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An engineering economics approach to the estimation of forest fuel supply in North-Trøndelag county, Norway

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Abstract

The article reports a study performed in North-Trøndelag county in Norway, aiming at identifying the economic supply curve for forest fuels. Using an engineering economics approach, the potential forest fuel production is described as a function of the existing traditional forestry. Based on a set of energy raw materials including (i) harvesting residues, (ii) low-quality trees, (iii) thinnings and (iv) hardwoods, necessary adjustments of the existing forestry technology are described and used as a basis for the calculations. Depending on fuel market prices, a total annual amount of forest fuels close to 0.5 TWh is available in the county. © 2004 Elsevier GmbH. All rights reserved.

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Introduction

Increased diffusion of modern bioenergy-based space heating in Norway is a theme with a history that stretches over at least two decades. The main motivation for expanded bioenergy use has changed from one of rural development and job creation in the 1980s (OED, 1982) to the focus on the role of bioenergy in the climate

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question in the 1990s and onward (OED, 1999). After the autumn 2004 Russian ratification of the Kyoto protocol, making it a binding international agreement, the challenge of reducing global carbon emissions from energy use is further emphasised. The Norwegian goals for bioenergy use are embedded in the target of increasing the annual production of water-distributed heat based on new renewable energy sources, including heat pumps and waste heat, with 4 TWh by 2010 (OED, 1999).

The successful diffusion of biofuels in the Swedish energy market is frequently used as a reference relative to the processes of the Norwegian development of the bioenergy market. Although the Scandinavian neighbours share many similarities in terms of biomass resources, the two countries have followed different paths in the development of their energy systems and thus bioenergy use. Statistics show that a total of 15 TWh of biomass-based energy was produced in Norway in 2001 (Statistics Norway, 2002), while, for comparison, the Swedish production of bioenergy was 97 TWh in 2000 (STEM, 2001). Forest fuels alone accounted for 15 TWh of the Swedish bioenergy production.

In this paper, a study of the potential supply of forest fuels from the North-Trøndelag forest is presented. North-Trøndelag is a county in mid-Norway, with relatively large forestry resources and with an economy that is, in relative terms, dependent on agriculture and forestry and related industries. Although the climate challenge is a global issue, it is likely that solutions to this problem will differ between geographical regions. The path towards a more sustainable energy system will be a result of the general regional context, consisting of, e.g. economic, technological and cultural elements, and particularly the constraints and opportunities given by the natural resource base, within which the development of sustainable energy technology takes place. Therefore, in this study, we take as starting point the current state of the region's forestry and discuss how this industry could contribute in an initial phase of a transition towards increased use of forest fuel in the Norwegian energy system. The concrete supply structure that is derived in this analysis, cannot be generalised to other and different contexts. More universally applicable, however, is the principal approach to the climate challenge that is taken, together with the principles and methods applied in the cost model representing the backbone of this study.

Woody energy raw materials seem to enter an expanding bioenergy market in a certain sequence. Typically, by-products from sawmills and other wood industry are utilised early in this sequence due to their low cost availability and in some cases good quality. These products are often used for internal energy needs in the wood industry or they may be used as is for energy production in heating plants. Dry and fine fractions may be refined further in the production of pellets or briquettes. Different kinds of wood wastes are also regarded suitable for energy production, but the utilisation of these products is highly dependent on the features of the general waste policies. The next step in this sequence is the utilisation of forest fuels, i.e., wood materials harvested in the forest for energy purposes. This production of forest fuels is the subject of this paper.

A weakness of previous bioenergy resource inventories in North-Trøndelag, is that they have focused on the physical quantitative availability of the energy resources,

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