited data.

Decision-making criteria assessment

Table 8. Option 1

Decision making criteria	**Assessment**
Scientific integrity	Scientific integrity is N/A • Pros: Based on the framework for transparency of Økland et al39, enhancing transparency is possible pre- per- and post- activity. The discussed option taps into the following tools of transparency: - Pre-activity: establishing precise procedures and scripts (providing a detailed framework of inventory quality reporting, with clear definition of the requirements)

[39] Økland, A., Lillebo, B., Amdahl, E., & Seim, A. (2010). A framework for transparency. In POMS 21st Annual Conference, Vancouver, Canada.

Decision making criteria	Assessment
	- Per-activity: visual control and split of the requirements per-box to ease the perception of completeness of the information (kanban board) • Cons: On the other hand, applied to financial reporting, studies assume that enhancing disclosure requirements alone would not close the communication gap, and require improvements in quality of the communication and disclosure processes40 (i.e. come from within reporting organizations).
GHG accounting and reporting principles	• Pros: The option is expected to enhance transparency. • The option is not likely to directly impact principles of accuracy, completeness, consistency and relevance, although some indirect impacts may occur (e.g. increased internal visibility of information sources may encourage change of sources to promote more accuracy, consistency, and relevance).
Support decision making that drives ambitious global climate action	• Pros: The option is intended to provide stakeholders with information regarding the main aspects of the input data sources and quality characterization, modelling choices (allocation), calculation methods used, etc. In that way, internal and external stakeholders may be informed on reliability of the inventory to support effective action. • Cons: The disclosure requirements may be perceived and interpreted differently across different readers, potentially leading to: vagueness of the determined characteristics in question and misinterpretation of the disclosed information.
Support programs based on GHG Protocol and uses of GHG data	• Pros: The option is intended to provide stakeholders with information regarding the main aspects of the input data. When disclosed, the information will be available for all audiences. • Cons: While even with the incorporated measures the requirements would be quite generic, the information may receive different interpretation and misunderstood, with disparities increasing between different types of audiences, and when the preparer of information is coming from a different background/tradition. • The options would likely have little effect on interoperability with other programs. • On the potential to fulfil the objectives see Table 9
Feasibility to implement	• Pros: The approach is fairly easy to implement and is accessible, adoptable and feasible for audiences of different backgrounds. Due to relative simplicity, the approach would likely not impede adoptability the GHG Protocol. • Cons: Due to potential perceived differences in (generic) requirements and qualitative nature of evaluations, the effort needed may be perceived differently

Discussion point

To what extent does the option satisfy the objectives of addressing the issue? The Secretariat has provided a preliminary assessment in the table below.

[40] Ho, S. S., & Wong, K. S. (2001). A study of corporate disclosure practice and effectiveness in Hong Kong. *Journal of International Financial Management & Accounting*, *12*(1), 75-102.

Table 9. Option 1's potential to fulfill the objectives

Objective	Effectiveness of the option in meeting objective
Provide information on whether the inventory quality is fit for the intended use	Low to medium: Qualitatively, possibly not enough
Provide information on the certainty of the reported emissions (indication of emissions size)	Low: Qualitatively and indirect, as an interpretation of the provided information
Provide information on reliability of the inventory / category point as a basis for planning actions	Low to medium: Qualitatively, possibly not enough
Provide information on reliability/certainty of achieved emission reductions / increases	Low: Qualitatively and indirect, as an interpretation of the provided information, needs a more rigorous tracking through multiple years of reporting
Evaluating the organization's stewardship and transparency efforts	Medium: Qualitative

Option 2. Data quality scoring

Description

This option involves introducing mandatory quantitative data quality assessment to the input data and/or the resulting inventory. This option would allow for shifting the focus in inventory preparation from the source of the data to the quality of the data, and provide a measurable scale of data quality as a benchmark.

In this option, a preparer of the inventory would be required to perform a quality assessment of the input data/inventory datapoints and report the quality of the inventory for the users of the information.

