APPENDIX B. COMPARISON OF EXISTING GUIDANCE DOCUMENTS APPLICABLE TO COMPARATIVE IMPACT ASSESSMENTS

Introduction

The World Resources Institute conducted a landscape analysis of existing practices related to product-level comparative impact assessments. The results are summarized in a separate working paper. Part of the analysis involved a comparison of the major guidance documents and standards expressly developed for, or potentially applicable to, such accounting. This appendix provides the comparison in full.

Overview of Existing Standards and Guidelines

- To date, the following documents have been published (Table B1) and are in use today:
- Global e-Sustainability Initiative (GeSI) and Boston Consulting Group (BCG). *Evaluating the Carbon-Reducing Impacts of ICT: An Assessment Methodology* (GeSI and BCG 2010).
- World Resources Institute (WRI). *Greenhouse Gas Protocol Policy and Action Standard* (WRI 2014).
- International Council of Chemical Associations (ICCA) and World Business Council for Sustainable Development (WBCSD). *Addressing the Avoided Emissions Challenge* (ICCA and WBCSD 2013).
- International Electrotechnical Commission, IEC/TR 62726:2014. *Guidance on Quantifying Greenhouse Gas Emissions Reductions from the Baseline for Electrical and Electronic Products and Systems* (IEC 2014).
- International Telecommunication Union, ITU-T L.1410. *Methodology for Environmental Life Cycle Assessment of Information and Communication Technology Goods, Networks and Services* (ITU 2014).
- The Institute of Life Cycle Assessment (ILCA). *Guidelines for Assessing the Contribution of Products to Avoided Greenhouse Gas Emissions (Version 1)*. (ILCA 2015).

For the sake of brevity, much of the ongoing discussion will refer to these publications by number (e.g., #3 for ICCA and WBCSD 2013).

The list excludes documents that are written in a language other than English and/or no longer appear to be used.

Of the listed documents, four (#1, 3, 5, 6) estimate comparative impacts (specifically, negative comparative impacts or avoided emissions) by comparing product GHG inventories. A fifth (#4) estimates them by comparing product GHG inventories, while also identifying the baseline product through a project accounting approach. The sixth document (#2) uses an approach informed by project accounting but adapted to accounting for policies and actions.

Two documents are cross-sector (#2 and #6), and others cover the information and communications technology (ICT) (#1, 4, 5), chemical (3#), and electronics (#4) industries.

Each document has a different definition for avoided emissions but claims to support a range of often overlapping applications, typically around supporting research and development (R&D) activities and external communications (Table B1).

Definitions of key terms are provided in the working paper.

Table B1 | **Major Existing Guidelines or Standards Applicable to Avoided Emissions**

	PUBLICATION	SECTOR	GENERAL METHODOLOGY	BUILDS ON WHAT STANDARDS?	DEFINITION OF AVOIDED EMISSIONS	STATED APPLICATIONS
1	**GeSI and BCG (2010)**	Information and communications technology (ICT).	Attributional: Compare product GHG inventories; the impact is calculated at the level of a functional unit.	ISO 14040:2006 and 14044:2006.	"Enabling effects" defined as the extent to which ICT technologies and systems can reduce or avoid the carbon emissions associated with traditional manual, mechanical, or physical activities.	■ Inform customer purchase and procurement decisions. ■ Provide evidence base for government efforts to introduce supportive policies. ■ Improve understanding of carbon-reducing potential of ICT products. ■ Accelerate adoption of ICT products.
2	**GHG Protocol (2014)**	All sectors.	Consequential: GHG effects of a policy or action are estimated relative to a baseline scenario.	Not stated.	GHG effects are changes in GHG emissions or removals that result from a policy or action.	■ Assess and communicate the GHG effects of a policy/action (or a package of related policies/ actions) before, after, and during implementation. ■ Primarily intended for use by governments and policy analysts, but with stated applicability to the private sector.
3	**ICCA and WBCSD (2013)**	Chemical.	Attributional: Compare product GHG inventories; the impact is calculated at the level of a functional unit.	ISO 14040:2006 and 14044:2006; aims to be consistent with GHG Protocol Product Standard, PAS2050, ISO/TS 14067 .	A reduction in GHG emissions is represented by the difference between the life cycle emissions of the solution of the reporting company and the product to which that solution is compared.	■ Assess avoided emissions potential of products. ■ Support R&D efforts. ■ Credible external communications. ■ Support efforts among value chain partners to improve and communicate overall sustainability of product systems.

