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Facts and Figures on the Use of Bioenergy in the Nordic Countries

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Facts and Figures on the Use of Bioenergy in the Nordic Countries

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1 Background

This report is part of a collection of smaller reports under the Nordic Bioenergy Project "***Opportunities and Consequences of an Expanding Bioenergy Market in the Nordic Countries***", which aims to provide factual background information on the status of bioenergy in the Nordic countries. These factual reports cover the following themes:

Econ Pöyry-Report no. 2008-057: Status and Potentials of Bioenergy in the Nordic Countries - Summary

Econ Pöyry-Report no. 2008-054: Facts and Figures on the Use of Bioenergy in the Nordic Countries

Econ Pöyry-Report no. 2008-055: Facts and Figures on the Use and Potential of Biomass Resources for Bioenergy in the Nordic Countries

Econ Pöyry-Report no. 2008-052: Current Bioenergy Application and Conversion Technologies in the Nordic Countries

Econ Pöyry-Report no. 2008-0563 Current Bioenergy Policies and Measures in the Nordic Countries

Econ Pöyry-Report no. 2008-056: Global Aspects of Bioenergy Imports

The Nordic Bioenergy Project was launched in May 2007 by the Nordic Council of Ministers with the aim to help coordinate bioenergy activities in the Nordic countries and improve the visibility of existing and future Nordic solutions in the complex field of bioenergy, energy security, competing uses of resources and land, regional development and environmental impacts.

In addition to the collection of smaller background reports, the Nordic Bioenergy Project has prepared the report "***Energy, Economic and Regional Perspectives in an Expanding Bioenergy Market in the Nordic Countries***". This report provides an overview and analysis of the issues at stake for the Nordic countries in terms of the role of bioenergy in meeting various energy, industrial and regional development policy objectives. The report raises a number of questions in this regard and offers a number of perspectives to inspire future Nordic framework conditions.

During the project, two workshops were held on the themes "***Bioenergy in the Nordic Countries: Status, Opportunities and Risks***" and "***Bioenergy in the Nordic Countries: Lessons & Future Framework Conditions".*** Presentations and summaries from the workshops along with the above mentioned reports are published on the following website:

http://www.nordicenergy.net/bioenergy

2 Current Use & Potential of Biomass Resources for Bioenergy in the Nordic countries

This report provides a description of the current use and future potentials of bio-energy resources in the Nordic countries in terms of the energetic content of the biomass resource before it's converted to an energy form.

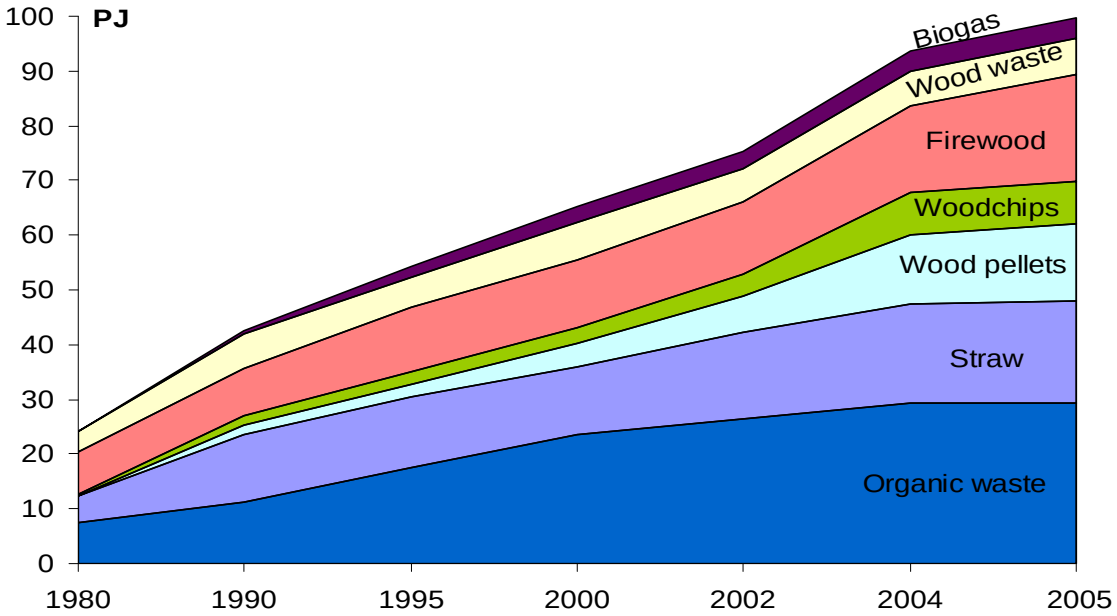
3 Biomass Use and Potentials in Denmark

3.1 Biomass Use in Denmark

The use of biomass for energy purposes more than tripled from 1980 to 2005 from ca. 24 PJ (6.66 TWh) in 1980 to nearly 100 PJ (27.75 TWh) in 2005. Today, biomass used for energy represents 12.2per cent of gross inland energy consumption (2005 numbers).