Considerations

To introduce data quality scoring, a scoring methodology would need to be developed. Below is a general overview of the potential scoring methodologies analogous to those already in practice:

1. Development of a data quality assessment scoring matrix
    - 1.1. Choice of the level of assessment
        - 1.1.a on the level of activity data and emission factors
        - 1.1.b on the level of the inventoried datapoint (activity data * EF)
    - 1.2. Choice of assessment differentiation based on specificity
        - 1.2.a same assessment (matrix) for primary and secondary data
        - 1.2.b different assessment (matrices) for primary and secondary data
    - 1.3. Choice of (intrinsic) data quality dimensions
        - 1.3.a Reaffirming the existing 5 dimensions of technological, temporal, and geographical representativeness, completeness and reliability
        - 1.3.b. Adding one or more of the dimensions of: Process completeness (flow accounting); process review; consistency; reproducibility; uncertainty
    - 1.4. Choice of a scoring framework
        - 1.4.a. 5 scale option (analogous to the current example matrix, and LCA scales adopted from Wiedema)
        - 1.4.b. 4 scale option (analogous to the current recommended matrix)
        - 1.4.c. 3 scale option (analogous to PACT)
    - 1.5. Development of the relevant matrices and data quality hierarchy

2. Development of an inventory quality calculation method
    1.1. (if 1.1a is chosen) Deriving inventoried datapoint quality through data quality of activity data and emission factors
        2.1.a. Average
        2.1.b Lowest of the two
    1.2. Calculation of the aggregates score
        2.2.a Average
        2.2.b Weighted average

Examples

In the example below (Table 10) the chosen scoring assesses the level of activity data and emission factors separately, with 5 currently existing dimensions and the scale 1 to 4 (with 1 being the best scoring option).

Table 10. Example of data quality scoring

Data	**Technology**	**Time**	**Geography**	**Completeness**	**Reliability**	**Total**
Activity data	1	1	2	2	2	1.6
Emission factor	2	3	1	3	3	2.4
a. Datapoint DQR (average)	1.5	2	1.5	2.5	2.5	2
b. Datapoint DQR (max of the two)	2	3	2	3	3	2.6

Data for Category 1	**Emissions**	**Technology**	**Time**	**Geography**	**Completeness**	**Reliability**	**Total**
Procurement item 1	20t CO_2e	2	3	2	3	3	2.6
Procurement item 2	80t CO_2e	1	1	2	1	2	1.4
a. Inventory quality (average)	50%/50%	1.5	2	2	2	2.5	2
b. Inventory quality (weighted average)	20%/80%	1.2	1.4	2	1.4	2.2	1.6

Example of reporting is shown below for one scope 3 category (Figure 13):

Category 1. Purchased goods and services

Parameter	Activity 1	Activity 2	Activity 3
Activity description			
Activity data			
Data type			
Data source			
Emission factor			
Data type			
Data source			
GWP applied			
Calculation method(s)			
Allocation method(s)			
Assumptions used			
Calculation method(s)			
Percentage of emissions calculated with supplier specific data			
(Optional) uncertainty level			
Inventory quality score			
Technological representativeness			
Geographical representativeness			
Temporal representativeness			
Completeness			
Reliability			
DQR average			

Total category DQR: DQR (Technology, Time, Geography, Completeness, Reliability)

Total scope 3 DQR: DQR (Technology, Time, Geography, Completeness, Reliability)

Figure 13. Example of reporting with data scoring

Implications

Requirement

Consideration of the need and possibilities of imposing limitations on inventory quality is discussed in a different discussion paper. However, if a recommendation to impose a limitation is to be adopted, Option 2 technically allows for the following options:

a. Impose minimum input data quality requirements
b. Impose minimum inventory quality score

Per datapoint, per category, for significant categories, or total.

Improvements

Consideration of the need and possibilities of imposing a requirement for improvement of inventory quality is discussed in a different discussion paper. However, if a recommendation to impose a such requirement is to be adopted, Option 2 technically allows for only one option:

a. Requirement to increase the inventory score

Per datapoint, per category, for significant categories, or total.

Data transfer

Implications for data transfer: supplier specific data request and consequent transfer needs to include data quality data to support data quality assessment.

