Preliminary

Intermediate report

Nordic Energy Perspectives

Biomass market and potentials

Nordic, European and global perspectives

March, 2009

Preface

Nordic Energy Perspectives (NEP) is an interdisciplinary Nordic energy research project with the overall goal of demonstrating means for stronger and sustainable growth and development in the Nordic countries.

NEP analyses the national and international political goals, directives, and policy instruments within the energy area, as well as their influence on the Nordic energy markets and energy systems and the infrastructures and institutional structures. NEP aims at clarifying to decision-makers the consequences of political and strategic decisions for politicians, energy actors and the public. The project is to promote a constructive dialogue among researchers, politicians, authorities and actors on the energy markets. For further information about the project, please visit: *www.nordicenergyperspectives.org*.

This series of reports are the second reporting from the second phase of the project. The following intermediate and final reports are now presented:

Synthesis report, March 2009:

- Second NEP2 synthesis report *(Responsible: Peter Fritz, Håkan Sköldberg, Bo Rydén)*

Final reports, March 2009:

- Widened view of energy efficiency and the resource management *(Responsible: Bo Rydén)*
- Technology options for a low CO_2 energy system *(Responsible: Tiina Koljonen)*
- Wood markets and the situation of the forest industry in the Nordic countries *(Responsible: Per Erik Springfeldt)*

Intermediate reports, March 2009:

- Reference and policy scenarios *(Responsible: The NEP model group)*
- Global scenarios *(Responsible: Janne Niemi)*
- Biomass market and potentials *(Responsible: Tiina Koljonen)*
- Nordic perspectives on the EU goals relating to CO_2, renewable energy and energy efficiency *(Responsible: Thomas Unger, Bo Rydén)*
- Prominent strategies for environmental sustainability in the stationary energy sector *(Responsible: Anders Sandoff)*
- The future of the Nordic district heating *(Responsible: Monica Havskjold, Håkan Sköldberg)*
- Trade within the RES directive and related power interconnection issues *(Responsible: Berit Tennbakk)*
- Natural gas in the Nordic countries *(Responsible: Peter Fritz)*

Our intention in NEP is to present all reports in English. Due to lack of time, some of the texts in some of the reports are at this stage still in Scandinavian languages. We apologize for this. These texts will as soon as possible be translated into English. The translated texts/reports will be available on the project's web site, *www.nordicenergyperspectives.org*, soon after the Oslo conference.

Oslo, March 2009, *The NEP Research Group*

Content

1 Introduction

The use of biomass and liquid biofuels is expected to increase in energy production and in the transportation sector mainly due to national and international energy and climate strategies. Biomass has already now an important role in the Nordic energy systems, especially in Finland and Sweden. However, biomass is a limited energy source and the key question is the future availability and price of biomass based fuels for energy and biofuel production.

The increased demand of biomass has also created new markets for biomass as a fuel for energy production. Because biomass has relatively low energy content compared to the fossil fuels, it is worthwhile to process biomass to pellets or liquid biofuels and freight these biofuels. In the following, biofuel expression refers to liquid biofuels to be used for transportation. Solid biofuel expression refers to pellets to be used in boilers or stoves for energy production

Regarding the category of solid biomass resources, the following biomass types may be categorized: wood resources, field biomass resources, and waste. Wood resources are largely utilized by forest industry, which also produce industrial waste liquors (i.e. black liquor) and solid biomass by-products suitable for energy production. A large share of these industrial side products are utilized at site but some solid by-products (i.e. saw dust, bark, wood chips) may be also considered as biomass resource for energy or biofuel production. On the other hand, biomass from thinning and felling of forests (i.e. forest residues) represent a large share of wood resource potentials, which could be used more effectively than today.

Wood resources can be expected be the dominant biomass resource in Finland, Norway and Sweden due to a large share of forest land area compared to the field land area. In Denmark, the situation is wise versa, and also the climatic conditions are more favourable for agricultural production compared to the other Nordic countries. Within Europe and also globally agrobiomass is expected to have a dominant role as an energy resource in the long run. Field biomass resources for energy production include field side products and energy crops. Agricultural side products include straw, tops, cobs, stalks, and other residues from sugar crops, root crops, cereals, pulses, and oil crops. Currently, only minor amounts of agricultural side products are utilized and even smaller amount are used for energy production. However, there are some exemptions, like Denmark, which utilizes already now considerable amounts of straw for energy production. Cultivation of energy crops is not even compiled on statistics (reed canary grass in Finland is an exemption), and therefore it is not known how much energy crops are cultivated today. However, the largest share of global biomass for energy production is expected to originate from energy crops in the future.

Utilisation of municipal and other waste as well as recycled fuels is also expected to grow in the future. Landfills, sewage treatment plants, and processing of animal manure or other biological wastes produce methane due to digestion. This biogas can be collected and utilized in heat and power production. In Denmark and Sweden, a large share of bioenergy already now originates from waste. In the other Nordic countries large share of energy content of waste is not utilized.

This intermediate report aims at verifying the Nordic biomass potentials to be used in energy and liquid biofuel production in the Nordic countries. Biomass and especially biofules could also be imported to the Nordic area. On the other hand, Nordic biomass could be exported to those countries, which have better ability to pay from biomass, pellets or biofules. In chapter 2, an overview of the biomass potentials in Denmark, Finland, Norway, and Sweden are reported. A short overview of the EU- and global-level biomass potentials are given in chapter 3 to give a wider perspective on future biomass potentials and demands. In chapter 4, the Nordic potential estimates are used to evaluate the possibilities to increase the share of bioenergy in the stationary energy production and in transportation sector. In chapter 5, the paying ability of solid biomass within EU countries is compared to analyse the potential import and export countries of biomass. Finally, chapter 6 concludes the biomass market and potential findings from the Nordic perspective.

2 Biomass resource potentials in the Nordic countries

Below, biomass resource estimates for each Nordic county are shown. It seems that each resource estimate has used different approaches, which makes the verifying extremely difficult. Tradition and the present use are one of the reasons for these different approaches. For example, the shown Swedish estimates represent the highest potentials, which may be considered as more or less theoretical (at least in the short term). The other potentials could be referred as technical potentials, which take into account technical constraints to utilize biomass. Economic potentials of biomass are reported in context of the NEP scenarios. The new EU directive also includes several limitations for using biomass, which is not considered as “sustainable”. Those limitations are especially important when considering using imported biomass.

2.1 *Finland*

2.1.1 Forest wood

In Finland the largest biomass reserves are based on forest wood. Forest industry utilizes forest and that is why there are lot by-products, sawdust, bark and other by-products. Another important by-product from forest industry is the black liquor from pulp mills.

Table 1 shows potential for forest based biomass in Finland (source: Puuenergian teknologiaohjelma 1999 – 2003. Teknologiaohjelmaraportti 5/2004. Pentti Hakkila. Loppuraportti 134 s/.

Table 1 Maximum potential of forest based biomass in Finland (Mm^3)

	stem with bark	crown refuse	totally
Pre-commercial thinning, Mm^3	3	1	4
First thinning, Mm^3	3	3	6
Later thinning, Mm^3	1	5	6
Forest residues from final felling, Mm^3	2	12	14
All stumps, Mm^3	15	0	15
Totally, Mm^3	24	21	45

Forest biomass potential is estimated to be totally 45 million m^3 Finnish Forest Research Institute (Metla) has estimated techno-economic potential to be about 16 million m^3 *(Metsätalouteen ja metsäteollisuuteen perustuvan energialiiketoiminnan mahdollisuudet Satu Helynen, Martti Flyktman, Antti Asikainen & Juha Laitila. VTT Tiedotteita 2397.Espoo 2007. 66s.)*

Table 2 shows the potential distributed in different sources of forests.

Table 2 Techno-economic potential of forest energy

	Crown and branches from pine forests	Crown and branches from spruce copse	Stumps from spruce copse	Energy wood from young forests
Million m^3	4.8	1.7	2.5	6.9

Total potential according to table 2 is 15.9 million m^3. Stumps from pine forests are not included in the potential.

2.1.2 By-products from forest industry

In 2006 in Finland use of raw wood was totally 81.5million m^3 from which more 90 %, 75.5 million m^3, was used in forest industry. The share of domestic raw wood was 56.3 Mm^3 and 19.2 Mm^3 was imported mainly from Russia. Most of raw wood was used in pulp industry, 32.4 Mm^3, Sawmill industry is the second largest user of the raw wood, 27.3 Mm^3.

Most important by products of forest industry are sawdust, bark, wood chips and black liquor from pulp mills. Wood chips are mainly used in pulp mills.

Saw log is split up sawn timber and by-products. From saw log typical share of sawn timber is 48% that of wood chips 30%, that of sawdust and that of bark 12%. In plywood industry the share of end product is about 30 – 35% and rests are by-products.

In pulp mills the share of end product is less than 50% and the rest is bark and black liquor that is utilized in recovery boiler. In mechanical pulp mill almost 95% from stem wood (without bark) is utilized in pulp production.

By-products (sawdust, bark, e.g.) from forest industry represents 17 – 18 TWh and black liquor 40 – 45 TWh.

