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# Potential market for bio-based products in the context of European greenhouse gas reduction strategies

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## 1. Introduction

In the European Union, it is estimated that 50% of the primary energy supplied by different renewable energy sectors comes from wood (EurObserver 2003). The wood energy sector is based on sustainable use of European forests and to a certain extent recovered wood, forest industrial by-products (e.g. bark and sawdust) and wood from plantations: energy from agriculture, i.e. agricultural residues, e.g. straw, also contributes to the EU energy supply (European Commission 1997).

According to the White Paper for renewable sources *COM(97) 599* (European Commission 1997), the European Union is required to double the amount of renewable energy in the European primary energy supply from 6% in 1997 to 12% by 2010. The majority of the additional renewable energy needed to achieve the set target could come from biomass, which means that, additionally, 26 Mtoe (1 EJ) of biomass could be used for energy (Parikka 2005a). A possible alternative for covering future demand for renewable energy is increased utilisation of wood from plantations, energy crops, recovered wood, forest and agricultural residues and by-products from the wood-processing industry. At present, the utilisation



*P. Ranalli (ed.), Improvement of Crop Plants for Industrial End Uses*, 509–521.

of these materials, mainly forest residues, is low compared with the estimated potential (Parikka 2005a & 2005b).

The future development of renewable sources of energy within the EU also depends on the environmental impacts and different technical and non-technical barriers (Madlener et al 2005; Parikka 2005a).

One important aspect in the appraisal of these resources is the assessment of potential, which forms a part in the setting of targets and limits for practical utilisation (Parikka 2002 & 2004). Another important aspect is public opinion – how to improve the acceptability of renewable resources. There are several other factors to take into account, e.g. noise, visual intrusion, environmental concerns and even other non-technical obstacles (Madlener et al 2005).

In the Kyoto process, the European Union declared the intention to reduce greenhouse gas emissions ($CO_2$, $CH_4$, $N_2O$ etc.) by 8% by the year 2010, with reference to the 1990 emission levels (European Commission 2006). Biomass, and especially woody biomass, could substitute fossil fuels, e.g. in electricity and heat supply; thereby, contributing substantially to the reduction of greenhouse gas emissions (GHG), principally $CO_2$ from fossil fuel combustion (Karlopoulos and Tsikardini 2004).

The fast growing market for wood fuel and other renewables in Europe in recent years has already raised questions concerning their influence on the environment. Some of these resources are already physically available in the form of recovered wood, residues from agriculture and forestry, as well as from related industries (Parikka 2005a). Established over the past 10 years, the bioenergy trade is now a viable alternative for countries and regions lacking resources, and a business opportunity for countries with an oversupply (Alakangas et al 2002).

## 2. Existing European strategies for green house gas reduction

The following short summary presents the existing European strategies for green house gas reduction.

**Table 17.1**. Existing European strategies for green house gas reduction strategies.

| **Renewable energy in the EU** | |
|---|---|
| 88/349/ | Council Recommendation of 9 June 1988 on developing the exploitation of renewable energy sources in the Community. |
| COM(97) 599 | Communication from the Commission - Energy for the future: renewable sources of energy - White Paper for a Community strategy and action plan. |
| COM(2000) 769 | Green Paper - Towards a European strategy for the security of energy supply. |
| Directive 2001/77/ | Promotion of electricity produced from renewable energy sources in the internal electricity market. |
| Directive 2002/91/ | Energy performance in buildings. |
| Directive 2003/30/ | Promotion of the use of biofuels or other renewable fuels for transport. |
| Directive 2003/96/ | Directive on energy taxation. |
| Directive 2004/8/ | Promotion on co-generation (combined heat and power). |
| SEC(2004) 547 | Communication from the Commission to the Council and the European parliament: The share of renewable energy in the EU. A Commission Report in accordance with the Article 3 of Directive 2001/77/EC proposals for concrete actions. |
| COM (2004) 366 | A Commission staff working document: The share of renewable energy in the EU country profiles. An overview of renewable energy sources in the enlarged European Union. |
| European Commission Memo (2004) | Renewable energy to take off in Europe ? - 2004 - Overview and scenario for the future. |
| **EU climate strategy and emission rights trading** | |
| ECCP – programme I | The first European Climate Change Programme (ECCP) was launched by the Commission in 2000. |
| ECCP – programme II | The second European Climate Change Programme (ECCP) was launched by the Commission in 2005. |
| COM(2000) 87 | Green Paper on greenhouse gas emissions trading within the European Union. |
| Directive 2003/87 | Emissions trading - National allocation plans. |
| Kyoto Agreement | The EU and its Member States ratified the Kyoto Protocol in late May 2002. |

Source: Eurolex (2005); European Commission (2006).

