IEA Bioenergy task 40 – Country report 2007 for Norway

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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". The previous country report for Norway by Bolkesjø, Trømborg and Solberg (2006) is available at ww.bioenergytrade.org.

Norway has large resources of oil and gas. Oil and gas extraction including services accounted for 25% of GDP in Norway in year 2006. 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 8% of the production of primary energy bearers. Bioenergy constitutes 6% of the domestic consumption, electricity 49% and fossil fuels 45%.

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 CO_2-equivalents by 2020, including carbon uptake in forests. Measures in the field of renewable energy and energy efficiency will play an important role for fulfilling the green house gas reduction targets. The government has proposed a national target of 14 TWh/50 PJ increased use of bioenergy by 2020, 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 2006 to be 49 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. The main sources bioenergy in Norway is firewood used in the households and wood residues used internally 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.

Less than half of the annual increment 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 biproducts 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. 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 4.7 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.

GDP in 2006 was 2 155 780 million NOK Oil and gas extraction including services accounted 25%, manufacturing 8.5%, wholesale and retail trade 6.8%, business services 8.7%, health and social work 7.4% and general government 13.7% (Statistics Norway 2008).

1.2 Main industries

Feil! Fant ikke referansekilden. shows the economic importance of selected sectors in Norway.

Table 1. Share of GDP for manufacturing and selected sectors in Norway 2006.

Sector/industry	Percentage of total GDP
Agriculture, hunting and forestry	0,7 %
Fishing and fish farming	0,6 %
Oil and gas extraction including services	21,6 %
Food products, beverages and tobacco	1,6 %
Textiles, wearing apparel, leather	0,1 %
Wood and wood products	0,4 %
Pulp, paper and paper products	0,2 %
Publishing, printing, reproduction	0,8 %
Refined petroleum, chemical and mineral products	1,0 %
Basic chemicals	0,4 %
Basic metals	0,6 %
Machinery and other equipment n.e.c	2,3 %
Building of ships, oil platforms and moduls	1,1 %
Furniture and other manufacturing n.e.c	0,3 %
Electricity and gas supply	1,9 %
Construction	4,0 %
Wholesale and retail trade, repair of motor vehicle	7,5 %

Source: 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 CO2 equivalents.

The green house gas reduction targets will be reached through broad and general economic measures, CO2-emission credits and CO2-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 budget for renewable energy, energy efficiency and carbon capture and storage will be increased with NOK 70 million in 2008, and another NOK 300 million in 2009, giving a total budget of at least NOK 600 million in 2010. I addition NOK 150 million will be set aside for a development and demonstration programme for offshore wind turbines and other immature energy technologies. An action plan for switching from fossil fuels to renewable energy sources for heating, including among others a ban on oil fired heating systems in public buildings and commercial buildings above 500 square meters and requirements of flexible energy systems, will be launched. The Government will also resume the negotiations with Sweden in order to establish a common green certificate market. If no agreement is reached a support scheme with equivalent incentives shall be introduced.

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 12 TWh/43,2 PJ within 2020 compared to 2001. In comparison the total domestic energy consumption was approximately 225 TWh/810 PJ in 2006.

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, proposed to be increased to NOK 20 billion by 2009, gives a yearly yield of approximately 440 million in 2008 and 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 2008 approximately NOK 1,45 billion will be allocated. 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.

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 2005 corresponds to 40% of the production in EU 27 (Eurostat 2007). As seen by Table 2 is the net domestic energy consumption only about 8% of the production of primary energy bearers. 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, domestic use and heat market 2006 (PJ). Source: Statistics Norway (2008).

Energy source	Production of primary energy carriers	Net domestic consumption	Domestic heat market[1]	Domestic Transport
Biofuels	51	49	30	-
Fossil fuels	9 216	360	36	214
Electricity	507	390	112	3
Total	**9 774**	**799**	**178**	**217**

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. 1) Use of bioenergy within forest industries is not included in the domestic heat market.

