# SCOPE 3 CATEGORY 11 GHG ASSESSMENT

GUIDELINE FOR THE SEMICONDUCTOR SECTOR

SEMI – Semiconductor Climate Consortium (SCC)

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# TABLE OF CONTENT

# LIST OF TABLES

# LIST OF FIGURES

# EXECUTIVE SUMMARY

The objective of the Guideline is to establish a comprehensive framework that promotes clarity and consistency in accounting for Scope 3 Category 11: Use of Sold Products (3.11) emissions across the semiconductor industry value chain, and provide guidance for overcoming shared challenges faced by companies in assessing 3.11 emissions.

The Guideline's intended audience is Semiconductor Climate Consortium (SCC) member companies and other organizations operating in the semiconductor industry value chain, who seek to enhance their 3.11 assessment.

The Guideline is founded upon established international standards, notably the Greenhouse Gas (GHG) Protocol suite of corporate standards. However, it does not seek to simply reiterate 3.11 relevant guidance already available and should not be the starting point for companies looking to develop 3.11 calculations. Instead, this Guideline goes beyond current GHG Protocol guidance to help semiconductor industry value chain companies contextualize and apply guidance as well as address some of the grey areas.

At the time of this document's release, the GHG Protocol suite of corporate standards is undergoing revisions and the GHG Protocol anticipates releasing draft guidance for public consultation in 2025 and publishing final standards/guidance in the latter half of 2026. In the event that updated GHG Protocol guidance conflicts with this Guideline, the GHG Protocol shall supersede it (see References section for current versions in use).

The following main considerations are emphasized in the Guideline:

- For the purposes of this Guideline, GHG accounting and reporting of a 3.11 inventory should be based on six GHG accounting principles: relevance, completeness, consistency, transparency, accuracy, and precision.
- Companies should disclose the methodology used to calculate their GHG inventory.
- The recommendations in the Guideline do not prohibit companies from pursuing other decarbonization efforts or exercises on their own or internally.

Beyond the development of this Guideline, other collective actions that could be implemented in the future to facilitate companies within the semiconductor industry value chain in their ongoing pursuit of enhancing the accuracy of 3.11 estimation are:

- Developing standardized questionnaires for customer data collection
- Providing training for GHG accounting
- Developing a common emissions factors database
- Facilitating an SCC emissions data program for collecting and exchanging corporate and product data
- Promotion of third-party assurance and verification best practices

# 1. INTRODUCTION AND SUMMARY

## 1.1 BACKGROUND

The Semiconductor Climate Consortium (SCC) is a global industry association representing over 90 companies worldwide within the semiconductor value chain, focused on the challenges of climate change and working to promote and accelerate industry value chain efforts to reduce greenhouse gas (GHG) emissions.

The consortium's members are committed to working toward the following pillars and objectives:

**Collaboration:** align on common approaches, technology innovations, and communications channels to continuously reduce GHG emissions.

**Transparency:** publicly report progress and Scope 1, 2, and 3 emissions annually.

**Ambition:** set near- and long-term decarbonization targets with the aim of reaching net-zero emissions by 2050.

The SCC enrolled the assistance of ERM[1] in developing a Guideline to support companies in the semiconductor industry value chain in measuring and reporting their Scope 3 Category 11: Use of Sold Products (3.11) emissions accurately and consistently.

Scope 3 emissions are indirect emissions that result from value chain activities and often account for the largest portion of emissions in a company's GHG inventory. Accurate reporting of Scope 3 emissions can help companies understand their emissions profile and know where to focus emissions reduction efforts.

3.11 includes emissions from the use of sold products by end users over the products' expected lifetime. This category includes both direct and indirect use-phase emissions. Direct use-phase emissions arise from a product's direct consumption of energy (fuels or electricity) or production of GHG emissions during use, like a server consuming electricity while running. Indirect use-phase emissions, meanwhile, arise from a product's indirect consumption of energy or production of GHG emissions during use, such as the energy required to cool/mitigate a server's heat load. While the server itself is not consuming the energy required for cooling, the energy is indirectly required for the server's operation. Products may have both direct and indirect use-phase emissions or just one or the other. The GHG Protocol considers calculating and disclosing indirect use-phase emissions as optional, but companies should aim to account for them when these emissions are assessed to be significant.

[1] See Section 6: Acknowledgments

### 1.2 DEVELOPMENT

The SCC leveraged subject-matter experts across the semiconductor value chain to lead and participate in a working group. Within the SCC Scope 3 Working Group, a 3.11 core team was formed to discuss major topics and guidance options to help build consensus among membership. Key methodological challenges were identified and discussed. In total, 19 companies were interviewed and a core team of participants was involved in the process to help understand specific context and concerns of members. Figure 1 shows an overview of the main topics covered with participants in the working group and individual interviews.

This Guideline was developed under the authority of SEMI and the SCC Scope 3 Working Group. Any revisions, corrections, or updates to this document are at the discretion of the SEMI SCC. It is anticipated that future versions of this Guideline will be published to reflect any updates to existing standards and changes to best practices.

**FIGURE 1 OVERVIEW OF MAIN TOPICS COVERED WITH PARTICIPANTS**

| Situation | Common Challenges | Companies' Goals |
|---|---|---|
| • Companies participating in the working group are heterogenous in terms of maturity and sophistication of 3.11 emissions accounting process implemented.<br>• Many companies either do not publicly report complete 3.11 emissions or do so without transparent methodology required to compare to other organizations. | • Determining 3.11 relevance and exemptions for various company types in the value chain.<br>• Identifying direct vs. indirect use-phase emissions.<br>• Limited data and insight into downstream use of sold products.<br>• Lack of methodology to incorporate customer renewable energy.<br>• Lack of transparent, standard, and comparable reporting between companies. | • Develop or improve GHG estimations.<br>• Integrate primary data.<br>• Promote collective actions within SCC ecosystems (e.g., data characterzion and exchange approaches).<br>• Enable reductions from renewable energy to be reflected in accounting.<br>• Avoid overly burdensome reporting requirements. |

## 1.3 ACCOUNTING PRINCIPLES

For the purposes of this Guideline, GHG accounting and reporting of a 3.11 inventory should be based on the GHG accounting principles below:

**Relevance:** GHG accounting is considered relevant when it provides the necessary information for users, including both internal and external stakeholders, to make informed decisions. The relevance principle, for example, should be applied when determining the inventory boundary and in selecting data sources.

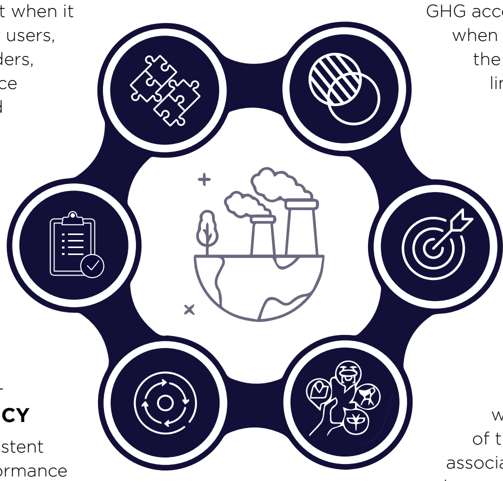
**Completeness:** GHG accounting is considered complete when all relevant emissions sources within the chosen inventory boundary are accounted for. Any exclusions should be transparently documented and justified.

**Consistency:** GHG accounting is considered consistent when allowing for meaningful performance tracking of emissions over time.

**Transparency:** GHG accounting is considered transparent when disclosing all information regarding the processes, assumptions, and limitations of the inventory.

**Accuracy:** GHG accounting is considered accurate when data uncertainties are avoided as far as practical, i.e., an accurate data measurement is as close as practically possible to the true or accepted value for this data.

**Precision:** GHG accounting is considered precise when estimation methods – regardless of the inherent accuracy or limitations associated with each method – are rigorously and correctly applied.



### 1.4 TERMINOLOGY

The Guideline, in accordance with the GHG Protocol and International Organization for Standardization (ISO) Standard, uses specific terms to connote GHG accounting requirements and recommendations. In particular:

- "Shall" is used to indicate a requirement.
- "Should" is used to indicate a recommendation.
- "May" is used to indicate an option that is permissible or allowable.
- "Can" is used to indicate that something is possible; for example, that an organization or individual is able to do something.

# 2. PURPOSE & SCOPE

### 2.1 PURPOSE

The SCC aims to drive progress on climate challenges within the semiconductor value chain and support the Paris Agreement and related accords driving the 1.5°C pathway. The purpose of this document is to support companies within the semiconductor value chain in the calculation and reporting of GHG Protocol Scope 3.11 Use of Sold Products emissions.

This Guideline intends to:

- Complement and contextualize existing standards and guidance issued by the GHG Protocol suite of corporate standards, Science Based Targets initiative (SBTi), and Intergovernmental Panel on Climate Change (IPCC).
- Refine 3.11 characterization and reporting with a goal of providing the data needed to inform reduction strategy and actions across the industry.
- Establish a semiconductor industry value chain position in support of engagement with standard setting bodies.
- Promote alignment of emissions estimation practices that will aid in the assurance and disclosure processes.

## 2.2 INDUSTRY SEGMENTS COVERED

The semiconductor industry value chain comprises an intricate web of activities and participants involved in diverse tiers of production, spanning from raw materials suppliers to end-product manufacturers. For this iteration of the Guideline, six segments within the semiconductor value chain were assessed:

- **Chemicals, Gases, and Materials Suppliers** provide the raw materials, specialty process chemicals, and specialty materials that are used in semiconductor manufacturing. These companies manufacture, market, and sell materials consumed by the other segments.
- **Equipment Manufacturers** supply equipment to other companies throughout the semiconductor industry value chain (fabrication equipment, testing equipment, etc.). These companies design, manufacture, market, and sell equipment.
- **IC Designers (IC Design, Fabless)** design, market, and sell semiconductor products, but outsource manufacturing activities to third parties (foundries).
- **Integrated Device Manufacturers** design, manufacture, market, and sell semiconductor products.
- **Foundries** market and sell manufacturing capabilities/services to other companies (IC designers). They typically do not design, market, or sell physical semiconductor products.
- **Outsourced Semiconductor Assembly and Test (OSATs)** market and sell outside assembly, packaging, and testing services to other companies in the semiconductor industry value chain. They typically do not design or sell physical semiconductor products.

Companies that sit further downstream (producing end products and solutions such as consumer products, data centers, etc.) are not addressed in this Guideline.

Note that for the purpose of framing this Guideline's recommendations, the six industry segments have been defined with a narrow set of typical activities and products. In reality, companies may provide multiple products/services that fit into different segments. Users of the Guideline need to assess their own unique operations to determine applicability of recommendations, aligning their different products/services with relevant segment recommendations.