2.1.3 Agricultural fuels

In Finland total use of agricultural residues and energy crops has been minor. In Finland total field area is about 2.3 million hectares. Annual crop yield of the straw has been estimated to be 2.1 million tonnes. If techno-economic potential from the total potential is 20 % this means 400 000 tonnes per year. Energy content of this amount is approximately 1.5 TWh.

During last fifteen years reed canary grass as an energy source has been studied in Finland. In 2008 field area for reed canary grass is about 20 000 hectares. Finbio has made a target for utilizing of different kind of energy crops. The target for reed canary grass is 150 000 hectares in 2020 that means in best conditions energy content of 4.5 TWh.

2.1.4 Wastes and recycled fuels

In 2004 municipal solid waste amount was about 2.6 million tons from which 59 % was put in landfills, 29% was utilized as raw material and 9% was used in energy production. It has been estimated that in 2016 demand for capacity of waste incineration is 700 000 – 750 000 t. Assuming share of renewable energy 60% we get 420 000 – 450 000 t. (*Kohti kierrätysyhteiskuntaa. Valtioneuvoston 10.4.2008 hyväksymä valtakunnallinen jätesuunnitelma vuoteen 2016.*)

2.1.5 Biogas

In the end of year 2006 biogas was gathered from 33 landfills, from sewage treatment plant in 16 towns and from four farms. Biogas was collected 127 000 million m^3 from which 63% was utilized.

Biogas potential based on raw material has been estimated to be 6.7 – 18 TWh depending on what resources have been taken in account. (*Arvio biomassan pitkän aikavälin hyödyntämismahdollisuuksista Suomessa. Asiantuntijatyöryhmän raportti. 12.2.2007.*)

2.2 Sweden

2.2.1 Forest biofuels

Table 3 shows estimation for biomass resources from forests in Sweden.

Table 3. Forest fuel potential

	TWh
Residues from final felling	44
First thinning	13.1
Pre-commercial thinning	12.4
Firewood	9.3
Non industrial round wood	5.8
Firewood from parks etc.	2.8
By-products form forest industry	
wood chips	3.3
sawdust	8.8
bark	14.7
Recycled wood	4.4
Total	118.6

Table 3 does not include black liquor and stumps. In Sweden potential for black liquor in 2020 is estimated to be 45 TWh and 50 TWh in the long run. Stump potential is estimated to be 20 TWh and in the long run 24 TWh.

2.2.2 Agricultural fuels

By-products

In Sweden total field area is about 3.2 million hectares. Annual straw yield has been estimated to 7 TWh. Manure (as biogas) has been estimated to be 4.5TWh and beet leaves 0,5 TWh.

Table 4 shows potential of other agricultural fuels in Sweden

Table 4. Agricultural fuels in Sweden

	TWh
Energy crops from existing fallow land	5 -10
Areas that nowadays used for producing crude corn	4,5 -7,5
Grassland that is not needed for forage production	5 – 7,5
Improvement potential and better cultivation technology	4 – 14
Field reclamation	2 -8
Total	20,5 – 47

2.2.3 Waste

In 2006 about 10.3 TWh wastes was utilized in heat production and 1.2 TWh in electricity production. Based on Swebio (2007), the capacity of waste incineration will grow 30 % in 2009. In addition biogas production from wastes in 2006 was 1.2 TWh.

In 2020 total waste amount of 7.8 million tonnes will be utilized which means an energy content of 23.4 TWh. When assuming the share of renewable waste is 60 % then the renewable energy of waste is 14 TWh.

2.2.4 Summary

Table 5 shows the summary of renewable energy potential in Sweden.

Table 5 Renewable energy potential in Sweden

	TWh
Wood fuels	129
Black liquor	45
Agricultural fuels	39
Renewable share of waste	14
Total	227

2.3 Norway

2.3.1 Forest biofuels

In Norway total use of bioenergy in 2006 was 14.5 TWh. Unutilized forest energy potential has been estimated to 12 -16 TWh

2.3.2 Waste

In 2003 municipal solid wastes were utilized in energy production 0.9 TWh. Total potential of wastes has been estimated to be 4.4 TWh from which 2 TWh is unsorted. Possibility to increase utilization has been estimated to be 1.5 TWh.

2.3.3 Agricultural fuels

Potential for agricultural fuels has been estimated to be 4,5 TWh. A very small share of total potential agricultural fuels has been utilized.

2.3.4 Biogas

Total biogas potential has been estimated to be 4.0 TWh. Only minor share of biogas potential is utilized.

Table summaries biomass fuel potential on Norway

Table 6. Summary of biofuels in Norway, TWh

	Use/ Production	Import	By-products	Energy use	Possible increase	Total
Wood chips	6.4	1.9	4.6	0.9	3.7	4.6
Forest industry	10	5.6	5.4	5.3	0.1	5.4
Furniture- and wood products	0.5	1.8	1.2	0.7	0.5	1.2
Municipal solid waste	4.4	Unsorted 2		0.9	1.5	2.4
Landfillgas	1			0.1	1	1.1
Other biogas	3.0			0.1	3.0	3.1
Forest woodfuels	7.2			7.2	12 - 16	19.2 – 23.2
Agricultural biofuels	4.5			0,1	4.5	4,6
Total, TWh				16	27 - 31	43 - 47

2.4 Denmark

2.4.1 Agricultural fuels

In Denmark utilizing straw has long tradition. Total straw potential has been estimated to be 55 PJ(15,3 TWh) from which one third has been utilized annually.

2.4.2 Wood fuels

Wood fuel potential has been estimated to be 40 PJ (11,2 TWh) and it is almost totally utilized.

2.4.3 Manure

Manure biomass fuel potential has been estimated to 40 PJ (11,1 TWh) and from that only 10 % has been utilized annually.

2.4.4 Waste

Waste energy potential has been estimated to be 11.2 TWh and it is almost totally utilized (10.2 TWh).

2.4.5 Summary

Table 7 summarizes biomass fuel potential in Denmark.

Table 7. Summary of biofuels in Denmark.

Biomass	Use	Potential	Possible increase
Straw	5 TWh	15.3 TWh	10.3 TWh
Wood biomass	7.6 TWh	10 TWh	2.4 TWh
Municipal waste	10.2 TWh	11.2 TWh	1 TWh
Manure (Biogas)	1 TWh	11 TWh	10 TWh
Total	23.8 TWh	47.5	23.7 TWh

3 Global and EU-wide biomass potentials and demands up to 2050

3.1 Global biomass potentials and demand scenarios

The global energy use of biomass today accounts for approximately of 10 % (45 EJ) of primary energy consumption. About 90 % of this biomass is wood based and according to the FAO Statistics, about half of wood consumption is firewood and the other half industrial consumption (see figure 1). Especially in developing countries, firewood is mainly used for cooking. Energy use of agricultural biomasses from total biomass energy use is less than 10%.

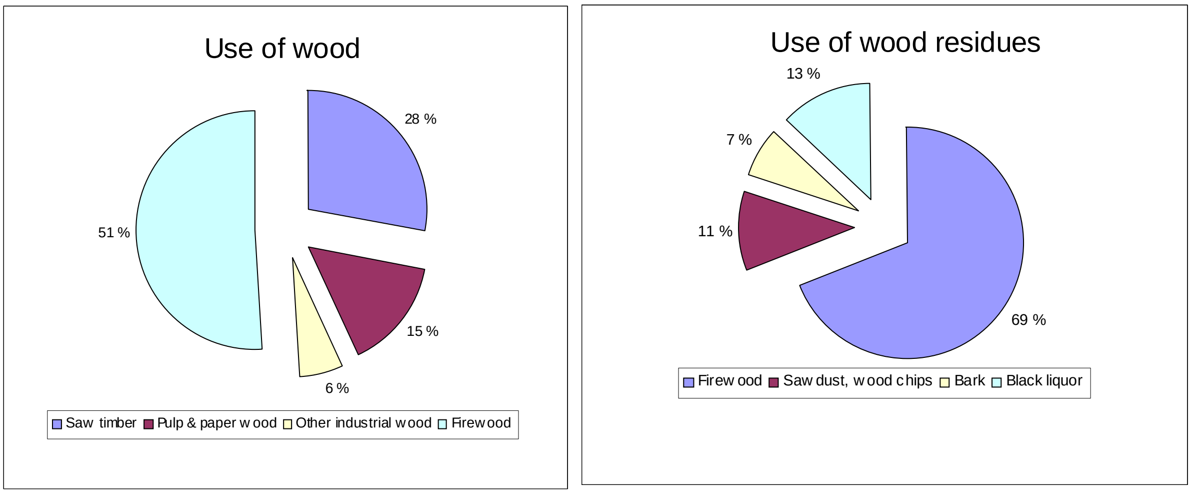

Figure 1. Use of wood and wood residues in 2006 (FAO Statistics 2008).

