International Standard

ISO 20915

Life cycle inventory calculation methodology for steel products

Méthodologie de calcul de l'inventaire du cycle de vie des produits en acier

Second edition
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CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 21, *Environment related to climate change in the iron and steel industry*.

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This second edition cancels and replaces the first edition (ISO 20915:2018), which has been technically revised.

The main changes are as follows:

— stainless steel has been included;

— definitions have been clarified [product, scraps, recycling rate, coal and fuel (fossil and biogenic)];

— declared unit has been used instead of functional unit;

— alternative recycling methodologies have been allowed;

— explanations of primary data share (PDS) and data quality rating (DQR) have been added;

— examples of main outputs include CO_2 (for CCU);

— contractual instruments (energy attribute certificates, RECs, guarantees of origin, green energy certificates) and residual mix information have been included in electricity;

— co-product allocation has been modified to avoid double counting the benefits of co-product;

— for clarification, process gas in allocation specifies inclusion of combustion.

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Introduction

The life cycle inventory (LCI) of steel products is an important component in the support of life cycle assessments for a wide range of products and applications that contain steel or where steel is used to support the manufacture, production or delivery of products. ISO 14044 [1] explains as follows.

LCA addresses the environmental aspects and potential environmental impacts (e.g. use of resources and environmental consequences of releases) throughout a product's life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (i.e. cradle-to-grave). There are four phases in an LCA study:

a) the goal and scope definition phase,

b) the inventory analysis phase,

c) the impact assessment phase, and

d) the interpretation phase.

The life cycle inventory analysis phase (LCI phase) is the second phase of LCA. It is an inventory of input/output data with regard to the system being studied. It involves collection of the data necessary to meet the goals of the defined study.

This document describes the methodology for the analysis of the steel life cycle inventories that should be applied to a wide range of steel products, and represents the main process routes for global steel production. This includes the extraction of raw materials from the earth through to the production of steel products at the factory gate, as well as provision for scrap recycling of steel products and the treatment of steel scrap. The methodology conforms to the principles and framework set out in ISO 14040 [2] and ISO 14044 [1] and demonstrates how these principles should be applied to steel product manufacture and steel recycling.

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The life cycle of steel products consists of the following stages (see Figure 1):

— sourcing of natural resources (which includes mining, transportation and intermediate processing of raw materials) and scrap (recovered from both the manufacturing processes and the end of life of final products);

— production of steel products at the steelworks, including scrap recovery;

— manufacturing of final products by downstream users, for example, by customers of the steel industry, such as automotive, construction and engineering industries;

— use of final products, where the environmental performance of the final product depends on the steel products being used; for example, the fuel (or energy) consumption of an automobile depends partly upon the weight of its steel components;

— end of life of final products, including scrap recovery.

— recycling of scrap from both the manufacturing process and the end of life of final products to substitute the use of raw materials from the earth.

This document covers life cycle stages including sourcing of raw materials from the earth and scrap, production of steel products at the steelworks, and recycling of scrap. It does not cover the manufacturing of final products and the use of final products.

All global steel production is sourced from different ratios of scrap and primary ores. Therefore, an understanding of the value of steel recycling becomes a necessary part of the steel product LCI.

It is generally understood that the recycling of metallic materials makes a positive contribution towards reducing resource consumption and energy requirements, and helps to avoid the potential impacts of raw materials extraction and processing. However, all recycling routes (including the processing and transport of recycled materials) carry environmental burdens and these should be quantified as part of a life cycle assessment.

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A critical factor in the understanding of the benefits of materials recycling is the quality of the materials and products produced from the recycled material. Where the recycled products which are made to the same inherent properties as those sourced from primary materials, this is described as closed-loop recycling.

With the existing process and scrap quality controls, steel sourced from (scrap-based) steel recycling can be made to the same specification as steels sourced from the (iron ore based) primary routes. The properties of the different steel grades are achieved through different alloying concepts as well as process steps, such as heat treatment and secondary steel metallurgy allows the control of alloying and tramp element levels. This proves the judgement that steel recycling is to be regarded as closed-loop recycling.

Life cycle assessment may be used to quantify the potential benefits of recycling to conform to the guidance set out in ISO 14044:2006 [3], 4.3.4.3.

