National tiered greenhouse gas emissions limits for steel construction products

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Background

Steel plays a key role in the construction of many structures due to its unique physical properties, but it can be a major contributor to the greenhouse gas (GHG) emissions associated with the construction of buildings and infrastructure assets. Many built assets contain substantial amounts of steel. Their production is energy intensive and can involve chemical reactions that emit significant quantities of carbon dioxide. As construction of our built environment is a key source of GHG emissions both globally and in Canada, there is a need to address the GHG emissions associated with the steel used in construction.

By establishing limits on the GHG emissions footprint (i.e., the embodied carbon) of steel products, construction projects can meaningfully reduce their environmental impact while driving demand for low-carbon material manufacturing and strengthening Canada's path toward meeting its climate commitments.

Intent

This document establishes limits on the procurement of commonly used categories of structural and reinforcement steel products, as well as relevant semi-finished precursors, based on the GHG emissions associated with their production. These limits support compliance with the *Standard on Embodied Carbon in Construction* for major federal construction projects and may be referenced in embodied carbon requirements by other Canadian jurisdictions and organizations.

Definitions

Embodied Carbon (EC) is the emissions associated with the creation of a product or asset. For the purposes of this document, it is an environmental indicator used to describe the climate-related environmental impacts of a product or asset. As an output of a life cycle assessment (LCA) such as an Environmental Product Declaration (EPD) it is represented as the product or asset's Global Warming Potential (GWP) and expressed in terms of tonnes or kilograms of carbon dioxide equivalent (tCO2e or kgCO2e).

Primary Steel is steel whose iron content is derived from the reduction of iron (or ilmenite) ore. Pig iron, direct reduced iron and hot briquetted iron are examples of primary iron for making primary steel.

The ***Primary Steel Adjustment Factor*** represents the embodied carbon of best-in-class primary steel and is the maximum value that may be deducted from the embodied carbon of a product proportionate to its primary steel content.

Primary Steel Credit is the value that may be deducted from the embodied carbon of a product by applying the primary steel adjustment factor to the product's primary steel content.

Secondary Steel is steel made from recycled materials, typically from metal scrap.

Project Authority for the purposes of this document is the business owner or regulatory body whose embodied carbon requirements apply to the project.

Unfabricated Steel or Unfabricated Product is a steel product that has undergone some form of rolling process but still needs further transformation prior to its installation on a construction site.

1. National tiered limits

The limits established in this document are applicable to the procurement of steel products for projects located in Canada[1] and do not apply to product categories that are not listed in Table 1. These limits are also referred to as Embodied Carbon limits (EC limits) and are measured in kilograms of carbon dioxide equivalent per metric tonne (kg CO2e/*t*) of steel. The tiered structure of the limits:

- incentivizes the procurement of products that have the lowest embodied carbon while providing flexibility for projects where limited options are available
- includes a primary steel adjustment factor to encourage procurement of lower embodied carbon product derived from either primary or secondary steel production methods

Table 2 includes separate limits for unfabricated products for several product categories. These limits enable compliance when using data for unfabricated products.

Compliance with these limits is determined by comparing them to the embodied carbon of facility-specific Environmental Product Declarations (EPDs) of eligible products or (expressed in the EPD as the product's GWP), where unavailable, by comparing the product's embodied carbon as defined by a third-party verified life cycle assessment that includes facility-specific data for the steel-making activities involved in the production of the product's steel content. The limits and primary steel adjustment factor are subject to change in future iterations of this document, and guidance from the project authority of applicable projects may further define the application of these limits in meeting their requirements.

1.1 Product categories

Table 1 describes the categories of steel products that the limits may be applied to and currently apply to only carbon and low-alloy steel products (i.e., the limits do not apply to stainless steel).

Table 1: Product categories

Product category*	Description
Reinforcing bar (rebar)	Commodity-grade textured steel bar used to strengthen concrete in highway and building construction. Can be delivered in straight or coiled form.
Hollow structural sections	High-strength welded steel tubing used as structural elements in buildings and other structures and a variety of manufactured products.[2]

[1] The *Standard on Embodied Carbon in Construction* defines the applicability of these limits to major federal government construction projects.

[2] Hollow Structural Sections, Steel Tube Institute.