Table B1 | **Major Existing Guidelines or Standards Applicable to Avoided Emissions (continued)**

	PUBLICATION	SECTOR	GENERAL METHODOLOGY	BUILDS ON WHAT STANDARDS?	DEFINITION OF AVOIDED EMISSIONS	STATED APPLICATIONS
4	**IEC (2014)**	Electrical and electronic products and systems (e.g., ICT systems and components of renewable energy systems).	Impact of a product is quantified relative to either another product or an actual project.	ISO 14064:2 and GHG Protocol Project Protocol.	Defines GHG reductions as "calculated decrease of GHG emissions between a baseline scenario and the project."	■ Enable companies in sector to quantify their contribution to society in reducing emissions. ■ Allow product-related projects to be evaluated in terms of project methodologies. ■ Support R&D efforts. ■ External communications. ■ Official certification and recognition of GHG reduction units (e.g., credits), when supported by additional standards.
5	**ITU (2014)**	ICT goods, networks and services; guidance also provided on software.	Attributional: Compare product GHG inventories; the impact is calculated at the level of a functional unit.	ISO 14040:2006 and 14044:2006.	Environmental load reduction quantified by comparing the LCA results between reference product and target product systems.	■ Enable telecommunication operators and service providers to assess the environmental load of one or more services carried by their ICT networks.
6	**ILCA (2015)**	All sectors.	Attributional: Compare product GHG inventories; the impact is calculated by multiplying the avoided emissions per functional unit by the amount of final product(s) in use and then by an attribution factor.	Informed by ISO 14040:2006 and 14044:2006, L1410, IEC TR62726, ICCA/WBCSD 20013, GHG Protocol Project Protocol, and Japanese industry/jurisdictional guidelines on avoided emissions.	The "contribution to avoided emissions" is defined as the quantified amount of contribution of the target product to reduced GHG emissions through the whole life cycle of final product(s) that achieve the reduction effects on environmental loads, in comparison with a baseline amount.	■ Support R&D efforts. ■ External communications. ■ Inform efforts of governments and industry bodies.

Source: Compiled by authors.

Comparison of Accounting Approaches

The six documents differ across a range of key accounting issues. This section summarizes these differences and Tables B4 though B7 detail each document's specifications for each issue. Differences are most marked on the following issues:

Treatment of extraboundary effects (Table A5). Some documents (#3, 4, 6) do not consider extraboundary effects. Documents #1 and #2 do consider extraboundary effects, while #5 states that extraboundary effects related to infrastructure (e.g., highways) may be assessed when looking at the large-scale implementation of ICT systems. Otherwise, document #5 considers that extraboundary effects should be excluded, because infrastructure is assumed to exist independently of ICT services.

Defining the assessed product and reference product (Table B6). Each document provides quite different guidance:

- Both #2 and #4 state that the reference product system should represent the conditions most likely to occur in the absence of the assessed product. Both also state that the reference product should be recalculated when undertaking a new assessment to reflect changes in properties of the system boundary.
- However, only #2 and #3 are explicit in stating that potential changes in the reference product should be accounted for from the beginning.
- Document #2 provides the most, albeit generic, guidance on this point. It requires that the reference product system take into account policy and nonpolicy drivers that do not result from the assessed product. These drivers include changes in economic activity, population, energy and product prices, weather, autonomous technological improvements, and structural shifts in the economy. Document #2 recommends that GHG effects be modeled as dynamic (linear or nonlinear) changes, rather than be assumed to remain constant over the assessment period.
- As a starting point for identifying the reference product, document #2 suggests looking at (i) the continuation of current technologies, practices, or conditions; (ii) discrete baseline alternatives (e.g., least-cost alternative practice or technology) that have been identified using environmental, financial, economic, or behavioral analysis or modeling; or (iii) a performance standard or benchmark that is indicative of baseline trends. Again, these starting points would have to be adjusted to reflect the policy and nonpolicy drivers.
- In turn, document #3 requires companies to calculate a reference product that assumes no future changes. However, for products with a long use phase, it also recommends that companies perform a qualitative scenario analysis or calculate an alternative scenario using a discount factor. Document #3 allows established products or the weighted average of all currently implemented technologies
- The documents other than #2 and #3 do not mention the need to adjust the reference product for policy and nonpolicy drivers.
- For example, in document #4 the available options include the average of all products on the market at one time, conventional technologies, best available technologies, and the exact system being replaced by the assessed product. Document #5 allows any system to serve as the reference product. Finally, stated options in document #6 include products with the highest market share, products that represent the average of the product category concerned, products before new technologies are developed, and previous versions of the same product from the company.
- In short, there is considerable variation in terms of the permitted reference product options and the degree to which the baseline should reflect changes in policy and nonpolicy drivers.