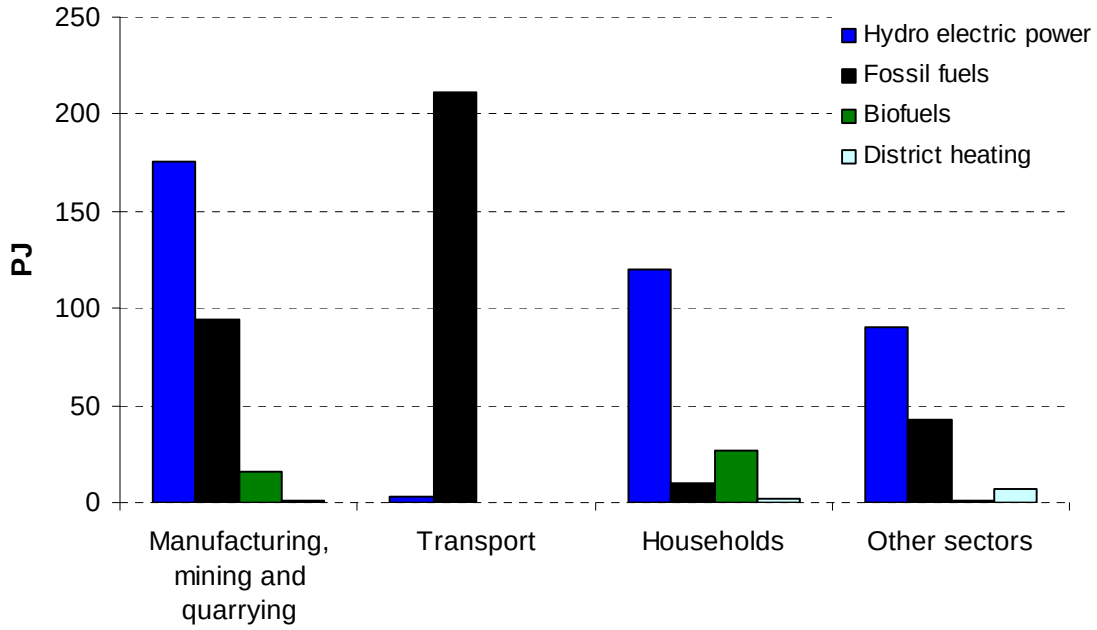

Figure 1. Energy consumption by sector 2006 (PJ). Source: Statistics Norway (2008)

Figure 2 shows the development in consumption of renewable and non-renewable energy in Norway from 1990 to 2006. The energy consumption has increased by 15% from 1990 to 2006, the major increase is in non-renewable energy, mainly due to increased transport. 96% of the electricity consumption is from hydro-electric power (average figure 1996-2006). The variation in consumption of non-renewable consumption is caused by variations in import of non-renewable electricity.

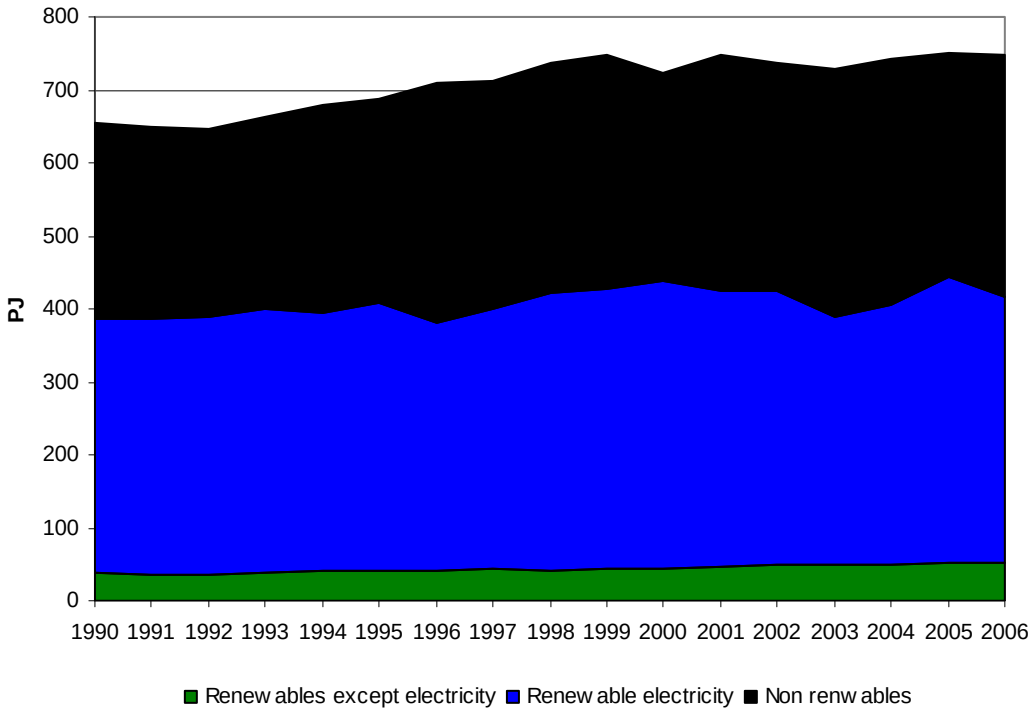

Figure 2. Domestic energy consumption 1990-2006. Source www.ssb.no. Conversion of energy, i.e. energy used in production of other energy commodities, is not included, in order to avoid double counting. For district heating, however, the distribution between renewable and not renewable is based on the energy commodities used in the production. For imported electricity, information about production technology is lacking. For lack of data, it is assumed that 50 per cent of the imports from Sweden for the whole period are renewable energy and the rest non-renewable.