Hot-rolled structural sections	Steel rolled in a hot rolling mill that can be I-beams, H-beams, wide-flange beams and sheet piling. These products are then detailed, cut, drilled, bolted, welded and otherwise processed at the fabricator in order to prepare them for installation. They are used in a wide range of applications in building and infrastructure projects.[3]
Structural steel plate	Sheet steel with a width of more than eight inches, with a thickness ranging from one quarter of an inch to more than one foot.
Open web steel joists	Open web lightweight steel trusses consisting of parallel chords and a triangulated web system, proportioned to span between bearing points.[4]
Sheet steel deck	Profiled cold-formed sheet steel used as roof deck, non-composite floor deck or composite floor deck, typically made of coated cold-rolled steel.[4]
Cold-formed steel sections and panels†	Typically refers to light-frame construction where the vertical and horizontal structural elements are primarily formed by a system of repetitive framing members.
Merchant bar	A group of commodity steel shapes that consist of rounds, squares, flats, strips, angles and channels, which fabricators, steel service centres and manufacturers cut, bend and shape into products. Merchant products require more specialized processing than reinforcing bar.
Hot-rolled sheet, strip and plate‡	A coil of steel rolled on a hot-strip mill. It can be sold in this form to customers or further processed into other finished products.
Cold-rolled sheet, strip and plate‡	Sheet steel that has been pickled and run through a cold-reduction mill. Strip has a final product width of approximately 12 inches, while sheet may be more than 80 inches wide.

* All product category descriptions are from the American Iron and Steel Institute[5] unless otherwise noted.

† Excluding sheet steel deck.

‡ Including in coil form.

Table 2: National tiered embodied carbon limits for steel construction products

Product category	Best 20% EC limit* (kg CO2e/*t*)	Best 40% EC limit* (kg CO2e/*t*)	Best 50% EC limit* (kg CO2e/*t*)
Rebar	703	773	793
Rebar (unfabricated)	622	684	702
Hot-rolled sections	**1,008**	**1,105**	**1,140**
Hot-rolled sections (unfabricated)	820	898	927
Hollow structural sections	**1,542**	**1,810**	**1,908**
Hollow structural sections (unfabricated)	1,329	1,560	1,645
Structural plate	**1,476**	**1,646**	**1,709**

[3] Fabricated and Hot-Rolled Structural Steel Sections (Painted), Canadian Institute of Steel Construction
[4] Build Using Steel - Build Using Steel
[5] Glossary of steel industry terms, American Iron and Steel Institute.

Structural plate (unfabricated)	1,262	1,407	1,461
Cold-formed steel sections and panels	**1,721**	**2,242**	**2,355**
Sheet steel deck	**1,860**	**2,034**	**2,213**
Open web steel joist	**1,239**	**1,344**	**1,394**
Merchant bar	**625**	**720**	**740**
Hot-rolled sheet, strip, plate	**1,158**	**1,401**	**1,505**
Cold-rolled sheet, strip, plate	**1,848**	**2,021**	**2,102**

*Limits are for fully fabricated products except where otherwise specified and are applicable only to carbon steel and low-alloy steel products at this time.

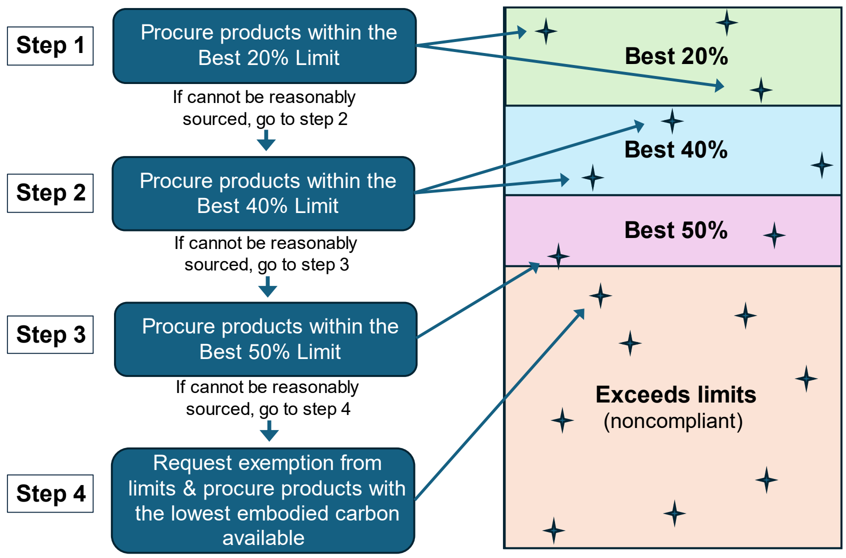
2. Application

For projects where these limits apply, construction services providers are required to procure steel products that are within the lowest range of embodied carbon that can be reasonably sourced for each category listed in Table 2 of this document. The project authority (i.e., the client or jurisdictional authority who has imposed embodied carbon requirements on the project) may define further what constitutes a reasonable justification to apply less stringent tiers for a given product category, such as undue incremental costs or project delays.