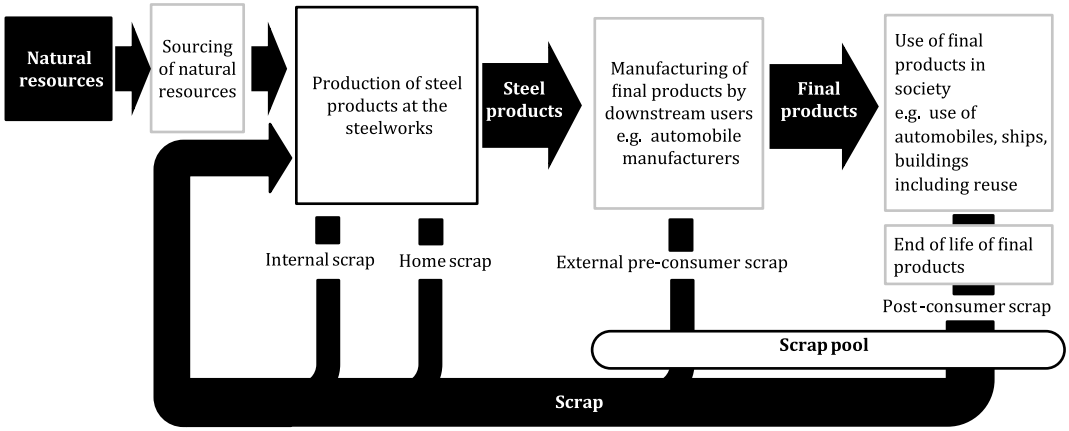

Figure 1 — Schematic diagram of the life cycle of steel

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Life cycle inventory calculation methodology for steel products

1 Scope

This document specifies guidelines and requirements for conducting life cycle inventory (LCI) studies of steel products reflecting steel's capacity for closed-loop recycling, including:

a) specification of the declared unit used for LCI calculation of steel products;

b) definition of the system boundaries used for LCI calculation of steel products;

c) evaluation of scrap in LCI calculation of steel products;

d) evaluation of co-products in LCI calculation of steel products;

e) reporting of LCI calculation results of steel products.

The application of LCI results, including life cycle impact assessment (LCIA), is outside the scope of this document.

2 Normative references

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The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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ISO 6929, *Steel products — Vocabulary*

ISO 14040, *Environmental management — Life cycle assessment — Principles and framework*

ISO 14044, *Environmental management — Life cycle assessment — Requirements and guidelines*

ISO 14044:2006, *Environmental management — Life cycle assessment — Requirements and guidelines*

3 Terms and definitions

For the purposes of this document, the terms and definition given in ISO 6929, ISO 14040, ISO 14044 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
life cycle inventory
LCI, noun
phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle

[SOURCE: ISO 14040:2006 [4], 3.3]

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3.2
steel product
item manufactured from steel and shipped out from steelworks

EXAMPLE Semi-finished products (e.g. slab, billet, bloom, ingot), steel powder, hot rolled steel, pickled hot rolled steel, cold rolled steel, finished cold rolled steel, electrogalvanized steel, hot-dip galvanized steel, tin-free steel, tinplated steel, organic coated steel, section, plate, rebar, engineering steel, wire rod, seamless pipe, UO pipe, welded pipe, and forged steel.

3.3
final product
product containing steel that requires no additional transformation prior to its use

EXAMPLE Automobiles, building structures, building envelopes, components, packaging, kitchen equipment and industry process equipment.

[SOURCE: ISO/TS 18110:2015 [5], 2.2, modified — The example has been added.]

3.4
scrap
ferrous scrap (iron and steel material) in metallic form that is recovered in multiple life cycle stages, including in steel production processes (*home scrap* (3.6)), the manufacturing processes of *final products* (3.3) (*external pre-consumer scrap* (3.7) and the end of life of final products (*post-consumer scrap* (3.8)), and is recycled as a raw material for steel production

3.5
internal scrap
scrap diverted from the waste stream during a crude steel making unit process that is then recycled within the same unit process (e.g. basic oxygen furnace (BOF) or electric arc furnace (EAF))

Note 1 to entry: Internal scrap is excluded from the definition of *home scrap* (3.6).

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3.6
home scrap
internal pre-consumer scrap diverted from the waste stream during a steel manufacturing process, for example from the rolling and processing mills

Note 1 to entry: *internal scrap* (3.5) which can be recycled within the same process (e.g. basic oxygen furnace (BOF) or electric arc furnace (EAF) is excluded from this definition.

