SUSTAINABLE BALANCE OF BIOFUELS SUPPLY-DEMAND IN ESTONIA

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1. INTRODUCTION

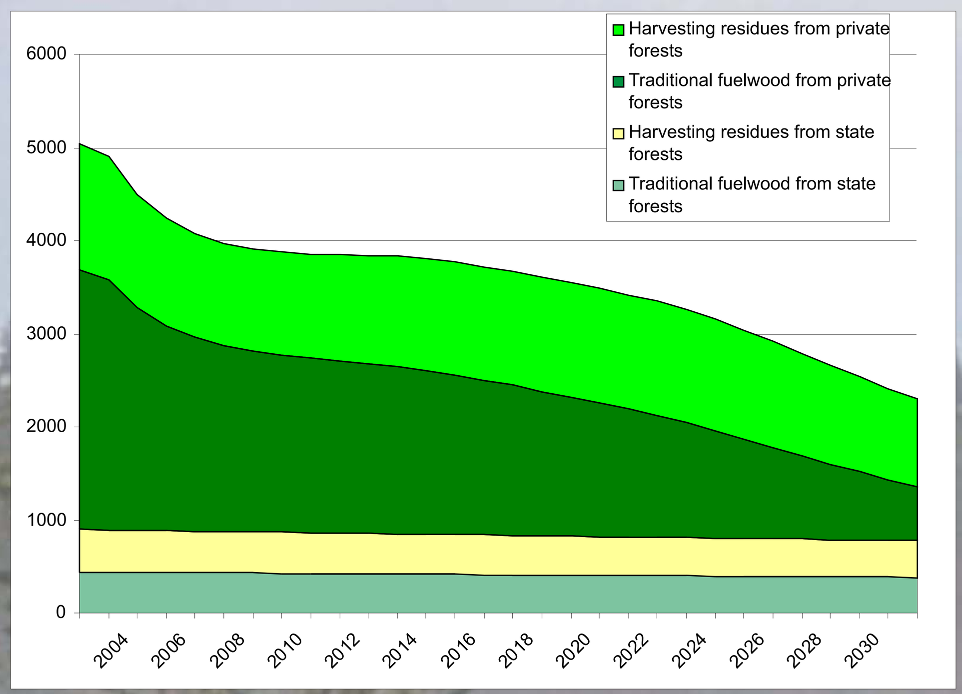
The Long-term Development Plan for the Estonian Fuel and Energy Sector and the Estonian Forestry Development Programme 2001-2010 have pointed out the importance of extensive utilization of biofuels for energy production. Estonia has declared the commitment to increase the share of renewables in electricity production up to 5.1% by the year 2012. The aim of the present study was to forecast the possible changes in the utilization of biofuels during the coming years.

2. RESOURCES OF THE WOOD FUEL

According to the latest forest surveys [1], the area of woodland in Estonia is 2.25 Mha (51.5% of land area) and the calculated growing stock is 462 Mm^3. The allowable level of utilization of forest resources fixed by the Forestry Development Programme 2001-2010 is relatively high, 13.1 Mm^3, due to the overbalance of middle-aged and mature stands in private forests.