Example below (Figure 14) presents a possible roll-up of the data in data transfer

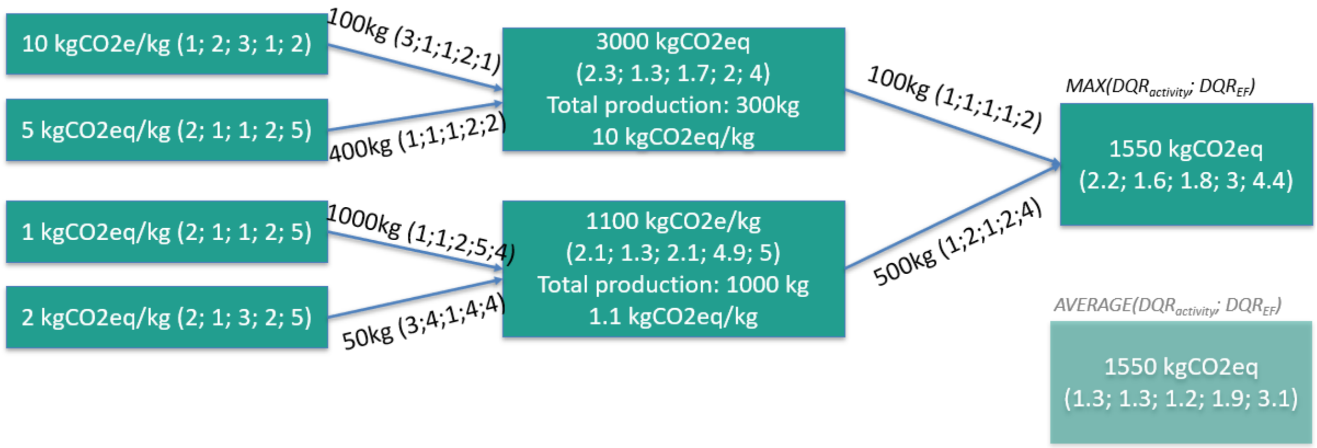

Figure 14. Data quality roll-up in data transfer in the value chain, Option 2

Hotspot analysis (hotspotting)

In case of introduction of the minimum requirements for inventory creation, hotspotting can be defined through the data quality scoring (e.g. input data or inventory with lower score can be used in hotspotting).

Decision-making criteria assessment

Table 11. Option 2

Decision making criteria	Assessment
Scientific integrity	Scientific integrity is N/A • Pros: A pedigree matrix data quality scoring was in use in LCA since its introduction in 1996 by Weidema and Wesnaes[41], and overall is strongly recommended or mandated by major LCA frameworks (including EPA and EC recommended), and became the main framework for data quality assessment. Cons: However, it is noted to be in need for improved repeatability and interpretability[42]. • Shrimali (2022)[43] argues that scoring (on the example of PCAF) holds intrinsic limitation as "the reliability scores do not directly indicate the magnitude of the underlying uncertainties in the constituent Scope 3 emissions" (p.44)
GHG accounting and reporting principles	• Pros: The option is expected to enhance transparency. • The option is not likely to directly impact principles of accuracy, completeness, consistency and relevance, although some indirect impacts may occur (e.g. increased internal visibility of information

[41] Weidema, B. P., & Wesnæs, M. S. (1996). Data quality management for life cycle inventories—an example of using data quality indicators. Journal of cleaner production, 4(3-4), 167-174.
[42] Cooper, J.S., Kahn, E. (2012) Commentary on issues in data quality analysis in life cycle assessment. Int J Life Cycle Assess 17, 499–503.
[43] Shrimali, Gireesh. "Scope 3 emissions: measurement and management." *The Journal of Impact and ESG Investing* 3, no. 1 (2022): 31-54.

