IEA Bioenergy task 40 – Country report 2011 for Norway

Erik Trømborg

Department of Ecology and Natural Resource Management
Norwegian University of Life Sciences
P.O Box 5044
1432 Ås
Norway
erik.tromborg@umb.no

DECEMBER 2011

Task 40: Sustainable International Bio-energy trade

IEA Bioenergy

EXECUTIVE SUMMARY

This report is a part of the work of IEA Bioenergy Task 40 working group-"Sustainable International Bioenergy Trade: Securing Supply and Demand" and gives a picture of the situation regarding bioenergy in Norway for the year 2010. Previous country reports for Norway are available at ww.bioenergytrade.org.

Norway has large resources of oil and gas. Oil and gas extraction including services accounted for 20% of GDP in Norway in year 2010. The production of hydro electric power is also high in a European scale; the Norwegian production corresponds to about 40% of the production in EU 27. The net domestic energy consumption is only about 10 % of the production of primary energy carriers. Bioenergy constitutes 7% of the domestic consumption, electricity 51% and fossil fuels 42%.

Norway's targets for GHG emissions are to reduce the annual emissions by 15–17 million tons of CO2-equivalents by 2020 – adjusted for carbon stock changes in forests – and to become carbon-neutral by 2030 . Measures in the field of renewable energy and energy efficiency will play an important role for fulfilling these targets. Preliminary estimate of the share of renewable in domestic energy consumption is 62% for 2010 but implementation of the EU directive regarding the use of energy from renewable resources (RES) will force Norway to increase this share. The recent negotiations with EU defined a RES target of 67.5% by 2020. The government has proposed a national target of 50 PJ (14 TWh) increased use of bioenergy by 2020, almost a doubling of the current production. A strategy plan which outlines and coordinates necessary measures in order to reach the bioenergy target was lunched April 1. 2008. Measures in the field of bioenergy are divided among different policy areas, where environment, energy, agriculture, forestry and rural development are the most important. The need for increased energy security, as the hydro electric power production varies according to rainfalls, is another major factor for the political attention on bioenergy.

Statistics Norway reports the total bioenergy consumption in 2010 to be 61.6 PJ including biomass use in district heating. About 50% of the consumption is heat produced in wood stoves in private households, 25% is biomass in district heating and 25% is use of biomass for internal heating and drying in industries (mainly forest industries). About 60% of the households in Norway have furnaces for solid fuel, mainly wood stoves. The use of wood pellet plays a minor role in the heat market.

Less than half of the annual growth of roundwood in Norway is harvested annually, hence forest resources represents the major potential for increased bioenergy production in Norway. The sustainable potential use of biomass for energy production is uncertain, but are estimated to be around 140 PJ (39 TWh), close to a threefold of the current production. The potential will be larger if more of existing roundwood harvest is directly used for energy production in stead of use by the forest industries. Agricultural land can also be used for energy crops, but limited availability of agricultural land limits the potential (agricultural land covers 3.2% of total land area). The theoretical potential, if all biomass resources where used for energy production, would be around 180-210 PJ (50-55 TWh).

Norway has a relatively high price levels both for wood and labour compared to other European countries. As a result, prices of biofuels are also relatively high compared to other countries. Norway is a significant importer of wood. The main part of the import is

used for pulp and paper production. A fraction of the imported wood are utilised for energy production, either directly (wood fuel) or indirectly through use of bi-products like bark, sawdust and black liquid. The availability of biomass is in general no barrier for energy production in the short run, increasing demand will however effect prices and hence profitability of energy production.

The main barriers for increased use of bioenergy in Norway are relatively low prices of electricity in relation to the investment costs for bioenergy systems. Air to air heat pumps play an increasing role in detached houses and larger heat pumps with heat exchange to ground or sea water as a major competitor to biomass systems. In existing buildings, increased used of bioenergy is in the short run limited to current infrastructure, water born heat distribution and chimneys in private households. 75% of the buildings for living and 50% of the buildings in the service sectors are based on heating by electric space heaters. The total economic potential for heating is estimated to around 100 PJ. Other barriers are lack of know-how in the value chain for bioenergy, including contractors, politicians, consultants and consumers.

The opportunities for bioenergy in Norway is availability of domestic biomass resources, increasing demand for renewable energy, more political attention and incentives and increased resources for R&D for development of more efficient value chains including appropriate technology for sustainable biomass supply and energy conversions appropriate for Norwegian buildings. Some years ahead, second generation biofuels based on forest resources can be an opportunity for increased use of bioenergy in Norway.

CONTENT

1. GENERAL INTRODUCTON

1.1 Country characteristics

With a land area of 304 280 km2 and 4.9 million inhabitants, Norway has the lowest population density in Europe after Iceland, with 15 inhabitants per $km^{2.}$. A rough climate, poor soil and difficult terrain mean that a large part of the country is unsuitable for settlements or agriculture. Almost 80 per cent of the population live in urban settlements, where the population density is 1 595 per km^2. Most of the pressure on areas is therefore concentrated around urban settlements and adjacent agricultural and forest areas. However, the pressure is also increasing in sparsely populated areas due to the construction of roads, holiday houses and power lines etc.