Attribution of avoided emissions to value chain partners. Only documents #3 and #6 provide guidance on attribution.

- Under document #3, attribution is optional, and companies must always report the total avoided emissions per functional unit. If attribution is desired, a company must qualitatively communicate the contribution of its product to the total value chain avoided emissions (see Table B2). Attribution must not be done if the contribution is judged "too small to communicate." Document #3 offers no formal guidelines on quantitative attribution, but does recommend that any quantitative attribution be based on the use of a ratio that value chain partners agree to.
- Under document #6, attribution is required. Attribution can be based on the following methods: (1) the extent of technological contribution or value added from components and services in the production of final product(s); (2) the use of a ratio that value chain partners agree to; or (3) independent original criteria determined by the evaluators themselves.
- Under document #6, if an appropriate contribution ratio cannot be determined, then companies shall not attempt a quantitative attribution and shall instead qualitatively explain how the target products contribute to the emissions avoided by the assessed products.
- Under both documents #3 and #6, any attribution should take into account all value chain partners needed to achieve the defined user benefit, although each guidance is ambiguous about how this should be done.
- Table B3 summarizes the guidance on attribution in documents #3 and #6.

Table B2 | **Means of Qualitatively Expressing the Contribution of a Chemical Product to the Total Value Chain Avoided Emissions under #3**

SIGNIFICANCE OF CONTRIBUTION	RELATIONSHIP BETWEEN CHEMICAL PRODUCT AND ASSESSED PRODUCT
Fundamental	The chemical product is the key component that enables the GHG emission-avoiding effect of the assessed product.
Extensive	The chemical product is part of the key component, and its properties and functions are essential for enabling the GHG emission-avoiding effect of the assessed product.
Substantial	The chemical product does not contribute directly to the avoided GHG emissions, but it cannot be substituted easily without changing the GHG emission-avoiding effect of the assessed product.
Minor	The chemical product does not contribute directly to the avoided GHG emissions, but it is used in the manufacturing process of a fundamentally or extensively contributing product.
Too small to communicate	The chemical product can be substituted without changing the GHG-avoiding effect of the assessed product.

Source: (ICCA and WBCSD, 2013)

Table B3 | **Existing Guidance on Attributing Avoided Emissions to Value Chain Partners**

DOCUMENT	WHEN?	HOW?	WHAT PARTS OF VALUE CHAIN?
#3: ICCA & WBCSD, 2013	■ Attribution is optional. ■ Total value chain avoided emissions per functional unit must always be reported. ■ Must not allocate (or report total value chain avoided emissions) if own contribution is judged "too small to communicate" (see Table 8). ■ Technology users (i.e., the buyers of the end product) may report the complete value chain avoided emissions.	■ No formal guidelines on quantitative attribution. ■ Following are suggested steps: If there is no consensus along value chain on how to attribute, the company should (1) check which attribution method (economic or physical) best represents the contribution of individual value chain partners and apply it and (2) check attribution factors and results with partners. ■ When other partners use a different attribution method, companies are recommended to include this method as a separate scenario. ■ If service providers are part of the value chain, attribution based on physical criteria is not allowed.	■ Should include all value chain partners that are addressed in the assessment (and identified by starting from the defined user benefit and looking upstream in the value chain to see which partners are needed to achieve the user benefit).
#6: ILCA, 2015	■ Attribution is required. ■ If contribution ratio cannot be determined, then shall report the emissions avoided per functional unit and provide qualitative explanations about how the target products contribute to the avoided emissions of the final products.	■ Attribution may be based on (1) extent of technological contribution or value added from components and services in the production of final product(s), (2) use of a contributor ratio based on the consensus among stakeholders, or (3) independent original criteria determined by the evaluators themselves.	■ Varies according to which segments of the value chain contribute to the reduction effect. ■ All stakeholders (e.g., including retailers, sales and advertising agents) can be selected if the avoided emissions are accomplished by all of them. ■ Alternatively, only some stakeholders relevant to the manufacturing stage of the final product may be selected if the reduction effect is attributable to manufacturing processes.

