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DG INTERNAL POLICIES OF THE UNION

- Directorate A -

ECONOMIC AND SCIENTIFIC POLICY

WORKING PAPER

HOW TO INCREASE THE USE OF BIOMASS IN AN ENLARGED EUROPE

PE 358.359

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"How to Increase the Use of Biomass in an Enlarged Europe"

In collaboration with

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Project No. IP/A/ITRE/ST/2004-22

AEBIOM – European Biomass Association

EBBF - European Bioenergy Business Forum

31 March 2005

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Acronyms and Abbreviations

Country acronyms

EU 15

AT	Austria
BE	Belgium
DE	Germany
DK	Denmark
EL	Greece
ES	Spain
FI	Finland
FR	France
IE	Ireland
IT	Italy
LU	Luxembourg
NL	Netherlands
PT	Portugal
SE	Sweden
UK	United Kingdom

EU+10 (New EU member states)

CY	Cyprus
CZ	Czech Republic
EE	Estonia
HU	Hungary
PL	Poland
LT	Lithuania
LV	Latvia
MT	Malta
SI	Slovenia
SK	Slovakia

Candidate Countries

BG	Bulgaria
RO	Romania
TR	Turkey

Further acronyms and abbreviations

CHP	Combined Heat and Power
DH	District Heating
ETBE	Ethyl Tertiary Butyl Ether
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IENICA	Interactive European Network for Industrial Crops and Their Applications
RES	Renewable Energy System (Sources)
RES-E	Renewable Energy Electricity Production
RRM	Renewable Raw Materials
TPES	Total Primary Energy Supply

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1 Executive summary and recommendations

It is a main aim of the energy policy of the EU to double the share of renewable energies in gross inland consumption from 5.4 % (in 1997) to 12% (in 2010). Bioenergy is supposed to play a main role in the implementation of this policy and, in 2010, 130 Mtoe of biomass need to be used for energy production, which is an increase of 74 Mtoe compared to 2001. As a conclusion the EU (COM (2004) 366) stated that considerable efforts need to be taken to reach this aim.

With the entry of the Baltic countries Estonia, Lithuania, Latvia, the central European countries Czech Republic, Hungary, Poland, Slovenia, Slovakia and the Mediterranean Islands of Cyprus and Malta to the former EU 15 in May 2004 an additional challenge to reach these aims is posed on the EU. In the new EU member states the share of renewable energies of primary energy demand is quite different and may account from around 40% in Latvia and above 10% in Estonia and Slovenia down to less than 2% of total primary energy supply (TPES) in Cyprus, Czech and Hungary. The technologies used are mainly hydro and bioenergy, but often these are not state of the art and e.g. private biomass furnaces with low efficiencies and high emissions dominate. However, in the east European and Baltic countries vast agricultural and forestry areas are available for biomass production and at considerable low price levels (for land and labour).

Across Europe the policies to support renewable energies and in particular bioenergy is quite diverse and range from feed-in tariffs (e.g. Germany, also Estonia, Latvia, Hungary), quota obligations for green electricity (e.g. Poland) to tax exemptions or reductions for liquid biofuels. Currently the European Commission has announced to install a 'Biomass Action Plan' where actions to promote the development of the bioenergy market will be identified and implemented.

Thus, the current use of renewable energy sources and particularly of biomass and the enlargement of the EU poses important questions how to develop the bioenergy market in the future and reach the agreed political aims.

Within these frame conditions the present study was initiated by the European Parliament in order to provide a comprehensive overview, give concise data and present recommendations for policy options to increase the use of biomass in the enlarged EU 25.

As a conclusion of this study the present situation and future prospects of the bioenergy market and the necessary policies to develop this market in the EU 25 are summarised in the following six remarks:

1. **Biomass use and biomass markets in the EU 25**

   Across Europe the biomass and bioenergy markets are diversified quite strongly. In order to develop and implement a consistent policy numerous biomass sources with very different characteristics, many technologies in various stages of development, different markets e.g. for electricity, heat, cold, fuel and raw material and different political and social frame conditions in the EU 25 need to be considered and included. The use of biomass is connected with a growing positive attitude throughout Europe, also the various instruments and measures implemented by many countries in the EU to support the use of biomass are not really controversial. From this point of view the **harmonisation of the political instruments** to support the use of biomass seems not to be a primary aim in the short term. Instead, a **continuous and**

consequent setting and persuit of ambitious objectives for the use of biomass in Europe seems to be an important measure in the short term, allowing the development of the bioenergy market according to the economic, political and environmental frame conditions in the national and local environments. However, the "EU Biomass Action Plan" seems to be an adequate measure to efficiently allocate scarce economic resources to the environmental and political aims set in this area and to establish a harmonised approach with variations on a national level in the medium and long term.

2. **Biomass competition: Raw material and/or energetic use**

Biomass availability is generally high in most of the EU 25 countries and may account for between 10 and 20% of primary energy demand. However, the costs and economics of biomass production and availability are decisive for the future development of the biomass markets. In general it seems advisable to promote the use of **biomass as a raw material** in the first place – biomass can be the source for many items and industrial products. Subsequently, the residues should be transferred and used in the **bioenergy market**. This procedure may increase the overall competitiveness of biomass due to dual or more economic income opportunities in the utilisation chain. A thorough adjustment of the different uses in such a utilisation chain for biomass would be very important as for an environmental friendly and clean use and conversion of biomass a defined quality and a low content/absence of toxic substances is necessary. For those biomass sources, where a raw material use is not feasible, a **direct energetic use** in the energy markets is possible.

3. **Biomass as a challenge for the agriculture sector**

Agriculture as one of the main biomass producers (besides forestry) may be one of the main profiting sectors from a biomass boom. Among other measures, the 2005 CAP reform seems to be a promising initiative to allow such a development. However, besides remaining a **raw material producer** for industry and the energy sector, agriculture may as well play a growing **role as energy producer** e.g. in the biogas sector and increase the added economic value of their activities substantially. This requires considerable efforts for a good integration of biogas plants into the existing energy infrastructure and e.g. the necessity to sell heat (and cold) to consumers. Policies need to support this requirement for poly-generation and energy production efficiency.

4. **Bioenergy technologies: increasing the economic competitiveness and knowledge base**

According to the variety of biomass resources and process chains a large selection of technologies exists for the energetic use of biomass. However, many technologies are still in a demonstration or pilot plant stage (e.g. gasification) and investment and operating costs are often higher compared to conventional and fossil fuel based technologies. A support with public money of such market segments seems to be necessary also on a long term perspective. However, economically competitive technologies exist (e.g. pellet boilers) already today! As a consequence it is crucial for a wider spread of bioenergy to **increase the economic competitiveness**, particularly by strong research and development, both, on a fundamental and applied level. At the same time the **transfer of knowledge and information** on existing, competitive and economic technologies and ways to use biomass should be enforced stronger to relevant industries, stakeholders and the public (e.g. by information campaigns).

5. Bioenergy promotion policies

Across Europe a wide variety of political instruments is implemented on the bioenergy market. **Feed-in tariffs** seem to increase the number of bioenergy installations considerably and thus lead to a quick increase of the use of biomass. However, the exact design of the economic incentives within this system is difficult to equilibrate and adjust to the development of technologies and markets. **Quota obligations**, on the other hand, may result in a more efficient use of (scarce) economic resources, however, they may not yield such immediate results and require more public administrative efforts to control and supervise that the rules are kept.

6. Bioenergy promotion policies in the new member states

The policies to increase the use of biomass in Europe has to be set to new grounds, also due to the enlargement of Europe to the EU 25. The range of frame conditions across the EU 25 has increased considerably. The stagnation of the CO_2 emission reductions across Europe in the last years show that without further efforts the aims set in the Kyoto protocol will not be reached. However, the economic situation in the new EU member states needs to be taken into account in the development of political instruments to promote bioenergy. The common agriculture policy (CAP reform) forms the basis for a **biomass production on a large scale** also in the new member states, which could be a good economic basis for farmers there. As a second step the 'old' and inefficient technologies to use biomass in these countries need to be replaced by advanced and modern technologies. This should be supported by public supporting schemes (promotion and information) in order to pave the way for a larger use of biomass. As a quick technical measure in hard coal and lignite processing power plants the fossil fuel could be replaced by biomass (**co-firing!**). By this method also emission certificates could be produced and traded within the European Emission Trade System (ETS).

Concluding remarks

In general the biomass sector is a very promising market as well in terms of volume (potential) and in terms of technology and innovation. It is still underdeveloped but has a high future potential, particularly for the agriculture and energy sector. Some remarks need to be made:

1. As **biomass resources are limited** it should be a primary objective of all policies to promote an efficient and effective use of biomass, e.g. by combining the raw material and energy use and/or by poly-generation (CHP). For this a thorough evaluation of the most effective and most wanted process chains and technologies is necessary.

2. As **financial resources are scarce**, which is particularly true for the new member states, policies need to be directed towards promoting the economic competitiveness of biomass and bioenergy technologies and markets. This may be achieved by strengthening Research & Development on one hand and by increasing the dissemination and spread of available technologies and the mobilisation of scale up effects e.g. by information and transfer campaigns on the other hand.

2 Analysis and conclusions on single policies, markets and technologies

2.1 Policy instruments in the renewable energy sector of the EU 25

The analysis of political interventions in the energy sector shows an unbelievable variety of instruments applied. As the electricity market was as a state monopoly, the sector was seen as a playing field for political decisions and market intervention. Even newer developments, seeing the energy sector as a part of competition and free market economy, do not allow to keep politics out of the game. There is a need for regulatory work, there is a need for a referee if rules and prices for the access to the grid e.g. for biomass energy have to be decided. There are externalities and long term scarcity to be taken into account, which are not reflected in traditional market economy prices.

But as interventions in energy market are done on different political level and based on different political priorities – for example German coal subsidies can only be justified for their employment effects, but are strongly opposed to climate policy or RE targets – it is important to see the total effect of all applied tools. And there it becomes evident, that no consistent RE policy exists. There are areas, for example in the wind energy sector, where specific income tax incentives generated by accumulation of losses make this investment particularly interesting for top salary earner, which is politically not intended. There are also latest technological trends, which can result in an unjustified high level of subsidies.

In times of restrictive budgets, it is a challenging task to find a reasonable level of political incentives supporting RE to reach the politically given target of biomass energy increase. It should be the task of the EU to look carefully to the functioning of the common market for RE and to avoid any distortion of competition. It is the challenge of national, regional and communal legislators to offer complementary instruments, strengthening the incentive to reach the political target, but not to waste the taxpayers money.

2.1.1 The AEBIOM proposal for an energy taxation scheme

The taxation of energy based on the CO_2 content will be a strong support for the climate policy targets, but it has an unequal effect within EU member countries: Those countries (or companies) producing electricity on a fossil base (in particular coal) will suffer under extremely growing costs, while those producing electricity on nuclear base are free of additional charges. As national interests are in this case extremely divergent (France nuclear/Germany coal), it is difficult for the EU Commission to present a consensus proposal.

But it is worth to remember, that there was already an agreement on this matter in 1992, when a common EU energy taxation scheme, based half on the energy content and half on the CO_2 emission with a yearly increasing rate, failed due to the refusal by Great Britain. This system could not be set into place as unanimous decisions were needed for a common EU tax policy.

If a common EU energy tax scheme can not be reached, a harmonized approach with variations defined on national level would be helpful. Concerning the amount of energy taxation, there is a proposal from the European Biomass Association AEBIOM, proposing a tax/fee of € 260 per ton of oil.

The proposed fee/tax system has three components:

1. A carbon dioxide fee depending on the content of carbon (emissions of carbon dioxide) in different fossil fuels. A high fee level will give stronger economic incentives to choose fuels and systems with low emissions of carbon dioxide.
2. A deduction proportionate to the amount of heat used for heating purposes and/or electricity produced. The levels for heat or electricity should be decided separately preferably with a higher level on electricity. The total deduction should be equal to the total carbon dioxide fee on a national basis. The carbon dioxide fee and the deduction create together a transfer system, where no money leaves the system.
3. A fiscal energy consumption tax proportionate to used electricity or heat. The purpose of this tax is mainly fiscal and the level could be decided individually for heat and electricity as well as country depending on the desired state income from this sector. Of course the level will influence the total energy consumption. For reasons of competition the energy consumption tax could be reduced or omitted for the industrial sector (a strong steering effect can still be maintained by means of the carbon dioxide fee).

2.1.2 Bioenergy installations and the European Emission Trade System (ETS)

Up to now biomass power plants are more or less not eligible to take part in the European Emission trade system. This is due to the fact that eligible plants need to be larger than 20 MW and the majority of bioenergy plants are smaller than this threshold value. Also the rules for substitution poses a problem to biomass power plants as the baseline and the replaced fossil energy system is not clear. As single opportunity bioenergy power plants may be included within the project based mechanisms, e.g. Joint Implementation (JI). It seems to be an encouraging effect if it could be established to include the CO_2 reducing bioenergy power plants within this system.

2.1.3 Promotion of Research and Development (R&D)

In many technologies, also bioenergy, further progress and results need to be achieved in terms of efficiency, environmental performance and economic competitiveness. It is a well proven instrument to come forward in these fields by increasing the R&D efforts and correlations between the R&D efforts and the performance of technologies show that there is an important positive correlation.

R&D should be strengthened and integrated on EU-Level. This was only the case for nuclear energy, where hundreds of millions of Euros have been spent by the different national European governments since the sixties, but it is also true for today's situation of RES. But the progress made in European integration allows to reduce double work on national level, and to avoid inefficient tax expenditures and to unify R&D efforts under the roof of a consistent EU program.

2.1.4 The “Biomass Action Plan” of the EU Commission

The Communication on “The share of renewable energy in the EU” (COM(2004) 366) concluded that further efforts – in particular in the biomass sector – are needed in order to achieve the above policy objective. In 2001, total biomass production for energy purposes was 56 Mtoe. By 2010 74 Mtoe more are needed to reach the aim. Each sector has to contribute ambitious aims: electricity 32 Mtoe, heat 24 Mtoe, and biofuels 18 Mtoe leading to a total biomass based energy production of 130 Mtoe in 2010. This additional biomass production can only be achieved in the short term with strong and targeted measures and actions in all three sectors (electricity, heat, and biofuels for transport) and a better coordination of EU policies. The Community “Biomass Action Plan” shall ensure the achievement of this objective and already addresses all important fields of action. As the four main fields of action the questionnaire distinguishes: i) biomass availability, ii) Market barriers for power, heat and CHP, iii) market barriers for biofuels for transport and IV) horizontal issues. It is important that this action plan will be developed as an integrated and consistent program and implemented accordingly.

2.2 Bioenergy markets

2.2.1 The bioenergy electricity market

2.2.1.1 State of the art

Throughout Europe the electricity market for biomass is not as far developed as expected and possible. Biomass, however, has been set an important role for reaching the EU aim regarding the share of green electricity in total electricity consumption. Large biomass potentials remain to be developed.

The bioenergy electricity market is mainly fed by solid biomass, especially woody biomass. Nevertheless there are great differences between the EU 15 and the 10 new Accession States (EU+10). Currently, for the EU+10 solid biomass is the only source for electricity from biomass. The Czech Republic is the only country for which biogas plays a noteworthy role, too. Within the EU 15 solid biomass in sum is the prevailing bioenergy source, although for some countries biowaste (e.g. Denmark, France) and biogas (e.g. United Kingdom., Germany) are important bioenergy sources.

Adapted technologies for electricity production from **biomass combustion** are available and operative such as steam engine, steam motor and also innovative steam cycles such as the organic rankine cycle (ORC) and to a lesser extent the Kalina cycle.

Electricity production from **biomass gasification** is still in a demonstration phase. In the larger size (> 1 MW) only one type of installation is known to be fully operative (Güssing, Austria). The small scale market (20 - <500 kW) is developing, but not yet market available. However, this market and technology is very promising.

Pure electricity production in **condensing power plants** with efficiency of 35 % and in future perhaps higher percentage is restricted to certain biomass resources such as old used wood.

Electricity production in **CHP units** becomes more wide spread, particularly in connection with biomass based district heating projects of communities.

Co-firing of biomass in coal power plants is an interesting option for a quick move towards more biomass use in electricity production and is favoured by the possibilities to integrate biomass electricity production within the Emission trading scheme.

The small scale and innovative applications for electricity production with CHP such as stirling motor, micro gas turbine and fuel cells are not readily available on the market and need to be developed in strong research and development efforts.

2.2.1.2 Feed-in tariffs vs. quota regulations in the electricity market

Across Europe several countries have decided to promote the renewable energy market by establishing a feed-in tariff promotion system. However, almost exclusively all these systems are applied only to the electricity market, no feed-in tariff systems are presently known for the heat and/or for biogenic gas market. Due to the very different promotion systems and the different implementation periods for the systems, a stringent benchmark on the performance of either the feed-in tariffs or the quota regulations is not possible within this limited study.

With respect to the electricity market for biomass the **feed-in tariff regulation** seems to be quite successful in terms of installed capacity. This is particularly true for Germany, where the number of installations have increased largely after such policy instruments have been set into place. However, there are indications that feed-in tariff regulations do not have similar stimulating effects e.g. on the costs and prices of bioenergy and thus e.g. on the competitiveness against other and conventional/fossil energy technologies. Feed-in tariffs seem at least partly to protect a technology from real market competition. Attempts to regulate this ‘protection mechanism’ by introducing decreasing tariffs over the years of implementation may be able to compensate this effect. The degression, however, needs to be thoroughly adapted to the ‘learning rate’ of technology development and to the competition situation within the market.

Quota regulations, also combined with trade of certificates, tend to represent a way to set ambitious targets and find a cost efficient way to achieve these aims.

If scale-up effects of a high market penetration of biomass technologies are not contradicted by the ‘protection effect’, feed-in tariffs for electricity production seem to be a very effective measure to increase the use of renewable energies and particularly biomass in Europe. If biomass utilisation needs to be implemented in the most cost effective way, quota regulations seem to be quite effective.

However, this applies mainly to the electricity market. If feed-in tariffs are really that successful it should be considered to extend this measure to other energy markets such as the heat and biogenic gas market. However, the effects of such policies on the markets are largely unknown and need to be thoroughly prepared.

2.2.2 The bioenergy heat market

2.2.2.1 State of the art

Throughout Europe the share of biomass use for heat production is much higher than for electricity. For most of the EU 25 countries biomass is the major source of renewable heat and is near to 100 % of renewable heat production. However, the development of biomass heat generation is not stable for all of the EU 25 countries. The annual growth rates since 1997 up to 2001/2002 are negative for e.g. Estonia, Latvia, United Kingdom (about –6 %) and are positive for e.g. Slovena and Slovakia (about +20 %), Italy (+9 %) or Ireland, Germany and Lithuania (+6 %). As a regional source with low energy density which therefore should rather be used regionally, biomass will have to continue to play a prominent role in the heat market.

This certainly applies for the **small scale heat market** for private houses, office space heating, schools, swimming pools, public buildings etc. In this market segment the use of wood pellets is very attractive and also faces a steep increase in sold appliances particularly in Austria, Germany, Denmark and Sweden. Various technologies for the use of wood pellets are on the market and a strong medium enterprise business has developed in this segment.

For **medium to large size heating plants** wood chips which are produced from residues coming from forestry and industry may serve as a fuel. The further development and increased integration of district heating networks promises a more efficient and environmental friendly heat supply. Extended (although sometimes rather old) district heating networks are present in the new member states such as Poland but to a much lesser extent in the EU 15 countries such as in Germany and UK. The construction of new district heating networks, however, may be expensive and needs to find favourable frame conditions. This is particularly true for old and firmly established residential housing areas.

In many energy conversion processes excess heat is available, which is mostly wasted and thrown away. Adequate rules and policies should encourage the use and exploitation of excess heat and thus increase the efficient use of the biomass resource. In many areas of Europe, particularly in the Mediterranean and the Balcony, and during the summer also in the more northern areas, excess heat is available which cannot be used for heating purposes. In these cases it is advisable to use the heat for **cooling and climatisation and/or for drying**. Technologies for heat driven thermal cooling appliances are on the market and readily available. Due to the lack in small scale thermal chiller appliances the installation and use of (micro) cooling networks and of buffer storage is an interesting opportunity to use biomass efficiently.

2.2.2.2 Promotion incentives for the heat market

For the use of heat no comparable or specific EU directive exists as compared to the provision of electricity or biofuels. Only for Poland (2005) reports a feed-in-system for heat, where the price can be negotiated in certain limits between the producer and consumer.

Furthermore, as mentioned above the application of **feed-in tariffs and quota obligations** for heat in particular needs to be evaluated in detail. In Germany discussions have started to develop such a system. Additionally, supporting **subsidies** to reduce the higher investment costs in this market seem to be still necessary. In Germany the “Marktanreizprogramm-MAP”, with fixed subsidies for bioenergy installations such as pellet boilers and also biogas plants, represent such a system.

2.2.3 The liquid biofuel market

2.2.3.1 State of the art

Throughout Europe the market for liquid biofuels is largely dominated by the production and use of biodiesel. Additionally the production of ethanol plays a noteworthy role. The main actor within the biodiesel market is Germany, followed by France and Italy. The Czech Republic is the only EU+10 country with relevant biodiesel production capacities. Ethanol is produced especially within Spain, Poland, France and Sweden.

The main biomass resource for **biodiesel production** is rape, followed by sunflower and other plant oils. The use of biodiesel as sole fuel is technically standard throughout Europe. For pure plant oil special motors or motor adaptations are necessary. Due to low future threshold levels for S- and N-emissions for vehicle operation (EU-Norm 4 and 5) and the problem, that biodiesel will not meet these targets, the use of biodiesel as sole biofuel will probably fade out in the next years. However the use of biodiesel blends, perhaps up to 20% will form an attractive alternative for this market. Within the large fuel market this alternative for biodiesel represents a reliable, large and long term market bases for this industry.

Important biomass resources for **ethanol production** are wheat, barley and sugar beet. Market situation for ethanol within the EU 25 countries has to be discussed with regard to other ethanol markets as e.g. in Brasil. Compared to Europe the Brasil market is well developed and ethanol production costs currently are much lower than in Europe. Thus Europe bioethanol production faces strong competition from overseas.

Synthetic biofuels, which may be produced from almost any organic resource, are thought to be a promising alternative biofuel. At present the technology for reliable gasification processes with sufficient large amounts of the desired components is not really ready at the market. One installation is known (CHOREN, Freiberg, Germany), where considerable amounts of BTL-fuels (biomass to liquid) are produced. However, in technical and also particularly in economic terms many questions need to be answered. E.g., the biomass resource (mainly energy plants from agriculture) need to be supplied in considerable amount to central large processing units at a reasonable price and also the gasification process still needs to be optimized in terms of quality and economy.

In general the efficiency of the conversion of biomass into liquid biofuels is quite low compared to the provision of heat and/or electricity.

2.2.3.2 Promotion incentives for the liquid biofuel market

The **EU biofuel directive**, and the many **tax reduction and exemption regulations** in the EU 25 have made the use of biofuels an attractive alternative for the mobility and stationary sector. The national reports on the implementation of the directive will give information and evaluation on the first steps and measures as well as on market developments within the various EU 25 countries.

2.2.4 The biomass raw material market

The use of biomass as raw material is very much diversified and covers many markets from paper, furniture, building and construction to pharmacy, lubricants, fibres, colours and textiles.

This segment covers an even larger market than the energy sector and can therefore not be covered in full in this work.

In general many products in these raw material process chains may be recycled and eventually used for energetic purposes. However, once being used as a commercial material, many biomass based products are contaminated with hazardous and toxic substances, and may therefore only be used in combustion plants with special treatment of the residues.

It is, however, recommended to favour the 'dual' use of biomass, first as raw material and secondly as source of energy.

2.2.5 Agriculture and the CAP reform

The **CAP reform** currently set into place and valid from 1. Jan. 2005 creates completely new frame conditions for farmers and the agriculture market throughout Europe. The main issue is to – stepwise - uncouple the subsidy payments from agriculture production and replace this system by a area-related payment of subsidies. The payment requirements may be traded and cross-compliance rules are set into place. For the bioenergy sector it is important to mention that for the production of energy plants a payment of 45 EUR/ha may be paid additionally.

