CHAPTER 11.

Biogenic product and TCDR-based product emissions

This chapter provides requirements and recommendations on accounting for and reporting biogenic product emissions (i.e., biogenic CO_2 emissions not related to land management) and emissions from technological carbon dioxide removal (TCDR)-based products. To account for and report on the storage of biogenic or TCDR-based carbon that is physically contained in product or waste carbon pools, see Chapter 15.

11.1 Overview

Biogenic product CO_2 emissions (i.e., gross biogenic product CO_2 emissions) are CO_2 emissions released to the atmosphere at the point of oxidation (from combustion, decomposition, or other processes) from biogenic products (e.g., bioenergy feedstocks, fiber, etc.).

Biogenic product CO_2 emissions are not zero, and biogenic products cannot be assumed to be carbon neutral. Biomass combustion releases CO_2 emissions to the atmosphere at a rate (per energy content) comparable to that of fossil fuels.[1] Companies calculate biogenic CO_2 emissions using emission factors that reflect the CO_2 emissions released at combustion, decomposition, or other processes, by type of biogenic product, such as those provided by the IPCC and those made available on the GHG Protocol website.[2] Similarly, companies must also account for and report any CH_4 and N_2O emissions from biogenic product use or disposal.

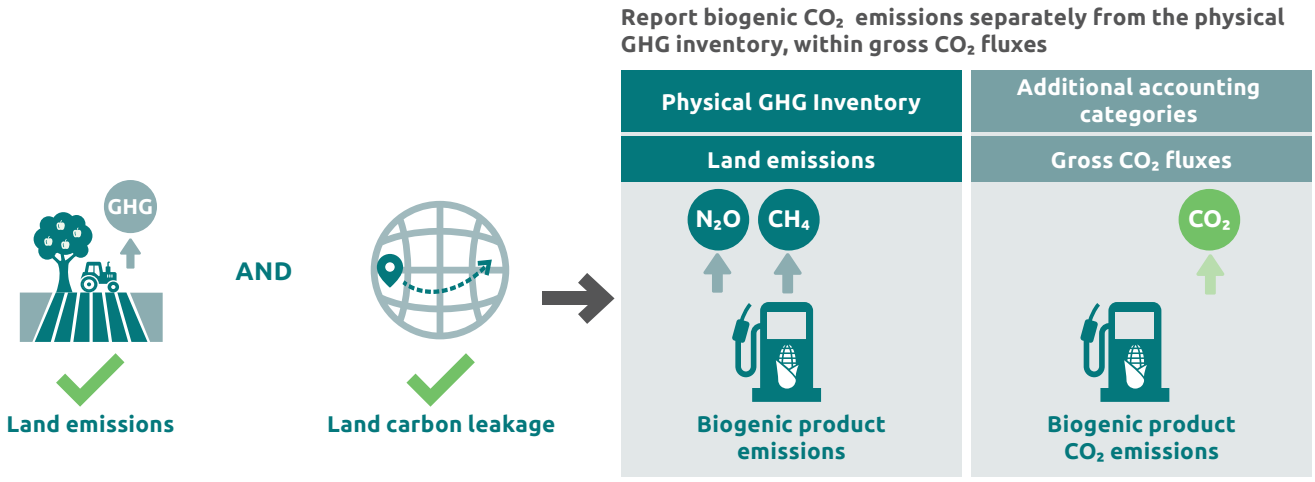
Only by quantifying the life cycle impacts of biogenic products can companies understand the net CO_2 flux (i.e., the net of gross biogenic land CO_2 removals, gross biogenic land CO_2 emissions, and gross biogenic product CO_2 emissions) associated with a biogenic product's life cycle. Where all land emissions are accounted for, the net biogenic CO_2 flux is included under the "emissions" (or "removals") accounting categories, and the gross CO_2 emissions and gross CO_2 removals may be separately reported under the

"gross CO_2 fluxes" accounting category, to ensure transparency and avoid double counting. A similar approach is taken for technological CO_2 removal and use pathways (e.g., direct-air-captured carbon-based fuels).

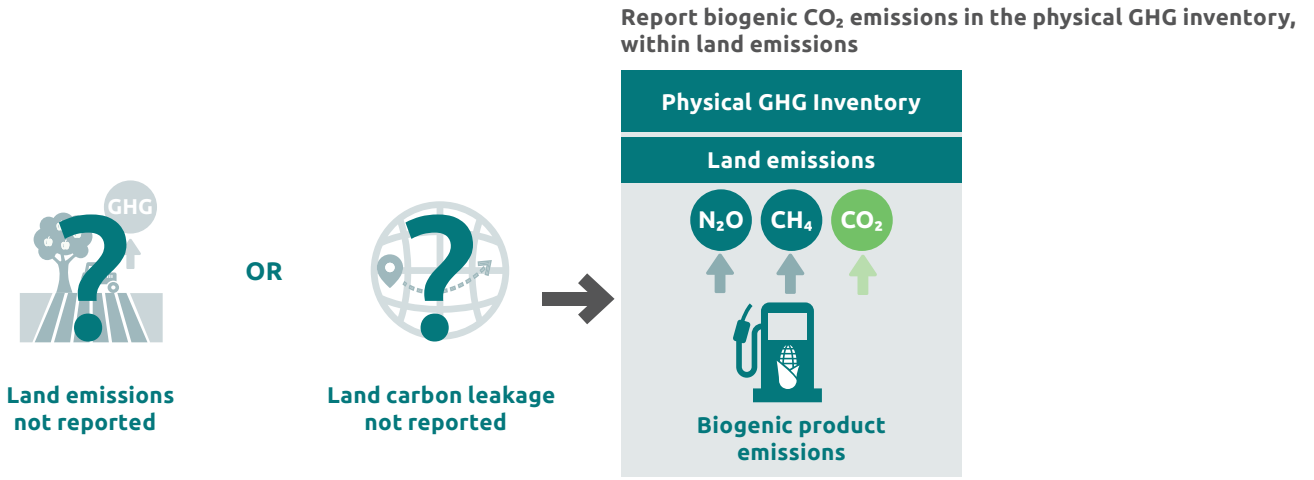
- How non-food, non-feed biogenic product CO_2 emissions are reported in this *Standard* depends on whether or not the reporting company accounts for and reports all life cycle GHG emissions associated with biogenic products, including net land carbon stock changes (Figure 11.1 and Requirement 17).
- Technological carbon dioxide removal (TCDR)-based product CO_2 emissions are separately reported depending on whether or not the company reports all life cycle GHG emissions (Requirement 18).

Figure 11.1 Two scenarios for biogenic product emissions reporting

SCENARIO 1. Life cycle emissions and land carbon leakage are accounted for and reported



SCENARIO 2. Life cycle emissions or land carbon leakage are unknown or not reported



11.2 Requirements

11.2.1 Accounting requirements

REQUIREMENT 17:

Biogenic product emissions accounting[3]

Companies that purchase, consume, process, or sell biogenic products (excluding food and feed products and biogenic waste) **shall** account for biogenic product emissions associated with such products according to the following requirements:

