

Carbon Accounting for Long-Lived Operating Assets

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The Carbon Accounting Standards Initiative (CASI)

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Executive Summary

Companies around the world increasingly seek to account for the carbon emissions embodied in the assets used to produce goods and services. For long-lived operating assets, those embodied emissions are recognized when the asset is acquired or constructed. This whitepaper articulates a standard for recognizing and measuring the CO₂ embodied in long-lived assets. Consistent with the historical-cost perspective that governs financial accounting for property, plant, and equipment, the standard calls for the capitalization of the emissions embodied in an acquired asset as its initial CO₂ book value and the subsequent amortization (depreciation) of that book value over the asset's useful life. When the use of the asset is causally linked to the production of specific goods and services, the periodic amortization charges become part of the cradle-to-gate product carbon footprints of those products and therefore are included in the entity's current or future Net CO₂-Contribution. If no such causal link can be established, the emissions embodied in the asset are also capitalized, but the periodic amortization charges are applied to the entity's current Net CO₂-Contribution. An example extends the numerical illustration of CASI Whitepaper No. 2 to a setting in which new machinery is acquired.

Preface

This standard addresses the recognition and measurement of carbon emissions embodied in operating assets whose useful lives extend over multiple accounting periods. Machinery, equipment, buildings, and transportation vehicles are applicable examples. In contrast to consumable production inputs, such as materials or purchased electricity, long-lived assets enable and support the production of goods and services over multiple periods. In accordance with the core principles of Completeness, Timely Recognition, and Temporal Consistency (Whitepaper No. 2), these emissions are not charged entirely in the period when the entity assumes control of the asset but instead are prorated among the periods in which the asset is productive.

The treatment developed here builds on the foundations of Integrated Corporate Carbon Accounting (ICCA) set out in CASI Whitepaper No. 1 and on the double-entry bookkeeping architecture for CO₂-statements set out in CASI Whitepaper No. 2. The unit of measurement is tons of CO₂ equivalent (tCO₂e).

CASI Standard on Long-Lived Assets

When an entity assumes control of a new long-lived operating asset, an ICCA system adopts three accounting constructs.

1. The entity records (debits) the CO₂ embodied in the acquired asset in an account on the left-hand side of the CO₂-balance sheet. The corresponding credit is recorded in the account Indirect Emissions Transferred In, thereby adding to the entity's indirect (Scope 2 and upstream Scope 3) CO₂ liabilities. The recorded figure becomes the initial CO₂ book value of the asset.
2. The entity assesses a useful life for the asset, that is, the number of accounting periods over which the asset is expected to be productive.
3. The entity chooses an amortization schedule for the asset. This schedule has the property that the amortization charges, summed over the useful life, equal the initial CO₂ book value.

In accordance with the ICCA Core Principles of Completeness, Timely Recognition, and Temporal Consistency (CASI Whitepaper No. 1), these constructs ensure that the emissions embodied in long-lived assets are recognized when the entity assumes control of the asset. Further, the subsequent amortization charges are prorated among the periods in which the asset is expected to remain productive.

Recognition and initial measurement

The initial CO₂ book value is determined from the best available data, in accordance with the following preference hierarchy. As a first preference, the entity uses a supplier-specific figure for which the supplier's carbon auditor, a certified independent third party, has provided assurance that the figure was assessed in accordance with carbon accounting standards commensurate with those articulated by CASI or with the applicable ISO rules for life-cycle assessment (LCA). Where an assured supplier figure is not available, the entity uses an unassured supplier-specific figure, such as a supplier declaration or an environmental product declaration, subject to a plausibility review. Where no supplier-specific figure is available, the entity uses a recognized default or industry-average emission factor. Where none of these is available, the entity conducts its own LCA in accordance with the applicable ISO rules. The entity discloses which level of the preference hierarchy has been applied.

Useful life

The default choice for the useful life of the asset is the figure the entity applies for financial accounting purposes. An alternative useful life requires justification based on comparable data for similar assets and acceptance by the entity's carbon auditor.

Amortization schedule

The straight-line rule is the default choice for the periodic amortization charges. When the amortization charges are based on the passage of calendar time, this standard does not permit accelerated or decelerated schedules. For some operating assets, the expected degradation of the asset is tied to usage, for example, the cumulative number of operating hours. In such cases, the periodic amortization charge may be based on the actual usage in the period relative to the total usage expected over the asset's life.