Figure 3 shows the development of energy prices for households and agriculture 1978-2006. Liberalisation and internationalisation of the electricity market from the early nineties have given more equal prices between different energy commodities but also increased electricity prices. Electricity prices are still relatively low compared to other European countries. High dependency of electricity for heating and industrial purposes, make the Norwegian society vulnerable for high electricity prices.

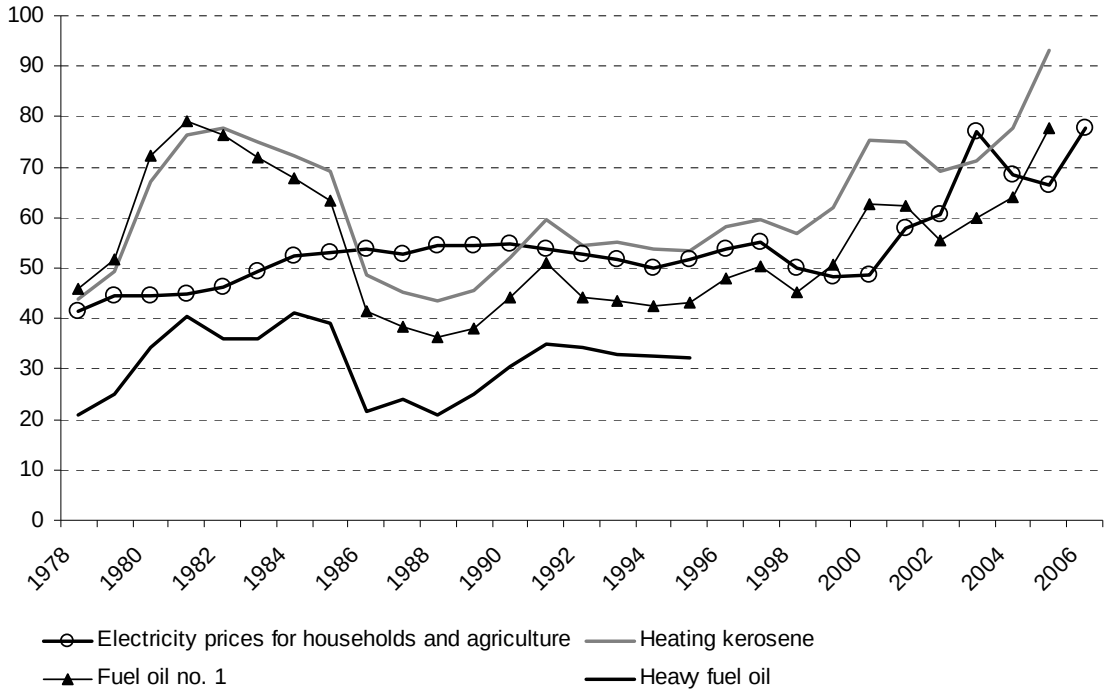

Figure 3. Calculated prices of utilized energy for households and agriculture. 1978-2006. Fixed 1998-prices. Øre/kWh. All taxes included. The prices are calculated with the following thermal efficiency coefficients: Electricity 100 per cent, kerosene and heavy fuel oil: 75 per cent. The thermal efficiency coefficient for light heating oil has increased gradually from 58 per cent in 1978 to 80 per cent from 2002. 1 eurocent = 8 øre. Source: Statistics Norway (2008)

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 production can vary between 89 TWh and 150 TWh, due to variations in precipitation. The domestic consumption was 123 TWh in 2006 and is estimated to be 135, TWh in 2015 (NVE 2005). Figure **4** shows production, export, import and gross production of electricity in Norway from 1950 to 2006.