The real GDP declined from 2008 to 2009, but increased by 0.7% in 2010 (real prices). Oil and gas extraction including services accounted 20% of GDP in 2010 (Statistics Norway 2011).

1.2 Main industries

Table 1 shows the economic importance of selected sectors in Norway.

Table 1. Share of GDP by kind of main activity in Norway 2010.

Sector/industry	Percentage of total GDP
Agriculture, forestry and fishing	2 %
Manufacturing, mining, electricity, building and construction	15 %
Oil and gas extraction including services	20 %
Communication and transport	4 %
Other services	354 %
VAT etc	11 %
General government	16 %
Commodities, vehicle repairs	7 %

Source: Statistics Norway 2011. National accounts: www.ssb.no

1.3 National climate change policy

On 28 March 2008 the White Paper on Norwegian Climate Policy was adopted by Stortinget (The Norwegian Parliament) with several amendments which strengthen both the emission reduction targets and the measures in order to reach them.

The Norwegian climate change targets are to become carbon-neutral by year 2030 and to reduce the annual greenhouse gas emissions by 15–17 million tons of CO2 equivalents by 2020, including carbon uptake in forests. This implies that about two thirds of

Norway's total emissions reduction has to be made nationally. In 2005 the Norwegian greenhouse gas emissions was 54 million tons CO_2 equivalents.

The green house gas reduction targets will be reached through broad and general economic measures, CO_2-emission credits and CO_2-tax, and a set of specific measures within different sectors and industries.

Measures in the field of renewable energy and energy efficiency will play an important role for fulfilling the green house gas reduction targets. Among others, the research budgets for renewable energy, energy efficiency and carbon capture and storage have increased steadily the last years including establishment of around 10 research centers for renewable energy including one for bioenergy. The Government has also established a common green certificate market where the countries have agreed to produce 95 PJ (26,4) TWh) of new renewable electricity within 2020. Half of it shall be produced in Norway and it is expected that hydroelectric and wind power will be the main technologies for fulfilment of this target in Norway.

1.4 National renewable energy and energy efficiency policy

The Norwegian Government has sett a concrete target for increase in renewable energy production and energy saving. The target is to increase the production of environmental friendly energy or to save energy equivalent to 40 TWh/144 PJ within 2020 compared to 2001. In comparison the total domestic energy consumption was approximately 225 TWh/810 PJ in 2006. The share of renewable in domestic energy consumption was 62% in 2008. Implementation of the EU directive regarding the use of energy from renewable resources (RED, EU, 2009) will force Norway to increase this share and Norway has agreed to increase the renewable share to 67.5%. I 10% renewable energy share in the transport sector by 2020 is also likely to be implemented.

The main measures in order to reach the target are investment support and information and advisory services. The measures are partly financed by a levy on the distribution tariff for electricity, yearly yield from a governmental fund and additional grants over the state budget. The levy corresponds to approximately NOK 700 million pr. annum. The governmental fund, which has a capital of NOK 10 billion, was increased to NOK 20 billion in 2009, this gives a yearly yield of approximately 440 million 2009 and 880 million pr. annum from 2010. All together between 1,5-1,6 billion will be allocated for investment support to renewable energy and energy saving from 2010. In 2009 another 1,2 billion has been added to the budget in order to battle the financial crises in the renewable energy sectore. In total approximately 2,6 billion will be allocated in 2009. The funds will be managed by Enova SF, which is a state owned company which is established solely for the purpose of managing the funds and rune the measures. Enova was established in 2002 and operates on a contract with the Ministry of Petroleum and Energy. The contract specifies quantitative targets for how much renewable energy and energy saving that should result from Enova's effort. According to today's contract Enova should contribute to at least 4 TWh/14,4 PJ increased production of central heating based on renewable sources of energy, including heat pumps and waste heat, and 3 TWh/10,8 PJ increased production of wind power. The heating target of 14,4 PJ will be reached by the end of 2009.

In order to strengthen the efforts for increased use of bioenergy a strategy plan has been launched, see the bioenergy policy section for further references.

1.5 Energy production and consumption

Large resources of oil and gas make Norway an energy nation. The production of hydro electric power is also high in a European scale, the Norwegian production in 2009 corresponds to 39% of the production in EU 27 and 7.3% of the total renewable energy production in EU-27 (Eurostat 2011). As seen by Table 2 the net domestic energy consumption is only about 8% of the production of primary energy carriers. Bioenergy constitutes 6% of the domestic consumption, electricity 49% and fossil fuels 45%.

Norway has a high share of electricity in its energy consumption (Figure 1). Power consumption per capita is roughly 10 times the world average. Reasons for this include extensive power-intensive manufacturing, and the fact that electricity is a more common source of heating than in other countries.

Table 2. Energy production and domestic use and heat market 2010 (PJ). Source: Statistics Norway (2011).