Inventoriable versus periodic amortization charges

The periodic amortization charges are applied in one of two ways. (1) When the asset can be linked, on a causal basis, to the production or delivery of the entity's sales products, the charges are inventoriable, and the entity applies them to its work-in-process accounts, where they remain on the asset side of the CO₂-balance sheet until the corresponding products are sold. (2) When the asset cannot be linked to the production of specific products, the charges are periodic, and the entity applies them to its pool of General and Administrative emissions and charges them to the current Net CO₂-Contribution (NCC).

Treating amortization charges as inventoriable mirrors the financial accounting for operating assets, where the depreciation of plant and equipment is a product cost that enters inventory and is recognized in cost of goods sold when the product is sold (IAS 16; IAS 2). Inventoriable carbon amortization charges follow the path of any other production-related emissions. They pass from work-in-process to finished goods, where they become an upstream Scope 3 component of the cradle-to-gate PCFs of the entity's products. These emissions are therefore recognized in the NCC as part of Carbon Emissions in Goods Sold (CEGS), in the period in which the products are sold.

For operating assets whose use cannot be causally linked to sales products, for example, machinery used for R&D facilities or corporate jets, this standard calls for capitalizing the embodied emissions and subsequently expensing the periodic amortization charges as part of General and Administrative emissions. Such an accounting treatment nonetheless permits the calculation of full-cost cradle-to-gate PCFs. To do so, the partial-cost PCFs, which emerge as some direct or indirect emissions are included in the account General and Administrative emissions, are marked up by a common factor given by the ratio of General and Administrative emissions to CEGS. Thus, lacking a causal basis for assigning General and Administrative emissions, the entity effectively charges these emissions in proportion to their partial-cost PCFs to obtain full-cost PCFs.

CO₂ book values over time

Let the initial CO₂ book value of the asset be denoted by $B(0)$, while the amortization charge recognized in period t is denoted by $d(t)$, for $t = 1, \dots, T$, where T denotes the useful life measured in accounting periods. Amortization schedules satisfy

$$d(1) + d(2) + \dots + d(T) = B(0).$$

Thus, the amortization charges, summed over the useful life, are equal to the initial book value. The CO2 book value at the end of period t , denoted by $B(t)$, equals the beginning-of-period book value, $B(t-1)$, less the amortization charge in period t ,

$$B(t) = B(t-1) - d(t).$$

Under the straight-line rule, the amortization charge in each period is constant, that is, $d(t) = B(0) / T$. Therefore, the book value declines in equal increments to zero at the end of the useful life.

Default rule

For carbon accounting issues concerning long-lived operating assets that are not explicitly addressed by this standard, the entity may apply rules that are the carbon accounting equivalent of financial accounting rules prescribed under IAS 16, Property, Plant and Equipment.

Discussion

Materiality. The emissions embodied in long-lived assets that do not appear to be material in terms of CO₂ content need not be capitalized. Accordingly, such long-lived assets may be omitted from the CO₂-balance sheet, provided the total embodied emissions of the assets deemed to be CO₂ immaterial do not exceed 3% of the entity's total upstream Scope 3 emissions in either the previous or the current accounting period. The emissions for assets that are deemed immaterial are fully expensed in the period in which the entity assumes control of these assets.

Use-phase emissions. Long-lived assets may give rise to emissions while they are in use. A combustion engine emits CO₂ as it burns fuel, and a machine draws electricity as it operates. Use-phase emissions are distinct from embodied emissions and are recognized in the period in which they occur. Emissions from fuel combustion at the entity's own facilities, for instance, are direct (Scope 1) emissions. Emissions embodied in purchased electricity used to operate the asset are indirect (Scope 2) emissions. These emissions are charged in the period in which they are incurred to either the Work-in-Process (WIP) accounts or to the account General and Administrative emissions, thereby adding to the current Net CO₂-Contribution.

Asset impairment or retirement. An asset may lose its productive capacity before the end of its estimated useful life, for example, through damage or obsolescence. The entity may also scrap or retire an asset without transferring it to another party. In each of these cases, the entity charges the remaining CO₂ book value of the asset to General and Administrative emissions in the current Net CO₂-Contribution. The asset's carbon book value is thereby written down, in the period of the event, as its embodied emissions are no longer expected to be charged to future production.