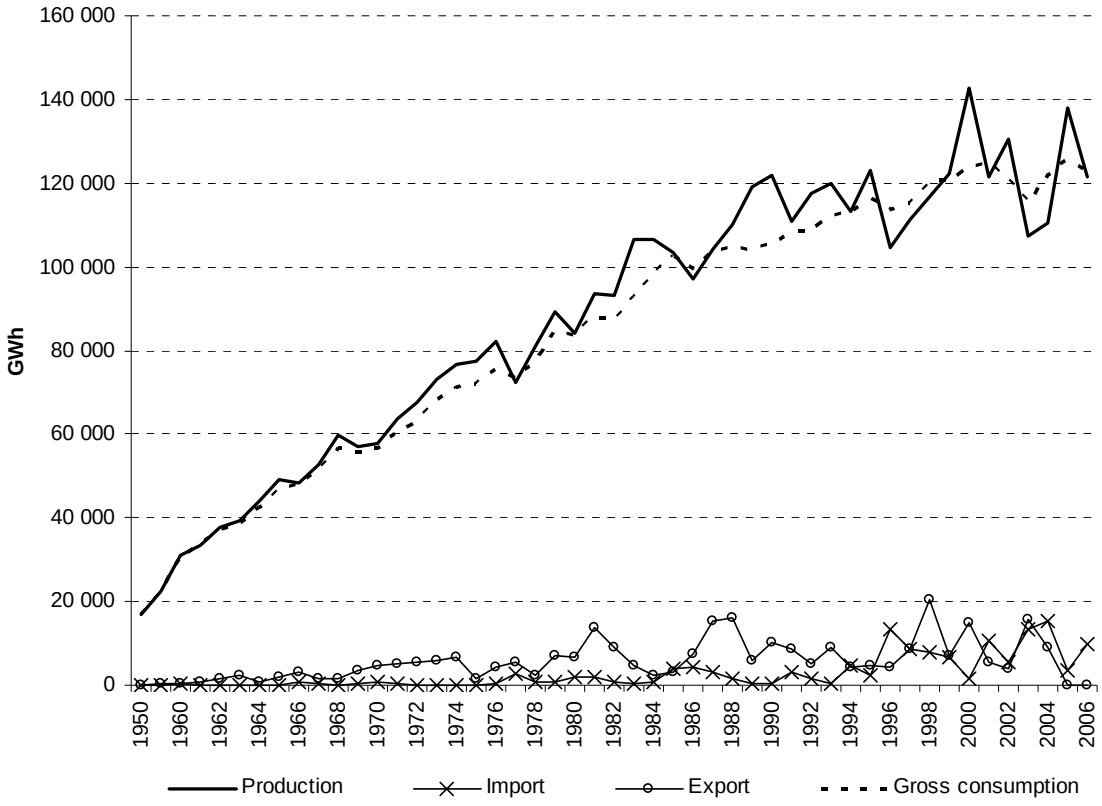

Figure 4. **Production, imports, exports and consumption of electric energy. 1950, 1955 and 1960-2005. GWh. Source www.ssb.no**

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
- 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. 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 increment 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 5.). 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).

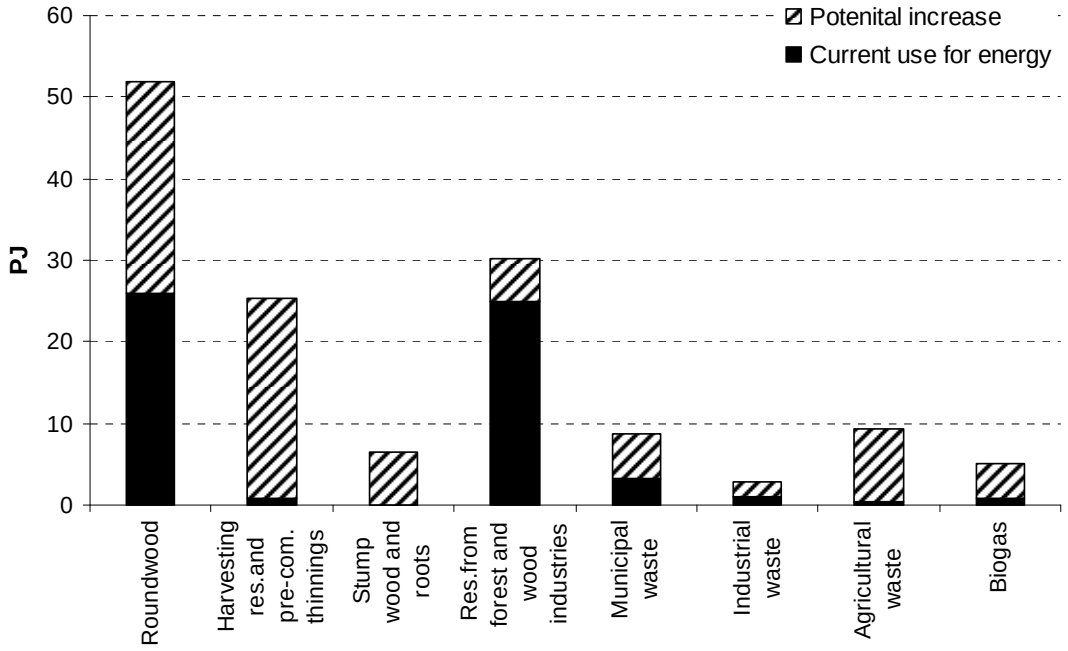

Figure 5. Current use and potential use of biomass for energy production in Norway. Based on Langerud et.al 2007 and Bernard & Bugge 2006.