Energy source	Production of primary energy carriers	Net domestic consumption
Biofuels	61.6	62.5
Fossil fuels	8210.9	335.3
Electricity	427.8	408.3
Total	**8700.3**	**806.7**

Sources: Statistics Norway (www.ssb.no). The difference between primary energy carriers and net domestic consumption is caused by international trade, consumption in energy sectors, consumption in energy sectors, losses in distribution etc.

The energy balance for 2010 shows a stable use of biomass in Norway.

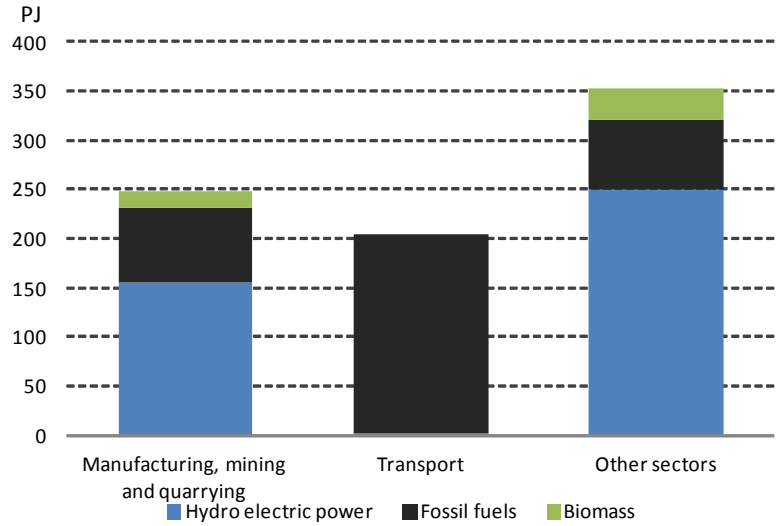

Figure 1. Energy consumption by sector 2010 (PJ). Source: Statistics Norway (2011)

The Norwegian electricity production is characterized by high dependence of hydro electric power, variation in annual production and limited transmission possibilities for export-import. 99% of the electricity production in Norway is hydro electric power, 0.6% thermal power and 0.4% wind power. The installed capacity increased steadily up to around 1990. Since 1990, policies have developed towards more focus on environmental objectives such as preservation of water falls. As a result, there has been very limited growth of hydropower capacity in recent years. More remodelling of existing plants and investments in small hydro-electric power stations have increased the capacity somewhat in recent years.

The annual hydro power production can vary between 89 TWh and 150 TWh, due to variations in precipitation and the consumption vary by temperature and industrial activities. The domestic production was 118.8TWh (427.8 PJ) in 2010 and the consumption electricity was 113.6 TWh (409 PJ) in 2010. Total export was 7.1 TWh, import 14.7 TWh. 39% of the electricity was consumed by industrial sectors (Manufacturing, mining and quarrying).

2. BIOENERGY POLICY

2.1 Targets and strategies

In addition to the overall renewable energy and energy saving targets, the government has proposed a national target of 14 TWh/50 PJ increased use of bioenergy by 2020. A strategy plan which outlines and coordinates necessary measures in order to reach the bioenergy target was lunched 1 April 2008 (Strategi for økt utbygging av bioenergy, Olje- og energidepartementet, 2008). Measures in the field of bioenergy are divided among different policy areas, where environment, energy, agriculture, forestry and rural development are the most important. By joint focus and better coordination the target will be reached.

The main strategy for fulfilling the bioenergy target is to increase the use of bioenergy for heating followed by a balanced increase in the supply of wood and forest based fuels.
The strategy will be support by the following range of measures:

- Establishment of a bioenergy forum lead by the Minister for Petroleum and Energy
- Regulatory energy and climate planning by all municipalities
- Compulsory water born heating distribution in public buildings above 500 m2
- Removal of compulsory reduction in transmission tariffs for spot electricity used for central heating
- Investment support for district heating, central heating based on renewable energy and conversion of fossil fuel based heat production in industry
- Support for harvesting residues from logging and thinings
- Tax incentives for investments in bioenergy in the forestry sector
- Increased investment support for pellet stoves in private households
- Prohibition against instalment and replacement of oil-burners in new and existing buildings
- Increase budgets for R&D in the field of renewable energy

- Development of efficient logistics and supply changes for forest and wood waste based fuel
- Various information and advisory measures

As mentioned above there is a variety of support measures which supports the development of bioenergy. Besides Enova SF, Innovation Norway gives support to district heating and other bio-based energy systems. Investments costs for heating can be supported with 20-40%, a common support level in Europe. The Norwegian Agricultural Authority handles the support and tax measures for forest operations and investments related to bioenergy. Small incentives and relatively low electricity prices explains the low production of bio-based electricity in Norway. The government is currently taking up the discussion with Sweden to establish a common market for green certificates, mine while electricity production from bioenergy will be given investment support on the same terms as heat production.