# 3. SCOPE 3 CATEGORY 11 IN THE SEMICONDUCTOR INDUSTRY VALUE CHAIN

## 3.1 DESCRIPTION OF SCOPE 3 CATEGORY 11: USE OF SOLD PRODUCTS

According to the GHG Protocol, 3.11 is defined as including emissions that result from the end use of sold products over the lifetime of those products. These emissions include the products' lifetime direct emissions (e.g., emissions from the consumption of energy or use/release of GHG chemicals/gases) and indirect emissions (e.g., emissions from the indirect consumption of energy or use/release of GHG chemicals/gases).

> While related, Category 10: Processing of Sold Products accounts for the emissions from processing of sold products prior to the end user taking possession. This includes the emissions from the processing of intermediate products before they are sold to the end consumer. Note that 3.11 is still applicable to intermediate products sold by a company, as intermediate products may have relevant use-phase emissions after processing or inclusion into a final product.

Many companies in the semiconductor value chain sell an intermediate product that is further incorporated into a final product. It is the use of the sold product in that final system that is the subject of 3.11. Care should be taken to determine when the sold product is "used" (3.11) in its final form versus "processed" (3.10).

Some products may be used with no further processing and will only have 3.11 emissions. An example would be a chemical company that provides a specialty gas used in making integrated circuit (IC) devices; the specialty gas is consumed, abated, or vented from the IC device manufacturer's operations and this is the final use of that gas. The emissions occur when the customer uses the gas in the manufacturing process, not when the final user of an electronic device uses that device.

Other products may go through one or more intermediate manufacturing steps before being used and will have both 3.10 and 3.11 emissions. One example is an IC device: the device is sold by the IC device manufacturer to a smartphone manufacturer, where it is incorporated into a smartphone (here there are 3.10 processing emissions related to assembly) and in that smart phone is where the IC device is used (3.11 emissions from electricity use).

A product could also have processing emissions in 3.10 but then no use-phase 3.11 emissions. An inert product such as ceramic semiconductor IC packaging material can have 3.10 emissions from the assembly process when it is incorporated into a finished device, but that packaging material does not then directly go on to have attributable 3.11 emissions in the finished IC device's use phase (as packaging material does not consume energy).

Companies that sell intermediate products that go on to have attributable use-phase emissions should go down the value chain past the 3.10 processing activities to identify and calculate 3.11 use-phase emissions. (unless the company plans to make exclusions - see 4.1.2 Intermediate Products Exclusion). This is what an IC device manufacturer would do to trace and/or make assumptions regarding the inclusion of ICs into end products and estimate power consumption attributable to the IC while a part of the end product.

## 3.2 KEY DEFINITIONS

Key Definitions

- **Intermediate product:** Inputs to the production of other goods or services that require further processing, transformation, or inclusion in another product before use by the end consumer. Intermediate products are not consumed by the end user in their current form.
- **Final product:** Goods and services that are consumed by the end user in their current form, without further processing, transformation, or inclusion in another product.
- **Direct use-phase emissions:** Products that directly consume energy (fuels or electricity) during use, fuels and feedstocks, or emit GHGs during product use.
- **Indirect use-phase emissions:** Products that indirectly consume energy (fuels or electricity) during use.
- **Market-based accounting:** A method to quantify GHG emissions based on GHG emissions emitted by the generators from which the reporter contractually purchases electricity bundled with instruments, or unbundled instruments on their own.
- **Location-based accounting:** A method to quantify Scope 2 GHG emissions based on average energy generation emissions factors for defined locations, including local, subnational, or national boundaries.
- **Lifetime emissions:** The total amount of emissions produced over the course of an item or product's life.

# 4. SCOPE 3 CATEGORY 11 EMISSIONS ESTIMATION

## 4.1 APPLYING THE SCOPE 3 GHG INVENTORY BOUNDARY

### 4.1.1 SCOPE 3 CATEGORY 11 BOUNDARY

3.11 includes the lifetime GHG emissions from the use of products (any goods or services) sold in the reporting year. A reporting company's 3.11 emissions represent the Scope 1 and 2 emissions of end users. The GHG Protocol divides these emissions into two types, direct and indirect use phase emissions; see Table 1 for more details.

See Table 2 for segment specific examples of potential direct and indirect use-phase emissions sources. This Guideline focuses on the key products and activities of each segment as described in Section 2.2 Scope: Industry Segments Covered. Organizations may not fall neatly into a segment and should consider their own unique operations and products throughout this Guideline.

### TABLE 1 EMISSIONS FROM USE OF SOLD PRODUCTS (GHG PROTOCOL SCOPE 3 STANDARD)

| Type of Emissions | Category Boundary | Product Type |
|---|---|---|
| Direct use-phase emissions | Required to include | Products that directly consume energy (fuels or electricity) during use (note that these products may also consume energy indirectly) |
| | | Fuels and feedstocks (these product types are not typically sold by companies in the semiconductor industry value chain) |
| | | GHGs and products that contain or form GHGs that are emitted during use, such as perfluorocarbons (e.g., CF4, C2F6, C3F8 and c-C4F8), hydrofluorocarbons (CHF3, CH3F and CH2F2), nitrogen trifluoride (NF3), and sulfur hexafluoride (SF6) |
| Indirect use-phase emissions | Optional to include | Products that indirectly consume energy (fuels or electricity) during use (note that these products may also consume energy directly) |

### TABLE 2 EXAMPLES OF POTENTIAL USE-PHASE EMISSIONS SOURCES

| Industry Segment | Direct Use Phase (Required) | Indirect Use Phase (Optional) |
|---|---|---|
| Chemicals, Gases, and Materials Suppliers | Emissions associated with the use of gases with high global warming potentials (GWP) and byproducts from abatement processes | Emissions associated with<br>• Operation of gas abatement processes<br>• Process electricity use<br>• Ancillary heating and chemical mixing |

<table>
<tr><td>Equipment Manufacturers[3]</td><td>Emissions associated with the direct use of fuel or electricity by sold equipment</td><td>Emissions associated with<br>• Cooling required by heat load from equipment operation<br>• Emissions of process gases flowing through equipment and related abatement systems<br>• Equipment peripherals (modules not produced by the equipment manufacturer but are added to the tool by the customer and have associated energy and chemical consumption)<br>• Onsite compressed air and ultrapure water production</td></tr>
<tr><td>IC Designers (IC Design, Fabless)</td><td>Emissions from the direct use of electricity by an IC (power draw)</td><td rowspan="2">Emissions associated with<br>• Cooling required by heat loads from IC usage<br>• Total energy used by final products (smartphones, servers, auto, etc.)<br>• Power used by data centers and networks that support final products such as smartphones</td></tr>
<tr><td>Integrated Device Manufacturers</td><td>Emissions from the direct use of electricity by an IC (power draw)</td></tr>
<tr><td>Foundries</td><td colspan="2">The Foundry segment as defined in this guidance markets and sells services, and those services have no associated downstream 3.11 use-phase emissions. The foundry's services are provided to the IC owners, and those services end when the owners' products leave the foundry operational boundary. The use of ICs by end users is not the use of a foundry's services.<br><br>If a foundry sells goods or services outside the typical service defined in this guidance, they should account for any relevant 3.11 emissions.</td></tr>
</table>

[3] See SEMI S23-1021 for a more comprehensive listing of potential emissions sources.

| | |
|---|---|
| OSATs – Outsourced Semiconductor Assembly and Test | The OSAT segment as defined in this guidance markets and sells services, and those services have no associated downstream 3.11 use-phase emissions. The OSAT's services are provided to the IC owners, and those services end when the owners' products leave the OSAT operational boundary. The use of ICs by end users is not the use of an OSAT's services.<br><br>If an OSAT company sells goods or services outside the typical service defined in this guidance, they should account for any relevant 3.11 emissions. |

The minimum boundary of 3.11 as defined by the GHG Protocol and reiterated by the SBTi includes direct use-phase emissions of sold goods or services. Indirect use-phase emissions are considered optional but encouraged when indirect use-phase emissions are assessed to be significant.

Companies should decide which use-phase emissions to account for in 3.11 based on the emission's relevance to their overall organization. The determination of relevance is based on the qualitative and quantitative criteria listed in Table 3. Note that emissions can be relevant but still excluded from an inventory due to data limitations (see 4.1.2 Intermediate Products Exclusion). Relevance and exclusions are ultimately business decisions that must be made by reporting companies. This Guideline does not define "thresholds" for any of the relevance criteria in Table 3, as there is not an accepted single answer that applies across all companies.

**TABLE 3 CRITERIA FOR IDENTIFYING RELEVANT SCOPE 3 ACTIVITIES (GHG PROTOCOL SCOPE 3 TECHNICAL GUIDANCE)**

| Criteria | Description of Activities |
|---|---|
| Size | They contribute significantly to the company's total anticipated Scope 3 emissions. |
| Influence | There are potential emissions reductions that could be undertaken or influenced by the company. |
| Risk | They contribute to the company's risk exposure (e.g., climate change-related risks such as financial, regulatory, supply chain, product and technology, compliance/litigation, and reputational risks). |
| Stakeholders | They are deemed critical by key stakeholders (e.g., customers, suppliers, investors, or civil society). |
| Outsourcing | They are outsourced activities previously performed in-house or activities outsourced by the reporting company that are typically performed in-house by other companies in the reporting company's sector. |
| Spending or revenue analysis | They are areas that require a high level of spending or generate a high level of revenue (and are sometimes correlated with high GHG emissions). |
| Other | They meet any additional criteria developed by the company or industry sector. |

This Guideline maintains the optionality of indirect use-phase emissions, as organizations within the semiconductor industry value chain may have limited ability to collect data, develop the use-case assumptions required, and/or to influence these emissions.

SBTi requires the disaggregation of these optional indirect use-phase emissions under its framework, stating, "Companies must report optional emissions, e.g. indirect use-phase emissions, separately from the main 3.11 emissions, as they are beyond the GHG Protocol minimum boundary." (SBTi Criteria Assessment Indicator 13.4). While the GHG Protocol does not specifically speak to it, this SCC Guideline recommends disaggregation in reporting to increase standardization and transparency.

Among the various semiconductor industry segments, Foundries and OSATs are unique, as the "products" they market and sell are services (contract manufacturing and assembly/testing), the emissions from which are the Foundry/OSAT's Scope 1 and 2. They typically do not design, market, or sell a finished physical good. The GHG Protocol definition of sold "product" includes both goods and services. SBTi emphasizes that companies are required to include emissions from the use of services in criterion 13.7 of the SBTi Services Criteria Assessment Indicators. That an organization provides a service rather than physical product does not automatically preclude it from reporting 3.11. However, this Guideline asserts that the Foundry and OSAT segments as defined in section 2.2 provide services that have no associated 3.11 use-phase emissions. The use of ICs by end users is not the use of a foundry or OSAT's services, which end after other companies' products leave their operational boundaries. If a foundry or OSAT sells goods or services outside the typical services as defined in this guidance, they should account for any relevant 3.11 emissions.