Recently, VTT and MTT Agrifood Finland have analysed the global and regional biomass theoretical and technical potentials and biomass demands up to 2050 within a Tekes funded national project called SEKKI. The analysis was made based on FAO statistics for existing field and forest areas as well as their usage for food, energy, or industrial production. The analysis takes in to account the estimated population growth and thereby the need to increase food production as well as the progresses in cultivation and harvesting technologies. Figure 2 shows the global energy potential estimates for field biomass with different diets and figure 3 the estimated global distribution of field biomass resources for energy use. Increased consumption of meat needs more land area for food production and therefore the land available for growing energy crops would be smaller. The mixed diet refers to the existing situation, and the vegetable and meat diets substantially increased vegetable or meat consumption compared to the mixed diet. It should be noted that neither new field area was allowed to be hacked nor saw-timber was not allowed to be used for energy use.

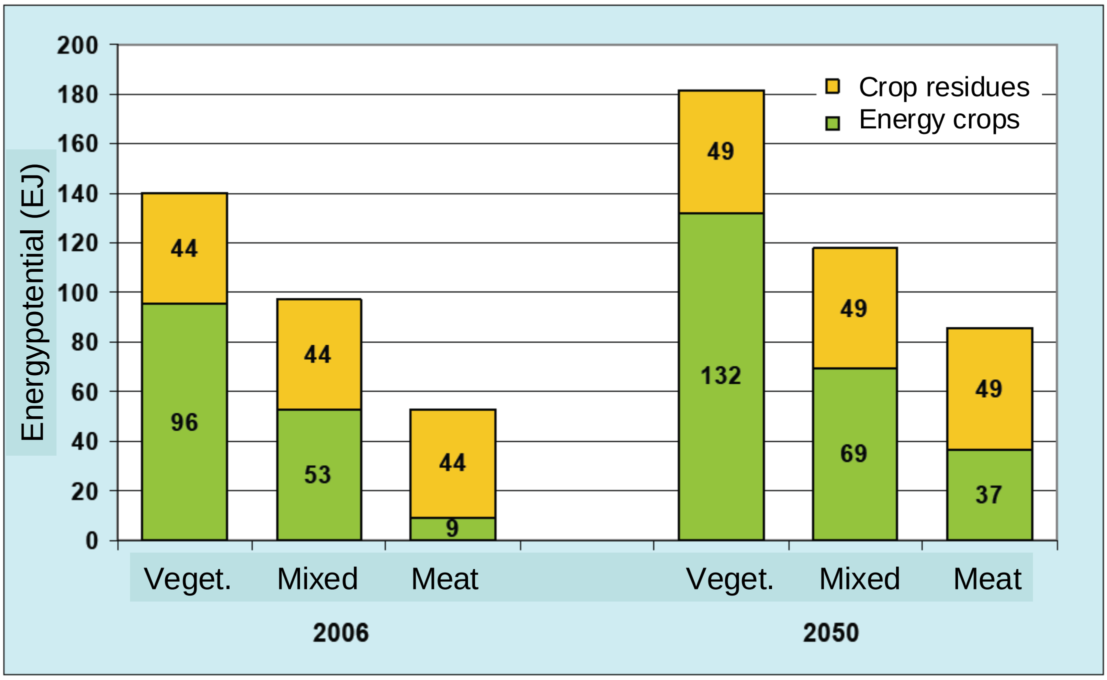

Figure 2. Global energy potential of field biomasses (source: MTT Agrifood Finland 2009). The estimates represent technical potentials.

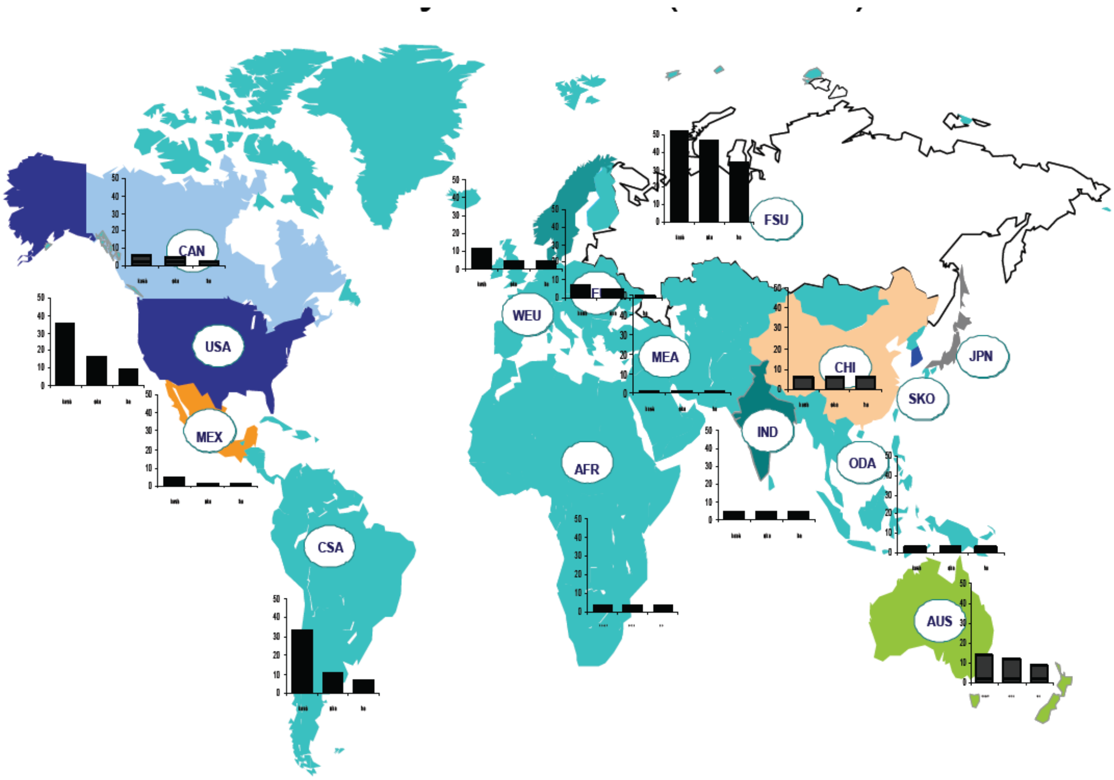

Figure 3. Regional energy potential of field biomasses in different diets (source: MTT Agrifood Finland 2009). The estimates represent technical potentials in EJ.

It seems that the best opportunities to produce field biomass for energy use in the near future are found form South-America, USA, Australia, and Canada. In the future, Eastern Europe and Russia could be potential areas for energy crop production.

Figure 4 shows the estimated global wood biomass resources and figure 5 the estimated amounts of industrial side products from forest industry in different world regions. By summing up both field and wood resources, we end up to the potential values from 80 EJ to 220 EJ. The upper value is very well inline with the other recently published analysis (see e.g. IPCC 2007). However, it evident that the long term biomass potential estimations has great uncertainty not only due to changes in technologies and land use, but also due to climate change.

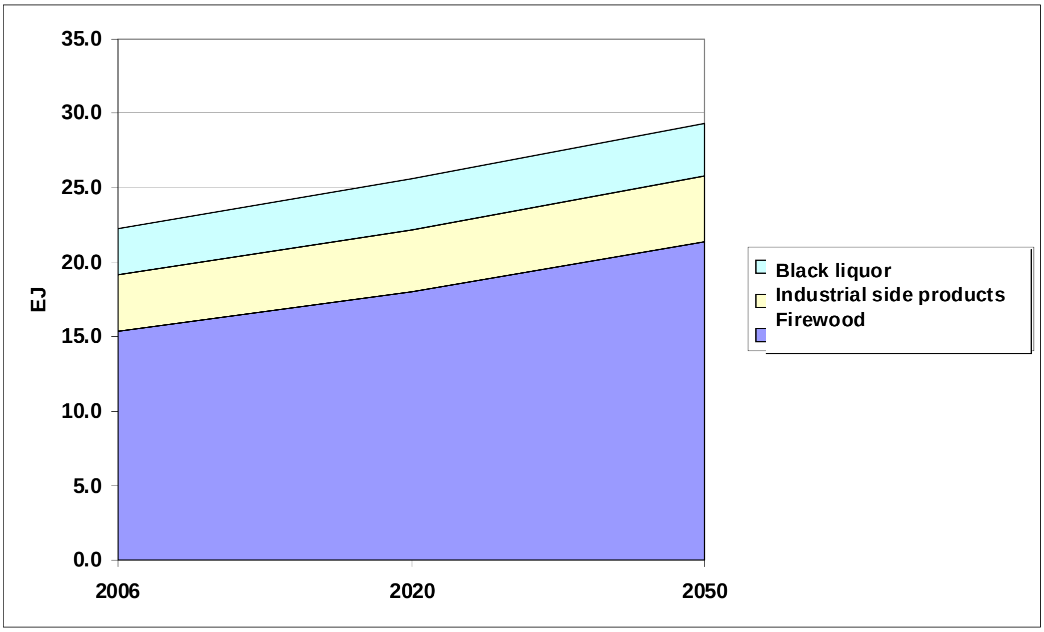

Figure 4. Global wood resources up to 2050.