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 2006 to be 48 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 5 gives estimates of domestic bioenergy production based on different biofuels.

Table 4. Domestic bioenergy production 2006 for heating.

	Quantity for energy (1000 ton)	Assumed heat value (GJ/ton)	Energy content (PJ)
Firwood in households	1 757	13,70	24,1
Waste in district heating	1 340	4,70	6,3
Wood chips and bark in district heating	200	11,00	2,2
Briquettes	34	16,90	0,6
Pellets	30	17,30	0,5
Residuals in forest industries	1 570	10,00	15,7
SUM	**4 932**		**49,4**

Based on data from www.ssb.no (energy balance and district heating figures 2006) 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. 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 in Norway.

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 6 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.

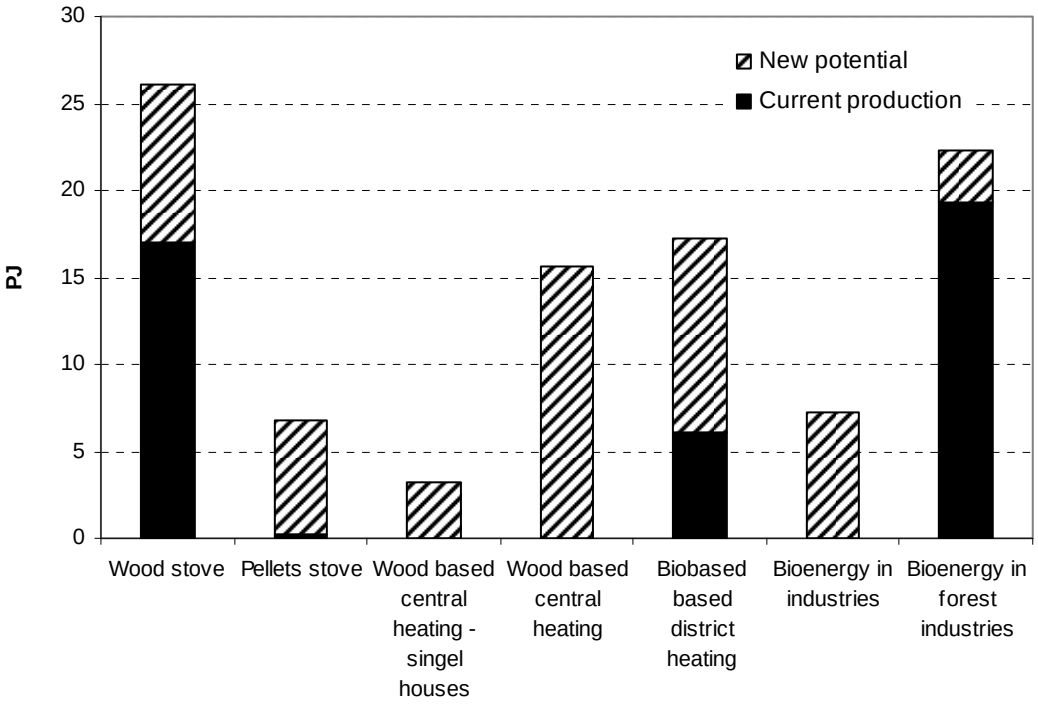

Figure 6. Net production of bioenergy and estimated potential for increased bioenergy production by increased use of wood stoves and replacement of fossil fuels (Based on data from Statistics Norway). The potential for wood based district heating and wood based central heating cannot be added as replacement 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)

Figure 7 shows the projected heat production based on biomass at different energy prices in Norway by year 2015. The figure illustrates the strong relationship between price and energy production. Subsidies for bioenergy production are not included in the figure. The current subsidies for investments in bioenergy production are 20-40% of investment costs for district heating facilities, between 1.5 and 3 Euros per GJ in most cases. The average price for district heating was 18.5 Euro/GJ ex VAT in 2006.

