

Sankey diagrams of woody biomass flows in the EU

2021 release

ABSTRACT

A new release of Sankey diagrams of woody biomass flows in the European Union as a whole are available for the years 2009 to 2017 on the European Commission Knowledge Centre for Bioeconomy web portal at:

<https://ec.europa.eu/knowledge4policy/publication/forestry-sankey> .

This technical brief provides data sources and methods applied to derive the estimates. Moreover, it provides the detailed definitions of the items in the flows.

Introduction

Wood is a highly versatile material and can be used and reused in cascade in different processes. The two main sectors for woody biomass uses are wood-based products industries and energy production, but they are not parallel processes. Indeed, primary wood is directly used for either manufacturing or energy, but industrial transformation of wood generates by-products that are used as inputs for the production of other wood-based products or for energy generation. The Sankey diagram of material flows is a commonly used tool to illustrate the whole value chain. It represents an assessment of woody biomass flows within the forest-based sector, showing the relations between biomass sources and uses. It organizes information in nodes (representing sources, processes or uses) and oriented arrows representing flows between pairs of nodes. In the Sankey diagrams, the width of each arrow is proportional to the magnitude of the represented flow, i.e., to the amount of transferred biomass in a common unit.

A new release of Sankey diagrams of annual woody biomass flows in the EU¹ for the years 2009 to 2017 provides an overview of the value chain of wood in the EU, and its trends. They are consistent with the Wood

Resource Balances (WRB) [1]. All the amounts are reported in a common unit of measure: cubic meters solid wood equivalent² (Mm³ SWE).

Available data is often fragmented and inaccurate. As a result, there could be significant differences between the reported sources and the declared uses in the nodes. Some assumptions have been applied to create a consistent visualisation as described in the following section. The definitions are presented in the last paragraph of this brief.

Data and methods

Amounts of woody biomass sources and uses, both domestic and traded, were derived from the same data sources described in [1], for all the Member States and aggregated at EU-level. Particular attention has been paid to the design step, optimizing the level of aggregation of the woody biomass flows in the Sankey diagram to improve readability.

The Sankey diagram referring to the EU for the year 2017 is provided in Figure 1. The diagrams for the preceding years, which are all available on the link in the abstract, are structured in the same way. All numbers are in million cubic meters solid wood equivalent (Mm³ SWE). The arrows show direction and

¹ European Union, 27 Member States from 2020.

² Solid wood equivalent: amount of solid wood fibre contained in the product.

size of the flow while their colours are intended to provide guidance to the main flow categories.

Removed and traded roundwood is derived directly from the Joint Forest Sector Questionnaire (JFSQ) data [2]. Conversion factors from UNECE/FAO [5] were used to get these quantities over bark as well as the total available bark. Woody biomass required by the material industry, as well products and by-products amounts, were estimated from JFSQ data applying country and sector-specific input/output coefficients from INFRO [4]. Conversion to the common unit Mm^3 SWE (solid wood equivalent) was made by applying conversion factors from input and output coefficients [4]. The quantity of wood pellets for the years 2012-2017 were derived from JFSQ, while from Eurostat for the previous years, they were interpolated as was done in previous versions [1]. Conversion factors to convert wood pellets to Mm^3 SWE were derived from the Joint Wood Energy Enquiries (JWEE) [6].

Nodes representing woody biomass for energy were estimated from the JWEE data complemented with the progress reports of the National Renewable Energy Action Plans (NREAP) [7], as reported in the Wood Resource Balance [1]. "Uncategorized wood" is equivalent to the "unknown wood" class in the WRB table reporting wood supply for energy [1].

Data on recovered pulp as well as virgin and recovered paper production are derived from JFSQ. Conversion factors to convert pulp and paper products to Mm^3 SWE are derived from Jochem et al. [9]. Yield ratios for papermaking are taken from Van Ewijk et al. [8], while for processing recovered paper are obtained from the work of Mantau [10].

Trade data for all the commodities are derived from JFSQ [2].

Post-consumer wood (PCW) is partly derived from input coefficients from INFRO [4] applied to the material sector and partly from the JWEE data. Those two components equal the PCW flows in the Sankey diagram.