Source: Compiled by authors

Other Accounting Issues

Other differences exist on the following issues:

- Data quality (Table A7). Not all documents provide guidance on data quality. Document #6 requires compliance with ISO 14040/14044. Documents #4 and #5 require primary data for all processes under the control of the reporting company, while document #1 recommends primary data where available. Both documents #1 and #5 prefer a process-sum approach but indicate that a hybrid approach can be used when warranted by the scale and complexity of the study (e.g., when looking at extraboundary effects). Document #2 does not specify a preference for top-down or bottom-up approaches but considers that the choice of approach should be determined by the assessment's objectives, relative significance of the action/policy being assessed, data availability, and available resources.
- The duration of the assessment period (Table B4). Some documents (#2, 5, 6) base the assessment period on the service life, lifetime, or replacement time of the product, while document #2 bases it on how long GHG effects are expected.

The documents provide fairly consistent guidance on the following issues:

- Defining which life cycle phases to assess (Table B5). Most allow specific phases or sinks/sources to be excluded if they are identical or very similar between the reference products and assessed products (#2–#6) or if they do not contribute significantly to the avoided emissions impact (#1, 2, 4, 5). To help ensure a conservative assessment, document #4 also allows companies to assess all life cycle phases of the assessed product and only selected stages of the reference product.
- Uncertainty analysis (Table B7). Either recommended (#1, 6) or required (#2, 4, 5). Documents #2 and #5 require that the uncertainty assessment include a sensitivity analysis of key methodological parameters and assumptions.
- Intermediate products (Table B6). Documents #3, #4 and #6 state that if the assessed product is a component of more than one final product, a representative end product may be selected as the basis for the assessment.

Very little guidance is provided on the following topics:

- Scaling results to a product's market size (Table B7). Most documents do not provide guidance on how to scale impacts from the level of the functional unit to the level of the number of final products in use. For ex-post assessments, document #6 requires the use of actual sales records or, if sales data are unavailable, of production or shipment numbers. In turn, document #4 suggests shipment numbers. Both suggest anticipated sales numbers for ex-ante assessments. Neither document makes a distinction between total sales/shipment numbers and the number that is likely to actually replace existing or future stock.
- The treatment of other environmental impact categories (Table B4). These are out of scope for most publications. The exception is document #3, which recommends that companies perform a full LCA or screening multi-criteria LCA and check for trade-offs. If such trade-offs are found, companies are required to report on the relevant environmental impact categories in the same way as they report on GHG emissions and should consider not reporting avoided emissions at all.
- Aggregation of results to the company level (Table B7). Most documents (#1, 3–6) do not provide guidance on aggregating results at the level of a product portfolio or an entire company. (Note: many companies, however, do perform this aggregation using these documents as a basis, but without adhering to the detailed product-level reporting requirements.) Document #2 does provide guidance on aggregating the GHG effects of different policies/actions. Here, the methods and data sources used for different actions/policies must be comparable, and any potential overlaps and interactions among the actions/policies have to be accounted for.

Table B4 | **Treatment of Non-GHG Environmental Impact Categories and Time Horizons**

DOCUMENT	TREATMENT OF ENVIRONMENTAL IMPACT CATEGORIES OTHER THAN GHG EMISSIONS	ASSESSMENT PERIOD
ICCA and WBCSD (2013)	■ Companies should perform a full or screening multi-criteria LCA and check for trade-offs. ■ If trade-offs are identified, companies shall report on the relevant environmental impact categories in the same way as they report on GHG emissions and should consider not reporting avoided emissions at all.	■ Defined by the end-use application and may not be the same as the lifetime of the chemical product. ■ Shall be in line with standards used in the market—e.g., product category rules, studies from reputable organizations, and studies by leading companies in the value chain. ■ Typically, a single year.
ILCA (2015)	If significant trade-offs are expected, they should be reported.	■ Set with reference to the legal durable years, the physical lifetime, and the replacement time of assessed product(s).
IEC (2014)	■ Focuses on GHGs only. ■ Stated that results may be used as input into a multi-criteria assessment.	■ Based on the design specification prepared by the organization, published technical information as a legal standard, a PCR, a sector-specific standard, etc. ■ Duration of study should be consistent with typical time of technical advancement.
ITU (2014)	GHG impacts must be assessed, but companies can decide whether/how to report non-GHG impacts.	■ The operating lifetime (excluding storage time). ■ Only definable for ICT goods (not networks or services) and should be based on available information on actual goods' use (e.g., statistics for similar solutions or information on commercial lifetime). ■ Otherwise, economics statistics may be used (e.g., depreciation time) but are considered less accurate and should be avoided.
GeSI and BCG (2010)	Focuses on GHGs only.	■ No guidance.
GHG Protocol (2014)	Focuses on GHGs, but standard may also be used to account for non-GHG impacts.	■ For ex-ante assessments: based on the time horizon of the GHG effects included in the assessment boundary. ■ For ex-post assessments: the assessment period should cover the period between the date of policy implementation and date of assessment.