Besides investment support, grants for R&D by the Norwegian Research council will be an important instrument for fulfilling the bioenergy strategy. Research and development activities within the field of bioenergy have been relatively low up to recently. The governmental funding for research and development in renewable energy was NOK 250 mill in 2006, of which 44 mill was allocated to renewable energy including solar, wind, bio, ocean and water energy (www.forskningsradet.no). 2007 figures were at the same level. Funding for research and development activities within bioenergy are currently increasing as a result of new national targets for renewable energy and reduced GHG-emissions.

Different processes are initiated to explore research needs and opportunities related to renewable energy including bioenergy, including the strategy process *Energi21*. The purpose of Energi21 was to establish a broad and unified R&D strategy between the Government and private industry within the energy sector (www.energi21.no). Among others the strategy gives priority to research in the filed of efficient and renewable heating.

3. DOMESTIC BIOMASS RESOURCES

3.1. Biological potential

Less than half of the annual growth of roundwood in Norway is harvested annually, hence forest resources represents the major potential for increased bioenergy production in Norway. The sustainable potential use of biomass for energy production is uncertain, but are estimated to be around 140 PJ (39 TWh), close to a threefold of the current production (Figure 2.). The potential will be larger if more of existing roundwood harvest is directly used for energy production in stead of use by the forest industries. Agricultural land can also be used for energy crops, but limited availability of agricultural land limits the potential (agricultural land covers 3.2% of total land area). The theoretical potential, if all biomass resources where used for energy production would be around 180-210 PJ (50-55 TWh).

In 2008 a potential study for biogas was carried out by Enova. The study shows a annual potential for biogas production of 6,1 TWh / 22 PJ.

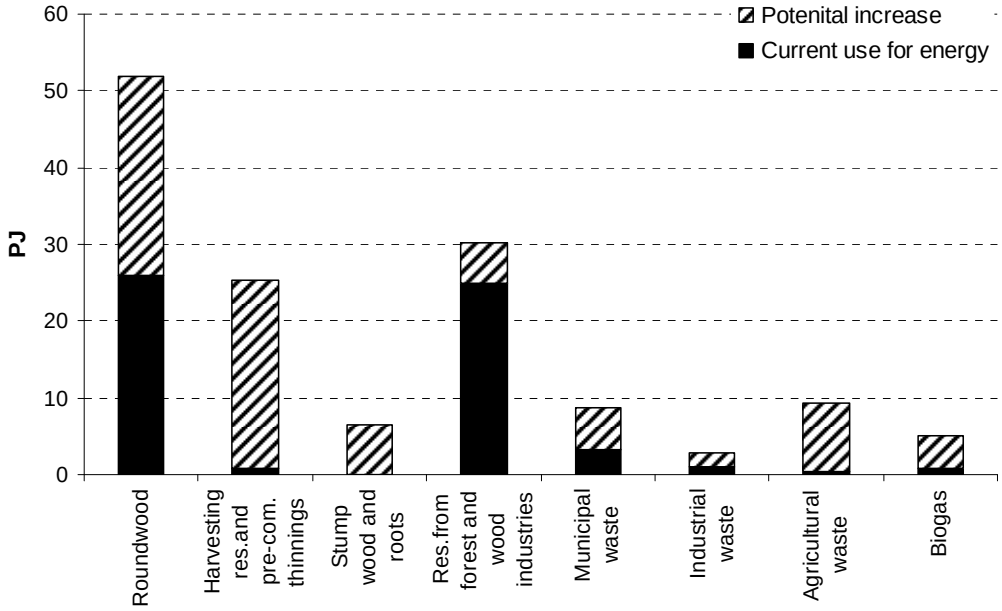

Figure 2. Current use and potential use of biomass for energy production in Norway. Based on Langerud et.al 2007 and Bernard & Bugge 2006.

3.2 Economic potential

Table 3 is based on a study by Bernard & Bugge (2007) who classified the biomass potential into cost classes. The costs include procurement, transport, treatment, storage, etc. The results illustrate that increased energy prices and/or reduced biomass costs are needed if the biomass potential shall be utilized for energy production

Table 3. Biomass resources by cost classes. Based on Bernard & Bugge (2007)

	< 0 Euro/GJ	0-2 Euro/GJ	2-3.5 Euro/GJ	3.5-5 Euro/GJ	5-7 Euro/GJ
Roundwood				9.7	22.3
Harvesting residuals				3.6	10.8
Residuals forest industries			0.4	5.4	8.6
Agricultural residuals		0.4		7.2	3.6
Wood waste	1.8			1.1	0.7
Municpal waste	5.4				
Waste for biogas production	1.8	1.1			
Sum PJ	**9.0**	**1.4**	**0.4**	**27.0**	**46.1**

4. CURRENT AND EXPECTED FUTURE ENERGY USE OF BIOMASS

4.1 Current bioenergy production

Statistics Norway reports the total bioenergy consumption in 2010 to be 53 PJ including biomass use in district heating. About 50% of the consumption is heat produced in wood stoves in private households and 35% is bioenergy in forest industries with limited availability of statistical data. Table 4 gives estimates of domestic bioenergy production based on different biofuels.