## 3. Use of biomass fuels in Europe

In the late 80's, few statistics on renewable energy, either at the EU level or in the member states, existed. The Council recommendation of 1988 *88/349/EEC* (Eurostat 2004) stipulated that the member states, in collaboration with the Eurostat should establish a statistical system for Renewable Energy Sources (RES) (Eurostat 2006).

The use of renewable energy sources in the EU (25) are presented in Table 17.2. The total gross inland energy consumption in 2003 was 72 124 PJ in 2003. The share of all renewables was 6%, about 4 329 PJ, and the share of biomass and biofuels was 3,9%, about 2 880 PJ (Eurostat 2006).

**Table 17.2.** Gross inland energy consumption in the EU(25).

| All categories | PJ | % |
|---|---|---|
| - Natural gas | 17 086 | 23,0 |
| - Oil | 27 038 | 38,0 |
| - Coal | 13 163 | 18,0 |
| - Nuclear | 10 517 | 15,0 |
| - Renewables | 4 229 | 6,0 |
| | | |
| Total | 72 134 | 100,0 |
| | | |
| Renewables | | |
| - Wind | 159 | 3,7 |
| - Solar | 26 | 0,6 |
| - Hydro | 1 045 | 24,1 |
| - Geothermal | 221 | 5,1 |
| - Biomass and biofuels | 2 880 | 66,5 |
| | | |
| Total | 4 229 | 100,0 |

Source: (Eurostat 2006)

The share of wood in the EU (25) energy supply (wood as fuel in households and wood as fuel in industry and power plants) is about 50% of all renewables, about 2 000 PJ (Thrän and Kaltschmitt 2002).

## 4. Potential of biomass fuels in Europe

The total biomass energy potential in Europe is about 9 EJ/a (Kaltschmitt 1999; Kaltschmitt and Neubarth 2000; Thrän and Kaltschmitt 2002). The total practically available annual biomass quantity in Europe is approximately 5.2 EJ (Table 17.3): this figure is based on statistics from 20 European countries (Vesterinen and Alakangas 2001). The share of available woody biomass for fuel is about 4 EJ per year (e.g. forest industry by-products, forest and logging residues, firewood, recovered wood, etc.). A comparison between the available potential with the current use on European level, indicates approximately 32% of existing biomass energy potential is used (Kaltschmitt 1999; Thrän and Kaltschmitt 2002; Eurostat 2006).

**Table 17.3.** Biomass for energy resources in Europe, PJ per year.

| PJ/a | Forest residues | Solid ind. by-products | Ind. black liquors | Firewood | Wood wastes | Densified wood fuels | Other biomass fuels | Peat | Total |
|---|---|---|---|---|---|---|---|---|---|
| Austria | 150. 0 | 50.0 | 0.0 | 40.0 | 18.0 | 3.0 | 9.0 | 0.0 | 270.0 |
| Belgium | 7.0 | 13.0 | 8.0 | 0.0 | 3.0 | 0.0 | 0.0 | 0.0 | 31.0 |
| Denmark | 11.0 | 5.0 | 0.0 | 3.0 | 0.0 | 4.0 | 46.0 | 0.0 | 69.0 |
| Finland | 96.0 | 47.0 | 135.0 | 49.0 | 0.0 | 1.0 | 11.0 | 165.0 | 504.0 |
| France | 38.0 | 42.0 | 0.0 | 258.0 | 111.0 | 0.3 | 412.0 | 0.0 | 861.3 |
| Germany | 142.0 | 40.0 | 0.0 | 0.0 | 81.0 | 0.0 | 511.0 | 0.0 | 774.0 |
| Greece | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Ireland | 3.0 | 7.0 | 0.0 | 3.0 | 1.0 | 0.0 | 0.0 | 40.0 | 54.0 |
| Italy | 0.0 | 36.0 | 0.0 | 83.0 | 24.0 | 0.0 | 0.0 | 0.0 | 143.0 |
| Netherlands | 4.0 | 3.0 | 0.0 | 0.0 | 45.0 | 1.0 | 24.0 | 0.0 | 77.0 |
| Portugal | 68.0 | 27.0 | 22.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 117.0 |
| Spain | 59.0 | 87.0 | 23.0 | 12.0 | 52.0 | 0.0 | 386.0 | 0.0 | 619.0 |
| [1]Sweden | 238.0 | 46.4 | 125.0 | 27.0 | 27.0 | 18.0 | 22.0 | 13.0 | 516.4 |
| UK | 16.0 | 12.0 | 0.0 | 27.0 | 175.0 | 0.0 | 70.0 | 0.0 | 300.0 |
| Estonia | 30.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.2 | 30.0 | 79.2 |
| Latvia | 8.0 | 12.0 | 0.0 | 32.0 | 0.0 | 1.0 | 0.0 | 15.0 | 68.0 |
| Poland | 101.0 | 68.0 | 16.0 | 26.0 | 40.0 | 0.0 | 205.0 | 122.0 | 578.0 |
| Romania | 0.0 | 23.0 | 3.0 | 58.0 | 0.4 | 0.0 | 0.1 | 0.0 | 84.5 |
| Slovakia | 6.0 | 0.1 | 5.0 | 3.0 | 3.0 | 0.1 | 13.0 | 0.0 | 30.2 |
| Slovenia | 2.0 | 7.0 | 0.0 | 8.0 | 0.1 | 0.0 | 0.0 | 0.0 | 17.1 |
| Total | 979 | 526 | 337 | 629 | 581 | 28 | 1 728 | 385 | 5 193 |