- **Biogenic product CO_2 emissions**: Companies **shall** account for scope 1, scope 2, and scope 3 biogenic product CO_2 emissions from combustion, decomposition, or other processes, using biogenic product CO_2 emission factors by type of biofuel or biomaterial. Companies **shall** report biogenic product CO_2 emissions in one of the following two accounting categories, depending on whether or not the company reports all scope 3 life cycle GHG emissions and other metrics:
  - **Separately as "gross CO_2 fluxes"**: Companies **shall** report "biogenic product CO_2 emissions" under "gross CO_2 fluxes" (separately from "emissions") in the scope corresponding to the point of oxidation, if they meet the following criteria associated with the biogenic product:
    - **Life cycle GHG emissions**: The company **shall** account for and report all life cycle GHG emissions associated with the biogenic product, including land use change emissions and the annual net land carbon stock changes of sourcing lands, and
      - The company **should** have information on where the biogenic product was sourced from (at a minimum, country of origin, or more precise levels of traceability),[4] and
    - **Land carbon leakage**: The company **shall** account for and report land use and land carbon leakage (where required) associated with the biogenic product.
  - **As "land emissions"**: If companies do not meet both criteria above, they **shall** report "biogenic product emissions" under "land emissions" (within "emissions") in the scope corresponding to the point of oxidation.
- **Biogenic product CH_4 and N_2O emissions**: Companies **shall** account for direct and indirect biogenic product CH_4 and N_2O emissions from combustion, decomposition, or other processes, using biogenic product CH_4 and N_2O emission factors by type of biofuel or biomaterial. Companies **shall** report biogenic product CH_4 and N_2O emissions in the scope corresponding to the point of oxidation.
- **Life cycle GHG emissions, land use, and land carbon leakage of biogenic products**: Companies **shall** account for all life cycle GHG emissions, land use, and land carbon leakage (where required) of biogenic products and report the upstream life cycle GHG emissions, land use, and leakage in either scope 3, category 1 or scope 3, category 3 as follows:
  - **Biomaterials**: For biomaterials consumed by the reporting company, report upstream life cycle GHG emissions, land use, and leakage in scope 3, category 1 (Purchased goods and services).
  - **Bioenergy feedstocks**: For bioenergy consumed by the reporting company, report upstream life cycle GHG emissions, land use, and leakage in scope 3, category 3 (Fuel- and energy-related activities not included in scope 1 or scope 2).
- **Any other scope 1, scope 2, or scope 3 emissions**: If applicable.

Food and feed products and biogenic waste: Companies that purchase, consume, process, or sell biogenic food or feed products and/or that acquire, use, or dispose of biogenic waste **shall** account for biogenic product emissions associated with such products or materials according to the following requirements:

- **Biogenic product CO_2 emissions:** Companies **shall** account for and report biogenic product CO_2 emissions that occur in the reporting company's operations or value chain under "gross CO_2 fluxes" separately from the physical GHG inventory.
  - Biogenic product CO_2 emissions from food and feed products intended for human or animal consumption **may** be excluded.
- **Biogenic product CH_4 and N_2O emissions:** Companies **shall** account for and report biogenic product CH_4 and N_2O emissions in the "biogenic product emissions" accounting subcategory under "land emissions" in the physical GHG inventory.

REQUIREMENT 18:

TCDR-based product emissions accounting

Companies **shall** account for scope 1, scope 2, and scope 3 CO_2 emissions from technological carbon dioxide removal (TCDR)-based products at the point of oxidation (when they are released to the atmosphere). Companies **shall** report TCDR-based product CO_2 emissions in one of the following two categories, depending on whether or not the company reports all scope 3 life cycle GHG emissions:

- **Separately as "gross CO_2 fluxes"**: If companies have information on the origin of the CO_2 or carbon in the TCDR-based product that demonstrates the CO_2 is technologically removed CO_2, and account for and report all life cycle GHG emissions associated with the TCDR-based product in scope 3, they **shall** report "TCDR-based product CO_2 emissions" under "gross CO_2 fluxes" separately from "emissions," in the scope corresponding to the point of oxidation.
- **As "fossil fuel and industrial emissions"**: If companies do not have information on the origin of the CO_2 or carbon in the TCDR-based product (i.e., whether the carbon is technologically removed CO_2) or do not account for and report all life cycle GHG emissions associated with the TCDR-based product in scope 3, they **shall** report TCDR-based product CO_2 emissions under "emissions" as "fossil fuel and industrial emissions," in the scope corresponding to the point of oxidation.

11.2.2 Reporting requirements

Reporting requirements for biogenic product emissions

Companies that purchase, consume, process, or sell biogenic products (excluding food and feed products and biogenic waste) **shall** report:

- **Biogenic product CO_2 emissions** either in the "biogenic product CO_2 emissions" accounting subcategory under "gross CO_2 fluxes" separately from the physical GHG inventory, or in the "biogenic product emissions" accounting subcategory under "land emissions" in the physical GHG inventory, depending on whether or not the company reports all scope 3 life cycle GHG emissions, land use, and land carbon leakage, if relevant.
- **Biogenic product CH_4 and N_2O emissions** in the "biogenic product emissions" accounting category under "land emissions" in the physical GHG inventory.

- **Life cycle GHG emissions** attributable to the biogenic products in the relevant "emissions" accounting category and subcategory.
- **Land use** associated with the biogenic product in the "land occupation" accounting subcategory under "land use" separately from the physical GHG inventory.
- **Land carbon leakage** associated with the biogenic product, if relevant, in the "land carbon leakage" accounting category separately from the physical GHG inventory.
- **Any other scope 1, scope 2, or scope 3 emissions** if applicable.

Food and feed products and biogenic waste: Companies that purchase, consume, process, or sell biogenic food or feed products and/or that acquire, use, or dispose of biogenic waste **shall** report:

- **Biogenic product CO_2 emissions** that occur in the reporting company's operations or value chain under "gross CO_2 fluxes" separately from the physical GHG inventory, in the scope corresponding to the point of oxidation.
  - Biogenic product CO_2 emissions from food and feed products intended for human or animal consumption **may** be excluded.
- **Biogenic product CH_4 and N_2O emissions** in the "biogenic product emissions" accounting subcategory under "land emissions" in the physical GHG inventory, in the scope corresponding to the point of oxidation.

Reporting requirements for TCDR-based product emissions

Companies that purchase, consume, or sell TCDR-based products **shall** report:

- **TCDR-based product CO_2 emissions** either in the "TCDR-based product CO_2 emissions" accounting subcategory under "gross CO_2 fluxes" separately from the physical GHG inventory or in the "fossil fuel and industrial emissions" accounting category in the physical GHG inventory, depending on whether or not the company reports all life cycle GHG emissions and has information on the origin of the CO_2.

11.3 Recommendations

Box 11.1 Policy implications

Policymakers and GHG programs **should** set their own policies for regulating or setting targets for biogenic product CO_2 emissions at the emissions source (e.g., smokestack or tailpipe) and land use regulations that limit agricultural land expansion for bioenergy production, as relevant to policy objectives. Policymakers and GHG programs are encouraged to consider the entirety of emissions, removals, land use, and land carbon leakage associated with the production and consumption of biogenic products.

11.4 Guidance on the requirements and recommendations

This section provides guidance on accounting for and reporting gross CO_2 emissions from biogenic and TCDR-based products (i.e., products that are associated with removal-and-use pathways). For guidance on how to account for and report on the *storage* of biogenic or TCDR-based carbon in product carbon pools or waste carbon pools, see Chapter 15. For broader guidance on product-level accounting, see Section 1.5 and Requirement 3, which describe how this *Standard* relates to the GHG Protocol *Product Standard* (WRI and WBCSD, 2011b).

11.4.1 Overview of removal-and-use pathways

Carbon cycle pathways are comprised of multiple individual carbon fluxes in a biogenic or TCDR carbon cycle. A "removal-and-use" pathway represents a carbon cycle pathway where CO_2 removed from the atmosphere is later returned to the atmosphere through CO_2 emissions (Figure 3.3). For further background information on carbon cycle pathways, see Section 3.4.1.