Decision making criteria	Assessment
	sources may encourage change of sources to promote more accuracy, consistency, and relevance).
Support decision making that drives ambitious global climate action	• Pros: The option provides some valuable information about overall quality of the inventory and/or inventory point, which can provide a guidance in action planning prioritization, and direct attention to significant categories that lack quality in data. • Cons: However, the somewhat subjective nature of judgement may create additional uncertainty and/or misinform action. • Additional high burden of assessment may be implemented at the costs of action.
Support programs based on GHG Protocol and uses of GHG data	• Pros: The information available to the user can be of importance for drawing conclusions and making decisions, and, in combination with qualitative descriptors, can give at least a general context. • Cons: However, the quantitative assessment presented to the user is very likely to be based on a subjective interpretation or judgement of a different individual. Quantitative assessment is based on averaging in aggregation, thus blending the quality of all datapoints and somewhat diluting the usefulness of the provided information. Low to medium support to user. • Pros: The option is of medium to high interoperability with other frameworks, introducing data quality assessment to larger carbon reporting frameworks (SBTi, CDP, ESRS, IFRS), although additional changes from the frameworks in their operational tool may be required. The option is potentially highly interoperable with frameworks that already have data quality scoring system if resembles that used by them (e.g. PCAF, TfS, PACT), • Cons: It however will be of low interoperability if the adopted system shows to be different. Same applies to LCA frameworks. • On the potential to fulfil the objectives see Table 12
Feasibility to implement	• Pros: Implementation is largely accessible for wide audience. Audience already familiar with data quality scoring (LCA practitioners, preparers for PCAF and TfS) will have an advantage. • Cons: It does require either a special software operation, or significant quantitative modelling skills. Implementation process is of high difficulty and duration.

Discussion point

To what degree does the option satisfy the objectives of addressing the issue?

Table 12. Option 2's potential to fulfil the objectives

Objective	Effectiveness of the option
Provide information on whether the inventory quality is fit for the intended use	Medium: Quantitative, subjective
Provide information on the certainty of the reported emissions (indication of emissions size)	Medium: Quantitative, subjective
Provide information on reliability of the inventory / category point as a basis for planning actions	Medium to high
Provide information on reliability/certainty of achieved emission reductions / increases	Medium to high, assuming consistency in scoring
Evaluating the organization's stewardship and transparency efforts	High: Quantitative

Option 3. Disaggregated reporting based on quality

Description

The option involves introducing separate (disaggregated) reporting of scope 3 emissions based on the different quality of inventory data. This option would allow for transparency, clearly communicating the information that could be used for different objectives and different users. In this option, a preparer of the inventory performs an assessment of the data and assign the resulting inventoried data to one or another tier of reporting. Inventory data of the same tier in the same category/activity can be summed up, but different tiers of inventory data are reported separately.

Considerations

To introduce separate (disaggregated) reporting of the inventory based on quality, a tiered approach needs to be developed. In doing so, the following choices need to be made:

1. Choice of the principle of tier differentiation
    - 1.1. Based on data quality assessment
        - 1.1.a Qualitative based on tiers: e.g. tier 1, tier 2, tier 3
        - 1.1.b Qualitative based on categories: e.g. measured, calculated, estimated
        - 1.1.b Quantitative: e.g. data quality score 1 to 4
    - 1.2 Based on data type and source
        - 1.2.a Primary vs secondary
        - 1.2.b Spend data vs average activity data vs supplier specific data
        - 1.2.c Combustion vs life cycle factors
    - 1.3 Based on scoping:
        - 1.3.a Scope 1 and other
        - 1.3.b Scope 1 and 2, and other
    - 1.4 Other

2. Development of a data quality assignment algorithm:
    - 2.1. Assign data types into groups (for options 1.1.a and 1.1.b)
    - 2.2. Refine definitions and conditions (for options 1.2)
    - 2.3. Develop a data scoring methodology (for option 1.1.c)

Example

In the example below the differentiation is qualitative from tier 1 to 3 (with tier 1 being the best data).

Table 13. Option 3, example of separate reporting based on quality

Category	Year 1	Year 2	Year 3
Category 1. Purchased goods and services	*1000*	*1200*	*1100*
Tier 1	200	200	100
Tier 2	700	500	400
Tier 3	100	500	600
Category 2. Capital goods	*500*	*600*	*600*
Tier 1	0	0	0
Tier 2	200	0	0
Tier 3	300	600	600

Category	Year 1	Year 2	Year 3
…..			
TOTAL	**15500**	**15000**	**18000**
Tier 1	2500	1000	500
Tier 2	11500	12500	12000
Tier 3	1500	1500	5500

Implications

Requirement

Consideration of the need and possibilities of imposing limitations on inventory quality is discussed in a different discussion paper. However, if a recommendation to impose a limitation is to be adopted, Option 3 technically allows for imposing a minimum or maximum share of the inventory that shall be accounted on a certain tier.