#### 4.1.2 INTERMEDIATE PRODUCTS EXCLUSION

**GHG Protocol Technical Guidance Highlight**

"When a company sells an intermediate product that directly emits GHGs in its use phase, it is required to account for direct use-phase emissions of the intermediate product by the end user, (i.e., emissions resulting from: the use of the sold intermediate product that directly consumes fuel or electricity during use; fuels and feedstocks; GHGs released during product use). Companies may optionally include the indirect use-phase emissions of sold intermediate products. In certain cases, the eventual end use of sold intermediate products may be unknown. For example, a company may produce an intermediate product with many potential downstream applications, each of which has a different GHG emissions profile and be unable to reasonably estimate the downstream emissions associated with the various possible end uses. In such a case, companies may disclose and justify the exclusion of all downstream emissions related to sold intermediate products."

Semiconductor products are generally intermediate products – goods that are inputs to the production of other goods or services that require further processing, transformation, or inclusion in another product before use by the end consumer. Intermediate products are not consumed/ used by the end user in their current form. While the use-phase emissions of intermediate products after inclusion into a final product are included under the GHG Protocol 3.11 minimum boundary, they can be excluded when companies are unable to reasonably estimate downstream emissions.

The SCC maintains the intermediate product exclusion outlined by both the GHG Protocol [in section 6.4 of the Corporate Value Chain (Scope 3) Accounting and Reporting Standard] and indicator 13.6 of the SBTi Criteria Assessment Indicators. This exclusion only applies to cases where the end use(s) of an intermediate product is unknown, such as in the case where an intermediate product has many potential downstream applications (and potentially several intermediate processing steps before reaching those applications), each of which has a different GHG emissions profile and where a company is unable to reasonably estimate the downstream emissions associated with the various possible end uses. Known end use(s) of intermediate products are to be included.

Companies should make their own determination when deciding if their product's end use is known or unknown to them and if a reasonable estimate of emissions can be made. Note that end use(s) do not need to be exact to be useful in estimating 3.11 emissions. Companies typically select representative final products as proxies for sales of products in known broad categories or general applications (i.e., modeling CPU power consumption in a standard computer as a proxy for all CPUs sold into consumer product market). When the end market and application is simply unknown, a company may make broad assumptions regarding the percentages of their sold intermediate products that are being used in different representative final product types based on market research or general understanding of the markets. It is also common to make assumptions around the geographic distribution of the use of final products when that is necessary. The SCC has determined this compromise of overall accuracy to achieve a more complete inventory is preferred, with the goal of increasing accuracy over time (see chapter 4 of the GHG Protocol Scope 3 Standard for more info on tradeoffs between accounting principles).

Estimating Scope 3 categories typically requires various assumptions, so it is up to companies to consider the relevance of the emissions associated with their intermediate products and their ability to develop reasonable assumptions and representative scenarios when deciding whether to make exclusions. Furthermore, companies should only exclude the products for which they are unable to develop estimates rather than the entire category; these exclusions shall be disclosed and justified.

The GHG Protocol and SBTi depart from each other on intermediate products in one aspect. The GHG Protocol indicates companies may exclude "all downstream emissions related to sold intermediate products" from categories 9, 10, 11, and 12 for products selected for exclusion (GHG

Protocol Corporate Value Chain (Scope 3) Standard (2011)). Meanwhile, SBTi states, "Companies are expected to account for all downstream Scope 3 categories from intermediate products and services, where relevant. In the instance that a company faces barriers to calculating emissions from one category of Scope 3, the company shall demonstrate its best efforts to calculate these emissions, and this shall not preclude them from providing an estimate of emissions in other categories (SBTi Corporate Net-Zero Standard Criteria -Version 1.2 (2024)). This SCC Guideline does not recommend one approach over the other, but instead highlights the potential need to still calculate other downstream categories for intermediate products selected for exclusion if submitting to SBTi.

## 4.2 DATA COLLECTION AND ESTIMATING EMISSIONS

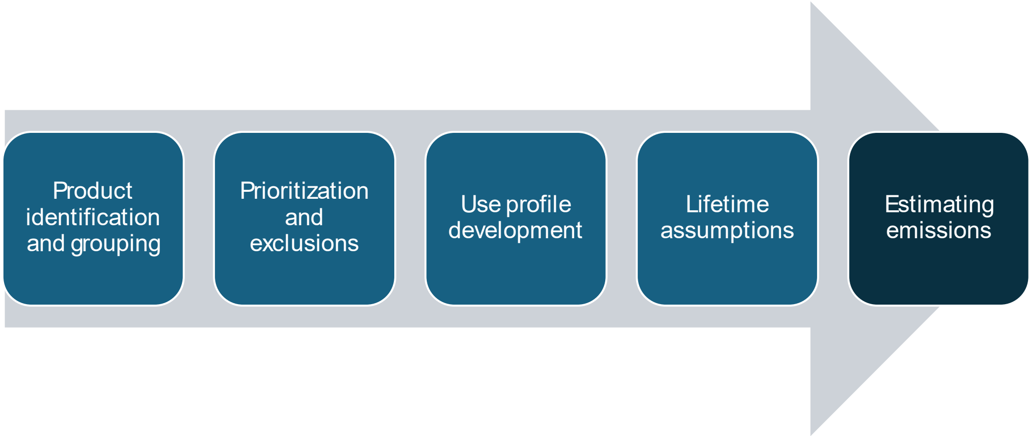
### 4.2.1 DATA COLLECTION

An inherent challenge of 3.11 is that these emissions occur outside the reporting organization. As knowledge of the emissions may be limited, it is recommended that organizations follow the process outlined in Figure 2.

#### *4.2.1.1 PRODUCT IDENTIFICATION AND GROUPING*

Before developing assumptions, companies should initially assess all their sold products and services to determine which have relevant use-phase emissions that fall within the minimum boundary. Companies should not determine all of 3.11 to be not applicable or relevant based only on certain products. Organizations will often have a mix of products that vary in applicability and may deviate from the typical products associated with the segments as defined earlier in this guidance.

**FIGURE 2 EMISSIONS ESTIMATION PROCESS FOR CATEGORY 11**



For example, a foundry might primarily provide manufacturing services that are not applicable but then also market and sell some of their own products that have relevant use-phase emissions. In this situation, the foundry should calculate and disclose any relevant use-phase emissions from those products. Additional considerations when identifying relevant products are product use-phase (direct vs. indirect) and type (products that directly or indirectly consume energy, fuels/feedstocks, and GHGs or products that contain/form GHGs) as introduced in Table 1.

If a company sells a large selection of products, or if the use phase of multiple products is similar (use profile, power consumption, lifespan, etc.), it may choose to group similar products and use average statistics for a typical product to represent the full product group. This can significantly ease the reporting burden of having to classify and develop unique calculations for every single product in a company's portfolio.

#### *4.2.1.2 PRIORITIZATION AND EXCLUSIONS*

To demonstrate completeness in an inventory, a company should try to account for all applicable sold products and use-phase emissions in its 3.11 calculations. However, products that have been identified as more relevant may be prioritized for more detailed data collection and assumption development. Products determined to not be relevant or intermediate products whose uses are unknown may be excluded.

Companies can use a variety of methods to determine prioritization:

- Data collection for product groups that are determined to have high emitting potential
- Data collection for product groups that are important to the business and responsible for a large portion of company sales
- Data collection for product groups in which the company has a higher degree of influence over emissions, and reporting would enable reductions to be reflected in accounting
- Data collection for product groups that pose an outsized risk for the company (financial, reputational, etc.)

Once emissions have been estimated for prioritized products, intensity factors or other proxy methods can be used to account for other products, where reasonable, to avoid exclusions or to simplify calculations for lower priority products. As an example, if products are sold to a distributor and the final end market is unknown, a weighted average of known end uses for that same or similar product can be leveraged to estimate the emissions from those products. Companies should note all assumptions and exclusions and provide justification for their choice of estimation methodology.

#### *4.2.1.3 USE PROFILE DEVELOPMENT*

The end use of the products is required to estimate 3.11 emissions, but this may vary depending on many factors that are hard to predict. Assumptions shall be made on how customers use sold products paired with product specifications/testing results, which creates a "use profile." Use profiles for products can vary significantly based on the product, end-use scenario, and geography/region where it is used.[3] An IC in a smartphone used by a typical American consumer will have a significantly different use profile than an IC in a data center server in Europe. Similarly, customers who purchase tetrafluoromethane may use different abatement technologies (or may not abate certain GHGs at all), resulting in different emissions impact.

For each product group, companies need to determine the activity data required based on product type.

**TABLE 4 PRODUCT TYPE AND ACTIVITY DATA FOR USE PROFILE**

| Product Type | Use Profile Activity Data |
|---|---|
| Products that consume energy | Typical energy consumption (TEC) |
| Fuels and feedstocks | Quantities of fuels/feedstocks |
| GHGs and products that contain/ form GHGs emitted during use | Quantities and types of GHGs, percentage of GHGs released during use of product |

[3] Geography is useful both to help define customer behaviors as well as during calculations if electricity emissions factors are being used.

For products that consume energy, companies may test to determine their typical energy consumption (TEC). TEC is typical energy consumed by a device/equipment under test while in normal operation during a representative period of time. The annual TEC is a value for typical annual energy use, using measurements of average operational mode power levels scaled by an assumed typical duty cycle that represent annual use for the product. TEC definitions and specific methods of testing are often defined in various energy efficiency and product standards. Companies should attempt to use the most relevant product standards for identifying, calculating, and modeling profile attributes.

Numerous product standards are available depending on the product type. Four examples are presented here to illustrate the types of standards that could be used:

- SEMI S23-1021$^{E2}$ - GUIDE FOR ENERGY, UTILITIES, AND MATERIALS USE EFFICIENCY OF SEMICONDUCTOR MANUFACTURING EQUIPMENT describes energy use rate measurement methods and annualized state assumptions that can be leveraged by equipment manufacturers.
- IEC 62623: DESKTOP AND NOTEBOOK COMPUTERS - MEASUREMENT OF ENERGY CONSUMPTION provides testing and calculation methods to determine energy consumption for devices and can be leveraged by semiconductor product manufacturers.
- ETSI ES 203 215 ENVIRONMENTAL ENGINEERING (EE); MEASUREMENT METHODS AND LIMITS FOR POWER CONSUMPTION IN BROADBAND TELECOMMUNICATION NETWORKS EQUIPMENT provides testing and calculation methods to determine energy consumption for devices and can be leveraged by semiconductor product manufacturers.
- 2019 REFINEMENT TO THE 2006 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES - VOLUME 3: INDUSTRIAL PROCESSES AND PRODUCT USE - CHAPTER 6: ELECTRONICS INDUSTRY EMISSIONS provides information that can be used to estimate emissions from fab operations that may be useful to chemical and gas suppliers when determining the use and emission case for their products.

