Whitepaper

Translating Scope 3 Inventories into an Actionable Framework of Economic Activities and GHG Sources

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Executive Summary

Organizations have developed detailed Scope 3 inventories and publicly set ambitious targets to reduce their value chain emissions. Taking action to reduce these emissions has proven to be a complex and difficult task. Early efforts rightfully focus on the “no-regret” and known reduction actions. These include improving sourcing and utilization internally and engaging select tier 1 suppliers to commit to Science-Based Targets (SBTs). While these actions can drive meaningful reductions, they may not be enough to reach the ambitious targets set by many organizations.

Part of the challenge for decarbonizing Scope 3 value chain emissions is that these emissions can be difficult to identify. Sometimes the emissions occur deep in the value chain, far removed from an organization’s visibility. An example of this could be the diesel fuel used in mining raw material to construct data center. In other cases, the emissions may comprise a large portion of an organization’s total Scope 3, but they are difficult to see if they’re fragmented across many suppliers. An example of this could be the grid electricity consumed by an organization’s hundreds or thousands of tier 1 suppliers of goods and services.

We have developed a systematic approach to help organizations better pinpoint these difficult to identify emissions. This approach allows organizations to take their existing Scope 3 inventory and translate it into the language of Scope 1 & 2 emissions sources. Once the Scope 3 inventory is translated into these terms, it is easier for organizations to identify emissions hot spots and apply some of the more traditional Scope 1 & 2 emissions reduction actions, in partnership with other value chain stakeholders.

To apply this approach, we start with the existing Scope 3 inventory and apply two additional lenses to it. The first lens identifies the economic activities underpinning each Scope 3 inventory item. The second lens identifies the greenhouse gas (GHG) emissions sources underpinning each economic activity. These two additional lenses align with well-known and adopted analyses, particularly **sectoral pathways**, **life cycle assessments**, and **national pathways**.

This work serves as a first step to help organizations better understand the root sources of the GHG emissions that comprise their Scope 3 inventory. This approach can also help organizations identify how they can intervene in their value chains to drive meaningful reductions that go beyond tier 1 vendors and/or drive reductions at scale in emissions fragmented across many suppliers. However, more guidance and clarity are needed from GHG accounting standards and leadership programs on how organizations can account for these value chain interventions. That additional clarity could help foster the investment certainty needed to drive the decarbonization action required to meet ambitious Scope 3 reduction goals.

We are excited to make this approach public. We believe it sets out a practical way to make sustainable value chains start happening today, with only 8 years left in the “decade to deliver”.