These new rules may give farmers a security for producing biomass and getting fixed and reliable subsidies for this production sector up to the year 2013. However, within the EU only 1.5 Mio ha may be used under this energy plant production regime.

2.3 Bioenergy technologies: State of the Art and Recommendations

Due to the fact that raw material use is too much diversified and very complex, in this chapter only technologies for energy supply will be covered.

2.3.1 Combustion of Biomass

Combustion of biomass in various technologies still forms the main process for the energetic conversion of biomass, for heat as well as for electricity production. Many different boilers are available on the market, however, boilers with high efficiency and low emissions are predominant in the EU 15 countries. In the EU+10 many old wood stoves and heating systems exist which do not meet modern technology and environmental requirements.

In the **small scale combustion market** boilers and heating systems based on wood pellets attain much public attention and start to gain an important market position. With this technology a comfortable, reliable and cost effective solution is available and at market penetration. Due to higher investment costs this segment still needs some kind of public support, particularly in form of investment cost reduction and in public awareness and promotion.

The **biomass combustion technologies at larger scale** e.g. using wood chips, are also at market availability. Due to higher investment costs compared to fossil fuel based solutions in this market a public support still seems to be necessary to come to a stronger market penetration. As mentioned the co-firing of biomass is an attractive alternative to use a larger quantity of biomass within short time period. The technology is available and is being further developed in all countries, which use coal to a larger extent.

Research and Development is particularly necessary in order to be able to use a larger variety of biomass residues, e.g. olive kernels and nut shells (particularly in the Mediterranean), to meet higher environmental requirements, particularly in terms of particles, NO_x and CO and also with problematic biomass (e.g. wood powder, grain, and mill residues) and also to achieve those aims at considerable lower costs.

2.3.2 Gasification of Biomass

Gasification of biomass represents a very attractive technology for a wider use of biomass as energy source. This is due to the fact that within the gasification process all types of biomass and all parts of the biomass resource can be used and converted to energy. Secondly, the gasification product is available in the form of a gas and thus more easily to use and convert in various technologies such as gas turbines and motors, CHP-units and even as source for the synthesis of liquid biofuels.

However, although since long this technology has being developed, the final technical breakthrough has not yet been achieved. This is due to the fact that many by-products are being produced in the **gasification process** which may harm the process and reduce the value of the produced gas. Also for the different purposes different qualities of the gas need to be achieved, which requires an adapted and well equilibrated process lead. Therefore more efforts, particularly in the form of R&D need to be put in this technology in order to achieve the breakthrough.

Biogenic gases, which shall be used in more advanced and complex conversion technologies, need to be made available in a purified, clean and qualitative high form. For some conversion technologies certain contents of gas components such as methane (CH_4), hydrogen (H_2) or carbon-monoxide (CO) are necessary. Therefore **purification and gas-reformation technologies** are necessary to deliver the desired gas quality. These technologies need to be supplied at attractive economic conditions in order to keep the costs and price low and competitive.

2.3.3 Biogas production

The production of biogas is a long known and established technology and forms a very attractive and important source of energy. As biomass resource mainly manure and agriculture residues are taken. In recent time the use of solid biomass from agriculture (energy plants) becomes more and more important (e.g. Germany). The use of those sources, however, makes further technological research and development necessary, as the characteristics of e.g. energy crops differ clearly from those of manure (e.g. water content, structure, chemical parameters). The main producers of biogas are farmers and also associations of interested and engaged persons and companies. **Biogas technologies** therefore are very important to create a new income for farmers and establish a new added value and regional process chains.

However, the produced biogas is not always used efficiently. The produced electricity is mainly fed into the public grid and the produced heat is often not used or even to a minor extent. Therefore the good integration of biogas plants into the existing energy system e.g. by finding a consumer for the **excess heat** may lead to a more efficient use of biomass and the biogas technology.

In connection with proper gas purification technologies (see above, biomass gasification) it is an attractive future prospect for biogas to feed it into the gas-grid and utilize it at another place with higher efficiency and better environmental performance. However, legislation and the frame conditions are lacking largely in many EU-countries including the EU 15.

2.3.4 Synthesis of liquid biofuels from biogenic gases (biomass to liquid – BTL)

Apart from gasification of biomass (see above) the synthesis of a liquid bio-fuel is a known and established technology, although rather applied in large plants overseas for the synthesis of liquid fuels from natural gas.

The main challenge in this process is the proper and well equilibrated integration of the gasification and synthesis process for the desired utilisation e.g. as fuel. This challenge needs to be supported by intensive R&D efforts.

2.3.5 Production of bio-diesel and ethanol

The production of liquid bio-fuels is a well known and highly optimized technology. Some economic reduction potentials may be realized by scale-up effects, when larger amounts are produced. Large capacities for the production of biodiesel and ethanol are presently being built or are under construction (e.g. biodiesel plants in France and Spain, ethanol plants in Spain and Germany).

The main challenge for the development of these technologies lies in the creation of favourable and equal production conditions for agriculture throughout Europe and in the maintenance of a certified biofuel quality. In the new EU +10 countries large areas for the production of energy crops exist and may serve as the basis for a larger proportion of biomass supply in this bio-fuel sector.

However, the biomass resources used for bio-diesel and ethanol production are organic materials, which naturally contain larger amounts of sulphur and nitrogen. These components may cause problems in terms of keeping the strong emission limits for cars set by the EU (EU IV and V). The purification of the biofuels to the required standards are connected with higher costs, which could decrease the attractiveness of this bio-fuel.

2.4 Environmental effects of bioenergy production and use

The use of biomass for energetic purposes is generally connected with a good environmental performance and climate change reduction potential due to the fact that the CO_2 emitted during combustion is recycled within the ecosystem and is fixed in new biomass.

However, the combustion of biomass is also connected with the emission of higher levels of other components which may be hazardous to the environment, e.g. particles (dust), nitrogen compounds (mainly NO_x) and partly also CO.

Since the new EU directive on **particle emissions** has been set into force in many European areas and particularly in condensed urban areas with high traffic load the concentrations of particles are often above the allowed threshold level. Particularly small and medium size biomass combustion plants often are not equipped with particle reduction measures. In this plant size such measures are often not yet available and – if available - may lead to increased investment costs, even above acceptability. In order to meet the set environmental emission limits, strong efforts need thus to be taken to reduce the emissions of particles and other hazardous compounds of biomass combustion.

The increased use of biomass therefore requires strong R&D and technological efforts to reduce particularly the particle emissions from such technologies and installations.

3 Introduction

In May 2004 the former EU 15 was enlarged by the entry of the Baltic countries Estonia, Lithuania, Latvia, the central European countries Czech Republic, Hungary, Poland, Slovenia, Slovakia and the Mediterranean Islands of Cyprus and Malta. Particularly in the east European and Baltic countries vast agricultural and forestry areas are available and suitable for the production of biomass for energetic use, and particularly at a considerable low price level (land and labour). Thus the enlargement of the EU poses important questions on how this situation will affect the market situation for the bioenergy sector and the future prospects of its development in Europe. The increased use and promotion of renewable energies play an important role in addressing the problems of climate change and the still growing dependency on energy imports in Europe. For biomass as stored solar energy, which is suitable for base load energy supply and with a high resource potential this is particularly true. Thus, to reach the ambitious target of the European Union to achieve a 12% share of renewable energies in gross inland consumption by 2010, a thorough control of the achievements and a strategic future development of the current situation is crucial.

This report has been written on request of the European Parliament in order to assess and evaluate the frame conditions and possible political measures to increase biomass utilisation in the enlarged EU 25.

3.1 Current state: renewable energies and biomass utilisation in the EU

In 2001 the share of renewable energies including bio-waste in EU 15 was 6% (CEC, 2004). Bioenergy accounted for almost 2/3 of this share. The mean growth rate of renewable energies was 3%, however growth of primary energy demand is 8%.

In the Bioenergy sector three main fields have to be covered: the electricity market, the heat market and liquid biofuels. In the EU 15 electricity market the share of renewable energies is quite high (15 %, year 2000), more than 85 % of this share is based on hydro. In the heat market (share of 9%) biomass is the dominating renewable energy source. The liquid fuel sector, however, relies only to a minor extent on renewable resources. In 1999 about 0,13 % of end energy demand was supplied mainly by biodiesel and to a low proportion by ethanol (Staiß, 2003).

The current share of renewable energies in the new EU member states is quite different. It may account for more than 40% (Latvia) of primary energy demand, and is mainly based on hydro and bioenergy. However, the technologies in operation are mostly not state of the art. E.g. in the bioenergy sector private biomass furnaces with low efficiencies and high emissions dominate. In order to promote biomass use in these countries, new, clean and comfortable technologies have to be introduced and also the image and public acceptance of biomass in comparison with fossil based solutions has to be improved.

The policy of the promotion of renewable energies and in particular bioenergy is quite diverse in Europe and ranges from feed in tariffs (e.g. Germany, also Estonia, Latvia, Hungary) to quota obligations (e.g. Poland) for green electricity to national programs and legal acts for tax exemptions or reductions in the liquid biofuel sector.

3.2 Objectives and structure of the study

Within these frame conditions it is the objective of the study to provide a comprehensive overview, give concise data and present recommendations for policy options to increase the use of biomass in an enlarged Europe of EU 25. The study shall focus on the advantages and constraints of biomass from an economical, social, geopolitical and environmental point of view, with particular reference to its role in climate change and climate change policy.

Based on these objectives the study is structured as follows:

In **part I** general information on the basics for biomass utilisation in EU 25 is given.

In **chapter 4** the different biomass resources are defined and classified in terms of their suitability to be used in energetic and/or non-energetic applications.

In **chapter 5** general data on the EU 25 countries are given which are important for the biomass sector.

In **chapter 6** the available data on the actual use of biomass for energetic purposes is analysed and, wherever possible distinguished between the electricity, heat and biofuel market.

In **chapter 7** information is presented on the actual use of biomass in non-energetic uses.

In **chapter 8** the future potential of biomass in the EU 25 countries for energetic and non-energetic utilisation is described.

In **part II** policy actions and market intervention measures are analysed and proposals are given.

In **chapter 9** proposals are listed concerning policy actions to increase the use of biomass as a raw material.

Chapter 10 gives an overview on proposals concerning policy actions to increase the use of biomass in the three areas electricity, heat and biofuels.

Chapter 11 discusses the question of direct market intervention measures.

In **Chapter 12** economics and market prices are subject, whereas **chapter 13** analyses the availability of biomass and land use.

Chapter 14 summarises proposals of policy instruments at EU-level which increase the use of biomass comprising among others legislation and R&D.

Part III contains a literature overview (**chapter 15**) (in addition the chapter references) and examples of best practice for biomass utilisation within the EU 25 **(chapter 13)**.

Part IV contains a list of references (**chapter 17**)

Part I: GENERAL INFORMATION ON BIOMASS IN THE EU 25

4 Biomass resources and options for biomass utilisation

4.1 Definitions

Biomass as a general term is considered any organic matter that is available on a renewable or recurring basis (excluding old-growth timber), including dedicated energy crops and trees, agricultural food and feed crop residues, wood and wood wastes and residues, aquatic plants, grasses, residues, fibers, and animal wastes, municipal wastes, and other waste materials (Biomass Research & Development Initiative, 2005).

As a renewable raw material biomass can be taken for energetic and non-energetic purposes (besides agricultural production). Table 4-1 gives an overview on the various "products" resulting from these two categories.

Table 4-1: Energetic and non-energetic products of biomass utilisation

Energetic utilisation	**Non-energetic utilisation**
Electricity	Lubricants and hydraulic fluids
Heat/Cold	Washing powders and cleaning agents
(Bio-)fuels	Biodegradable materials and plastics reinforced by natural fibre
	Building and insulation materials
	Medicine/Pharmaceuticals
	Paints and lacquers
	Paper and cardboard
	Textiles

As shown in **Table 4-1** a broad range of products can be derived from biomass raw materials. Additionally, a variety of biomass resources exist which serves as raw material for the different provision and production processes. Structuring of the biomass sources therefore is necessary (see chapters 4.2 and 4.3).

4.2 Biomass resources for energetic utilisation

Figure 4-1 gives an overview on the various biomass sources for the energetic utilisation path and the provision of electricity, heat/cold and biofuels.

		woody biomass	**Herbaceous biomass**	**biomass from fruits and seeds**	**others (including mixtures)**
Energy crop	*direct*	**- WOODFUELS** - energy forest trees - energy plantation trees	**AGROFUELS** - energy grass - energy whole cereal crops	- energy grain	- - - -
By-products	*direct*	- thinning by-products - logging by-products	- crop production by-products: - straw	- stones, shells, husks	- animal by-products - horticultural by-products - landscape management by-products
	indirect	- wood processing industry by-products	- fibre crop processing by-products	- food processing industry by-products	- biosludge - slaughterhouse by-products
End use materials	*recovered*	- used wood	- used fibre products	- used products of fruits and seeds	**MUNICIPAL BY-PRODUCTS** - kitchen waste - sewage sludge

Figure 4-1 Classification of biofuel sources by different characteristics (FAO, 2002). The term "by-products" includes the improperly called solid, liquid and gaseous residues and wastes derived from biomass processing activities.

The raw material for energetic utilisation mainly comprises wood fuels (i.e. woody biomass), agro-fuels (i.e. herbaceous biomass and biomass from fruits and seeds) and a category which e.g. includes animal by-products. Within these three main categories a further distinction can be drawn. According to their way of production and provision biomass can be divided into

- energy crops which are produced explicitly for energy provision,
- by-products which among others include wastes and residues from production and procession activities, and
- end use materials.

Thus, it becomes clear, that biomass for energetic utilisation results from various sectors and production / provision pathes which implies a broad range of fuel properties (e.g. water content, nitrogen content, size, etc.). If these characteristics are not clear defined and described are more widespread use of biomass within the EU 25 will be hampered.

In this context, to support a more widespread use of biomass the Commission of the European Community has decided to give a mandate to CEN, the European Committee for Standardisation, to initiate the development of European standards for solid biofuels. A Technical Committee "Solid Biofuels" (CEN/TC 335 Solid Biofuels) has been established by CEN end of May 2000 in Stockholm to undertake the drafting work which has far proceeded until now.

4.3 Biomass resources for non-energetic utilisation

For non-energetic purposes a broad range of utilisation options exists (see **Table 4-1**). Non-food crop products con be sourced from a very wide range of crops. Over 100 have been identified by the IENICA (Interactive European Network for Industrial Crops and Their Applications) website alone (http://www.csl.giv.uk/ienica).

Figure 4-2 gives an exemplary overview on main biomass sources and crop categories. Due to clearness a distinction will be made between raw material from forests ("forest wood") and raw materials resulting from cultivation on agricultural area ("cultivated crops"). Further distinction results from the industrial application categories for the various crops.

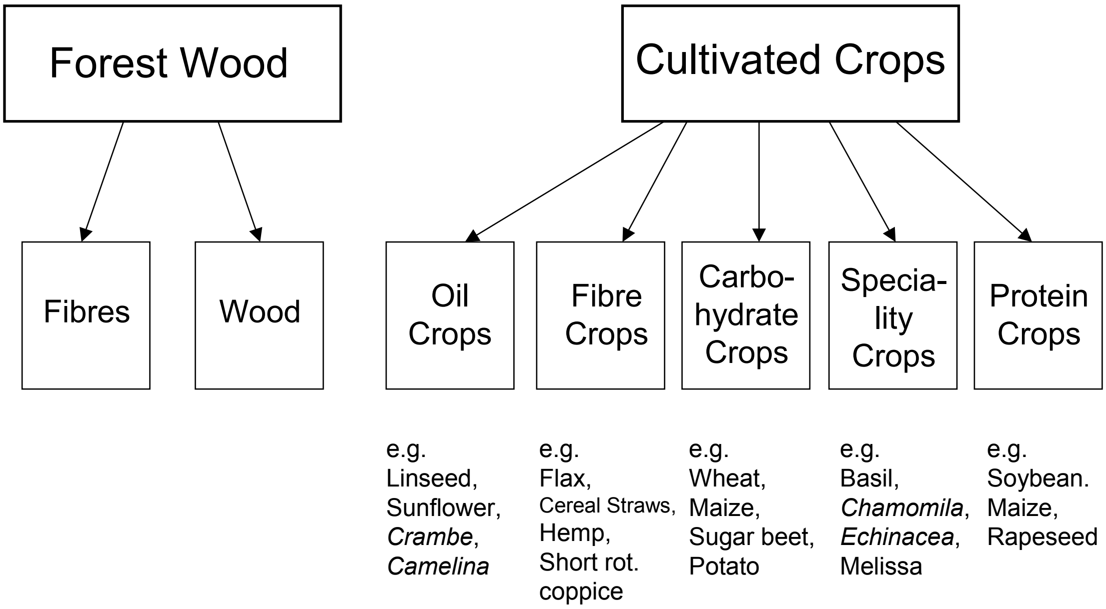

Figure 4-2 Exemplary classification of biomass for non-energetic utilisation (based on IENICA-Project)

Due to this complexity in crops and industrial applications/products the present report can give only a general overview on "non-energetic utilisation" and refers to the relevant literature for further details.

5 General data on EU 25 relevant for biomass production and use

The present study aims to evaluate the current and possible future perspectives on biomass potential and utilisation and on the political actions to be taken to increase the use of biomass in the recently formed EU 25 (Figure 5-1). Where possible data are given separately for the EU 15 and the 10 new member states (EU+10).

Figure 5-1 EU 25: geographical overview (/http://europa.eu.int/abc/maps/index_en.htm/)

In the following data are given for the countries which are of importance for the role of biomass production and utilisation from an European point of view.

5.1 Country area, population and general land-use

The accession of the 10 countries Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Hungary, Slovenia, Malta and Cyprus to the European Union in 2004 added about 75 Mio people and an area of about 750 000 km^2 to the former EU 15.

Figure 5-2 gives an overview on the area and population for the EU 25 countries.

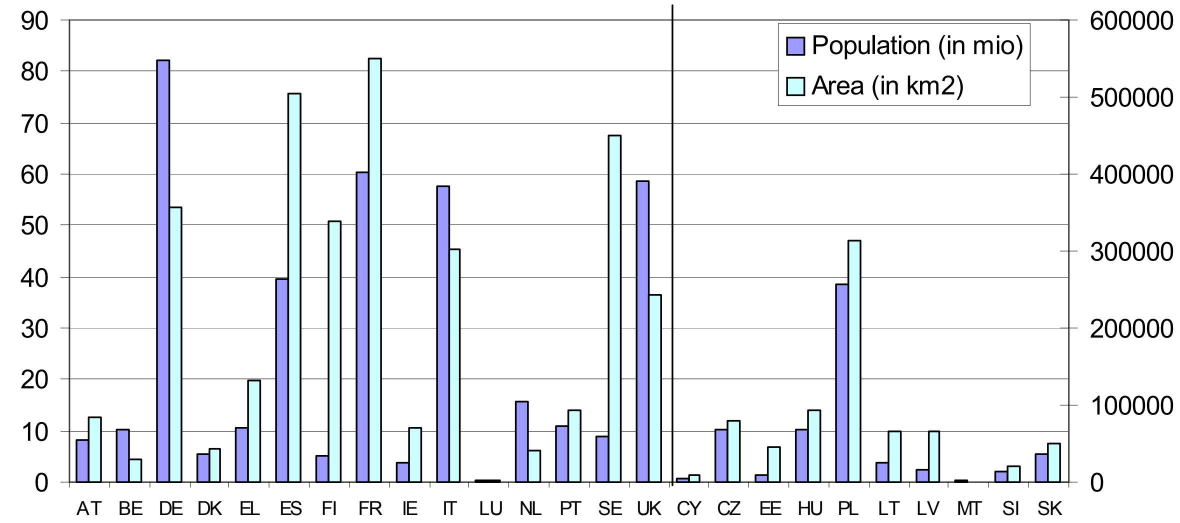

Figure 5-2 Country area (in km^2) and population (in mio) of the EU 25 (DFA/DEA, 2004)

As for the EU 15 also the EU+10 countries are characterised by large agricultural and forestry areas. Figure 5-3 shows the huge potential for agricultural production and wood which may be used or is already exploited for energetic and industrial purposes.

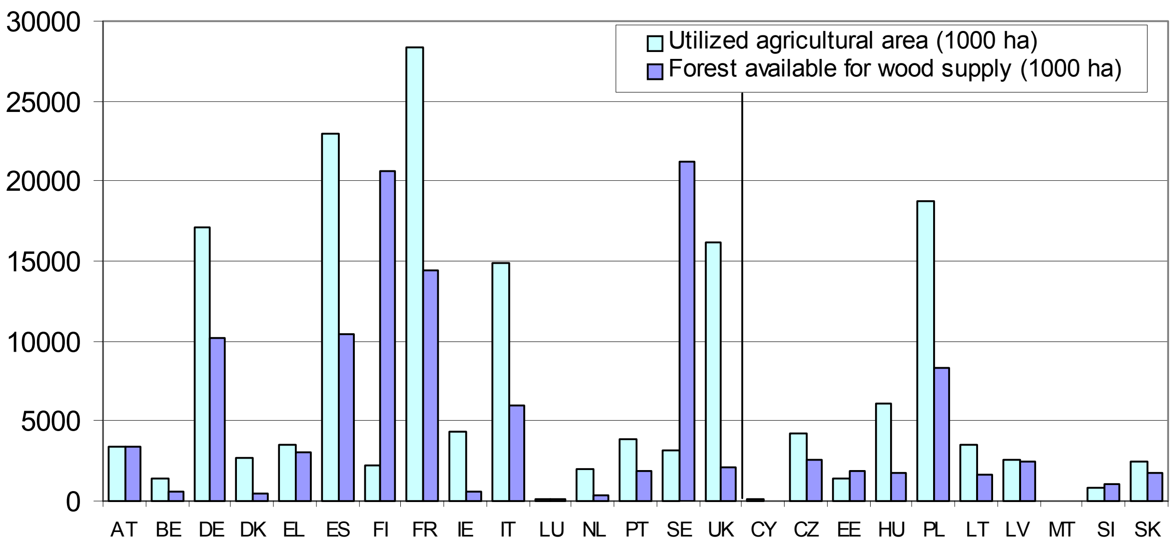

Figure 5-3 Area under agricultural use (in 1000 ha) and forest available for wood supply (in 1000 ha) for the EU 25 countries (Year 2000) (EC, 2003)

In the EU+10 countries the share of agriculture of gross domestic product (GDP) is generally higher compared to most of the countries of the EU 15 where it is about 1.6 % (year 2002 data) (Figure 5-4). Only in the Czech Republic this share (1,2 %) is below the EU 15 average. This shows the importance of the agricultural sector within the EU+10 compared to the EU 15.

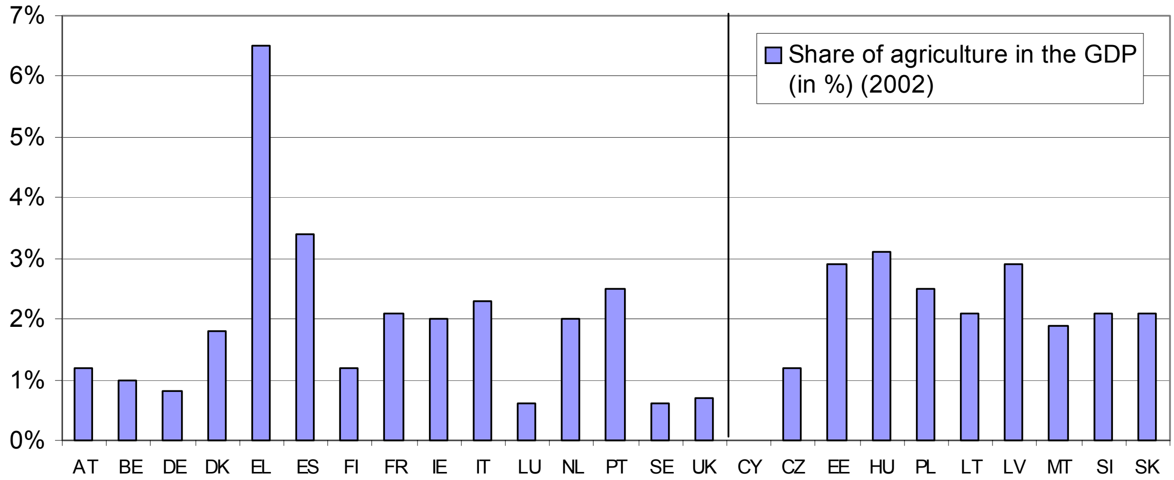

Figure 5-4 Share of agriculture of gross domestic product (GDP) (%) (DG Agriculture, 2004)

5.2 Renewable energies, energy provision and utilisation

In the EU various targets promoting the use of renewable energy have been set for 2010:

- Doubling the share of renewable energy in national gross energy consumption from 6 % to 12 %.
- Increasing the share of green electricity in total electricity consumption from 14 % to 22 %.
- Raising the share of biofuels in the transport fuel market to 5,75 %.