For semiconductor products that could potentially be included in many different final applications, companies should use their sales data to determine what markets are being sold into, which may help determine generic end products such as smartphones, personal computers, and servers.

Examples of where use profile data may be sourced from include:

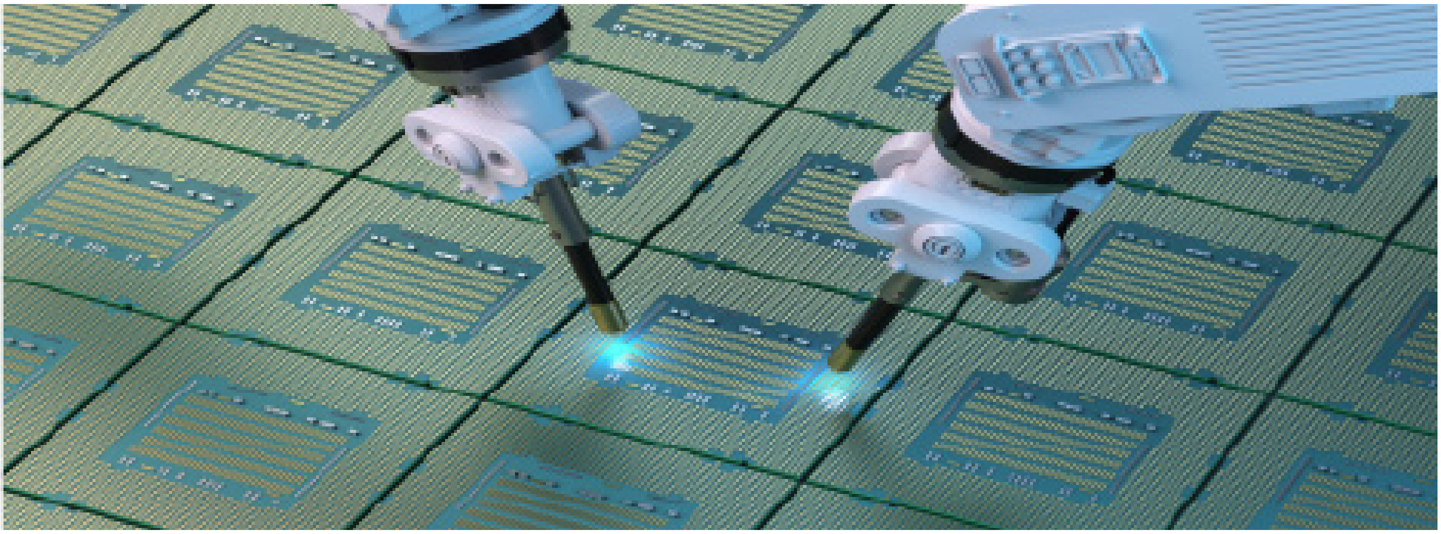
- Industry benchmarks
- Product category rules
- Previous emissions studies
- Consumer studies
- Internal utilization models
- Data collected from supply chain

The same product may have many different use profiles, and a company may develop multiple use profiles that are then averaged to simplify. This average can be weighted based upon most likely activity.

#### *4.2.1.4 PRODUCT LIFETIME ESTIMATION*

When calculating 3.11 emissions, companies need to make assumptions about their product's expected lifespan. These assumptions directly impact the total emissions that are attributed to that product and accounted for in the inventory. The basis for lifespan assumptions can vary from product warranty information and publicly available research to actual laboratory testing or customer feedback. Companies should make reasonable assumptions and attempt to improve their accuracy and transparency over time when possible. Note that changes in GHG emissions calculation methodology (changes in assumptions) over time may require a base-year recalculation. If updated assumptions are due to changes in product specifications over time rather than the refinement of existing assumptions, recalculation is not required. Companies should consult their own base-year review and recalculation policies to determine if specific changes in assumptions will trigger recalculation. Capturing accurate lifetime emissions helps demonstrate the magnitude/totality of emissions associated with a company and product. However, it is worth noting that, at a certain point, exact lifespan only provides greater insight into a product's durability rather than its GHG emissions performance compared to other products.

There are several potential options for developing lifespan assumptions depending on industry segment. See examples below in Table 5. The SCC has also compiled some sources for optional standardized lifespan assumptions based on common final products in Table 6. Once determined/selected, the reporting company shall document the lifespans used to calculate 3.11 emissions along with their basis/source.



## TABLE 5 POTENTIAL LIFESPAN BASIS BY SEGMENT

| Segment | Potential Basis |
|---|---|
| Chemicals, Gases, and Materials Suppliers | • Default atmospheric lifetimes/GWPs (gases) |
| Equipment Manufacturers | • Warranty length<br>• Service life (installed and in-service equipment –relevant if maintenance is being performed by the original manufacturer or some other known party)<br>• Historical data of years in the field and R&D provided estimates<br>• Country specified [e.g., use of Japanese Product Liability Law (PL Law)]<br>• Return and refurbish programs |
| IC Designers (IC Design, Fabless) & Integrated Device Manufacturers | • Industry and consumer research<br>• Public lifecycle assessments (LCA) of final products<br>• Warranty lengths of final products<br>• Country specified (e.g., Korea Ministry of Environment Guidelines for indicating environmental product declaration)<br>• Refresh cycles of final products[4]<br><br>Note: Lifespan is typically based on the assumed final products ICs are used in (phones, computers, automotive, servers, etc.) rather than the ICs themselves – reporting companies make assumptions around the final products their devices likely are used in as the basis for lifespan. |

[4] A “refresh cycle” in product development refers to the periodic process of updating or significantly improving an existing product with new features, design elements, or technology, essentially giving it a “fresh” iteration in the market, often done to maintain competitiveness and appeal to customers. A consumer example of this is Apple’s regular iPhone releases. While consumers often use products past refresh cycles, they can still be useful when determining consumer behavior and reasonable lifetime estimates.

### TABLE 6 SOURCES AND EXAMPLES OF LIFESPAN ASSUMPTIONS

| Segment | Sources | Description |
|---|---|---|
| Chemicals, Gases, and Materials Suppliers | IPCC Global Warming Potential Values | Lifespan assumptions not applicable for gases (uses GWP values). See IPCC GWPs from the latest adopted AR version. |
| Equipment Manufacturers | Typical SCC membership estimates | SCC equipment members typically used lifespans ranging from **10-25 years** based on the options listed in **Table 5.** Ideally companies should be consistent in the bases and criteria used to determine lifespan across different equipment within their portfolio. |
| | Japanese Product Liability Act (PL Act) | The Japanese PL Act is a law in Japan used to hold manufacturers liable for compensation if a product is defective. It states that a product liability claim must be filed within **10 years** of the product's delivery date. Some SCC membership uses this as the basis for their equipment lifespan assumptions **(10 years).** |

| Segment | Potential Basis | |
|---|---|---|
| IC Designers (IC Design, Fabless) & Integrated Device Manufacturers | U.S. Department of Transportation, Bureau of Transportation Statistics - Average Age of Automobiles and Trucks in Operation in the United States, Bureau of Transportation Statistics | Dataset with average ages of various automobile types in operation in the United States. |
| | U.S. Environmental Protection Agency (USEPA) ENERGY STAR Scope 3 Use of Sold Products Analysis Tool | Tool developed by the USEPA that allows retailers to benchmark and project corporate Scope 3 GHG emissions associated with the use of sold products. It contains ENERGY STAR product lifespans for over 100 various energy consuming products (residential appliances, consumer electronics, commercial products, etc.). |
| | Korean Environmental Product Declaration Certification Guide, 2024. | Set of guidelines and standards that companies in South Korea must follow to obtain certification for their product's environmental impact. The guide covers information on product use stage, providing lifespans for various energy consuming products (residential appliances, consumer electronics, commercial products, etc.). |

*4.2.1.5 PRODUCT UPDATES AND UPGRADES*

**NOTE REGARDING PRODUCT UPGRADES AND CHANGES OVER PRODUCT LIFETIME:**

Organizations with products whose use or management may change over time face additional challenges developing use-case assumptions. For specialty gases, customers may change abatement methods from year to year. Manufacturing equipment could be upgraded, receive life-extending maintenance, or be remanufactured/rebuilt. Anticipated changes that impact a product's lifespan such as standard upgrades/maintenance should be accounted for in initial lifetime assumptions (e.g., it is assumed a car will receive maintenance over its life based on standard consumer behavior/use, so this maintenance contributes to the assumed lifespan). However, anticipated changes after the reporting year that would change a product's use profile (such as a software update that improves a product's efficiency) should not be reflected in calculations until they are actually implemented. Rather than proactively attempting to incorporate these into a product's expected use assumptions, companies would best capture the calculations in subsequent reporting years once the change is implemented. This applies to situations where while there is an anticipated change over the product's life, there is uncertainty in whether and/or when that change would be implemented (i.e., it requires specific action by a customer that isn't standard or guaranteed). Per the GHG Protocol, to address any inaccuracies that may occur due to changes after the reporting year and enable consistent tracking of emissions over time, companies should recalculate base year emissions for 3.11 with updated product use assumptions when any significant changes in assumptions occur. It is optional to recalculate the emissions for the years between the reporting year and base year.

*4.2.1.6 PRODUCT REUSE, REMANUFACTURE, AND SECOND LIFE*

The SCC recommends product life should exclude potential remanufacture, rebuilds, or recycling of a product by third parties that go beyond standard maintenance. Steps to remanufacture a product can differ from the original manufacture and can alter the product to a high degree. There is limited benefit to the reporting company in attempting to capture these potential instances unless it is an understood and standard practice.

**4.2.2 ESTIMATING EMISSIONS - CALCULATION METHODS**

Calculation methodology and requirements for 3.11 are outlined in the GHG Protocol Technical Guidance for Calculating Scope 3. There are four reportable use-phase product emissions types. Note that products may have more than one emissions type (i.e., emissions from both direct and indirect energy consumption or emissions from both direct energy consumption and GHG leakage):

- Product Emissions Type 1: Emissions from a product's direct consumption of energy (fuels or electricity) during use: involves breaking down the use phase, determining emissions per product, and aggregating emissions.
- Product Emissions Type 2: Emissions from fuels and feedstocks: involves collecting

fuel use data and multiplying them by representative fuel emissions factors.