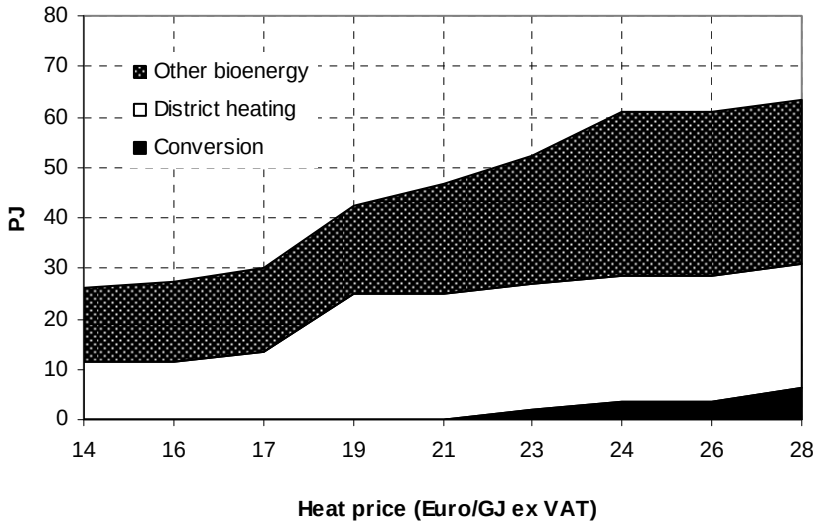

Figure 7. Projected bioenergy production in 2015 at different heat prices. Energy production in the forest industries is not included in the figures.

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).

District heating was produced by 40 enterprises in 2006 and the total length of the distribution net was 780 kilometres. 9 PJ was delivered consumers, of which 70% where delivered to the service sector and 17% to households. 68% of the energy input in district heating where biofuels, 18% electricity, 11% from fossil fuels and 4% from waste heat.

The forest industries in Norway consist of 290 sawmills, 10 pulp and paper mills and 3 mills that produce particle board.

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.

Table 5 shows the prices of different refined solid biofuels in 2004, delivered at production sight in Norway. The current pellets production in Norway is mainly based on various types of wood waste and/or cheap energy for drying from waste incineration having low or no other alternative use. The potential for further utilization of wood waste is limited and increased biofuels production levels will thus require use of virgin wood or import of wood waste.

Table 5. Market prices (in EUR/GJ) of various biofuel types in 2004, excluding transport costs and VAT. Source: www.nobio.no [1].

	2004	2005	2006
Pellets, small bags	14.4	14.2	16.2
Pellets, large bags	12.2	12.2	13.7
Pellets, bulk	10.7	10.5	12.3
Briquettes, large bags	14.0	12.6	9.4
Briquettes, bulk	6.8	6.8	7.1
Bark		2.5	2.9
Logging residues*	8,1	7,3	9,2
Forest industry residues	5.5	6.4	3.6

Demolition wood	4.1	4.0	3.7

[1] The exchange rate 1 € = 0 8 NOK has been used.

The current use of biomass is mainly firewood, residuals and waste. An substantial increase in bioenergy in Norway will mainly be based on forest resources and the pulpwood prices give an indicative level for the raw material costs. Figure 8 shows the recent development of pulpwood prices in Norway given per GJ. Trømborg et al (2007) estimated how increased utilisation of forest resources for energy production will affect the pulpwood prices and showed that roadside prices for pine and non-coniferous pulpwood will increase by 20-30 percent if the bioenergy production increased by 30 GJ.

