CASE STUDY

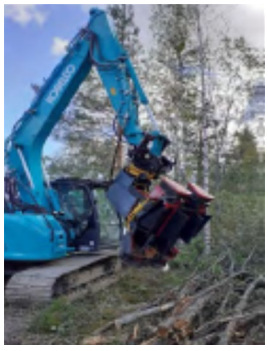
Innovative technology for the energywood supply chain – a focus on young or unmanaged thinning stands typical in Finnish forestry conditions

The goal of the case study is to demonstrate the capacity of innovative energywood supply technology that was considered especially suitable for mobilizing forest biomass from young or unmanaged thinning stands under the conditions that are typical of Finnish forestry. The aim is to demonstrate the entire energywood supply chain from harvesting to forwarding, chipping and transport of forest chips.

The case study includes the demonstration of an innovative harvesting solution with the RISUPETO harvesting device. A BRANCHES showcase of that particular machine and the entire related energywood supply chain was organized as a stand-alone event on Thursday 13.4.2023 from 11 to 14 in the village of Mansikkavirta, Sonkajärvi, North-Savo, Finland (Figure 1). The RISUPETO device is a novel felling head for efficient harvesting of small diameter wood biomass both in forests and edge zones of infrastructure. A video is available from the event through the following link:

The case study includes the entire energywood supply chain with the following elements and machines:

- harvesting with the RISUPETO harvesting device mounted on an excavator
- forwarding of energywood with a forwarder equipped with a specific cutting grapple
- chipping of energywood with a drum chipper at the roadside storage
- transportation of chips with a chip-truck



KEY WORDS

Energy wood, continuous felling-bunching, logging, excavator, cutting device

COUNTRY

Finland

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Figure 1. RISUPETO harvesting device presented at the BRANCHES showcase-day in Finland

BIOMASS HARVESTING

RISUPETO is a new generation energy wood harvester device. The way the device works, in short, is that it harvests (i.e. cuts, accumulates, fells and bunches) whole-trees within one working cycle. The harvesting of trees from 1 to 30 cm is done without additional work cycles. The machine has been used at sites with dense young stands where the undergrowth has not been harvested, the biomass removal is high and the removal potential of merchantable stem wood is low. When mechanized harvesting has been carried out in the past, operations have typically required the manual removal/clearing of the undergrowth in order to be able to operate with a harvesting machine. With this device, there is no need for that at all, the undergrowth removal harvesting of all-sized wood up to 30 cm is done simultaneously when thinning the forest to the extent that it becomes a growing forest following the current forest management practices/ recommendations. In a way, at best, it may save even up to a 1000 euros per hectare while no need to make pre-clearing work, and, managing the forest by RISUPETO, all the harvested wood can be sold as energy wood. The energywood removal will become high party due to the need to open thinning tracks in 20 m space. The width of the track itself follows typical width of a conventional CTL-thinning resulting in 4-5 m. The remaining forestry professionals of manual pre-clearing can be used to those exact places where it is not worth of using this method.

The RISUPETO felling head cuts standing trees with two parallel disk sawblades and accumulates trees in an upright position to the collecting chamber using rotating collecting arms (Figure 2). The collecting arms are attached to the two vertical cylinders, which rotate at the same speed as the disk sawblades. When the collecting chamber of the felling head is full, the accumulated tree bunch is moved to the pile and dropped out. The unloading of the tree bunch is done by tilting the felling head downward and rotating the disk saws and collecting arms in the opposite direction from that during cutting. The width of the hydraulically powered accumulating felling head is 1.0 m, and the maximum cutting diameter with one cut is 30 cm. There is a recognition device that uses pressure sensors, motors in the upper end, the direct drive that rotates and the slowly rotating guillotine-type blade collecting material in the hold. When a bigger tree comes up against it, it changes from series connection to parallel connection, so the speed is reduced by half and the power is doubled, and it can cut even a big tree.

Figure 2. RISUPETO harvesting device suitable for mobilizing forest biomass from young or unmanaged thinning stands.