Improvement

Consideration of the need and possibilities of imposing a requirement for improvement of inventory quality is discussed in a different discussion paper. However, if a recommendation to impose a such requirement is to be adopted, Option 3 technically allows for requirement to increase or decrease the share of inventory reported on a certain tier.

Data transfer

Implications for data transfer: supplier specific data request and consequent transfer needs to be relayed in the respective updated format, with the disaggregation of the data by quality.

The example below (Figure 15) presents a possible roll-up of the data in data transfer

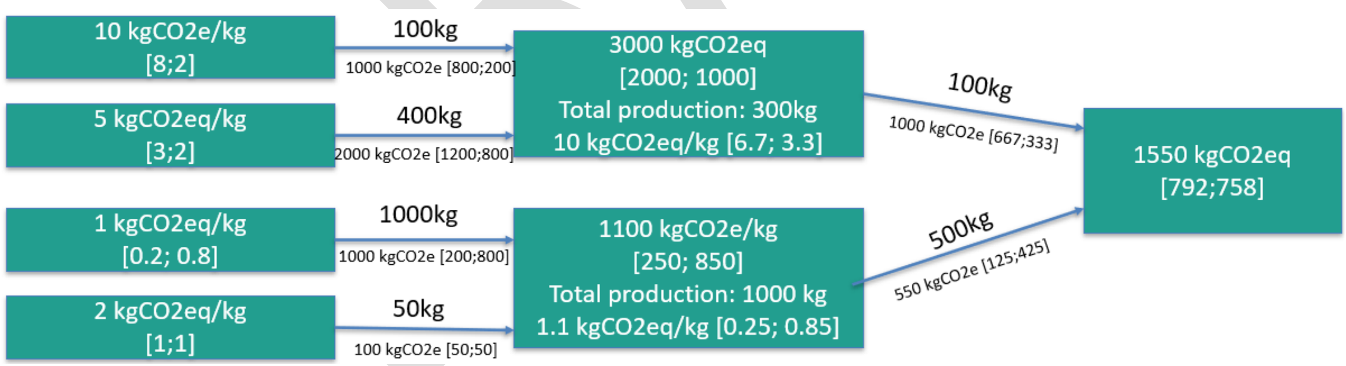

Figure 15. Data quality roll-up in data transfer in the value chain, Option 3

Hot spot analysis (hotspotting)

Hotspotting can be combined with lower quality data reporting. A possibility arises to introduce a mandatory hotspotting procedure, in which all categories may be calculated on the lower tier inventory level. The values then can be used as the base for mandatory accounting of significant/relevant categories on a higher quality/tier level.

Decision-making criteria assessment

Table 14. Option 3

Decision making criteria	Assessment
Scientific integrity	Scientific integrity is N/A • Pros: Roll-up reporting of scope 1 and 2 data is suggested by Klaassen and Stoll (2021)[44] as a potential method to improve the boundaries inconsistency and reduce scope 3 reporting error. It also somewhat conceptually corresponds to registration and transfer of GHG emissions along the value chain in accordance to Ramanna et al., 2024 [45] • Some parallels can be drawn with the separate reporting of pro-forma numbers in financial reporting, which is required to be reported separately from the GAAP accounting due to potential misleading of investors (Bhattacharya et al,2004[46]; James and Michello, 2003[47]). Use of pro-forma has been improving in the US since 2002's regulatory adjustment (Entwistle et al, 2006[48])
GHG accounting and reporting principles	• Pros: The option is expected to enhance transparency. • The option is not likely to directly impact principles of accuracy, completeness, consistency and relevance, although some indirect impacts may occur (e.g. increased internal visibility of information sources may encourage change of sources to promote more accuracy, consistency, and relevance).
Support decision making that drives ambitious global climate action	• Pros: The option provides valuable information to internal and external stakeholders, providing more guidance on the prioritization of action, and direct attention to significant categories and activities lacking in quality. Disaggregated reporting of the numbers of different quality gives users input information for their own interpretation, somewhat reducing the probability of misinformed judgement. • Cons: Additional burden of disaggregated reporting may be implemented at the costs of action.
Support programs based on GHG Protocol and uses of GHG data	• Pros: Medium to high support to users. The information available to the user is of importance for drawing conclusions and making decisions, and, in combination with qualitative descriptors, can provide a fair context on the inventory composition, and current quality of measurement of the GHG inventory. While the provided numbers are aggregated primary information, they create a specific input for interpretation by the information user. • Cons: The option is currently not incorporated in other frameworks, but some may be able to adjust upon introduction of changes (SBTi, CDP, ESRS , IFRS). Those reporting with using other data quality addressing frameworks (e.g. scoring in PCAF, TfS, PACT, LCA), would not be able to translate it directly. • On the potential to fulfil the objectives see Table 15Table 9