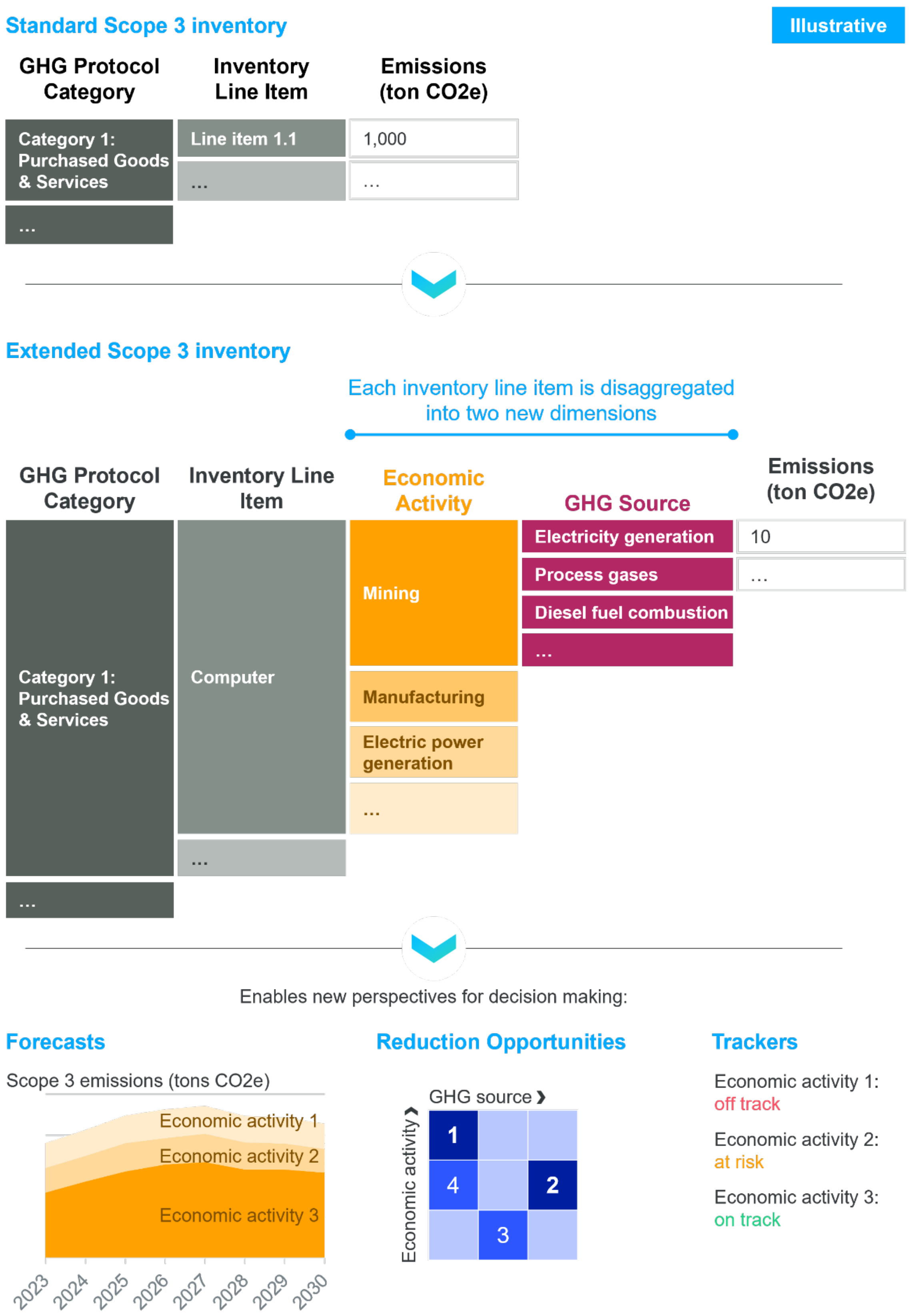

Figure 1: visual overview of this paper's methodology to disaggregate an organization's scope 3 inventory categories into economic activities and GHG emission sources, enabling new perspectives for decision-making

Scope 3 Inventories and Mitigation Initiatives Today and Why a New Perspective is Needed

How Scope 3 is Addressed Today

Today, Scope 3[1] is reported along 15 categories of activities as required by the **GHG Protocol Scope 3 Standard**. With more companies reporting on all material categories and improving the accuracy of Life Cycle Assessments (LCA) and product-specific emission factors, a clear picture has emerged. Scope 3 tends to make up the majority of a company's total emissions for most sectors, and a small subset of Scope 3 categories often make up the bulk of value chain emissions for each reporting company.

The Science-Based Target Initiative (SBTi) standard for Scope 3 recommends, in increasing order of ambition, setting supplier or customer engagement targets[2], intensity targets, or absolute targets, such that emissions remain within the carbon budget calculated by IPCC. Targets must adhere to SBTi's minimum requirements for the boundary and emission abatement rates. Near-term Net Zero targets must be met 5-10 years from the date of commitment, with 2030 being a common target year for organizations. Therefore, only 8 years are left for many companies to meet value chain targets, within which emission reduction activities must be prioritized, approved, piloted, and scaled.

Today, 3 types of **Scope 3 emissions reduction activities** are commonly pursued by organizations:

1. **Initiatives internal to a company** including circularity, procurement switching to lower carbon products, emission targets for research & development, operational model re-design including for business travel and commuting, employee engagement
2. **Supplier- and customer- dependent initiatives** including committing suppliers to their own SBTs (typically the largest tier 1 suppliers) and finding efficiencies in transportation & distribution
3. **Public advocacy** including joining industry associations and voicing support for adding renewables and storage solutions to the electric grid

Challenges

For companies setting highly ambitious, near-term reduction targets, the activities listed above may be too limited to achieve these targets, especially for high growth companies. Long and complex value chains require decarbonization action not only internally and at tier 1 suppliers, but throughout all tiers of the value chain. Internal action, supplier engagement, and advocacy are at risk of not cascading up value chain tiers at a pace sufficient to meet an organization's science-based target. Organizations are often unclear on what they can do beyond these actions due to a number of challenges.

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[1] Scope 3 is defined by the GHGP as all indirect emissions (upstream and downstream) resulting from value chain activities except from the generation of purchased heat or acquired electricity, steam, heating, or cooling consumed by the reporting company

[2] Supplier or customer engagement targets are only valid for near term targets. Learn more in the **Corporate Net-Zero Standard of SBTi**

The first challenge is that Scope 3 inventories are organized differently from Scope 1 and 2 inventories. Scope 3 inventories are organized by categories describing the reporting company's business activities (e.g., purchasing goods and services) while Scope 1 and 2 inventories are organized by categories describing the source of greenhouse gases (e.g., stationary combustion from owned furnaces, or the use of purchased electricity). Therefore, data in Scope 3 inventories does not align with many of the known reduction strategies for Scope 1 and 2 emission, such as purchasing low carbon electricity and fuels, implementing resource efficiency measures, and re-designing products and industrial processes.

A second challenge is that forecasting and tracking progress towards Scope 3 targets is often not feasible with available datasets. An organization's ability to forecast and track progress toward targets is critical for making decisions on emission reduction programs. However, large emission categories are commonly estimated at the level of generic commodities or activities, national averages, and timeframes of several years that only cover historical estimates[3]. The ideal solution to enable forecasting and progress tracking would be to collect product- and supplier-specific historical emission factors and forecasts that are updated year after year. However, getting to this level of sophistication is a technically complex, multi-stakeholder, and time-consuming task that will require years to achieve, if ever.

With less than 10 years left for many organizations until their near-term targets, waiting for clearer data risks delaying decision-making, limiting emission reduction initiatives, and missing targets. An alternative solution that clarifies GHG sources, reduction levers, forecasts, and tracking can enable decision making.

[3] For example, a common GHG accounting method is the spend-based method, which maps a company's general ledger to a list of generic commodities. The annual spend is then multiplied with the emission factor of that commodity in kgCO2e/USD. Spend-based emission factors are secondary data calculated with Environmentally Extended Input-Output (EEIO) analyses, which are comprehensive but are inherently broad national and economic averages, incur several years of delay from measurement to publication, and are often only updated every few years. In addition, EEIO analyses are historical only and do not include forecasts for emission factors. Because of these data limitations, companies using a spend-based method are not able to forecast, track, and account for the impact of their emission reduction activities in their scope 3 inventory.

