FINAL DRAFT
Technical Report

ISO/DTR 25078

ISO/TC **287**

Secretariat: **ABNT**

Voting begins on:
2025-02-27

Voting terminates on:
2025-04-24

Wood and wood-based products — Examples of calculating displacements potentials for wood-based products and considerations for further analyses

Titre manquant

Reference number
ISO/DTR 25078:2025(en)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 documents 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 287, *Sustainable processes for wood and wood-based products*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

ISO 13391-1 defines a framework for calculating greenhouse gas dynamics of wood and wood-based products, see Figure 1. The framework identifies the displacement potential relating to displacing alternative products by using wood and wood-based products. This includes quantification of the value chain emissions of both the wood-based product and the alternative product, as shown in Figure 1. Displacement is composed of two parts, the greenhouse gas emissions related to the wood-based product(s) and the prevented greenhouse gas emissions related to the alternative product(s), see Figure 1.

ISO 13391-1 provides calculation guidance for all aspects of the greenhouse gas emissions related to the wood-based product's value chain. ISO 13391-3 considers the emissions of alternative products and further elaborates on the calculation of displacement potentials. This document provides additional background and examples to users of ISO 13391-1 and ISO 13391-3. It includes aspects of the calculations as such, and also the wider context of analysing factors that can affect to what extent the displacement potential is realised.

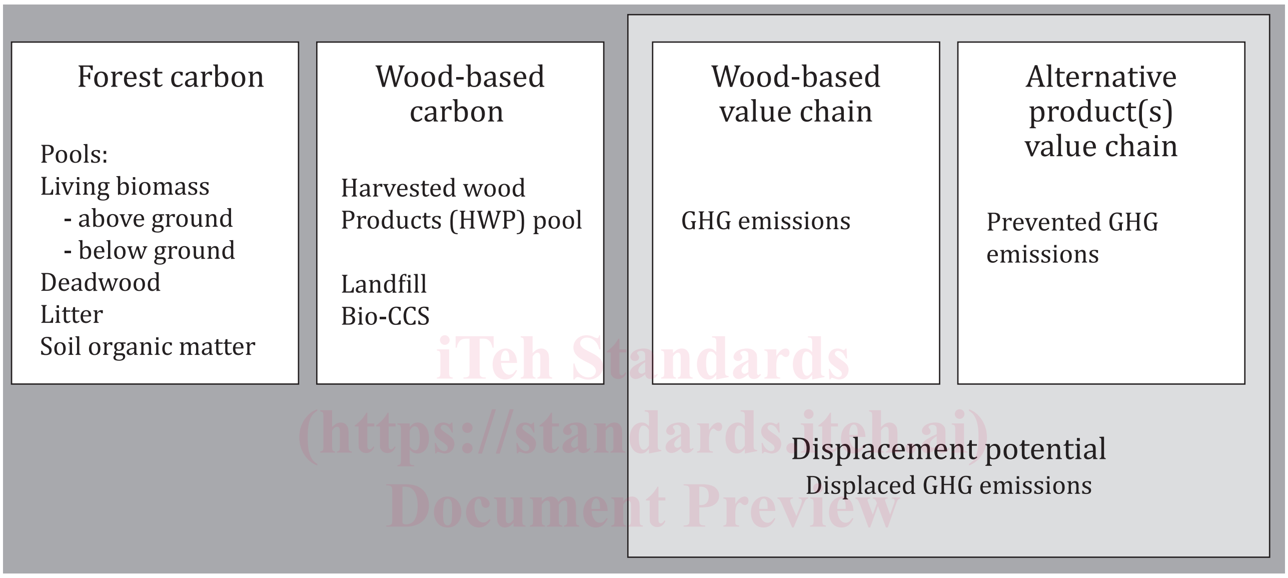

Figure 1 — Illustration of the components of the greenhouse gas dynamics of wood and wood-based products

This document provides background and examples in the following areas:

— Clause 4: Approaches for identifying alternative products, i.e. products with similar functionality but with different material origins that can be displaced by wood-based products. This pairing of alternatives is a basis for the calculation of displacement potentials.

— Clause 5: Examples of how to establish displacement factors, i.e. the quantity of greenhouse gas emissions avoided through displacement (in carbon dioxide equivalents) per unit of biogenic carbon (in carbon dioxide equivalents) contained in the wood-based product(s). The displacement factors are thus expressed in t CO_2e/t CO_2e and are as such unitless.