Table 4. Domestic bioenergy production 2010 for heating.

	Quantity (1000 ton)	Heat value (GJ/ton)	Energy content (PJ)
Firwood in households	1488	13,7	25.0
Waste in district heating	2000	4,7	9.4
Wood chips and bark in district heating	445	11	4.9
Briquettes	31.3	16,9	0,7
Pellets	45.1	17,3	0,6
Residuals in pulp and paper	1170	10	11.7
Other industries including sawmills	470	10	4.7
SUM			57.7

Based on data from www.ssb.no (energy balance and district heating figures 2010) and www.nobio.no (pellets and briquettes).

The electricity production based on biomass is around 0.5 TWh/1.8 PJ and based on biomass from waste and residuals in wood pulp production.

The use of biodiesel is growing rapidly in Norway and increased from 39.2 million litres in 2007 to 103.6 million litres in 2008 which is about 4% of the total diesel consumption for transport. 96% of the biodiesel consumption is blended with regular diesel. The consumption of bioethanol is still very limited in Norway (Statistics Norway 2009). There are currently only two producers of biodiesel in Norway. The production is based on mainly imported rapsoil. Bioethanol is not produced in Norway and the import is limited but increasing. There is also an increasing interest investments and research in second generation biofuel.

4.2 Future use

The main barriers for increased use of bioenergy in Norway is relatively low prices of electricity in relation to the investment costs for bioenergy systems. In existing buildings, Increased used of bioenergy is in the short run limited to current infrastructure, water born heat distribution and chimneys in private households. Figure 3 shows the existing use and estimated potential for different bioenergy technologies in Norway based on

current infrastructure and potential in new buildings. The total economic potential is around 100 PJ.

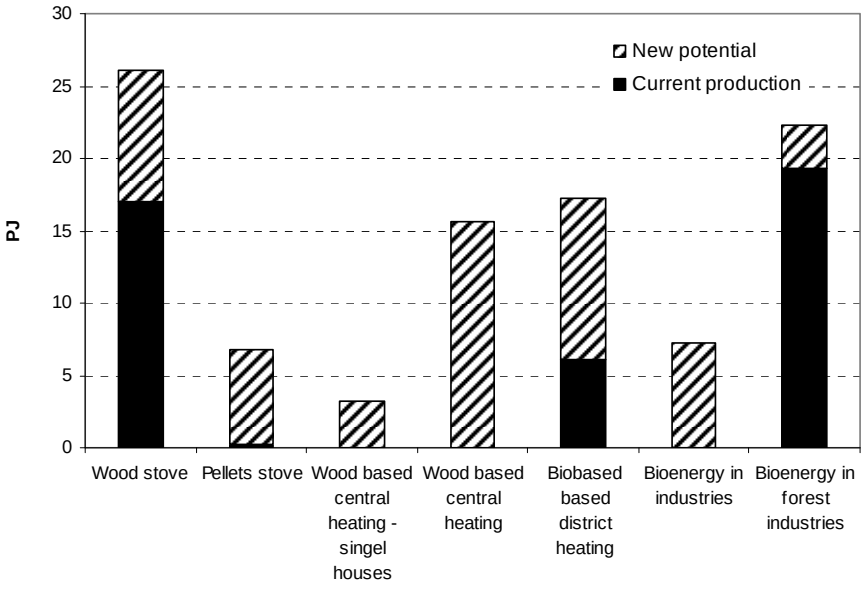

Figure 3. Net production of bioenergy and estimated potential for increased bioenergy production by increased use of wood stoves and replacement of fossil fuels. The potential for wood based district heating and wood based central heating cannot be added as replacement of fossil fuels in service sectors and multi-dwelling buildings in urban areas are included in both. Based on Trømborg et al (2007a and b)

A recent study by Trømborg et al (2011) shows how the price of biomass as well as other fuel prices affect the competitiveness of biomass in central and district heating in Norway. Heat pumps in central heating systems represent strong competition to biomass under the assumptions in this study and hence limit the use of biomass. The production of heat based on biomass in central heating and expansion of existing district heating plants is estimated to increase with around 3 TWh under a likely development in the biomass and energy markets. The increased production will be between 2 and close to 6 TWh by 2020 depending of the development of energy prices. Increased production above 5 TWh will demand a combination of very high electricity prices and significant increases in the support to biomass and bioenergy production. The government target of 14 TWh more bioenergy by 2020 compared to the 2007-level is not likely to be met by the heat market. The current energy in the transport sector is 58 TWh and increased use of liquid biofuels can be a mean to fulfill the government target for bioenergy.

5. CURRENT BIOMASS USERS

As shown above, the main sources bioenergy in Norway is firewood used in the households and wood residues used in the forest industries. About 60% of the households in Norway have furnaces for solid fuel, mainly wood stoves. The use of pellet stoves is increasing, but plays a minor role in the heat market. 7 600 pellets stoves where sold in Norway between 2003 and 2006. Electricity constitutes 76% of the stationary energy consumption in households, fuelwood 17%, oil/kerosene 5%, district heating 1% and fossil fuels like LPG, coal and natural gas 1% (2005 figures from www.ssb.no).