Why a New Perspective is Needed

To take faster action with greater impact, an extension to the GHGP framework is needed to align Scope 3 inventories to the underlying **GHG emitting activities and sources** that companies are already familiar with: the types of emission sources that organizations already work on today for their own Scope 1 and 2 emissions.

Most emissions reduction opportunities available to companies have been defined and acted on at the level of economic activities and GHG sources. For example, the economic activity of road freight and the associated GHG source of diesel combustion can be addressed with zero-emission vehicles, and governments are acting on it with financial incentives for the purchase of these vehicles. Therefore, identifying emission reduction solutions can be simplified by analyzing the underlying emissions-causing economic activities embedded in the Scope 3 emissions of an organization.

In addition, organizations need to forecast their Scope 3 emissions to enable decision-making for setting a Scope 3 target and justifying the funding of emission reduction activities. Public forecasts for the two new dimensions—economic activities and GHG sources—are widely available and can be incorporated to forecast the evolution of an organization's Scope 3 emissions. For example, **Nationally Determined Contributions (NDC)** submitted by countries to the United Nations can feed the forecast of emissions in each country where the value chain operates. **SBTi's sector-based requirements** define the trajectories of economic sectors and can be integrated into an organization's Scope 3 (assuming that its specific suppliers will be aligned to SBTi's trajectories).

Finally, a new perspective is needed to start tracking Scope 3 emissions towards the target year. Primary data from suppliers for their activities specific to supplying a customer organization is best practice, but still a major challenge. In the meantime, tracking is enabled to a limited extent through the two new dimensions proposed here. Tracking of emissions at the economic level is enabled by incorporating National Inventory Submissions (NIS) that are submitted yearly to the UNFCCC by each member country. NIS discloses historical emissions year-by-year, by economic sector, and by GHG source. These give indications of yearly progress made by sectors embedded in an organization's value chain to transition to low-emission activities and energy sources. As Scope 3 reporting and interventions become the norm, we may expect more frequent updates to emission factor databases, more suppliers providing product-specific carbon reports, and new mechanisms to account for interventions. For example, **Gold Standard's guidance on value chain (Scope 3) interventions** "aims to enable and incentivize value chain Interventions by providing an approach to recognize and include their impact in reporting towards quantitative GHG reduction performance targets, even in cases where direct knowledge and measurement of specific value chain participants is challenging[4]"

When Scope 3 is analyzed by the actual economic activities causing emissions, the emission reduction solutions become clearer for both companies and suppliers, and faster action can be taken for greater impact.

[4] For example, through the "supply shed" concept defined as "a group of suppliers in a specifically defined geography and/or market providing similar goods and services that can be demonstrated to be associated with the company's supply chain." (Source: **Gold Standard**)

A New Perspective: Translating Scope 3 Emissions into Economic Activities and GHG Sources

Introduction

In this section, we introduce a methodology to get a new perspective, which views Scope 3 emissions through the lens of economic activities and their associated GHG sources.

This perspective is not meant to create a new accounting or reporting methodology. Instead, it aims to enable the understanding of which activities in the global economy have emissions embedded in a company's Scope 3, how these activities emit greenhouse gases, how they can transition to lower emission alternatives, and how fast they are forecasted to transition. Equipped with this understanding, companies can gain the clarity needed to decide which parts of the economy and which intervention levers to focus their resources on for catalyzing action, including:

- Engaging suppliers with more targeted inquiries
- Switching product sourcing to a greener alternative
- Financially sponsoring projects to address upstream emission sources
- Investing in the development of climate solution technologies
- Advocating for specific transitions

Focusing on emitting activities is aligned with LCA methodologies, but LCAs often aggregate GHG emissions bottom-up across the value chain's goods and processes at the product level, presenting results as emissions per product/functional unit. Our methodology instead takes a top-down approach, disaggregating Scope 3 totals.

Figure 2 provides a visual overview of this paper's methodology. A company's Scope 3 is first disaggregated into economic activities, then GHG Sources, using allocation factors. The two new dimensions of economic activities and GHG sources offer new perspectives. For example, the ranking of Scope 3 tonnage by economic activity and GHG source clarifies which activities must transition to new resources, technologies, and processes for an organization to achieve its Scope 3 targets.