Subsequent sale or transfer. An entity may transfer a long-lived operating asset to another firm before the end of the asset's useful life. When dealing in such assets is not part of the entity's normal (ordinary) business activities, the transfer is not an ordinary operating transaction. Its carbon effect is therefore recognized in Other Comprehensive Emissions (OCE); see revised WP No.2 and the example below. The selling entity removes the remaining book value from its CO₂-balance sheet and recognizes the same amount in OCE. The sum of the Net CO₂-Contribution and OCE becomes the entity's change in legacy Emissions on the CO₂-Balance Sheet.

Self-constructed assets. Some entities construct long-lived assets — such as buildings, production plants or data centers — rather than acquire them ready for use. For such assets, the embodied emissions are not given by a single supplier figure but accumulate over the construction period as the entity incurs them: the upstream emissions embodied in purchased materials and equipment, the emissions embodied in purchased energy consumed on site, and the direct emissions of construction activity at the entity's own facilities. These emissions accumulate in a construction-in-progress account on the asset side of the CO₂-balance sheet, in the same way that financial accounting accumulates the cost of an asset under construction before it is placed in service. Each input is measured

under the preference hierarchy set out for initial recognition, and the entity discloses the level of the hierarchy applied. Only emissions directly attributable to bringing the asset to the condition necessary for its intended use are capitalized. Prior to the asset becoming productive, no amortization is recognized. On commissioning, when the asset is ready for its intended use, the accumulated balance becomes the asset's initial CO2 book value, and amortization begins under the standard's normal rules for useful life and amortization schedule. Consistent with the historical-cost perspective of this standard, the emission factor applied to each input is the best available factor at the time the input is physically incorporated into the asset and is not revised thereafter; where construction spans several years, the factors for inputs not yet incorporated may be updated as better data become available.

Capital improvements. Carbon emissions incurred in order to improve or expand a long-lived asset may be capitalized. Emissions embodied in a capital improvement are added to the CO2 book value of the asset and are amortized over the asset's remaining useful life, in the same way as the asset's original embodied emissions. The emissions embodied in activities that merely maintain an asset are treated as use-phase emissions of the period in which they are incurred. Where a capital improvement is itself constructed by the entity, the embodied emissions are accumulated in the same way as for self-constructed assets before being added to the asset's CO2 book value.

Owned versus leased assets. The accounting for emissions in long-lived assets reflects the horizon over which the entity holds the right to use the asset. An entity that owns the asset capitalizes its full embodied emissions and amortizes them over the asset's useful life. An entity that leases the asset capitalizes only the share of the embodied emissions that corresponds to the lease term, equal to the embodied emissions multiplied by the ratio of the lease term to the asset's useful life, and amortizes that amount over the lease term. At lease inception, the lessor reduces its CO2 book value by the lessee's share, which the lessee recognizes as the initial book value of its right-of-use position. The lessor retains the remaining embodied emissions on the asset side of its CO2-balance sheet, does not amortize this residual during the lease term, and resumes amortization over the remaining useful life when the asset is returned at the end of the lease. The lessee's and lessor's amortization amounts always sum to the asset's original embodied emissions. Use-phase emissions are recognized in each period by the entity that operates the asset.

Transition. For long-lived assets already in use at the date of adoption of this standard, the entity establishes opening CO2 book values from the best available evidence, such as prior greenhouse gas disclosures or reconstructed estimates of the assets' embodied emissions and remaining useful lives. Where such evidence is not available, or where the asset is immaterial under the rule above, the entity may assign the asset an opening CO2 book value of zero. The entity shall disclose the basis for establishing the opening balance.

Relation to GHG Protocol and other existing industry guidelines. This standard differs from the Corporate Value Chain (Scope 3) Standard of the GHG Protocol, which includes the emissions embodied in acquired long-lived assets in the year of acquisition (Scope 3, Category 2) as part of the entity's current corporate carbon footprint measure. The two

approaches differ in timing but lead to identical total NCC figures over the lifetime of the acquired asset. The accounting treatment prescribed by this standard ensures that PCFs and NCC statements are not subject to shocks resulting from the acquisition of new CO₂-intensive production assets.