Source: Compiled by the authors.

Table B5 | **System Boundaries**

DOCUMENT	TYPES OF GHG EFFECTS TO CONSIDER	WHICH GHGS TO EVALUATE?	DEFINING THE GHG SYSTEM BOUNDARY (I.E. DETERMINING WHICH POTENTIAL PROCESSES TO INCLUDE IN THE ASSESSMENT)
ICCA and WBCSD (2013)	Processes along life cycle of reference and assessed products.	Seven GHGs covered by the UNFCCC and Kyoto Protocol.	■ May omit identical parts or processes in the life cycle of the assessed and reference products, based on published LCAs or own estimates. If processes are omitted, shall not declare a ratio of avoided emissions relative to the reference product.
ILCA (2015)	Processes along life cycle of reference and assessed products.	Seven GHGs covered by the UNFCCC and Kyoto Protocol.	■ May omit processes that are common to both the assessed and reference products. May also omit processes that are not identical but are very similar, provided that only a minor or negligible difference exists across life cycles. If processes are omitted, shall not declare a ratio of avoided emissions relative to the reference product.
IEC (2014)	Processes along life cycle of reference and assessed products.	To be identified based on considerations of relevance and international frameworks (e.g., Kyoto Protocol).	■ May omit processes by either (1) conducting carbon footprints that cover all lifecycle stages of the assessed product and selected stages of the reference product, or (2) omitting similar stages of both the assessed and reference products when the associated emissions are equal, cancel out, or are deemed insignificant. Option 1 is considered the more conservative approach and is useful when the emissions from some life cycle stages of the reference product are unknown or difficult to calculate. ■ Guidance recommends the use of IEC TR 62725 to assess and quantify the significance of life cycle stages other than the use phase.
ITU (2014)	■ Processes along life cycle of reference and assessed products. ■ Indirect infrastructure effects may be assessed and reported separately when looking at large scale implementation of ICT solutions.	No guidance.	■ Processes or input/output data may be excluded if they are the same in both product systems. Otherwise, must not exclude processes that are deemed significant relative to any (ISO-defined) cut-off criteria, which include mass, energy, and environmental significance. ■ As a basis for a cutoff, either modeled, secondary. or primary data can be used.
GeSI and BCG (2010)	■ Processes along life cycle of reference and assessed products. ■ Extraboundary effects can be excluded based on goal and scope of the assessment and if unlikely to significantly affect emissions.	No guidance.	■ May exclude life cycle processes across both the assessed and reference products that do not significantly contribute to the avoided emissions impact (as assessed by a screening method) and do not materially affect the study's conclusions. ■ Screening assessment may use modeled data, secondary data (preferred), or primary data.
GHG Protocol (2014)	■ Processes along life cycle of reference and assessed products. ■ Extraboundary effects. ■ Potential effects to be identified by mapping causal chains that trace the process by which the policy/action leads to GHG effects through a series of intermediate effects.	Seven GHGs covered by the UNFCCC and Kyoto Protocol. May include other GHGs.	■ May omit sources/sinks/drivers that remain constant between the assessed and reference product systems. Otherwise, all significant GHG effects, sources, sinks, and GHGs should be included in the system boundary. ■ Significance should be assessed based on the likelihood and magnitude of individual effects and take into account the assessment's context and objectives. ■ Recommends the use of proxy data or simplified estimation methods as alternative to excluding effects.

Source: Compiled by the authors.