— Clause 6: Examples of tier 1 displacement factors for broad product categories based on the literature.

— Clause 7: Review of factors that can influence realisation of displacement potentials in society, including the development of the wider economy and consumption patterns.

Wood and wood-based products — Examples of calculating displacements potentials for wood-based products and considerations for further analyses

1 Scope

This document provides examples and background literature for identifying and calculating greenhouse gas displacement potential for wood-based products as defined in ISO 13391-3, including the calculation of displacement factors.

This document also provides a review of considerations for further analyses that address the impact of these potentials over time in a broader economy setting.

2 Normative references

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.

ISO 13391-1, *Wood and wood-based products — Greenhouse gas dynamics — Part 1: Framework for value chain calculations*

ISO 13391-3, *Wood and wood-based products — Greenhouse gas dynamics — Part 3: Displacement of greenhouse gas emissions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13391-1 and ISO 13391-3 apply.

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

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

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

4 Establishing alternative products

Defining the functional unit is fundamental when calculating displacement factors and working with value chain emissions estimates for alternative products. This is in order to allow for an objective comparison between the alternative product and the wood or wood-based product. As per ISO 14040, a functional unit is defined as the “quantified performance of a product system for use as a reference unit”. It is best practice to apply expert judgement when establishing the alternative product to ensure functional equivalence. However, it is important to recognize that a specific material can fulfil more than one function. For instance, in the case of a concrete shear wall, the wall provides structural capacity, a barrier to sound transmission, as well as fire protection. In comparison, a wood-framed wall might only provide structural capacity, and additional materials such as acoustic insulation and gypsum board are needed to meet the sound transmission and fire protection requirements, respectively. Therefore, when establishing the alternative product to a wood-based product to evaluate the displacement potential, it is best practice to examine the functional unit from a system perspective.

Functional units for construction products can be based on building components providing a specific function (e.g. 9 m × 9 m floor plate that supports an office space) or a complete building system (e.g. 4-storey residential building). A life cycle assessment (LCA) can then be performed to determine the emissions of both the wood-based product and alternative options in order to determine the displacement potential. Environmental Product Declarations (EPD) can be used to perform the assessment. However, a direct comparison of the EPD results between the wood-based product and an alternative product can only be performed when the EPD is based on the same declared unit with functional equivalency, and the conditions for comparing EPDs in ISO 14025 are met.

Similarities between the wood-based product and the alternative product can be defined to simplify the analysis. For instance, when the functional unit is defined as a building, it can sometimes be assumed that the operational energy use for the wood building is the same as the operational energy use for the alternative (e.g. concrete or steel) building. Similarly, the scope of the functional unit can be defined to simplify the comparison, for example limiting the functional unit to just the superstructure of the building. This approach would not capture the impact of the mass of the superstructure in the foundation design, but the results of the study can be more broadly applied if repeatable construction is being considered e.g. where the building structure is being repeatedly constructed in multiple locations.

It is also important to account for the geographical location where the alternative product is manufactured and used. The energy production system, technological efficiency, and electrical grid will all impact the emissions of the manufacturing, use, and end of life stages of the wood-based and alternative product. Emissions will also reflect the geographically relevant manufacturing processes, use conditions, and end of life processes.

Equivalence between the system boundary of the alternative product and the system boundary of the wood-based product is necessary to ensure consistency for the comparison. A comprehensive study would consider the full life cycle, including raw material extraction, processing, transportation, manufacturing, distribution, use, re-use, maintenance, replacement, and final disposal. This approach is often referred to as ‘cradle-to-grave’. Another commonly used approach is ‘cradle-to-gate’ and can be selected where only the stages up to the end of manufacture are currently available. Establishing the processes for life cycle stages beyond the manufacturing gate will require assumptions, and there will therefore be inherent uncertainties in the study and reduce the representativeness of the results. Additionally, since there is no guarantee of the exact destiny of the product, providing a description of each plausible scenario in a report provides transparency about the analysis, the assumptions and the results.

An evaluation of the products that are readily available on the market and commonly used to perform the required function within the defined temporal boundary assists in establishing the alternative product. It is entirely possible that a single wood-based product can displace several other products, so a representative set of alternative products would then be selected. It is equally possible that some wood-based products do not displace any other products at all, for example where the wood-based product is the market leader or default choice for a given application, e.g. paper within books. It would be possible to compare a printed book with an e-reader, but at this current time the e-reader is not the item being displaced, it is in fact displacing the book.