- Product Emissions Type 3: Emissions from GHGs and products that contain or form GHGs that are emitted during use: involves collecting data on the GHGs contained in the product and multiplying them by the percent of GHGs released, GHG emissions factors, and removal/abatement efficiencies (if known and applied).[5]
- Product Type 4 (Optional): Emissions from a product's indirect consumption of energy (fuels or electricity) or emissions of GHGs. The reporting company should calculate emissions by creating or obtaining a typical use-phase profile over the lifetime of the product and multiplying by relevant emissions factors.

This guidance covers product emissions types 1, 3, and 4, as they are the most relevant to the semiconductor industry value chain (the industry generally does not produce and sell fuels/feedstocks).

#### *4.2.2.1 CALCULATION METHOD FOR DIRECT USE-PHASE EMISSIONS FROM PRODUCTS THAT DIRECTLY CONSUME ENERGY (FUELS OR ELECTRICITY) DURING USE*

In this method, the company multiplies the TEC of each product by the expected lifespan, amount sold, and an emissions factor. Companies should then aggregate resulting use-phase emissions of all products.

**Activity data needed**

- Average expected lifespan
- Quantities of products sold
- Annual TEC (fuel/electricity consumption) of product(s)

**Emissions factors needed**

- Lifecycle emissions factors for fuels
- Lifecycle emissions factors for electricity

**Data collection guidance**

Data sources for activity data include:

- Internal data systems
- Sales records
- Surveys
- Product specifications
- Testing results
- SEMI 3.11 Guidance Table 7: Sources for Optional Standardized Assumptions

Data sources for emissions factors include:

- The GHG Protocol website (www.ghgprotocol.org)
- Lifecycle databases
- Government published data (USEPA, Defra, etc.)
- Company or supplier developed emissions factors
- SEMI 3.11 Guidance Table X: List of emissions factor databases

[5] Standard assumptions on removal/abatement can be found in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories - Volume 3: Industrial Processes And Product Use - Chapter 6: Electronics Industry Emissions.

It is important to consider the region where products are used, especially if the product consumes electricity because electricity grid emissions factors can vary significantly. If a product is used globally, a company may consider using a global average electricity emissions factor; however, estimating product use at a more granular level (either regional or national) and applying regional or national electricity grid emissions factors would result in more accurate emissions estimates for this category.[6]

**Calculation formula: Direct use-phase emissions from products that directly consume energy (fuels or electricity) during use**

| $CO_2$e emissions from use of sold products = |
|---|
| **sum across fuels consumed from use of products:**<br>∑ (average expected lifespan of product × quantity sold in reporting period<br>× annual TEC (fuel) of product (kWh) × emission factor for fuel (kg $CO_2$e/kWh))<br>+<br>**sum across electricity consumed from use of products:**<br>∑ (average expected lifespan of product × quantity sold in reporting period<br>× annual TEC (electricity) of product (kWh) × emission factor for electricity (kg $CO_2$e/kWh)) |

Source: Greenhouse Gas Protocol Technical Guidance for Calculating Scope 3 Emissions (version 1.0)

[6] Scenario uncertainty can also be helpful here.

*4.2.2.1.1 EXAMPLE CALCULATION 1: DIRECT ENERGY (IC DESIGNERS (IC DESIGN, FABLESS))*

(Note: The activity data and emissions factors in the case studies below are illustrative only, and do not represent actual data.)

Case Study: Company A is an IC Design company that designs a semiconductor IC. This IC is sold to a variety of customers, many of which produce phones. The company knows that 500,000 units using its design were sold in the reporting year but does not have insight into the regions to which the final products were sold. To estimate the direct emissions, Company A outlined the following calculation:

**Emissions source:**

- Direct use-phase emissions from electricity used to power the CPU device used in smartphones

**Activity data needed:**

- Average expected lifespan of products
- Quantities of products sold
- Average use scenarios/annual TEC

**Emissions factor needed:**

- Lifecycle emissions factors for electricity

**Calculation:**

∑ (average lifespan of product × number sold in reporting period × electricity consumed per year (kWh/year per unit) × emissions factor for electricity (kg $CO_2$e/kWh))

### TABLE 7 EXAMPLE IC DESIGNER EMISSIONS ESTIMATION

| Input Data | | Source |
|---|---|---|
| Average lifespan | 3 years | Typical lifespan of final device (phone) |
| Quantity produced | 500,000 units | Reporting period sales data |
| TEC (electricity consumption per year) | 0.28 kwh/year per phone CPU | Consumer studies of phone use and known IC device power draw |
| Electricity emissions factor | 0.481 kg $CO_2$e/ kwh | World average factor Energy Institute - Statistical Review of World Energy |
| **Emissions Estimation Results** | | |
| Total $CO_2$e = (3 years × 500,000 units × 0.28 kwh/unit × 0.481 kg $CO_2$e/kwh) = 202,020 kg $CO_2$e = 202.02 tons $CO_2$e | | |

*4.2.2.1.2 EXAMPLE CALCULATION 2: DIRECT ENERGY (EQUIPMENT MANUFACTURERS)*

(Note: The activity data and emissions factors in the case studies below are illustrative only, and do not represent actual data.)

Case Study: Company B is an equipment manufacturer in the semiconductor industry value chain. They produce a piece of specific equipment used to make semiconductor ICs and that equipment has a useful life of 10 years. In the reporting year, the company sold 1,500 units to two regions and knows how many were sold to each region. To estimate the direct emissions, Company B outlined the following calculation:

**Emissions source:**

- Direct use-phase emissions from deposition chamber that directly consumes electricity

**Activity data needed:**

- Average expected lifespan of products
- Quantities of products sold
- TEC per year

**Emissions factor needed:**

Lifecycle emissions factors for electricity

**Calculation:**

- ∑ (average lifespan of product × number sold in reporting period × typical energy consumption (kWh) × emissions factor for electricity (kg $CO_2$e/kWh))

**TABLE 8 EXAMPLE EQUIPMENT MANUFACTURERS EMISSIONS ESTIMATION**

| Input Data | | Source |
|---|---|---|
| Total lifetime | 10 years | Historical data |
| Quantity shipped region 1 | 1,000 units | Reporting period sales data |
| Quantity shipped region 2 | 500 units | Reporting period sales data |
| TEC [equivalent electricity consumption per year (without additional resources or process cooling water [PCW])] | 5.86E6 kwh/year | Internal testing per SEMI S23 |
| Region 1 emissions factor | 0.3 kg $CO_2e$ / kwh | Region 1 factor from Energy Institute - Statistical Review of World Energy |
| Region 2 emissions factor | 0.5 kg $CO_2e$ / kwh | Region 2 factor from Energy Institute - Statistical Review of World Energy |
| **Emissions Estimation Results** | | |
| Total $CO_2e$ = (10 years × 1,000 units × 5.86E6 kwh/unit × 0.3 kg $CO_2e$/kwh) + (10 years × 500 units × 5.86E6 kwh/unit × 0.5 kg $CO_2e$/kwh) = 3.22E10 kg $CO_2e$ = 3.22 E7 ton $CO_2e$ | | |

*4.2.2.2 CALCULATION METHOD FOR DIRECT USE-PHASE EMISSIONS FROM GHGS AND PRODUCTS THAT CONTAIN OR FORM GHGS THAT ARE EMITTED DURING USE*

Some products are or may contain GHGs that are emitted during use or at the end of the product's useful life (e.g., products that contain refrigerants). If the reporting company is a producer of products containing GHGs, use-phase emissions are calculated by multiplying the quantities of products sold by the percentage of GHGs released per unit of GHG contained in the product and by the GWP of the GHGs released.

**Activity data needed:**

- Total quantities of products sold
- Quantities of GHGs contained per product
- Percentage of GHGs released throughout the lifetime of the product

**Emissions factors needed:**

- GWP of the GHGs contained in the product, expressed in units of carbon dioxide per unit kilogram of the GHG (e.g., 25 kg $CO_2$ e/kg)

Note: If different GHGs are released by the product, the total carbon dioxide equivalent should be reported and the breakdown of GHGs (e.g., $CO_2$ , CH4 , N2O) may be reported separately (see chapter 8 of the Scope 3 Standard).

The company should first account for all the different types of GHGs contained in a product, then aggregate for all products. If the use phase of a product is likely to be similar for multiple products, companies may group similar products.

**Calculation formula: Direct use-phase emissions from greenhouse gases and products that contain or form greenhouse gases that are emitted during use**

| $CO_2$e emissions from greenhouse gases and products that contain or form greenhouse gases that are emitted during use = |
|---|
| **sum across GHGs released in a product or product group:**<br>∑ (quantities of product sold × GHG contained per product × % of GHG released during lifetime use of product × GWP of the GHG)<br><br>**then**:<br>sum across products or product groups:<br>∑ (use phase emissions from product or product group 1,2,3…)<br><br>Note: if the % released is unknown 100% should be assumed. |

Source: Greenhouse Gas Protocol Technical Guidance for Calculating Scope 3 Emissions (version 1.0)

*4.2.2.2.1 EXAMPLE CALCULATION 3: DIRECT GHG PRODUCTS (CHEMICALS, GASES, AND MATERIALS SUPPLIERS)*

(Note: The activity data and emissions factors in the case studies below are illustrative only, and do not represent actual data.)

Case Study: Company C is a chemical manufacturing company that supplies the semiconductor industry value chain. The company sold 1,000 kg of hexafluoroethane to an IC manufacturer for use in a 300 mm wafer IC production process. The direct emissions and byproduct emissions from the use of the chemical can be assessed using the approaches and factors set out in the IPCC 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 3: Chapter 6 guidance. To estimate the direct emissions, Company C outlined the following calculation:

**Emissions source:**

- Direct use-phase emissions from gas processes

**Activity data needed:**

- Total gas sold (kg)
- Wafer processing type
- Use of abatement devices

**Emissions factor needed:**

- IPCC default emissions factors (fraction released) for the chemical
- GWP of chemical

**Calculation:**

- ∑ (total product (kg) × default emissions factor (fraction released) × global warming potential (kg $CO_2e$/kg) + (total product (kg) × default byproduct emissions factor (byproduct generated and released) × global warming potential of byproduct (kg $CO_2e$/kg))

### TABLE 9 EXAMPLE CHEMICAL MANUFACTURERS EMISSIONS ESTIMATION

| Input Data | | Source |
|---|---|---|
| Process type | 300 mm wafer processing with no abatement | Customer request |
| Number sold | 1,000 kg | Sales data |
| Default emissions factor for C2F6 | 0.8 | IPCC Chapter 6 Table 6.9 |
| C2F6 GWP | 12,400 | IPCC Sixth Assessment Report, 2020 (AR6) |
| Byproduct emissions factor for CF4 | 0.21 | IPCC Chapter 6 Table 6.9 |
| C2F4 GWP | 0.004 | IPCC Sixth Assessment Report, 2020 (AR6) |
| **Emissions Estimation Results** | | |
| Total $CO_2e$ = (1000 kg × 0.8 kg released/kg used × 12,400 kg $CO_2e$/kg) + (1000 kg × 0.21 kg released/kg used × 0.004 kg $CO_2e$/kg) = 9,920,000 tons $CO_2e$ | | |

*4.2.2.3 CALCULATION METHOD FOR INDIRECT USE-PHASE EMISSIONS FROM PRODUCTS THAT INDIRECTLY CONSUME ENERGY (FUELS OR ELECTRICITY) OR EMIT GHGS DURING USE*

In this method, the reporting company should calculate emissions by creating or obtaining a typical use-phase profile over the lifetime of the product and multiplying by relevant emissions factors.