Table B6 | **Defining the Baseline Product System and Solution**

DOCUMENT	DEFINING THE ASSESSED PRODUCT	DEFINING THE REFERENCE PRODUCT	ADDITIONAL NOTES
ICCA and WBCSD (2013)	May be a final product or a component of a final product.	■ If assessment is conducted at the chemical product level: shall be any alternative established chemical product(s) with a high (combined) market share of at least 20%, based on sales volume in the reference year. ■ If assessment is conducted at the end-use level: shall be the weighted average based on shares of all currently implemented technologies for the same user benefit (including the studied end-use solution). ■ Reporting company shall always calculate a base case that assumes no future changes (i.e., use latest actual data). ■ For products with a long use phase, company should also conduct a qualitative scenario analysis or calculate an alternative scenario using a discount factor.	■ The solution and baseline system should use the same functional unit, set following ISO 14040/14044. ■ In addition, the systems being compared must – Be at the same level in the value chain. – Deliver the same function to the user. – Be used in the same application. – Be distributed/used on the market, and not in the process of being banned, in the reference time period and geographic region. - Be exchangeable for the typical customer in the selected market in terms of functionality, technical qualities (e.g., stability and durability), and any additional benefits rendered during use and disposal. – Be as consistent as possible in terms of data quality, methodology, assumptions, etc.
ILCA (2015)	■ May be a final product or a component of a final product. ■ If the assessed product is a component of more than one final product that achieves the reduction effects, then calculations should be performed for each of the final products that achieve the reduction effects. If this is difficult to do, then representative product(s) may be chosen for assessment.	■ Must be a final product(s). ■ Possible choices include (1) product(s) with the highest market share, (2) product(s) that is/are publicly acknowledged as the average of the product category, (3) previous version of the product(s) of the same company, (4) product(s) that can be fitted for standard values that are determined based on legislations or regulations, and (5) products before new technologies are developed.	The solution and baseline system should use the same functional unit, set following ISO 14040/14044.

Table B6 | **Defining the Baseline Product System and Solution (continued)**

DOCUMENT	DEFINING THE ASSESSED PRODUCT	DEFINING THE REFERENCE PRODUCT	ADDITIONAL NOTES
IEC (2014)	■ May be a final product or a component of a final product ■ Should the assessed product have a range of final configurations, then calculations should be performed for the configuration that is most representative of the goal, scope, and boundary conditions of the study.	■ Should represent conditions most likely to occur in absence of proposed project. Defined under a performance standard or project-specific procedure. ■ Stated options under the performance standard procedure include the average efficiency of all products existing in the market at a given time or of the products introduced to the market within a certain period of time. ■ Stated options under the project-specific procedure include conventional types of technologies or practices (e.g., a diffused technology or product in the market). ■ Other choices mentioned in document include (1) the exact specific system or product to be replaced by the assessed product, (2) best available technology (such as the top of similar activities), (3) historical conditions (such as GHG emissions or activity level data), and (4) relevant legal requirements. ■ No guidance is provided on what percentage market penetration rate would constitute conventional practice; it is considered that this value will differ between sectors and regions.	■ The assessed and reference products should use the same functional unit, although exceptions are permitted when equivalence is difficult to determine. In such cases, a product unit (e.g., one unit of an older model) may be used instead of the functional unit (the guidance is unclear on this point). ■ The reference product system should be continuously updated to reflect the natural evolution of technologies and systems. ■ Products that no longer exist when the solution is assessed should not be included in the reference product system.
ITU (2014)	Any ICT good, network, or service product system.	Either (1) any non-ICT system (e.g., commuting) or (2) a different ICT good, service, or network (which may be older).	The assessed and reference product systems should use the same functional unit, set following ISO 14040/14044.
GeSI and BCG (2010)	No guidance.	No guidance.	
GHG Protocol (2014)	Any action or policy (or a package of policies or actions) larger in scale than an individual project.	■ Represents the events/conditions most likely to occur in absence of policy/action being assessed. Not a historical reference point, but instead explicitly incorporates other policy and nonpolicy drivers that are expected to significantly affect the sources/sinks included in the system boundary. ■ Some possible starting points for defining the reference product system include (1) the continuation of current technologies, practices, or conditions; (2) discrete baseline alternatives (e.g., least-cost alternative practice or technology), identified using environmental, financial, economic, or behavioral analysis or modeling; and (3) a performance standard or benchmark indicative of baseline trends. ■ Ex-ante assessments must define a reference product system, whereas ex-post assessments can use either such a system or a comparison group method (where effect is compared using a control group that is otherwise equivalent), or both. ■ The reference product system should also account for free rider effects, as relevant.	■ Nonpolicy drivers include changes in economic activity, population, energy and product prices, weather, autonomous technological improvements, and structural shifts in the economy. ■ Reference values can be obtained from published data sources or developed de novo (by adjusting historical data for policy and nonpolicy drivers). ■ Where relevant and feasible, GHG effects should be modeled as dynamic (linear or nonlinear) changes in parameters over time, rather than assumed to be unvarying. ■ The reference should be recalculated every time an ex-post assessment is performed.