Many studies are careful to do this based not only on functional equivalence, but also market share of the various alternative products, i.e. assigning factors based on the proportion of the various products that can be displaced by the wood-based product.

5 Establishing displacement factors for wood-based products

5.1 General

Clause 5 provides calculation examples for the establishment of displacement factors based on the literature. It includes consideration of greenhouse gas emissions in the wood-based product(s) value chain as well as the emissions from alternative products.

NOTE 'Emissions from alternative products' is a term defined in ISO 13391-1. This document also deals with situations that do not lead to displacement.

As per ISO 13391-3, the displacement factor for a specific use of wood-based product(s) is calculated as given in Formula (1):

$$f_{\mathrm{D,spec}} = \frac{m_{\mathrm{E,ap}} - m_{\mathrm{E,w}}}{w_{\mathrm{B,w}} - w_{\mathrm{B,ap}}} \tag{1}$$

where

$f_{\mathrm{D,spec}}$	is the displacement factor for a specific use of the wood-based product in a specific geographical scale, expressed in t CO_2e/t CO_2e;
$m_{\mathrm{E,ap}}$	is the quantity of emissions from alternative products with functional equivalence to the wood-based product considered, expressed in t CO_2e;
$m_{\mathrm{E,w}}$	is the greenhouse gas emissions related to the wood-based product considered, expressed in t CO_2e;
$w_{\mathrm{B,w}}$	is the quantity of biogenic carbon content in the wood-based product placed on the market in the specified time period, expressed in t CO_2e;
$w_{\mathrm{B,ap}}$	is the quantity of biogenic carbon content in the alternative product, expressed in t CO_2e.

NOTE Formula 1 is the equivalent of a widely recognized formula used in e.g. Sathre and O'Connor,[44] but the symbols have been re-drafted in accordance with ISO drafting rules.

Two other useful formulae from ISO 13391-1 is for converting wood volume to carbon dioxide equivalents in two steps.

The mass of wood at dry condition can be calculated using Formula 2:

$$m_{\mathrm{dry}} = \frac{\rho_{\omega} \times V_{\omega},}{1 + \frac{\omega}{100}} \tag{2}$$

m_{dry}	is the mass of wood at oven dry condition (moisture content of 0 %)
ω	is the gravimetric moisture content of wood (e.g. 12 % mass of water per mass of dry wood);
ρ_{ω},	is the density of wood at moisture content of ω;
V_{ω}	is the volume of wood at moisture content of ω;

The biogenic carbon content in wood can be calculated using Formula 3:

$$w_{\mathrm{B}} = \frac{44}{12} \times w_{\mathrm{C,f}} \times m_{\mathrm{dry}} \tag{3}$$

where

w_{B}	is the is biogenic carbon in wood expressed in carbon dioxide equivalents (CO_2e);
$\frac{44}{12}$	is the molecular mass ratio of CO_2/C;
$w_{\mathrm{C,f}}$	is the carbon fraction in wood at oven dry condition, 0,5 as the default value.

ISO 13391-3 further details how displacement factors are calculated for sets of wood-based products, divided into first use (including recycled material) and final use (recovery for energy purposes). This clause, however, only deals with examples of calculating displacement factors for specific use(s) of wood-based product(s).

ISO 13391-3 requires that data sources and displacement factors used in calculations are transparently documented, including the alternative product(s) and product system(s) used with justification.

Determining displacement factors for specific uses can be complicated and depends on consideration of a range of factors including:

— ISO 13391-3, requires that the functional unit is based on the intended function or service of the product and defined as the quantified performance of a product system in terms of its unit, magnitude, and if relevant, duration, reuse, and level of quality;

— ISO 13391-3, recommends that system boundaries suitable for conducting the life cycle assessment (LCA) of the wood-based product are defined. It is required that the system boundaries, including choices made, are transparently documented and justified;

— Displacement factors can vary with geographical location depending on variations of greenhouse gas emissions in both of the compared product value chains for a specified functional unit;

— Calculations can refer to comparable parts in the value chain where the system boundary is defined equivalently. The starting point is the “cradle” to account for all upstream emissions. The “gate”, representing delivery of the product(s) to the customer is often used as the other boundary, under the assumption that emissions further downstream are of similar magnitudes for the alternative products. A “cradle-to-grave” boundary can therefore be more accurate for determining the displacement factor so as to account for the entire value chain in the comparison, although data for downstream emissions of reasonable quality and comparability can be difficult to obtain;

— Wood-based value chains are complex and integrated. While displacement factors for individual products at the consumer end can be straightforward to calculate, the displacement factors of products in the upstream value chain (e.g. sawn wood, wood-based panels, paper, wood pulp, wood-based energy products and roundwood) requires aggregations and weighting of downstream product mixes, depending on the set of identified alternatives.