To reach these targets, specific policies and measures are being implemented in the EU and on national levels (see chapter 10 and 11). **The assessment of the development state of renewable energy within the EU 15 makes clear, that the progress towards meeting the targets has begun. However, to achieve the 2010 targets further policies and measures have to be implemented (CEC, 2004)**.

The following chapter gives a short overview on the current status of renewable energies within the energy system of the EU 15 as well as for the EU+10.

5.2.1 Role of renewable energy in national gross energy consumption

In the White Paper on Renewable Energy (COM(97)599) the target to double the share of renewable energy in national gross energy consumption was set from 6 to 12 % for 2010 for EU 15.Figure 5-5 shows the distribution of energy resources on gross inland energy consumption in the EU 25. The share of renewable energies is still rather small (5,8%) compared to fossil solid fuels, oil, gas and nuclear power.

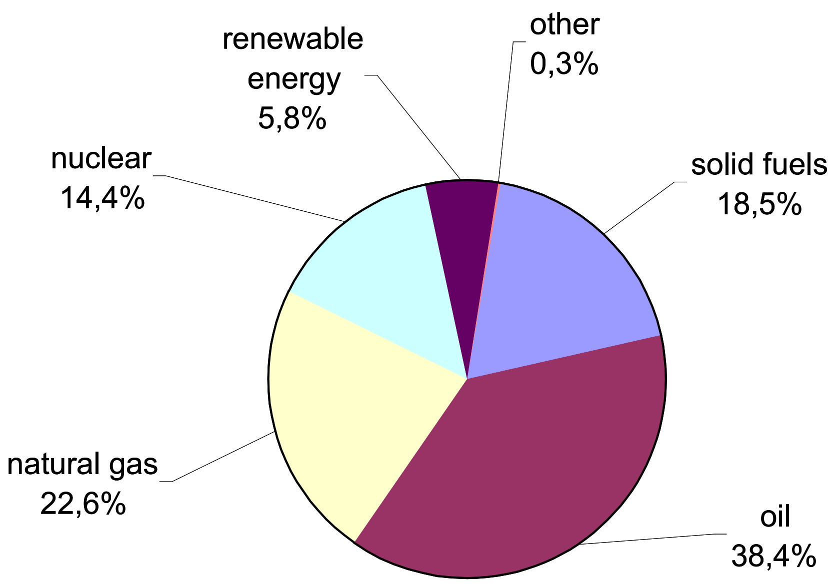

Figure 5-5 Distribution of energies in gross inland energy consumption in EU 25, year 2000 (CEC, 2004)

Within the EU 15 the share of renewable energies in primary energy consumption amounts to 5,48 % for 2003 vs. an objective of 12 % for 2010. For the last three years there has been a stagnation for renewable energy as for 2001 this ratio was estimated at 5.6 % and for 2002 at 5.08 % (EurObserv`er, 2004). Figure 5-6 gives an overview on the share of renewable energies in primary energy consumption in the EU 15 for the year 2003. It becomes clear, that the situation is very different for the various countries.

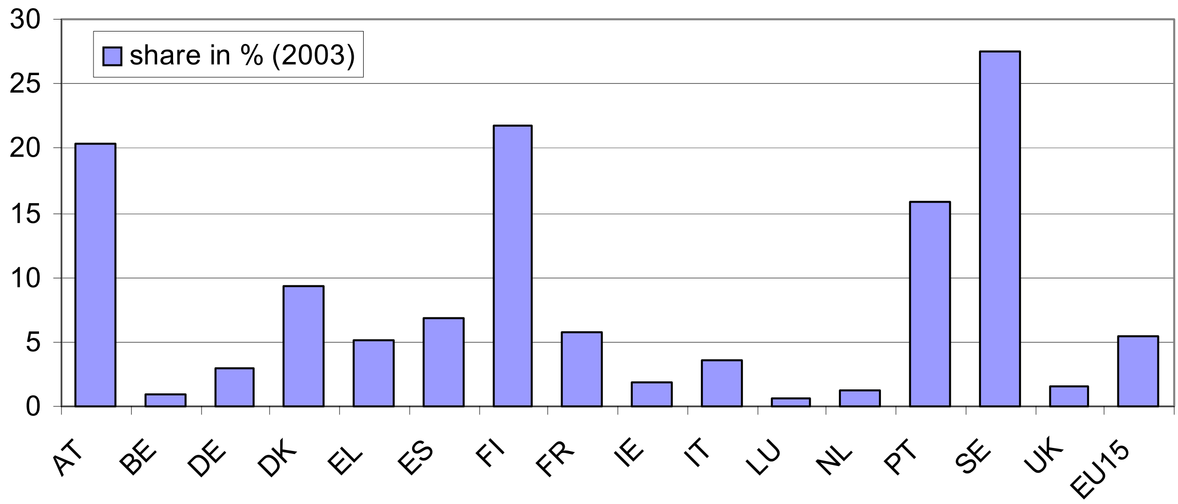

Figure 5-6 Share of renewable energies in primary energy consumption of EU 15 in 2003 (EurObserv`er, 2004)

Renewable energies are widely used in Austria, Sweden, Finland and Portugal with a national share of primary energy consumption ranging between 15.8% and 27.6%. They are also used significantly in Denmark, France, Spain and Greece, with a share of between 5% and 9%.

Figure 5-7 gives an overview on the renewable energy share in total primary energy supply (TPES) including the EU+10 for the year 2001. Latvia provides a share of about 35 % which is more than any other country within the EU 25. In Latvia, hydroelectric facilities provide about 75 % of electricity generation, although the supply reliability is complicated (frozen rivers during very low winter temperatures) (CEC, 2004b). In Slovenia and Estonia renewable energies contribute about 10 % to TPES. For Slovenia this is due to hydro-power whereas in Estonia hydro-power as well as biomass play an important role.

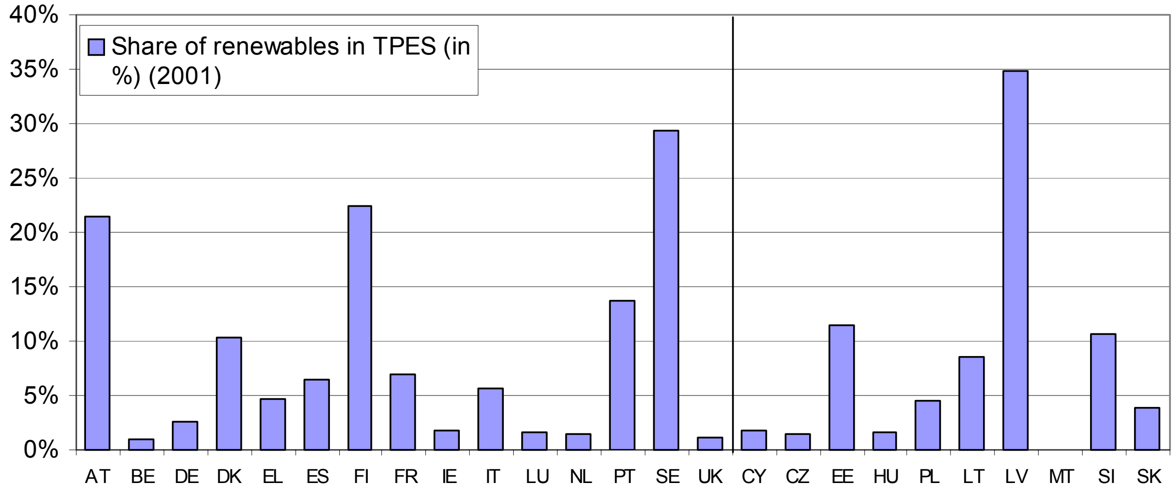

Figure 5-7 Renewable energy shares in Total Primary Energy Supply (TPES) (%) (IEA, 2003)

5.2.2 Role of renewable energies in electricity supply

The EU 15 as well as the new member states are subject to the requirements of the Directive 2001/77/EC, where for the EU 15 the target to increase the share of green electricity in total electricity consumption was set to increase from 14 % to 22 % by 2010. The member states adopted the green electricity directive and set national targets. The overall target for the enlarged EU thus is a 21 % share of green electricity in total electricity consumption by 2010.

Figure 5-8 gives an overview on the share of renewable energy in electricity generation. Compared to other fuels (solid fuels, nuclear and natural gas) the contribution of renewable energies with 13,7% is rather small.

The Commission Report COM(2004)366 (CEC, 2004) evaluated the state of development of renewable energies in the EU and the progress that has been made by the EU 15 towards achieving national targets for 2010 for electricity from renewable energy. One main result of the Report is that the overall target of 22% green electricity in 2010 for the EU 15 will be met if member states reach the national objectives they have adopted under the 2001 directive in order to promote green electricity from renewable energy sources. Although progress towards meeting the national targets has begun, the 2010 target will not be reached under current policies even under a scenario of reduced total electricity demand due to energy efficiency measures. On the basis of current trends, it is likely that 18 to 19% total electricity consumption in 2010 will be produced from renewable energy sources for the EU 15. The main reason why the target may not be reached is because electricity production from biomass has not been as high as initially previewed (CEC, 2004, p12ff).

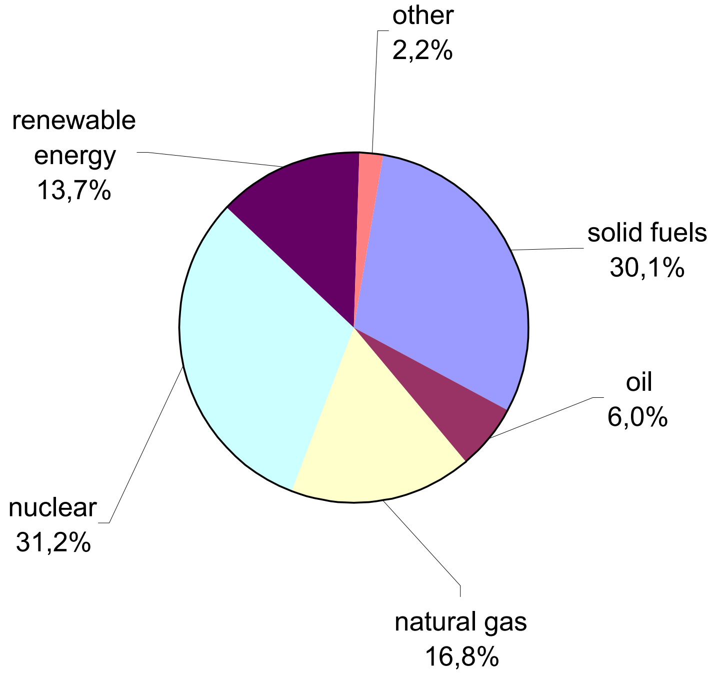

Figure 5-8 Electricity production from different energy resources in the EU 25 for the year 2000 (CEC, 2004)

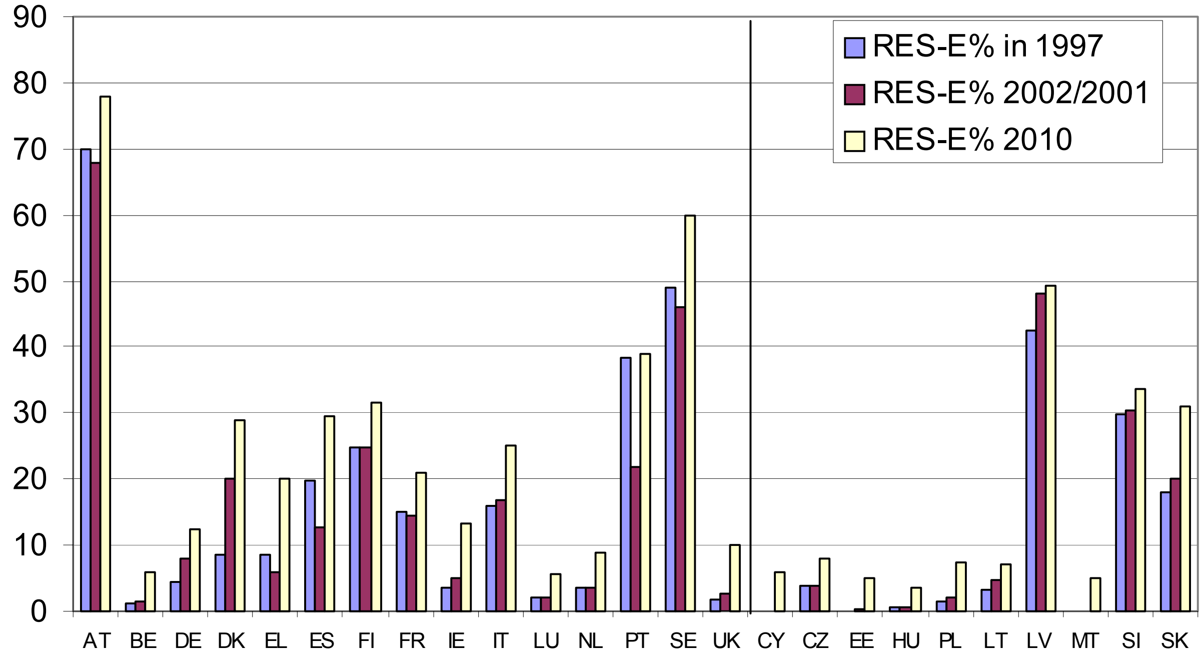

Figure 5-9 Share of Renewable Energy Electricity Production (RES-E) in 1997 and 2001/2002 and national indicative RES-E targets 2010 for EU 25 (CEC, 2004b)

However, there are considerable differences between the different countries (Figure 5-9). EU 15 countries can be roughly divided into three groups that are more or less on track to reach their targets for the share of green electricity:

- Denmark, Finland, Germany and Spain have initiated energy policies that should allow them to achieve their national targets.
- Austria, Belgium, France, Ireland, the Netherlands, Sweden and the United Kingdom, have started to implement appropriate policies that could allow them to reach their objectives
- Greece and Portugal need to reassess their policies if they also wish to be on the track
- Italy and Luxembourg adopted new laws in March 2004. The effects have not been assessed until now.

The situation in the new member states will be assessed in 2006. These countries adopted the green electricity directive only recently. Figure 5-9 shows that some of the EU+10 countries made good progress in reaching the 2010 target. This is true e.g. for Lithuania, Latvia and Slovenia, whereas some countries clearly have to strengthen there activities as e.g. Cyprus, Malta, Hungary, Estonia.

5.2.3 Role of renewable energies in liquid fuel supply

The biofuel Directive (2003/30/EC) covers the EU 25 member states and sets the target to raise the share of biofuels in the transport fuel market to 5,75%.

National reports on the implementation of Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport have been published recently. The reports are available for 20 countries of the EU 25 (2004/2005) (Member States Reports, 2004). Results of the national reports will be taken into consideration in chapter 6.3.

6 Utilisation of biomass for energy supply

Biomass (incl. wastes) already plays a considerable role in renewable energy production within the EU (Figure 6-1). Nevertheless, to reach the European targets on the promotion of renewable energies further efforts are necessary. The (CEC, 2004 p.36) calculated that **in 2001 the EU 15 used about 56 Mtoe of biomass for energy purposes. Achieving the Union`s renewable energy targets for 2010 would need approximately 74 Mtoe more – 32 Mtoe for electricity generation, about 18 in the form of biofuels and 24 for heating (total 130 Mtoe).**

Within the EU 25 the share of biomass in the renewable electricity and heat market differs clearly.

- **National renewable electricity markets:** the share of bioenery production ranges between 0 % (Cyprus, Malta, Latvia, Slovakia) and more than 50 % (Belgium, Estonia).
- **National renewable heat markets:** In most of the countries biomass plays the most important role (compared to solar thermal heat and geothermal heat) which a share of more than 90 % in the national renewable heat markets.
- **National biofuel markets:** within the biodiesel and bioethanol markets different actors can be identified. Biodiesel is produced in Germany, France, Italy, Austria, Denmark and the Czech Republic. Bioethanol plays an important role in France, Spain, Sweden, the Czech Republic and Poland. No such particular markets exist for the other countries.

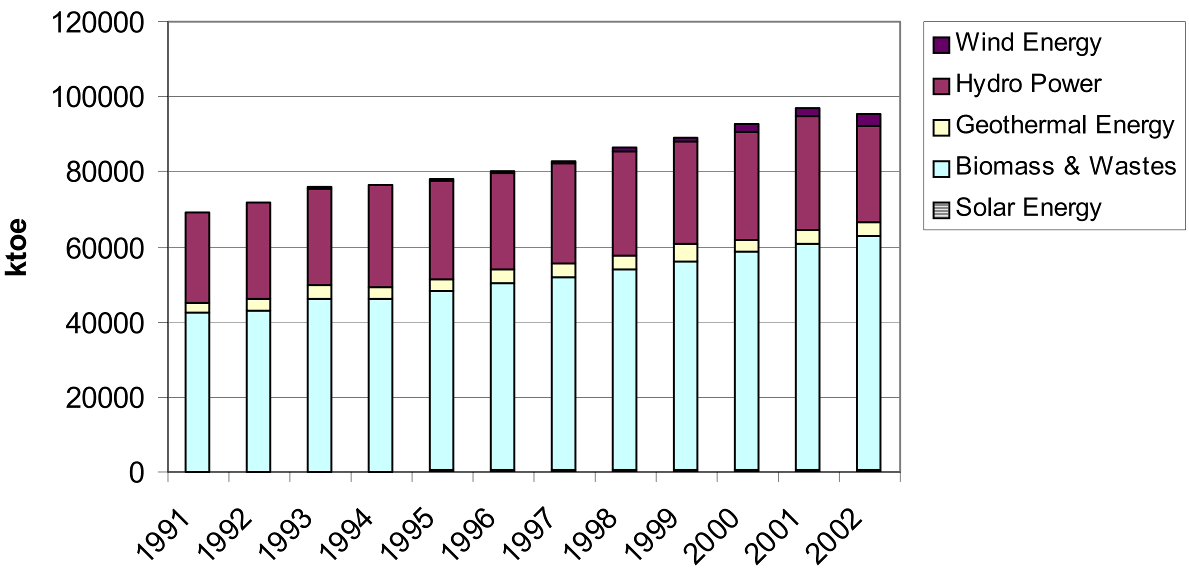

Figure 6-1 Share of Bioenergy production (incl. wastes) of total renewable energy primary production within EU 25 (Eurostat, 2004)

Following the renewable electricity, heat and biofuel markets will be explained in detail.

6.1 Role of biomass in the electricity market

6.1.1 Biomass penetration in the electricity market

Between 1997 and 2001, Finland, Denmark and the UK (mainly using biogas) were the only countries where biomass electricity grew steadily. In some countries biomass contribution grew comparably but intermittently and in others it stayed small.

In 1997, the commission expected that 68% of the growth in electricity supply from renewable energy sources would come from biomass. 24% could come from wind power and 8% from a mixture of hydro, geothermal and photovoltaik power. Now, the strong growth of wind power may lead to a contribution of 50% by wind to the target set in the Directive. Hydro, geothermal and photovoltaik power can be expected to contribute 10%. Consequently the target will only be achieved if biomass contributes the remaining 40%, this would mean a gowth in produced energy from 43 TWh in 2002 (Eurostat, non-consolidated figures) to 162 TWh or 18% per year – compared with a rate of only 7% a year over the past 7 years (CEC, 2004).

Figure 6-2 gives an overview on the EU 25 national bioenery electricity production (GWh) and the share of bioenergy in the national RES-electricity market.

- Each of the EU 15 countries produces electricity from biomass. However, there are great differences between the countries. Finland provides nearly 10 000 GWh from bioenergy, whereas Greece, Ireland and Luxembourg only show little penetration. The 2002 data gives about 6 700 GWh for Germany and for Spain, Sweden, the United Kingdom and France about 3 500 to 4 000 GWh electricity from biomass.
- The share of bioenergy in national RES-electricity production can not be derived from these absolute figures above. In Finland e.g. electricity production from biomass is the highest in the EU 15 due to a strong expansion of biomass-fueled CHP and district heating. Nearly 10% of the domestic electricity demand in Finland is now met by biomass (CEC, 2004b). However, on national level bioenergy is only one important renewable source. Hydro also plays an important role in Finland.
- Electricity from large and small scale hydro dominates the renewable electricity market in France, Austria, Greece, Italy, Portugal, Sweden, Whereas e.g. for Germany, Spain and the United Kingdom electricity from wind power installations show to have big market shares in renewable electricity. Thus it becomes clear, that biomass is one renewable source amongst a mixture of available renewables within the EU 15.
- For the EU+10 countries the Czech Republic dominates in electricity production from biomass with about 650 GWh electricity from biomass in 2002. For Cyprus, Latvia, Malta and Slovakia there currently exists no bioenergy electricity market (year 2001/2002).

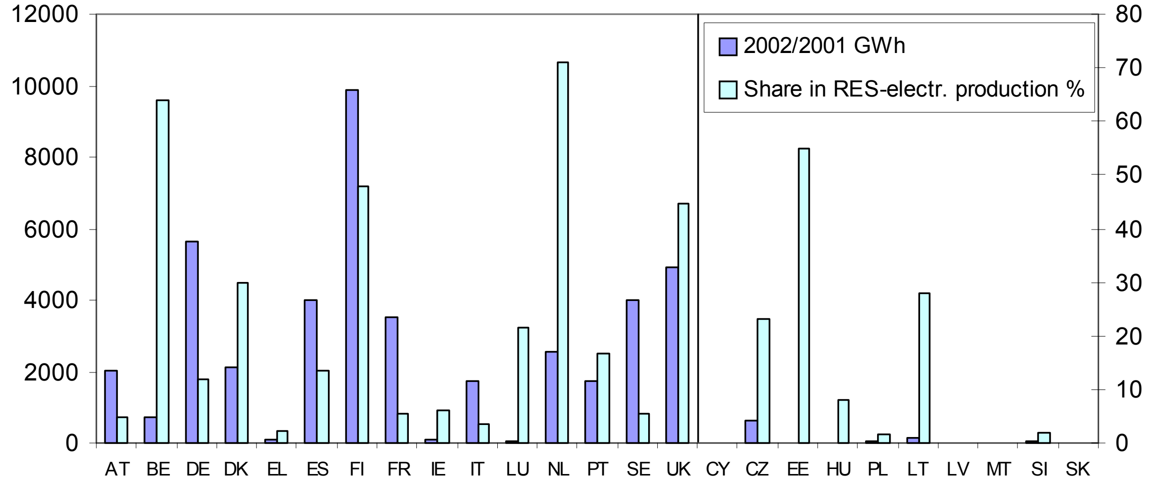

Figure 6-2 EU 25: share of bioenergy production in the national electricity markets (RES-electricity production) (CEC, 2004b)

- In some of the EU+10 countries, however, biomass contribute clearly to the total RES-electricity production. Other renewable sources for electricity production (e.g. hydro, wind, photovoltaics) play a minor role. In most of the new Member States there is an important potential for the use of biomass for both electricity and heat generation. This is particular true for the widely unexploited potential for electricity generation in Hungary, Czech Republic, Slovakia, Latvia, Lithuania and Estonia (CEC, 2004b).

6.1.2 Sources of biomass for electricity production

Within the EU 15 (Figure 6-3) and the new member states (Figure 6-4) there are great difference due to the most prevailing biomass sources for electricity production.