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[44] Klaaßen, Lena, and Christian Stoll. "Harmonizing corporate carbon footprints." Nature communications 12, no. 1 (2021): 1-13.

[45] Ramanna, K. et al. A proto-standard for carbon accounting and auditing using the E-liability method v. 1.5.4, The E-liability Institute, 2024.

[46] Bhattacharya, N., Black, E. L., Christensen, T. E., & Mergenthaler, R. D. (2004). Empirical evidence on recent trends in pro forma reporting. *Accounting Horizons*, *18*(1), 27-43.

[47] James, K. L., & Michello, F. A. (2003). The dangers of pro forma reporting. *The CPA Journal*, *73*(2), 65.

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Decision making criteria	Assessment
Feasibility to implement	• Pros: Implementation is largely accessible for a wide audience, although will require re-considerations in tools used for data collection and reporting. • Cons: Implementation process is of medium difficulty but may be tedious in the introduction stage.

Discussion point

To what extent does the option satisfy the objectives of addressing the issue?

Table 15. Option 3's potential to fulfil the objectives

Objective	Effectiveness of the option
Provide information on whether the inventory quality is fit for the intended use	Medium to high: quantitative
Provide information on the certainty of the reported emissions (indication of emissions size)	Medium to high: quantitative
Provide information on reliability of the inventory / category point as a basis for planning actions	Medium to high: quantitative
Provide information on reliability/certainty of achieved emission reductions / increases	Medium to high: quantitative, may be confusing with moving from one category to another
Evaluating the organization's stewardship and transparency efforts	High: Quantitative

7. Preliminary Comparison of Options

The following comparison of the options provides a preliminary comparative assessment, which will be used as an input for discussion within the Scope 3 Technical Working Group.

7.1 Meeting the Objectives

Table 16. Options comparison: meeting the objectives

Objective	Option A: Improved implementation of current GHG Protocol requirements	Option B: Data quality scoring	Option C: Disaggregated reporting based on quality
Provide information on whether the inventory quality is fit for the intended use	Low to medium: Qualitatively, possibly not enough	Medium: Quantitative, subjective	Medium to high: quantitative
Provide information on the certainty of the reported emissions (indication of emissions size)	Low: Qualitatively and indirect, as an interpretation of the provided information	Medium: Quantitative, subjective	Medium to high: quantitative
Provide information on reliability of the inventory / category point as a basis for planning actions	Low to medium: Qualitatively, possibly not enough	Medium to high	Medium to high: quantitative
Provide information on reliability/certainty of achieved emission reductions / increases	Low: Qualitatively and indirect, as an interpretation of the provided information, needs a more rigorous tracking through the years of reporting	Medium to high, assuming consistency in scoring	Medium to high: quantitative, may be confusing with moving from one category to another
Evaluating the organization's stewardship and transparency efforts	Medium: Qualitative	High: Quantitative	High: Quantitative