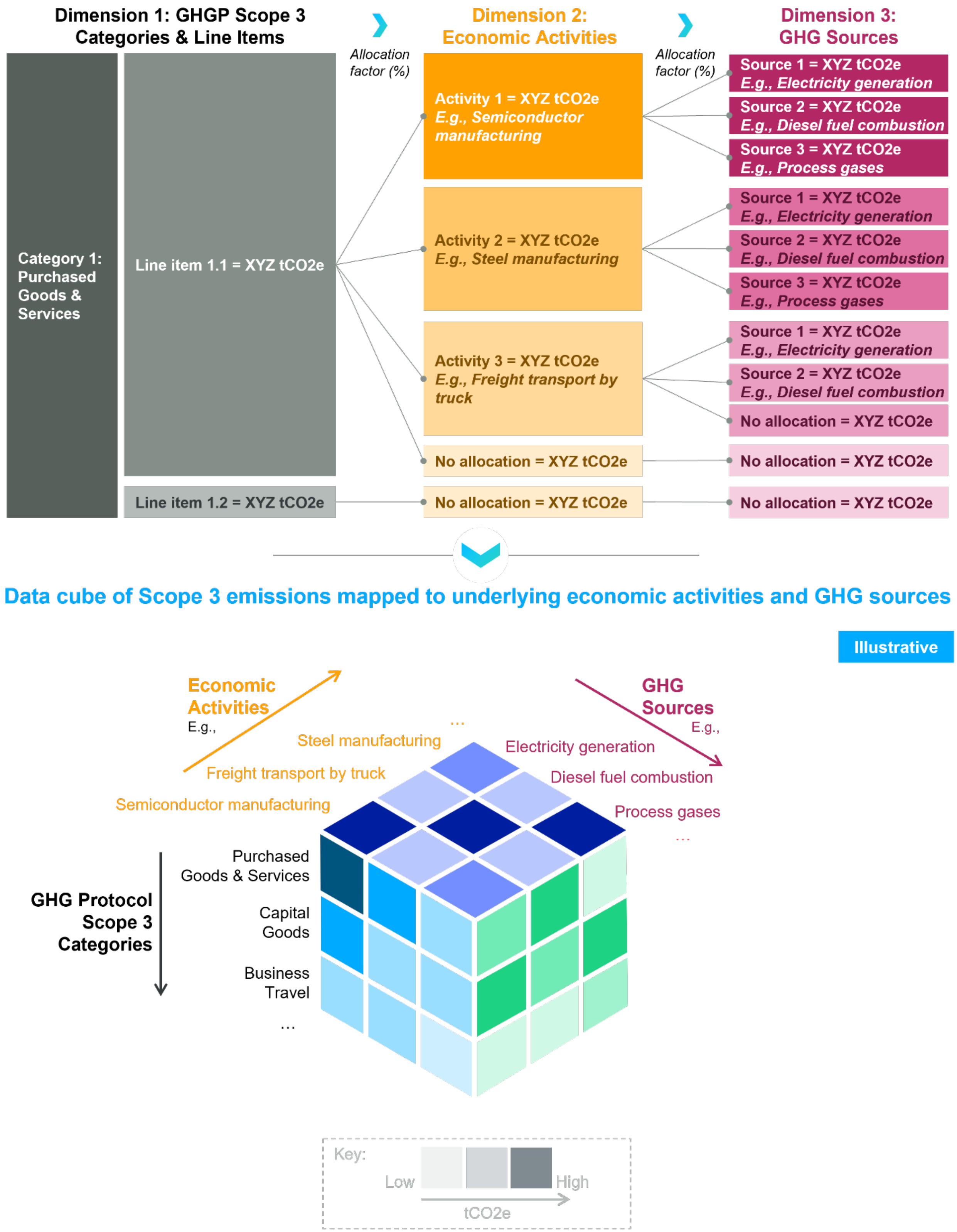

Figure 2: Disaggregation methodology using allocation factors to split inventory line items into emissions from economic activities and GHG sources, enabling new perspectives for decision making

Where are we starting?

Prior to applying this paper's methodology, an organization should have conducted a standard Scope 3 inventory following the categories and methods in the Greenhouse Gas Protocol Scope 3 Standard. Calculating a Scope 3 inventory requires collecting activity data and emission factors into inventory line items organized by category. Typical activity data types include the company's spend data, activity data, and/or units of goods and services for particular business activities. Emission factors include EEIO and LCA factors. See the GHG Protocol calculation guidance for additional information.

Scope 3 inventories use data tables organized with the following dimensions, inputs, and outputs:

Dimensions	Inputs	Outputs
• Year / timeframe • Scope Category (e.g., Cat 6 – Business Travel) • Line item (typically, a good or service)	• Raw measure (e.g., USD spend, mileage, etc.) • Emission factor (e.g., tCO2e/USD)	• Emission estimate for line item (tCO2e)

Table 1: dimensions, inputs, and outputs of a scope 3 inventory

Where are we going?

After applying this paper's methodology, the Scope 3 inventory will be elaborated with two additional dimensions (economic activities and GHG sources). Each line item's emission tonnage is allocated to each economic activity and GHG sources using allocation factors. The output is a Scope 3 inventory disaggregated into emissions from its embedded economic activities and GHG sources. Below is a summary of the extended Scope 3 inventory's dimensions, inputs, and outputs.

Dimensions	Inputs	Outputs
• Year / timeframe • Scope category (e.g., Cat 6 – Business Travel) • Line item (typically, a good or service) • Economic activity • GHG source	• Line item's emissions (tCO2e) • Allocation factor of a commodity's emissions to an economic activity (%) • Allocation factor of an economic activity's emissions to a GHG source (%)	• Line item's emissions from the contribution of the economic activity and the GHG source (tCO2e)

Table 2: dimensions, inputs, and outputs of a scope 3 inventory after applying this paper's methodology

The first of the two additional dimensions contains the economic activities associated with a line item's emissions. An economic activity is defined as "a process that, based on inputs, leads to the manufacture of a good or the provision of a service" (**Insee**). That could include copper mining, semiconductor manufacturing, office-based professional services, or other activities. Several exhaustive classifications of economic activities are readily available in the field of economics. These economic classifications have been used in the field of sustainability as well. For example, the US-EEIO data set uses the BAE classifications, and IPCC uses the UN-ISIC classification.

