f3 FACTS NOVEMBER 2025 – FEEDSTOCK FOR BIOFUEL PRODUCTION

Primary residues from the forest

Main forestry products are timber and pulpwood, but unprocessed residues from forestry, such as tops, branches and defective roundwood can be harvested for energy purposes. Currently, a major part of the harvested residues is used in heat plants and combined heat and power plants. However, forest residues also have a large potential as a feedstock to produce biofuels. By gasification and further treatment residues can be used to produce e.g. methanol, ethanol, DME, hydrogen, FischerTropsch diesel and substitute natural gas (SNG). By pretreatment and fermentation, forest residues can be utilized for ethanol production. Another potential lies in the different high value products that can be coproduced when forest residues are utilized in so called biorefineries.

Forest management

In Sweden, the productive forest area is around 23 million hectares. The dominating forest type is conifer (spruce and pine), but also broadleaved and mixed forest types are common. A rotation period can vary from 50 years in southern Sweden to over 100 years in the north. Common practice is to plant seedlings, but natural sowing from seed trees can also be used. Thinning is done to concentrate the growth to fewer trees to achieve better timber quality. There is a large energy potential in collecting forest residues from thinning, even though this is not currently done in any considerable scale in Sweden, mainly due to practical problems of transporting the trees out of the forest without damaging the remaining trees. Final felling is in Sweden often done as clearcutting followed by plantation of new trees, but the concern about decreasing biodiversity and forest ecosystem services has established a growing societal interest in alternative management methods, such as selective logging and continuous cover forestry (Sveriges Lantbruksuniversitet 2024).

The latest revision of the Renewable Energy Directive, that entered into force in November 2023 with an implementation in Swedish legislation in 2025, stipulates that harvesting is carried out considering maintenance of soil quality and biodiversity in accordance with sustainable forest management principles, with the aim of preventing any adverse impact. Furthermore, it should be carried out in a way that e.g. avoids harvesting of stumps and roots. Hence, the energy potential in stumps is limited.

Tops and branches

Tops and branches are part of the biomass that is not taken out of the forest for production of wooden products such as pulp and timber. The tops of the trees are cut, since this part is too small to be used as timber or pulpwood. Tops and branches make up about 15-20% of the mass of the whole tree. During the felling, tops and branches are put in stacks, along with the timber and pulpwood. The stacks of tops and branches are left in the clearing to dry for a period and for the needles to fall off since needles make a good forest nutrient. The semi-dried tops and branches are then taken out of the forest to be stored in windrows alongside the nearest road before transport to user.

There are many different operational and logistics' management options for handling of tops and branches. Since the residues are bulky, they are normally chipped in the forest with mobile chipping equipment before so that transportation can be carried out efficiently. The bulky residues can also be transported to a central chipping facility before the residues are distributed to the customer. Storing of chipped wood can be problematic as it leads to dry matter losses. It also leads to heat development and risk of self-ignition. Storing wet wood chip can lead to molding, with risks of spreading spores that are unhealthy to inhale. Therefore, longtime storage of wood chips is rarely recommended. This requires a balance between supply and demand, which is a logistical challenge.

Stumps

At present almost all stumps are left in the forest after final felling in Sweden. With about 1520% of the whole tree's energy contained in the stump, they were earlier considered as an important potential for bioenergy. However, the latest revision of the Renewable Energy Directive from November 2023 stipulates that harvesting of stumps and roots must be avoided to maintain biodiversity and for soil reinforcement (Energimyndigheten 2025a).

Defective roundwood

Börjesson (2025) estimates that about 3,4 % of the final felling, corresponding to 5,3 TWh per year, ends up as defective roundwood that is chipped and used for energy purposes in heat and power plants. Considering future effects from climate change on forestry (e.g. insects favored by warmer weather), the quantities of damaged wood will probably increase.

Current production and potential

In 2023, unprocessed residues from forestry in Sweden contributed with about 24 TWh of energy, of which about 9 TWh from tops and branches and only a very small part (0,3 TWh) deriving from stumps (Energimyndigheten 2025b)[1]. The residues are mainly used for heat and electricity production. There is currently no commercial production of biofuels from unprocessed forest residues in Sweden.

It is difficult to obtain statistics on how many hectares the residues are collected from, which can be explained by the reporting routines. The forest owners are only obliged to report the intention to take out residues after final felling, but this intention is not always followed through. During 2024, about 98 000 hectares of forest were reported as intended for harvesting of tops and branches. (Skogsstyrelsens statistikdatabas 2025).

For different reasons not all forest residues can be collected. For example, harvesting should not at all be done on wetlands or steep grounds, and a certain amount of the residues needs to be left in the forest for ecological reasons, especially in broadleaved forests. Taking these restrictions into account, Skogforsk (2023) estimates the current potential in tops and branches to 21 TWh per year. Based on long term predictions for felling and on scenarios for the Swedish forestry, accounting for different developments in policy, technology, market, and climate, Börjesson (2025) estimates the bioenergy potential in tops and branches to between 10 TWh/year and 25 TWh/year between 2030 and 2050, depending on scenario. Although the amounts of defective roundwood in the future are difficult to quantify, Börjesson (2025) estimates their bioenergy potential to between 6 and 13 TWh/year between 2030 and 2050, depending on scenario.

Chemical properties

These are the chemical properties for tops, branches, and stumps. The table shows mean value and range (in parentheses). Regarding lignin content, the numbers refer to spruce, in other cases they are not defined.

	Tops and branches	Stumps	Defective roundwood
Lower heating value (MJ/kgdm)*	19.9 (18.8-20.1)	19.5 (19.1-20.6)	16,6-19,6
Ash content (%)	2.7 (1.3-4.7)	1.5 (1.4-18)	0,4-0,7
lignin content (%)	21.5 (15.6-27.4)	19.5	*

* dm = Dry Matter. Source: Värmeforsk (2012, Forest Refine (2014), Rebio (2025) and Skogforsk (n.d.) * No data has been found

[1] The remaining almost 15 TWh came from fire wood (7 TWh), round wood chips (6 TWh), whole tree chips (0,9 TWh) and residues from parks and gardens (0,3 TWh).

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Industry, universities, institutes, and authorities participate in f3. Together, the members create new collaborations, increase knowledge, and identify obstacles and possible solutions for an actual and rapid transition to renewable fuels in the transport sector.

The Innovation Cluster is financed by its member organizations together with the Swedish Energy Agency and is hosted by Chalmers Industriteknik.

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