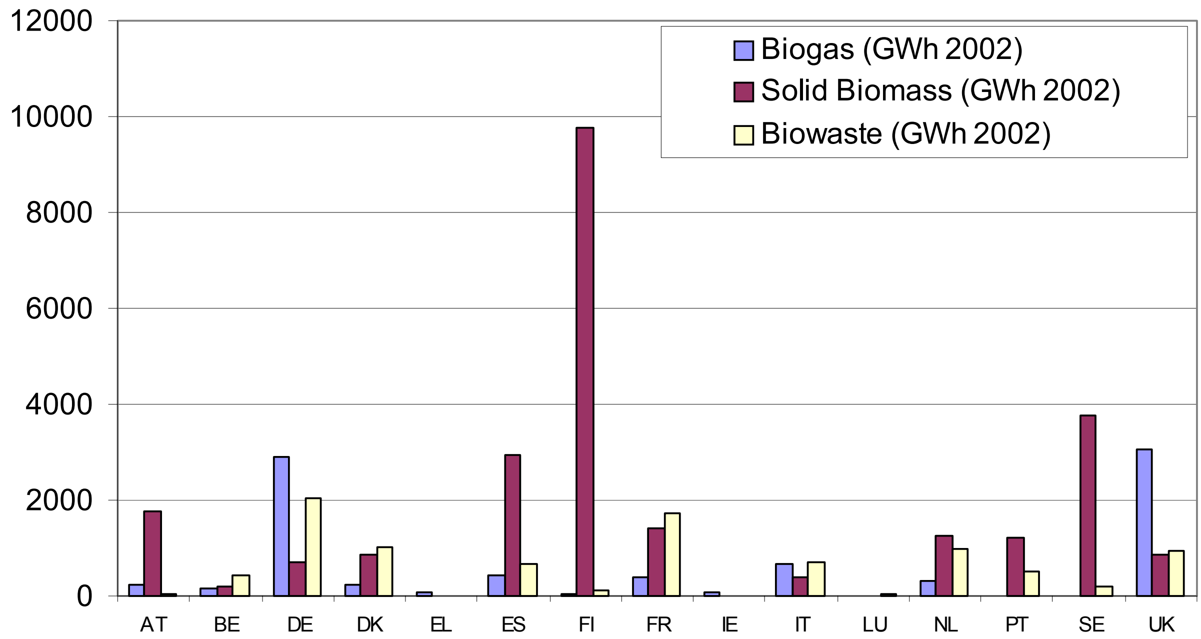

Figure 6-3 EU 15: Biomass sources for RES electricity production (CEC, 2004b)

In the EU 15 solid biomass and biowaste play the most important role. Nevertheless, e.g. in the UK and Germany biogas is the main pathway for electricity production. In the new member states biogas is only relevant for the Czech Republic. For the other states – as far as electricity from biomass is concerned – solid biomass is the dominant energy carrier.

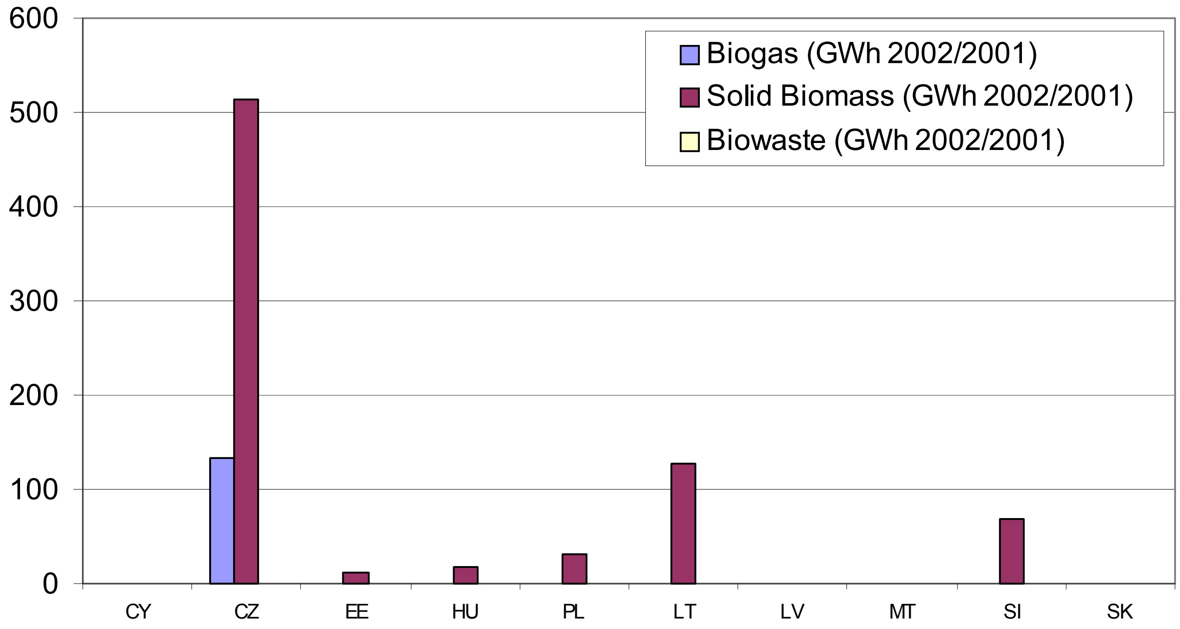

Figure 6-4 EU+10: Biomass sources for RES-E production (CEC, 2004b)

6.1.3 Costs for electricity production from biomass and other renewable energies

Cost data for electricity production are mainly determined by the factors i) fuel costs, ii) plant investment costs, and iii) maintenance costs. Some general conclusions can be drawn:

- "Renewables for power generation" (IEA, 2003b) gives costs for biomass electricity plants of 7 €-cents per kWh or more.
- Costs can be reduced when biomass is used in combined heat and power (CHP) plants (down to 5 to 6 €-cents per kWh) or for co-firing of biomass in fossil fuelled power plants, where investment costs on the power cycle are low (down to 2-4 €-cents per kWh)
- For comparison, the wholesale cost of electricity produced by conventional power plants is around 3 €-cents per kWh based on data in IEA, 2003b. (CEC, 2004, p10).

Thus, biomass electricity often is given higher costs as their conventional alternatives if compared on an individual basis without considering the impact of the total energy system costs. However, it has to be taken into account that the rising prices for fossil fuels may change the data above and make the use of bioenergy more favourable.

In Figure 6-5 data is given on the electricity generation costs of different renewable energies in Germany for 2004.

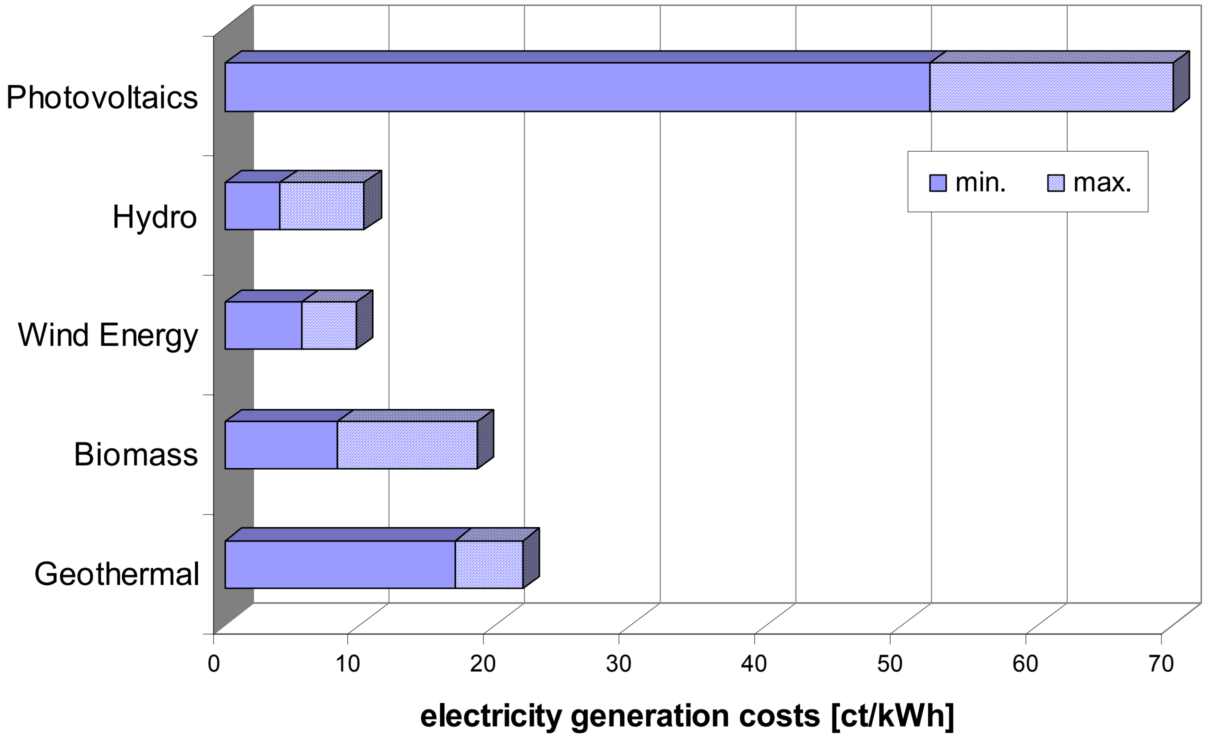

Figure 6-5 Comparison of electricity generation costs from renewable energy resources in Germany (IER, 2005)

6.1.4 Technologies for electricity production from biomass

Combined heat and power (CHP) is suitable for various applications. It can be used to provide space heating and domestic hot water to individual houses or a group of buildings. Generated electricity may be fed to the grid. The relatively new technology has reached the commercialisation stage also for small scale applications (50-500 kWel).

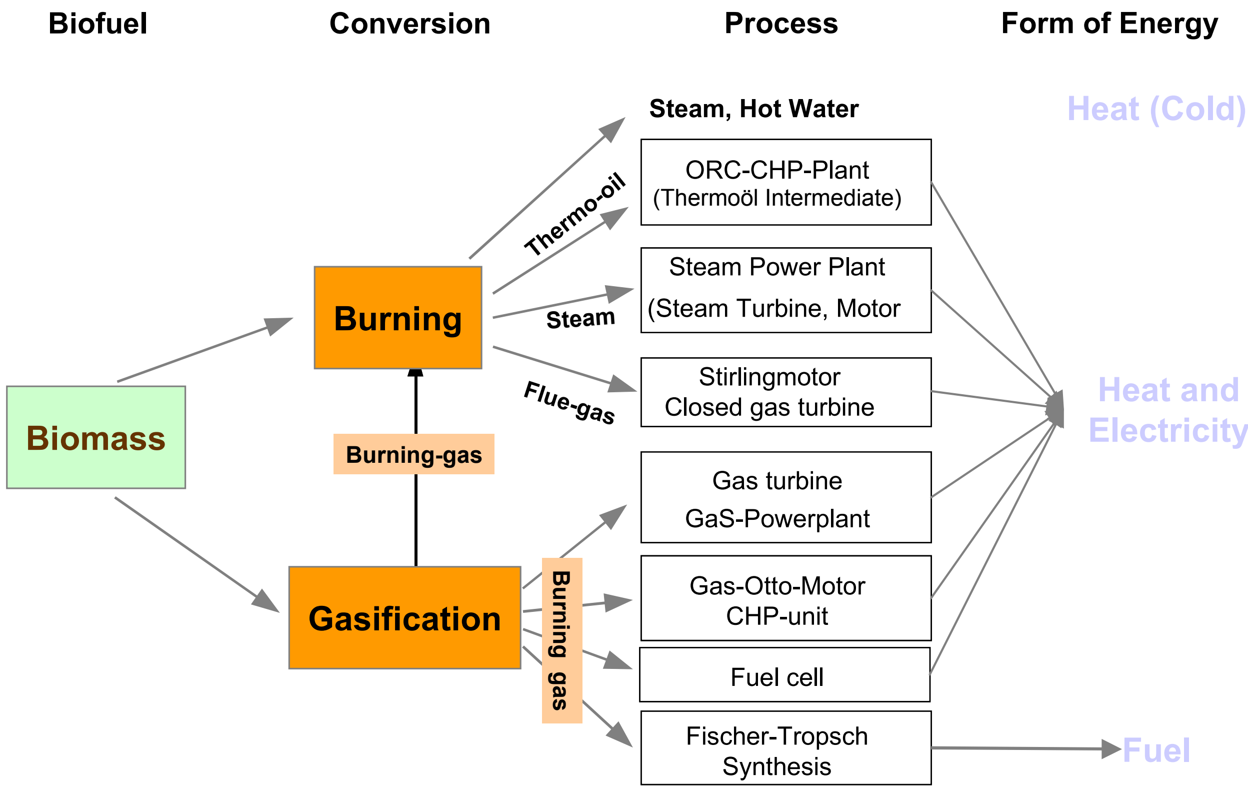

Figure 6-6 Different possibilities for the energetic utilisation of biomass (IER, 2004)

Figure 6-6 gives a general overview on different possibilities of the energetic utilisation of biomass for provision of heat (cold), electricity and liquid fuels. The stage of development of several technologies is presented in Figure 6-7. Steam turbines are the technologies, which have reach direct market competitiveness, whereas e.g. the organic rankine cycle process is near market readiness and biomass gasification is still in the pilot or demonstration phase.

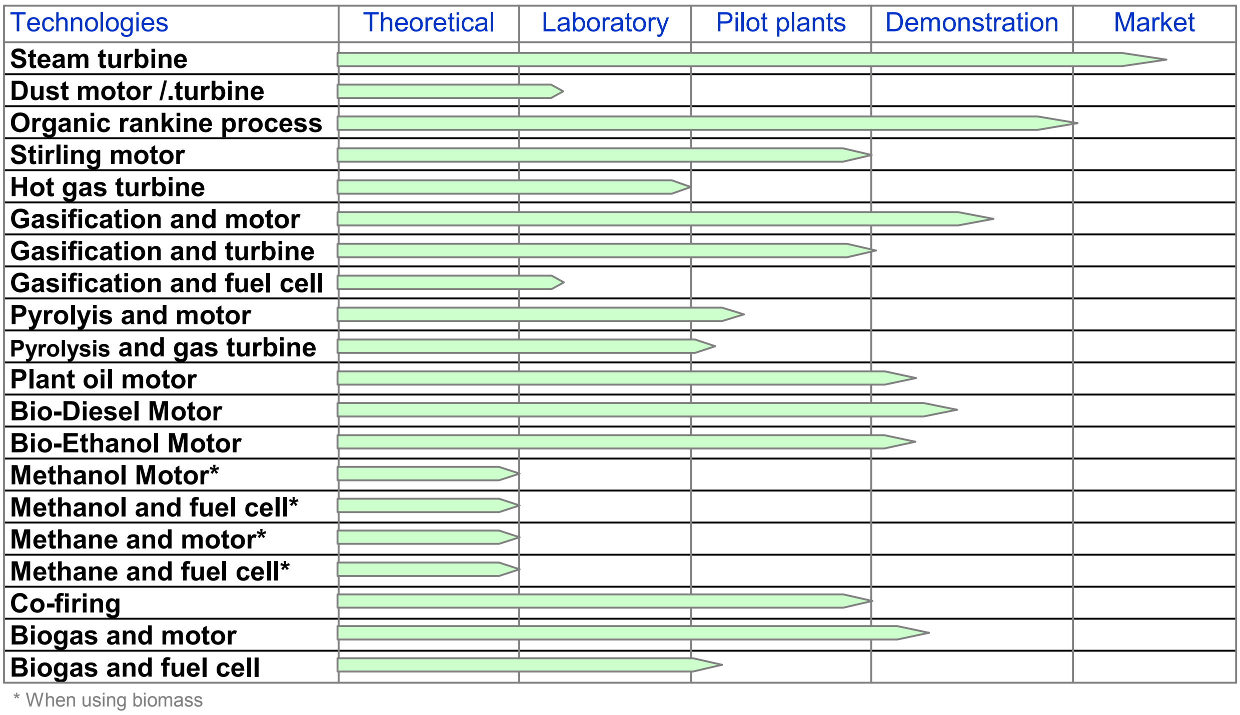

Figure 6-7 Stage of development of biomass energy conversion and utilisation technologies (IER, 2004 based on Fichtner, 2002)

6.2 Role of biomass in the heat market

6.2.1 Biomass penetration in the heat market

Heat from renewable energy sources is used in many different ways. Heat demand for industrial purposes often calls high temperatures or steam at high pressure. For such requirements renewable heat will typically be provided via the combustion of biomass (wood or industrial waste and residues). For heating or hot water demand in buildings a wider range of technologies and sources such as district heating or centralised supply for larger scale and commercial/public/residential buildings applications can be used. Here economies of scale may encourage investment in technologies such as large boilers, geothermal or CHP. Domestic heat demand and other small-scale demands can be met using technologies such as solar panels, wood stoves, geothermal sources etc. (CEC, 2004).

In the EU 25 RES-heat sector biomass plays the most prominent role (see Figure 6-8). For most of the EU 25 countries biomass is the major source of renewable heat and is near to 100 % of the RES-heat production. Solar thermal heat and geothermal heat incl. heat pumps only play a minor role. This is not true for a few of the new member states. For Cyprus e.g. generation of solar thermal heat is an important source of heat supply, for Hungary and Slovakia, geothermal heat (incl. heat pumps) plays a considerable role besides biomass (CEC, 2004b).

However, the development of biomass heat generation is not stable for all of the EU 25 countries. The annual growth rates since 1997 up to 2001/2002 are negative for Estonia (-7%), Latvia (-6%), UK (-5%), Austria (-2%), Denmark (-2%), Sweden (-2%), Poland (-1%). For the other countries the role of biomass has been proceeding in the last years although the rates differ clearly: Luxembourg (26%), Slovenia (21%), Slovakia (20%), Italy (9%), Lithuania (6%), Ireland (6%), Germany (6%), Belgium (5%), Hungary (5%), Czech Republic (5%), Finland (3%), France (1%), Greece (1), Spain (0,7%), Portugal (0,3%), Netherlands (0%).

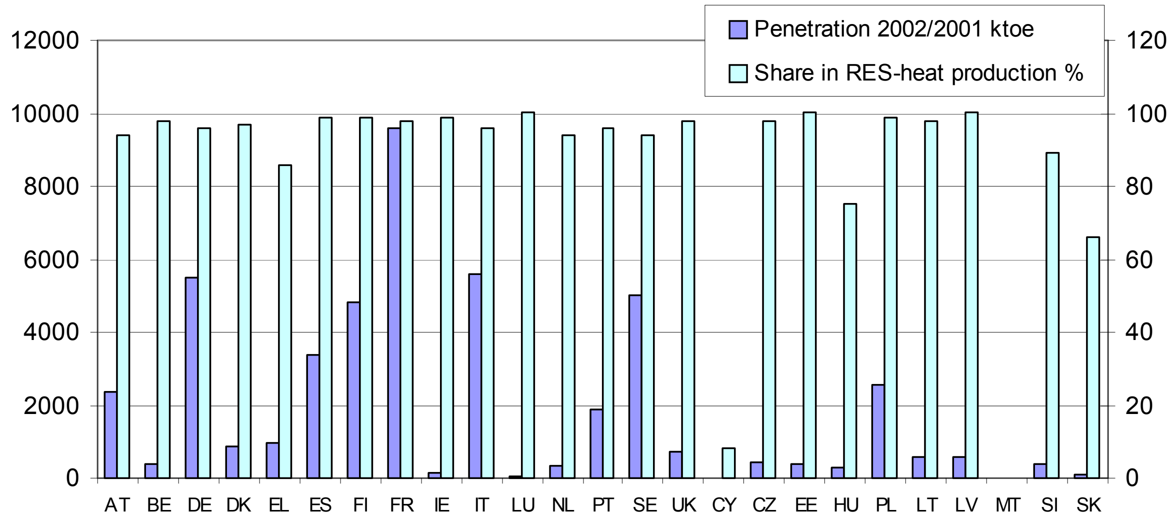

Figure 6-8 EU 25: share of bioenergy production in the national heat market (CEC, 2004b)

Due to the important role of biomass in the RES heat sector, some detailed country description are given exemplarily:

- **Austria:** The penetration of biomass heat production decreased in recent years. Even though it is still by far the most important source for RES-heat. The strong position in absolute figures is due to the continued and widespread use of traditional biomass-based heating (CEC, 2004b).
- **In Germany**, biomass heating is largely dominated by wood and wood-waste applications in households and a growing share of biogas, accounting for about 13% of the biomass heat consumption by the end of 2001. The production of heat from wood in households remained quite constant over recent years (CEC, 2004b).
- **Finland and Sweden:** In the heat sector the use of biomass has grown substantially over the past decade in particular in new CHP and district heating installations (by nearly 50 % compared with 1990 for Finland).
- **France**: The heat sector has remained more or less stable over the past decade. The current use of heat from RES amounts to approximately 10 Mtoe, which covers 7% of the domestic energy consumption for heating purposes. Biomass is the main source of renewable heat and is used on a relatively stable level. The largest contribution comes from wood-firing in households, which covers 90 % of the heat production from RES (CEC, 2004b).
- In **Hungary** currently fuel wood combustion is the primary utilisation of biomass. Forestry waste and sawmill by-products are burnt in furnaces providing heat for the forestry

industry or briquetted for retail sale. Nearly 40% of the round wood production is used for energy purposes (CEC, 2004b), Reiche,2003).

- In **Latvia** biomass energy is mainly used as firewood in small, and as a rule, low- efficient boilers in private households (CEC, 2004b). Wood is the most important domestic fuel. Since the mid nineties, firewood, wood residues and wood chips are increasingly used in local and district heating systems (Reiche, 2003).
- **Lithuania**: Among the biomass energy sources wood was used for space heating of individual houses by burning in stoves with small efficiency as compared to Latvia. In 1994 waste wood and specially prepared wood chips were started to be used burning them in district heating boilers with higher capacity (>1 MW). Now the totally installed capacity of such combustion wood boilers reaches around 120 MW (CEC, 2004b).
- For **Slovenia**, too, wood is an important fuel for space heating, particularly in the residential sector.
- In **Estonia** the share of wood fuel used to produce heat was prevailing over the last years, but the form of wood is changing. While the share of firewood is decreasing, the share of wood-chips is increasing ("Ministry of Economic Affairs and Communications" in Reiche, 2003).
- For **Poland** biomass covers over 98% of renewable energy production. Biomass is considered to be the most promising of renewable energies in Poland. **Table 6-1** gives an overview on biomass energy technologies implemented in Poland in 2001. Wood small-scale heating plants are representing the most important technologies with 5 500 MWt power installed.

Table 6-1: Biomass energy technologies implemented in Poland in 2001 (GUS 2002b in Reiche, 2003) (liquid biofels not included)

Specification	No. of units	Power installed (MWt)	Energy production	
			Electricity (GWh/a)	Thermal (TJ/a)
CHP systems in pulp & paper and furniture industry	3	330	449.1	5 298.5
Wood industrial and DHP (only heat) (> 500 kW) [1]	150	600	-	9 633.6
Straw district heating plants (> 500 kW) [1]	35	50	-	802.8
Wood small-scale heating plants (< 500 kW) [1]	110 000	5 500	-	88 308.0
Straw small-scale heating plants (< 500 kW) [1]	150	45	-	722.5
Biogas CHP- and DH-systems[2]	29	38.9	72.5	250
Landfill gas CHP- and DH-systems[2]	17	15.9	59.0	102

[1] estimated data
[2] Data from 2000

6.2.2 Sources of biomass for heat production

The role of different biomass sources already has been explained above for the various countries. It can be summarised as follows:

Woody biomass: Most of the biomass needed for heating is still wood – in various forms from pieces of wood over wood chips to wood pellets. The biomass market for space heating within the EU 15 remains stable. Significant incentives are needed to overcome this problem and to encourage more efficient wood-burning stoves and boilers. Polygeneration from biomass (CHP) is a good option for the industrial-scale use of wood.

Biogas: The biogas sector has undergone constant development in most of the countries of the EU. Biogas has the dual advantage of eliminating greenhouse gas emissions while producing energy at the same time. Biogas can be used to produce electricity, heat or liquid transport fuel. 60% of biogas is used in electricity production and 40% in heat production, the production of fuels from biogas is negligible. In 2002, EU 15 biogas production was 2,8 Mtoe; 10% higher than 2001. This growth rate is too slow to achieve the 15 Mtoe proposed for 2010. (CEC, 2004 p31).