Source:Vesterinen and Alakangas (2001).

[1] The figure for Sweden has been updated. The new total figure for Sweden is 516 PJ per year (Lönner et al 1998; Parikka 2003).

The wood energy potential is especially important in countries where forests cover a considerable part of the total land area, e.g. the Nordic countries (Europe). By-products from forest industry, such as bark and sawdust in sawmills and bark in pulp mills, are currently the largest commercially used biomass source (Kaltschmitt and Neubart 2000; Parikka 2002 & 2004).

The types of the more important wood energy resources differ. In Finland and Sweden it is either wood or wood residues harvested during or after harvesting of industrial round wood or by-products from forest industry; whereas, e.g. in Germany approximately two-thirds of the estimated resources is straw. These differences are partly caused by the different means of estimating the resources, but the main reason is the land use (Vesterinen and Alakangas 2001).

The group "Other biomass resources", which includes biomass types such as short rotation coppice (e.g. Willow), energy grass (e.g. Reed canary grass) and straw, is especially dominant in France, Germany, Spain and Poland. In these countries, the other biomass resources means mainly straw (Vesterinen and Alakangas 2001).

Availability of wood residues (wood residues including bark, sawdust, wood chips etc.) at European level varies rather little and the quantity is dependant on industrial use of round wood. A major part of wood residues are used for industrial purposes: bark is used for energy purposes and an increasing quantity of sawdust is used for production of densified biofuels, i.e. pellets and briquettes, raw wood chips are mostly used for pulp (Parikka 2002; FAO 2004a). Statistics, e.g. from FAO (2004a) indicate increased production of split firewood at European level.

The industrial round wood sector is particularly important, typically having a large impact on wood fuel prices (as does pulp and paper, and some other industries). Round wood (i.e. timber, veneer, pulp wood, etc.) is used as industrial raw material and as construction material. However, of the total round wood quantity about 40% of the total quantity is primary or secondary process residues, suitable only for energy production, e.g. for the production of densified biofuels (FAO 2004b).

## 5. Potential market for biomass fuels in Europe

### 5.1 Markets for biomass in Europe

Biomass is typically a crop grown and used in the local society. Bulky material and high transport costs have kept it local up to modern time.

Trade between countries and regions is an effective way to distribute specialities among companies and organisations in a more specialised world. Trade usually increase rationalisation in the forest sector and liberalisation strongly supports this development. Problem could be that areas like the forestry sector internationally is not very well developed to meet this movement and discussions are going on a global scale how to meet this (Hillring 2006).

International statistics is not covering this trade in biofuel completely. Efforts to summarise global trade and the trade patterns have been done by different authors (NUTEK 1993; Hillring and Trossero 2006).

Within the European union, trade of industrial biofuels occurred some decade ago: early trade paths of olive stones from southern (Spain) and recovered wood from central Europe (Germany) were to Swedish district heating plants (Alakangas et al 2002). Later, trade from countries in the Baltic area increased (Latvia, Estonia Poland, Russia) both for regular round wood destined for the forest products industry in the Nordic countries and for low quality timber and residues for energy companies in Sweden, Denmark, Germany and the Netherlands.

The driving force behind the biofuel trade in Europe is based on efforts to reach the limitations in emissions dictated by the Kyoto protocol and other international agreements. Higher international energy prices are another important factor. The situation differs among the regions in Europe. Some areas such as the Nordic countries are rich in forest resources and have a large demand for biofuels. Other countries such as Russia have even greater forest resources but virtually no demand for biofuels. In central Europe, some countries are rich in forests (such as France) but biomass from the agricultural sector dominates. The most extreme example is the Netherlands, with a dense population and an extensive agriculture sector, the majority of the biofuel supply needs to be imported, even though it is expected to grow in the future.

