Supply Curves for Whole Trees from Early Energy Thinning and Stump Cores

The supply of innovative assortments from forest to three bio refineries located in the project region was considered. Cost and energy use supply curves for whole trees from early energy thinnings and for stump cores were created. An innovative forestry regime including early energy thinning instead of pre commercial thinnings can provide about 80 thousand OD t/year for each potential biorefinery. The whole tree bundling at the harvesting stage can significantly lower the supply costs and energy demand, compared to the supply of loose small trees. The harvesting of stump cores integrated into the supply of sawlogs can provide up to 100 thousand OD t/year per facility, which is ca. 20 % of potential stump biomass. The innovative integrated harvesting of stump cores gave a 10-25 % lower cost and halved energy use, compared to conventional supply of stumps as separate assortment.

Introduction

In the systems analysis sub-project of Forest Refine, we have calculated supply curves for novel forest feedstock assortments delivered to the cities of Storuman, Umeå and Örnsköldsvik. Supply curves show the amount of feedstock that can be offered to the market at a given market price. According to economic theory, the market price and the amount of goods supplied to the market depend on the supply curve and its interaction with the corresponding demand curve.

Small whole trees and stumps offer a large potential of forest biomass in the project region, that is currently under-utilized due to the high supply costs for such assortments when using conventional supply systems, therefore we analyzed the cost and energy efficiency of innovative supply alternatives for such biomass to biorefineries.

Energy thinning whole trees

In the conventional Nordic forestry regime, a pre-commercial thinning (PCT) must be carried out when the tree heights reach approximately 5 m in order to reduce stand density, successively a first thinning for pulpwood is carried out when the tree heights is approximately 8-10 m. Often PCTs are neglected, resulting in biomass rich and diametrically heterogeneous stands at the time of first thinning, with most of biomass unsuitable for pulpwood production. An alternative to this treatment is to perform an early energy wood thinning instead of a PCT when the tree height is approximately 6-7 m with removal of whole trees by boom corridor harvesting technique (cf. Bergström et al. 2007). The whole tree biomass harvested from small trees is a bulky material, and in order to optimize the transportation some densification is needed. Therefore, we analyzed the innovative supply of whole trees from energy thinning in case they are harvested and successively loose compressed on the forwarder bunk by use of compressing stakes and in the case of bundling the whole trees at the harvesting stage with a purpose-built bundle harvester.

Stumps

In the conventional harvesting systems of final fellings, the stumps are harvested as a separate assortment by use of excavators; afterwards the stump biomass is forwarded and transported to the industry as a loose material. As an innovative alternative supply, we analyzed the harvesting of the stump cores (that is the central part of a stump) integrated with felling of sawlogs with a feller-puller machine (cf. Berg et al. 2014), afterwards the stump cores are forwarded and transported together with the sawlogs and sieved out at the sawmill gate.

Results

Energy thinning whole trees

Figure 1 shows the supply curves for whole trees from early energy thinnings, handled loose or bundled at harvesting site. The harvested amounts are about 80 thousand ODt/year for all three considered locations. The alternative which applies bundling of the trees at harvest site has markedly lower supply costs (typically below 800 SEK/ODt) than the alternative where the trees are handled loose (typically around or above 800 SEK/ODt). Also energy use is lower for the bundling alternative by a little less than 1 %-age point and lies around 2-3 % of the energy content of the delivered feedstock.