Others: Other forms of biomass such as energy crops from agriculture need to be implemented. The technology and logistics to use them are more or less developed, however they may still be expensive. Energetic incentives are necessary to promote this sector and increase e.g. the use of whole grain plants, short rotation coppices or straw for energy production in the future.

6.2.3 Costs for heat production from biomass

The heat generation costs from biomass are given in Table 6-2 for two exemplary heat production plants in Germany (cost basis 2004).

Table 6-2: Heat generation costs for two heat plants from biomass (without heat distribution) in Germany 2004 (IER, 2004)

		0,5 MW boiler	5 MW heat plant
Basic data			
Yearly produced heat	MWh/a	1 000	11 400
Amount of biomass needed	t/a	330	2 940
Investment cost	T€	200	1 500
Running costs :			
Cost of capital [c]	T€/a	20,5	155
Cost for biomass	T€/a	16,5	186
Personal cost	T€/a	10	52
Maintenance Costs	T€/a	3,5	30
Other cost [b]	T€/a	2	15
Total running cost	T€/a	32	334
Total Cost [d]	T€/a	52,5	489
Specific heat generation costs	**€-cent/kWh**	**5,3**	**4,3**

A = spec heat generation costs without heat distribution
b = insurance, running costs, etc.
c = Investment cost x Annuity factor
d = equiv. with yearly heat production costs

Further economic data are provided in chapter 9 Economics and market prices.

6.2.4 Technologies for heat production

The majority of current biomass-derived heat energy comes from wood combustion technologies. Direct combustion for heat production and driving a steam cycle are available at a commercial market ready stage with a constant drive for the improvement of efficiency and reduced emissions. In the small scale heating systems to produce heat logwood, pellets, woodchips and other forms of wood are used. In the larger district heating systems typically based on either fluidised bed boilers or grate boilers wood is burned in the form of wood chips, refuse-derived fuel, waste wood, sawdust and straw (EUBIA, 2003).

The production of heat from gasified biomass resources is scarce throughout Europe, although some pilot plants exist e.g. in Scandinavia, but not at a commercial, market ready scale.

6.3 Role of biomass in the fuel market

6.3.1 Biomass penetration in the fuel market

The biofuels sector in the EU is divided into two distinct sectors, the biodiesel and ethanol sector. In the EU 15 the biodiesel and ethanol yield 1 743 500 tons (equiv. to 1 488 680 toe) in 2003. In comparison with 2002 this is a growth of 26,1%(EurObserv`er 2004b).

Biodiesel from oilseed is the most common biofuel. Biodiesel (FAME – Fatty acid methyl ester) is produced from rape or sunflower seed and can be used either in pure form or as an additive to diesel fuel. Ethanol is derived from bacterial fermentation of beets, corn, barley or wheat and can be used directly as a petrol additive or in the form of ETBE (ethyl tertiary butyl ether). Other biofuels, derived from wastes and residues account for only a small share (EurObserv`er 2004b).

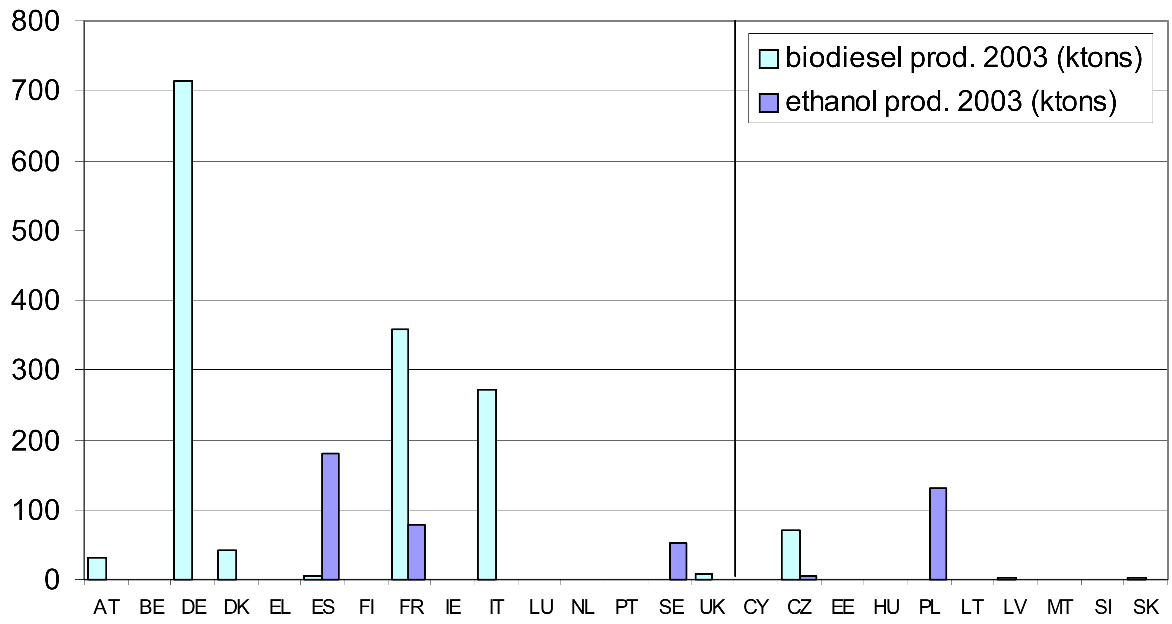

Figure 6-9 EU 25: share of biofuels in the national fuel market (EurObserv`er 2004b, Member States Reports 2004, CEC 2004b)

Figure 6-9 shows the share of biofuels in the national liquid fuel market and demonstrates the great differences in biofuel penetration in the EU 25.

Some more information for the diesel and ethanol sector are given in the following:

Biodiesel sector

According to the Biofuels barometer 2004 and the National reports on the implementation of Directive 2003/30/EC eleven countries have production capacities for biodiesel.

- For the EU 15 Germany, France and Italy are the main producers. For several year Germany is the number one producer with today 715 000 tons, i.e. 58.9% growth compared to 2002. France produced 357 000 tons of biodiesel in 2003, a figure that exceeds its production quota set at 317 500 tons per year. Surplus production is exported to Germany and Italy. Italy's biodiesel production is in market increase with a production of 273 000 tons, i.e. a growth of 30 % with respect to 2002 (EurObserv`er 2004b). Austria, Denmark, the United Kingdom, Spain and Sweden only play a minor role in biofuel production (EurObserv`er 2004b).The main raw material for production of biodiesel is rape seed (ZSW, 2004).
- Within the new member states, the Czech Republic is the main producer, providing about 70 ktons biodiesel in 2003. This is number 4 position within the EU 25. The RME share of diesel sales in the Czech Republic amounts to 2,3 % in 2003. Slovakia and Latvia show comparably low amounts of biodiesel production. The share of biofuels in transport fuels in Latvia is 0.3% (Member States Reports, 2004). In Slovakia the share of biodiesel in the overall domestic consumption of petrol and diesel is about 0,14 % (Member States Reports, 2004).

Ethanol-Sector

In 2002, European ethanol production amounted to 317 200 tons vs. 216 000 tons in 2001. This is about a 45% growth. In 2003 ethanol production amounted to 309 500 tons vs. 317 200 tons in 2002, i.e. a decrease of 2,5% (EurObserv`er 2004b). Ethanol growth rate was lower than that of the biodiesel sector. Within the EU 15 the main raw materials for ethanol production are wheat, barley and sugar beet. Spain is leader in ethanol production followed by Poland, France and Sweden and the Czech Republic (Table 6-3). It should be noted that in Sweden and the Czech Republic ethanol is not transferred into ETBE (Schmitz, 2003).

Poland is the only country among the new member States to have developed this sector in a significant way. According to the Chamber of Commerce of Distilleries, the domestic bioethanol production for the production of ETBE was 131 640 tons in 2003 (166 millions of litres) compared to 65 660 tons in 2002 (82,8 millions of litres). The equivalent ETBE production, calculated from a standard 2,13 coefficient, was around 280 390 tons in 2003. This production level put Poland to the second rank of the new European Union, behind Spain and ahead France. The Polish Parliament adopted a new law granting a tax exemption for the production of ethanol mixed with petrol in November 2003. The definitive percentages and the size of this exemption are determined on a yearly basis after approval of the annual budget (EurObserv`er 2004b).

Table 6-3: Ethanol (Et-OH) and ETBE production in the EU 25 (2003) (Schmitz 2003, ZSW 2004, EurObserv`er 2004b)

	France	**Spain**	**Sweden**	**Czech Republic**	**Poland**
Ethanol and ETBE production in EU in 2003 (EurObserv`er 2004b)	77.200 t (Et-OH) 164.250 t (ETBE)	180.000 t (Et-OH) 383.400 t (ETBE)	52.300 t (Et-OH)	5.000 t (Et-OH)	131.640 t (Et-OH) 280.390 t (ETBE)
Used raw material (Schmitz, 2003: 2001 data)	ca.75% sugar beet ca. 25% wheat	100% barley and wheat	100% wheat	No data available	No data available
Price for ethanol (Schmitz, 2003: 2001 data)	Ca. 400-500 €/m3	Ca. 400-500 €/m^3 (estimated)	Ca. 500-650 €/m^3 (estimated)	No data available	No data available

6.3.2 Costs for fuel production from biomass

The Commissions´s Communication on "Alternative fuels for road transportation and on a set of measured to promote the use of biofuels" (COM(2001)547) quotes costs of the order of €500/1000 litres for biofuels, compared with €200-250/1000 litres for oil-based fuels at USD30/barrel. Due to current changes in fossil fuel prices, the differences between biofuels and fossil fuels have altered.

CIEMAT, Spain, public research facility on energy, the environment and technology, have developed a bioethanol production process using cereal straw making it possible to reduce raw material product costs by half. This process can be used to produce 1 litre of ethanol with 6kg of straw for 18 c€, while 3 kg of wheat or barley, i.e. at a cost of 36 c€, are needed to produce the same amount. This price drop would make biofuel competitive with petrol. This research project should soon lead to a production plant in Salamanca.

Further economic data are provided in chapter 9 Economics and market prices.

6.3.3 Potentials and technologies for biofuel production

Table 6-4 gives an estimate on the potential for biofuel production in the EU.

Table 6-4: Potential for liquid biofuel production in the EU (Specht, 2004)

	EU -15	**EU - 27**	**World**
Consumption of transportation fuels [EJ/a] 1999	10,5	12,0	70,2
Biomass Potential [EJ/a]	6,8	8,9	104,0
Unused biomass potential [EJ/a]	4,6	6,9	63,8
Substitution potential [EJ/a]	1,2	2,1	19,1
Substitution potential [%]	11	18	28

Other liqueurs resulting from the paper pulp industry. This substance contains glucose that can be fermented and distilled. However, the amount of liqueur available limits ethanol production using this process. Another technology consists of producing ethanol from raw cellulose coming from different woods, straw or bagasse. In order to experiment this process, Sweden has built a pilot facility for producing ethanol from raw cellulose in Örnsköldsvik that's been operational since May 2004.

7 Utilisation of biomass for non-energetic applications

7.1 Biomass resources for non-food and raw material utilisation

Biomass is used in a lot of different applications in the non-food and raw material utilisation sector. The main resources are wood (for furniture, pulp and paper) and different products from agriculture.

Figure 7-1 gives an overview on total round-wood production within the EU 25. Round-wood production (the term is used as a synonymous term for „removals“) comprises all quantities of wood removed from the forest and other wooded land or other felling site during a certain period of time. A principal distinction is made into fuel-wood and industrial round-wood.

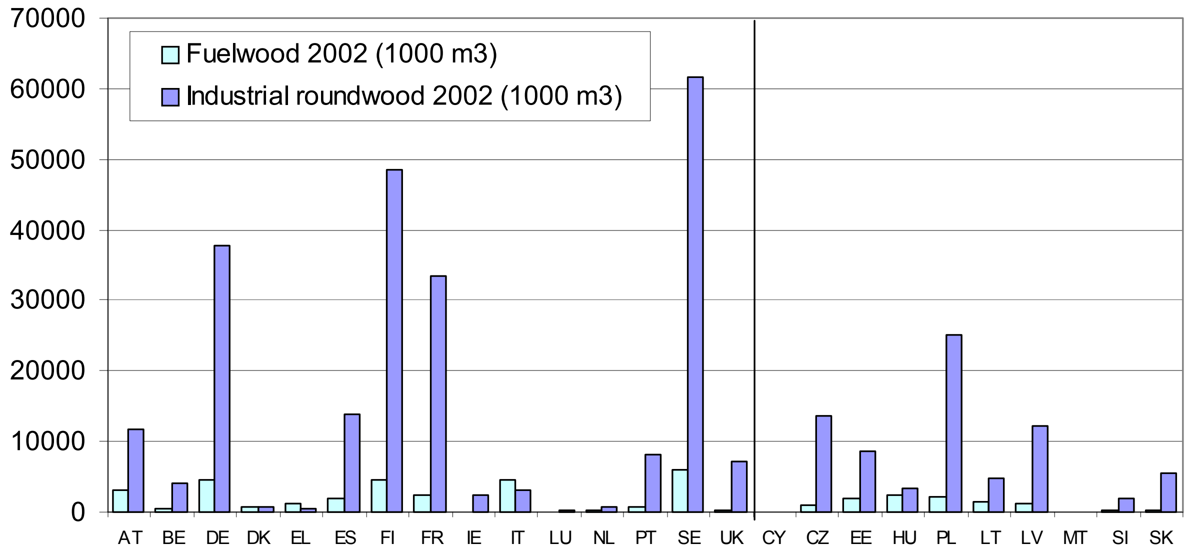

Figure 7-1 Removals by round-wood category, year 2002 (EC, 2003)

Total removals for the whole EU 25 added up to 350 million cubic meters in the year 2002. According to (Schuck, van Brusselen, 2004) the increase in fellings and also removals is the highest in the new Member States. Removals here increased around 4.5 percent in the period 2001-2002 (86 million cubic meters in 2002), compared to an increase of around 2 percent in the old Member States that was for large part the effect of extraordinary removals after the disastrous storm damages in the year 2000 (265 million cubic meters in 2002).

In the EU 25, the consumption of round-wood is higher than the production (i.e. removals) and consequently the region is a net importer of round-wood.

In the year 2002, round-wood consumption in the EU 25 area amounted to about 374 million cubic meters. The new Member States are net producers, with removals being 16 percent higher than consumption. They thus contribute positively to the round-wood trade balance of the Union as a whole. Eighty-eight percent of the round-wood consumed in the old Member States is harvested within the EU 15 region.

Industrial round-wood is divided into three categories, which characterise the final use to which wood is attributed: Sawlogs/veneer logs, Pulpwood and Other industrial round-wood (includes round-wood that will be used for poles, piling, posts, fencing etc.) (Figure 7-2).

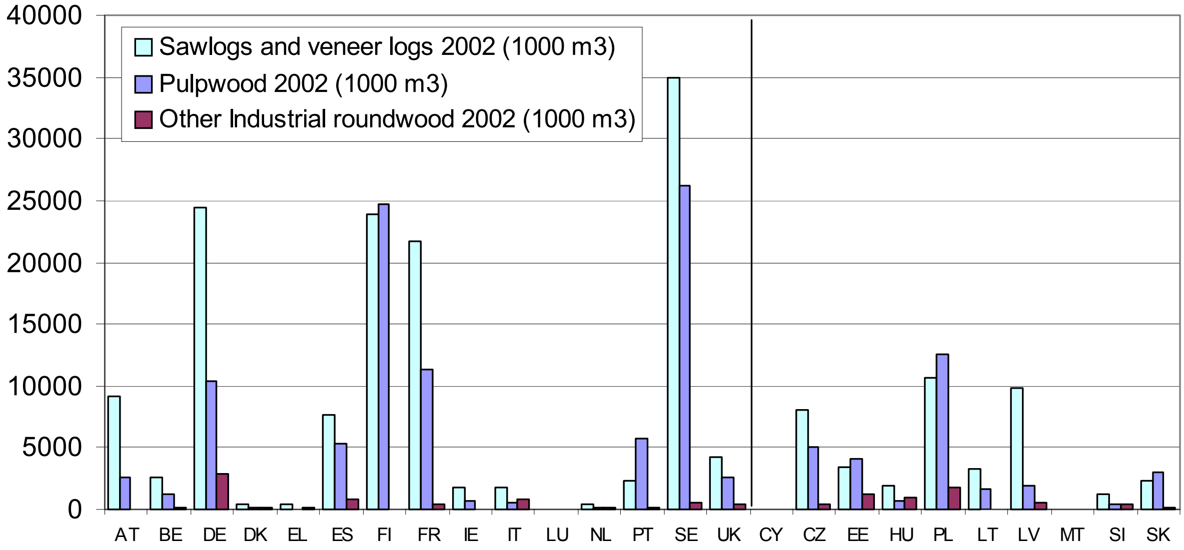

Figure 7-2 Removals of Industrial round-wood by round-wood assortment (EC, 2003)

Sawlogs/veneer logs and pulpwoods are the main roundwood assortments from EU 25 forests. Whereas for some countries clear preferences can be identified (e.g. Sawlogs/veneer logs for Germany, Austria, France of Latvia) other countries are more balanced according to their assortment (e.g. Finland, Poland).

Nevertheless, it has to be taken into account, that the assortments presented above may undergo secondary non-energetic utilisations (e.g. sawmill residues for production of wood chipboards) or final energetic utilisations.

Table 7-1 gives an exemplary general overview on areas of non-food crops in Europe (EU 15). Oilcrops play the most important role within EU 15 and can be used for energetic as well as non-energetic options.

Table 7-1: Areas of Non-Food Crops in Europe (1998) (Askew, 2003)

	Hectares
Linseed	314 000
Oilseed (on set-aside for industrial use)	408 000 Rape: 340 000, Sunflower: 68 000
Fibre Flax	170 000

Hemp	39 000
Short Rotation Coppice	19 000
Total	915 000

7.2 Share of biomass raw material in the production process

Table 7-2 gives an overview on the main market for renewable materials within the EU 15 with a focus on cultivated crops. Additionally an outlook on future potential market penetration is given. The current approximate market for renewable raw materials differs clearly. In total numbers lubricants from renewable materials contribute to the EU market with a total amount of 100 000 tonnes (year 1999). The market penetration share however is only 2 %. In contrast, within surfactants applications renewable raw materials contribute 460 000 tonnes to the EU market. This corresponds to a current market penetration of 20 %.

Table 7-2: Main markets for renewable raw materials within the EU 15. The total potential market penetration is a rough estimate taking into account technical and political feasibility over a ten to twenty years´ perspective. (RRM: Renewable Raw Materials) (Askew, 2003)

Application area	Total current EU market (`000 tonnes)	Current approximate market for RRM (`000 tonnes)	Current market penetration (%)	Approximate total potential market for RRM (`000 tonnes)	Approximate total potential market penetration (%)
Polymers	33 000 (1998)	50 (1997)	0.15	300	1
Lubricants	5 000 (1999)	100 (1999)	2	1 000	20
Solvents	4 000 (1999)	60	1.5	235	12.5
Surfactants	2 300 (1998)	460	20	2 300	100
Fibres/Comp.	Na	90	Na	Na	Na

The market for the use of biomass for non-energetic purposes is important, however extremely wide and diversified. For reasons of concentration a detailed description and analysis is not possible in this study. For detailed market description for the EU 15 and EU+10 therefore see the National reports for the Interactive European Network for Industrial Crops and their Applications (IENICA) (http://www.ienica.net//). Additional information is given by (Ehrenberg, 2002).

8 The future potential of biomass in the EU 25

The assessment of biomass future role potential in the EU 25 takes into account the biomass resource potentials in the EU 25 countries (biomass availability). Additionally, the possible future progress in technology as well as political frame conditions or expected biomass supply and demand are important aspects determing the possible future role of biomass. Furthermore, for various biomass sources (e.g. energy crops on agricultural land) competing options for energetic resp. non-energetic utilisations have to be considered.

The data for this assessment will be taken from a literature review on biomass potential in the EU 25 resp. on bioenergy´s role in the EU energy market (Nikolaou et al. 2003, Reiche 2003, Siemons et al. 2004, Ragwitz et al. 2004, Thrän et al. 2004). The results of the study from (Siemons et al., 2004) will be set as a main reference. The reason is that this study is already finished and published (which is not the case for (Thrän et al., 2004) and (Ragwitz et al., 2004)) and that detailed information has been elaborated for each of the EU 25.

According to (Siemons et al., 2004) the following main conclusions for the utilisation of biomass can be summarised:

- **Biomass potential for the EU 15 amounts to 131 Mtoe/year in the year 2000 growing by more than 30% up to 172 Mtoe/year in the year 2020. For the EU+10 (plus BG and RO), the availability for 2000 is 28 Mtoe increasing to 38 Mtoe/year in 2020. This yields an overall potential in the EU 25 of presently 159 Mtoe/year and 210 Mtoe/year in 2020.**
- **Forestry by-products, (refined) wood fuels and solid agricultural residues have been identified as the most important biomass resources for the years 2000 up to 2020. This is the case for the EU 15 as well as for the EU+10 (plus BG and RO).**
- **The assessment of biomass future role potential shows that refined wood fuels, forestry by-products and solid industrial residues (mainly from the secondary wood processing industries) which are already important resources, are of growing importance. Additionally, the role of agricultural residues is growing. Furthermore, international trade will play an important role.**
- **For production of solid energy crops and transport fuels, it has been assumed that the current set aside area (about 10 % of arable land) is available.**

In the following, more detailed information will be given on the future role of biomass for energetic and non-energetic utilisation.

8.1 Energetic utilisation

Biomass availability i.e. the available resource potential and the future role of biomass within the EU 25 will be discussed according to (Siemons et al., 2004), who used an energy model called SAFIRE.

8.1.1 Biomass availability

Table 8-1 gives an indicative overview on the availability of bioenergy in the EU 25 plus Bulgaria and Romania as calculated by (Siemons et al., 2004). The biomass potential for each country has been identified based on the technical resource potentials (i.e. total production of all resources, given no economic limits) minus the amount of biomass which is not available for various reasons (e.g. because of technical, physical, environment, agronomic, silvicultural limits).

Table 8-1: Availability of bioenergy in Europe in 2000, 2010 and 2020 (Mtoe/year) (Siemons et al., 2004)

	EU 15			EU+10, (incl. BG, RO)		
	2000	**2010**	**2020**	**2000**	**2010**	**2020**
Tradeables:	**86**	**93**	**101**	**21**	**22**	**24**
Forestry byproducts & (refined) wood fuels	34	38	42	7.9	8.7	9.6
Solid agricultural residues	25	28	31	7.3	8.1	8.9
Solid industrial residues	11	12	13	2.1	2.4	2.6
Solid energy crops [1]	16	16	16	3.2	3.2	3.2
Non-tradeables:	40	53	66	7.1	9.4	13
Wet manure	11	12	13	3.4	3.8	4.2
Organic waste						
- Biodegradable municipal waste	6.7	17	28	0.5	2.5	5.7
- Demolition wood	5.3	5.8	6.4	0.6	0.6	0.7
- Dry manure	1.9	2	2.3	0.4	0.4	0.5
- Black liquor	9.9	11	12	0.7	0.8	0.9
Swage gas	**1.7**	**1.9**	**2.1**	**0.4**	**0.4**	**0.5**
Landfill gas	4	3.8	2.1	1.1	0.9	0.4
Transport fuels:	4.9	4.9	4.9	0.8	0.8	0.8
Bioethanol [1]	**3.7**	**3.7**	**3.7**	**0.5**	**0.5**	**0.5**
Biodiesel [1]	**1.2**	**1.2**	**1.2**	**0.3**	**0.3**	**0.3**
Total bioenergy	131	151	172	28	32	38

1 it is assumed that 50 % of the set-aside area is available for solid energy crops and 25 % each for biodiesel and bioethanol

In 2000 the biomass availability for the EU 15 amounts to 131 Mtoe/year with a grow up to 172 Mtoe/year in the year 2020. For the EU+10 plus BG and RO, the availability for 2000 is 28 Mtoe increasing to 38 Mtoe/year in 2020.