### 5.2 European trade patterns

Solid biofuels such as wood residues, pellets and wood chips are traded within Europe and reached a level of almost 50 PJ per year in 1999

(Vesterinen and Alakangas 2000). Biofuel trade between European countries is a growing interest, because international trade can provide fuels at lower prices. In several cases, the national biomass market is underdeveloped for organised international trade; however, projects may benefit countries with unexploited biomass resources where fuels are available on an international market. Although there may be (even notable) cross-border trade of e.g. domestic firewood between neighbouring countries, this trade is more or less occasional and beyond official statistics (AFB-Net 2000). In some countries (e.g. Portugal), the statistics reveal traded biomass amounts, but as the source/destination countries are unknown, these flows cannot be included in the total figure. However, in some cases the trading countries are known, but the traded biomass types are not (AFB-Net 2000).

The largest volumes of biofuel are traded from the Baltic countries (Estonia, Latvia, and Lithuania) to the Nordic countries (especially Sweden and Denmark, but also Finland). Some volumes are also traded from Finland to other Nordic countries, and between neighbouring countries in Central Europe, especially the Netherlands, Germany, Austria, Slovenia and Italy. The traded biofuels include densified wood fuels (pellets and briquettes) and industrial by-products (sawdust, wood chips), and recovered wood in Central Europe. The annual production of wood pellets in Europe is estimated to be about 12-13 million tonnes. There is also intercontinental trade of biofuels. Sweden imports biofuels from Canada, and Italy imports firewood from Northern Africa. In addition, Germany exports firewood to the Middle and Far East (AFB-Net 2000).

Scandinavian biofuel markets have increased and national energy policies have contributed strongly to this trend (Vesterinen and Alakangas 2000). Taxes on energy with a clear environmental profile were introduced during the early 1990s in Scandinavian countries. Fossil fuels for heat production are heavily taxed, whereas biofuels are untaxed. In electricity production, all fuels are untaxed, and consumers pay the tax. In Finland and Sweden, investment support promoted growth capacities and contributed to biofuel demand.

A new project, EUBIONET II (2006) is underway, and covers the European trade of biofuels. No results are currently available yet, but preliminary studies from Sweden indicate that trade has doubled compared with 5-6 years ago. There has been a change in the mix of biofuels imported to Sweden, with a significant increase in wood pellets, tall oil and ethanol.

## 5.3 Fuel prices

Energy prices in general have increased over the past 30 years, especially during the past 3 to 4 years, which also provides more incentive for alternative energy sources such as wood for energy (Figure 17.1). Oil prices increased substantially in 2004-2005 due to several factors such as increased global demand, limited capacity for oil refineries, political violence in key production areas e.g. the Middle East, and natural catastrophes e.g. in the Southern United States. Levels over 60 USD per barrel were reached at some periods. This development on the oil market forced prices on all energy to increase, which created new energy solutions and provided an opportunity for alternatives such as wood fuel to be competitive (NUTEK 1993).

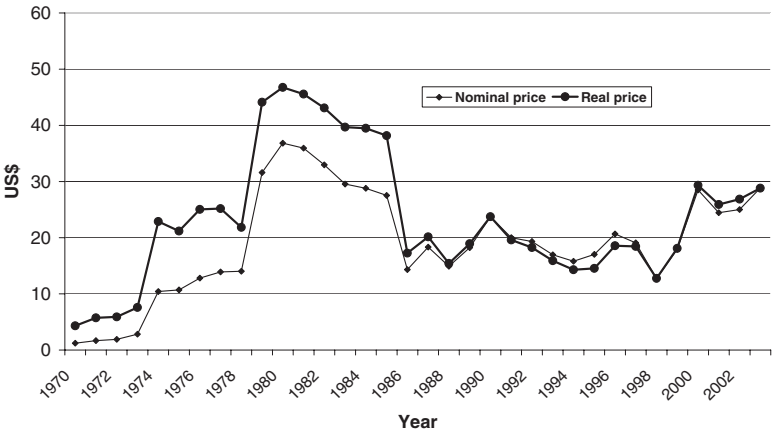


**Fig. 17.1.** Nominal and real prices of light crude oil, 1970-2004, Source: STEM (2005b) Periodical.

Table 17.4 provides examples of European wood fuels prices, which are the result of increased trade on wood fuels between European countries and which have led to well established international wood fuels prices (Hillring 2006). There is of course a range of prices set by the market situation, production cost and cost of competing fuels. By-products traded at 3-4 €/GJ, wood chips around 3.5-4.5 €/GJ and wood pellets around 5-6 €/GJ. Swedish market prices (2005) for wood fuels to heating plants vary between 3.4 €/GJ for by-products and 6.2 €/GJ for wood pellets (Hillring 2006). A survey

of the prices of different fuels was undertaken in 1999 (Vesterinen and Alakangas 2000; AFB-Net 2000). Since then, oil prices have risen significantly, which has also influenced wood fuel prices.