The total use of biomass resources for energy purposes (including heat, electricity and transportation) in Denmark make up around 70per cent of the consumption of renewable energy. The main source is based on solid biomass; organic waste, straw, firewood and wood pellets and chips. Biogas only consists of a minor share. Figure 3.1 below shows the increase in the use of biomass for energy purposes from ca. 25 PJ (6.94 TWh) in 1980 to almost 100 PJ (27.7 TWh) in 2005. This data is based on primary energy consumption, i.e. it shows the energetic value of the biomass before it is converted and transformed into energy.

Figure 3.1 Use of Biomass for Energy Use in Denmark 1980-2005



Source: Danish Energy Authority (2006).

Most of the use of biomass in Denmark is based on national resources. However, of a use of 14 PJ (3.8 TWh) wood pellets, 11 PJ (3.05 TWh) are imported from other countries and only 3 PJ (0.83 PJ) are based on Danish biomass resources. Denmark also has a production of bio-diesel (2.7 PJ / 0.75 TWh in 2005) which, however, is not used in Denmark, but exported mainly to Germany.

The use of firewood (especially in households) has been steadily increasing during the last two decades. It is expected, that the development will settle at a more constant level. The use of straw and wood pellets and chips are expected to increase further during the next 10 years (especially in central combined heat and power plants) due to political agreements. Denmark has a production of rapeseed

for bio-diesel, all of which is exported to Sweden and Germany and a small production of short rotation coppice.

3.2 Biomass Potentials in Denmark

The Danish resources of biomasses available for energy production are estimated by the Danish energy Agency to be 165 PJ (45.8 TWh) per year. Half of these resources are used today.

Table 3.1 Resource Potentials and Current Use of Biomass in Denmark.

PJ/year	Biomass potential for energy use	Current use of Biomass for energy[1]	Difference
Straw	55	18.5	36.5 (66per cent)
Organic waste	30	28.7	1.3 (4per cent)
Wood	40	34.4	5.6 (14per cent)
Biogas	40	3.8	36.2 (91per cent)
Total	165	85.4	79.6 (48per cent)

[1]In addition, 13.8 GJ wood is imported per year

Source: Energistyrelsen (2005).

The use of organic waste and wood for energy purposes are nearly completely utilised. Potentials remain in the use of straw and biogas. Around one third of straw resources and one tenth of biogas resources are used at present, leaving a large unused biomass potentials for straw (66per cent) and biogas (91per cent) in Denmark.

In addition to the traditional biomass resources, Denmark has the potential to restructure the agricultural production in order to produce energy crops.

The EEA (2006)[1] estimates the yearly potential in Denmark for bioenergy to be lower at approximately 104 PJ (28.8 TWh) per year with the main potential in manure and solid agricultural wastes. The EEA methodology for estimating biomass potentials are based on a sustainable use and management of the land with no utilisation of set aside fields in order to preserve biodiversity and other environmental services.

[1] EEA (2006) How much bioenergy can Europe produce without harming the environment?

4 Biomass Use & Potentials in Finland

4.1 Biomass Use in Finland

The use of bioenergy in Finland for energy purposes represented in 2004 20per cent of gross inland energy consumption (312 PJ out of 1564 PJ). Bioenergy represented 41per cent of total renewable energy use in Finland, with 312 PJ originating from biomass sources out of a total 372 PJ renewable energy.

More than half of the total primary energy is used by industry and the widespread use of CHP accounts for about one third of the electricity generation.

About 20 percent of the total consumption of primary energy is based on wood, which in 2004 represented 42 million m3 (306 PJ). Import of raw wood for energetic use is significant. About 45 percent of imported raw wood was used in the production of energy in 2004, while 22 percent of wood based energy came from imported raw wood. The largest export streams from Finland of biofuels are tall oil[2] and wood pellets. The import of raw wood and the export of wood pellets have increased significantly[3] .