- Forestry by-products, (refined) wood fuels and solid agricultural residues have been identified as the most important biomass resources for the years 2000 up to 2020. These raw materials represent more than 40 % of the available biomass resources for the EU 15 and about 50 % of the biomass raw materials for the New member States (incl. BG and RO). Additionally, solid industrial residues, solid energy crops and wet manure show considerable amounts which range between 11 and 16 Mtoe for the EU 15 (year 2000) and between 2.1 and 3.4 Mtoe for the EU+10 (plus BG and RO).
- For production of solid energy crops and transport fuels, it has been assumed that the current set aside area (about 10 % of arable land) is available. 50 % has been set to be available for solid energy crops and 25 % each for raw materials for biodiesel and bioethanol. This results in an availability of 16 Mtoe/year within the EU 15 and of 3.2 Mtoe/year for the New member States for the year 2000 as well as for 2020. However, varied assumptions on available agricultural area will result in varied availabilities. Additionally, the data presented disregard import possibilities.
- The most important growth occurs for biodegradable municipal waste. This is a result of the EU wide implementation of the EC directive on the landfill of waste (1999/31/EC), discouraging the landfilling of biodegradable waste and prescribing a time schedule to reduce this manner of waste disposal to a specific level. For the EU 15 availability will

rise from 6.7 Mtoe in 2000 to 28 Mtoe in 2020. For the EU+10 (plus BG and RO) an availability of 0.5 Mtoe in 2000 and of 5.7 Mtoe in 2020 has been identified.

Following, detailed country data will be provided exemplary for those biomass resources which have been identified as the most relevant according to their availability.

Forestry by-products and (refined) wood fuels

Figure 8-1 shows that there are clear differences among the EU 15 countries according to the available resources on forestry by-products and refined wood fuels.

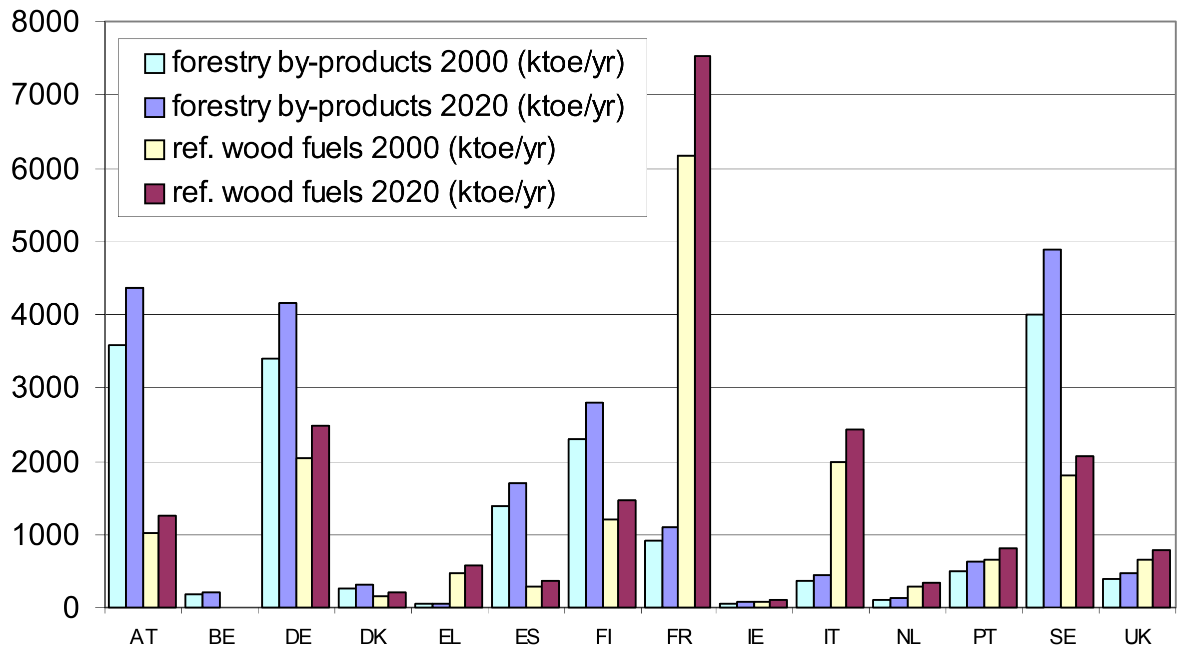

Figure 8-1 Availability of forestry by-products and of refined wood fuels in the EU 15 (in ktoe/year) for 2000 and 2020 (Siemons et al., 2004) (no data for Luxembourg)

Sweden, Austria, Germany and Finland play an important role according to the provision of forestry by-products.

Refined wood fuels are defied as pellets, briquettes and other such solid wood fuel products which are made from residues from the forestry sector and the wood processing industry. The data in Figure 8-1 for the EU 15 should not be regarded as limited numbers, as in the eventually forestry residues and solid industrials residues can also be used to produce refined wood fuels. Within the EU 15, France has been identified as main actor providing more than 6000 ktoe/year in 2000.

For the new member states no separate figures are given on forestry residues and wood fuels. Thus combined figures are presented in Figure 8-2. In these countries a large part of the wood fuels originate directly from forest residues, contrary to refined wood fuels used in the EU 15. Within the EU+10 Poland, Latvia, Lithuania and Estonia are identified as the main wood fuel actors.

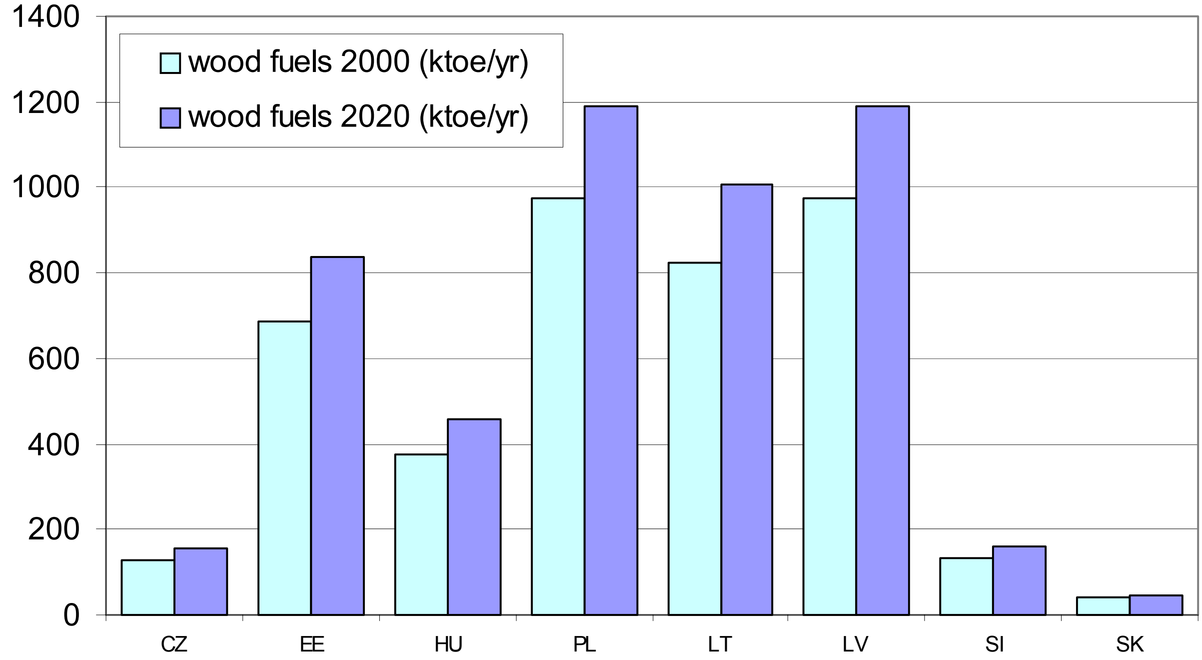

Figure 8-2 Availability of forestry by-products and of refined wood fuels (combined data) in EU+10 (in ktoe/year) for 2000 and 2020 (Siemons et al., 2004) (no data for Cyprus and Malta)

Solid agricultural residues:

Residues from crops that cover over 1 % of the total Utilized Agricultural Area in EU 15 and produce dry lignocellulosic residues (moisture content < 50 %) were considered.

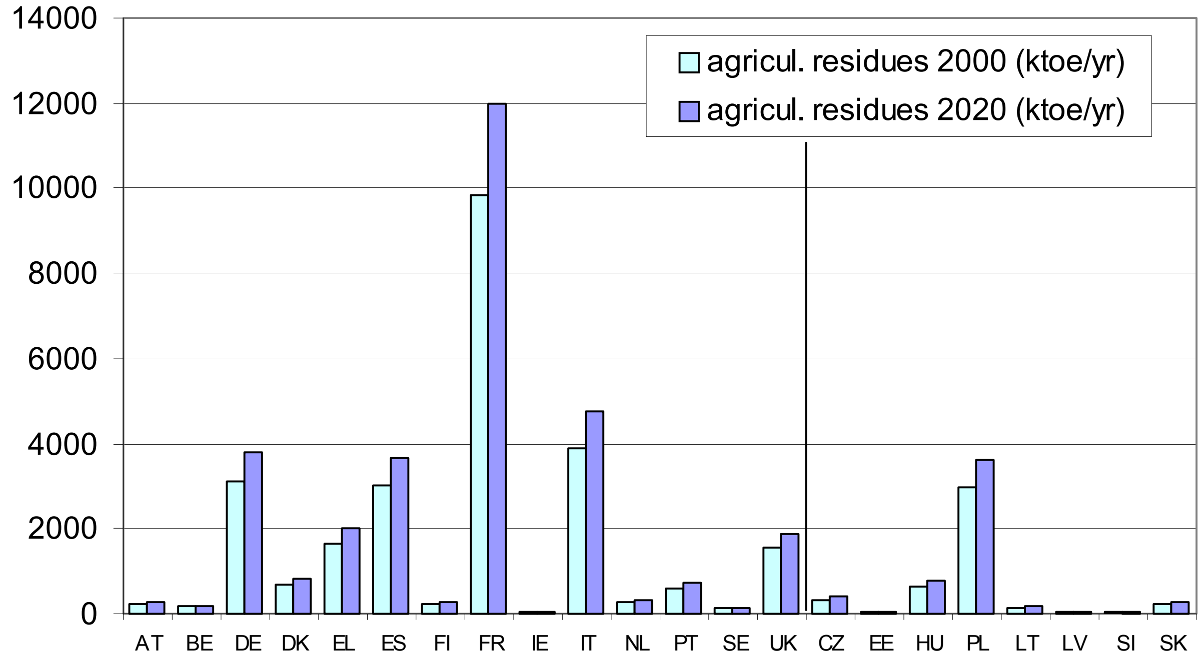

Figure 8-3 Availability of solid agricultural residues in the EU 25 (in ktoe/year) for 2000 and 2020 (Siemons et al., 2004) (no data for Luxembourg, Cyprus and Malta)

The technical potential of these crop residues was estimated on the basis of cultivated area or agricultural production for each crop in each country, for the year 2000 and average product to residue rations or residue yields derived from literature. Based on this data, an availability factor has been set of 30 % for all agricultural field residues under consideration. This takes into account, that several technical, environmental and economic factors exists, which prevent that the technical potential is used completely (Siemons et al., 2004).

Figure 8-3 are in line with the data on utilized agricultural area given for each country in Figure 5-3. However, yield differences have to be taken into account. Thus, availability of agricultural residues within EU 15 is prevailing in France, Germany, Spain and Italy. For the EU+10, Poland shows a potential which is comparable to those countries.

Solid industrial residues:

Solid industrial residues consist mainly of clean wood fractions form the secondary wood processing industry. These residues are often already dried and are released at a central location, which reduces logistic and pre-treatment costs. Wood industries already uses part of these residues for heating purposes like space heating and wood drying. Some residues like sawdust are suitable for wood pellet production.

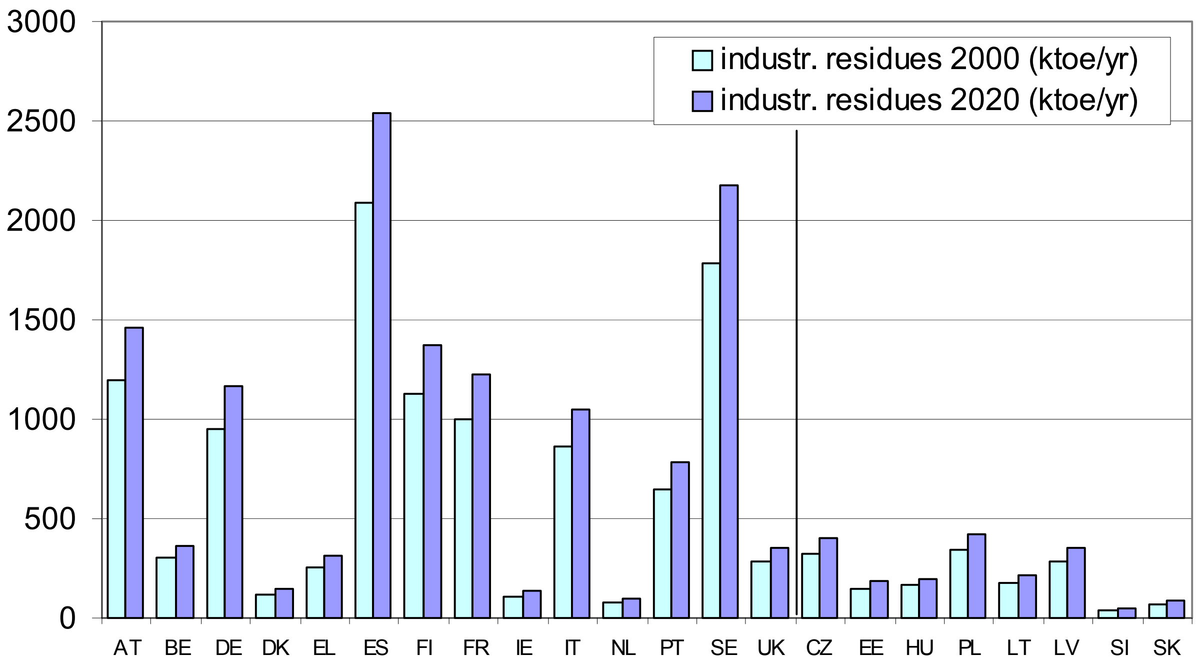

Figure 8-4 Availability of solid industrial residues in the EU 25 (in ktoe/year) for 2000 and 2020 (Siemons et al., 2004) (no data for Luxembourg, Cyprus and Malta)

Figure 8-4). No main actor may be identified for the EU+10 although Poland, the Czech Republic and Latvia are most important. (

Solid energy crops:

(Siemons et al., 2004) based the data on availability of energy crops on information on the land set-aside under the two set-aside schemes of the Common Agricultural Policy (voluntary and compulsory set-aside). For the new member states information was collected for the agricultural land that is left idle. It was assumed that 50% of the set-aside land is available for solid energy crops and that this figure remains stable up to 2020. The assumption of linking energy crops availability to set-aside serves to get an impression of the potential of this resource, relative to other resources. The percentage of agricultural area which has been identified for energy cropping differs between 1 and 10 % for the EU 15 countries and 1 and 20 % of the arable land for the EU+10 (**Table 8-2**).

Table 8-2: Set aside land of total arable land (%) in the EU 25 (no data for LU, CY and MT)

AT	BE	DE	DK	EL	ES	FI	FR	IE	IT	NL	PT	SE	UK	CZ	EE	HU	PL	LT	LV	SK	SI
8	3	10	9	1	10	8	8	3	3	2	4	10	10	2	20	4	1	10	15	2	6

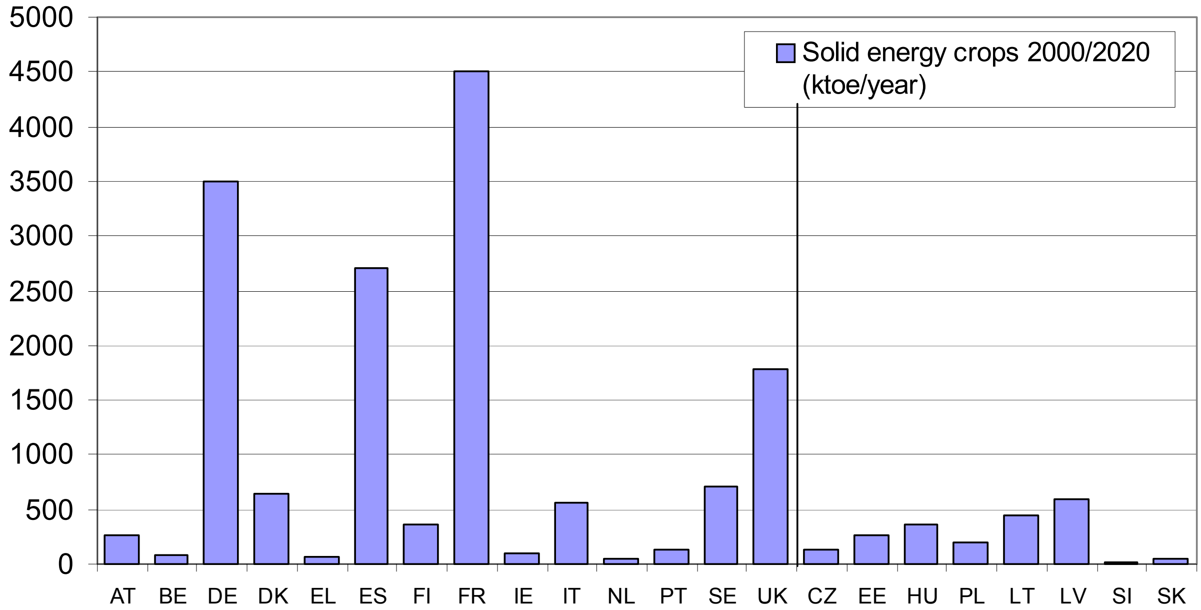

Figure 8-5 Availability of solid energy crops in the EU 25 (in ktoe/year) for 2000 and 2020 (Siemons et al., 2004) (no data for Luxembourg, Cyprus and Malta)

As the availability of energy crops is linked to the current set aside area taking into account the yield potential for each country, the data in Figure 8-5 gives a very manifold picture. Solid energy crops cultivation dominates within France, German, Spain and the United Kingdom. For the EU+10 Latvia, Lithuania and Hungary provide energy potentials of 360 to 600 ktoe per year.

Please note, that the approach presented here only is one possibility for calculation of potential. (Thrän et al., 2004) e.g. calculate the technical potential for energy crops for supply and the production of energy crops. Thus costs/prices for energy crops play an important role determining the available energy potential compared to other options of biomass production on the available agricultural area.

Wet manure:

The average volume of faeces and urine largely differ from one type of animal to another and mainly depends on their age and liveweight. (Siemons et al., 2004) referred to mean values taken from literature. Additionally, with regard to the possibilities for collection and energy use of the manure (in view of keeping animals outdoors, or in small farms), it has been assumed that only 50 % is considered available for energy production.

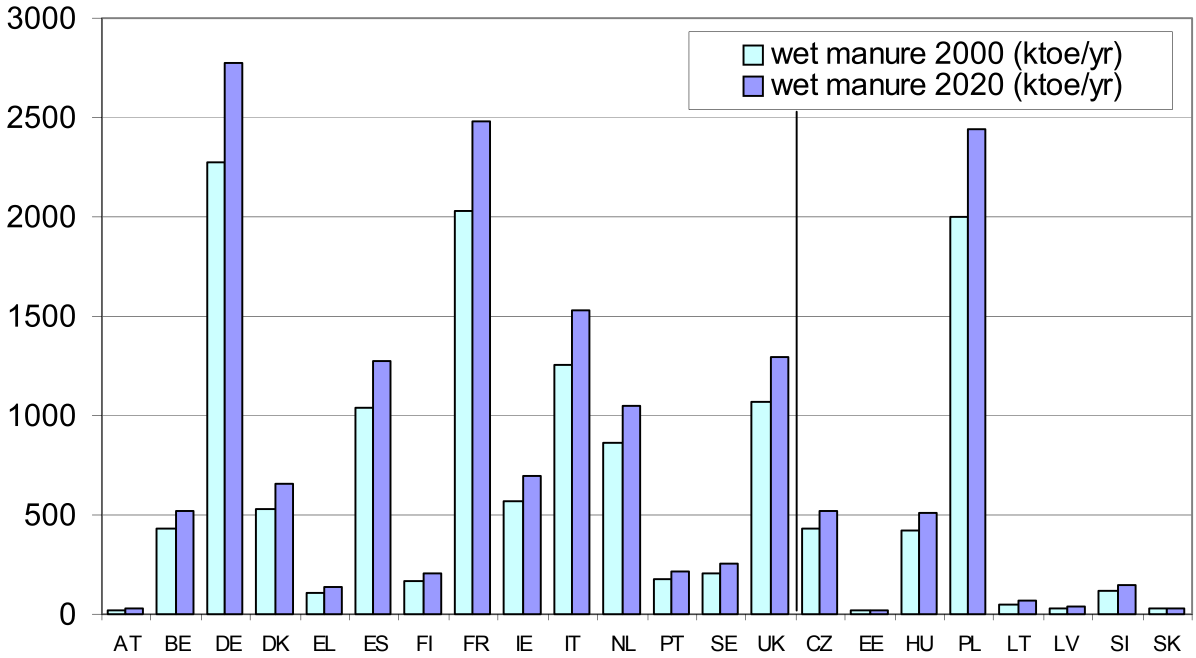

Figure 8-6 Availability of wet manure in the EU 25 (in ktoe/year) for 2000 and 2020 (Siemons et al., 2004) (no data for Luxembourg, Cyprus and Malta)

Wet manure availability within the EU 25 is dominated by Germany, France and Poland. The energy potential for those countries has been identified to be about 2000 ktoe/year for Poland and France and about 2300 ktoe/year for Germany in 2000 (Figure 8-6).

Biomass future role potential

Based on the SAFIRE model certain scenarios have been calculated to assess biomass future role potential.

Figure 8-7 and Figure 8-8 exemplary illustrate results for a scenario on biomass availability and utilisation in 2020 for EU 15 and EU+10 (Siemons et al., 2004). For both country groups availability and share of utilisation is highest for forestry by-products/refined wood fuels and solid agricultural residues.

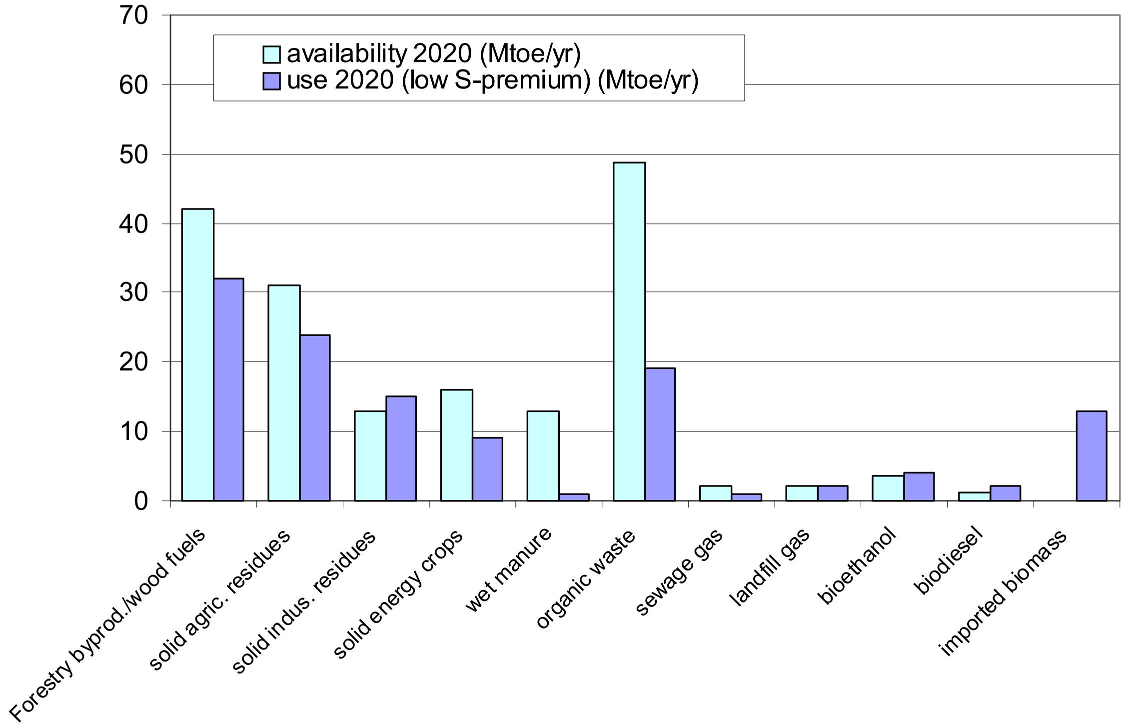

Figure 8-7 EU 15: Availability and use of biomass in 2020. Scenario: Technology Base Case, Low Sustainability-Premium (in Mtoe/year) (Siemons et al., 2004) (no data forLux.)

