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How to analyse and maximise the forest fuel supply availability to power plants in Eastern Finland

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ABSTRACT

The annual use of forest fuels has grown rapidly in Finland during the 21st century. In 2007 the annual use was 5.3 TWh (firewood use excluded), whereas the targeted growth by the year 2010 is 10.6 TWh, i.e. some 5 million m^3. The purpose of this work was to evaluate the maximum availability of forest fuels to CHP plants in Eastern Finland. The total availability to the selected CHP plant population was 7 TWh at the maximum transport distance of 100 km. The main share came from logging residues, 3.3 TWh, and the rest from stumps, 1.8 TWh, and small diameter energy wood, 1.9 TWh. The highest plant-specific availability reached the level of 1.7–1.8 TWh, but the overlapping procurement areas reduced the availability for most plants to a level less than 1 TWh. In all plant sites peat fuel could be partially compensated with forest fuels according to availability, but not completely due to the boiler technology. Increasing the targeted national forest fuel use presupposes the use of new logistics supply solutions, such as other transport modes and regional buffer storage networks. This makes it possible to widen the traditional procurement area-based on truck transportation, which is less than 60 km because of a dense plant network.

1. Introduction

The annual use of forest fuels has grown rapidly in Finland during the 21st century. In 2007 the annual use was 5.3 TWh (firewood use excluded), which dropped from the peak level of 6.1 TWh in 2006 [1,2]. The main reason for this change was the low prices of emission allowances in 2007 at the end of first trading period. Therefore, more peat fuels were used instead of wood fuels in the CHP plants. Last year's fall calls for more intensified future use of forest chips, since the targeted growth by the year 2010 is 10.6 TWh, i.e. some 5 million m^3 [3]. An expert group appointed by the Ministry of Trade and Industry has settled on a target level of 15 TWh by the end of 2015 [4]. Finnish Bioenergy associations have made a proposal to start a new Bioenergy Programme, where the target for forest chips is as high as 25–30 TWh by the end of 2020 [5]. An increase at least of 1 TWh per year is required to realise this trend. The national raw material reserve makes it possible to reach these targets since techno-economical potential is calculated to be 30 TWh per year without jeopardising the sustainability of forest fuel supply [6].

According to the sample plot results performed by the Forestry Development Centre Tapio, logging residues were collected from at least 25% and stumps from 5% of all regeneration felling sites of private forest owners in 2007 [7]. The harvesting rate of residues was less common in the eastern and northern provinces in Finland and most common in Central Finland and Kainuu province. In particular, high demand and the location of large-scale end-user sites have caused this regional variation in Finland. Harvesting areas have increased rapidly compared to 2006, logging residues by 33% and stumps by 50% [7]. Felling areas owned by state or forest industries were excluded from this test sample type study. According to the national study of techno-economical energy wood

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potential and use in 2006, the potential recovery rate was even higher, some 30% for logging residues and some 20% for stumps [8]. These values were calculated only from the collecting sites suitable for recovery. However, despite the different study methods, both studies showed large unused potential especially from the energy wood collecting areas for stumps and small diameter energy wood.

The Commission of the European Communities has set targets at the EU level for renewable energy to triple its share from the current level of 7% measured from energy end use to 20% by the end of 2020, and to reduce greenhouse gases by 20% by 2020 compared to 1990 [9]. The country-specific targets for Finland would increase the share of renewable from the current level of 28.5–38%. A majority of this increase will be allocated to bioenergy, which constituted 86% (83 TWh) of the renewables in 2007 [10]. This target set by the Commission would be higher than the targets set by the Finnish government in the Action Plan for Renewable Energy 2003–2006 [3]. Therefore, the Finnish government is currently updating Finland's climate and energy strategy to meet the goals set for the EU energy policy. For example, forest chips covered 1.3% of the total energy consumption and its share could reach a maximum level of 5–6% by the end of 2020, depending on energy consumption. The Commission has also made a directive proposal to increase biofuel use in traffic to the level of 10% throughout the EU by 2010. This target can only be met by biofuels that fulfil the sustainability criteria proposed by the Commission. Using the biofuel sustainability criteria the goal to achieve more efficient use of resources and minimise the negative environmental impact of biomass harvesting. The criteria for greenhouse gas reductions, biodiversity and land-use exclusion will exclude such biomass sources that do not fulfill these conditions.