This standard also departs from the recommendations issued by the Product Life Cycle Accounting and Reporting Standard of the GHG Protocol (2011), the Catena-X Product Carbon Footprint Rulebook, and the recommendations provided by Together for Sustainability (TfS). The guidelines issued by these organizations recommend that emissions embodied in fixed assets be excluded from the PCFs of an entity's sales products. PCFs would then only reflect the CO₂ emissions in materials, energy, and applicable direct emissions, but not the emissions embodied in plant, machinery and buildings. In contrast, the standard developed here specifies that embodied emissions in assets that are causally linked to production be included in PCFs, subject to amortizing these emissions over the useful life of the asset.

Modified Boundaries for Determinating PCFs

Current LCA practice, ISO 14067 and industry guidance provided by PACT, CatenaX and TfS were built on the current GHG Protocol concept where the emissions for long lived assets (mainly scope 3.2) are typically reported as part of the Corporate Carbon Report in the period of purchase (or construction) of these assets. However, there is generally no causal temporal link between the emissions embodied in acquired capital goods and the products produced and sold in that period. By applying ICCA and amortizing the emissions embodied in capital goods, companies will attribute emission charges to the periods of the use phase of the assets. This will generally reduce the volatility of the reported corporate carbon footprints.

The recommended change in the determination of PCFs will require a careful transition and possibly a “defined starting date” in order to ensure continuity in supplier/customer relationships and a continued level playing field in goods and services markets, where reported PCFs are already a substantial procurement criterion. By analogy, the inclusion of the so-called “methane slip” (methane leakage) in the PCFs of natural gas based products became the new prevalent standard after scientific studies established the methane slip as a significant contribution in emissions to products derived from natural gas. But without transparent communication at all stakeholder levels that a methodological change in the determination of the PCFs for natural gas based products was warranted, the trust in PCFs and corporate carbon accounting would have been compromised.

As described in Whitepaper No. 2, companies can implement ICCA by calculating PCFs either on a full- or partial cost basis, provided any non-inventoriable emissions are charged to the Net CO₂-Contribution. Therefore, until the above mentioned “defined starting date” for the calculation of PCFs in accordance with this standard, ICCA can be implemented with companies maintaining their current narrower boundaries for determining PCFs and charging the amortized emissions embodied in long-lived assets directly to the Net CO₂-Contribution.

Illustrative Example

To illustrate the standard, we extend the numerical example of CASI Whitepaper No. 2. That example considers an imaginary company, GOCASI Ltd. , which produces two product lines, A and B, in a two-step process. GOCASI's opening CO₂-balance sheet for 2026 coincides with its closing balance sheet for 2025 (CASI Whitepaper No. 2, Table 3). On that balance sheet, the account Machinery and Equipment carries a balance of 165 tCO₂e.

At the start of 2026, GOCASI acquires a new machine. The supplier provides an assured PCF for the machine of 120 tCO₂e, which becomes the machine's initial CO₂ book value. GOCASI assesses the useful life at four years and adopts the straight-line rule, so that the annual amortization charge is $120 / 4 = 30$ tCO₂e. The machine processes both product lines, and each unit of A and each unit of B requires the same processing time on the machine.

Acquisition. GOCASI records the machine's embodied emissions on its CO₂-balance sheet. This entry debits Machinery and Equipment by 120 tCO₂e and credits Indirect Emissions Transferred In by 120 tCO₂e (journal entry JE-1). The acquisition raises the carbon embodied in the entity's operating assets and the matching liability by the same amount. It does not affect the current Net CO₂-Contribution.

Amortization. During 2026, GOCASI processes 400 units of A and 200 units of B on the machine. Because the machine is causally linked to the production of these units, the amortization charge is inventoriable. The annual charge of 30 tCO₂e is spread over the 600 units processed, all of which require the same processing time, for a uniform charge of $30 / 600 = 0.05$ tCO₂e per unit. The amortization entry debits Work-in-Process A by $400 \times 0.05 = 20$ tCO₂e and Work-in-Process B by $200 \times 0.05 = 10$ tCO₂e, and credits Machinery and Equipment by 30 tCO₂e (journal entry JE-2). These debits and credits remain on the asset side of the balance sheet.

Table 1 records the two journal entries in the format of the transactions tableau of CASI Whitepaper No. 2.

Table 1. Transactions tableau for the new machine, 2026 (tCO₂e).