More than half of the energy use of solid wood processing by-products takes place at the place of production. The market supply was estimated at 40 PJ per year for the period 2002-2010.[4] Finland began producing wood pellets in 1998 and the production was 190,000 tons in 2004. Only one fourth of the domestic production of pellets is used in Finland. The remainder is exported to countries with more preferential tax systems place. The production of wood briquettes was estimated as remaining at the same level as in 2000, equalling 35,000 tons (0.6 PJ).[5]

[2] Tall oil is a viscous yellow-black odorous liquid obtained as a byproduct of the Kraft process of wood pulp manufacture.

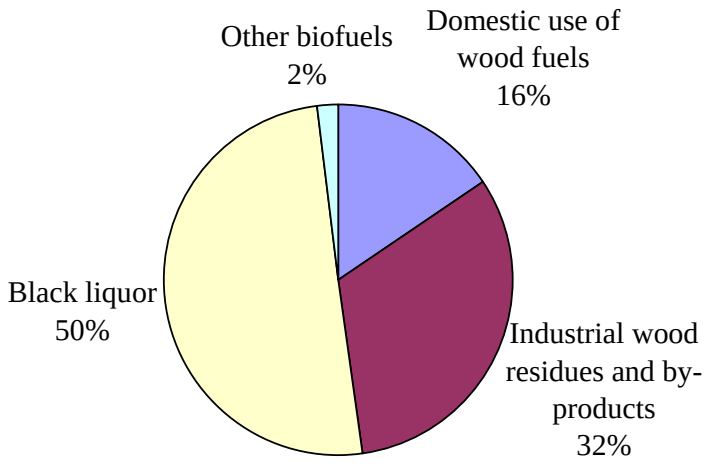
[3] Heinimö & Alakangas (2006).

[4] Ranta et al., 2005, as reported in Heinimö & Alakangas (2006).

[5] Heinimö & Alakangas (2006).

Figure 4.1 below shows the main uses of the 312 PJ of biomass in Finland in 2004. Black liquor represents the main biomass resource used for energy purposes (157.1 PJ) followed by industrial wood residues and by-products (100.5 PJ) and the domestic use of wood fuels (48.5 PJ).

Figure 4.1 Use of Biomass for Energy Use in Finland, 2004



Source: Statistics Findland, 2005

4.2 Biomass Potentials in Finland

Approximately 20 percent of the total consumption of primary energy in Finland is based on wood resources. In 2004, this represented about 42 million m3 (306 PJ). Total use of solid wood fuel amounted to 14.4 million m3 in 2004, including forest residues of 2.7 million m3.

Potential Forest Resource for Energy Use

With a vast forest cover of 76per cent (23.3 million ha) and a growing standing biomass (the total growth of stem wood has exceeded the use since the 1970s) a fair potential for increased use of woody biomass exists in Finland. The Finnish Forest Research Institute, Metla, has estimated that the annual sustainable stem wood removals from Finnish forests amount to 69 million m3. The commercial use of stem wood represented in 2004 only 80per cent of the sustainable use of (56 million m3). The National Forest Programme aims at an increased annual use of wood for energy production by 2010 with additionally 5 million m3 harvested.[6]

According to the Finnish Forest Research Institute, 11.4 – 20.0 million m3 (82-144 PJ) constitute the technically harvestable potential of forest fuel. A recent study by Lappeenranta University of Technology puts the techno-economical

[6] Heinimö & Alakangas (2006)

potential of forest fuel in 2010 as 86 PJ. Less than one fourth of the production potential is used, mainly due to economical and geographical constraints.[7]

Table 4.1 Biomass Growth in Finnish Forests

Type of Biomass Growth	Yearly Growth (Million m3)
Growing stock of stem wood biomass	2 090
Growth of stem wood	87.0
Total drain of growing stock	69.9

Source: Finnish Forest Research Institute, 2005 cited from Ytalo, 2005 and Heinimö, Jussi & Alakangas, Eija (2006)

Potential Forest Industry By-products for Energy Use

The current use of forest industry by-products for energy purposes was 77 PJ in 2004. Pöyry has estimated that the production levels in the forest industry will slightly decrease in the future partly due to tightening competition. Therefore also the potential for the use of by-products from forest industry will decrease by approximately 10 per cent to 70 PJ (19 TWh) by 2020. Black liquor represents by far the largest bioenergy resource in Finland totalling about 156 PJ and (See Figure 4.1) making out nearly 11per cent of the total primary energy demand in Finland. The amount of black liquor for energy production is estimated to remain at the current level in the future.

Potential Agricultural Bioenergy Production

It is expected that agricultural set aside areas will increase from 241,000 hectares in 2005 to about 0.5 million hectares over the next few years, offering a potential for alternative land use. Reed canary grass appears to be of particular interest in Finland. The area under cultivation increased from 8,700 hectares in 2004 to ca. 17,000 ha in 2006.