The use of district heating is slowly but steadily increasing. Figure 5 shows the fuel used in district heating. As illustrated by the figure, biomass including waste

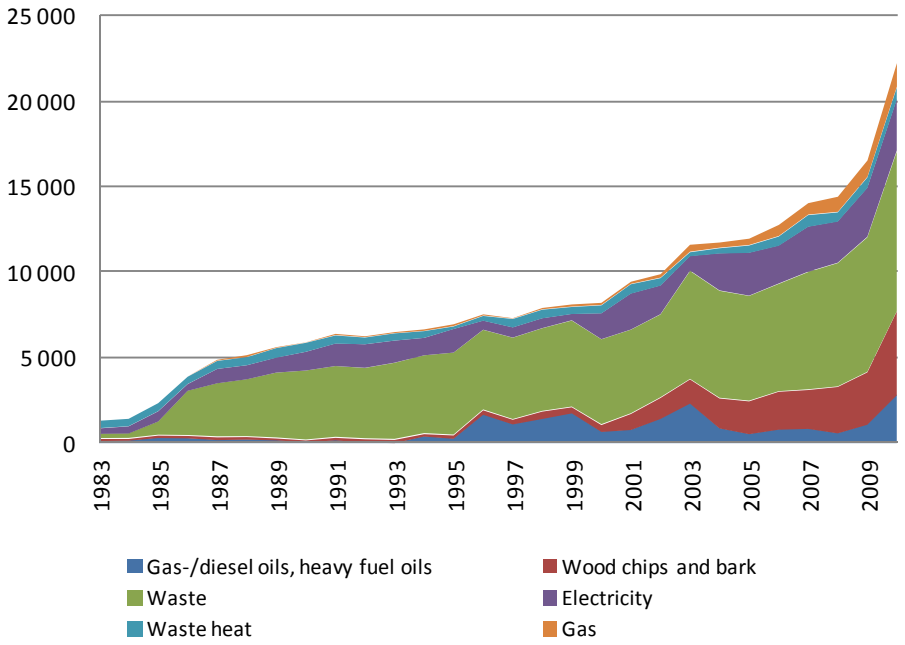

Figure 5. Consumption of fuel used for gross production of district heating. 1998-2007. PJ. Based on data from www.ssb.no

The forest industries in Norway consist of close to 300 sawmills, 18 pulp and paper mills and 3 mills that produce particle board (Trømborg& Sjølie 2011).

Figure 6 shows the production, import, export and domestic sales of wood pellet in Norway. The domestic sales of briquettes was 48 000 tonnes in 2010.

The consumption of firewood in household was estimated to be 25 PJ (6.95 TWh) in 2010 with a net energy delivery of 15.1 PJ (4.21 TWh) (Statistics Norway 2011[1]).

[1] http://www.ssb.no/vis/magasinet/miljo/art-2011-11-15-01.html

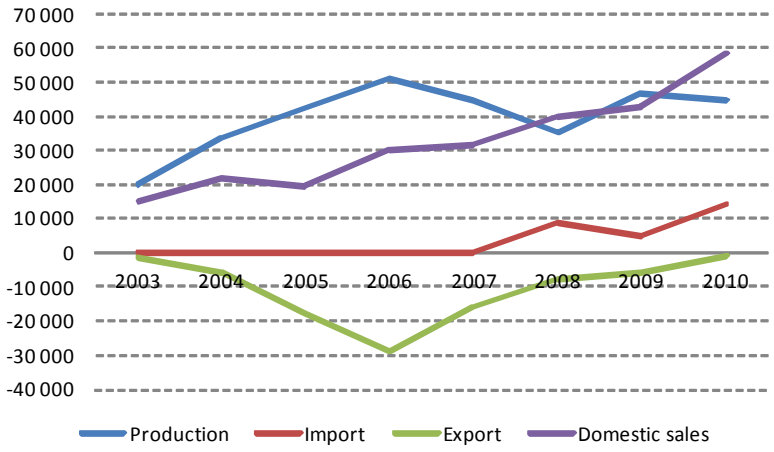

Figure 6. Production, import, export and domestic sales of wood pellets in Norway in tonnes. Based on data from the Norwegian Bioenergy Assocation (www.nobio.no)

6. BIOMASS PRICES

Norway has a relatively high price levels both for wood and labour compared to other European countries. As a result, prices of biofuels are also relatively high compared to other countries.

Figure 7 shows the bulk price development up to 2010 for wood pellets and briquettes relative to 2004.