The second additional dimension contains the GHG Source defined as "any physical unit or process which releases GHG into the atmosphere" (**GHG Protocol**). This could include electricity generation, diesel fuel combustion, fugitive methane, or other sources. Exhaustive classifications of GHG sources are also readily available, including from the IPCC (Table 8.2 of the **IPCC Guidelines, volume 1, chapter 8**) and the **EPA.**

A company may elect to integrate additional dimensions to gain greater insights into which emitting activities need to decarbonize, particularly dimensions around the activity's geography and value chain tier.

How will we get there?

Line-item totals are allocated to the two new dimensions using two new inputs derived with the following calculations:

- *Allocation factor of a line item's emissions to an economic activity (%)*
  = [Economic activity's contribution to line item's emission factor (tCO2e/unit)] / [Line item's emission factor (tCO2e/unit)]
- *Allocation factor of an economic activity's emissions to a GHG source (%)*
  = [GHG source's contribution to economic activity's emissions (tCO2e)] / [Economic activity's total emissions (tCO2e)]

The detailed methodology to derive these allocation factors is described in step 3 and 4 below.

The disaggregated emission estimates are calculated from allocation factors as follows:

Line item's emissions from the contribution of economic activity A and GHG Source B (tCO2e)
= [Line item's emissions (tCO2e)]
** [Allocation factor of the line item's emissions to economic activity A (%)]*
** [Allocation factor of economic activity A's emissions to GHG source B (%)]*

Practical considerations

Disaggregating Scope 3 emissions can be a perplexing task, therefore we take an approach that prioritizes practicality and actionability. The objective is getting to an answer that enables decision-making on deep decarbonization action, thus prioritizing practicality and actionability over exhaustiveness and accuracy.

Concretely, this means:

- Getting started quickly by using existing knowledge about the company's value chains
- Guiding the analysis by assessing which line items, economic sectors, and GHG sources are likely to make up the bulk of Scope 3 emissions and iterating as needed
- Using secondary data and making reasonable assumptions as relevant

Detailed Analysis Steps

In the following, we describe the four analysis steps recommended to translate a Scope 3 inventory into economic activities and GHG sources. Each step is illustrated with a case study.

Analysis Step 1

Identify the likely main economic activities and GHG sources to guide the analysis with a statement like "*x% of our Scope 3 can be allocated to the y number of economic activities a, b, c, and the z number of GHG sources d, e, f*". The analysis will either validate or invalidate this statement, in which case another iteration is started. Allocating the entirety of Scope 3 economic activities will likely not be feasible. Therefore, we recommend that a percentage coverage (e.g., 80%) be used to guide the analysis.

Inputs	Outputs
Required: • Company's Scope 3 inventory • Any existing knowledge about value chains relevant to your company (e.g., from internal teams, desk search, existing LCAs, etc.) **Optional:** • EPA Organizational SMM Prioritization Tool • Lifecycle assessments (LCAs) • Environmentally-extended Input-Output analyses • CDP Climate Questionnaires • UN ISIC, NAICS, or other classifications of economic activities • UN CRF or other classifications of GHG sources	• Targeted % proportion of Scope 3 to be allocated; • List of economic activities to be used for allocation; • List of GHG sources to be used for allocation

Table 3: inputs and outputs of step 1

Case Study 1

In 2022, this methodology was applied to Meta's 2020 and 2021 GHG inventory. This case study describes that approach but uses publicly available data instead of Meta specific data, such as Meta's proprietary LCAs. Meta's 2021 Scope 3 is concentrated in Purchased Goods and Services (Category 1) and Capital Goods (Category 2), which total 84% of all Scope 3 emissions. These categories have value chains associated with Meta's corporate activities, digital services, data centers, and consumer electronics. Additional emissions categories include, Use of Sold Products (Category 11), and Upstream Transportation and Distribution (Category 4). Combined, these 4 categories cover 98% of Meta's Scope 3 emissions.

Taking Meta's data centers for example, the Scope 3 inventory may have several associated line items that materially contribute to categories 1 and 2 like compute servers. Existing knowledge about compute servers obtained from LCAs conducted by Meta leads to the expectation that most emissions will come from the manufacturing of semiconductors (processors, solid state storage, etc.). For this illustrative case study, we roughly estimate for now that 80% of upstream compute server emissions can be attributed to the economic activity of semiconductor manufacturing.

Searching semiconductors in the **EPA Organizational SMM Prioritization Tool** indicates that grid electricity and process gases are the main GHG sources. Therefore, for the line item of data center compute servers, we hypothesize that 60% of the emissions of the economic activity semiconductor manufacturing can be allocated to the 2 GHG sources of grid electricity generation and fugitive process gases.

Repeating this thinking across each of the four key value chains listed above, the following statement is made to guide the analysis (illustrative for this case study) "*80% of Meta's Scope 3 can be allocated to the 3 economic activities of semiconductors manufacturing, steel manufacturing, freight transport by truck, and the 3 GHG sources grid electricity generation, fugitive process gases, and diesel fuel combustion.*" If this statement turns out to be wrong after going through the subsequent analysis steps presented below, we would include more economic activities and / or GHG sources to cover a greater percentage of the Scope 3.