Biogenic carbon cycle

The biogenic carbon cycle begins with gross biogenic land CO_2 removals that remove CO_2 from the atmosphere via biogenic sinks and store that biogenic carbon in biomass carbon pools. This biogenic carbon can then be transferred to dead organic matter, soil, biogenic products, or geologic carbon pools. Ultimately, that biogenic carbon can then be released back to the atmosphere as:

- Gross biogenic land CO_2 emissions, due to the combustion, decomposition, or respiration of land-based carbon pools;
- (Gross) Biogenic product emissions, due to the combustion or decomposition of biogenic products; or
- Gross CO_2 emissions from geologic storage, due to fugitive losses of biogenic carbon stored in a geologic reservoir.

Table 11.1 provides definitions and examples of key terms related to the biogenic carbon cycle. Figure 11.2 provides an illustration of the biogenic carbon cycle, including relevant biogenic carbon flows and carbon stock changes.

Table 11.1 Key terms related to the biogenic carbon cycle

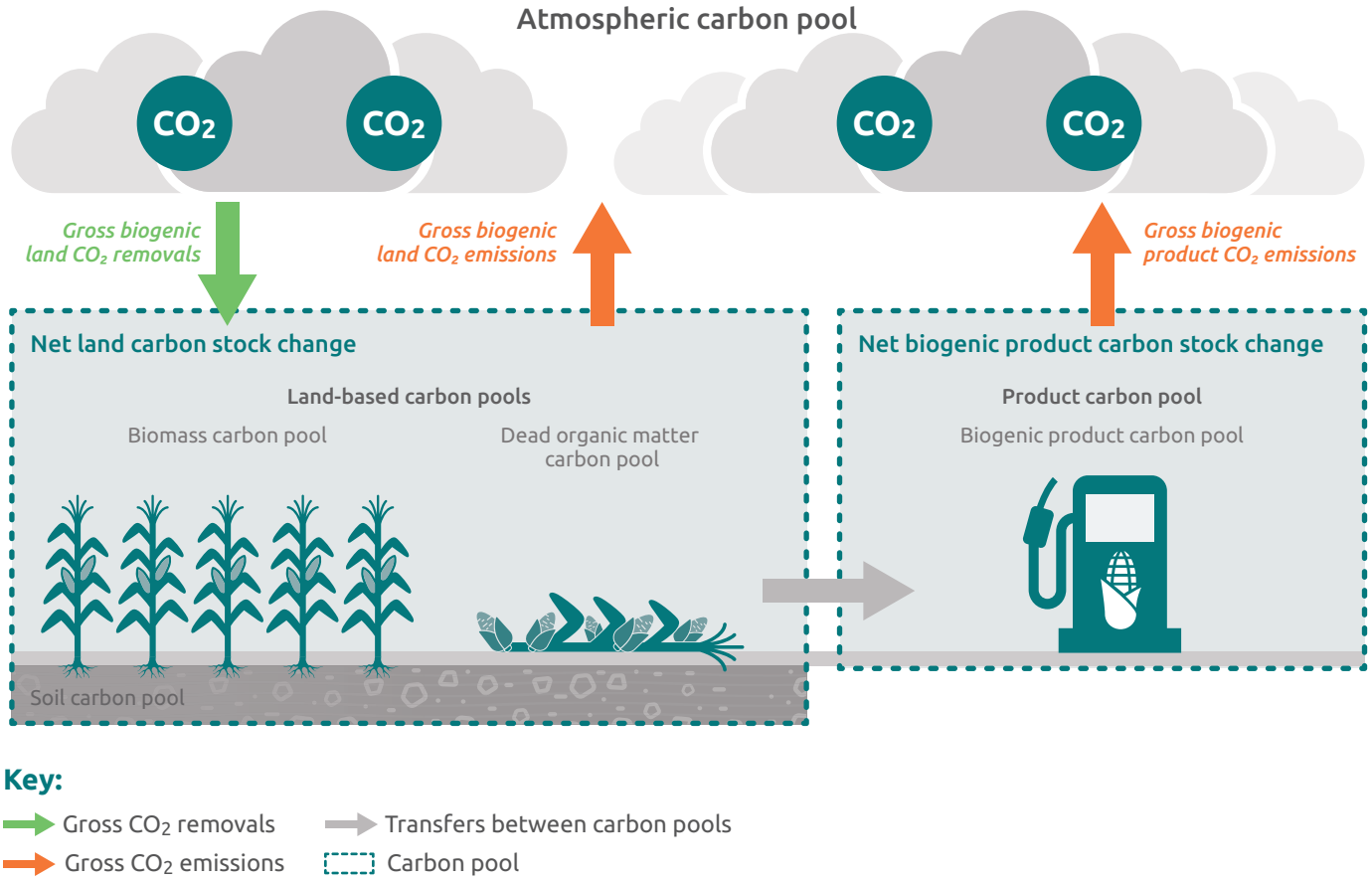
Term	Definition	Examples
Biogenic carbon	Carbon in, or derived from, living organisms or biological processes, but not from fossil fuels or other fossilized materials	Carbon in plant biomass, soil organic matter, food crops, animal products, wood fiber, or biofuels
Biogenic product	A good or material that contains biogenic carbon during the use stage of the product life cycle	Food and feed crops, animal products, wood products, or bioenergy feedstocks
Biological sink	A biological process, primarily photosynthesis, that removes CO_2 from the atmosphere	Plant photosynthesis
Biogenic product CO_2 emissions	Gross CO_2 emissions from combustion, biodegradation, or other losses from biogenic product carbon pools to the atmosphere. Also referred to as "Gross biogenic product CO_2 emissions," which is an accounting subcategory under "Gross CO_2 fluxes"	CO_2 emissions from the combustion of biomass or biofuel

Table 11.1 Key terms related to the biogenic carbon cycle (cont.)

Term	Definition	Examples
Gross biogenic land CO_2 emissions[a]	Gross CO_2 emissions from combustion, biodegradation, or other losses from land-based carbon pools to the atmosphere	CO_2 emissions from agricultural residue burning on croplands, or from agricultural residue decomposition on croplands
Gross biogenic land CO_2 removals[b]	Gross CO_2 removals from atmospheric CO_2 transferred via biological sinks to land-based carbon pools	CO_2 removals from plant growth

Notes: a. "Gross biogenic land CO_2 emissions" are distinct from "Land management net biogenic CO_2 emissions" (see Chapter 9), which are accounted for as net emissions following a stock change accounting approach (see Section 3.4.4). b. "Gross biogenic land CO_2 removals" are distinct from "Removals," as covered in Chapters 12 and 13, which represent net removals accounted for using a stock change accounting approach.

Figure 11.2 Representation of carbon stock change and flows within the biogenic carbon cycle



Note: Gross CO_2 fluxes using flow accounting are presented as arrows above the pools; stocks are presented as dotted boxes; net CO_2 fluxes using stock change accounting are presented in teal text at the top of each dotted box.

TCDR carbon cycle

The TCDR carbon cycle is associated with technologies that remove CO_2 from the atmosphere, such as direct air capture. A TCDR carbon cycle begins with technological CO_2 removals by technological sinks (e.g., a direct air capture facility) that store TCDR-based carbon in products or geologic carbon pools. TCDR-based carbon can then remain stored in TCDR-based product or geologic carbon pools, or be emitted back to the atmosphere as:

- (Gross) TCDR-based product CO_2 emissions, due to combustion, degradation, or other losses from TCDR-based products; or
- Gross CO_2 emissions from geologic storage, due to fugitive losses of TCDR-based carbon stored in geologic reservoirs.

CO_2 removal technologies used to generate TCDR-based products can lead to short-term carbon cycling (i.e., in removal-and-use pathways), for example, through the production of short-lived products such as direct-air-captured CO_2-based fuels. Alternatively, CO_2 removal technologies can be applied for long-term carbon storage in geologic reservoirs (i.e., in removal-and-storage pathways), such as direct air carbon capture with geologic storage. Chapter 14 provides accounting requirements and guidance for removals in geologic storage pathways.