Applicable projects must follow the sequence below (also visualized in Figure 1) for procuring steel products from each category listed in Table 1:

- Construction services providers are required to procure steel products that are within the lowest 20% embodied carbon range for each category listed in Table 2 of this document (referred to as the “Best 20% EC limit” in Table 2); or
- Where products in a given category cannot be reasonably sourced within the best 20% EC limit, service providers must instead procure products that fall within the lowest 40% embodied carbon range (i.e., the “Best 40% EC limit” in Table 2); or
- Where products in a given category cannot be reasonably sourced within the best 40% EC limit, service providers must instead procure products that are at least better than the industry average in terms of embodied carbon (i.e., the “Best 50% EC limit” in Table 2).
- Where products in a given category cannot be reasonably sourced within the best 50% EC limit, service providers must submit a request for exemption from these limits for that product category.

Figure 1: Steps to applying steel limits in procurement



2.1. Primary steel adjustment factor

Steel production can be broadly categorized into two main manufacturing processes. Primary steel production makes new steel from raw materials such as iron or ilmenite ore, coking coal or natural gas, and limestone. Secondary steel production recycles existing steel, including scrap metal. Most steel products contain a mix of primary and secondary steel.

In recognition that the demand for primary steel will remain high in the coming decades due to an insufficient supply of scrap metal, there is a need to incentivize cleaner primary steel production. Means exist to produce primary steel that generate fewer GHG emissions. When evaluating products that contain primary steel, an adjustment factor that reflects the difference between best-in-class primary and secondary steel production of up to 585 $kgCO_2e/t$[6] can be deducted from the embodied carbon of that product in proportion to its primary steel content. This deduction acts as a primary steel credit, enabling products that contain cleaner primary steel to be compliant with EC limits established in this guide.

[6] The primary steel adjustment factor value was derived by comparing data from publicly available EPDs of leading low-emissions secondary steel products with low-emissions primary steel production as modelled by Argonne National Laboratory: [Cost and Life Cycle Analysis for Deep CO2 Emissions Reduction for Steel Making: Direct Reduced Iron Technologies](#) (Zang et al., 2023).

2.1.2 Primary steel credit calculation and application method

Where the primary steel content of a product is known, its primary steel credit may be quantified by proportionately applying the adjustment factor to the product's primary steel content. Where a product's facility-specific EPD or other documentation published by the manufacturer declares the recycled steel content, it may be assumed that the remainder of its content is composed of primary steel. Where applicable, the credit is subtracted from the primary steel portion of the product's embodied carbon (declared as GWP in an EPD) prior to comparing it to the limits. The credit is intended solely to make best-in-class primary steel production more competitive with recycled steel manufacturing in meeting EC limits and shall not be used in any embodied carbon disclosure of the project's structural materials or as part of whole-building (or asset) life cycle assessments. The primary steel credit does not apply to products whose primary or recycled steel content is not declared in an EPD or other documentation published by its manufacturer.

A product is considered compliant with a limit for its product category if the limit is greater than the fabricated product's embodied carbon, taking into account any relevant credit for primary steel content in the product. The formulas below shall be used to determine a product's compliance with the limits:

Equation 1: determine the product's primary steel content (based on recycled content)

$F_{primary} = 1 - F_{recycled}$

Equation 2: determine value of the primary steel credit

$$EC_{with\ credit} = EC_{whole\ product} - [F_{primary} \times EC_{primary\ credit}]$$

Equation 3: determine compliance with the product category's limits

Within best 20%	if	$[EC_{with\ credit} \leq EC_{20}]$
Within best 40%	if	$[EC_{20} < EC_{with\ credit} \leq EC_{40}]$
Within best 50%	if	$[EC_{40} \leq EC_{with\ credit} \leq EC_{50}]$

Where:

- $EC_{with\ credit}$ = a product's modified embodied carbon for determining compliance with the limits
- $EC_{whole\ product}$ = total embodied carbon (reported as GWP) in the supporting EPD for life cycle stages A1, A2, and A3 of the product
- $F_{PRIMARY}$ = fraction of primary steel in the product, from 0 to 1
- $EC_{primary\ credit}$ = current value of the primary steel credit
- $EC_{20,\ 40,\ or\ 50}$ = the relevant EC limit for a given category of product

See the examples below that demonstrate how the primary steel adjustment factor may be used to determine the value of the credit to be deducted from a product's carbon footprint when determining a product's compliance with a limit.