One practical tool in reaching the targets set for renewable energy is the emission trade system. The emission trade of CO_2 allowances will boost the rate of growth of forest chip use as they are almost the only realistic alternative to decrease CO_2 emissions in the near future without reducing energy production in Finnish CHP plants. In the future, other potential end-user options for forest biomass will also emerge, such as pellets, cellulose-based ethanol or methanol from the Fischer-Tropsch (FT) process. The export of chips or refined fuels could be an alternative because of the varying payment ability and incentives for biomass energy use in different EU countries. In previous studies [11,12], the demand and supply balance of wood fuels at the provincial level have been evaluated both without the effect of emission trade and when the emission trade price level was 20 € per tonneCO_2 for emission allowances in 2010. Regionally, the potential demand for wood fuels for energy use was higher than the supply in all provinces in Finland. According to the results of the optimisation model, wood fuels were used most in the provinces of South Karelia and Central Finland. The main reason for this is the high density of forest industry in these provinces. This leads to a high supply of by-products from the forest industry, mainly for the internal use of forest integrates. The wood fuel demand and supply were well balanced in the provinces of Eastern Finland, South Karelia (demand vs. deliveries 83%), North Savo (79%), South Savo (71%) and North Karelia (71%), being at a higher level compared to the average value of Finland (68%) [12]. This study showed that on average, Eastern Finland has better opportunities to increase forest fuel usage because of its vast biomass resources and felling activity. Only provinces with a long national border like South Karelia may have poorer possibilities to use traditional truck-based transportation to increase forest fuel deliveries to plants near the border because of the smaller potential procurement area.

The purpose of this study is to evaluate the maximum availability of forest fuels to the large-scale CHP plants in Eastern Finland and the capability to use forest fuels, including the provinces of South Karelia, South Savo, North Savo and North Karelia. The study examines the factors influencing the availability between alternative plant sites and possibilities for using forest fuels to compensate for other fuels in the study area.

2. Material and methods

2.1. *Forest biomass potential for energy purposes*

The forest fuel sources consisted of logging residues and stumps from final fellings and small diameter energy wood from early thinnings. The supply potential calculations of logging residues and stump biomass were based on the GIS databases of final felling stands of forest industry integrates from the year 2000. This data was aggregated and complemented by area-based felling data of other felling organisations (Fig. 1). This calculation procedure was developed and presented in earlier studies [13,14].

The forest biomass potential at a plant level was determined according to the size of the procurement area and the forest biomass area-based potential within each procurement area. Economic reasons limited the maximum transport distance as well as the boiler location in relation to the national border in Eastern Finland. The maximum transport distance was limited to 100 km because all transportation was based on trucks. Overlapping procurement areas were allocated between alternative CHP plant sites by minimising the transport distances.

In addition, the road infrastructure and its efficiency had an effect on the size of the procurement area. In particular,

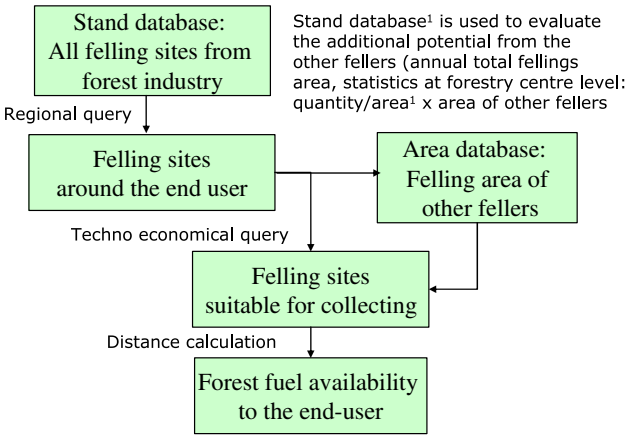

Fig. 1 – The calculation procedure of forest fuel availability to combine the stand and area database.