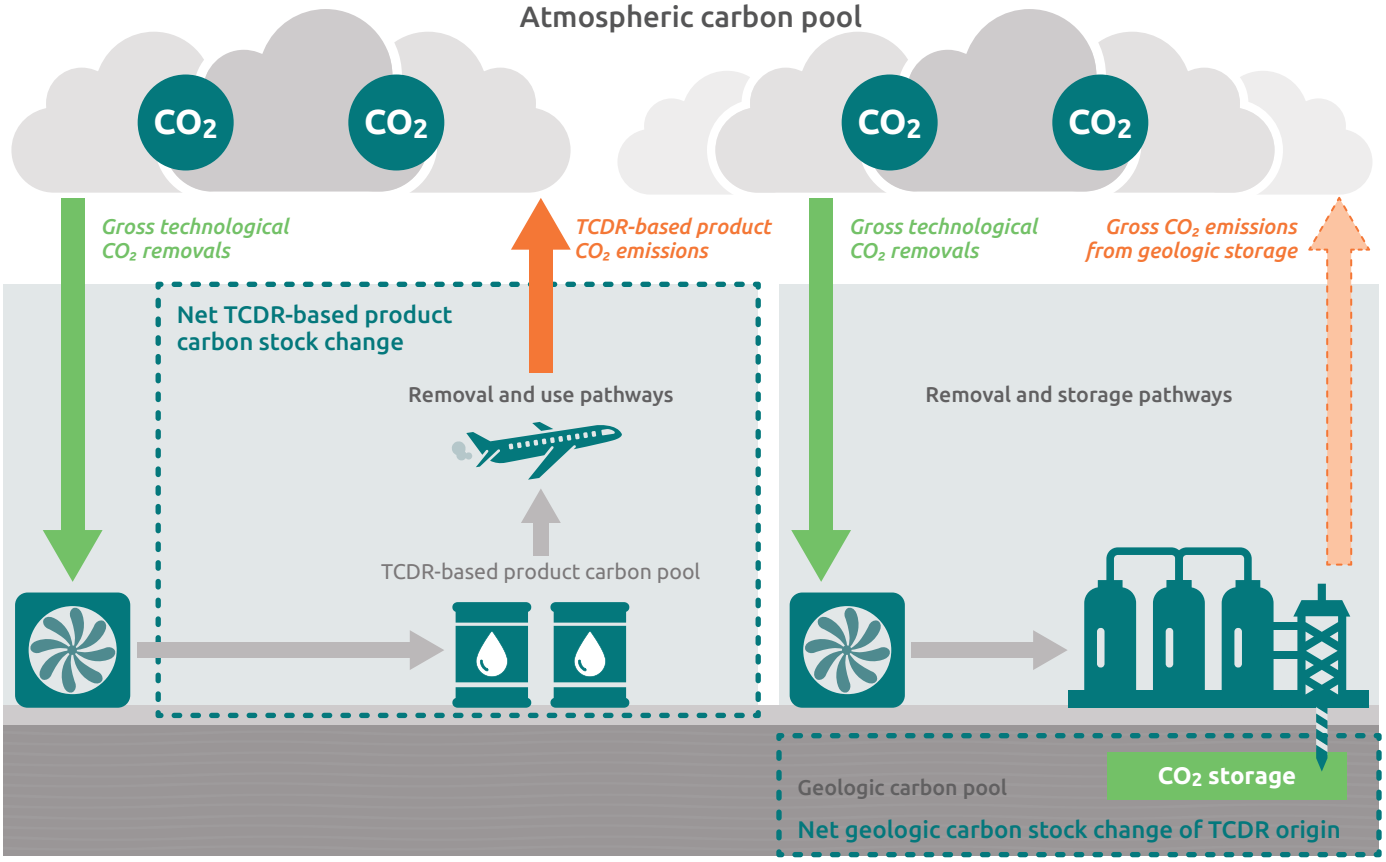
Table 11.2 provides definitions and examples of key terms related to the TCDR carbon cycle. Figure 11.3 provides an illustration of the TCDR carbon cycle, including relevant TCDR carbon flows and carbon stock changes.

Table 11.2 Key terms related to the TCDR carbon cycle

Term	Definition	Examples
TCDR-based carbon	Carbon derived from technological carbon dioxide removal (TCDR) processes	Carbon in direct-air-captured CO_2, carbon in captured biogenic CO_2 after biomass combustion
TCDR-based product	A good or material that contains TCDR-based carbon during the use stage of the product life cycle	Direct-air-captured CO_2-cured cement, or direct-air-captured CO_2-based alternative fuels
Technological sink	A mechanical or chemical process that removes CO_2 from the atmosphere or captures biogenic CO_2 from a source, and stores such CO_2 or other forms of carbon derived from CO_2 removals in non-atmospheric carbon pools	Direct air capture facility, bioenergy carbon capture and storage facility
Gross technological CO_2 removals	Gross CO_2 removals from atmospheric CO_2 transferred via technological sinks to TCDR-based product carbon pools or geologic carbon pools	CO_2 removals from a direct air capture facility, CO_2 removals from enhanced weathering[a] projects
TCDR-based product CO_2 emissions	Gross CO_2 emissions from combustion, degradation, or other losses from TCDR-based product carbon pools to the atmosphere	CO_2 emissions from the use of direct air capture-based alternative fuels
Gross CO_2 emissions from geologic storage	Gross CO_2 emissions from fugitive CO_2 emissions or other CO_2 losses to the atmosphere from a geologic reservoir containing captured and stored CO_2	Fugitive CO_2 emissions occurring at the injection site for geologic reservoirs storing CO_2

Note: a. Detailed guidance on accounting for removals due to enhanced weathering is not provided in this version of the *Guidance*, due to the need for additional research and methodology development at the time of publication.

Figure 11.3 Representation of CO_2 removals and CO_2 emissions fluxes within a technological carbon dioxide removal (TCDR) carbon cycle



Key:

- Gross CO_2 removals
- Gross CO_2 emissions
- Transfers between carbon pools
- Carbon pool
- Indicates gross CO_2 emissions *may* or *may not* happen

Note: Gross CO_2 fluxes using flow accounting are presented as arrows above the pools; stocks are presented as dotted boxes; net CO_2 fluxes using stock change accounting are presented in teal text within each dotted box.

11.4.2 Biogenic product emissions accounting

Biogenic product emissions are not zero, and biogenic products cannot be assumed to be carbon neutral. Only by accounting for the life cycle emissions, land use, and land carbon leakage attributable to a biogenic product can companies understand the net CO_2 flux (i.e., the net of gross biogenic land CO_2 removals, gross biogenic land CO_2 emissions, and biogenic product CO_2 emissions) associated with a biogenic product's life cycle. Companies applying this *Standard* are required to account for all of these impacts based on where they occur in their operations or value chain, as set forth in Requirement 4.

Biogenic product CO_2 emissions accounting for bioenergy and biomaterials

Companies that purchase, consume, process, or sell biogenic products (excluding food and feed products and biogenic waste) are required to report biogenic product CO_2 emissions in one of two accounting subcategories,

depending on whether or not they account for and report all life cycle emissions (including land emissions, land use, and land carbon leakage where required) associated with the biogenic products (see Figure 11.1). If such conditions are met, the company reports biogenic product CO_2 emissions separately from the physical GHG inventory as "biogenic product CO_2 emissions" (an accounting subcategory under "gross CO_2 fluxes"); where such conditions are not met, the company reports these emissions within the physical GHG inventory as "biogenic product emissions" (an accounting subcategory under "land emissions").