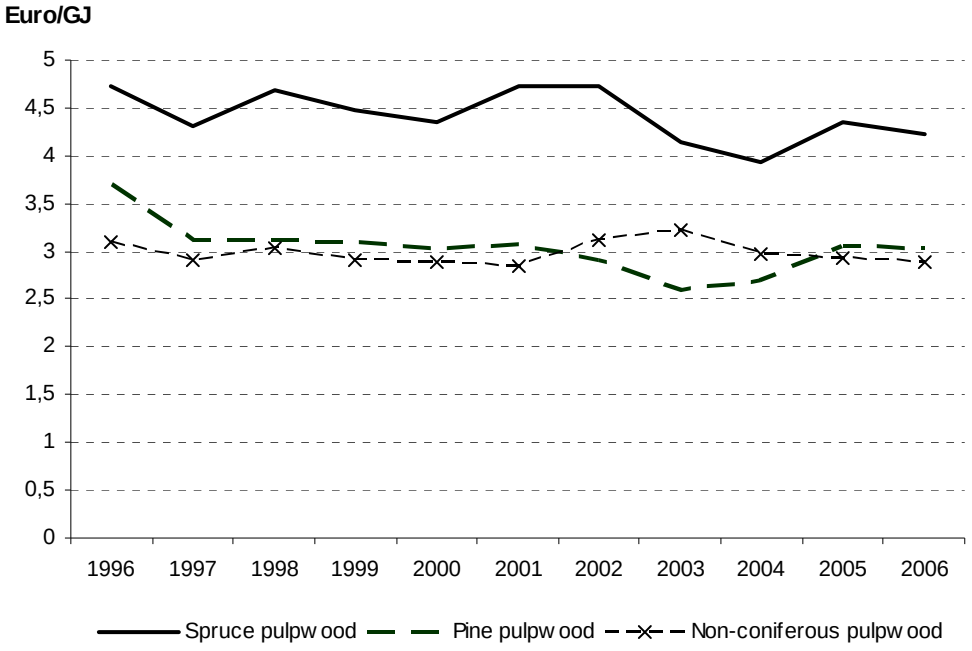

Figure 8. Pulpwood prices in Norway 1999-2006 delivered roadside and measured in Euro per GJ. Annual average exchange rates (1998 rates used for 1996-1999). GJ/m3 is 6,67 for spruce, 7.72 for pine and 8.58 for non-coniferous (average density in Norway and 40% water of total weight). Prices and energy content is without bark.

Figure 9 shows historical development of net energy prices, including all taxes, for fire wood, light fuel oil, kerosene and electricity. Oil, electricity and kerosene prices are from Statistics Norway, whereas the price development of fire wood is based on historical timber prices and processing costs according to Hole (2001). The data includes all costs except capital costs of heating equipment. The historical price figures explain a large portion of the relatively minor use of bioenergy in Norway, compared to neighbouring countries like Sweden and Finland. Until about 2000, fossil fuels and electricity have been cheaper than fire wood and other solid biofuels in Norway. After 2000, the rising prices of oil and electricity internationally, and corresponding decline of Norwegian timber prices, have made solid biofuels like fire wood economically competitive towards electricity, light fuel oil and kerosene (the main

competitors). It should be stressed though, that high investment costs hamper the substitution to bioenergy from electricity and oil in existing buildings, although fuel prices are substantially lower.

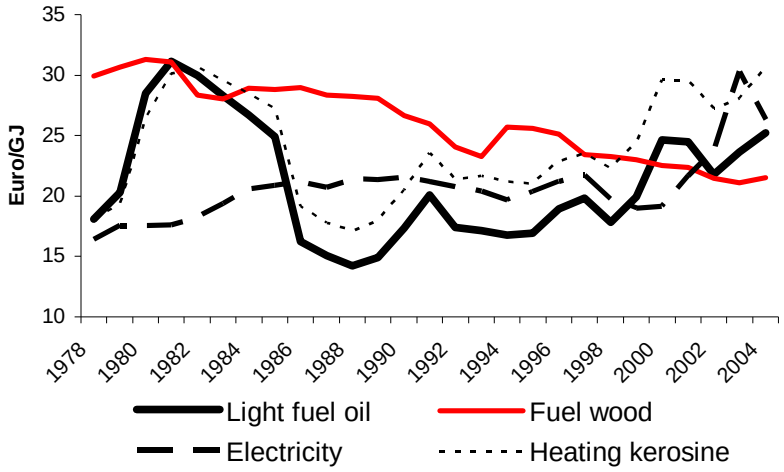

Figure 9. Real (1998) prices of net energy (including all taxes) for oil, electricity and fire wood (Sources: Statistics Norway (www.ssb.no)

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 5.3 PJ of immediate energy production in 2006. 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. The fraction of the wood export used for energy is unknown but likely to be around 2.5 PJ. Hence the net import of wood for energy was around 3 PJ in 2006.

Table 6. Import of wood for energy production 2006 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	175	7,2	1,3	5
Chips or particles	781	0,7	0,6	23
Waste wood and sawdust	251	3,6	0,9	384
Sawlogs, conifers	241	1,3	0,3	254

Pulpwood, conifers	1506	1,6	2,4	471
Sum	**2 954**		**5,4**	**1 137**

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).

Figure 10 shows the development of direct and indirect wood import used for energy from 2002 to 2007 based on the same per unit assumptions as in Table 6. High electricity prices in 2003 is a likely reason for the relative high direct wood import that year. The indirect import varies according to wood demand in the forest industries, harvesting conditions and the international wood market.