3.7
external pre-consumer scrap
scrap diverted from the waste stream during a manufacturing process of *final products* (3.3), such as vehicles, white goods and buildings and includes scrap generated outside the boundaries of the steel production

Note 1 to entry: *home scrap* (3.6) generated outside of the product boundary under assessment would be included.

3.8
post-consumer scrap
scrap generated by households or by commercial, industrial and institutional facilities in their role as end users of the *final product* (3.3) which can no longer be used for its intended purpose.

Note 1 to entry: This includes returns of scrap from the distribution chain. Returns of scrap from the distribution chain are products that have reached end of life status before use, due to damage etc.

Note 2 to entry: This includes scrap from any facilities which are not parts of steel making process.(e.g. any disposable scrap from the office)

[SOURCE: ISO 14021:2026 [6], 3.4.10, modified]

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3.9
external scrap
scrap provided from outside of the steelworks, including *external pre-consumer scrap* (3.7) and *post-consumer scrap* (3.8), which are outside the boundaries of the steel production site. This also includes *home scrap* (3.6) from the steel production facility which is external to the product boundary.

3.10
scrap input rate
ratio of the mass of *external scrap* (3.9) recovered for recycling to the mass of steel products to be shipped out from the steelworks gate, calculated as shown in Formula (1)

$$R = (a + b)/P \quad (1)$$

where

- a is the mass of *external pre-consumer scrap* (3.7) recycled including external home scrap to the product boundary.;
- b is the mass of *post-consumer scrap* (3.8) recycled;
- P is the mass of steel products shipped out of the gate

Note 1 to entry: Scrap input rate does not refer to the % recycled content in the steel produced.

3.11
end of life recycling rate
ratio of the mass of *post-consumer scrap* (3.8) recovered for recycling to the mass of steel in *final product* (3.3) , calculated as shown in Formula (2):

$$\beta = b/F \quad (2)$$

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where

- b is the mass of *post-consumer scrap* (3.8) recycled;
- F is the mass of steel products contained in the *final product* (3.3)

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3.12
manufacturing yield
ratio of the mass of steel contained in *final products* (3.3) to the total mass of *steel products* (3.2) used for manufacturing the final product

3.13
ferrous raw material
raw material from the earth that becomes one of the main constituents of *steel products* (3.2), and which may have undergone intermediate processing to prepare it for iron making

EXAMPLE Lump ore, iron ore fine, sinter, pellet, hot briquetted iron (HBI), direct reduced iron (DRI).

3.14
process coal
coal used in iron and steel making processes

EXAMPLE Coking coal, injection coal, sintering coal, BOF coal, EAF coal, DRI coal.

Note 1 to entry: Coal can be of both fossil and biogenic origin.

3.15
non-ferrous raw material
non-ferrous material for *steel products* (3.2) other than *ferrous raw material* (3.13) or *process coal* (3.14)

EXAMPLE Zinc, tin, aluminium, chromium, nickel, molybdenum and manganese.

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3.16
ferro-alloy
alloy of iron with non-iron alloy metals, such as manganese, silicon, chromium, nickel and molybdenum used in the steelmaking process

3.17
other input material
material input and consumables for steel production other than *ferrous raw material* (3.13), *process coal* (3.14), *non-ferrous raw material* (3.15), *ferro alloy* (3.16) and *scrap* (3.4), which does not ultimately form part of the *steel product* (3.2)

EXAMPLE Refractory, electrode, chemical materials, limestone, dolomite.

3.18
fuel
energy source for generating heat, steam and power other than *process gas* (3.21)

EXAMPLE Boiler coal, fuel oils, natural gas, LPG, biogas.

Note 1 to entry: Fuel can be of fossil and biogenic origin.

3.19
industrial gas
gas for steel production other than *fuels* (3.18) or reducing agent

EXAMPLE Oxygen, nitrogen, argon, hydrogen, carbon dioxide, compressed air.

Note 1 to entry: Hydrogen can be used as a fuel, or is included here as an industrial gas when used as an uncombusted industrial gas, e.g. for the provision of reducing atmospheres in production processes.

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3.20
co-product
any of two or more products coming from the same unit process or product system

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Note 1 to entry: Any recovered material that can be used by another interested party is included.

[SOURCE: ISO 14044:2006 [3], 3.10 modified — Notes 1 to entry have been added.]

3.21
process gas
gas that is produced as part of the processes on the steel production site

Note 1 to entry: Coke oven gas, blast furnace gas, BOF gas, DRI gas.