The Sankey flow diagram is shown in Figure 1. There we see that the quantities, as represented by the flows may be directly derived from the starting node. This is the case when only one flow is coming out of a starting node. Examples are the starting nodes for net-import,

domestic removals or uncategorized woody biomass. In the cases where flows are representing net-exports, the quantities, as represented by the flows, are equal to the end node. Incoming and output flows to manufacturing processes (except the paper sector) are derived by the JFSQ data multiplied respectively by the input and output coefficients [4]. For the paper and paperboard production, incoming flows equal the output flows of the preceding processes, while output flows are estimated with the yield ratios described above.

The flow of roundwood to energy is estimated from the "direct wood" class in the WRB table reporting wood supply for energy [1]. Roundwood, in this case, is the sum of what is denoted in the diagram as 'domestic removals', 'net imported roundwood' and 'unreported primary' when present for a given year. This value is under bark; the bark is treated separately in the dark green arrow in the left of the diagram. The origin of the biomass used for energy is not always specified in the reporting. These unspecified quantities are denoted as "uncategorized woody biomass" and are represented with the grey arrow.

The category "unreported primary" is introduced when the total uses of roundwood exceed the reported sources to balance the first node. In cases where the total sources exceed the uses, the category "unreported uses" appears in the diagram.

The "indirect wood" class from the WRB table has been further refined for the purposes of these Sankey flow diagrams. The flows of indirect wood are here are first attributed as the flows from post-consumer wood (PCW, yellow arrows), then net-imports wood pellets, by-products and finally, bark (from roundwood). This amount of bark is equal to the total bark that is estimated from the reported roundwood, minus the bark quantity that is used in the products. In cases where the incoming flows are larger than the declared uses of secondary woody biomass for energy, the "unreported uses" are first attributed to bark, then to by-products.

In some cases, it was not possible to reasonably attribute the difference between input and output to any flow and nodes are left unbalanced (e.g., when reported net-export is larger than domestic production). The node "paper and paperboard" is always unbalanced because recovered paper is smaller than the available stock.