**Table 17.4.** Minimum, maximum and average fuel prices (including taxes) in the 18 selected European countries (1999).

| Fuel | Country Minimum, €/GJ | | Country Maximum, €/GJ | | Average €/GJ |
|---|---|---|---|---|---|
| Forest residues | Germany | 1.02 | Italy | 8.33 | 3.42 |
| By-products, forest products industry | Romania | 0.58 | Poland | 9.07 | 2.38 |
| Firewood | Slovakia | 1.01 | UK | 14.00 | 5.26 |
| Wood waste | Ireland | -4.00 | Poland | 3.31 | 0.97 |
| Refined wood fuels | Latvia | 3.24 | Germany | 18.22 | 8.37 |
| Other biomass | Slovakia | 0.83 | Poland | 12.00 | 4.68 |
| Peat | Finland& Latvia | 2.10 | Ireland | 3.75 | 2.83 |
| Heavy fuel oil | Slovakia | 1.40 | Ireland | 12.00 | 6.74 |
| Light Fuel oil | Slovakia | 3.10 | Denmark | 14.30 | 6.74 |
| Natural gas | Slovakia | 1.10 | Italy | 16.21 | 5.80 |
| Coal | Poland | 1.19 | Germany | 12.78 | 4.53 |

Source: Vesterinen and Alakangas (2000); AFB-Net (2000).

## 6. Conclusion and discussion

Biomass has the potential to substitute for the use of fossil fuels in Europe; however, the exploitation of this potential is only advisable if there are promising economic and/or environmental effects.

A transition process is now taking place and many conditions are changing, including policy level decision-making, forestry practices, agricultural policy and the forest industry. In addition, the international biofuel trade will be an important factor in the future: the global benefit of displacing fossil fuel with modern biofuel use is obvious, as life cycle analyses indicate that biofuel supply systems are neutral in terms of emissions $CO_2$ to the atmosphere.

According to the White Paper, the overall aim is to double the share of renewable energy from 6% to 12% of the total energy consumption in the EU by 2010: a major part of this renewable energy could come from biomass. This means that an additional 1 EJ of biomass per year could be used for energy in the European Union. A possible alternative is to cover the future demand for renewable energy by increased utilisation of wood from plantations, energy crops, forest and agricultural residues, and by-products from the wood-processing industry.

In the Kyoto summit, the European Union pledged its intention to reduce greenhouse gas emissions ($CO_2$, $CH_4$, $N_2O$ etc) by 8% by the year 2010, compared to the 1990 emission levels. Biomass, and especially woody biomass, could be used to substitute fossil fuels, e.g., in electricity generation and heat supply. Biomass will therefore substantially contribute to the reduction of Greenhouse Gas (GHG) emissions, mainly $CO_2$, from fossil fuel combustion.

Practical experience and research has shown that locally sustainable biofuel systems can be operated across Europe. All impacts are manageable with straightforward measures that are generally an extension of, e.g. good conventional forestry and agricultural practice. Another way of doing this is to issue recommendations for the removal of residues, e.g. logging residues, with the purpose of minimizing the risks for long-term adverse effects on soil fertility and the environment.

The biofuel trade is a viable alternative for countries without their own resources and for countries with an oversupply. The international biofuel market prices are established in Europe, however volumes are still limited. In the future, both the use and the trade of biofuels is expected to increase, in Europe, the self supply, high fossil energy and electricity prices and international environmental agreements are the main driving forces for the development of this industry.

The share of wood in the EU(25) energy supply (wood as fuel in households and wood as fuel in industry and power plants) is about 50% of all renewables, about 2,0 EJ. This means that the share of wood in the EU(25) energy system is about 2.8% The corresponding share of biomass and biofuels is about 3.9% and about 6.0%for all renewables.

It was found that the potential of different biomass fuels in Europe is about 9 EJ per year (the current use is about 2,9 EJ per year), meaning that about 32% of the total resources are currently in use. The annual biomass fuel quantity practically available in Europe is about 5.2 EJ per year.

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