Note 2 to entry: Process gas used by another interested party is regarded as a co-product

3.22
waste
resource that is no longer considered to be an asset as it, at the time, provides insufficient value to the holder

Note 1 to entry: The holder can choose to retain, discard, or transfer the waste.

Note 2 to entry: Value can be assigned to waste as a result of a need from another interested party, at which point the resource is no longer considered waste, it changes to co-product.

Note 3 to entry: The assignment of value to waste as a resource is linked, in part, to the available technology (e.g. landfill mining).

Note 4 to entry: Some regulations require the holder to dispose of certain types of waste, while others assign value to waste.

Note 5 to entry: Because resources include the energy content or energy potential of materials, such energy, when liberated during a process and not recovered for another use, can be considered a waste.

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[SOURCE: ISO 59004:2024 [7] , 3.3.6 — Notes 3 to entry have been modified.]

3.23
primary data
quantified value of a process or an activity obtained from a direct measurement or a calculation based on direct measurements

Note 1 to entry: Primary data need not necessarily originate from the product system under study because primary data might relate to a different but comparable product system to that being studied.

Note 2 to entry: Primary data can include emission factors and/or activity data.

[SOURCE: ISO 14067:2018 [8] , 3.1.6.1, modified]

3.24
secondary data
data that do not fulfil the requirements for primary data

Note 1 to entry: Secondary data can include data from industry association, databases and published literature, default emission factors from national inventories, calculated data, estimates or other representative data, validated by competent authorities.

Note 2 to entry: Secondary data can include data obtained from proxy processes or estimates

[SOURCE: ISO 14067:2018 [8] , 3.1.6.3, modified]

3.25
stainless steel
steel with at least 10,5 % (mass fraction) Cr and maximum 1,2 % (mass fraction) C

[SOURCE: ISO 15510:2014 [9] , 3.1]

3.26
declared unit
quantity of a *steel product* (3.2) for use as a reference unit in an *life cycle inventory* (3.1)

[SOURCE: ISO 14050:2020 [10], 3.7.11, modified]

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4 Basic conditions for LCI of steel products

4.1 General requirements

The requirements and guidelines set in this document shall be followed in addition to those set by ISO 14040 and ISO 14044.

4.2 Function and declared unit

The function of steel products is to form a part of final products with a certain function, such as automobiles, cans and bridges. For steel products LCI, it is more appropriate to use declared unit as steel can be used for different functions which are defined for the different final products.

For an LCI of steel products, the declared unit should be set as a mass-based unit of a specified grade or type of steel product to be shipped out from the steelworks gate. Where applications are based on other declared capacities, suitable explanation and conversion guidance shall be provided.

4.3 System boundary

As shown in Figure 2, the system boundary used for the LCI study of steel products shall include all of the production steps from input materials (raw materials from the earth, scrap, etc.) to steel products ready to be shipped from the steelworks, including the recycling of steel products (i.e. cradle-to-gate). This includes production processes at the steelworks and all the upstream processes, including energy conversion, raw

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material mining, material preparation and transportation of materials to the steelworks site. The effect of scrap recycling, or the burdens of using scrap and the credits for the recovery of steel products, should be considered according to the procedure described in 5.5. The calculation of steel product LCIs should include allocation on scrap to reflect the nature of closed-loop recycling. Cradle-to-gate LCIs without scrap allocation may be reported when this is aligned to the goals and scope of the study. Additionally, care should be taken that if no burdens are assigned to scrap inputs, then no credits should be applied to steel recycling. Also, the recovery and use of steel industry co-products outside of the steelworks shall be taken into account. The allocation procedure is described in 5.3. The system boundary does not include the manufacturing of final products using steel products or their use in society.