Entry	Machinery and Equipment	Work-in-Process A	Work-in-Process B	Indirect Emissions Transferred In
JE-1 Acquisition	+120			+120
JE-2 Amortization	-30	+20	+10	
Net change, 2026	+90	+20	+10	+120

In Table 1, the columns Machinery and Equipment, Work-in-Process A and Work-in-Process B are asset accounts, and Indirect Emissions Transferred In is a liability account.

The carbon amortization charges pass from work-in-process into finished goods and, when the corresponding units are sold, into Carbon Emissions in Goods Sold. They thereby become part of the cradle-to-gate PCFs of the two product lines. Table 2 shows the effect on the 2026 PCFs, relative to the 2025 figures reported in CASI Whitepaper No. 2.

Table 2. Effect of the new machine on the 2026 cradle-to-gate PCFs.

	Product A	Product B	Total
Units processed on the machine, 2026	400	200	600
Amortization charge allocated (tCO ₂ e)	20	10	30
Amortization charge per unit (tCO ₂ e)	0.05	0.05	
2025 cradle-to-gate PCF (tCO ₂ e per unit)	3.00	0.70	
2026 cradle-to-gate PCF (tCO ₂ e per unit)	3.05	0.75	

At the end of 2026, the machine's CO₂ book value is its initial book value less the first year's amortization, 120 - 30 = 90 tCO₂e. This balance will be charged to production over the machine's three remaining years of service. Table 3 shows the updated book value at the end of the calendar year.

Table 3. CO₂ book value of the new machine (tCO₂e).

Item	tCO ₂ e
Initial CO ₂ book value, 1 January 2026	120
Amortization, 2026	(30)
CO ₂ book value, 31 December 2026	90

Subsequent sale. To illustrate the accounting for a sale, suppose that at the start of 2027, GOCASI sells the machine to another manufacturer when the remaining CO₂ book value is 90 tCO₂e. Selling used machinery is not part of GOCASI's ordinary business activities, so the carbon effect is recognized in *Other Comprehensive Emissions* (OCE). GOCASI debits OCE by 90 tCO₂e and credits Machinery and Equipment by 90 tCO₂e (journal entry JE-3). The buyer debits its own Machinery and Equipment account by 90 tCO₂e and credits Indirect Emissions Transferred In by 90 tCO₂e. The 90 tCO₂e leaves GOCASI's CO₂-balance sheet without affecting its Net CO₂-Contribution (NCC) for 2027. However, GOCASI adds the sum of its NCC for 2027 and OCE to its CO₂-balance sheet account "Legacy Emissions" for 2027.

Appendix: Other Comprehensive Emissions

Note. This appendix introduces Other Comprehensive Emissions as an extension of the CO₂-statement architecture set out in CASI Whitepaper No. 2.

According to CASI Whitepapers No. 1 and No. 2, a company's Net CO₂ Contribution (NCC) reflects the direct and upstream indirect emissions that were incurred by a company and its suppliers in producing and delivering the company's current product sales. If there are significant emissions resulting from transactions that are not part of the company's ordinary business operations, these emissions should be recorded as a separate line item rather than as part of the Net CO₂-Contribution figure. In analogy to Other Comprehensive Income, we refer to this line item as Other Comprehensive Emissions (OCE).

OCE is a carbon contribution account that, like the Net CO₂-Contribution, begins and ends each period with a zero balance. It records the carbon effect of events that the applicable CASI standards classify as lying outside the entity's ordinary operating activities. At the end of the period, the combined Net CO₂-Contribution and OCE are closed to the Legacy Emissions account. OCE is not shown as a separate account on the CO₂-balance sheet.

The sum of the Net CO₂-Contribution and OCE for the period is the Combined Change in Legacy Emissions.

$$\begin{array}{l} \text{Change in Legacy Emissions in period } t \\ \hline \text{Net CO}_2\text{-Contribution (NCC)} \\ + \text{Other Comprehensive Emissions (OCE)} \\ = \text{Combined Change in Legacy Emissions} \end{array}$$

The introduction of OCE ensures that Net CO₂-Contribution remains a measure of the entity's Cradle-to-Gate Corporate Carbon Footprint. Transactions and events to be reflected in OCE will be specified in subsequent CASI standards. Under the standard for long-lived operating assets, the only such event is the transfer of a long-lived operating asset to another firm provided such transactions are not part of the entity's ordinary business operations.

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