

## Description of the material flow and life cycle assessment model HoLCA

The material flow and life cycle assessment model HoLCA was developed as part of the UBA project BIOMASSEKASKADEN (Fehrenbach et al. 2017), a study modelling the cascading use of biomass on behalf of the German Environmental Agency.

The HoLCA model was created in compliance with the requirements of ISO 14040 and 14044 and applies to LCAs that seek to meet these standards. Furthermore, it may be applied for carbon footprint studies carried out in compliance with ISO 14067.

The structure of the model is based on the entire wood flow in Germany (excluding wood imports). Starting with forestry, emissions from the various processing stages and supply chains of the respective products or product groups are included. Modelling in HoLCA is carried out with the Umberto software. In version 1.0, the baseline material flows of the model are derived from data reporting the itemised wood raw material balance of Germany by Mantau (2012). The current update to version 2.0 is based on the current raw material monitoring for Germany (Döring et al. 2020).

In addition, the individual modules of HoLCA include life cycle background data on inputs (energy, other raw materials or chemicals, water, etc.) and outputs (emissions to air and water, waste, etc.).

The following modules represent the overarching structure of the model:

- **Forestry:**

Version 1.0 included six product groups:

- Logs, coniferous
- Logs, broadleaf
- Industrial wood, coniferous
- Industrial wood, broadleaf
- Forest residues
- Bark

The update to version 2.0 integrates the dynamic calculation of the carbon stock or the storage balance from Hennenberg et al. (2019).

- **Saw mill:**

In this module, the input (logs, coniferous and broadleaf) is converted into sawn timber with the corresponding energy input and linked with the production of sawmill by-products. These are used in proportions for the production of wood-based materials, use in the paper/cardboard and pulp industry and the production of wood pellets.

- **Production of sawn timber products:**

Sawn-wood products are divided into three main groups in version 1:

- Construction timber
- Solid wood furniture

- Packaging wood (mainly pallets)

Again, arising by-products (offcuts, sawdust and shavings) are added to the pool of sawmill by-products (see above). As in other processing operations, some of the sawmill by-products are used to cover the energy needs (steam, heat) of the processing plant.

- **Production of wood-based panels**

The products are subdivided as follows

- pressed particle boards
- MDF boards
- OSB boards
- LDF boards

The raw material consists of industrial wood and sawmill by-products as well as a proportion of waste wood. Data on energy input and materials (e.g. resins) are adopted from Rüter and Diedrichs (2012) in version 1.0.

- **Paper/cardboard and pulp industry**

This two-part module is integrated in HoLCA in a highly aggregated form. The input data are derived from various life cycle assessment studies prepared by ifeu. The raw material consists of industrial wood and sawmill by-products. The common recycling rates are taken into account. The products are paper, cardboard and paperboard.

- **Production of chemicals**

At present, this very innovative branch of production is only included in the model with a very low mass flow. Data sets for the production of liquid hydrocarbons, which can be used as fuels or chemicals, are used as a baseline here.

- **Use phase**

The use phase for material products considered in the model is limited to the calculation of carbon storage over the use period.

- **Collection of waste wood**

After use, the wood products are transferred to the waste wood pool. This is separated into waste wood classes and the proportion of wood in residual household waste.

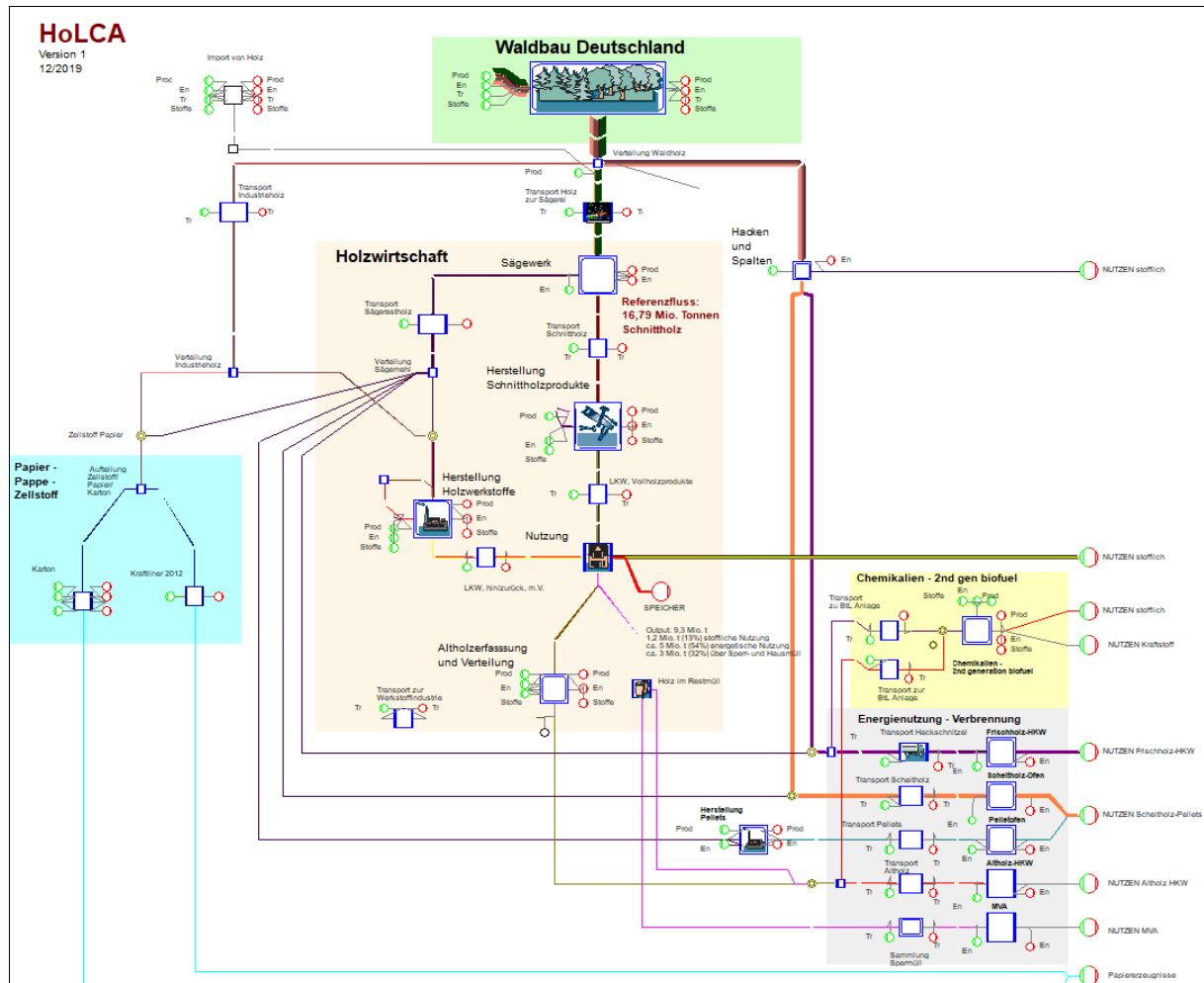
The model can be set to two different time frames here:

1. life cycle balance: each material flow is managed until the end of its life cycle.
2. annual balance: since the input is defined by the annual production of forest wood, the total flow can also be set to a one-year period, i.e. only the respective annual quantity goes into the waste wood pool, which results in a larger quantity of wood remaining in storage.

- **Energy wood**

This includes the use of fresh wood

- Wood in residual household waste is combusted in municipal solid waste incineration plants.



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