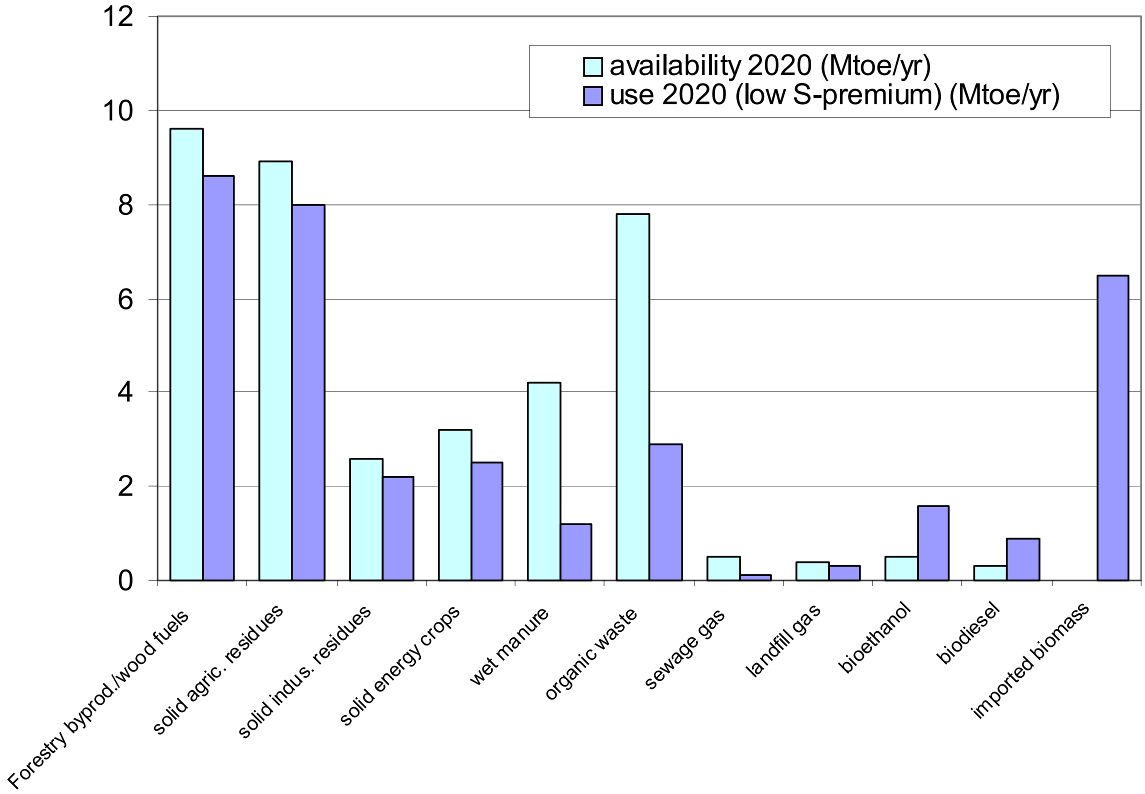

Figure 8-8 EU+10: Availability and use of biomass in 2020. Scenario: Technology Base Case, Low Sustainability-Premium (in Mtoe/year) (Siemons et al., 2004) (no data for Cyprus and Malta, including data for BG and RO!)

8.1.2 Conclusions on the future role for biomass in the EU 25

The following main conclusions on the future role of biomass within the EU 25 have been drawn by (Siemons et al., 2004, p. 163ff) from the various scenarios.

Tradeables:

Refined wood fuels, forestry by-products and solid industrial residues (mainly from the secondary wood processing industries) are already an important resource, and their relevance is growing. Solid agricultural residues, such as wheat straw, are a major source of biomass fuels that is still underutilised in most countries. There are several technical difficulties related to this resource (e.g. excessive corrosion in heat exchangers), and agricultural residues are released seasonally. This makes careful planning of logistics and storage necessary. In all countries biomass imports are expected by 2020. If low sustainability premiums are continued to be applied, imports are necessary in 2010. Without international trade in biofuels, bioenergy´s role remains very limited. If sustainability premiums become high, import provides most in the growth of bioenergy.

Non-tradeables:

Wet manure is abundantly available. However, this resource has a low energy density. It cannot be transported cost-effectively and needs to find applications virtually on a farm scale. At such relatively small scales of application, capital costs involved remain high. This is why wet manure contributes only little to achieving targets set for bioenergy. Of course, there is a level of sustainability premium which makes the energy conversion of wet manure attractive.

Organic waste forms a substantial part of the bioenergy resource of the EU 25. The implementation of the landfill directive redirects biodegradable municipal waste from landfill towards other purposes, mainly incineration with energy recovery, and as a result the potential of this resource increases considerably. The modelling shows, that this resource may play an important role in the consumption of bioenergy. At the same time, the potential of sewage gas and landfill gas stabilises on a low level.

Transport fuels:

The consumption of energy crops for transport fuels does not increase much in the scenarios of fixed sustainability premiums, even if values of as high as 100 €/tonne CO_{2eq}. are applied. In the analysis, no other incentives than the sustainability premiums were applied to any of the transport biofuels. Tax exemptions, such as employed in several countries were not applied in the scenarios. Note that a tax reduction of about 0.10 €/litre for biodiesel and ethanol, corresponds to sustainability premiums of 50 and 90 €/$tonne_{CO2,}$ respectively.

International trade:

The scenarios simulated the option of international trade (intra Europe and also imports into the EU). A standard price of 6 €/GJ was applied for which large imports are possible. In both the low and high sustainability premium scenarios most of the growth of bioenergy´s role in 2020 is possible because of this type of trade. As it appears, imports will be most relevant in the following countries (under the low sustainability-premium scenario): Germany, Belgium, Greece, the Netherlands, Denmark and the United Kingdom.

Trade flows can only develop for derived biofuels of high densities. Examples are bioethanol and pellets. Also shipping (rather than road or rail transport) seems a general prerequisite. Transporting pellets by road over a distance of 300 km can be more expensive than their transport over 10.000 km by means of a bulk carrier.

8.2 Non-energetic utilisation

Assessment of biomass availability and biomass future role potential for non-energetic utilisation will be presented for wood/forest and cultivated crops separately.

8.2.1 Cultivated Crops

Significant market opportunities for bio-renewables were identified in the oils, fibers, carbohydrates, and speciality product sector although degree of exploitation was variable between EU member states (Askew, 2002).

Table 7-2 already presented an estimate of the potential market penetration and amounts of production with regard to an ten to twenty years´ perspective (i.e. 2010. 2020). It is estimated that surfactants from renewable raw materials may become a dominant role with a total potential market penetration of 100 %. Lubricants and solvents based on renewable raw materials may have a market penetration share of 20 % resp. 12.5 %. The role of polymers on renewable basis remains small with about 1 % market penetration.

(Askew, 2003) also gives some numbers on savings in greenhouse gas emissions under various market scenarios (**Table 8-3**).

Table 8-3: Savings in greenhouse gas emissions (expressed as CO_2-equivalents) under various market scenarios. Secondary savings e.g. from fuel savings or recycling are not shown (Askew, 2003)

Application area	Current market penetration (%)	Current savings in GHG emissions (`000 tonnes)	Approx. total potential market penetration (%)	Approx. total potential additional savings in GHG emissions (`000 tonnes)
Polymers	0.15	100	1	600
Lubricants	2	200	20	2 000
Solvents	1.5	-	12.5	max. 1 000
Surfactants	20 [a]	1 700	50-100 [c]	2 000
Fibres/Comp.	[b]	[b]	[b]	[b]
		2 000		5 600 [d]

[a] of which 16 % is derived from vegetable oils and 4 % from animal oils and fats.
[b] very difficult to assess
[c] a clear over-estimation of today´s technical potential, but one that possibly could be achievable over a longer time perspective. For calculations of potential additional GHG savings, a somewhat more conservative market penetration potential has been used.
[d] which corresponds to about 1.5 % of the EU Kyoto commitments.

Nevertheless, raw materials cultivated on agricultural areas will face competition with regard to food and energy crops cultivation (see chapter 13). Biomass future role potential is framed by the growing competition between the various utilisation paths and the broad range of crops for cultivation.

8.2.2 Forest wood

No comprehensive data on forest wood future role potential within the EU 25 will be given. This is among others due to international trade as well as to competing utilisation paths. For forest wood non-energetic and energetic utilisation pathes are competing as described in chapter 13.

(Schuck, van Brusselen, 2004) compared growing stock, increment and felling within the EU 25:

The EU 25 is stocked with around 20 billion cubic meters. Twenty-five percent of this stock grows in the new Member States. The highest amount of **growing stock** per hectare can be found in Central Europe, where the growth conditions are more favourable (e.g. in Austria, Slovakia and Slovenia). The average growing stock in new Member States is 211 cubic meters per hectare, being considerably higher than the 140 meters per hectare in the old Member States. The growing stock is forecast to keep growing for the coming years in absolute terms as well as relative to the forest area - despite increasing pressures from market-demand for wood products.

A large amount of wood stocks are available in the European forests. The picture on the availability of forest resources can be complemented with the ratio of the amount of fellings over the net annual increment. This ratio allows to prospect, however limited, the sustainability of the utilisation of forest resources.

Such comparison shows that the net annual increment is higher than felling levels. In the old Member States, the yearly fellings (302 million cubic meters) amount to about 62.5 percent of the net annual increment (483 million cubic meters). In the new Member States this ratio is slightly higher, i.e. 64.8 percent (125 million cubic meters of net annual increment and 81 million cubic meters of annual fellings). On average for the EU 25 the ratio is 63.0 percent. The usefulness of such data are however limited as (1) actual availability of timber for felling may differ between countries and (2) the concentration of the harvest may be limited only to specific areas within a country.

The UN-ECE/FAO European Forest Sector Outlook Studies forecast that for the next twenty years, the ratio will increase to high levels but that it will stay well below 100 percent.

Part II: POLICY ACTIONS AND MARKET INTERVENTION MEASURES

9 Proposals on policy actions to increase the use of biomass as a raw material

9.1 Current policy actions and measures

To reach the economic competitiveness of renewable raw materials the EU and different national and regional governments have launched funding/promotion programmes. Some of these only concern renewable raw materials, others aim at the general funding of innovative and/or environmentally more compatible technologies. As an example some promotion schemes in Germany will be described a little more in detail.

The most important funding programmes and institutions are:

- European Commission
- Federal governments
- Regional and municipal governments
- Banks and financial institutes (KfW)
- Other Funding Institutions

In the following policy measures to increase the use of biomass as a raw material are described.

9.2 International Agreements

An important funding institution is the European Framework Program for Research and Technological Development. Promotion of Research and Development as well as net-working project. It includes the sector of Renewable Materials.

Currently, a number of trade or other restricting arrangements impact upon the full exploitation of bio-renewable crop products.

Perhaps the most obvious, because of the interest in development of oleaginous crops, has been that of the EC/US Oilseeds Agreement, commonly called 'Blair House Agreement'. This currently limits expansion of oilseeds in both the food and non-food sectors in EU.

Discussions under WTO roles will address this issue. Equally, WTO discussions will impact upon the way aid is paid to agriculture and the rural economy within EU and that in turn could lead to removal of price distortions between food and non-food produce. This development would considerably aid developments in the non-food sector for oilseeds and cereals.

Current discussions on revision of EC Regulation 2704/1999 are considered by industry at large to be bureaucratic and unhelpful.

9.3 Impact of EC Policy and the reformed Common Agricultural Policy (CAP)

Key elements of the CAP reform are:

- A single farm payment for EU farmers, independent from production; limited coupled elements may be maintained to avoid abandonment of production,
- this payment will be linked to the respect of environmental, food safety, animal and plant health and animal welfare standards, as well as the requirement to keep all farmland in good agricultural and environmental condition ("cross-compliance"),
- a strengthened rural development policy with more EU money, new measures to promote the environment, quality and animal welfare and to help farmers to meet EU production standards starting in 2005,
- a reduction in direct payments ("modulation") for bigger farms to finance the new rural development policy,
- a mechanism for financial discipline to ensure that the farm budget fixed until 2013 is not overshot,
- revisions to the market policy of the CAP:
- asymmetric price cuts in the milk sector: The intervention price for butter will be reduced by 25% over four years, which is an additional price cut of 10% compared to Agenda 2000, for skimmed milk powder a 15% reduction over three years, as agreed in Agenda 2000, is retained,
- reduction of the monthly increments in the cereals sector by half, the current intervention price will be maintained,
- reforms in the rice, durum wheat, nuts, starch potatoes and dried fodder sectors.

The legal texts were formally adopted at the Agriculture Council of September 2003.

For energy plants a single payment on the basis of area of 45 EUR/ha is paid since 2004.

Whilst there has been no specific EC policy to aid or extend the development of all plant-derived non-food products, some non-food crop species do benefit from aid (eg hemp and flax under [Reg 1308/70]; linseed under [Reg 569/76, 1774/76 and 1774/76]; high erucic acid rapeseed under [Reg 1204/72]. EC-funded regimes exist in several EU member states for starch potatoes [Reg 1868/94].

Controls on production of cereals, oilseeds (oilseed rape, sunflower and soya bean) and pulses (peas, beans), have been exercised through set-aside regulations (Reg EC 2461/99). A large number of crop plants can be grown on set-aside land (see annex II) and receive set-aside aid. Clearly, this arrangement has provided an opportunity for development of non-food crops, although the fact that set-aside area has varied considerably on a year to year basis has made production unstable. Additionally, for true sustainability, non-food crops or products must be viable in their own right.

Agenda 2000

Under the changes to the CAP agreed proposed in Agenda 2000 and agreed in the Berlin Compromise, support prices will be reduced and direct payments to farmers increased to help compensate for the price cuts. There will be a new rural development policy. In principle this could provide the basis for a shift of emphasis from production support towards environmental and rural development measures in the future. However, only very limited additional funds are to be made available for these purposes.

In the arable sector, the area payment for all crops will rise in two stages to 63 euro/t in 2001 converted to an area payment at the cereals reference rate and may increase further in 2002 if the Council of Ministers decide to make a further cut in the intervention price for cereals in that year. There are exceptions, which include oilseeds and linseed. For oilseeds, payments will fall to the standard rate, which applies from 2002 onwards with interim rates of 81.74 euro/t in 2000 and 72.37 euro/t in 2001. Maximum Guaranteed Area penalties may apply in 2000 and 2001 but in the event of this happening payment cannot be less than the 63 euro/t in 2001, falling to the standard rate from 2002 onwards.

Compulsory set-aside will be retained and the default rate for 2000-2006 is fixed at 10%. The European Commission and Council of Ministers will still be able to set a different rate each year if they agree to do so. Voluntary set-aside arrangements land will continue. Set-aside payments may be granted on a multi-annual basis for a period of up to five years. At the time of writing, it was anticipated that the present provision allowing farmers to put all of their land into set-aside if it is used for biomass production will be maintained.

The new rural development regulation recognises that rural development and environment should be supported as an integral part of the reformed Common Agricultural Policy (CAP). The development of non-food crops is included within the scope of the regulation as are other measures relating to the conversion and diversification of farming activities. The regulation specifically provides for a planting grant for crops such as short-rotation coppice, and may provide a basis for assisting *Miscanthus*, subject to including this in the UK's rural development plan and securing funding.

9.4 Proposals

Proposals will be summarised concerning policy actions to increase the use of biomass as a raw material in the industrial process and extend the range of possible uses. The proposals are taken from (Askew, 2002) who based his conclusions on the results of the IENICA-project (for more detailed information see e.g. (Askew, 2002) and (IENICA):

Actions needed at EU Level. Six Priority Areas were identified:

1. EC regulation is not well focused in terms of non-food crops. There is a need to develop and promulgate a clear concise long-term strategy for non-food crops and products. This requires co-ordination and pro-activity between DGs Agriculture, Environment, Energy, Industry, and Research. There must be a requirement laid upon EC/EU administration to de-

velop a coherent strategy for non-food products from plants and act in concert with it when regulations are revised or proposed. Anomalies in EC regulations should be removed including: flax and hemp regime and non-food but non-traditional markets; impact of EINECS (European Inventory of Existing Commercial Chemical Substances) and ELINCS (European List of Notified Chemical Substances Regulations) on non-food products; and plant derived crop protection products.

2. The needs of industry and the potential of agriculture need to be better understood and more clearly addressed.
3. EC policy makers should consider the total benefits of crop derived non-food products through standardised life cycle analysis procedures. Benefits should be positively promoted through the inclusion of such bio-renewables in EC tender documents for contracts. Support should be considered for the development of bio-renewable product specifications and labels to educate and identify for consumers.
4. CAP has a market distorting effect in the oilseeds (food vs. non-food) and fibres (clothing textiles vs. novel uses of fibres) sector. This needs to be examined and corrected when regimes or CAP are revised and during WTO activities.
5. The whole issue of non-food crops and products should form a coherent package within Framework 6 Programme of EC. That package should be part of the structured EC strategy on non-food crops and must be focused on industry needs and development of the rural economy.
6. Blairhouse Agreement/EC-US oilseeds agreement. Definitive statements on the long-term standing and precise meaning of this agreement are needed.

Legislative.

1. The requirements of anti-narcotics legislation limits the expansion of the hemp crop and in some countries (e.g. UK) adds to production costs. Development of nil THC hemp varieties and rapid diagnostics for THC containing hemp should be progressed since demand for hemp feedstocks is well established.
2. The European List of Notifiable Chemical Substances Regulations (ELINCS), and European Inventory of Existing Commercial Chemical Substances Regulations (EINECS) both apply to plant products. These are considered by industry to be expensive and constraining (e.g. in high viscosity esters) and their role and applicability to plant products should be reviewed.
3. Legislation on re-use of lubricants could offer good opportunities to expand vegetable oil use. Similarly, regulations on bio-lubricants for sensitive areas would be beneficial to the environment and should be considered EU-wide.
4. Demands for enhanced biodiversity are being progressed. The role of non-food crops, especially of novel species, should be considered in this context.

5. The regulation of plant protection and plant health products appears to be anomalous for plant derived materials: whole plants are exempt but plant components are not. These regulations should be re-viewed and, if appropriate from a risk viewpoint, revised.
6. The legislation relating to all aspects of non-food crops or products should be unified across EU, since trade in these products is transnational.
7. An EU series of standards regulating description and quality of bio-renewable materials and products should be developed in partnership with industry. It should be based upon environmental benefits. Such a scheme should be built on the principles of the Blue Angel or White Swan Eco-marks.
8. European Union regulation on wastes and waste disposal, including packaging should include aspects of bio-renewables that are beneficial to the environment.

Technical and Scientific.

1. There is a generic need to identify and characterise genotypes and cultivars with particular uses in provision of bio-renewable produce. This will not be easy in sectors like that of essential oils, where chemotaxonomy forms the only realistic taxonomic base. These characteristics should be available on websites like IENICA. Particular emphasis should be laid upon market "pull."
2. Industry and agriculture need to be linked in a proactive manner to facilitate the production of standards and specifications against which plant produce can be measured and assessed. Short, interactive vertically integrated production chain needs to be stimulated.
3. Whilst many extraction and purification techniques for plant products are well proven, there is a need to undertake continued development and refinement in order to keep pace with market needs and to identify higher value products. Equally, there is a pressing need to indulge in lateral thinking to develop novel extraction and purification procedures which also allow the exploitation of desirable secondary metabolites.
4. Agronomic and physiological studies need to be linked to sustainable economic production and end products quality parameters. These studies should include understanding of linkages with primary and secondary plant metabolites; modelling approaches should be included since they inter-relate existing research results and highlight areas of poor knowledge. These studies are particularly important for herbs and plants producing essential oils where much dubious data exists in the literature.
5. Processing and extraction procedures which are environmentally benign should be considered as high priority and special effort put into their development, validation, and economic demonstration.
6. Studies should be instigated to assess the extent to which initial processing of primary product can be undertaken in the production locality. This could benefit rural employment whilst reducing total production and transport costs.

7. The role of transgenic technologies in providing opportunities for novel and especially sophisticated molecules is important. Assessments need to be made of real market opportunities, since not all are economic, (e.g. lauric acid from rapeseed).

Environmental Issues.

Comparative life cycle analysis studies of major environmental polluters (e.g. NO_x, CO_2) should be undertaken and the relative positions of fossil derived and bio-renewable feedstocks confirmed. Priority should be given to the promotion of bio-renewable production where the benefits of the bio-renewable are proven (e.g. rape oil vs. phthalates). Within this requirement standardisation of LCA procedures is essential.

Economics.

1. The key issues in successful introduction of bio-renewables are unit cost and comparative performance. These aspects need to be assessed and defined for specific uses of oils, fibres, carbohydrates, protein, and speciality products. A total and real cost appraisal is essential for long-term sustainability.

2. Industry must be given incentives to change its practices where bio-renewables are shown to have overall benefits.

3. Efforts must be made to ensure exploitation of all plant components as primary and co-products. This would enhance economic and environmental sustainability. This means that crops like flax and linseed should be considered as bi-functional, requiring a change in EC perspectives.

4. New technologies often have a degree of uncertainty in their success. EC should continue to support and promote demonstration projects but these must be linked to realistically appraised market potential.

5. It is anticipated that all bio-renewable non-food products will undergo continuous improvement, particularly in terms of market orientation and reduction in true unit cost. This should be encouraged.

6. Logistical studies, including transport modelling, should be instigated to reduce cost of collection, packaging, and transport of bulk primary products like plant fibres in particular.

7. Structured contract systems and arrangements between producers, processors, and end users of bio-renewables are essential for success. EC should actively promote these relationships and develop "model structures."

8. The potential for import substitution with home grown bio-renewables in EU should be assessed. This could lead to considerable practical and economic benefits for agriculture, rural economy, and industry in EU-15.

Other Issues.

1. Bio-renewable products are generally viewed as desirable, environmentally beneficial, and healthy. Active management of this image must be undertaken to maintain and build upon it

where bio-renewables have economic and sustainable markets. Presumably this is an EC DG Environment role?

2. It must be noted that bio-renewables could be produced by traditional or organic methods. Both technologies have market places but efforts must be made to maintain and confirm identity of produce from each.

3. Those in EU-15 who are issuing tenders for contracts should be obliged to include specifications for inclusion of bio-renewables where performance and true cost have been shown to be superior to existing materials. Environmental benefits should be included in true cost assessment.

4. The potential for competition between bio-renewables should be recognised. Such competition could occur in a number of sectors, e.g. plastics, adhesives, polymers.

10 Proposals concerning policy actions to increase the use of biomass in the three main areas electricity, heat and (bio-)fuels

10.1 Overview over present policy targets and actions

The present energy policy of the EU reflects four main targets:

- secure energy supply to the Union,
- efficient and sustainable use of limited resource
- environmental protection and
- competitiveness.

In this framework a variety of policy measures has been taken in the last years to promote the use of renewable energy sources (**Table 10-1** and **Table 10-2**).

Table 10-1: RES promotion measures in EU 15 (except Luxembourg) (Eubionet, 2003).