The accumulating felling head is attached to the boom tip of the medium-sized crawler excavator. The advantages of excavators produced in high volumes include a purchase price lower than that of conventional forest machines such as harvesters and forwarders and, outside the harvesting season, the option of removing the harvesting equipment and using the base machine in the work for which it was originally designed.

Researchers from the Natural Resources Institute Finland (Luke) have studied the first version of RISUPETO in the clearing of field edges and roadside bushes (Laitila & Väätäinen 2021). That is where the device showed its abilities and development potential. The next version was then studied in a completely overgrown young forest restoration site (Laitila & Väätäinen 2023). The harvest result was excellent, and the productivity was at the highest level that has been achieved in similar conditions in the Nordic countries. This makes it possible to rehabilitate problematic sites, particularly overgrown and overdense sites, into a productive state.

A Practice Abstract of this device was presented during a BRANCHES WP2 workshop. The majority of the workshop participants selected this machine as a solution with high potential. Consequently, based on the workshop feedback, this device was chosen for the Finnish WP2 showcase day and case study. More information on the device can be found from the BRANCHES Practice Abstract PA4:

http://files.spazioweb.it/3e/57/3e57236d-e15e-4b7b-851c-a3698496dd3f.pdf

BIOMASS COLLECTING

Forwarding of energywood is carried out using a forwarder (Figure 3). In the demonstrated case, the forwarder was equipped with a specific grapple that cannot only load the material, but also cut the material to the length that is most desired (Figure 4). Moreover, cutting to the desired length while forwarding is more time and cost efficient, than cutting trees to the length with the RISUPETO. The grapple saw Mecanil SG280 RC-M G2, a combination of a grapple with a chainsaw is a product from the company Mecanil Oy Ab.

Figure 3. Collection of forest biomass from thinning using a forwarder..

Since during the previous step a whole tree felling unit (RISUPETO) is used, the material has the length of the harvested trees at the moment of felling. This whole tree length might be too long for the efficient handling during forwarding and piling at the roadside. The grapple saw is able to cut the pre-piled material to the desired length. The cutting can happen at the same time when grapping the material from the forest ground or when lifting the grapple load to the forwarder´s load space. The material is collected from the pre-piles in the forest site and brought to the roadside for storage.

Figure 4. The forwarder is equipped with a Mecanil grapple saw.

BIOMASS CHIPPING & TRANSPORTATION

The biomass chipping and transportation is typically managed by the company purchasing the energywood. The purchaser buys the wood that is harvested form the site, and utilizes their own equipment, in this typical case a wood chipper and a wood chip transport truck.

Figure 5. Chipping of biomass using a truck-mounted drum chipper.

Chipping of energywood: a truck- mounted drum chipper comminutes the whole tree material at the roadside storage into wood chips that are directly blown to the chip truck present at the roadside (Figure 5). The method of roadside chipping is the most common chipping method in Finland. Often, delimbed energy wood is the main energy raw material assortment, but also the provided whole trees work just fine for producing chips for energy use.

Transportation of chips: a chip-truck is loaded with forest chips directly blown by the chipping to the loading space of the truck (Figure 6). The comminuted material is then transported typically directly to the end-using facility, in this case a heating plant. The chips are usually brought directly to the plant without further storage, particular during winter months or heating season.

Figure 6. Chipping at the roadside directly to the chip-truck.

PRACTITIONERS' FEEDBACK & MOTIVATION FOR DEVELOPMENT

In general, the showcase presenting the entire chain with the harvesting, forwarding, chipping and chip transport was very attractive to the targeted audience. Professionals working with thinning operations, particularly energywood harvesting, seemed to be especially interested in the new technology presented during the BRANCHES showcase day. Attendees of the showcase day were really interested about this particular new device, RISUPETO. The showcase made participants more aware of the potential and benefits of this innovative device. Also, the company presenting the innovative device was very pleased with the arrangements, participation and overall interest of practitioners to the machine.

From an entrepreneur´s point of view, with the RISUPETO harvesting device it is easy and precise to control the movements of the harvester head, which allows the operator to leave the best trees standing. The purchase price of the excavator base machine is significantly lower compared to the price of a conventional logging machine. Furthermore, an excavator allows the use of the base machine also outside the harvesting season, e.g., for work it was originally designed.