5.2 Types of data sources

Calculation of displacement factors builds on documented data from different types of publications, including:

— Published scientific articles, including both review articles and articles addressing specific topics, such as housing construction, that have been published over the past 20+ years.

— The level of data detail can be lower than for LCA studies as the study in question can address a broader question where displacement factors are only a part

— As the literature is not standardized in the way that LCA studies are, it can be challenging to extract data that correspond with the applied system boundary. Analyses are not always documented to make the relevant data extraction possible, which can lead to excluding a study for data quality reasons;

— Comparative Life Cycle Assessments (LCAs)

— LCAs include standardized approaches to calculate and compare performances of products, see for example ISO 14044. This provides a good foundation for extracting data for calculation of displacement factors;

— LCAs can address very specific products in specific market contexts which can make it difficult to generalize the findings. For example, the alternative product(s) chosen are not always representative for the overall market, in which case the displacement factor would also not be representative.

  - In situations where several LCAs are available for comparing the wood-based product(s) to alternatives, an approach for utilizing the full set of information is to calculate a weighted mean or median of specific-use displacement factors across the studies.
- Life cycle assessments and Environmental Product Declarations (EPDs)
  - Where no comparative LCA is available it can be possible to obtain the required information for the wood-based product or the alternative product directly from individual LCAs or EPDs. This is considered further in 5.3.

5.3 Calculation approaches to determine value chain emissions of wood-based and alternative products

This clause builds on establishing a functional unit for the products or product systems that are to be compared, see Clause 4.

The greenhouse gas emissions for the wood-based product, and all identified alternative products, can be determined using environmental product declarations (EPDs) or life cycle assessments (LCAs). In addition to the functional equivalence, the relevant geographical region and energy mix are important as they can have different global warming potential depending on the location of manufacture, the process efficiencies at the particular factory and other factors. The more specific the data is (e.g. facility-specific, process specific, region specific, etc.), the more accurate the results will be. If EPDs or LCA data is not provided on a granular scale, national databases that provide average emissions factors for products can be referenced.

5.4 Calculation examples, including data sources

5.4.1 Example 1 – Wooden pallet vs. Plastic pallet

Case 1:

Based on a global review of published EPDs, two pallet EPDs were found from the same manufacturer, one for wooden pallets and one for plastic pallets.[45][46] These studies used the same system boundary, regional data and functional unit i.e. one loop usage of the plastic or wooden pallet (1 200 × 800 mm) in the system. The greenhouse gas emissions were reported to be 0,294 kg CO_2e and 0,478 kg CO_2e for the wooden and plastic pallet, respectively. The amount of solid wood used in the functional unit of wooden pallet is estimated at 1,04 kg. Following the formula in ISO 13391-3 for determining the biogenic carbon content, the $w_{B,w}$ is calculated here (assuming pallet wood with a moisture content of 20 %):

$$w_{B,w} = \frac{44}{12} \times 0,5 \times \frac{1,04}{1+20\,\%} = 1,589 \text{ kg } CO_2\text{e}$$

There is no biogenic carbon content in the plastic pallet, thus $w_{B,ap} = 0$;

Then using the formula for $f_{D,spec}$:

$$f_{D,spec} = \frac{m_{E,ap} - m_{E,w}}{w_{B,w} - w_{B,ap}} = \frac{0,478 - 0,294}{1,589 - 0} = 0,12$$

Case 2:

Deviatkin and Horttanainen[16] compare the carbon footprint of EUR-sized wooden and plastic pallets, taking into account a wide range of factors for the functional unit, including number of re-use rounds and repairs. The functional unit was set to 1 000 trips. greenhouse gas emissions for the plastic pallet was 15 × 62 = 939 kg CO_2e (15 pallets needed for the functional unit). Biogenic carbon content of the wooden pallet (50 pallets needed for the functional unit) was 50 × 36,0 = 1 798 kg CO_2e, including material for repairs. The