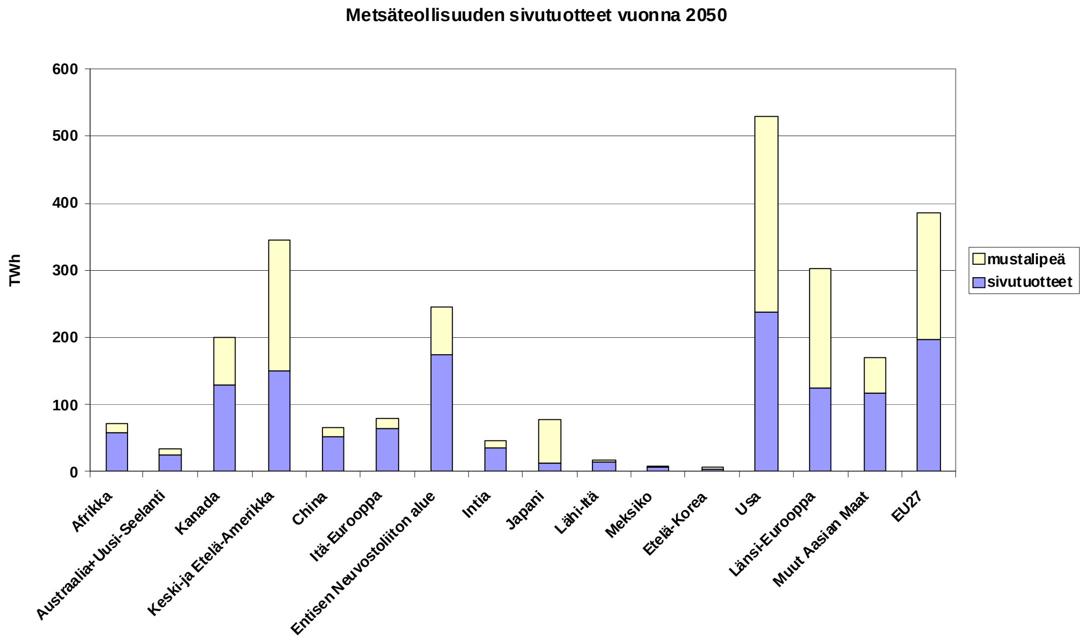

Figure 5. Estimated amounts of black liquor (yellow) and solid side products (blue) form forest industry in 2050 (1 EJ is about 277,8 TWh).

Global energy demand is expected to double by 2050 due to economic and population growths especially in the developing economies. The global energy consumption has been simulated with the Global Times energy system model by using exogenous GDP drivers calculated with Dynamic GTAP model. The assumptions for these drivers are presented in the intermediate NEP report dealing with global scenarios. In the policy scenario with Global Times the impact of the EU’s 2 °C target on greenhouse gas emissions has been simulated assuming global emissions trading and global consensus to tackle climate change. In the figures 6, global primary energy consumption is shown in the Baseline and 2 °C scenarios. In these simulations, the upper estimates (i.e. 220 EJ in 2050) of biomass resources are used. According to the global scenarios, the global biomass use for energy production could be increased to 20 % even though the primary energy consumption doubles from the current level. In 2050 the biomass use seems to be at its maximum, which means that assumptions on the resource estimates have a great impact on scenario results.

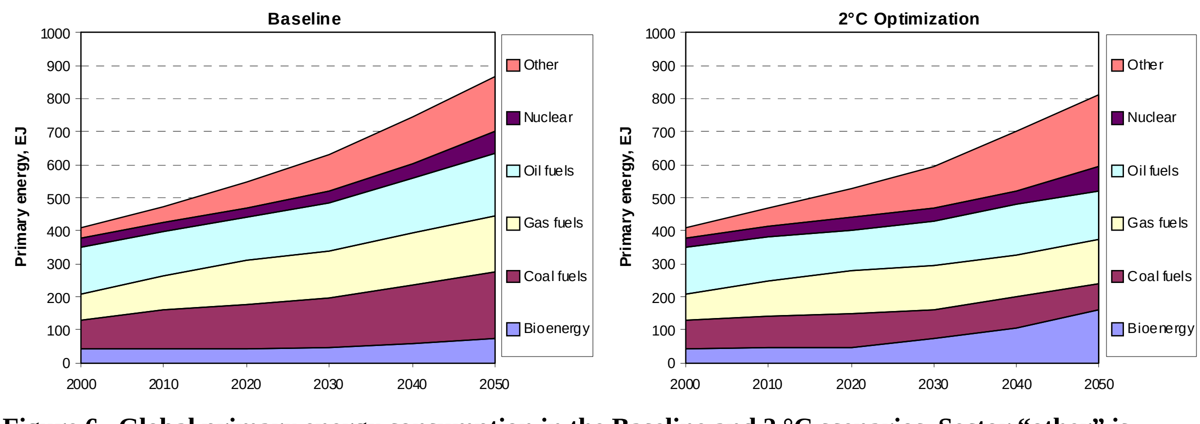

Figure 6. Global primary energy consumption in the Baseline and 2 °C scenarios. Sector “other” is mainly other renewables than biomass.

3.2 Biomass potentials and demand scenarios for the EU

Biomass potential estimates have also been given for an "EU-30" area, which includes EU-27 countries except Estonia, Latvia, and Lithuania, but includes Norway, Switzerland and Iceland. Figure 7 shows the estimated biomass potentials for the EU-30 area and figure 8 the use of biomass in the Baseline and two different 2 °C scenarios with different assumptions on gas import to the EU countries.

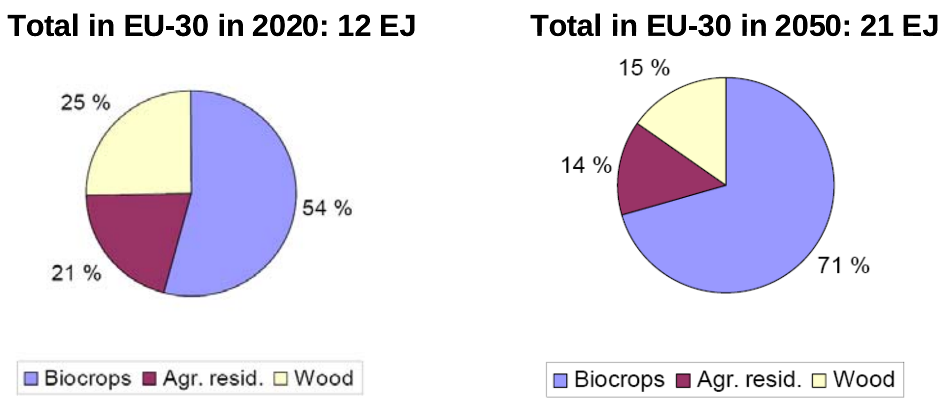

Figure 7. Estimated biomass potentials for EU-30 area in 2020 and in 2050.

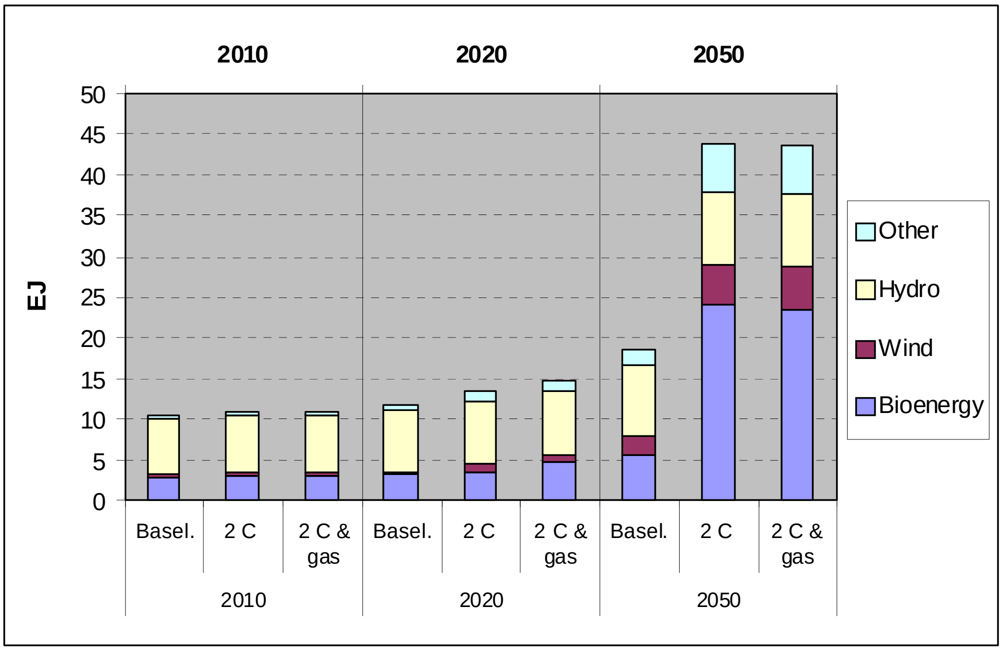

Figure 8. Renewable energy consumption in the EU-30-area up to 2050.