**Activity data needed**

- Quantities of products sold
- Average use duration or number of uses over lifetime of product
- Average use scenarios (e.g., weighted average of scenarios)
- Fuel indirectly consumed in use scenarios
- Electricity indirectly consumed in use scenarios
- GHGs emitted indirectly in use scenarios

**Emissions factors needed**

- Combustion emission factors of fuels and electricity
- GWP of GHGs emitted indirectly, expressed in units of carbon dioxide per unit kilogram of the GHG (e.g., 25 kg $CO_2$e/kg)

The emissions factors applied should be representative of the geography of where the product is sold as well as the reporting year.

**Calculation formula: Indirect use-phase emissions from products that indirectly consume energy (fuels or electricity) during use**

| **Indirect use-phase $CO_2e$ emissions of products =** |
|---|
| **sum across fuels indirectly consumed from use scenarios:**<br>∑ (total lifetime expected uses / use duration of product × % of total lifetime uses using this scenario × quantity sold in reporting period × fuel consumed per use / over use duration in this scenario (e.g., kWh) × emission factor for fuel (e.g., kg $CO_2e$/kWh))<br>+<br>**sum across electricity indirectly consumed from use scenarios:**<br>∑ (total lifetime expected uses / use duration of product × % of total lifetime uses using this scenario ×quantity sold in reporting period × electricity consumed per use / over use duration in this scenario (kWh) × emission factor for electricity (kg $CO_2e$/kWh))<br>+<br>**sum across indirect refrigerant leakage from use scenarios:**<br>∑ (total lifetime expected uses / use duration of product × % of total lifetime uses using this scenario ×quantity sold in reporting period × refrigerant leakage per use / over use duration in this scenario (kg) × emission factor for refrigerant (kg $CO_2e$/kg))<br>+<br>**sum across GHG emitted indirectly from use scenarios:**<br>∑ (total lifetime expected uses of product × % of total lifetime uses using this scenario ×quantity sold in reporting period × GHG emitted indirectly (kg) × GWP of the GHG) |

Source: Greenhouse Gas Protocol Technical Guidance for Calculating Scope 3 Emissions (version 1.0)

*4.2.2.3.1 EXAMPLE CALCULATION 4: INDIRECT PROCESS GAS (EQUIPMENT MANUFACTURERS)*

(Note: The activity data and emissions factors in the case studies below are illustrative only, and do not represent actual data.)

Case Study: Company D is an equipment manufacturing company that supplies tooling. The company's tools use hexafluoroethane in a 300 mm wafer IC production process. The indirect emissions and byproduct emissions from the use of the chemical can be assessed using the approaches and factors set out in the IPCC 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 3: Chapter 6 guidance. The company will model the emissions for ~80% of the tools and then use the modeled average for the remaining tooling. To estimate the direct emissions, Company D outlined the following calculation:

**Emissions source:**

- Indirect use-phase emissions from wafer manufacturing tools

**Activity data needed:**

- Emissions per wafer for tool recipe
- Tool count
- Wafer throughput
- Wafer processing type
- Use of abatement devices

**Emissions factor needed:**

- IPCC default emission factors (fraction released) for the chemical and byproducts released from abatement
- GWP of chemical

**Calculation:**

- ∑ GHG emissions per wafer x wafers per year per tool x total tools shipped x tool lifetime (years)
- The emissions per wafer are calculated in a similar way as in Example Calculation 3

**TABLE 10 EXAMPLE EQUIPMENT MANUFACTURERS EMISSIONS ESTIMATION**

| Input Data | | Source |
|---|---|---|
| Number of tools sold in the year | 100 Tool A<br>50 Tool B<br>20 Tool C<br>18 Tool D | Sales data |
| Wafer processing rate, Tool A | 10 wafers/minute or 600 wafers/hr | Equipment design specification |
| Wafer processing rate, Tool B | 8 wafers/minute or 480 wafers/hr | Equipment design specification |
| Annual process time and free time mode | 70% process / 25% free time / 5% off time | SEMI S23 |
| Product lifetime | 10 years | Historical data |
| Process type | 300 mm wafer processing with no abatement | Customer request |
| C2F6 volume used per wafer | 0.2 g/wafer (0.0002 kg/ wafer) | Process Recipe |
| Default emission factor for C2F6 | 0.8 kg C2F6 released/kg used | IPCC Chapter 6 Table 6.9 |
| C2F6 GWP | 12,400 | IPCC Sixth Assessment Report, 2020 (AR6) |
| Byproduct emissions factor for CF4 | 0.21 kg CF4 released/kg C2F6 used | IPCC Chapter 6 Table 6.9 |
| CF4 GWP | 0.004 | IPCC Sixth Assessment Report, 2020 (AR6) |

| Emissions Estimation Results for Tool A |
|---|
| Total lifetime $CO_2e$ for Tool A =<br><br>100 tools x 600 wafers/hour/tool x 8,760 hrs/year x 70% process time = 367,920,000 wafers/year<br><br>367,920,000 wafers/year x [(0.0002 kg C2F6/wafer x 0.8 kg C2F6 released/kg used x 12,400 kg $CO_2e$/kg) +(0.0002 kg C2F6/wafer x 0.21 kg CF4 released/kg C2F6 used x 0.004 kg $CO_2e$/kg)] = 729,953,342 kg $CO_2e$/year = 729,953.3 tonnes $CO_2e$/year<br><br>729,953.3 tonnes $CO_2e$/year x 10 years = 7,299,533 tonnes $CO_2e$ |
| **Emissions Estimation Results for Tool B** |
| Total lifetime $CO_2e$ for Tool B =<br><br>50 tools x 480 wafers/hour/tool x 8,760 hrs/year x 70% process time = 147,168,000 wafers/year<br><br>147,168,000 wafers/year x [(0.0002 kg C2F6/wafer x 0.8 kg C2F6 released/kg used x 12,400 kg $CO_2e$/kg) +(0.0002 kg C2F6/wafer x 0.21 kg CF4 released/kg C2F6 used x 0.004 kg $CO_2e$/kg)] = 291,981,336 kg $CO_2e$/year = 291,981.3 tonnes $CO_2e$/year<br><br>291,981.3 tonnes $CO_2e$/year x 10 years = 2,919,813 tonnes $CO_2e$ |
| **Total Emissions Estimation Results** |
| Total $CO_2e$ = (Tool A $CO_2e$ + Tool B $CO_2e$) / (Tool A percent of sales + Tool B percent of sales) = (7,299,533 tonnes $CO_2e$ + 2,919,813 tonnes $CO_2e$)/(53.19%+26.60%) = 12,807,803 tonnes $CO_2e$ |

*4.2.2.3.2 EXAMPLE CALCULATION 5: INDIRECT ELECTRICITY USE (EQUIPMENT MANUFACTURERS)*

(Note: The activity data and emissions factors in the case studies below are illustrative only, and do not represent actual data.)

Case Study: Company E is an equipment manufacturer selling semiconductor Automated Test Equipment (ATE), which is used to ensure the Devices Under Test (DUTs) meet performance standards.

The DUT requires some power so testing can be executed. The ATE this company produces supplies the power to the DUT. This means the energy consumed by the DUTs are reflected in the total electricity draw of the ATE. While in many cases the amount of energy the DUT requires is small enough relative to the overall total ATE energy consumption that it can be ignored in the energy and emissions accounting process (i.e., not enough of a factor to be worth the accounting effort/overhead), there are classes of DUT that have considerable power needs relative to the power profile of the ATE. In these cases, the indirect electricity consumption attributable to the DUT and supplied through the ATE may become significant enough that the overhead and complexity of the accounting process becomes worthwhile.

This example of ATE energy consumption is intended to help identify the direct and indirect electricity usage aspects of the equipment; specifically, what portion of the energy consumption is a function of the equipment itself (leading to direct 3.11 emissions) versus the portion that is a function of the DUT being acted upon by the equipment (indirect 3.11 emissions). This SCC guidance generally recommends the disaggregation of direct and optional indirect emissions (see section 4.1.1), which would require equipment manufactures to separate what electricity use and emissions are from the equipment and what are passed through the equipment. The equipment manufacturer would then choose to either report both direct and indirect emissions as separate totals or elect to not report the indirect portion (as these are optional emissions under GHG Protocol guidance).

However, in situations such as ATE energy consumption when separating the two is difficult or of limited value companies may choose to report combined direct/indirect energy use and emissions.

As a first step towards estimating the direct and indirect emissions, the company outlined the following calculation for the energy use. Once the direct and indirect electricity was determined, the rest of the calculation of emissions from the electricity use would follow the Example Calculation 2.

**Emissions source:**

- Direct and indirect use-phase emissions from ATE electricity

**Activity data needed for electricity use:**

- Utilization rates by mode
- Total AC Mains power draw
- Power draw for DUTs

### TABLE 11 EXAMPLE EQUIPMENT MANUFACTURERS ELECTRICITY USE ESTIMATION

| Input Data* | | | | |
|---|---|---|---|---|
| **ATE Operating Mode (S23 Definitions)** | **Utilization Rate by Operating Mode** | **Annual Hours for Each Operating Mode** | **ATE Average Power Draw per Operating Mode (kW) *** | **Annual Energy Consumption by Operating Mode (kWh)** |
| Process** | 70% | 6132 | 20 (18 for equipment and 2 for DUT) | 122,640 |
| Idle | 20% | 1752 | 12 | 21,024 |
| Rest | 0% | 0 | 6 | 0 |
| Sleep | 5% | 438 | 2 | 876 |
| System Off | 5% | 438 | 0 | 0 |
| | | | Total | 144,540 |
| *All data from internal testing per SEMI S23<br>**By S23 definition, the DUT is supplied power only in Process Mode | | | | |
| | | | | |
| **Indirect typical energy consumption (TEC) per year** | | | | |
| 6,132 hours/year x 70% process time x 2kW = 12,264 kWh per year | | | | |
| **Direct typical energy consumption (TEC) per year** | | | | |
| 144,540 total kWh/year – 12,264 DUT KWh/year = 132,276 kWh per year | | | | |

#### 4.2.3 MARKET-BASED ACCOUNTING

Organizations looking to reduce 3.11 emissions from products that consume electricity should seek to improve energy use efficiency. However, there is a limit to efficiency, particularly for products that are already highly efficient and have diminishing returns from further improvement. Additionally, improving energy efficiency does not guarantee reductions in overall energy consumption and, by extension, emissions.[7] To further enable and encourage reductions and value chain engagement, this SCC Guideline recommends incorporating renewable electricity procurement into 3.11 accounting. Note that this section is mainly applicable to companies that sell business products, as individual customers must be identified to reflect their renewable procurement. Companies that sell intermediate and consumer products will likely have difficulty leveraging this section's recommendations

**Grid Decarbonization**

Estimating future emissions rates of electricity grids is imprecise and relies on decarbonization scenario assumptions. These assumptions can vary drastically from conservative to optimistic and using them would make Scope 3 comparison between companies difficult. To avoid confusion and potential high variability of results, grid decarbonization assumptions should not be leveraged in 3.11 accounting. Instead, they can be used by companies to conduct scenario analysis or model projected emissions and targets.