According to VTT, Finland could supply 19 PJ of reed canary grass in district heating, electricity and pellet production by 2010. This would require a total of 150,000 – 230,000 hectares of reed canary grass.[8] The theoretical potential of cereal straw is estimated at 1.8 million tons, of which 10-20 percent could be used as energy (6 PJ).

A working group from the Finnish Ministry of Agriculture and Forestry has proposed that about 150,000 ha of agricultural land should be used for growing cereals and oil plants for liquid biofuel production and 50,000 ha for reed canary grass. Agricultural subsidies and a significant share of biofuels attributed to the transport sector are needed to make the production of grain and rapeseed

[7] Karjalainen et al., 2004 and Ranta et al., 2005, as reported in Heinimö & Alakangas (2006)

[8] Heinimö & Alakangas (2006).

competitive as compared to the world market price due to the climatic conditions in Finland.[9]

[9] Heinimö & Alakangas (2006).

Potential Biogas Production

Finland intends to reduce the amount of biodegradable waste put in landfills requiring that another 800,000 tons of waste derived fuels are used for energy recovery in 2016.[10] 3.3 PJ of used wood was used in 2004.

Biogas is mainly used for electricity and heat production although a small part has been used for biofuels. There are government decisions requiring the collection and use of landfill gas and the use of biogas has increased. A new strategy promotes measures for increasing the use of biogas from farms. According to Jyväsklyä Science Park [11] the techno-economical potential for biogas in energy production is 7.9 – 10.0 PJ in 2015 sourced from municipal solid waste, land fill gases, residues from the food processing industry, sewage disposal and from the agricultural sector (straw, litter, energy crops).

Table 4.2 summarises the potential of biomass resources in Finland by 2010-2015, based on readily available sources. The table excludes energy crops other than canary reeds.

Table 4.2 Potential Availability of Biomass Resources for Energy Purposes in Finland per year, 2010-2020

Fuel/Biomass Resource	PJ	TWh	Year	Comment	Source
Biogas	7.9-10.0	2.2–2.8	2015	Technico-economic potential	Jyväsklyä Science Park
Reed canary grass	19	5.3	2010	n/a	VTT
Straw	6	1.7	n/a	Theoretical potential	
Forest industry by-products	70	19.4	2020	n/a	Pöyry
Black liquor	160	44.4	2020		Pöyry
Solid wood biomass	86	23.9	2010	Technico-economic potential	Lappeenranta University of Technology
Domestic firewood	51	14.0		Marginal growth	
Total	399,9 - 402	111.0–111.6			

The EEA estimates the Finnish biomass potential to 393.5 PJ/year (1416.6 TWh/year) by 2030 with the main potential from black liquor and wood industry wastes.

[10] Tekes, 2003, kling, 2006; Ministy of Environment,2006, as reported in Heinimö & Alakangas (2006)

[11] Heinimö & Alakangas (2006).

5 Biomass Use and Potentials in Iceland

5.1 Biomass Use in Iceland

Bioenergy is currently almost negligible in Iceland, due to the large share of other renewables. Virtually all electricity and heat is produced by hydropower or geothermal power, so the sole potential of bioenergy is as a transportation fuel. There are, however, some municipal district heating utilities which use waste as a partial energy source, see Econ Pöyry (2008). There is also electricity production from biogas, which is collected from a landfill.

Biofuels have been used since the year 2000, when the first methane pumping station opened, but other biofuels have been imported, such as B5 biodiesel and E85 ethanol. While these biofuels are imported, there are plans to start production of biofuels such as ethanol and even biodiesel in Iceland in the near future.

5.2 Biomass Potential in Iceland

Arable land in Iceland is about 15.6 per cent of Iceland's land area, or 16,000 km^2. Currently only 8per cent of arable land is in use, while other 11per cent are forests. There is potential to increase the efficiency of already used land as well as breaking in new land for energy crop use.