Like in global scenarios, the use of biomass is at its maximum in 2050 in the 2 C scenario. It should be noted that in this example, global biomass trade was not assumed. Especially the import from Eastern Europe could increase the biomass use in energy production in the EU-area presuming that the ability to pay for biomass is higher in the EU-countries than in the other neighboring areas. Biofuel import especially from South America could also be feasible.

4 Scenarios for biomass use in energy production in the Nordic countries

In this chapter, biomass potentials presented in chapter 2 are used to give some perspectives on the use of indigenous biomass in each Nordic country. Figures 9-12 represent consumption of energy sources in heat and power production, space heating and transportation sectors in the Nordic countries separated into biomass and other energy sources in 2006 and 2020. The 2006 figures are taken from the statistics and the 2020 figures represent a possible scenario where the biomass use in heat and power sector has been increased by an amount simulated in the NEP scenarios (see the NEP report “Reference and policy scenarios”). The EU target of 10 % share of biofuels in transportation has been fulfilled and forest industry production has been cut by 30 % in 2020. The latter assumption is not in line with NEP scenarios but in this context we wanted to examine, how much biomass would be available, if pulp and paper production would be reduced in the Nordic countries. Also, biomass consumption was kept constant in single house residential heating, which should also be considered more carefully. Calculations also include some export and import of resources and fuel, e.g. all ethanol is imported, Sweden exports some of its forest residues to Norway and Denmark in 2020. Biomass usage in the heat and power production sector is aggregated into forest industry and other energy sector due to the endogenous nature of forest industry in the biomass flow model. Also, illustrated in the figures are total consumptions of biomass resources per nation and potential of these biomass resources.

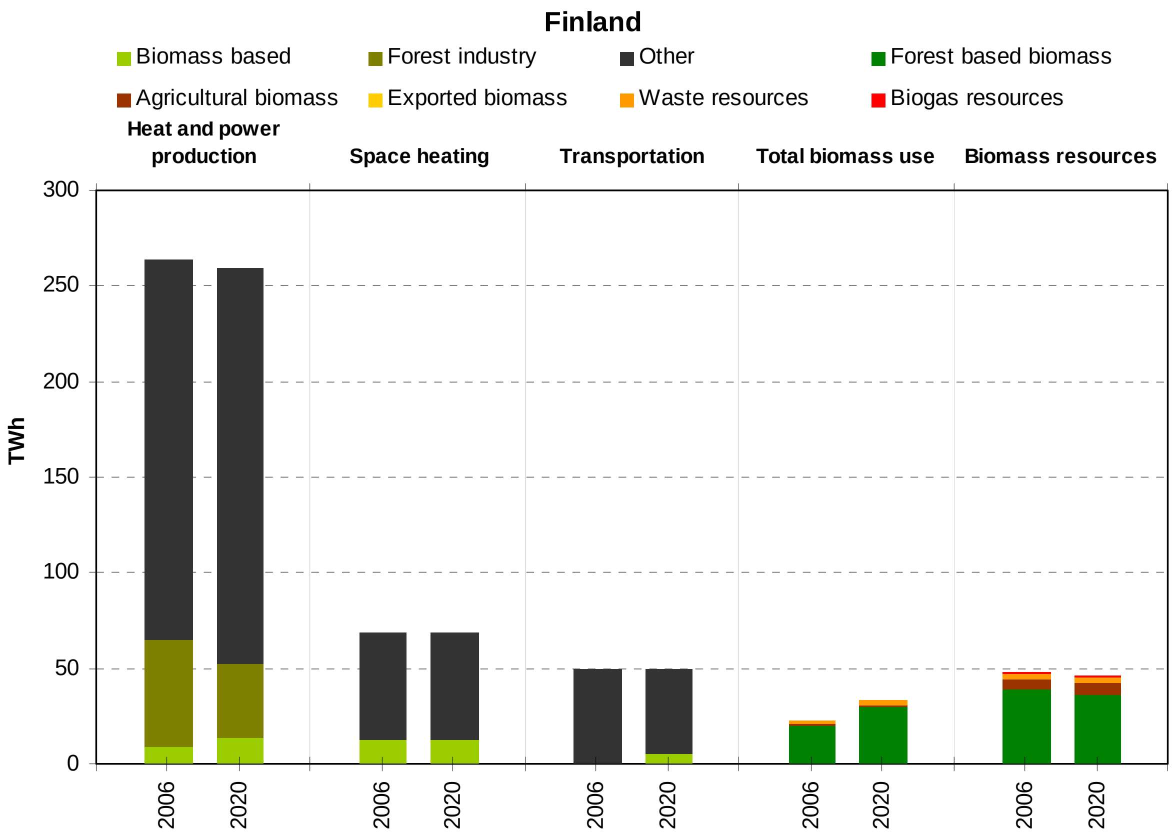

Figure 9. Biomass usage in heat and power production, space heating and transportation sectors in Finland compared to the potential biomass resources. Total biomass use doesn’t include black liquor or other biomass consumption utilised at site of forest industry.

The dominant role of forest industry in biomass use is clearly visible in heat and power production of Finland. The dark green area is mostly black liquor, but it also includes solid side products. In space heating, some pellets but mainly firewood is used. It can be seen that in 2006, biomass based fuel use in transportation sector was negligible with less than 0.01 TWh of ethanol used.

In the case of continuing decline of forest industry production the structure of available biomass resources can alter dramatically. The price structure and techno-economical availability of forest residues changes as round wood is harvested less for the purpose of paper and pulp production. Also other side products, like saw dust, wood chips and bark are produced less in the case of decreased production of forest industry. However, de facto amount of wood biomass remains unchanged. The key question is energy sector’s ability to pay for biomass in the future if low cost biomass would not be available.

Potential biomass resources in Finland consist mainly of forest residues and forest industry byproducts. According to the specified resources, biomass use can be increased by 82% compared to current usage.

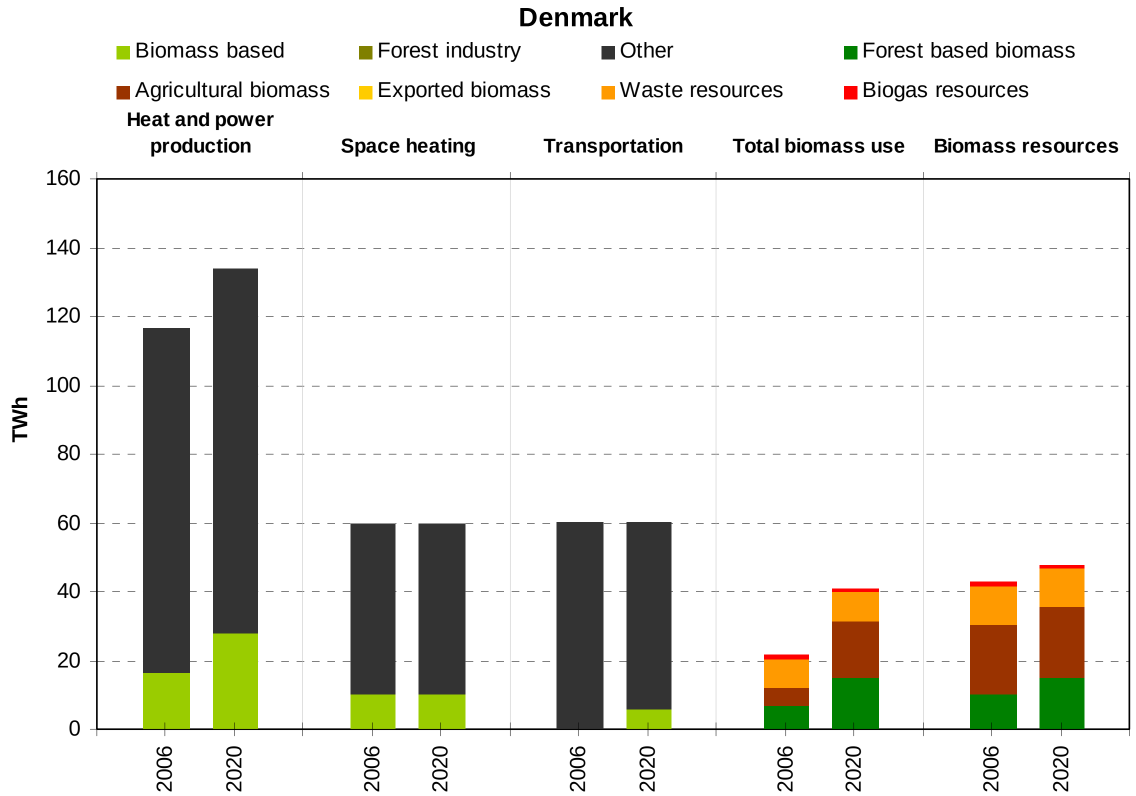

Figure 10. Biomass usage in heat and power production, space heating and transportation sectors in Denmark compared to the potential biomass resources.

Biomass use in Denmark is reasonable efficient. The available potential resources are almost completely based on agricultural biomass. Using the potential resources, biomass use can be increased 93 %.