Currently, when assessing electricity emissions, the GHG Protocol only references global, regional, and national average location-based electricity emissions factors for use in 3.11 (as of the date of this Guideline). It does not explicitly support or disallow alternatives. There are two primary actions that customers could take to incorporate renewable electricity procurement in their operations that a reporting company may want to recognize in their 3.11 estimate: 1) direct renewable energy use by the customer, and 2) procurement of renewable energy credits (REC) or other market-based mechanisms by the customer to offset their electricity use.

There are numerous ongoing discussions by global organizations on the topic of how to incorporate renewable electricity procurement in Scope 3. The GHG Protocol is also reviewing the potential integration of market-based accounting approaches into Scope 3 as a part of its standards and guidance update process. However, until the GHG Protocol releases final updated guidance (anticipated in the latter half of 2026), this SCC Guideline builds off the position papers published by the USEPA: *Renewable Electricity Procurement on Behalf of Others: A Corporate Reporting Guide* and *Renewable Electricity Procurement for Use of Sold Products*, leveraging three of their guiding principles:

1. Accounting should align with the GHG Protocol.
   - Reporting organizations should report location-based and market-based Scope 2 emissions following the quality criteria and emissions factor hierarchy defined in the GHG Protocol Scope 2 Guidance.
2. Scope 2 emissions should reflect purchasing choices.
   - Market-based Scope 2 emissions should reflect the purchasing choices of the reporting organization and not the purchasing choices of another party, unless a purchasing choice that benefits

[7] Total energy consumption may benefit from efficiency improvements but is ultimately driven by economic factors and market growth. If a product becomes 5% more efficient but its utilization increases 10%, the net impact is an increase in overall energy consumption (all other factors being equal).

another party is made explicitly to benefit the reporting organization's Scope 2 emissions. For this reason, a purchase of renewable electricity should be applied to only one organization's Scope 2 emissions.

3. Scope 3 emissions can reflect choices made by another party.
   - A reporting organization can quantify its Scope 3 emissions based on the market-based Scope 2 emissions of its suppliers or customers, even if the purchasing choices of those value chain partners are not made explicitly to benefit the reporting organization. The reporting organization should indicate in its public reporting if it is using location-based or market-based Scope 2 emissions. A reporting organization should not purchase renewable electricity and simply apply it to Scope 3 emissions without involvement[8] from its supplier or customer.

*It is important to note that while this guidance leverages the same principles as the USEPA practice papers, it departs from these papers in solutions to leverage the market-based emissions of customers reflecting only a single year in lifetime emissions accounting. The papers provide an annual emissions accounting approach (requiring an annual reassessment of the energy use of past sold products) as well as an alternative renewable electricity purchasing approach (requiring verified contracts for multi-year streams of RECs). The annual accounting approach in the short term is difficult to adopt as it requires data from previous years products and the alternative renewables approach requires multi-year streams of RECs, which is not how the REC industry currently operates. As such, this Guideline explicitly allows the extrapolation of current-year data into the future for the life of the product.*

Data in a reporting year (or from the former year if that is the most recent available) can be extrapolated for the lifetime of a product. In the same manner that a location-based electricity factor from the current reporting year is used for the entirety of a product's assumed lifespan, the data of a customer's renewable electricity procurement in the reporting year can be extrapolated for the product's assumed lifespan.

This guidance asserts that organizations that wish to incorporate renewable electricity purchases by customers may choose to calculate and report an additional 3.11 value that reflects customer market-based electricity emissions. This "dual reporting" requires that the original method using only average location-based emissions factors still be reported to ensure a more conservative estimate is available, for many of the same reasons provided in the GHG Protocol Scope 2 guidance for dual reporting of Scope 2.

To account for customer renewable electricity use, the reporting company shall be able to document customer market-based Scope 2 GHG emissions (i.e., through public reporting or direct engagement.) Note that, as with all other Scope 3 data, data from value chain partners will vary in quality and may not be fully aligned with a company's reporting practices.[9] Best practice is that this information is third-party

[8] The involvement is needed when purchasing on behalf of a customer to ensure the customer is able to apply the attributes retired on their behalf to their own market-based Scope 2 inventory. The USEPA paper details documentation to be shared with value chain partners, which enables proper retirement and allocation of attributes.

[9] One example of a point of potential misalignment to reporting practices is the reporting of biomass based renewable power. Biomass power generation results in emissions that are both inside and outside of the GHG Protocol reporting boundary. Emissions inside the boundary ($CH_4$ and $N_2O$ of any biogenic sources) should be included in properly reported Scope 2 data. Those outside the boundary ($CO_2$ from biogenic sources) should be disaggregated and reported separately outside of the Scope 2 data. However, this is frequently overlooked in Scope 2 reporting and the way a customer reports their market-based Scope 2 data may not align with the Scope 3 reporting company's approach to this topic.

verified in alignment with the GHG Protocol or other standards, such as RE100, to ensure credits meet quality standards and are being procured and retired properly.

With this information, a custom adjusted emissions factor may be determined and applied to products sold to specific customers who use renewable electricity. Data should be aligned at the most granular level available (i.e., region/location-specific sales to a customer aligned with their regional/location-specific renewable usage is preferred over global sales to a customer aligned with their global renewable usage). Adjusted emissions factors are assessed in the reporting year but are not required to be independently verified annually after the initial assessment. However, if it is determined that a customer has reduced their procurement of renewable electricity in subsequent years and that this reduction is likely to have a material impact on the reporting organization's base year, the reporting organization should recalculate its base year emissions.

#### *4.2.3.1 EXAMPLE APPLICATION OF MARKET-BASED GUIDANCE*

In 2024, a SEMI member sells 100 units of a product that consumes electricity to Customer XYZ that uses the product in Taiwan. The SEMI member has developed the following product level use case:

- Yearly power consumption: 100 kWh per unit of product
- Product lifespan: 5 years
- Emissions factor
    - o BEST CASE - Location-based emissions factor for the specific grid region where product is used

      Example: **Taiwan**

        - Electricity generation emissions factor (kg $CO_2$e/kWh): 0.636024
        - Residual emissions factor (kg $CO_2$e/kWh): 0.636151
    - o ALTERNATIVE - Global average emissions factor
        - Example from IEA: Global average grid factor (kg $CO_2$e/kWh): 0.481

Three examples of the calculation are presented below; each example assumes a different level of market-based renewable electricity is known to be used by Customer XYZ.

**TABLE 12 EXAMPLE RESULTS OF MARKET-BASED GUIDANCE**

| Summary results from examples | | | |
|---|---|---|---|
| **Example** | **Location/ Market** | **EF kg$CO_2$e/ kWh (location-based or inferred from customer)** | **Results (kg $CO_2$e)** |
| Example 1 | Location-based | 0.636024 | 31,801 |
| Example 2 | Market-based | 0 | 0 |
| Example 3 | Market-based | 0.469354 | 23,468 |

**Example 1**

In this example, it is assumed that the customer does not procure any renewable power or market-based instruments.

Location-based energy profile of the customer region is used to assess category 3.11. The current location-based emissions factor is assumed to be applied for the remaining lifetime of the product.

100 units * 100 kWh/unit * 5 years * 0.636024 kg $CO_2$e/kWh (location-based EF) = **Lifetime emissions of 31,801 kg $CO_2$e**

**Example 2**

In this example, it is known that the customer procures renewable power or market-based instruments that are equal to the total purchased power of the customer.

Market-based category 3.11 results if products are sold to the customer in Taiwan, and that customer reports a market-based Scope 2 total of 0 MT$CO_2$e for 2024 (meaning we can assume 100% use of renewable power or 100% coverage of electricity consumption by market-based instruments with emissions of 0). Based on this guidance, without additional information from the customer, we will also assume the continuation of this level of market-based procurement for the lifetime of the product.

100 units * 100 kWh/unit * 5 years * 0 kg $CO_2$e/kWh = **Lifetime emissions of 0 kg $CO_2$e**

**Example 3**

In this example, it is known that the customer procures some renewable power or market-based instruments that are only equal to a portion of the total purchased power of the customer.

Market-based category 3.11 results if products are sold to the customer in Taiwan, and customer reports a market-based Scope 2 total that is more than 0 MT$CO_2$e for 2024 but less than the location-based

Scope 2 reported by the customer (meaning there is some unknown percent coverage of electricity consumption by RECs or other market-based instruments). In this case, data found either in the customer's sustainability reporting or through direct customer engagement can be used to infer a customer specific EF.

Ideally, we would find a customer specific emissions factor or market instrument coverage at the regional/facility level from the customer. If that is not possible, then publicly available data could be used. In this example, the customer publicly reports a Taiwan-specific location and market-based Scope 2 and Taiwan-specific electricity consumption. These data points can be used to infer an emissions factor. If a regional-specific value is not available publicly, customer engagement is encouraged to determine this value. If this is not feasible, then the total global market-based Scope 2 value and global electricity consumption values reported by the customer for that year can be used.