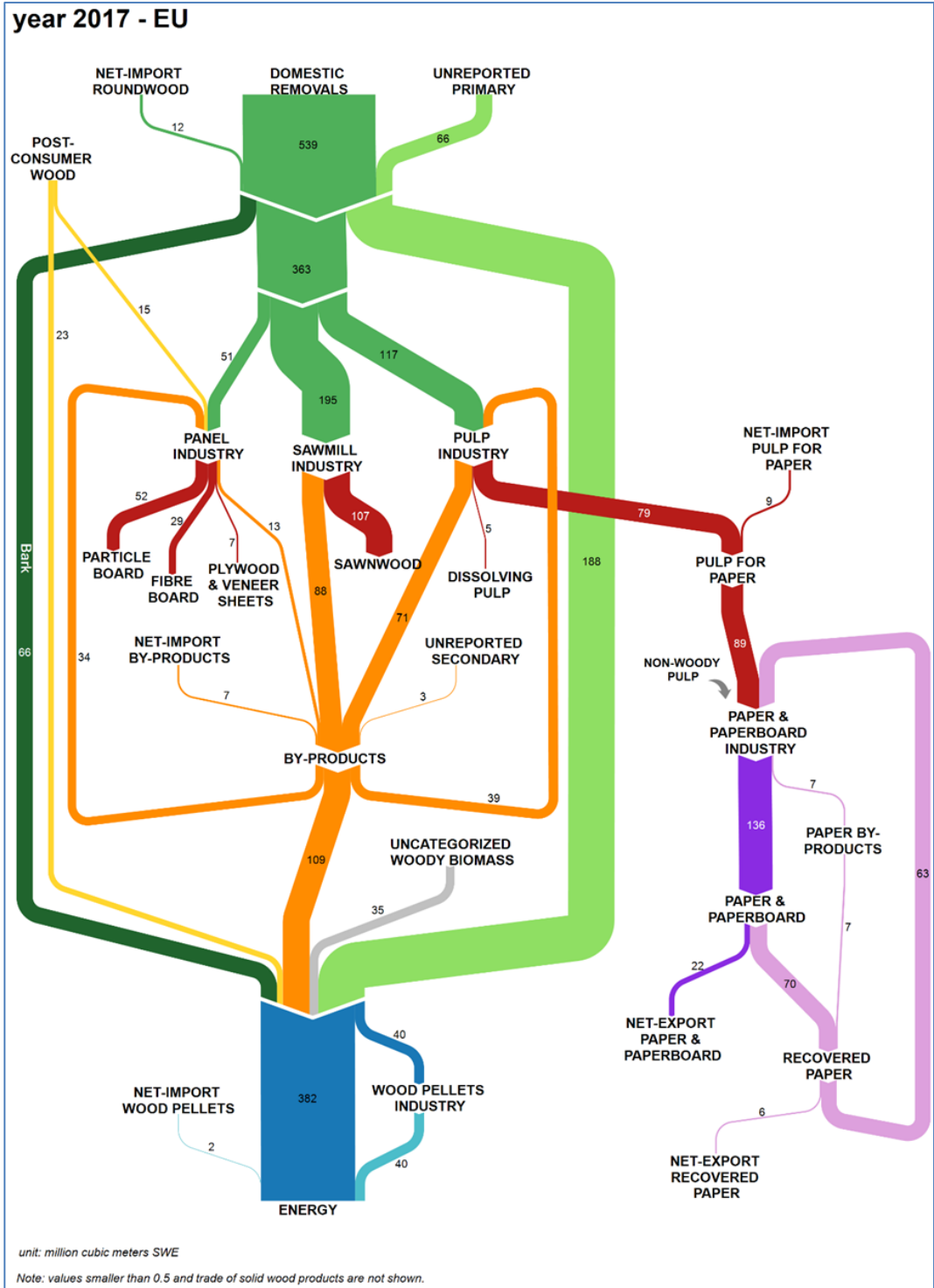


Figure 1 - Sankey diagram at EU level for the year 2017. The full time series can be found at the link cited in the abstract.

Definitions

Bark: It includes the amount of bark that is available for non-material uses, either directly or after processing of the roundwood.

By-products: Secondary product made in the manufacture of sawnwood, wood-based panels and wood pulp. In the diagrams, by-products include black liquor, sawmill residues, wood chips and particles (see [1]).

Dissolving pulp: Chemical pulp (sulphate, soda or sulphite) produced from wood of special quality, with a very high alpha-cellulose content (usually 90% and over). It includes high-purity cellulose. This type of pulp is always bleached and is readily adaptable for uses other than papermaking. It is used principally as a source of cellulose in the manufacture of products such as synthetic fibres, cellulose plastic materials, lacquers and explosives.

Energy: Woody biomass used for Heat and Power production.

Fibreboard: Panel manufactured from fibres of wood or other ligno-cellulosic materials with the primary bond deriving from the felting of the fibres and their inherent adhesive properties (although bonding materials and/or additives may be added in the manufacturing process). It includes fibreboard panels that are flat-pressed and moulded fibreboard products. It is an aggregate comprising hardboard, medium/high density fibreboard (MDF/HDF) and other fibreboard.

Panel industry: Woody biomass feedstock for the production of wood-based panels, including fibreboard, particle board, plywood and veneer sheets.

Paper & paperboard: Includes all paper suitable for printing or other graphic purposes; tissue and other hygienic papers for use in households or commercial and industrial premises; paper or paperboard mainly used for wrapping and packaging purposes; and other papers and boards for industrial and special purposes. It excludes finished products.

Paper by-products: Secondary product made in the manufacture of paper and paperboard.

Paper & paperboard industry: woody biomass feedstock for the production of paper and paperboard.

Particle board: It is an aggregate of particle boards and oriented strandboards. Particle board is a panel manufactured from small pieces of wood or other ligno-cellulosic materials (e.g., chips, flakes, splinters, strands, shreds and shaves) bonded together by the use of an organic binder together with one or more of the following agents: heat, pressure, humidity, a catalyst, etc. Particle board is also called chipboard. It includes medium density particle board (MDP), waferboard and flaxboard. It excludes wood wool and other particle boards bonded together with inorganic binders. Oriented strand board (OSB) is a structural board in which layers of narrow wafers are layered alternately at right angles

in order to give the board greater elastomechanical properties. The wafers, which resemble small pieces of veneer, are coated with waterproof phenolic resin glue, interleaved together in mats and then bonded together under heat and pressure. The resulting product is a solid, uniform building panel having high strength and water resistance. It excludes waferboard.