The potential biomass resources of Sweden are large, but the presented values seem quite optimistic from the techno-economical point of view as the potential resources allow an increase of 294 % in biomass consumption. Some other Swedish surveys report much lower potentials (see e.g. the report "Technology options for a low CO2 emission system"). As in Finland, bulk of biomass based heat and power production is due to forest industry. Biomass use in general is extensive, in fact more than the potential biomass resources of Finland. It should be noted, that the low biomass consumption figures come from the assumption with 30% decrease in forest industry production. Therefore the 2020 figures are not in line with the NEP scenario results, which imply increased use of biomass in the future.

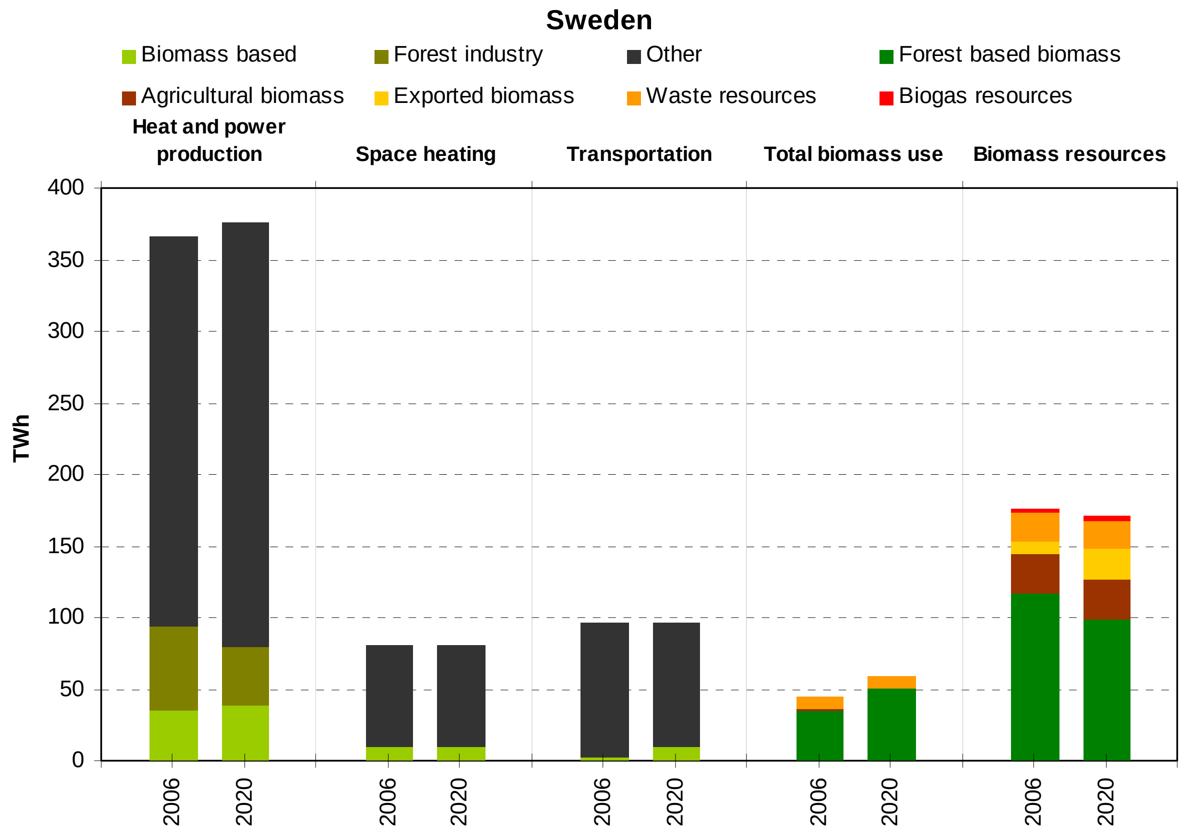

Figure 11. Biomass usage in heat and power production, space heating and transportation sectors in Sweden compared to the potential biomass resources.

Norwegian heat and power production is mainly characterized by substantial hydro power capacity. The potential biomass resources allow an increase of 67 % in biomass use.

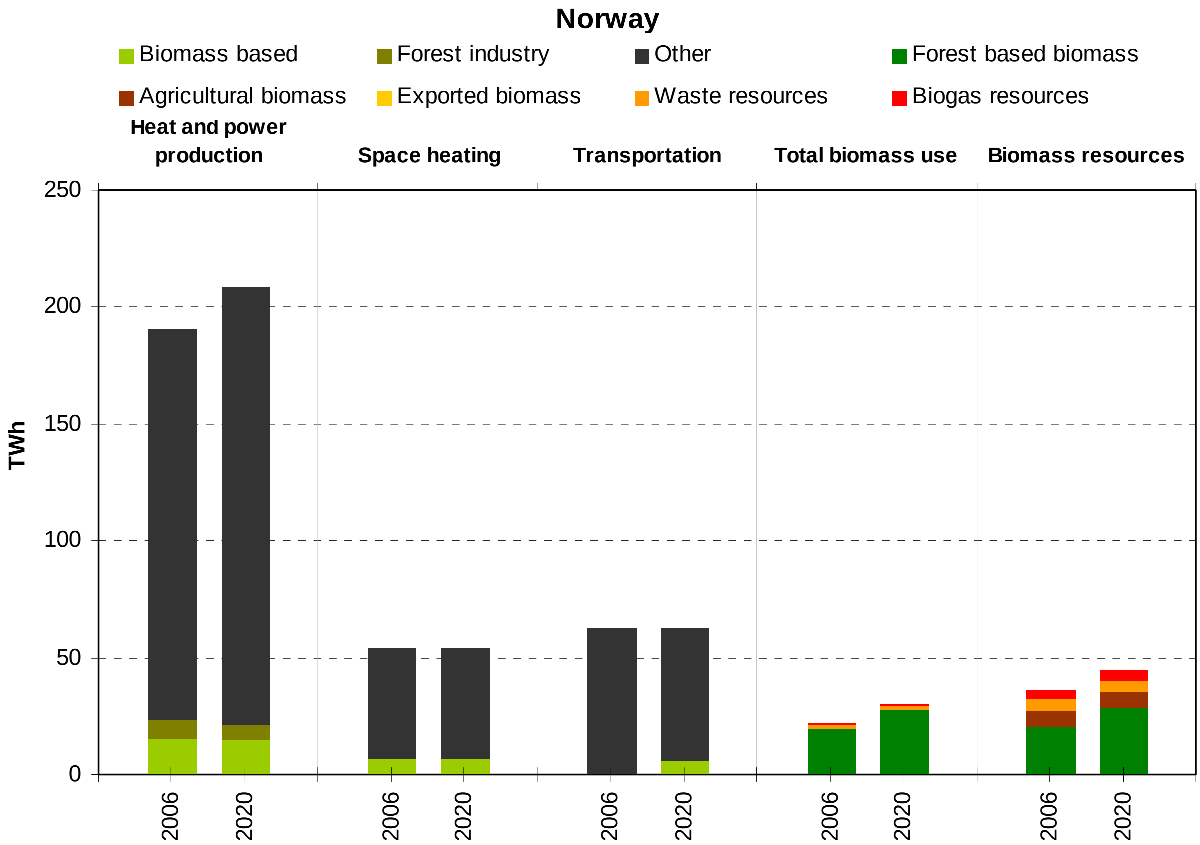

Figure 12. Biomass usage in heat and power production, space heating and transportation sectors in Norway compared to the potential biomass resources.

In figures 13 and 14 summaries of the Nordic biomass consumption in 2006 and 2020 are shown.

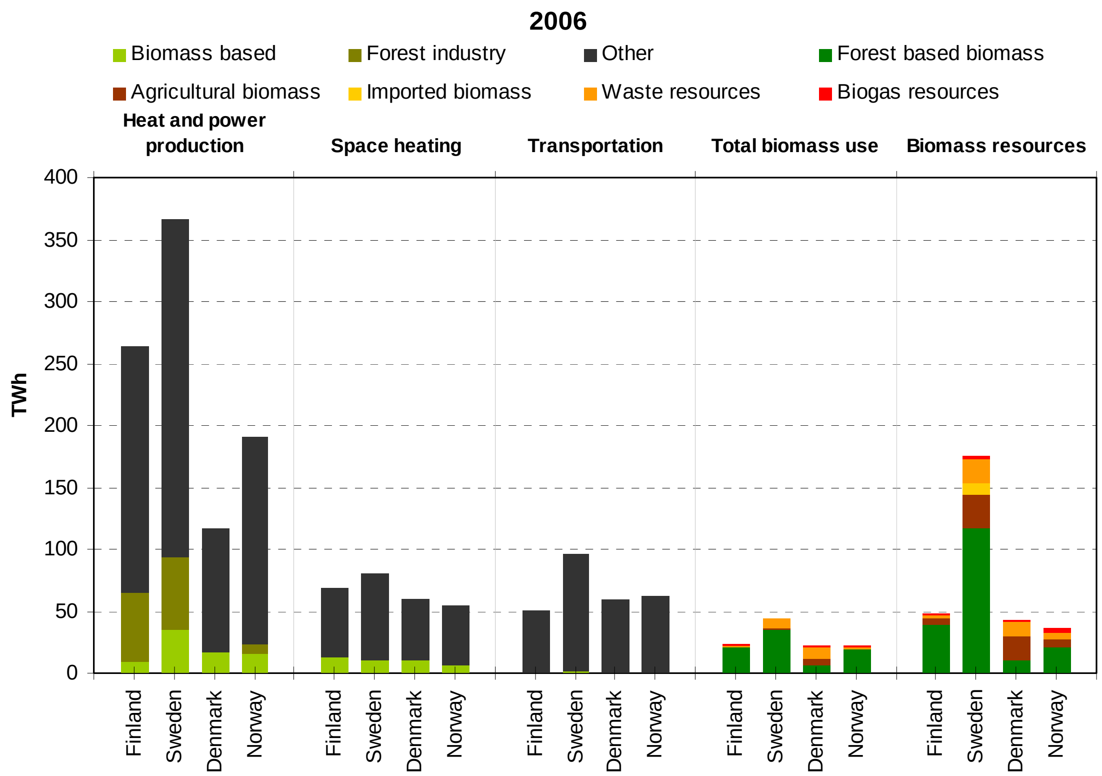

Figure 13. Biomass usage in heat and power production, space heating and transportation sectors in Nordic countries compared to the potential biomass resources in year 2006.

