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

National foreword

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Technical Report

ISO/TR 25078

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

*Bois et produits à base de bois — Exemples de calcul des
potentiels de déplacement pour les produits à base de bois et
considérations pour d'autres analyses*

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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 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).

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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 potentially 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.

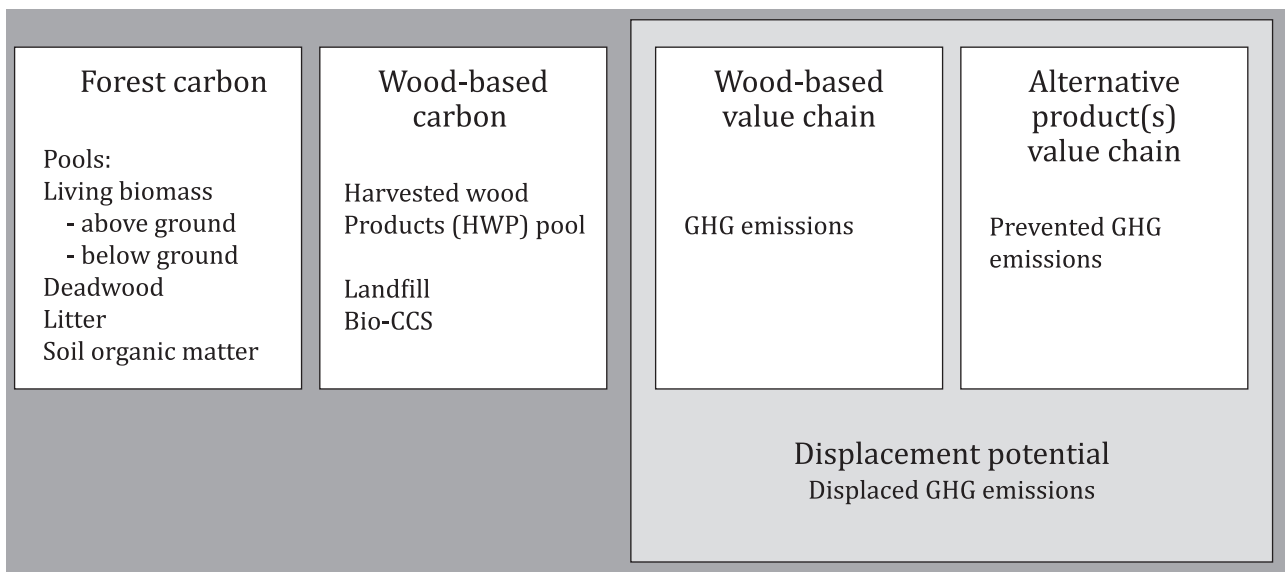


Figure 1 — Illustration of the components of the greenhouse gas dynamics of wood and wood-based products

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 CO₂e/t CO₂e 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 displacement 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 13391-3:2025, 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 13391-1:2025, *Wood and wood-based products — Greenhouse gas dynamics — Part 1: Framework for value chain calculations*

ISO 13391-3:2025, *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 14040:2006, 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 1 '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 \(1\)](#):

$$f_{D,spec} = \frac{m_{E,ap} - m_{E,w}}{w_{B,w} - w_{B,ap}} \quad (1)$$

where

$f_{D,spec}$ is the displacement factor for a specific use of the wood-based product in a specific geographical scale, expressed in t CO₂e/t CO₂e;

$m_{E,ap}$ is the quantity of emissions from alternative products with functional equivalence to the wood-based product considered, expressed in t CO₂e;

$m_{E,w}$ is the greenhouse gas emissions related to the wood-based product considered, expressed in t CO₂e;

$w_{B,w}$ is the quantity of biogenic carbon in the wood-based product placed on the market in the specified time period, expressed in t CO₂e;

$w_{B,ap}$ is the quantity of biogenic carbon in the alternative product, expressed in t CO₂e.

NOTE 2 [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](#):

$$m_{dry} = \frac{\rho_{\omega} \times V_{\omega}}{1 + \frac{\omega}{100}} \quad (2)$$

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](#):

$$w_B = \frac{44}{12} \times w_{C,f,dry} \times m_{dry} \quad (3)$$

where

w_B is the biogenic carbon in wood expressed in carbon dioxide equivalents (CO₂e);

$\frac{44}{12}$ is the molecular mass ratio of CO₂/C;

$w_{C,f,dry}$ 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.