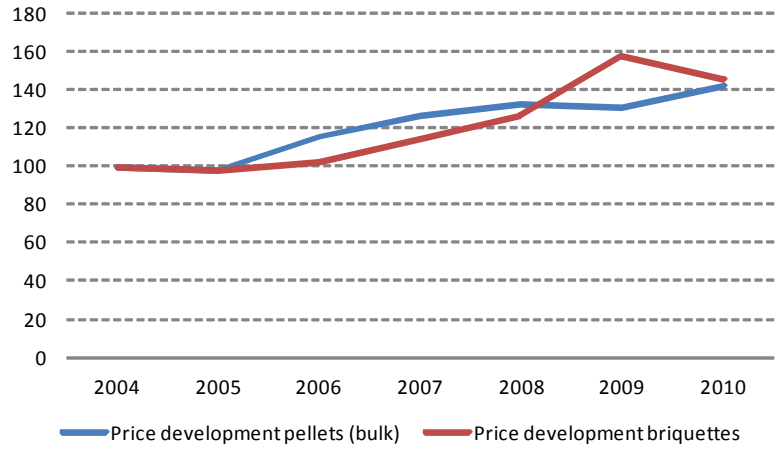

Figure 7. Development of bulk prices for wood pellets and briquettes relative to 2004 in nominal prices. Based on data from the Norwegian Bioenergy Assocation (www.nobio.no)

The current market price for wood chips in Norway is between 7.2 and 7.7 €/GJ delivered plant. Table 5 shows estimated wood chips costs delivered plant based on 2010

roundwood prices. The estimations show that current biofuel prices make pulpwood a competitive source of biomass for energy production.

Table 5. Wood chips costs based on 2010 pulpwood prices. Based on data from Statistics Norway.

	Av. roadside price per m3	Transp. 40 km	Chipping and storage	Adm 5%	Sum €/m3	€/MWh	€/GJ	Average harvest in 1000'
Spruce pulpwood	32,8	6,0	6,3	1,6	46,7	25,8	7,15	3 024
Pine pulpwood	34,5	6,0	6,3	1,7	48,5	21,0	5,83	670
Non-coniferous pulpwood	36,3	6,0	6,3	1,8	50,4	21,6	5,99	116
Biowood	17,6	6,0	6,3	0,9	32,5	16,2	4,51	200

The use of harvest residues is limited but increasing in Norway. 2-2.5 TWh of residues can be utilized when the market develops (Trømborg et al 2011).

7. BIOMASS IMPORT AND EXPORT

Norway is a significant importer of wood. The main part of the import is used for pulp and paper production. A share of the imported wood are utilised for energy production, either directly (wood fuel) or indirectly through use of biproducts like bark, sawdust and black liquid. Table 7 shows that the wood import gave around 3.4 PJ of immediate energy production in 2007. Eventually will most of the wood import be utilised for energy (paper, waste wood from buildings etc), but only the immediate use is estimated here. Import of other biomass than wood for energy use is very limited. The wood export is also significant.

Table 5. Import of wood for energy production 2007 in 1000 solid m3. Based on www.ssb.no

Commodity	Imports, 000' solid m3	For energy use in Norway GJ/m3	Energy use in Norway, PJ	Exports, 000' solid m3
Wood fuel	164	7,2	1,2	3
Chips or particles	929	0,7	0,7	42
Waste wood and sawdust	312	3,6	1,1	187
Sawlogs, conifers	288	1,3	0,4	331
Pulpwood, conifers	1698	1,6	2,7	580
Sum	**3 391**		**6,0**	**1 143**

Energy/m3 is based on the estimated share that are utilized for energy production (bark and sawdust within the sawmills and for pellets, waste wood for district heating, black liquid in the chemical pulp production, waste in mechanical pulp production).

The forest industries imports relatively large volumes of wood, mainly pulpwood, chips and particles. The total wood import was 2.5 mill tonnes in 2007 and the export 0.9 mill tonnes. Sweden is the major origin for import and export. Other countries for import to Norway is Russia and the Baltic states.

Table 6 shows the trade with pelles and briquettes. The increase in pellets production has to large extent been exported as domestic consumption is still low. Sweden is the main importer of pellets from Norway, whereas the Baltic countries are the main importer of briquettes (official statistics on trade flows not available).

A large pellets plant with an annual production capacity of 450 000 has recently started up in North Western Norway (BioWood Norway). When in full operation it will change the trade figures as it is mainly targeted on export.

Table 6. Production, import, export and domestic sales of pellets and briquettes 2003-2010. Data from www.nobio.no

		2003	2004	2005	2006	2007	2008	2009	2010
Briquettes	Production	2 791	29 594	37 615	42 171	38 676	37 383	30 336	31 255
	Import	2 760	672	2 392	786	6 504	6 789	11 250	19 568
	Export	589	1 038	899	4 339	1 177	2 758	1 337	4 790
	Domestic sales	27 661	28 904	35 912	34 194	40 711	40 904	41 508	48 071
Pellets	Production	20 296	33 567	42 339	51 340	44 827	35 115	46 624	45 100
	Import	300	237	232	0	0	9 080	4 849	14 014
	Export	1 297	5 566	17 980	29 003	15 672	7 800	5 796	755
	Domestic sales	15 322	22 055	19 497	30 184	31 868	39 791	42 943	58 505

Table 7 shows import and export of biofuels and some other major wood assortments in 2010.