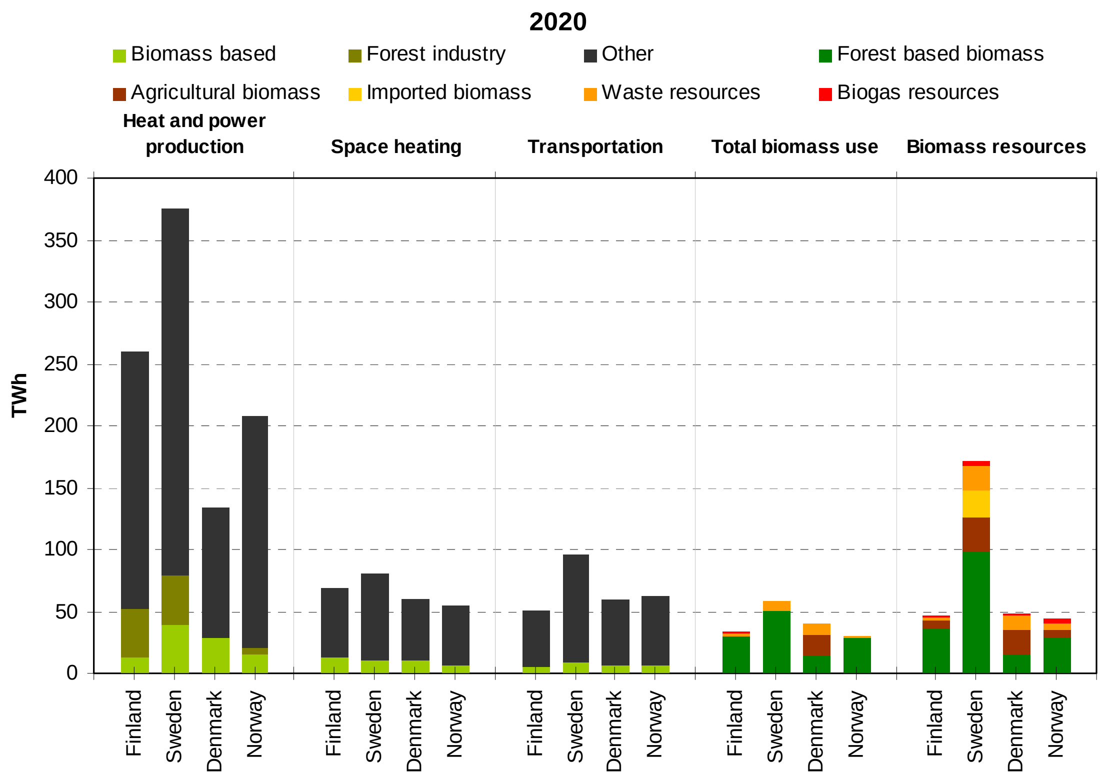

Figure 14. Biomass usage in heat and power production, space heating and transportation sectors in Nordic countries compared to the potential biomass resources in year 2020.

5 Development of biomass markets

In this chapter, an overview of the biomass and biofuel markets today and its possible development is given. In figure 15, the development of global biomass biofuel markets from 2004 to 2006 are shown. It is evident, that the biomass markets are not well established yet. The total trade of biofuels (both solid and liquid) accounts for less than 2 % of the world's bioenergy use and the direct trade less than 1 % respectively. Currently there is no common market place, price indexes, derivatives, or other products for risk management like for fossil fuels and other commodities. However, there are several national, EU-level, and international projects and efforts going on, which aim at promoting biofuel market development.

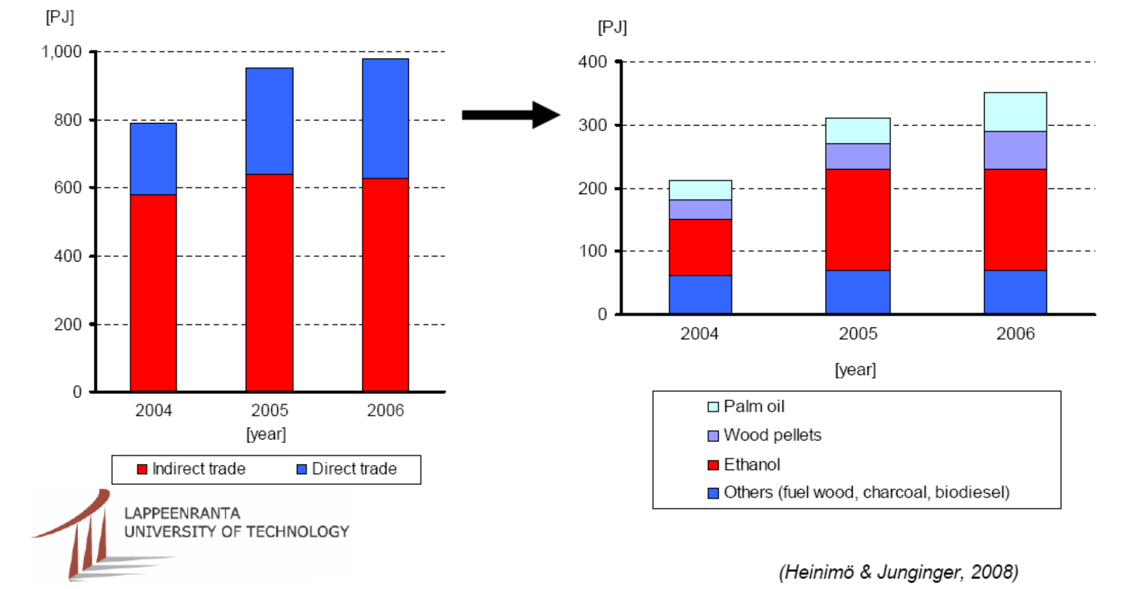

Figure 15. Development of biomass markets in 2004-2006 (Source: Heinimö & Junginger 2008).

It is evident that the EU's targets to increase renewables to 20 % by 2020 would facilitate biomass consumption and trade within the EU. Different EU countries have different incentives for renewables, and also energy taxation of fossil fuels differs. As a result, the paying capability of biomass and biofuels is different in each country. On the other hand, production costs of biofules (pellets, liquids) are also different in each country mainly due to availability and costs of biomass raw materials. In the next chapter, we look at the paying capability of wood fuel in energy production in different EU countries based on existing taxation and support for bioenergy.

5.1 Ability to pay for wood fuel in energy production in the selected European countries

In most European countries several incentives are used to promote the use of renewable energy resources:

- emission trading
- feed-in tariffs or green certificates

- energy taxes, CO_2-taxes, or taxes based on e.g. sulphur content

Variable costs of energy production are mainly fuel costs, except for wind, hydro, or solar power production. In the following example only those costs, which have an impact on fuel costs, are included:

- fuel prices of fossil fuels
- national renewable electricity support like feed-in tariffs, green certificates, ROI
- energy taxes for heat production
- price of emission allowance and specific emission factor for different fossil fuel

5.1.1 The impact of emission trading

One of the key factors in calculating the paying capability is the impact of the price of CO_2 allowance (EUA) on the variable costs. Fossil fuels have different emission factors, and therefore the impact of the EUA price differs. In the following, we have used specific emission factors presented in the table 8.

Table 8. Emission factors (source: Tilastokeskus) and the impact of CO_2 allowance price on variable costs.

Fuel	Emission factor g/MJ	Emission factor t/MWh	Emission trade 10 €/t CO_2 €/MWh	Emission trade 30 €/t CO_2 €/MWh
Coal	94,6	0,341	3,4	10,2
Natural gas	55,0	0,198	2,0	5,9
Heavy fuel oil	78,8	0,284	2,8	8,5
Milled peat	105,9	0,381	3,8	11,43

5.1.2 Country analysis and comparison of the paying capability of wood fuels

In the country analysis, potential biomass consumers and producers were selected in addition to the Nordic countries. Fossil fuel prices for coal, natural gas and heavy fuel oil were based on the most recent price data available for each country. Existing taxes and incentives for heat and power production in each country were also included in the analysis.