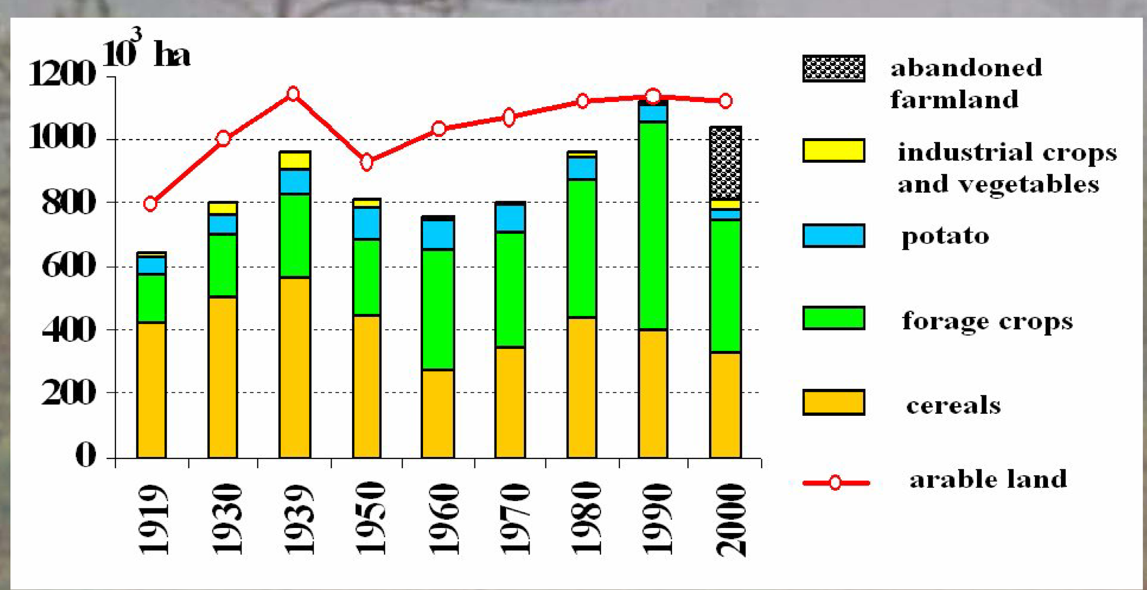
The calculation of the yield of the fuel wood for the coming 20-30 years period was based on the Estonian forest inventory data, functions of growth, algorithms of assortments and economical decisions [2]. The analysis of the age structure showed, that the biggest areas of forest will reach maturity during the coming 11-20 years period, quite a lot during the next 10 years and after 20 years the areas will start to decrease. Due to the big share of mature aspen and grey alder stands, in private forests the dominating assortment is fuelwood. But if the private forest owners start to harvest besides merchantable assortments the low quality wood, the available quantities of wood fuel will decrease step by step (Figure 1). The data indicates that today we can use for energy production about 5 Mm^3 of fuelwood and forest residues, after 30 years about 2.3 Mm^3. After 35-40 years the harvesting volumes are expected to stabilize and then a slight increase will follow.