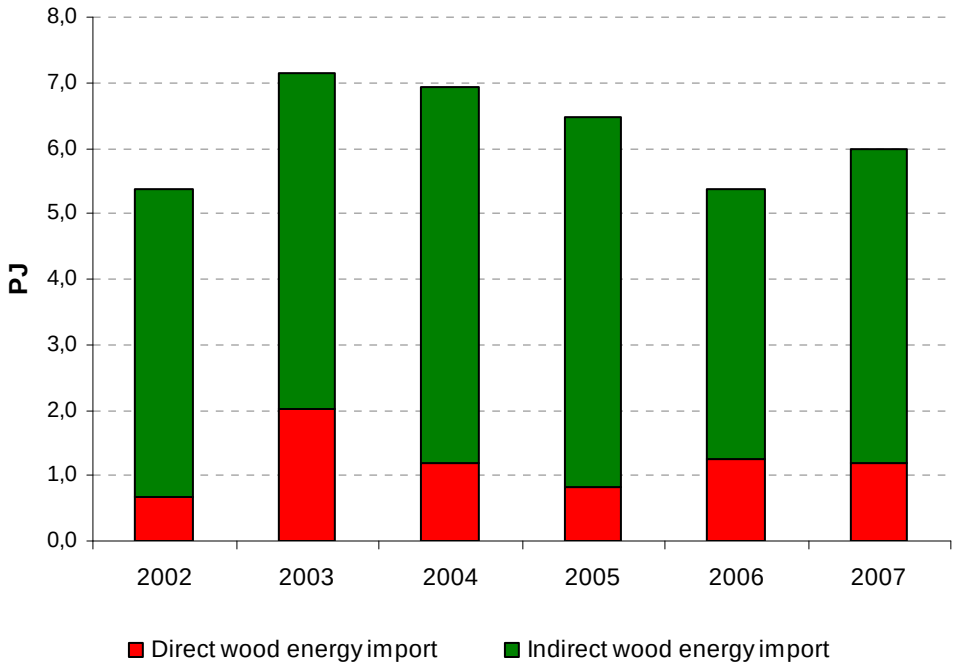

Figure 10. Direct and indirect wood import to Norway 2002-2005. Based on assumptions given in Table 6. Based on trade statistics from wwws.ssb.no. Preliminary data for 2007.

Figure 11 shows the trade with pelles and briquettes. The increase in pellets production has to large extent been exported as domestic consumption is still low. A large pellets plant with an annual production capacity of 450 000 ton is under planning in North Western Norway (BioWood Norway). A governmental support of NOK 97 mill committed (8 mill Euro).

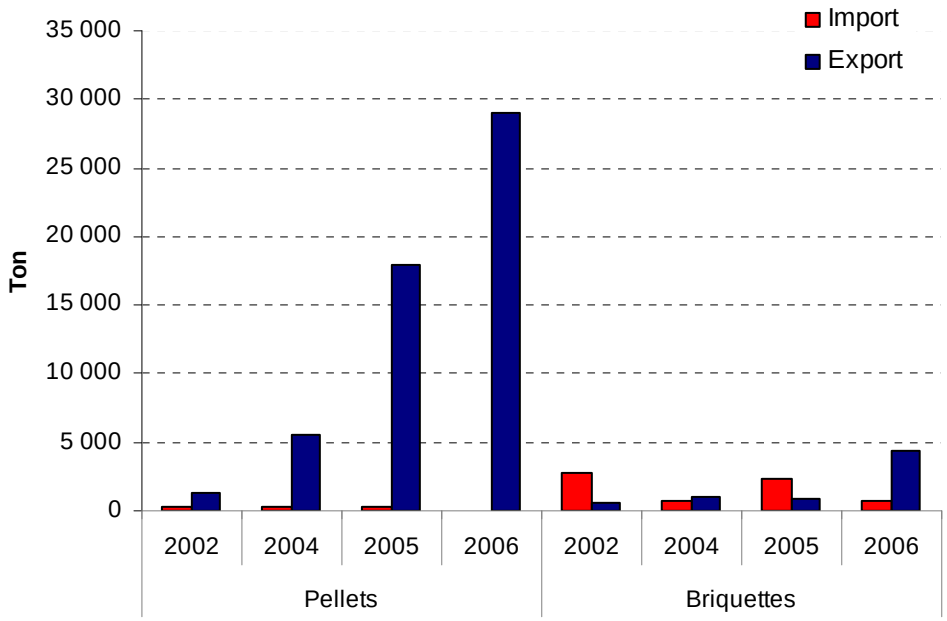

Figure 11. Import and export of pellets and briquettes 2002-2006. Data from www.nobio.no

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 Figure 7 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.

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