Companies report these emissions under the accounting subcategory "biogenic product CO_2 emissions" (within the "gross CO_2 fluxes" accounting category) if the reporting company satisfies the following two criteria:

1. **It accounts for and reports all life cycle GHG emissions associated with the biogenic product, including the annual net land carbon stock changes on sourcing lands**. To report biogenic product emissions separately from the physical GHG inventory as "gross CO_2 emissions," a company must account for all direct and indirect GHG emissions throughout the biogenic product's life cycle (i.e., "cradle to grave") as "emissions" within the physical GHG inventory. Lifecycle GHG emissions include both fossil fuel and industrial emissions and land emissions (i.e., land use change emissions, land management net biogenic CO_2 emissions, land management production emissions, and biogenic product emissions) for all relevant upstream and downstream scope 3 categories associated with the biogenic product. For example, a company that consumes soybean-based renewable diesel in its vehicle fleet must account for all upstream life cycle GHG emissions from soy production, soy processing, renewable diesel production, transportation, and storage. This includes any relevant land use change emissions from conversion of native ecosystems to soy croplands, land management net biogenic CO_2 emissions from any soil degradation on soy croplands, and land management production emissions from fertilizer use, other inputs, and so on. If information on any of the land emissions accounting subcategories required to be reported is incomplete and relevant subcategories are not reported (e.g., a company does not account for and report land use change emissions attributable to the biogenic product), companies must report biogenic product CO_2 emissions as a subcategory within the "land emissions" category (see item two below).

   To ensure accurate accounting of all life cycle GHG emissions associated with the biogenic product, companies are recommended to establish traceability for the biogenic product to, at a minimum, a country of origin (or preferably more precise levels of traceability). Companies do not need to achieve full traceability to LMUs and may use data from third-party databases that are representative of average practices on attributable productive lands within a company's value chain to estimate net land carbon stock changes related to production and consumption activities in the value chain for the biogenic product. If a company cannot establish traceability to at least the country of origin, it should improve its traceability and data quality.

2. **It accounts for and reports land use and land carbon leakage (where required) associated with the biogenic product**. To report biogenic product emissions separately from the physical inventory as "gross CO_2 emissions," a company must account for land use and land carbon leakage (where required) associated

with the biogenic product. In the land sector, where land area is finite and competition for land is increasing, there is a high potential for land carbon leakage, in which displacement of food or feed production drives agricultural land expansion, leading to land use change beyond the lands in a company's operations or value chain. Companies are required to account for land use and land carbon leakage associate with the purchase, consumption, or sale of non-food, non-feed biogenic products and report these values separately from the physical GHG inventory to ensure such global impacts are disclosed in their GHG report. Continuing with the example in item one above, to report biogenic product emissions separately from the physical GHG inventory as "gross CO_2 emissions," the company that consumes soybean-based renewable diesel fin its vehicle fleet must account for the land use and land carbon leakage associated with the production of that crop-based biodiesel.

For accounting requirements and guidance for calculating land use and land carbon leakage, see Chapter 8. If information on land use or land carbon leakage is incomplete (e.g., a company does not account for land carbon leakage for a relevant biogenic product following Requirement 13), companies must report biogenic product CO_2 emissions within the "land emissions" category.

The "biogenic product CO_2 emissions" accounting subcategory is not additive with the "emissions" category due to conceptual double counting between the net land carbon stock changes used to account for land management net biogenic CO_2 emissions (or land management CO_2 removals, if optionally reported) and gross biogenic product CO_2 emissions. Continuing with the example above, the same gross CO_2 emission flux would be counted twice if the carbon stock loss associated with the harvest of the soybean feedstock (a component of the net land carbon stock change used to account for land management net biogenic CO_2 emissions) and biogenic product CO_2 emissions associated with the combustion of the soybean-based renewable diesel were combined and reported in aggregate.

Companies report such emissions within the physical GHG inventory under the accounting subcategory "biogenic product emissions" (within "land emissions") if the reporting company does not meet one or both of the criteria above (i.e., the company does not account for relevant land CO_2 fluxes as part of their lifecycle GHG emissions and/or does not account for land carbon leakage). This accounting subcategory is additive with other emissions in the "emissions" accounting category because if the company does not account for and report relevant land CO_2 fluxes, there is no conceptual double counting between land emissions and gross biogenic product CO_2 emissions.

Biogenic product CO_2 emissions for food and feed products and biogenic waste

Biogenic product CO_2 emissions attributable to food and feed products and biogenic waste are not subject to the conditional general requirement set forth for biogenic products in Requirement 17. Companies that purchase, consume, process, or sell biogenic food and feed products and/or that acquire, use, or dispose of biogenic waste are required to account for and report biogenic product CO_2 emissions separately from the physical GHG inventory under the accounting subcategory "biogenic product CO_2 emissions" within "gross CO_2 fluxes." Companies that follow the GHG Protocol's corporate suite of standards, but for whom the *Land Sector and Removals Standard* does not apply (see Requirement 1), are required to take a similar approach to separately report biogenic product CO_2 emissions.

Accounting for and reporting biogenic product CO_2 emissions from food and feed products intended for human or animal consumption may be excluded. However, companies are still required to account for relevant life cycle GHG emissions, land emissions, land use, and land carbon leakage associated with food and feed products; see Requirement 4. For example, CO_2 emissions from human or animal respiration following food or feed consumption may be excluded when reporting biogenic product CO_2 emissions for food and feed products, but companies would account for life cycle GHG emissions (fossil fuel and industrial emissions, land use change emissions, land management production emissions, etc.), land use, and land carbon leakage (if relevant) associated with food and feed products.

Companies must account for biogenic product CO_2 emissions due to the oxidation (e.g., incineration or decomposition) of waste at the end of life of biogenic products and separately report these emissions as "biogenic product CO_2 emissions" within "gross CO_2 fluxes." For example, a company would account for the emissions from the incineration of biogenic waste or decomposition at a landfill in the scope corresponding to the point of oxidation.

When accounting for any upstream indirect emissions, removals, or other metrics associated with waste prior to its generation of the waste, companies should follow the "Allocation approach for waste" recommendation in Section 6.3. Since most of the upstream life cycle GHG emissions are not allocated to biogenic waste, biogenic waste is not subject to the conditional general requirement set forth for biogenic products in Requirement 17. Note that the allocation recommendation for waste in Section 6.3 is distinct from how companies must account for emissions and other metrics associated with losses and waste of agricultural products (e.g., food loss and waste) that occurred prior to purchase by the reporting company, in scope 3, category 1; see Requirement 3.

Biogenic product CH_4 and N_2O emissions accounting

The combustion, decomposition, and so on, of biogenic products can also release methane (CH_4) and nitrous oxide (N_2O). Companies are required to account for direct and indirect biogenic product CH_4 and N_2O emissions and report them within the physical GHG inventory under the accounting subcategory "biogenic product emissions" within "land emissions," in the scope corresponding to the point of oxidation.

For example, a company that consumes canola oil-based biodiesel in its vehicle fleet would account for the CH_4 and N_2O emissions released to the atmosphere at the combustion of the biodiesel and report these emissions in scope 1 under the subcategory "biogenic product emissions" within "land emissions." Note that biogenic product CH_4 and N_2O emissions are always reported as a subcategory within "land emissions," independent of whether biogenic product CO_2 emissions are reported within "land emissions" or separately within "gross CO_2 fluxes." Generally, biogenic product CH_4 and N_2O emissions released through combustion of a biofuel are relatively small compared to biogenic product CO_2 emissions.