Figure 1: Forecast of the wood fuel supply for the coming 30 years



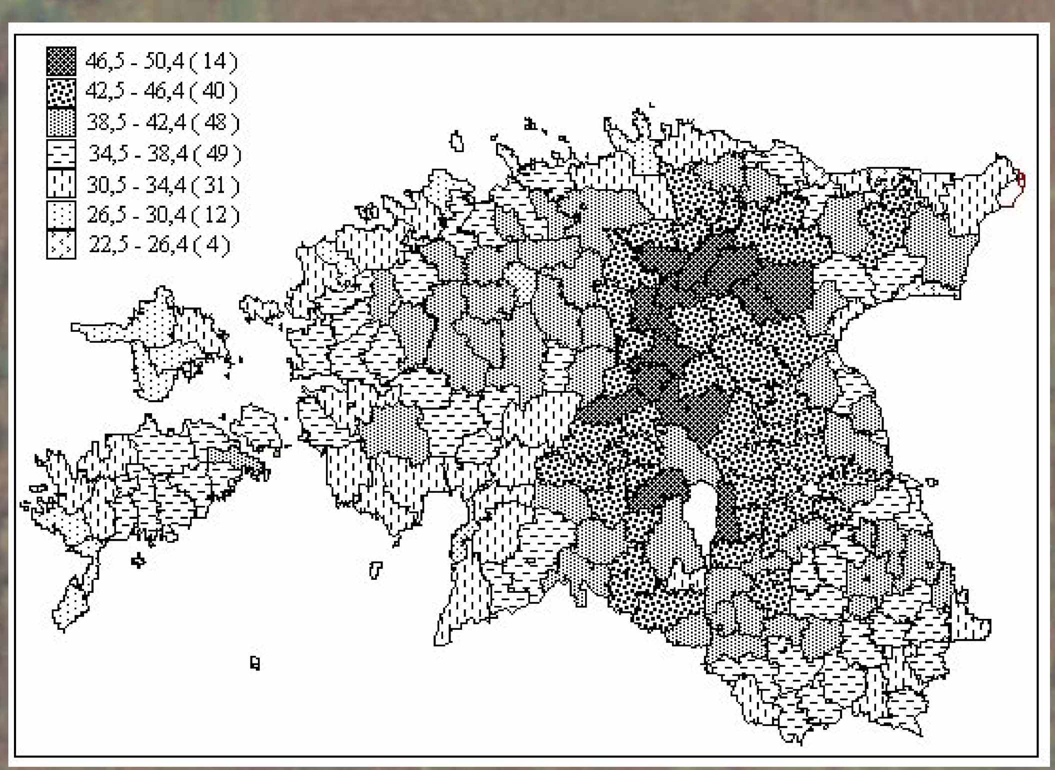
3. AGRICULTURAL RESIDUES AND POTENTIAL OF ENERGY FORESTS

Figure 2: Utilization of the arable land



During the last decade, the area of the abandoned farmlands has increased (Figure 2). Considering the present situation in cereal production, use of 25% of total straw production for fuel would make 100-150 thousand tons. In the future, with more intensive cereal production, the amount of fuel straw could be as much as 200-250 thousand tons. Based on the calorific value of straw, it would be possible to produce at present 0.4-0.6 TWh of energy, while in the future the corresponding amount could be 0.8-1.0 TWh.

Figure 3: Distribution of the soil quality by the parishes

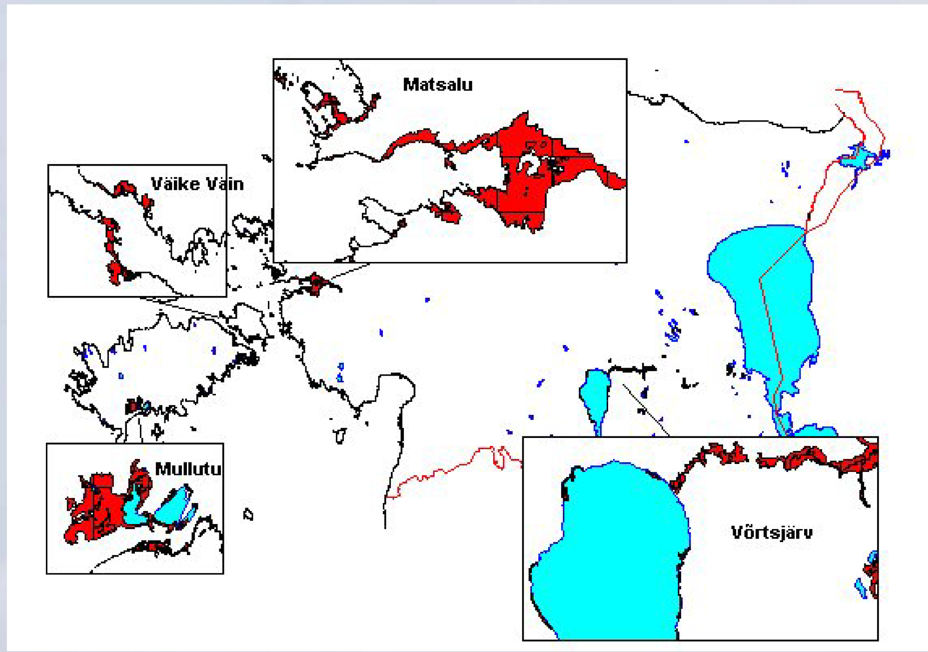


Soil quality on one-third of arable lands in Estonia is extremely low, ≤ 32 points (Figure 3). On these soils, development of traditional farming is unprofitable. Hence agricultural production is related to high economic risk at least on 350-370 thousand ha. One of the most promising alternatives for those lands is the cultivation of energy forests. If to cultivate the arable lands with low fertility soils with willow, the theoretical energy potential of plantations can be up to 9.8 TWh. However, the growth of this species depends largely on the soil, meteorological conditions and agro technology.