7.2 Comparing the three options against the decision-making criteria

Criteria	Option A: Improved implementation of current GHG Protocol requirements	Option B: Data quality scoring	Option C: Disaggregated reporting based on quality
Scientific integrity	Largely NA Enhancing transparency in preparation for inventory calculation and in calculation and reporting (pre- and per-activity: script, visual control)	Largely NA Evidence from LCA on data scoring Intrinsic limitations to score assigning	Largely NA Some evidence from pro-forma financial reporting
GHG accounting and reporting principles	Expected to enhance transparency Indirect influence on other principles	Expected to enhance transparency Indirect influence on other principles	Expected to enhance transparency Indirect influence on other principles
Support decision making that drives ambitious global climate action	Low to medium (open for interpretation)	Medium (subjective pre-interpretation)	Medium to high (specific input)
Support programs based on GHG Protocol and uses of data	Pro: High interoperability (fits all) Con: Low to medium support to user (generic input for own interpretation)	Pro: Medium to high interoperability (doesn't fit those with different scoring) Con: Low to medium support to user (Subjective interpretation done by others)	Pro: Medium to high support to users (specific input for own interpretation) Con: Low interoperability (not incorporated in current frameworks) but could be incorporated
Feasibility to implement	Easy and accessible	High difficulty and low accessibility	Generally accessible, may pose difficulties in data aggregation and transfer in introduction stage

Annex A. Decision Making Criteria

Decision-making criteria and hierarchy	Description
1. Scientific integrity	• First, approaches should ensure scientific integrity and validity, adhere to the best applicable science and evidence (including academic literature, modeling or other research) and align with the latest climate science.
2. GHG accounting and reporting principles	• Second, approaches should meet the GHG Protocol accounting and reporting principles of accuracy, completeness, consistency, relevance, and transparency. • Additional principles should be considered where relevant: conservativeness (for GHG reductions and removals), permanence (for removals), and comparability (TBD, subject to TWG and ISB discussions). Options may present tradeoffs among principles which should be evaluated. Refer to Annex 1 for further details.
3. Support decision making that drives ambitious global climate action	• Third, approaches should advance the public interest by informing and supporting decision making that drives ambitious actions by private and public sector actors to reduce GHG emissions and increase removals in line with global climate goals. • GHG Protocol accounting frameworks should accurately and completely measure emissions such that the resulting GHG data informs effective mitigation action and creates incentives for individual and systemwide GHG reduction in line with global climate goals. Accounting approaches should not support or incentivize actions that are contrary to global climate goals. • Approaches should provide the necessary information to support sector-specific decarbonization in line with climate goals.
4. Support programs based on GHG Protocol and uses of GHG data	• Fourth, approaches should promote interoperability with key mandatory and voluntary climate disclosure and target setting programs that are based on GHG Protocol standards, where appropriate, while ensuring policy neutrality. Refer to Annex 2 for further details. • Approaches should support appropriate uses of the resulting GHG emissions data and associated information by various audiences, including GHG programs, reporting companies, stakeholders and other users of the resulting GHG information.
5. Feasibility to implement	• Fifth, approaches which meet the above criteria should be feasible to implement, meaning that they are accessible, adoptable, and equitable. • GHG Protocol accounting approaches should support broad adoption of GHG Protocol standards, including in voluntary and regulatory settings, and consider different users (level of capacity, resources, geography, regulatory environments, etc.). • For aspects of accounting approaches that meet the above criteria but are difficult to implement, the GHG Protocol should aim to improve feasibility, for example, by providing guidance and tools to support implementation.

GHG accounting and reporting principles (for criterion 2)

For corporate-level inventories

A. **Accuracy:** Ensure that the quantification of GHG emissions (and removals, if applicable) is systematically neither over nor under actual emissions (and removals, if applicable), and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

B. **Completeness:** Account for and report on all GHG emissions (and removals, if applicable) from sources, sinks, and activities within the inventory boundary. Disclose and justify any specific exclusions.

C. **Consistency**: Use consistent methodologies to allow for meaningful performance tracking of GHG emissions (and removals, if applicable) over time. Transparently document any changes to the data, inventory boundary, methods, or any other relevant factors in the time series.

D. **Relevance:** Ensure the GHG inventory appropriately reflects the GHG emissions (and removals, if applicable) of the company and serves the decision-making needs of users – both internal and external to the company

E. **Transparency:** Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Disclose any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources used.