As set forth in Requirement 3, companies should apply global warming potential (GWP) factors from the most recent IPCC Assessment Report, including for biogenic product CH_4 emissions. The IPCC's *Sixth Assessment Report* (AR6) includes 100-year GWP factors for methane from fossil sources and non-fossil sources. The "non-fossil" CH_4 GWP value does not include the oxidation to CO_2 effect as the carbon at issue is either deemed not to be a net addition to the carbon cycle (i.e., of biogenic origin) or already accounted for in CO_2 emissions from the same source.[5] Further guidance on the application of methane GWP is found in the GHG Protocol's *IPCC Global Warming Potential Values* document.[6]

Scope 3 categories relevant to biogenic products

Companies are required to account for all life cycle GHG emissions, land use, and land carbon leakage (where required) attributable to the use of biogenic products and report the upstream life cycle emissions, land use, and land carbon leakage in either scope 3, category 1 or scope 3, category 3 as follows:

- **Biomaterials**: For biomaterials consumed by the reporting company, report upstream life cycle emissions, land use, and land carbon leakage in scope 3, category 1 (Purchased goods and services). For example, a company that uses plant-based packaging materials for the products they sell would need to account for the life cycle GHG emissions associated with those biomaterials in scope 3, category 1. For emissions, this includes cradle-to-gate life cycle GHG emissions from land use change, land management, harvesting, processing, and transportation of biomaterials up to the point of (but excluding) combustion or decomposition.
- **Bioenergy feedstock**: For bioenergy consumed by the reporting company or in the value chain of the reporting company (e.g., sustainable aviation fuel consumed during business travel), report upstream life cycle emissions, land use, and land carbon leakage in scope 3, category 3 (Fuel- and energy-related activities not included in scope 1 or scope 2). For example, a company with a fleet of vehicles that uses ethanol or ethanol-blended fuels would need to account for the life cycle GHG emissions associated with those biofuels in scope 3, category 3. For emissions, this includes cradle-to-gate life cycle GHG emissions from land use change, land management, harvesting, processing, and transportation of bioenergy feedstocks up to the point of (but excluding) combustion or decomposition. Box 11.2 provides an example of how to calculate and report biogenic product emissions for a crop-based sustainable aviation fuel (SAF) value chain.

Note that land use and land carbon leakage (where required) associated with the biomaterial, biofuel, or other biogenic product must also be reported according to the relevant scope 3 category and separately reported from emissions and removals. If companies have traceability to a sourcing region, LMU, or harvested area associated with the lands from which a biogenic product is sourced, they may use primary data collected from suppliers, supply chain coalitions, GHG programs, or other third parties providing data specific to the company's value chain. Where companies have limited traceability, life cycle emission factors and land use factors for biogenic products may be based on secondary data representative of the lands from which the biogenic products were sourced.

Data for biogenic product accounting

To satisfy Requirement 17, companies may use evidence from regulatory programs, certification programs, sustainability programs, or other mechanisms as a basis for providing information on biogenic product sourcing to determine if there are any land use change emissions and land management net biogenic CO_2 emissions on sourcing lands, as pertinent to this requirement. Such mechanisms should include either quantitative information on land use change and land carbon stock changes, or evidence that land carbon stock levels are maintained or strengthened over the long term (e.g., biomass sustainability certification, compliance with regulations or jurisdictional programs verified by national authorities, or independent third-party assurance fulfilling at a minimum ISAE 2000 limited assurance engagement).

Box 11.2 Reporting emissions and other metrics for crop-based sustainable aviation fuel

Consider an airline that purchases and consumes soybean oil-based sustainable aviation fuel (SAF) in the reporting year. The airline has physical traceability to a country of origin for all the soybean SAF feedstocks it consumes in the reporting year. The refined SAF is blended with conventional fossil fuel at a specific blend rate. The airline would report the life cycle emissions, biogenic product emissions, and other metrics associated with the SAF they consume as follows.

Table B11.2-1 Reporting emissions and other metrics for crop-based sustainable aviation fuel

Accounting category/ subcategory	Scope 1	Scope 3
Physical GHG inventory		
Fossil fuel and industrial emissions	Emissions from the combustion of conventional fuel blended with the SAF (calculated based on the specific blend rate of SAF and conventional fuel)	• Average emissions from the extraction, production, transport, and storage of conventional jet fuel • Average emissions from the in-field operation of tractors or other machinery in soybean feedstock production in the country of origin • Average emissions from the transportation of soybean and soybean oil feedstocks, and SAF production, transportation, and storage
Land use change emissions		Land use change emissions on lands attributable to soybean feedstock production based in the country of origin
Land management net biogenic CO_2 emissions		Net carbon stock losses on lands attributable to soybean feedstock production in the country of origin
Land management production emissions		Average emissions from the application of fertilizers and other soil amendments, and other production emissions associated with soybean feedstock production in the country of origin
Biogenic product emissions	Biogenic N_2O and CH_4 emissions from SAF combustion	
Additional accounting categories		
Gross CO_2 fluxes	Biogenic product CO_2 emissions from SAF combustion, reported under the "biogenic product CO_2 emissions" subcategory (*as the company accounted for and reported all lifecycle GHG emissions and land carbon leakage*)	Optional: "Gross biogenic land CO_2 removals" associated with the growth of soybean feedstocks and "gross biogenic land CO_2 emissions" from land-based carbon pools where soy feedstocks are grown
Land use		Land use, reported in hectares, attributable to the production of the soybean feedstocks
Land carbon leakage		Land carbon leakage due to the reduction or diversion of food or feed to produce soybean-based SAF (portion allocated to the soybean feedstock)

Note: a. This example is illustrative and not comprehensive and only highlights accounting categories relevant to SAF production and consumption.

11.4.3 TCDR-based product emissions accounting

The accounting approach for TCDR-based product emissions set forth in Requirement 18 requires companies to report TCDR-based product CO_2 emissions in one of two accounting subcategories, either as "TCDR-based product CO_2 emissions" (as a subcategory under "gross CO_2 fluxes") or as "fossil fuel and industrial emissions" (as a subcategory under "emissions").

TCDR-based product CO_2 emissions accounting

Companies report these emissions separately from the physical GHG inventory under the accounting subcategory "TCDR-based product CO_2 emissions" (within the "gross CO_2 fluxes" accounting category) if the company satisfies the following two criteria:

1. **It has information on the origin of the CO_2 or carbon in the product, demonstrating that the CO_2 is technologically removed CO_2.** To report TCDR-based product emissions separately from the physical GHG inventory as "gross CO_2 emissions," a company must have information that demonstrates the CO_2 or carbon in the product is technologically removed. For example, a company that purchases a concrete mix that is cured with direct-air-captured CO_2 must establish that the CO_2 used in the curing process is technologically removed from the atmosphere via a mechanical or chemical process or is captured biogenic CO_2 (e.g., CO_2 from a direct air capture facility or bioenergy and carbon capture facility). If information on the source of the CO_2 cannot be established, companies must report TCDR-based product CO_2 emissions as a subcategory under the "fossil fuel and industrial emissions" category (see item two below).
2. **It accounts for and reports all life cycle GHG emissions associated with the TCDR-based product in scope 3.** To report TCDR-based product emissions separately from the physical GHG inventory as "gross CO_2 emissions," a company must account for all direct and indirect GHG emissions through the entire TCDR-based product life cycle (i.e., cradle to grave) as "emissions" within the physical GHG inventory. This includes any relevant fossil fuel and industrial emissions during the cement life cycle, land use change emissions from the conversion of native ecosystems to mined lands, and so on. For example, a company that purchases a concrete mix that is cured with direct-air-captured CO_2 must account for all upstream life cycle GHG emissions from raw material extraction, cement production, mixing, transportation, and placement, as well as the GHG emissions from the direct air capture facility allocated to the captured CO_2. If information on any of the emissions accounting categories required to be reported is incomplete (e.g., a company does not account for emissions associated with the direct air capture facility sourcing captured CO_2 used in a TCDR-based product), companies must report TCDR-based product CO_2 emissions as a subcategory under the "fossil fuel and industrial emissions" category.