Analysis Step 2

In this step, we derive the allocation factors used as inputs to allocate each inventory line item's emissions to economic activities and GHG sources.

Step 2.1

To the extent possible, aim to allocate line items using data specific to your organization. For each Scope 3 category line item, identify existing data sources to disaggregate emissions into the listed economic activities and GHG source, and consider commissioning new data sources specific to your organizations. Examples include:

- Product LCAs from the manufacturer or designer
- Supplier-provided emission reports for the specific activities supplying your organization

A sequence of several datasets may be needed to disaggregate emissions down to the level of economic activities and GHG sources. Data characteristics (e.g., accounting boundary, timeframe, etc.) should closely match those of the line item to allocate and any mismatch, uncertainty, limitation, or assumption should be documented. Data should then be categorized into either one of the assumed main economic activity or GHG source or left as not categorized. Finally, the data should be converted into percentages of total emissions to allow for the allocation of an inventory line item's total emissions.

Case Study 2.1

In the illustrative example given in the previous step, we retained 3 economic activities (semiconductors manufacturing, steel manufacturing, freight transport by truck), and 3 GHG sources (grid electricity generation, fugitive process gases, and diesel fuel combustion) for subsequent allocation.

Meta conducted LCAs of its specific hardware and has the primary data to perform the allocation of the computer servers line item. In this example however, we will use an **LCA published by Dell**. We retain the following information from the LCA:

- 99.9% of emissions come from the Dell server's manufacturing and 0.1% from its transport. We assume transport is mostly emissions from road freight
- In addition, ~80% of a server's manufacturing emissions can be allocated to the economic activity semiconductors manufacturing and 0.8% to steel manufacturing

Therefore, our allocation factors to economic activities are 80% for "semiconductors manufacturing", 0.8% to "steel manufacturing", 0.1% to "freight transport by truck", and the remainder (19.1%). to "No allocation"

In the absence of organization-specific data to disaggregate GHG sources however, we need data not specific to Meta to continue the analysis, as described in the next step.

Step 2.2

Complete the allocation factors using data sources not specific to your organization.

Examples include:

- **Third-part lifecycle databases**
- **EPA's Organizational SMM Prioritization Tool**
- Environmental reports of industry-representative companies or associations
- Environmentally-Extended input-output models

The process described in step 2.1 to assess the quality of data sources and derive allocation factors may be replicated here. When completed, all Scope 3 line items should be 100% disaggregated into the retained economic activities, GHG sources, or a "no allocation" category.

Case Study 2.2

In the previous step, we allocated data center compute server emissions to semiconductor manufacturing, truck transport, and steel manufacturing from primary data, but data was missing to further allocate emissions to the GHG sources retained for this analysis (i.e., grid electricity generation, fugitive process gases, and diesel fuel combustion)

A third-party LCA on DRAM semiconductors indicates that 45% of emissions come from energy (assumed to be 100% grid electricity) and 13% from direct air emissions (fugitive process gases). The remainder (42%) remains unallocated to a GHG source.

Using the US EPA's Organizational SMM Prioritization Tool, we then disaggregate the GHG emissions of secondary steel products: 18% is allocated to grid electricity generation and 5% to diesel fuel combustion[5]. The remainder (77%) is not allocated to a GHG source.

Analysis Step 3

Multiply the line item's emissions by each allocation factor and store the results in the extended Scope 3 data table as illustrated in the example below.

Case Study 3

Let us assume for illustrative purposes that upstream GHG emissions for Meta's compute servers line item is 1,000 tCO2e.

Since we allocated in previous steps 80% of the line item "compute servers" total to "manufacture of semiconductors, 0.8% to "manufacture of steel", 0.1% to "freight transport by truck", and the remainder to "no allocation", we derive that 800 tCO2e from this line item is caused by the "manufacture of semiconductors", 8 tCO2e by "manufacture of steel", 1 tCO2e by "freight transport by truck", and 191 tCO2e is not yet allocated to an economic sector.

To disaggregate these results into GHG sources, since 45% of the semiconductor manufacturing emissions were allocated to the GHG source grid electricity and 13% to fugitive process gases, we derive that 360 tCO2e originate from grid electricity generation, 104 tCO2e from fugitive process gases, and 336 tCO2e is not allocated to a GHG source. Similarly for steel, ~1.4 tCO2e is allocated to grid electricity generation, 0.4 tCO2e to diesel fuel combustion, and 6.2 tCO2e is not allocated to a GHG source. The freight transport by truck is assumed to be 100% operational emissions from diesel fuel combustion i.e., 1 tCO2e is allocated to "diesel fuel combustion."