Example 1: Applying limits to a product with high primary steel content

For fabricated hot-rolled sections with a mill-specific EPD showing 1,605 kg CO_2e/t and a documented 20% recycled steel content. The primary steel content is therefore assumed to be 80%, and the credit would be applied by the following calculation:

$$F_{primary} = 1 - 0.2 = 0.8$$

$$EC_{with\ credit} = 1{,}605 - (0.8 * 585) = 1{,}137 \text{ kg } CO_2e/t$$

$$EC_{40} \leq EC_{with\ credit} \leq EC_{50}$$

$$1{,}105 < 1{,}137 \leq 1{,}140$$

Note in this example that the product falls within the best 50% limit for fabricated hot-rolled sections once the primary steel credit has been applied.

Example 2: Applying limits to a product with low primary steel content

An unfabricated hot-rolled section with a mill-specific EPD showing 900 kg $CO2e/t$ and a documented 85% recycled steel content.

$$F_{primary} = 1 - 0.85 = 0.15$$

$$EC_{with\ credit} = 900 - (0.15 * 585) = 812 \text{ kg } CO_2e/t$$

$$EC_{with\ credit} \leq EC_{20}$$

$$812 \leq 820$$

Note in this example that the product falls within the best 20% limit for unfabricated hot-rolled sections once the primary steel credit has been applied.

2.2 Unfabricated products

While some steel products have EPDs that represent the environmental impact of the fully fabricated product, others may only have EPDs available that represent their impacts prior to their final fabrication. Facility-specific EPDs for fully fabricated products being procured for a project must be used where available and must be compared to the fabricated limits for its respective category. Facility-specific EPDs of unfabricated products may be used to demonstrate compliance with limits where an EPD of equivalent resolution is not available for the fully fabricated product. Where EPDs for unfabricated products are used, they shall be compared to the unfabricated limits for that product category where available.

Example 3: Applying limits to unfabricated versus fabricated products

Two sources of hollow structural sections are being considered for procurement on an applicable project. One source (Product A) has a facility-specific EPD for the fabricated product, while the other source (Product B) has a facility-specific EPD for the unfabricated product. After accounting for any applicable primary steel credit for each product, the embodied carbon of Product A is considered to be 1,462 kg CO_2e/t, and Product B's embodied carbon is considered to be 1,578 kg CO_2e/t. To be compliant with the 20% limit for hollow structural sections, the embodied carbon of Product A must be less than the limit for fabricated products, and Product B's embodied carbon must be less than the unfabricated limit, respectively.

Equation for Product A's compliance with the best 20% limit:

$EC_{\text{with credit}}$ = 1,462 kg CO_2e/t,

Within best 20% if $EC_{with\ credit} \leq EC_{20}$

1,462 < 1,542

Therefore, Product A is compliant with the best 20% limit for fabricated hollow structural section.

Equation for Product B's compliance with the best 20% limit:

$EC_{\text{with credit}}$ = 1,578 kg CO_2e/t,

Within best 50% if $EC_{40} \leq EC_{with\ credit} \leq EC_{50}$

$1{,}560 \leq 1{,}578 \leq 1{,}645$

Therefore, Product B is compliant with the best 50% limit for unfabricated hollow structural section.

3. Compliance documentation

Refer to the project authority whose embodied carbon requirements are applicable to the project for information on how to document compliance and report project results.

4. Supporting and related resources

For major federal government construction projects:

- Standard on Embodied Carbon in Construction

For whole-building life cycle assessment:

- National Whole-Building Life Cycle Assessment Practitioner's Guide
- National Guidelines for Whole-Building Life Cycle Assessment

References

American Iron and Steel Institute. (2025). Glossary.

Canadian Institute of Steel Construction. (2021, December 13). *Canadian Institute of Steel Construction (CISC) Environmental Product Declaration (EPD): Fabricated Hot-Rolled Structural Steel Sections (Painted)*.

Steel Tube Institute. (2020). *Hollow Structural Sections (HSS) Overview*.

Treasury Board of Canada Secretariat. (2025, March 20). *Standard on Embodied Carbon in Construction*.

Zang, G., Sun, P., Elgowainy, A., Bobba, P., McMillan, C., Podkaminer, K., . . . Ma, O. (n.d.). *Cost and Life Cycle Analysis for Deep CO2 Emissions Reduction for Steel Making: Direct Reduced Iron Technologies*.