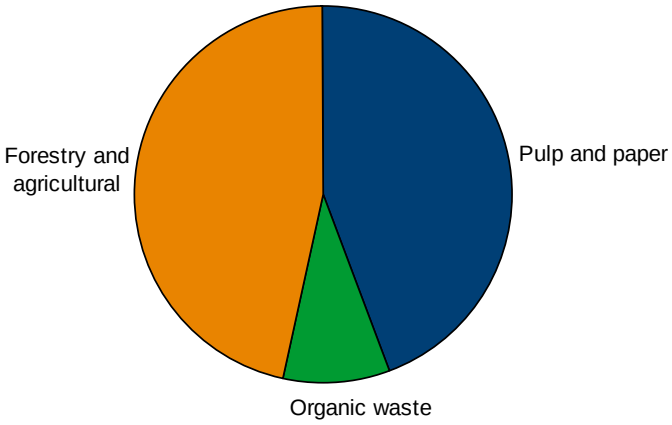
The Icelandic Biomass Company has estimated that between 20 and 30 million litres of ethanol could be produced. Biogas is already collected from the country's largest landfill.

6 Biomass Use and Potentials in Norway

6.1 Biomass Use in Norway

In Norway, 1.1per cent of the primary energy demand is covered by bioenergy (ca. 16 TWh), primarily as municipal waste utilisation for heat (See Econ Pöyry (2008)). Bioenergy represents only a small share of renewable energy in Norway. Figure 6.1 shows today's use of biomass for energy purposes in Norway. According to SSB, bioenergy covers 25 per cent of the need for energy in the pulp and paper industry. The other major bio energy source is waste from cuttings.

Figure 6.1 Use of Biomass for Energy Use in Norway, 2006



Source: factsheet on www.fornybar.no

According to Statistics Norway there are 10.3 million dekar[12] agricultural areas in Norway in 2006. Of this meadow totals 64 per cent, corn and oilseed crop 31 per cent and ecological farming approximately 4 per cent.[13]

[12] 10.3 million dekar corresponds to 1.03 million ha

[13] http://www.ssb.no/jordbruk/

Table 6.1 Biomass Use in Norway (TWh/year)

Fuel/Biomass Resource	Domestic resource	Import	Current use of Bioenergy
Raw wood	6.4	1.9	0.9
Processed Wood	10.0	5.6	5.3
Wood wastes from furniture & wood products	0.5	1.8	0.7
Municipal waste[2]	4.4	-	0.9
Wood wastes from construction[2]	0.9	-	0.3
Landfill gas[2]	1.0	-	0.1
Other biogas[2]	3.0	-	0.1
Wood fuel	7.2	-	7.2
Straw & Crop husks	4.5	-	0.1
Total	37.9	9.3	15.6

Sources: Fact-sheet on Fornybar.no

6.2 Biomass Potentials in Norway

According to a biomass fact-sheet on Fornybar.no the total theoretical Norwegian biomass potential is estimated at 425 TWh/year (1530 PJ/year).

Yearly production of wood, peat, straw, manure and aquatic biomass, which theoretically is possible to use for biofuel in energy production is estimated at 140 TWh (504 PJ) (Hohle, red., 2001). Most of this potential is not possible to use for energy purposes, because it is too costly to extract, it is already in use for other purposes than energy (timber, pulp and paper) or it is necessary to leave it in the nature to sustain the ecosystem.

Table 6.2 below shows a realistic potential for increased use of biomass in Norway, amounting to a total of 31 – 35 TWh (111 - 126 PJ). It may be possible to increase the use of biomass with 10 – 15 TWh/year to a fuel cost of 12 NOK øre/kWh. For energy prices below 50 NOK øre/kWh it may be possible to further increase the use of non-agro biomass up to 20 TWh/year (Hohle, red., 2001).

Table 6.2 Potential Availability of Biomass Resources for Energy Purposes in Norway

Fuel/Biomass Resource	TWh/year	PJ/year
Timber[2]	4.6	16.56
Processed Wood[2]	5.4	19.44
Wood wastes from furniture & wood products[2]	1.2	4.32
Straw & Crop husks[2]	4.5	16.2
oil crops[1]	0.2 – 0.25	0.75 – 0.9
Municipal waste[2]	2.4	8.64
Wood wastes[2]	0.8	2.88
Landfill gas[2]	1.1	3.96
Other biogas[2]	3.1	11.16
Wood fuel	19.2 – 23.2	69.12 – 83.52
Total	42.5 – 46.55	153 – 167.58

Sources: [1] Berg et al (2003); [2]Fact-sheet on Fornybar.no

Potential Agricultural Bioenergy Production

Berg et al. (2003) estimates that the bioenergy potential from agriculture in Norway can be increased from the current yearly 0.1 TWh (0.36 PJ) to 5.5 TWh (19.8 PJ). Of this, 4.5 TWh (16.2 PJ) are based on straw and crops residues and 1.0 TWh (3.6 PJ) from energy crops such as Mischantus, Reed Canary grass, Alfalfa, Napier grass, sorghum and hemp as well as short rotation species such as coppice. Due to the relatively small agricultural area in Norway, the potential for short rotation species is considered negligible.