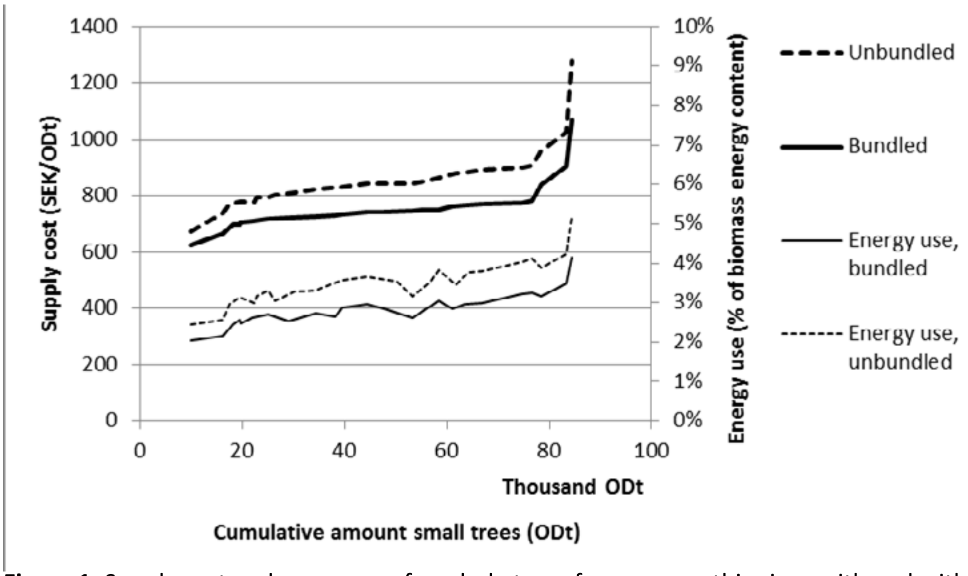

Figure 1. Supply cost and energy use for whole trees from energy thinnings with and without bundling, based on the case study of Örnsköldsvik. Chipping at terminal and delivery to industry is included.

Stumps

Figure 2 shows the supply curves for the innovative stump core harvesting integrated with the sawlogs supply compared to the conventional separate stump harvesting. The stump core supply cost and energy use is calculated as the additional costs and energy use for stump core extraction compared to the same operations without any extraction of stump biomass. In stump core harvest, only about 20 % of the stump biomass is recovered compared to conventional stump harvest, since the available amounts within the 120 km supply radius is much smaller (approximately 100 Thousand ODt/year for Umeå and Örnsköldsvik and just above 50 ODt/year for Storuman).The supply cost and energy use per ODt for a given harvesting site is however significantly lower for stump core harvesting than for conventional separate stump harvesting. Supply costs for stump core harvesting lies around 800 SEK/ODt while the supply cost in conventional stump harvesting is about 900-1200 SEK/ODt. Energy use is between 2-3% with the innovative supply and 4-6 % of feedstock energy content with a conventional stump harvesting

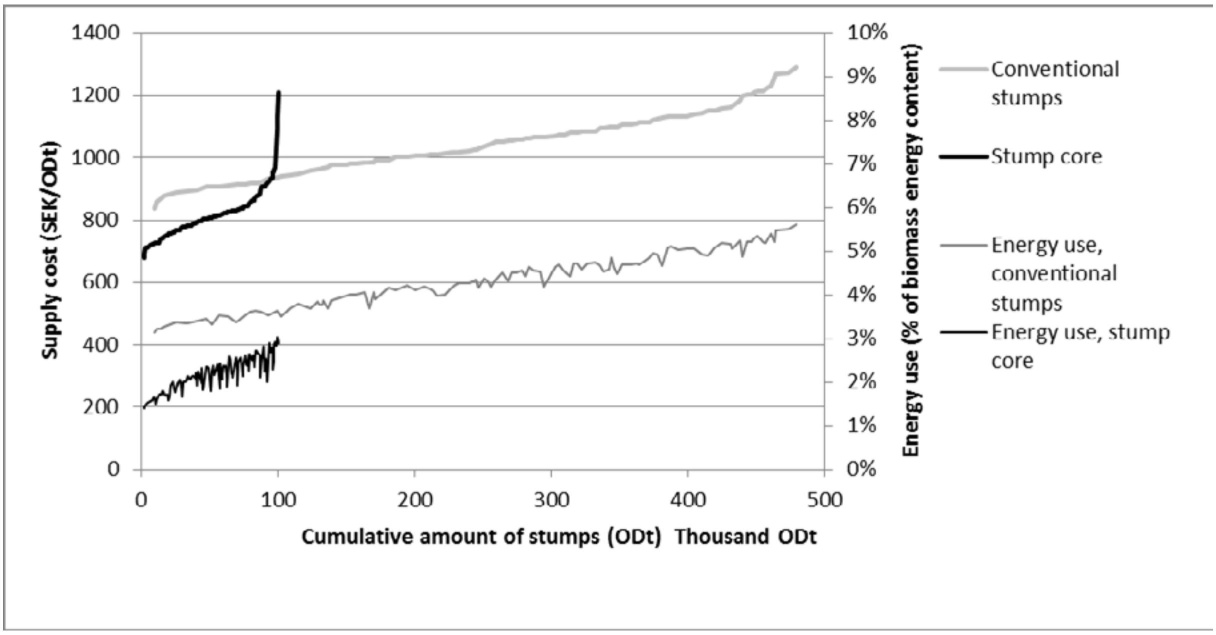

Figure 1. Supply cost for stump core harvest compared to supply cost for conventional stump harvesting, based on the case study of Örnsköldsvik. Chipping and delivery to industry is included.

LITERATURE

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