Below is the output at step 3:

[5] Assuming truck transport can be fully allocated to diesel fuel combustion

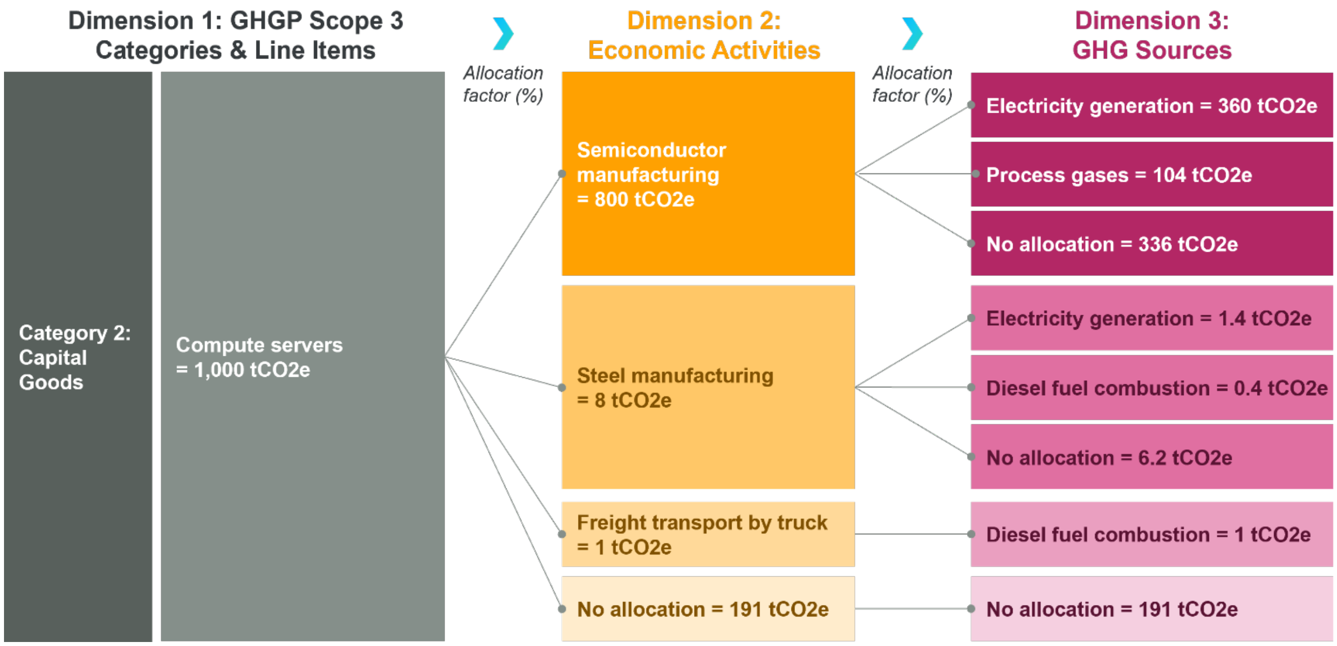

Figure 3: example output of the disaggregated line item "Compute servers" of the illustrative case study

Analysis Step 4

Roll up all emissions and assess whether allocated emissions cover enough of the Scope 3 total, otherwise iterate steps 1-3. If acceptable, proceed to interpreting results (discussed in the following section).

Case Study 4

In the illustrative table shown above for Meta's compute servers, rows fully allocated to an economic sector and GHG source sum up to 467 tCO2e or 46.7% of the total. In step 1, we stated that "*80% of our Scope 3 can be allocated to the 3 economic activities manufacture of semiconductors, manufacture of steel, freight transport by truck, and the 3 GHG sources grid electricity generation, fugitive process gases, and diesel fuel combustion.*" If all Scope 3 line items were only allocated at 46.7% as in this example for compute servers, the retained set of economic activities and GHG sources would be insufficient to meet the objective of 80% coverage of all Scope 3 emissions. We would then include new economic sectors or GHG sources and repeat steps 2-3 on the rows with no allocation.

Let us, however, assume for this example that the coverage objective was achieved. In the next section, we will discuss the implications and insights of this new perspective.

Discussion of Results

New Insights To Help Solve Value Chain Emissions

Deeply decarbonizing value chains requires new insights into *who* needs to transition *what* activity and *how*. New insights into the *who*, *what*, and *how* may increase confidence in decision makers to commit to ambitious Scope 3 targets, accelerate the approval of budget and resources, and develop a sustainability narrative that is more authentic.

By viewing Scope 3 emissions through this new lens of economic activities and GHG sources, a company can identify the subset of economic activities that must decarbonize to achieve its Scope 3 target – the *who*. In the illustrative case study of this white paper, semiconductor manufacturers are critical to decarbonize the capital goods emissions associated with data center servers.

In addition, the GHG sources embedded in an organization's Scope 3 are made explicit to understand which technologies and operations must transition to a zero-carbon alternative – the *what*. In the illustrative case study of this white paper, the generation of electricity and use of process gases for semiconductor manufacturing, and to a lesser extent the generation of electricity for steelmaking and the combustion of diesel in truck engines, must transition to lower-carbon alternatives such as renewable electricity, renewable gases, and electric vehicles.

Finally, the extended Scope 3 inventory enables us to forecast emissions and identify gaps to target that will require interventions – the first step of solving the *how*. With the two new dimensions of economic activities and GHG sources, the expanded Scope 3 inventory is set up for forward projections that can directly incorporate macro-economic decarbonization projections. For example, the projections of grid electricity emissions (obtained from NDCs) can be directly applied to the CO2e tonnage allocated to the grid electricity GHG source. In addition, we can rank the pairs of economic activities and GHG sources by their weight in the remaining value chain emissions to identify specific reduction opportunities. For example, diesel fuel combustion may occur in several economic activities including construction, waste haulage, long-haul trucking of finished goods, mining, etc. Displacing diesel is a different challenge for each of these activities — technologically, operationally, and economically. Different engagement approaches, technological solutions, and business models will be required for each pair of economic activity and GHG source. Ranking pairs of economic activities and GHG sources by their contribution to Scope 3 gives greater clarity for companies to prioritize which companies, industry associations, policy makers, NGOs, and others to engage. Going into these conversations with an initial understanding of emitting activities may improve the quality of supplier engagements by enabling companies to ask targeted questions. In turn, companies will gain understanding around what is already being done and what is still needed to further refine their Scope 3 projections, identify gaps to Science-Based Targets, and enable decision-making on interventions, including:

- Engaging suppliers with more targeted inquiries
- Switching sourcing of a good or product
- Advocating for policy changes
- Financing decarbonization projects in the value chain
- Investing in the development of new decarbonization technologies

Gaps and limitations to this methodology

Companies applying this methodology should remain aware of its gaps and limitations summarized below.