The RISUPETO device makes the piling of whole trees ready for forwarding, as well as has the advantage of collecting small wood. Using this device, it is possible to work without interruptions in those areas where it would not be very reasonable and economical with other machines.

A particular benefit of the machine occurs when the undergrowth has not been harvested, forest is overdense and the biomass removal is high. Traditional mechanized harvesting using purpose-build machinery have typically required pre-clearing of the undergrowth. With the RISUPETO device this pre-clearing step is unnecessary, and the harvesting is done simultaneously when thinning. Thus, the harvesting of trees is done without additional work cycles that would affect the efficiency, ideally benefitting even thousand euros per hectare compared to using conventional method.

TRADE-OFFS BETWEEN ECONOMIC, ENERGY AND ENVIRONMENTAL EFFECTS FOR CONVENTIONAL AND IMPROVED BIOMASS HANDLING APPROACHES

With the use of an energywood supply chain with the RISUPETO device it is possible to influence on environmental aspects. It is the aim to leave a certain amount of rotten wood in the forest, which is important from a biodiversity and environmental point of view. With this device, it is possible to leave the remaining stump as long as wanted, some want to leave stumps 30-40 cm long, others want them completely cut off close to the roots. If stumps are left longer, the device will shatter the stump, so the amount of rotting wood will multiply by the length of the stump, depending how much is planned to be left per hectare.

In Cut to length (CTL) harvesting, trees are delimbed and cross-cut to log assortments at the site using purpose-build machines. In that case the branches and treetops remain in the forest, meaning also that there will be less available wood material. One positive aspect about using the RISUPETO harvesting device is that the material is more precisely collected from the forest, and all the smaller trees, that would otherwise not be collected with a traditional machine, can also be brought along. Thus, the results will be a cleaner forest this way.

KNOWLEDGE TRANSFER POTENTIAL TO OTHER REGIONS

The presented innovative technology for the energywood supply chain has definitely a high potential to be transferred to other regions. The conditions of young, overgrown, overdense, and unmanaged thinning stands presented in this case through a typical case under Finnish forestry conditions can also be found in many other regions. There is a strong need to manage such stands in an efficient and sustainable way, ensuring the respective long-term objectives in forestry. Besides, the solution is suitable for mobilizing forest biomass in a profitable means.

The focus on an efficient energywood supply chain utilizing a locally available source of biomass can show benefits to the local and regional economy. The utilization of such a renewable source of energy brings economic and environmental benefits particular to rural communities, especially if the alternatives involve fossil-based solutions. Also, social benefits can be mentioned, particular through the employment of people along the entire value chain. The presented solution furthermore allows the flexible and year-round use of machinery, particularly for the investment of the excavator base machine.

SUMMARY

In conclusion, the value chain model based on innovative technology for the energywood supply chain is a model of circular economy that consists of the efficient use of biomass from young or unmanaged thinning stands typical in Finnish forestry conditions. The harvested biomass serves as a source of renewable energy, which can cover energy demands of the local or regional consumers. By doing so, the energywood circle is closed, and a green local economy is promoted in line with the EU's energy and climate goals.

References:

Laitila J. & Väätäinen K. (2021) Productivity and cost of harvesting overgrowth brushwood from roadsides and field edges, International Journal of Forest Engineering, 32:2, 140-154, https://doi.org/10.1080/14942119.2021.1903790

Laitila J. & Väätäinen K. (2023) The productivity and cost of harvesting whole trees from early thinnings with a felling head designed for continuous cutting and accumulation, International Journal of Forest Engineering, 34:1, 76-89, https://doi.org/10.1080/14942119.2022.2094192

ABOUT BRANCHES

BRANCHES is a H2020 "Coordination Support Action" project, that brings together 12 partners from 5 different countries. The overall objective of **BRANCHES** is to foster knowledge transfer and innovation in rural areas (agriculture and forestry), enhancing the viability and competitiveness of biomass supply chains and promoting innovative technologies, rural bioeconomy solutions and sustainable agricultural and forest management.

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