4. OTHER BIOFUELS

There are plenty of wetlands in Estonia that have reasonably high productivity of biomass. The total area of wetlands is approximately 24 thousand hectares and the largest of them are situated at Matsalu (in the delta of Kasari river), Noa-Rootsi, at Väike väin and lakes Peipsi and Võrtsjärv (Figure 4).

Figure 4: Location of biggest thickets of reed



The research data show that approx. 1-1.5 kg dry substance per 1 m2 is growing in the natural wetlands. The net calorific value of reed in spring is 4.2 MWh/t, which gives energy contents 42 MWh/y per hectare. The total primary energy potential of reed is estimated to be 474 GWh/y. Reed and cattail can be grown in the artificial wetlands (wetland cleaners) also. In this case the annual productivity can reach 4 - 5 kg/m2 [3]. In Estonia there are 939 villages and rural areas where the wastewater treatment can be solved on the basis of artificial wetlands. The yield of reed from these artificial wetlands can reach up to 16 000 t/y and primary energy content up to 67 GWh/y.

Based on the data of Statistical Office of Estonia [4] the number of poultry is 2.26 million, cows and cattle 0.41 million, sows and fatling pigs 0.33 million. If to handle 60% of the animal manure at biogas stations, the theoretically available primary energy content of biogas would be 0.4 TWh/y. The anaerobic digestion of food waste gathering from largest towns of Estonia can give up to 0.1 TWh/y and the total primary energy potential of municipal solid waste is estimated to be 1.6 TWh/y.

5. PEAT AS AN ALTERNATIVE

Peat is among the most important mineral resources of Estonia. The total resources amount to 2.37 billion tons, but about 40% of Estonian peat resources are under protection. The State Register of Mineral Resources of Estonia includes 281 peat deposits with reserves of fuel peat 0.94 billion tons. The area of production fields is about 21 000 hectares and peat is extracted from 80 deposits [5]. The volume of applicable (active) reserves as well as its annual extraction quotas is established by the Government of the Estonian Republic, taking into consideration the natural increment of peat. Annual quotas for peat extraction in Estonia are 2.78 million tons, which is distributed by extraction permits to the peat producers. Annual production of fuel peat ranges from 0.34 to 0.56 million tons depending on the weather conditions during the period of peat harvesting. The primary energy content of this amount of peat is approximately 1.7 TWh.

6. CONCLUSIONS

Production of biofuels and peat in the year 2002 and the theoretical potential for heat and power cogeneration in Estonia [2, 4] is presented in the following Table:

Biomass and peat fuels	Primary energy production in 2002	Theoretical potential today	Theoretical potential in 2030
	TWh	TWh	TWh
Fuelwood and harvesting residues	6.3	10.1	4.6*
Wood pellets and briquettes	1.1	1.2	1.2
Straw	-	0.4 0.6	0.8 1.0*
Energy plants	-	9.8	9.8*
Reed	-	0.6	0.6
Biogas	0.03	0.4	0.4*
Food waste	-	0.1	0.1*
Black liquor	0.2	0.2	0.2*
Peat fuels	1.67	8.3	8.3
Total	8.1	31.1 31.3	25.8 26.0

* These biofuels are available for cogeneration of heat and power, if needful equipment is installed.

Theoretical potential of primary energy content of non-conventional biomass (exc. wood fuels) resources is far over 10 TWh per year. This amount of primary energy is approximately equal to amount of heat production (10.5 TWh) in Estonian boiler houses and power plants in year 2002 (the share of heat consumed in district heating was 7.5 TWh). For comparison the total electricity production of Estonian power plants was 8.5 TWh in 2002. By conservative estimation the primary energy content of willow plantations, wetland plants and main agricultural residues is making ~30 % from consumption of fuels (36 TWh/y) for electricity and heat generation in 2002.

It is expected that these biomass sources in Estonia will be economically competitively after some years.

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