Figure 16 and 17 show how the ability to pay for wood fuel compared with fossil fuels varies in different European countries depending on energy production technology and type of fossil fuels. Energy production units with a thermal capacity at least of 20 MW are only included, which means that these plants are included in the EU’s emission trading system.

In Sweden and in Denmark the high price levels are based on high taxes for fossil fuels. Green certificates system for renewable electricity increase the ability to pay for biomass even further. In Austria, Germany and Great Britain feed-in tariffs or green certificates are used to support electricity production in combined heat and power using biomass fuels.

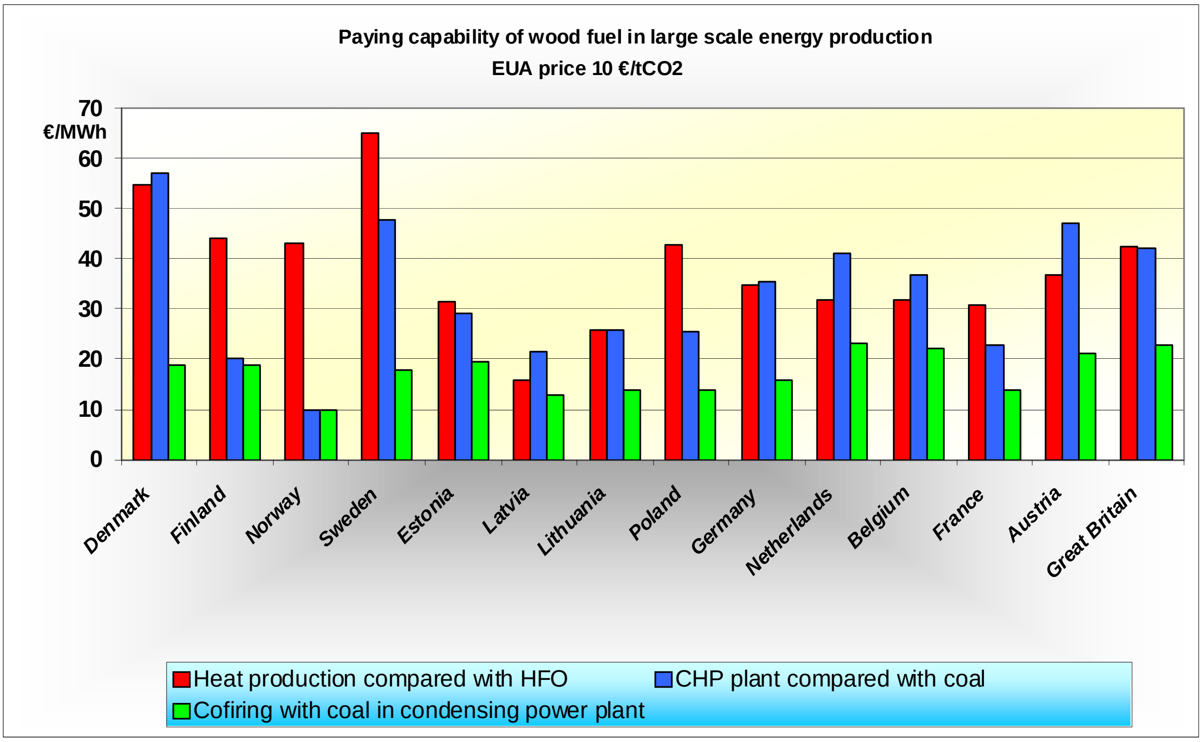

Figure 16. Paying capability of wood fuels in large scale energy production with a CO2 price level of 10 €/t CO_2 (exchange rates are from 27.2.2009).

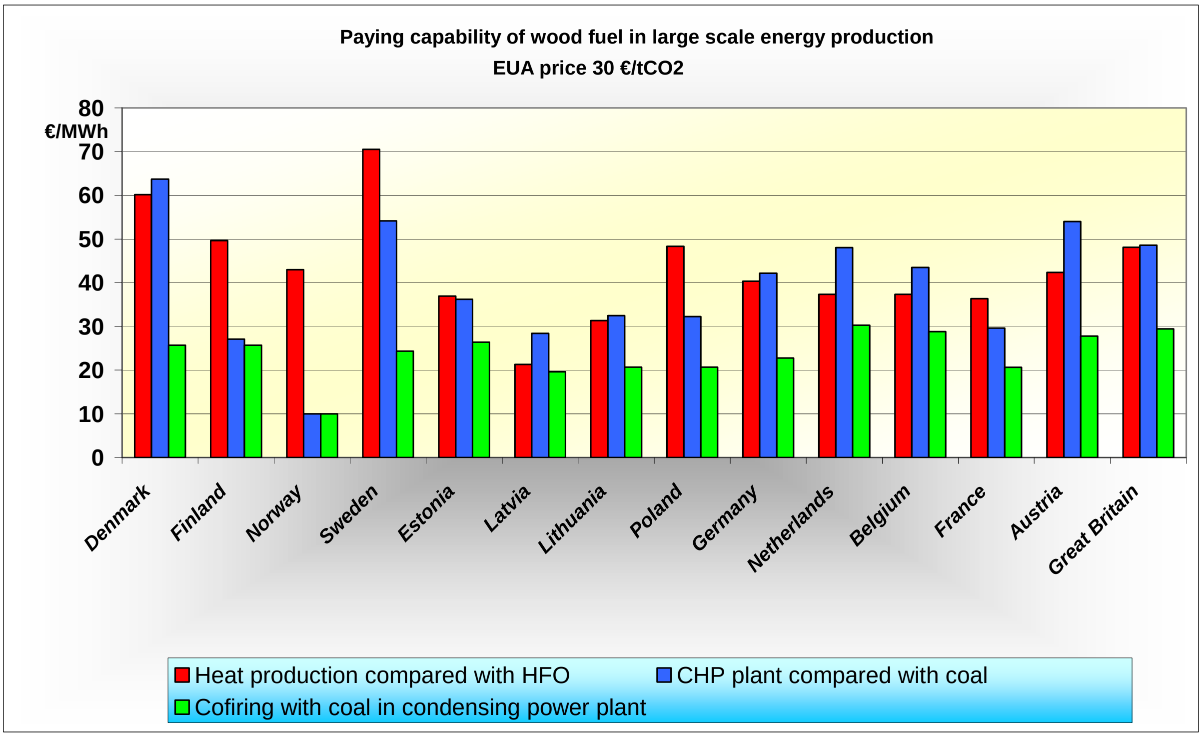

Figure 17. Paying capability of wood fuels in large scale energy production with a CO2 price level of 30 €/t CO_2 (exchange rates are from 27.2.2009).

6 Conclusions

The national and international climate policies would promote the use of biomass and biofulels in the future. According to the scenario calculations with Global Times model the global biomass consumption could increase by 2050 from the present 10 % to 20 % from total primary energy consumption even though the total energy consumption would double. However, the constraining factor in the future could be the limited amount of biomass available for energy production. In the long term, the largest share of biomass originates from field crops, and it is not known how much land area would be available for after feeding the growing population. Also, the impacts of climate change could reduce the potential field area.

The situation in the Nordic countries like Finland, Sweden and Norway is quite different as large share of our land is covered by forests. Finland and Sweden have also long traditions to utilize the side products of forest industry in energy production. In the future, the availability of low cost biomass in Finland and Sweden is largely dependent on the production of the forest industry, which has been declining especially in Finland during the last years. In the case of continuing decline of forest industry production the structure of available biomass resources can alter dramatically. The price structure and techno-economical availability of forest residues changes as round wood is harvested less for the purpose of paper and pulp production. Also other side products, like saw dust, wood chips and bark are produced less in the case of decreased production of forest industry. However, de facto amount of wood biomass remains unchanged.

Biomass use in Denmark is already now reasonable efficient. The available potential resources are mostly based on agricultural residues (straw) and waste. Compared to the other Nordic countries, Norway doesn’t utilize so much biomass even though it has reasonable biomass resources. Historically this is has been understandable because of large share hydro power in the Norwegian energy mix, but the situation would change as the Nordic energy markets would be more integrated with the Central European markets.

The preliminary calculations indicate that biomass use in the stationary energy production could be approximately doubled in each Nordic country by exporting some biomass from Sweden and Finland to Denmark and Norway. On the other hand, Sweden has today very high paying ability for wood compared to the other European countries, which motivates Sweden to import wood fuels. Also Denmark has high paying ability of wood due to high taxes of fossil fuels, much higher than Finland and Norway. It is therefore not surprising that Finland exports most of its pellet production to Sweden and other European countries.

Currently, there is no international market place for biomass fuels or price indexes and derivatives to manage risks associated with biomass fired energy production. Without any transparent and mature markets, biomass pricing and risk management is not easy and doesn’t motivate for new investments. However, the increased demand of biomass and biofuels motivates to create international biomass markets, like for other commodities, which could change the situation totally.