Table 7. Export and import of biomass 2010. Source: Statistic Norway 2011.

Type	Import	Eksport
Firewood	95 249	12 984
Wood chips for pulp and paper production	453 412	49 596
Wood pellets for energy production	17 410	3 590
Coniferous sawlogs	253 769	198 551
Pine pulpwood	1 749	336 208
Spruce pulpwood and other conif. except pine	687 458	231 168

8. BARRIERS AND OPPORTUNITIES

Enova initiated in 2007 a study of barriers to increased use of biomass for heating in Norway. The report from the study was carried out named "Ten years with red figures" and pointed out lack of infra structure and profitability as the two main barriers (Anon 2007). 75% of the buildings for living and 50% of the buildings in the service sectors are based on heating by electric space heaters. The study pointed out that there are profitable bioenergy projects, however that the profitability is low and many projects are therefore stopped. Low electricity prices combined with high investment costs for bioenergy are the main reasons for low profitability. The effect of public incentives is reduced by price variations, uncertainty about future price development and the market system for electricity. The effect of different price levels for heating is illustrated by **Error! Reference source not found.** above.

Other barriers pointed out by the study are lack of know-how in the value chain for bioenergy, including contractors, politicians, consultants and consumers. The availability of biomass is in general no barrier for energy production, increasing demand will however effect prices and hence profitability of energy production. The dominant role of the forest owners associations in the regional markets is viewed as a problem by some actors, others see it as necessary to establish a more industrial production chain.

The opportunities for bioenergy in Norway is availability of domestic biomass resources, increasing demand for renewable energy, more political attention and incentives and increased resources for R&D for development of more efficient value chains including appropriate technology for sustainable biomass supply and energy conversions appropriate for Norwegian buildings. Some years ahead, second generation biofuels based on forest resources can be an opportunity for increased use of bioenergy in Norway.

References

Anon 2007: 10 ÅR MED RØDE TALL - Barrierer for økt utbygging av lokale varmesentraler og nærvarmeanlegg. Studie for Enova SF 2007

Norsk Bioenergiforening, Norsk Varmepumpeforening, Norsk Petroleumsinstitutt (In Norwegian)

Bernard, B & Bugge, L.2006: Biomasse – nok til alle gode formål? Rapport KanEnergi 2006. http://www.kanenergi.no/oslo/kanenergi.nsf/Attachments/biorapport.pdf/$FILE/biorapport.pdf

Bolkesjø. T.F., Trømborg, E. & Solberg, B. 2006. Bioenergy from the forest sector: Economic potential and interactions with timber and forest products markets in Norway. *Scandinavian Journal of Forest Research*, 21: 175-185.

Bolkesjø. T.F., Trømborg, E. & Solberg, B. 2006. Biomass market and trade in Norway: Status and future prospects. Country Report for IEA Task 40. http://www.bioenergytrade.org

Eurostat 2011: Renewable energy statistics 2009. Available at http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=ten00082

EU 2009. Directive 2009/28/EC of the European Parliament and of the council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing. Directives 2001/77/EC and 2003/30/EC. Available at: <http://www.r-e-a.net/document-library/thirdparty/rea-and-fqd-socuments/REDDoc_090605_Directive_200928EC_OJ.pdf>

Hole, E. E. (ed.) 2001. *Bioenergi – Miljø, teknikk, marked*. Energigården, Brandbu.

Langerud, B., Størdal, S. , Wiig, H. og Ørbeck, M. 2007: Bioenergi I Norge – potensialer, markeder og virkemidler. Rapport Østlandsforskning 2007.
http://www.ostforsk.no/rapport/pdf/172007.pdf

NVE 2005: Kraftbalansen mot 2020.
http://www.nve.no/FileArchive/310/Krafbalansen-mot-2020.pdf

Statistics Norway 2008: Energy statistics.
http://www.ssb.no/energi/

Trømborg, E., Bolkesjø, T. F. & Solberg, B. 2007a: Skogbasert bioenergi til oppvarming - økonomisk potensiale i Norge og effekt av økonomiske virkemidler. Fagrapport nr 9 2007.
http://www.umb.no/ina/publikasjoner/fagrapport/if09.pdf

Trømborg, E, Bolkesjø, T.F. & Solberg, B. 2007b. Impacts of policy means for increased use of forest-based bioenergy in Norway – a spatial partial equilibrium analysis. *Energy Policy* 35 (2007) 5980–5990.

Trømborg, E, Havskjold, M., Lislebø, O. & Rørstad, P.K. 2011. Projecting demand and supply of biomass for heating in the Norwegian. *Energy Policy* 39 (11): 7049-7058

Trømborg, E. & Sjølie, H. K. 2011. Data applied in the forest sector models NorFor and NTMIII]. INA fagrapport 17, 58 pp. Available at www.umb.no/ina (publikasjoner).