**Example data:**

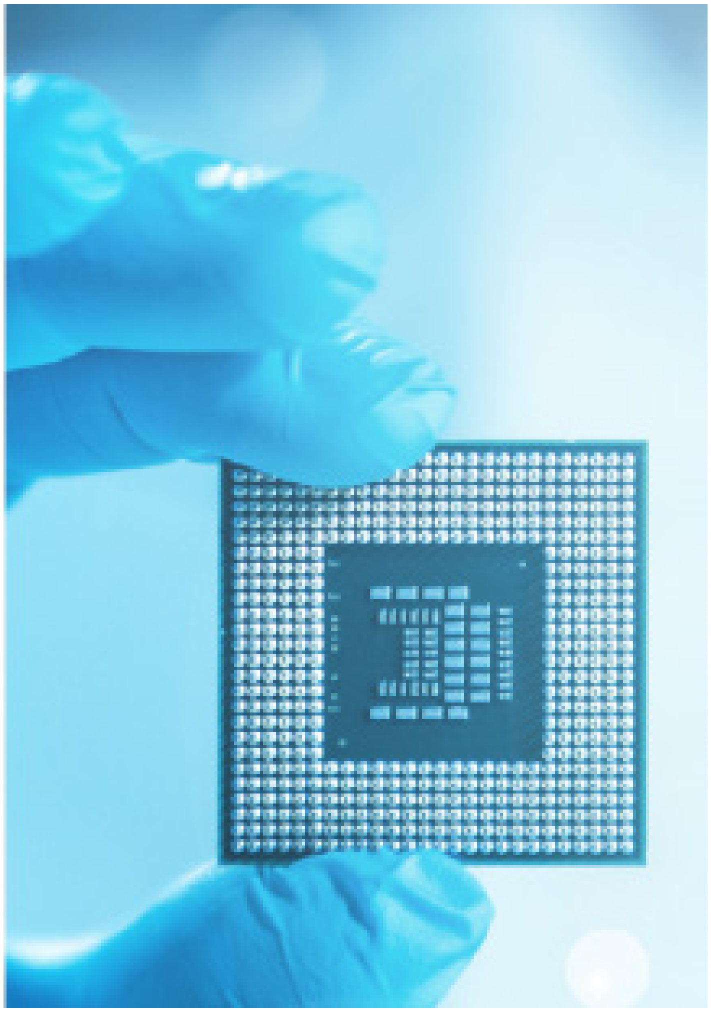
- Customer Taiwan sites – Market-based Scope 2 (MT-$CO_2$ equivalent): 10,150,252
- Customer Taiwan sites – Total indirect (electricity) energy consumption (GWh): 21,626

The two data points are used to develop a ratio of emissions to power (an average emissions factor)

10,150,252 / 21,626 = 469.354 MT$CO_2$e/GWh = 0.469354 kg$CO_2$e/kWh

With this information, we can infer an emissions factor of 0.469354 kg$CO_2$e/kWh when market-based instruments are incorporated. Based on guidance, without additional information from the customer, we will also assume the continuation of this level of market-based procurement for the lifetime of the product.

100 units * 100 kWh/unit * 5 years * 0.469354 kg $CO_2$e/kWh = **Lifetime emissions of 23,468 kg $CO_2$e**



# 5. REPORTING AND DISCLOSURE

## 5.1 SCC REPORTING GUIDANCE

Based on GHG Protocol guidance, companies are required to report a description of the methodologies and assumptions used to calculate emissions in 3.11.

> GHG Protocol: "Each Scope 3 category requires a description of the methodologies, allocation methods, and assumptions used to calculate Scope 3 emissions. Companies should report assumptions underlying reported emissions for each of the 15 Scope 3 categories. For example, for 3.11 (Use of sold products), companies should report information on average use profiles, assumed product lifetimes and other underlying assumptions."

These disclosures should include references to the underlying datasets and resources used, information and justification of any exclusions made (note that intermediate product exclusions are reserved for when the end use of an intermediate product is unknown) and approach to estimating market-based emissions if dual reporting.

## 5.2 ADDITIONAL REPORTING RECOMMENDATIONS

Outside of GHG Protocol requirements, companies are encouraged to report additional optional metrics that help users interpret emissions data. Because 3.11 accounts for lifetime emissions of products, it makes it harder for a user of the data to differentiate the impact from product durability versus product GHG performance. See Table 7 for suggested metrics to help demonstrate actual product performance and changes over time.

**TABLE 13 OPTIONAL REPORTING METRICS**

| Product Performance Information | Suggested Metric | Advantages |
|---|---|---|
| Average product emissions intensity | Average yearly GHG intensity of sold products (kg $CO_2e$ / unit sold) | Controls for variation in product lifespan assumptions and total sales, providing a normalized view of aggregated product portfolio performance. |
| Annual emissions from the use of sold products | Emissions that occur in a single year from all products sold in the reporting year (tonnes $CO_2e$) | Controls for variation in product lifespan assumptions, isolating absolute annual emissions. |
| Product life/durability | Lifetime/durability of sold products (years) | Provides context and transparency to user of the GHG inventory report. |

**Example of Optional Reporting Metrics**

The following illustrates an example of these metrics for a company with three product types. The details of the products are shown in the table and the calculation and example disclosure statement for each metric are presented after Table 8.

### TABLE 14 EXAMPLE PRODUCT DATA

| Product | Total Units Sold in the Reporting Year (units) | Product Life / Durability (years) | Average Product Emissions Intensity (kg $CO_2e$/unit sold) | Annual Emissions from Use of Sold Products (tonnes $CO_2e$) | Scope 3 Category 11 Use of Sold Products (tonnes $CO_2e$) |
|---|---|---|---|---|---|
| Product X | 1,000 | 5 years | 450 | 450 | 2,250 |
| Product Y | 500 | 1 year | 100 | 50 | 50 |
| Product Z | 100 | 10 years | 10,000 | 1,000 | 10,000 |
| **Totals** | **1,600** | **From 1-10 years** | **938** | **1,500** | **12,300** |

**Metric 1: Average Product Emissions Intensity**

The metric = total emissions that occur in a single year from all products sold in the reporting year / total units sold in reporting year

938 kg$CO_2$e/unit sold = 1,500,000 kg $CO_2$e / 1,600 units

Each of our products, on average, are associated with 938 kg $CO_2$e per product over the course of 1 year of use by our customers.

**Metric 2: Annual Emissions from the Use of Sold Products**

The metric = sum of total product emissions per year

1,500 tonnes $CO_2$e = (450,000kg + 50,000kg + 1,000,000kg) / 1,000 (unit conversion kg/tonne)

All products we sold this year, combined, would be associated with 1,500 tonnes of $CO_2$e over the course of 1 year of use by our customers.

**Metric 3: Product Life/Durability**

Can either be reported per product grouping:

- Product X: 5 years
- Product Y: 1 year
- Product Z: 10 years

Or as a range: Our products are expected to have a typical lifetime of 1 to 10 years.

Additional intensity metrics can also be reported that provide more granular or product-specific information (average energy efficiency of sold products, average emissions per hour of use, average emissions per wafer/IC device produced by sold equipment [equipment segment specific metric] etc.).

# 6. ACNOWLEDGEMENTS

The SCC Scope 3 Working Group was established to develop a harmonized approach to Scope 3 GHG emissions accounting and reporting for semiconductor companies. We have developed this guidance in partnership with specialist consultancy firm ERM.

**About ERM**

ERM is the largest global pure-play sustainability consultancy, partnering with the world's leading organizations to create innovative solutions to sustainability challenges and unlocking commercial opportunities that meet the needs of today, while preserving opportunity for future generations. For over 20 years, ERM has been delivering strategic sustainability and environmental solutions to the semiconductor industry, helping companies navigate regulatory complexities, reduce risk, and drive responsible growth.

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# 7. ADDITIONAL TABLES

### TABLE 15 LIST OF EMISSIONS FACTOR DATABASES

| Database | Description | Link |
|---|---|---|
| USEPA GHG Emission Factors Hub | USEPA's GHG Emission Factors Hub was designed to provide organizations with a regularly updated and easy-to-use set of default emissions factors for organizational GHG reporting. It includes emissions factors to estimate GHG emissions from various sources including US eGRID electricity generation and fuel consumption. | GHG Emission Factors Hub \| USEPA |
| USEPA Emissions & Generation Resource Integrated Database (eGRID) | USEPA's eGRID data includes emissions, emission rates, generation, heat input, resource mix, and many other attributes of power generation in the U.S. | Emissions & Generation Resource Integrated Database (eGRID) \| USEPA |
| UK Defra's Government conversion factors for company reporting of GHG emissions | The database provided by Department for Environment, Food, and Rural Affairs (Defra) in the UK provides emission factors to estimate GHG emissions from various sources including UK electricity generation and fuel consumption. | Government conversion factors for company reporting of GHG emissions - GOV.UK |
| IEA Emissions Factors Data sets | Annual GHG emissions factors for World countries from electricity and heat generation – located under "Data sets." | IEA – International Energy Agency |
| Intergovernmental Panel on Climate Change (IPCC) | AR4, AR5 and AR6 GWP values for converting other gases into $tCO_2e$. | IPCC — Intergovernmental Panel on Climate Change |

| Database | Description | Link |
|---|---|---|
| AIB European Residual Mix | Association of Issuing Bodies (AIB) European Residual Mix provides market-based emissions for non-renewable energy for EMEA region. | European Residual Mix \| AIB |
| USEPA Green-e Residual Mix | Market-based emissions for non-renewable energy for U.S. | Green-e® Residual Mix Emissions Rate Tables \| Green-e |
| USEPA EEIO | US Environmentally-Extended Input-Output models, providing emissions intensity for around 400 industry sectors. | US Environmentally-Extended Input-Output (USEEIO) Technical Content \| USEPA |
| EXIOBASE | A global, detailed Multi-Regional Environmentally Extended Supply-Use Table (MR-SUT) and Input-Output Table (MR-IOT), containing spend-based emissions factors for around 300 sectors. | Exiobase - Home |
| Japan Ministry of Environment | The National Greenhouse Gas Inventory Document of Japan includes GHG emissions and removals, as well as trends in GHG emissions from energy. | Ministry of the Environment, Government of Japan |
| Mexico RENE (Registro Nacional de Emisiones) | The Mexico RENE includes calculation of indirect GHG emissions by electricity consumption. | National Emissions Registry (RENE) \| Ministry of Environment and Natural Resources \| Government \| gob.mx |

| Database | Description | Link |
|---|---|---|
| Australian National Greenhouse Accounts | The Australian National Greenhouse Accounts includes state and territory electricity and T&D losses emissions intensity. | National Greenhouse Accounts Factors: 2023 - DCCEEW |
| Canada National Inventory Report | Canada's National Inventory report includes GHG sources and sinks, along with electricity intensity data by province. | Canada's official greenhouse gas inventory - Canada.ca |
| New Zealand Ministry of Environment | The measuring emissions guide includes emissions factors for organizations to calculate emissions. Factors include purchased electricity, heat and steam, fuel use, and T&D losses. | Measuring emissions: A guide for organisations: 2024 detailed guide \| Ministry for the Environment |
| Taiwan Energy Administration | The Taiwan Energy Administration publishes the electricity carbon emissions factor. | Energy Administration, Ministry of Economic Affairs, R.O.C. |

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- Science Based Targets initiative(SBTi),(2024), SBTi Corporate Net-Zero Standard Criteria (Version 1.2)
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