Companies report such emissions as "fossil fuel and industrial emissions" (as a subcategory under "emissions") if the reporting companies do not meet one or both of the criteria above.

If the TCDR-based product contains carbon from captured biogenic CO_2 that is not classified as waste or recycled content (see Section 11.4.5), companies are required to account for the full life cycle emissions, land use, and land carbon leakage (where required) associated with the fraction of captured biogenic CO_2 in the TCDR-based product, following Requirement 17.

To separately report TCDR-based product emissions under "gross CO_2 fluxes" following Requirement 18 and to satisfy the reporting requirements in Section 6.2.2, companies are required to report information demonstrating the origin of the captured CO_2, such as chain of custody documentation to the facilities or other assets where the TCDR-based carbon was removed from the atmosphere (or biogenic CO_2 was captured).

11.4.4 Policy implications of the accounting approach for biogenic product emissions in this Standard

The accounting requirements for biogenic product emissions in this *Standard* take a similar approach to the IPCC *Guidelines for National GHG Inventories*, which states that "IPCC Guidelines do not automatically consider or assume biomass used for energy as 'carbon neutral', even in cases where the biomass is thought to be produced sustainably" and that separate reporting of biogenic CO_2 emissions in different inventory categories "should not be interpreted as a conclusion about the sustainability or carbon neutrality of bioenergy."[7]

This *Standard* does not assume biofuels or other bioenergy feedstocks are "carbon neutral." Instead, companies are required to account for and report all GHG emissions in the life cycles of biogenic products, as well as land use and land carbon leakage (see Chapter 8) associated with such biogenic products. The separate reporting of biogenic product CO_2 emissions required by this *Standard* means that biogenic product CO_2 emissions are important and should be managed.

This *Standard* is not intended to be used to design or assess public policy but instead for annual, entity-level accounting and reporting of GHG emissions, removals, and other metrics. Similar to the approach taken by the IPCC, the accounting approach to biogenic product CO_2 emissions in this *Standard* is not meant to be interpreted as a conclusion about the sustainability or carbon neutrality of bioenergy or biogenic products.

11.4.5 Accounting for emissions of biogenic wastes

No allocation for waste generated in production

Waste is an output of a process or system that has no market value. If a production system or process produces waste, no emissions, removals, or other metrics from the system or process should be allocated to the waste. The company sourcing the waste should not account for any upstream indirect emissions, removals, or other metrics associated with the waste within their scope 3, prior to the generation of the waste. All emissions, removals, and other metrics from the system should instead be allocated among that system's other outputs. Note that this allocation guidance for waste is distinct from how companies must account for emissions and other metrics associated with the losses and waste of agricultural products (e.g., "food loss and waste") that occurred prior to purchase by the reporting company, in scope 3, category 1; see Requirement 3.

For example, bioenergy can be produced from various feedstocks, including waste from agricultural and other land systems. The emissions, removals, land use, and land carbon leakage in the life cycle of bioenergy feedstocks are accounted for like other agricultural products, following the allocation recommendations in Chapter 6 of this *Standard* and the *Scope 3 Standard*. These recommendations include the "Allocation approach for waste and recycled material" in Section 6.3 of this *Standard*.

Upstream indirect emissions, removals, and other metrics should not be allocated to biogenic waste outputs of a system or process. For example, agricultural residues acquired by a company that have no market value are allocated no upstream GHG emissions due to the production of agricultural products on the farm(s) that also resulted in those waste outputs. These upstream GHG emissions would be allocated entirely to other products sold (i.e., crops with a market value) by that farm. In other words, when accounting for the life cycle emissions of a biogenic waste product, the company does not account for upstream land emissions, land management CO_2 removals, land use, and land carbon leakage associated with waste within their scope 3, prior to the generation of the waste.

Reporting biogenic product emissions from waste

However, a company must still account for and report all life cycle GHG emissions associated with the biogenic waste *after* the point of waste collection (e.g., fossil fuel and industrial emissions associated with transportation, storage, and manufacturing processes to which the waste is an input). Companies must also report biogenic product CH_4 and N_2O emissions from the oxidation (e.g., combustion or decomposition) of the waste under the accounting subcategory "biogenic product emissions" within "land emissions" and report biogenic product CO_2 emissions separately from the physical GHG inventory under the accounting subcategory "biogenic product CO_2 emissions" within "gross CO_2 fluxes" (see Requirement 17).

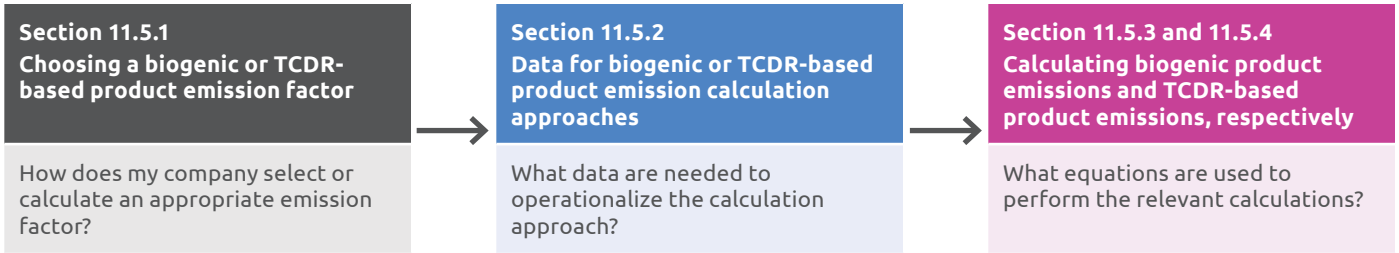
Reporting recycled product emissions

Under the recycled content allocation method (see Section 6.3), the use of recycled material is not associated with any emissions, removals, or other metrics upstream of the recycling process. All subsequent GHG emissions in the life cycle of the recycled biogenic material (beginning with and including the recycling process) are accounted for and reported, including biogenic product CH_4 and N_2O emissions reported as biogenic product emissions (as a subcategory under "land emissions" and biogenic product CO_2 emissions reported separately, as a subcategory under "gross CO_2 fluxes"). Companies may use the recycled content allocation method for post-consumer waste that is recycled (e.g., used cooking oil, recovered fiber) or reused (e.g., used clothing that is resold) regardless of the market value of the waste. As set forth in the reporting requirements in Section 6.2.2, companies applying the recycled content allocation method are required to report evidence both that the waste is post-consumer and that it has been reused or recycled.

11.5 Calculating biogenic product TCDR-based product emissions

Figure 11.4 provides an overview of the calculation guidance in Section 11.5.

Figure 11.4 Overview of Section 11.5



11.5.1 Choosing a biogenic or TCDR-based product emission factor

When calculating biogenic product CO_2 emissions, an emission factor is needed that corresponds to the type and application of biogenic product. To satisfy Requirement 17, companies in some instances report biogenic product CO_2 emissions separately from biogenic product N_2O, CH_4, and other non-CO_2 GHGs (see Figure 11.1). To satisfy this conditional separate reporting, separate emission factors are needed that allow for the disaggregation of biogenic product emissions by type of GHG (e.g., separate emission factors for biogenic product CO_2, N_2O, and CH_4). When calculating TCDR-based product CO_2 emissions, an emission factor is needed that corresponds to the type and application of TCDR-based product.