Post-consumer wood: Any waste wood fibre after at least one life cycle. It comprises wood from construction, renovation and demolition, but also packaging as well as old furniture.

Plywood & veneer sheets: Plywood is a panel consisting of an assembly of veneer sheets bonded together with the direction of the grain in alternate plies generally at right angles. The veneer sheets are usually placed symmetrically on both sides of a central ply or core that may itself be made from a veneer sheet or another material. It includes veneer plywood (plywood manufactured by bonding together more than two veneer sheets, where the grain of alternate veneer sheets is crossed, generally at right angles); core plywood or blockboard (plywood with a solid core (i.e., the central layer, generally thicker than the other plies) that consists of narrow boards, blocks or strips of wood placed side by side, which may or may not be glued together); laminboard and battenboard (with a thick core and composed of laths or battens of wood glued together and surfaced with outer plies); laminated veneer lumber (LVL) and composite plywood (plywood with the core or certain layers made of material other than solid wood or veneers). It excludes laminated construction materials (e.g., glulam), where the grain of the veneer sheets generally runs in the same direction, bamboo plywood and cellular board. Veneer Sheets are thin sheets of wood of uniform thickness, not exceeding 6 mm, rotary cut (i.e., peeled), sliced or sawn. It includes wood used for the manufacture of laminated construction material, furniture, veneer containers, etc. Veneer sheets used for plywood production within the same country are not double accounted.

Pulp for paper: Fibrous material prepared from pulpwood, wood chips, particles or industrial residues by mechanical and/or chemical process for further manufacture into paper and paperboard. It includes mechanical, semi-chemical and chemical wood pulp. It excludes recovered paper and pulp made from fibre other than wood.

Pulp industry: Woody biomass feedstock for the production of wood pulp.

Recovered paper: Waste and scraps of paper or paperboard that have been collected for re-use or trade. It includes paper and paperboard that has been used for its original purpose and residues from paper and paperboard production.

Roundwood: All roundwood felled or otherwise harvested and removed. It comprises all wood obtained from removals, i.e. the quantities removed from forests and from trees outside the forest, including wood

recovered from natural, felling and logging losses during the period, calendar year or forest year. It includes all wood removed with or without bark, including wood removed in its round form, or split, roughly squared or in other form (e.g. branches, roots, stumps and burls - where these are harvested - and wood that is roughly shaped or pointed). It is an aggregate comprising fuelwood, including wood for charcoal, and industrial roundwood (wood in the rough).

Sawmill industry: Wood feedstock for the production of sawnwood.

Sawnwood: Wood that has been produced from both domestic and imported roundwood, either by sawing lengthways or by a profile-chipping process and that exceeds 6 mm in thickness. It includes planks, beams, joists, boards, rafters, scantlings, laths, boxboards and "lumber", etc., in the following forms: unplaned, planed, end-jointed (e.g., finger-jointed), etc. It excludes wooden flooring, mouldings (sawnwood continuously shaped along any of its edges or faces, like tongued, grooved, rebated, V-jointed, beaded, moulded, rounded or the like) and sawnwood produced by resawing previously sawn pieces.

Solid Wood Equivalent: Amount of solid wood fibre contained in the product. It is the roundwood equivalent

volume (green volume prior to any shrinkage) needed to produce the product when there are no losses or wood residues [5]

Unreported secondary: Amount of by-products, required to reach a perfect balance between sources and uses of secondary wood.

Unknown uses: Amount of woody biomass required to reach a perfect balance between sources and uses.

Uncategorized woody biomass: Woody biomass used for energy production from unknown sources.

Unreported primary: Amount of roundwood, under bark, required to reach a perfect balance between sources and uses of primary wood.

Wood pellets industry: Woody biomass used for the production of wood pellets and other agglomerates. Wood pellets are produced either directly by compression or by the addition of a binder in a proportion not exceeding 3% by weight. Such pellets are cylindrical, with a diameter not exceeding 25 mm and a length not exceeding 100 mm. This class includes also agglomerates other than wood pellets, for example briquettes or logs.

References and suggested further reading

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