In addition, the energy potential of domestically grown oil-crops, taking into account the need for food and fodder, is estimated at 0.2-0.25 TWh (0.75 PJ – 0.9) per year.

Husks, separated when cleaning harvested crops can be utilized in combustion for energy purposes. Assuming that crop husks represents 1.5per cent of the raw crop, the potential in Norway is at 80GWh

NOBIO (2002) (as cited in NVE 2003) estimates that energy grasses can contribute with 0.8 TWh per year. The majority of Norway's 1.03 million ha agricultural land is grassland and meadows (64per cent). This takes into account the relatively small bioenergy potential of extensively managed grasslands.

Biomass Use & Potentials in Sweden

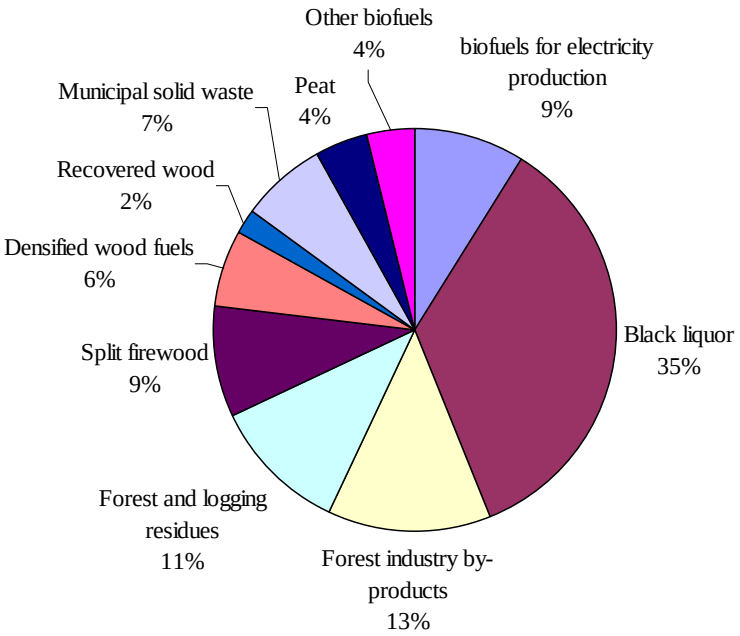
6.3 Biomass Use in Sweden

The use of bioenergy in Sweden increased from 10 percent of total gross inland energy consumption in the 1980s to 19 percent in 2006. This corresponds to 416PJ (116 TWh) biomass used in 2006 out of a total of 2247PJ[14] (624 TWh) gross inland energy consumption.

Swedish bioenergy primarily originates from the forestry sector, which accounts for approximately 90 percent of the bioenergy used. The forestry sector provides waste from logging, by-products from sawmills and pulp mills, and black liquor from the forestry industry, where the latter makes up the largest share. About 2per cent of the agricultural area under cultivation is used for the production of biomass for bioenergy purposes.

According to the Swedish Energy Agency, about 50 percent of the heat supply, 5 percent of electricity and about 2 percent of transport fuels were produced from biomass in 2005. In 2006, the biofuel share had increased to more than 3per cent of the total fuel consumption in Sweden. Figure 0.1 below shows the share of different types of biomass resources in the supply of bioenergy.

Figure 0.1 Use of Biomass for Energy Use in Sweden, 2005



Source: Hillring, B., (2006)

The major part of biomass used for energy is produced in Sweden and comes from by-products and residue flows in the forest sector. According to the Swedish

[14] Hillring, B., (2006)

Energy Agency the competition between the use of these resources for energy and for other purposes is not overly fierce.

Agricultural Bioenergy Production Today

Agriculture currently contributes approximately 1 TWh to the Swedish energy supply, mainly from straw, energy cereals and lignocellulosic energy crops, primarily salix. The current agricultural area under bioenergy production represents ca. 2 percent of useful agricultural area (UAA), or ca. 266,000 ha[15].

Sweden is at the forefront with regard to dedicated energy crops like salix and also with regard to what is called multifunctional biomass plantations (MPS). Wastewater sludge and landfill leachate is recycled or treated in salix plantations. There is already a number of salix/wastewater treatment systems established. The main form of competition in this sector is over the use of the cropland rather than the actual crop.[16] Salix accounts for about 15,000 hectares which makes up 0.5 percent of Swedish arable land. Salix production is still in an emerging phase but is increasing.