Source: Compiled by the authors.

Table B7 | **Data Quality and Aggregation**

DOCUMENT	DATA COLLECTION AND QUALITY	UNCERTAINTY	VERIFICATION	CAN RESULTS BE AGGREGATED (E.G., FOR COMPANY-WIDE APPLICATIONS)?
ICCA and WBCSD (2013)	No guidance.	For ex-ante assessments: The reporting company shall explain the scenarios used to project the future. For products with a long use phase (e.g., more than 10 years), the company should either 1) Provide a qualitative scenario analysis, explaining how each key parameter in the avoided emissions calculation might change in the future and how this influences the results; or 2) Calculate one alternative scenario using a discount factor—a process similar to the use of discount factors in financial accounting.	No guidance.	Not supported.
ILCA (2015)	Data collection and data quality shall comply with ISO 14040 and ISO 14044.	Sensitivity analysis and uncertainty analyses should be implemented.	A critical review or verification should be conducted.	Not supported.
IEC (2014)	■ Primary data should be used for all processes under the ownership or control of the organization that performs GHG reduction study. ■ Recommends guidance on data collection and quality in IEC/TR 62725:2013.	■ Uncertainty has to be evaluated. ■ The requirements in IEC/TR 62725:2013 and 14064-2:2006 should be taken into account. ■ Recommends monitoring GHG effects over the course of the project.	Should at least conduct an independent, first-party assurance or verification.	Not supported.
ITU (2014)	■ Primary data shall be used for all individual processes under the financial or operational control of the reporting company. Otherwise, ICT-specific secondary data may be used. ■ Data quality requirements follow ISO 14040/14044. ■ A process-sum approach is generally preferred for ICT systems, but a hybrid approach (process sum-EIO) can be used when warranted by the scale and complexity of the study.	■ Uncertainty shall be assessed in accordance with ISO 14044 and include a sensitivity analysis of significant inputs, outputs and methodological choices, and defined use scenarios. ■ Especially when modeled data are used, different scenarios should be assessed to establish a range of potential outcomes to limit the uncertainty. Refers to ISO 14044 for requirements on sensitivity analyses.	Refers to ISO 14040/14044 for requirements on implementing any critical review.	Not supported.

Table B7 | **Data Quality and Aggregation (continued)**

DOCUMENT	DATA COLLECTION AND QUALITY	UNCERTAINTY	VERIFICATION	CAN RESULTS BE AGGREGATED (E.G., FOR COMPANY-WIDE APPLICATIONS)?
GeSI and BCG (2010)	■ Primary data are preferred. ■ Process-sum approach generally preferred, but a hybrid (process sum-EIO) approach can be used when warranted by the scale and complexity of the study.	■ Uncertainty analysis is recommended. ■ Whenever assumption-based modeling is used, different scenarios (e.g., for scale of adoption) should be assessed to establish a range of potential outcomes and limit uncertainty.	No guidance.	Not supported.
GHG Protocol (2014)	■ Bottom-up (e.g., engineering models), top-down (e.g., macro-level statistical models) and hybrid approaches allowed. ■ The choice of approach should be determined by the assessment's objectives, relative significance of the action/policy being assessed, data availability, and available resources.	■ Qualitative and/or quantitative uncertainty assessment is required, as is a sensitivity analysis for key parameters and assumptions, including baseline options. ■ The rigor of the uncertainty assessment should be informed by the assessment's objectives, level of required accuracy, etc. (see table below).	Not required. Guidance provided in Ch. 13 of standard.	Yes. Companies can either estimate the GHG effects from a package of actions/policies (i.e., at the level of a company or product portfolio) or aggregate the effects of individual actions and policies. In the latter case, all potential overlaps and interactions among the policies and actions have to be accounted for, and the methods and data sources used for different actions/policies must be comparable.

Source: Compiled by the authors.