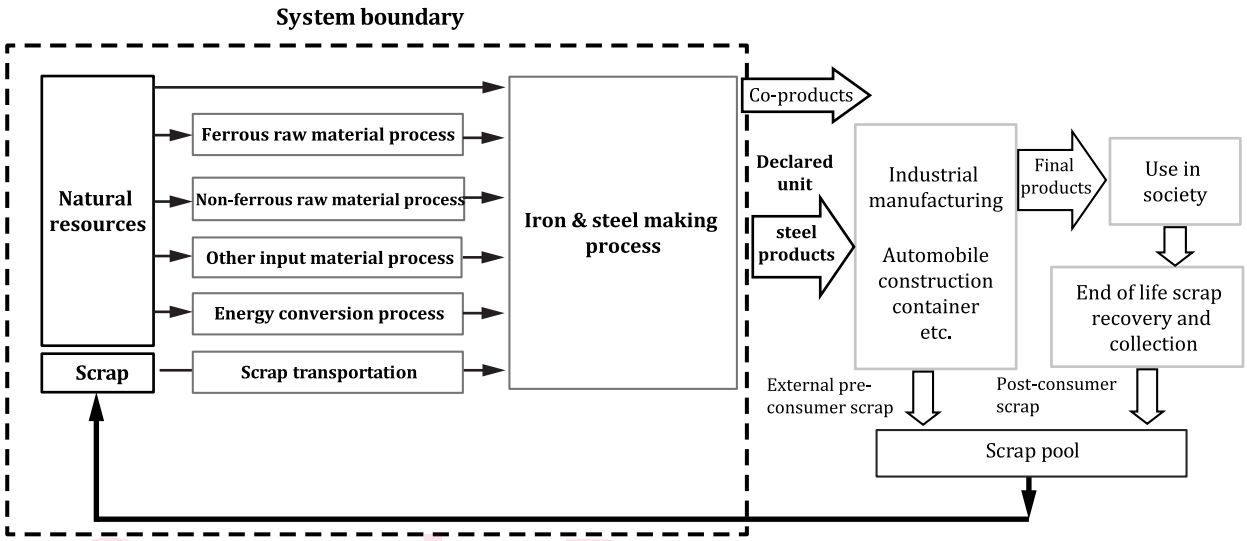

Figure 2 — System boundary

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The following items should be excluded from the system boundary. If any of them are included in the system boundary, this shall be clearly stated and explained.

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— Transportation of steel products beyond the gate.

— Transportation of co-products beyond the gate.

— Manufacturing of final products.

— Use of final products.

— Research and development.

— Business travel of employees.

— Production, decommissioning, repair and maintenance of capital goods unless impacts are known to be non-negligible or have an impact.

— Cleaning and legal services.

— Marketing.

— Operation of administration offices.

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4.4 Data quality

4.4.1 General

The data quality requirements set out in of ISO 14044:2006, 4.2.3.6, shall be followed, including time-related coverage (4.4.2), geographical coverage (4.4.3) and technology coverage (4.4.4). Additionally the share of primary data should be calculated using the methodology in subclause 4.4.6 of this document.

4.4.2 Time-related coverage

The timeframe of data collection should be one full representative year to adjust for seasonal variations. If the data set is not possible for a full year, this shall be explained and justified. Moreover, since the LCI results are prone to change over time for reasons, such as changes in operational rate due to economic conditions and technological improvements, the time period in which the data are collected shall be stated clearly. Primary data sets used in LCI studies should not be more than five years old. Any secondary data used should be less than 10 years old, unless its ongoing validity is justified. When using data outside of the reference year, the choice shall be explained and justified.

4.4.3 Geographical coverage

An LCI study of steel products may be reported with various geographical representations, for example, one steelmaking site, one steel company, national, regional or global coverage. When the study covers multiple steelworks (or companies, regions, etc.), the geographical coverage and representation should be clearly stated. The LCI should be presented as a weighted average by the production quantity of the covered scope, not a simple arithmetic average. For example, Product A produced by sites 1, 2 and 3 with mass M1, M2 and M3 would be averaged as: (LCI1 × M1 + LCI2 × M2 + LCI3 × M3)/(M1 + M2 + M3). Manufacturers contributing to the LCI shall be documented, and use of the data set shall be noted as applicable within the bounds of the contributing manufacturers.

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4.4.4 Technology coverage

This document covers production technologies of non-alloy steel and alloy steel, as defined in ISO 4948-1 [11].

NOTE According to ISO 4948-1 [11], alloy steel includes stainless steel.

4.4.5 Sources of the data

Steel production data shall be directly sourced from steel producers based on primary data, such as measurement, engineering calculations and purchasing records.

Primary data should be used instead of secondary data for at least the processes over which the manufacturer of the specific product has influence, as well as for the most relevant materials inputs, if available, and if it meets or complies with the data quality requirements herein. Data from the site(s) under study shall be prioritized.

Upstream data produced by suppliers should be used. If the information is not available, secondary data may be used. All secondary data should be representative for the scope of the LCI conducted.

Secondary data selection hierarchy:

a) Industry association data

b) General LCA data, e.g. commercial LCA databases, and default emission factors from national inventories

c) Other documented references, e.g. reviewed scientific literature

d) Proxy data with justification

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