The methodology's objective is to enable decision-making and should not be used for carbon accounting or reporting under current GHG standards.

The methodology's top-down disaggregation approach implies that each inventory's line item is composed of goods and services with equal distributions of emissions across the individual economic activities and GHG sources (or else is associated with allocation factors already accounting for these specific distributions). For example, disaggregating semiconductors by GHG source (as illustrated above) is highly dependent on the local grid electricity carbon intensity. Different distributions between the GHG sources of electricity generation and use of process gases are expected if manufacturing occurs in Taiwan, in Europe, or in the United States because the carbon intensity of these location's electricity differ greatly. Should the resulting error not be acceptable, emissions from compute servers and semiconductor manufacturing can be split by their manufacturing locations and then disaggregated by GHG source.

The methodology trades exhaustiveness and accuracy for actionability. Thus, inventory emissions that are not allocated to the retained set of economic activities and GHG sources may leave key emitting activities unaddressed. Any assumptions made in allocation steps, as well as uncertainty in primary and secondary data, may impact the resulting CO2e tonnage and ranking of economic activities and GHG sources. Finally, the efficiency of the iterative approach may be undermined if many iterations are required to meet a satisfactory coverage of Scope 3 and disaggregation accuracy.

Need for Industry Guidance and Standards to Maximize Intervention Reduction Potential

Identifying the root GHG sources of Scope 3 activities can unlock emission reduction opportunities. However, there is not widespread GHG accounting guidance on how to report emissions reductions from the upstream opportunities identified by this methodology. For example, if companies identify projects to reduce fugitive process gases released in semiconductor manufacturing, but those projects are located at suppliers upstream of supplier engagement programs or are not directly traceable to a company's Scope 3 inventory, there is uncertainty on how companies can account and report for these reductions in their Scope 3 and related SBT goals with the current data set limitations. However, new mechanisms are being developed to account for some of the value chain interventions that may be identified through this analysis. For example, **Gold Standard's guidance on value chain (Scope 3) interventions** "*aims to enable and incentivize value chain interventions by providing an approach to recognize and include their impact in reporting towards quantitative GHG reduction performance targets, even in cases where direct knowledge and measurement of specific value chain participants is challenging*". More guidance and clarity are needed from the GHG accounting standards and programs on accounting for these types of reductions in order to provide investment certainty for companies and drive decarbonization.

Recommended Next Steps

We invite organizations to take the following next steps after reading this white paper:

- Start by applying this analysis to your top Scope 3 categories. Category 1 (Purchased Goods & Services) is likely a good starting point for most organizations
- Based on the new insights gained through this analysis, take immediate action by identifying “no regret” moves. For example, if grid electricity generation is a large source of your Scope 3 emissions, engage with your team to understand what advocacy your company can have in greening the grid
- In parallel, start planning for longer-term actions and strategic bets. For example, explore investment options to scale the technologies on which the decarbonization of key economic activities / GHG sources depends
- Continuously improve your analysis by **incorporating more sophisticated methodologies and inputs as relevant** to:
    - Increase the coverage of Scope 3 emissions
    - Improve matching between allocation data source and good or service to disaggregate
    - Replace generic data with data specific to your organization
    - Match data temporarily and geographically
    - Reduce uncertainty in data
    - Disaggregate by geography and/or value chain tier
- Collaborate on accounting, tracking, and implementation with companies, industry associations, NGOs, policy makers, etc. Disseminate insights through publications to encourage peers to employ similar approaches
- Refresh this analysis with your yearly Scope 3 inventory to track progress towards your goals
- Work with peer companies and GHG accounting organizations on developing guidance, sharing learnings, and co-investing into solutions e.g.,
    - The **Value Chain Initiative** and **Gold Standard**
    - **GHG Protocol**
    - **WRI**
    - WBCSD **SOS 1.5** and **PACT** initiatives
    - **The Carbon Call**
    - **Business Alliance to Scale Climate Solutions**
    - **Sustainable Aviation Buyers Alliance**
    - **Getting to Zero Coalition**
    - Industry associations such as **ICMM for mining**

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Acronyms

CDP: Carbon Disclosure Project

EEIO: Environmentally-Extended Input-Output

EPA: Environmental Protection Agency

GHG: Greenhouse Gas

GHGP: Greenhouse Gas Protocol

IPCC: Intergovernmental Panel on Climate Change

LCA: Life Cycle Assessment

NAICS: North American Classification System

NDC: Nationally Determined Contributions

NGO: non-governmental organization

NIS: National Inventory Submission

SBT: Science Based Target

STBi: Science Based Target Initiative

UNFCC: United Nations Framework Convention on Climate Change

USD: US Dollar

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Thank You

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