Potential Agricultural Bioenergy Production

Studies on land availability for bioenergy production range from an additional 400,000 ha to 800,000 ha, this would represent between 3.9 per cent and 7.8 per cent of UAA. Table 0.1 gives an overview of studies estimating the potential for agricultural land available for bioenergy production in Sweden.

[15] Swedish Energy Agency (2006). 266,000 ha energy grasses is available for biofuel production according to SNV, 1997, quoted in "The future of bioenergy in Sweden – Background and summary of outstanding issues" ER 2006:30

[16] Energimyndigheten's report ER 2006:30 The future of bioenergy in Sweden – Background an summary of outstanding issues

Table 0.1 Potential for Land Available for Bioenergy Production in Sweden

Reference	Land available for bioenergy production (ha)	Comments
Biobränslekommissionen 1992	800,000	Estimate for 2005
SNV 1997, "Stigfinnare"	553,000 (1,953,000)	475,000 ha energy forests and 75,000 ha energy grasses. The higher number includes 1.4 Mha of land used for extensive production of broad-leaf trees or reed canary grass.
SNV 1997, "Vägvinnare"	458,000 (807,000)	458,000 ha energy grasses. Sensitivity analyses including higher yields in production of cereals and other crops indicate slightly above 800,000 ha of available land.
SNV 1997, "Målbild"	650,000	384,000 ha energy forests and 266,000 ha energy grasses.
LRF 1995	400,000	Estimate for 2020. 300,000 ha Salix and 100,000 ha wheat and rape seed.
LRF 2005	500,000-600,000	Refers to the area presently used for export crops and unused fallow land.

Source: The Swedish Energy Agency (2006).

Depending on the organisation and the definition of boundaries for bioenergy sources, estimates on the contribution of domestically grown bioenergy to the national energy production vary.

The Farmers' Association of Sweden (LRF) has estimated that it may be possible to supply 22 TWh (80 PJ) a year of biomass based on a range of sources like straw, food industry waste and different energy crops by 2020.

The Swedish Bioenergy Association, Svebio, estimates that a near doubling of bioenergy sources is possible from the present 115 TWh to more than 220 TWh (792 PJ) per year. Of this, Swedish agriculture could contribute with 30-35 TWh (108 – 126 PJ) of biomass with an increased use of agricultural residues and an increase in agricultural area for bioenergy production in the range of 20 – 30 per cent of total UAA (1-2 million ha).

Biomass Resource Potential

Based on a number of studies, the EUBIONET II country report for Sweden estimates a total potential from biomass in Sweden by 2020 at 162 TWh (583,6 PJ). This represents 40per cent of the primary energy production in Sweden in 2005 (399 TWh or 1437 PJ)[17]. Table 0.2 below shows the estimated potential

[17] Eurostat, Energy Statistics, Supply, transformation, consumption – all products – annual data, 2005.

biomass resource availability by 2020, covering forestry, forest industry by-products, paper and pulp industry by-products, peat, agro biomass and municipal solid waste. Agro biomass includes fuels and fuel raw materials such as salix, grains, straw and energy grasses (i.e. reed canary grass).

Table 0.2 Biomass Potential in Sweden by 2020

Fuel	TWh	PJ
[1]Forest and logging residues	75.0	270.0
[2]Industrial by products	13.3	47.9
[3]Black liquour	39.4	141.8
[4]Domestic firewood	12.0	43.2
[5]Densified wood fuels	6.4	23.0
[6]Recovered wood	2.5	9.0
[7]Tall-oil	1.2	4.3
[8]Peat	4.0	14.4
[9]Agro biomass	1.1	4.0
[10]Municipal solid waste	7.2	25.9
Total	162.1	583.6

Source: 1 Parikka (2003), 2 3 SCB (2005c), STEM (2005a&b), 4 Board of forestry (2005), 5 PIR (2005), District heating association (2005), 6 7 8 10 District heating association (2005), 9 LRF (2005). Referenced from: EUBIONET II Country report of Sweden

The EEA estimates the Swedish biomass potential to ca. 114 TWh/year (410.3 PJ/year) with the largest potential from black liquor and wood industry wastes. These figures are more or less the same as for 2006 when bioenergy contributed with 116 TWh/year (416PJ/year)[18].

Table 0.3 presents estimated potentials of biofuels based on agricultural products by 2020 in Sweden, according to Association of Swedish farmers.