Companies should use the most representative emission factors that reflect the specific type of product or material, its carbon content, and the relevant source process (e.g., stationary combustion, mobile combustion, decomposition in landfills, etc.).[8]

11.5.2 Data for calculating biogenic product and TCDR-based product emissions

Tables 11.3 and 11.4 provide a general overview of the types of data needed to estimate biogenic product or TCDR-based product emissions.

Table 11.3 Data for calculating and reporting biogenic product emissions

Data	Description
Biogenic product emission factor	An emission factor corresponding to the type and application of biogenic product. To satisfy Requirement 17, companies in some instances report biogenic product CO_2 emissions separately from biogenic product N_2O, CH_4, and other non-CO_2 GHGs. To satisfy this separate reporting, an emission factor is needed that allows for the disaggregation of biogenic product emissions by type of GHG.
Fraction of total product carbon of biogenic origin	To account for biogenic product CO_2 emissions, information is needed on the fraction, on a mass basis, of the biogenic carbon in the product. Some products include carbon of both biogenic and fossil origin, and the CO_2 emissions from the combustion, decomposition, and so on, of carbon in such products are reported separately in the inventory depending on the carbon's origin.

Table 11.4 Data for calculating TDCR-based product emissions

Data	Description
TCDR-based product emission factor	Emission factor corresponding to the type and application of the TCDR-based product.
Fraction of total product carbon of TCDR-based origin	To account for TCDR-based product CO_2 emissions, information is needed on the fraction, on a mass basis, of the TCDR-based carbon in the product. Some products include carbon of both TCDR-based and fossil origin, and the CO_2 emissions from the combustion, decomposition, and so on, of carbon in such products are reported separately in the inventory depending on the carbon's origin.

11.5.3 Calculating biogenic product emissions

Equation 11.1 is used to calculate biogenic product CO_2 emissions. A similar approach can be applied to calculate biogenic product CH_4 and N_2O emissions. Biogenic product emission factors reflect the gross biogenic GHG emissions released to the atmosphere through combustion, decomposition, or other processes, by type of biogenic product. Companies should use the most representative emission factors that reflect the specific type of product or material, its carbon content, and the relevant source process (e.g., stationary combustion, mobile combustion, decomposition in landfills, etc.).

Equation 11.1 Biogenic product CO_2 emissions

$$CO2\_BP\_GE = M \times f\_B \times EF\_BPCO2$$

Description		Unit	Source
$CO2\_BP\_GE$	Gross biogenic product CO_2 emissions	tonnes biogenic CO_2	Calculated
M	Mass of biogenic product	tonnes product $(year)^{-1}$	User input
f_B	Fraction of total product carbon of biogenic origin	tonnes biogenic C (tonnes product C)$^{-1}$	User input or default value
EF_BPCO2	CO_2 emission factor, based on the type of the product and application	tonnes CO_2 (tonnes product)$^{-1}$	User input or default value

For raw materials and products containing only biogenic carbon and no fossil or TCDR-based carbon (e.g., food or feed crops; animal products; forest products; or other raw materials grown on croplands, grasslands, or forest lands), the fraction of the total product carbon of biogenic origin in Equation 11.1 is 1. For intermediate or final products containing carbon of different origins (i.e., biogenic, fossil, and/or TCDR-based carbon), companies should determine the fraction of the total product carbon content that is of biogenic origin. For example, for a fuel blend with 10 percent maize ethanol (by volume, i.e., E10), the fraction of total product carbon that is of biogenic origin would be the biogenic carbon content of the ethanol (by weight) divided by the total product C content of the fuel (biogenic plus fossil carbon, by weight).

11.5.4 Calculating TCDR-based product emissions

Equation 11.2 is used to calculate TCDR-based product CO_2 emissions. TCDR-based product emission factors reflect the gross GHG emissions released to the atmosphere through combustion, decomposition, or other processes, by type of product containing carbon derived from technological CO_2 removals. Companies should use the most representative emission factors that reflect the specific type of product or material, its carbon content, and the relevant source process (e.g., stationary combustion, mobile combustion, decomposition in landfills, etc.).

Equation 11.2 TCDR-based product CO_2 emissions

$$CO2\_TP\_GE = M \times f\_T \times EF\_TPCO2$$

Description		Unit	Source
$CO2\_TP\_GE$	Gross TCDR-based product CO_2 emissions	tonnes TCDR-based CO_2	Calculated
M	Mass of TCDR-based product	tonnes product $(year)^{-1}$	User input
f_T	Fraction of total product carbon originating from TCDR processes	tonnes TCDR-based C (tonnes product C)$^{-1}$	User input or default value
EF_TPCO2	CO_2 emission factor, based on the type of the product and application	tonnes CO_2 (tonnes product)$^{-1}$	User input or default value

Companies are also required to account for all emissions in the life cycle of the TCDR-based product, including any process or fugitive emissions at the TCDR facility (e.g., a direct air capture facility). These life cycle emissions are distinct—and accounted separately—from TCDR-based product CO_2 emissions released at the point of oxidation of the product. When calculating emissions from TCDR facilities in the life cycle of TCDR-based products, companies should follow the guidance in Box 11.3.

Box 11.3 Life cycle emissions associated with TCDR-based products

When accounting for emissions from facilities in the life cycle of TCDR-based products that remove CO_2 from the atmosphere or capture biogenic CO_2, the following emission sources are accounted for and reported as "fossil fuel and industrial emissions" in the relevant scope:

- Emissions from the onsite use of fossil fuels to operate support equipment for the CO_2 capture and compression facilities.
- Emissions from purchased electricity and thermal energy used to operate the CO_2 capture and compression system.
- Fugitive emissions from fossil fuels that are released during the capture, compression, storage, and distribution processes.

Fugitive emissions of CO_2 derived from biological or technological sinks that have not been captured in the capture process, including emissions from the venting of CO_2 during capture and compression and the fugitive release of CO_2 during capture, compression, storage, and distribution, are reported as gross biogenic product CO_2 emissions or TCDR-based product emissions. Vented and fugitive emissions from capturing and compressing CO_2 include both intentional and unintentional releases. CO_2 may be vented during normal operation, process upsets, or shutdowns. Fugitive emissions may arise from the leaking (i.e., fugitive emissions) of CO_2 from equipment such as flanges, valves, and flow meters.

Endnotes

1 For example, CO_2 emission factors for coal are up to 103 kg CO_2 per MMBtu (one million British thermal units) and for petroleum products up to 76 kg CO_2 per MMBtu. CO_2 emission factors for wood and other solid byproducts are up to 105.51 kg CO_2 per MMBtu, and for other liquid biomass fuels up to 81 kg CO_2 per MMBtu. See EPA (2013).

2 Recommended emission factor databases to calculate biogenic product CO_2 emissions are provided in Chapter 11 of the *Guidance*. See Section 11.5.1.

3 This text includes elements that may change to align with the resolution on forest carbon accounting in future versions of this *Standard*. See Box 9.1.

4 This criterion is recommended for agricultural products. Whether it is recommended or required for forest products may be revisited in a future version of the *Standard*.

5 For a discussion on this topic, see Gillenwater and Benchimol (2024).

6 WRI and WBCSD 2024.

7 IPCC n.d. See "Frequently Asked Questions," Question 2-10. Task Force on National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/faq/faq.html.

8 Emission factors can be found in the IPCC *Emission Factor Database* (https://www.ipcc-nggip.iges.or.jp/EFDB/main.php), IPCC *Guidelines for National Greenhouse Gas Inventories* (https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html), the GHG Protocol website (https://ghgprotocol.org/calculation-tools), life cycle inventory databases, and other sources in the list of land sector calculation tools and resources available at https://ghgprotocol.org/land-sector-and-removals-guidance.

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