Table 0.3 Potential Production of Agro Fuels in Sweden by 2020

Fuel	TWh/year
Straw	7.0
Raw materials for biogas	3.0
Salix (Willow)	4.0
Grain, Reed Canary grass, Hemp etc.	2.0
Ethanol (grain and sugar beet)	5.0
FAME (e.g. RME)	1.0
Total	22.00

Sources: Parikka, Matti (2007) and http://www.lrf.se

[18] Swedish Energy Agency (2007), "Energy in Sweden - facts and figures 2007"

7 Summary

The bioenergy share of gross inland energy consumption varies in the Nordic countries from 4.2per cent in Norway to 12.2per cent in Denmark, 19per cent in Sweden and up to 20per cent in Finland (2004 numbers). Especially in Denmark, Sweden and Finland did the share of bioenergy increase significantly over the past 25 years.

The type of biomass resource utilised for energy purposes reflects to a large extent the natural resource availability in the country. Close to half of biomass use in Denmark (48per cent) originate from forestry comprising chips, pellets and firewood. The large remainder consists of organic waste and straw (47per cent) and only 4per cent of biogas.

Black liquor plays a prominent role in Finland and Sweden, with 50per cent and 35per cent of total biomass use respectively. Wood products and wastes represent the second large resource with 48per cent in Finland and 41per cent in Sweden.

Potential availability of domestic biomass varies from 111PJ/year in Norway to more than 500 PJ/year in Sweden. Potentials are found in biogas and straw in Denmark, in black liquor and wood industry wastes in Finland and Sweden, and in biogas, timber, and firewood in Norway. Table 7.1 below summarises the Nordic potential, including the current use of biomass.

Table 7.1 Summary of Nordic Biomass Potentials (including current use)

Country	National estimates PJ/year	EEA estimates PJ/year[1] (2030)	Land available for energy crops (ths. ha) 2010	2020
Denmark	165[3]	104	74[1]	0[1]
Finland	401[4]	393.5	486[1]	299[1]
Iceland	0.79	n/a	n/a[7]	n/a[7]
Norway	153-167.6[5]	n/a	See Note 2	See Note 2
Sweden	583.6[6]	565,2	135[1]	168[1]
Total	**1,494 - 1,509**	**1062,7 +**	**695 +**	**467 +**

Sources: 1EEA, 2006, Table 6.1.

2 Agricultural potential for energy crops are estimated to 3.6PJ/yr. Berg et al., 2003

3 Danish Energy Agency, 2005

4 See Table 4.2

5 www.Fornybar.no and Berg, 2003 Agricultural potential for energy crops are estimated to 3.6 PJ/year..

6 Hillring, B., 2006

7 81per cent of arable land in Iceland is currently unused, or 1.300 thousand ha.

References

Berg, L.N., Jørgensen, P.F., Heyerdahl, P.H., Wilhelmsen, G. (2003) Bioenergiressurser i Norge. Oppdragsrapport 7/2003 Norges Vassdrag- og Energidirektorat

Danish Energy Authority (2006), Energy Statistics 2005.

Econ Pöyry (2008): Fact and Figures on the Use of Bioenergy in the Nordic Countries.

EEA (2006) How much bioenergy can Europe produce without harming the environment? EEA Report No 7/2006.

Energistyrelsen (2005): Energistatistik 2005, Denmark.

Eurostat (2005), Energy Statistics, Supply, transformation, consumption – all products – annual data, 2005.

www.fornybar.no

Heinimö, Jussi & Alakangas, Eija (2006), Solid and Liquid Biofuels Markets in Finland – a study on international biofuels trade. IEA Bioenergy Task 40 and EUBIONET II - Country Report of Finland.

Hillring, B., (2006) Country report of Sweden, WPI Current situation and future trends in biomass fuel trade in Europe, EUBIONET II, SLU, Sweden.

Hohle, E. Eid (red.) (2001): Bioenergi. Miljø, teknikk og marked. Energigården, Brandbu.

Lensu, T., Alakangas, E. (2006) Country report of Finland, WPI Current situation and future trends in biomass fuel trade in Europe, EUBIONET II, VTT, Finland. http://www.lrf.se

NVE (2003), Bioenergiressurser i Norge.

Parikka, Matti (2007), *Potential of biofuels in Sweden. The future perspectives*. SLU from Bioenergy 2007 3rd International Bioenergy Conference and Exhibition Jyväskylä, Finland, Proceedings.

Statistics Finland (2005), Energy Statistics 2004.

http://www.ssb.no/jordbruk/

Swedish Energy Agency (2007), *Energy in Sweden - facts and figures 2007.*

Swedish Energy Agency (2006). The future of bioenergy in Sweden – Background and summary of outstanding issues. ER 2006:30