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain	Sweden	UK
Special programme to promote RES	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Green certificates for RES-e and/or emissions		X	X		X		O		X				X	
Special tariffs or production support for electricity from RES	X	X	X	X	X	X	X			X	X	X	X	X
Obligatory purchase of electricity from RES		X	X		X		X	X		x			X	X
Deregulation of electricity markets		X	X	X	X	X	X	X	X	X	X	X	X	X
CO2, NOx and /or sulphur tax, ecotax			X	X	X			O	X	X			X	
Tax refunding/reliefs for RES	X		X	X	X	X	X	X	X	X		X	X	X
Investment subsidies, support for RES	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Emission limits for boilers	X		X	X		X			X			X	X	
Environmental permit system/impact assessment				X		X		X					X	
Support for sustainable forestry				X										X
Support for biomass harvesting				X										
Regulations on cultivation of renewable resources			X		X	X	X				X	X	X	
Special regulations for small producers			X		X	X	X				X	X	X	
Guidelines about using natural resources		X		X		X							X	
Restrictions to landfilling				X		X								

X=already implemented O = to be implemented in the near future

Table 10-2: RES promotion measures in the new EU countries (CEC, 2003)

	Estonia	Latvia	Lithuania	Poland	Czech R.	Slovakia	Hungary	Slovenia	Cyprus	Malta
Feed in tariffs					X		X	X		
Fixed price purchase			X							
Direct grants									X	
Obligations				X						

X= already implemented

10.2 Measures for electricity production

In the white paper, ***Energy for the Future: Renewable Sources of Energy*** (COM(97)599) , renewable energy sources are given an indicative target of 12% for its contribution to the EU's gross inland energy consumption by 2010. A comprehensive strategy and action plan to achieve this goal is outlined. Specific objectives were set to regulate and create favourable framework conditions for RES. This included increased funding, both at national and community level, as well as specific targets and strategies for the individual member states. The member states were allowed to achieve their increase of RES according to their own potential.

A directive on ***Promotion of electricity produced from renewable energy sources in the internal electricity market*** (Directive 2001/77/EC) has been stated. The target in this directive, that is indicative and has to be reached 2010, is set to 22% of the total production of electricity compared to 13.9% in 1997. In this directive member states have individual indicative targets.

In the green paper, ***Towards a European Strategy for Security of Energy Supply*** (COM(2000)769) the Commission expressed a strong will and need to reduce the import of energy to the EU. The dependence of imported energy to the EU has already passed 50% and is expected to reach 70% within the next 20-30 years with a business as usual scenario.

The Commission has further proposed a new multi-annual programme for actions in the field of energy, ***"Intelligent Energy for Europe" Programme (2003-2006)*** (COM(2002)162), to follow the framework programme ended on 31 December 2002. With a budget of around 200 million EURO this programme implements the strategy outlined in the green paper.

Another important part of the EU's actions is the ***Campaign for Take-Off for Renewables*** (Campaign, 1999), which is designed to kick-start implementation of the EU's strategy for introduction of RES. The all-embracing goal for greenhouse gas reduction is stated in the Kyoto Protocol of the United Nations Framework Convention on Climate Change, UNFCCC (UNFCCC, 1997). The EU is in this committed to reduce their emissions, of a basket of six greenhouse gases, by 8% from a 1990 level to a target level calculated as an average between 2008 and 2012. Of the six greenhouse gases carbon dioxide is the most important as it contributes to about 80% of the total emissions of greenhouse gases from the Union. In June 1998 a system of burden sharing was agreed by the member states. All member states in the EU have now ratified the Kyoto Protocol, that has now entered into force after the recent ratification by Russia.

An important initiative from the Union to fulfil the goals for greenhouse gas reduction has lately been introduced with the new directive on ***Establishing a scheme for greenhouse gas emission allowance trading within the Community*** (Directive 2003/87/EC) It has been taken into operation on January 1st, 2005.

10.3 Measures for the promotion of heat from biomass

The sector of heat from biomass is **still dominated by traditional use of biomass**. Over the last decade it has only slowly been increasing.

The directive on the promotion of combined heat and power and the directive on home insulation had effects on the more effective use of biomass for heat. But there has been no directive so far focussing on the use of biomass.

Efforts have to be made to reach the target of 12% of renewable energies in that sector and to make use of the significant resources in the new member states.

Heat from biomass can be produced by a variety of technologies. The most effective way is in CPH in combination with district heating systems that is well connected to local biomass sources.

Biogas is already used to 40% to generate heat. It can be produced from various biogenic sources. In 2001 in the EU-15 the production of biogas was 2.8 million tonnes oil equivalent. But the growth rate is too slow to reach the target of 15 million tonnes oil equivalent in 2010

Wooden is still the most common biomass used for heating, especially in private households. But major efforts have to be made promote the use of more efficient burner technology on a larger scale. CHP is a good tool to use wood for heat production on an industrial scale. The new member states have well developed district heating systems that are currently still in most cases running on fossil fuels. Replacement of old boilers that will become necessary in the upcoming years will be a good way to introduce biomass based heating in these countries.

Other biomass such as annual energy crops has great potential that is still to be used and promoted. Other than wood, return on investment occurs after one year already. And farmers that participate in the set aside land regulations of the CAP are in general more familiar with the cultivation of annual crops than with forest management.

National programs that have been proven to be efficient is the Austrian program for the commercialisation of wood and the French “plan du bois” to promote the installation of efficient boilers and CHP. They could serve as a model for national initiatives in the new member states.

In any case we can expect a much faster growth in agriculture based biomass in comparison to forestry based.

10.4 Measures for the promotion of biofuels

New initiatives for transport and electricity were introduced. Special measures were suggested for the transport sector in order to increase the market share for liquid bio fuels. In the directive on ***Promotion of the use of bio fuels or other renewable fuels for transport*** (Directive 2003/30/EC) an indicative target at 2.0% in 2005 and 5.75% in 2010 of total fuel consumption in the transport sector is set by the EU.

In 2002 the market share of bio-fuel in the EU-15 gasoline and diesel market was 0.6%. In Check Republic bio-fuel had a market share of 1.3 % of all car fuels.

In 2004 ***seven EU member states*** had reduced tax or tax exemption (Germany, France, Italy, Austria, Sweden, Spain, UK)

Since January 2004 ***Poland*** has a law to promote the use of bio fuels.

Biodiesel from oil seeds is the most common type of bio fuel. Bio-ethanol from sugar beet or wheat is second place with an increasing tendency. Other bio fuels from disposals and residues only play a minor role.

Bio fuel is costly compared to fossil fuels, although the additional costs can be justified by positive effects on various policy sectors such as agriculture and environment.

Especially for the transport sector which is responsible for more than 30% of the energy consumption of the EU bio-fuels are an alternative. At present bio-fuel is the only possibility to replace oil by renewable energy in the transport sector. Bio-fuel supply is more secure than fossil oil as it can be produced domestically or imported from a wider variety of countries than oil.

Also on the employment bio fuels have an positive impact by creating 16 jobs per 1000 t of oil equivalent.

Taking into consideration these advantages the directive on for the promotion of bio fuel or other renewable fuels for transport was released. If the target of the directive is reached, the share of bio-fuels will rise from 1.4 Mio t of oil equivalent in 2001 to 19 Mio. t of oil equivalent in 2010.

But the progress in the field of bio fuels until 2010 and beyond will also depend on the development in fuel quality, innovation in bio fuel technology and the supply of biomass for the generation of bio fuels.

10.5 Present general steering instruments in the EU

Most of the EU member countries operate a variety of different steering instruments, all aiming to support and enhance the use of RES or biomass directly or indirectly. A recent survey (2003) among the AEBIOM member organisations as well as the country reports in the Altener-project “Biomass survey in Europe” (Alankangas and Vesterinen, 2003) gives a very diverse picture. Within member states the steering instruments consist of EU-directives and national laws and commitments.

Green certificates and minima quota belong to the category of **volume steering** instruments. Contrary to that are **price steering** instruments like fixed infeed-prices and eco-taxes and on fossil and nuclear fuel. A comparison of the economical costs of these instruments on a European level is at present not available. Speaking from national experience it can be expected that volume steering instruments will reach the political goal more precisely and at lower costs. Competition and free market powers will lead to an optimal solution.

If it is the goal to promote energy form certain sources such as wood, biogene gas etc. different prices have to be established.

In the new member states the steering instruments are normally limited to the **Flexible Mechanism in the Kyoto protocol and/or international support and aid programmes.**

The wide variety of national steering instruments depends mainly on differences in technical infrastructure, natural resources and industrial tradition, geographic and climatic conditions and last but not least on political will. The present national steering instruments consist either of market regulations, advantageous taxation, different kinds of subsidies or special financial tools.

The **market regulations** are used only in the production of electricity. Among the market regulations trading with certificates for green electricity is used in Belgium, Italy, the Netherlands and Sweden. **Feed-in prices** are used in Austria, Denmark, France, Germany, Ireland, Portugal and Spain.

Target values for **obligatory production** of electricity from RES are in place in all EU member states. But this does not mean target values for obligatory production of electricity from biomass.

Some countries, as France, Germany, the Netherlands and Sweden have a voluntarily system with **special (higher) consumer prices**. Most of the EU member countries except France and the Eastern European countries have deregulated their electricity markets.

Many of the countries use **advantageous taxation** for promoting biomass or bio energy. This advantageous taxation can consist of carbon taxation on fossil fuels or differentiated energy taxation or a combination of both as in Austria, Finland, Germany and Sweden. Some countries like France, Ireland and Latvia have restricted carbon taxes on fossil fuels. Italy operates only with carbon taxes and the Netherlands only with different energy taxation.

Different kinds of **subsidies** *or* **grants** are also widely in use. Most of these subsidies are set up for electricity production or conversion of heating (with fossil fuels or direct electricity) to biomass. Other kinds of subsidies, used to promote energy efficiency and/or research are in place in most of the AEBIOM member countries, with the exemption of most of the states in Eastern Europe. Bio energy-subsidies connected to support to developing areas and creation of new employment is used to a minor extent in most of the countries.

Special **financing tools** like redemption of loans, reduced interest rates, interest free loans and co-financing are used to a limited extent with the exemption of Austria, Belgium and Czech Republic that use different kinds of co-financing.

Another important contribution can be seen in a state guarantee for credits. This reduction of risk for a bank will lower the capital costs of the investor and this measure is politically most attractive, because there are no direct implication for the budget. The experience of Baden-Württemberg demonstrates that from 140 biomass heating systems during the last 10 years not a single heating failed economically.

Present policy measures show limited progress

Energy supply Taking into account a projected increase in energy consumption, the growth rate of renewable energy sources has to be doubled if the EU indicative target of 12% share of renewable energy sources will be met in 2010. The penetration of biomass exclusively has to be tripled. But according to the European Environment Agency (2002) (EEA, 2002) renewable energy targets are unlikely to be met under current trends. On the other hand experiences in some member states suggest that growth could be accelerated by appropriate support measures. In spite of a current rate of increase in combined heat and power, the production of electricity from biomass is not sufficient to achieve the EU indicative target of 18% by 2010. The growth rate in electricity production from total RES will have to increase roughly twofold to meet the EU indicative target of 22% of the total electricity consumption by 2010. This indicative target is also unlikely to be met. A more recent study (2003) presented at the Nordic Bioenergy Conference (Kopetz, 2003) also shows a very slow development of bio energy compared to the goals put forward by the Commission in the white paper on RES. Only 7% of the total proposed increase in 15 years was achieved in 2000. It should have been 33% after five years of the period between 1995 and 2010. This analysis also shows big differences between member states. Finland and Sweden realised respectively 60 and 40% of their expected goals during the first 5 years, but most member states reached far less then the medium 7%. **As long as there are no co-ordinated goals for each member states in line with the EU goal the big differences in development remains and the probability to reach the EU goal is small.**

10.6 Current limitation to the promotion of biomass

In most European countries the **lack of knowledge**, regarding modern technology for biomass heating with pellets, wood-chips or logwood is fundamental. Wooden fuels are often considered as an old dirty, expensive and labour demanding fuel (Rakos, 2003). Despite important initiatives from the EU more information about modern biomass technology is needed. Also **non-functioning markets** and difficulties with the supply of wooden fuels are important barrier for an expansion. Investment costs can furthermore be a dilemma since wood heating is characterised by higher investment costs and lower fuel prices. Competition from a strong established oil and natural gas industry is also considered as a strong threat to the bio energy sector.

10.7 Proposals to increase the use of biomass in an enlarged Europe

The EU must progress with domestic policies and measures. National and regional **indicative goals** for the development of RES in line with the European framework must be set up for electricity, heat and liquid fuels. Several conditions need to be improved for an efficient introduction of bio energy on the heat market such as: sufficient **taxation of fossil fuels**, development of **district heating networks**, financing **incentives** for private house owners **to switch to bio energy**, prevention of unnecessary expansion of natural gas networks, improved conditions for biomass production and as a whole a **stronger governmental support**. An effective introduction of trading with emission quotas is also important. It must embrace a wide part of the energy sector to be effective. For administrative reasons it must be handled as close to the source as possible (upstream). Auction of the quotas is to prefer in order to achieve a pricing that can lead to the intended reduction of greenhouse gas emissions. Currently member states operate too many different uncoordinated steering instruments at regional and national levels, including green certificates, investment aid, tax exemptions or reductions, tax refunds and direct price support schemes. This should be simplified. **Each new steering instrument has to be evaluated in the context of the existing ones.** Taking the differences between the European countries into consideration, **national experiences must be shared between the member states, especially when it comes to the new member states**.

According a survey undertake in 2003 amongst AEBIOM members representing the EU 25 (without Luxembourg) plus Russia the most needed measures are:

- New directive on renewable heat.
- Carbon dioxide taxation on fossil fuels.
- National targets for energy production from biomass must be set up individually in the member states, for electricity, heat and liquid fuels.
- Conditions to reach these targets have to be implemented in the member states.
- The EU's Structural Funds must be used in a larger extend for implementing biomass projects.
- Increased support must be given at national levels to implementation of biomass projects.
- Trading with emission quotas must increase both at national and at EU level.
- Simplified economic steering instruments for the member states must be put in place to improve EU's capability to implement bio energy.
- Further investments in infrastructure, R&D and demonstration projects on bio fuels.
- Establishing a European market for agro-energy and increase subsidies for promotion of energy crops.
- Support to third countries co-operation in order to strengthen the export opportunities for the European bio energy industries.
- Intensified campaigns for introduction of bio energy in small and medium size boilers.
- A functioning market for both processed- and non-processed biomass
- National targets for different RES sectors have to be put in place.

Furthermore actions have to be taken by the Commission to convince the member states to set up **indicative targets for biomass use** in specific sectors such as single house- and industrial heating systems, district heating and power production from biomass. These targets must be followed by introduction of the needed steering instruments to guarantee that the targets are met. Only the Union can solve such a task in co-operation with the member states. Trading with certificates for green heat can be an effective steering instrument for promotion of biomass. Parallel to the systems with trading of certificates for green electricity (introduced in some member states), certificates on heat can be developed and introduced. It is likely that such a certificate system can operate in parallel, both with certificates for green electricity and the scheme for greenhouse gas emission allowance trading that has taken into operation on January 1st, 2005 in the Union.

The Union should develop a new directive on promotion of biomass for heat production and for increased use of district heating, just as the Union already has adopted directives on the promotion of bio fuels, electricity from RES and the directive on promotion of cogeneration, which is another quota instrument.

A minimum level of carbon dioxide taxation on fossil fuels needs to be implemented in all member states.

More efforts have to focus on education and public awareness about the potential of biomass. Special target groups like plumbers and local planners should be addressed, as well as the general public. The potential for biomass introduction in the new member states should be given special priority.

Concerning the image of biofuels, it should become evident, that the applied conversion of biomass into heat and electricity represents latest technology.

In particular during a period of high unemployment rates the job creating effects of the replacement of fossil fuels by biomass should be underlined.

The fast growth rate expected in these countries and the need to renew the infrastructure gives new opportunities for investment in RES, and especially biomass.

11 The question of direct market intervention measures

The overall goal of market intervention measures in the field of biomass and especially bio energies is to reach a targeted volume in the market.

The methods used to achieve that goal have to be evaluated concerning their effectiveness reaching the volume target in time and at the lowest price possible.

In general, the use of **quota** delivers the **lowest prices** as it allows market mechanisms to steer the development of prices. It is **reliable** for investors and gives certainty of planning. As no subsidies are paid and the expenses of administration are low, it is **no burden to the government budget**.

Quota should be supported by mechanisms that **add external** costs occurring with the use of non-renewable materials to their **market price**. This system encourages permanent innovation and gives constant incentives to reduce the use of non-renewable materials.

This internalisation of external cost represents better the idea of a liberalised world market than the direct subsidisation of the use of biomass. It should therefore find more support of WTO than parts of the current EU agricultural policy.

Unfortunately there is still a controversial discussion, when it comes to a monetary quantification of external cost of the use of fossil energy. Concerned groups present its experts and calculate just 0,01 € per kWh for coal based electricity whereas ecological oriented experts calculated up to 1 € per kWh the external costs of nuclear power. In such a controversial discussion even the judgement of European Court from March 2003 allowing German government feed in prices covering the external benefit of renewable energy in not really helpful.

Fixed in-feed prices alone and schemes for direct subsidies for the use of biomass bare the risk that in case of fast technical improvements, **more subsidies are paid than necessary** to establish biomass in the market.

In the case of electricity production from biomass, new burner technologies lead to an increase in efficiency. With a fixed in-feed price as it is paid for example in Germany, electricity production becomes more profitable as it was expected and intended when the price was fixed. As programs of price guarantees frequently last for several years, they always bare the risk of leading into exaggerated subsidies. Higher costs to the government budget are the result.

On the consumer side, feed in-feed of renewable energies that are only temporarily available is cost effective. As these energies such as wind, solar and to some extend water-energy often are produced when demand is low, energy suppliers have to install production capacities that can keep up with the demand. Energy produced from biomass in this respect is far less problematic as it's supply can be adapted to fluctuating demand.

In the field of **heat from biomass** the in-feed mechanism that work for electricity can not be applied. Heat can not be transported over long distances and therefore it is necessary to have **customers close to the production place**.

A question to be considered is, whether quota, taxes and technical regulations have to be seen separately or if combinations are possible and might lead to better results.

Experience in Germany shows, that combinations are possible. Here the law for the in-feed of renewable energies as a means of rewarding the producers of renewable energies, was combined with an eco-tax that increases the costs of fossil energies. In addition to that, a directive based on the European directive on home insulation lowers directly the consumption of energy.

This combination of several tools allows to react very flexible on market development. Depending on the impact of each tool it can be modified to reach the targeted overall volume of biomass in the market.

On a European scale a more intensive combination of the market intervention measures should be analysed, as they exist on

European level	**Agricultural policy, emission trading**
National level	**Fiscal incentives and feed in pricing**
Regional level	**Subsidies and credit fascilities**
Community level	**Beneficial availability of land.**

Until now the energetic use of biomass was focused on agriculture and forest products, but in the context of the European landfill directive there is an increasing importance of biomass in waste, which can be converted in energy and under specific conditions even generate tradable emission reduction units.

12 Economics and market prices

The competitiveness of biomass is highly influenced by the price of non-renewable competitive products.

The market **performance** of biomass and especially bio energy is **deeply influenced by the development of prices for fossil alternatives**.

In a totally free market regenerative energies can not compete so far. The higher the price for renewable energies is, the more the production of them becomes attractive. As an result, investment in technology increases, which then leads to a growing profitability of renewable energies.

Over the last decade the oil price has been rising continuously. It is not likely that the trend of oil-price will go down to low levels known in the eighties. Decreasing stocks and increasing drilling costs make further increases in the price very probable.

This increase, on a long run, will improve the profitability of renewable energies from biomass. But it is in doubt that the price development alone will be sufficient to promote the use of biomass significantly.

A negative impact on the competitiveness of bioenergy derives from a strong Euro. As oil is mainly traded in US-dollar, a strong Euro lowers the price for EU oil consumers and decreases the competitiveness of alternative energy sources.

13 Availability of biomass and land use

The CAP reform has significantly influenced the availability of agricultural land and forest for biomass purposes. In the EU 15 an area of 4 million hectare representing 10% of the agricultural land have been set aside. In 2004/2005 an additional temporary reduction of 2 million hectares will be achieved. This adds to an area of 2.3 million hectares set aside voluntarily in 2003/2004. Of this area only 0.9 million hectares were used for energy crops in 2003. Two thirds of the energy production occurs in France and Germany with the UK, Spain and Denmark following (Buffaria, 2004).

The major result of the CAP reform was that it brought an end to subsidies for mass production an opened the door for the support of a diversified land use such as the production of biomass.

13.1 Competition of food, energy and industrial raw material production

Food, Biomass for energy and as industrial raw material will become the extended range of agricultural products. In the mid term run this might lead to a competition amongst these three. Energy and raw-material crops subsidised via the CAP reforms could become a competitor of the classical food production. Careful monitoring should be undertaken to avoid price increases in any of these three product groups as an result of the CAP reform.

At present, in the forest sector such kind of competition already exists. In Germany as well as in a number of other European countries subsidies for the use of energy wood have lead to an increase in demand of low quality timber. Traditional customers for that segment such as paper mills and particle-board producers are faced with increasing prices for their raw material.

But even if there was in future a shortage of land for the production of biomass, still there is the possibility of planting optimised crops that have higher volume of the desired biomass output on the same area.

In the field of energy production from biomass a clear trend leads toward crops that are yearly harvested and away from forest plants.

13.2 Biomass competition in a global market

The EU agriculture policy is guided by the idea of market protection. In the field of food, import from non-EU countries is limited by a customs system which is constantly questioned by the WTO. If the EU continues on a path of market liberalisation, introduction or continuation of import duties on biomass or biofuels will be difficult to impose.

A completely liberalised market for biomass and biofuels would have major impact on the profitability of biofuels. Especially subtropical developing countries have an enormous potential for the production of biofuels. Ethanol from sugar-cane and biodiesel from oil-palms are just two examples of biomass-products that can be produced at a low price outside the EU.

Most of the EU countries and especially the new members in eastern Europe have **disadvantageous biological and geographical settings**. Short vegetation periods cause long production times, compared with tropical or subtropical areas. In addition high land prices and labour costs reduce the profitability.

If it is he goal not only to promote the use of biomass but also support European farmers, regulation of imports has to be taken into consideration.

Not that affected by the world market are producers of biomass that is too spacious to be transported at low costs. Wood-chips, pellets and hay, just to mention some, get significantly cheaper the greater the distance to the customer gets. Here the goal of support programs for biomass, especially in the new EU members, must be to promote the **formation of clusters, that bring together customers and suppliers in short distance.**

14 Proposals of policy instruments at EU-level to increase the use of biomass (legislation, R&D, other)

In **Table 10-1** there is already a listing of political instruments applied in the different EU member countries. In addition to this tableau of applied instruments a more specific analysis of those instruments should demonstrate their compatibility with the economic system of a free market economy and cost efficiency.

14.1 Political instruments to increase the use of biomass energy

Energy is a relevant share in the budget of private households as well as in the cost structure of the production sectors from small hard craft up to industrial size. Therefore any major political decision, increasing this cost component will provoke resistance and a controversial debate.

For industrial companies, operating in the competitive EU market, national initiatives in energy policy can result in a distortion of competition and particularly during a time of high unemployment rates no national government likes to lose additional jobs due to the increase of energy prices.

In this challenging general context is situated the debate about most efficient political instruments to reach the given climate policy targets of GHG reduction. This analysis of political instruments is focused on the question, how to increase the use of energy from biomass, which is already today beside hydropower the most important source of renewable energy (RES). As the potential of hydro-power is limited, the expected growth will bring biomass in a leading position among the RES.

The traditional components to identify the price of a product in the market economy do not take environmental costs and longtime scarcity in consideration. Therefore the European political target of climate policy in the Kyoto Protocol, to reduce CO_2 emissions by 8 % during the first commitment period could only be reached by market mechanisms if the internalization of those external costs of climate change would be successfully implemented.

But there is even between scientific experts a highly controversial discussion going on about the monetary valuation of external costs of fossil or nuclear energy. If there is no objectively defined amount of those external costs to be expected, the doors are open for other political interventions or instruments to reach the target indicated from Kyoto Protocol.

There is a particular problem, when a fossil heating system has to be replaced and a tender has to decide about the future energy source. As the hardware investment for fossil energy is still considerable cheaper, investment in biomass without calculation external benefits of this alternative usually are not competitive. There is the organization of German cities - Deutscher Städtetag – recommending to their members to calculate the emissions of a ton of CO_2 with an amount of 50

€ during the whole life cycle of the plant, which makes investment in biomass much more attractive.

14.2 Divergent or harmonized national instruments in the EU Common Market

As the basic rules of a market economy in the EU interior market it should be respected, that any national tools have to be measured by its influence on market mechanisms and fair competition. Therefore any measures taken as a common EU approach should be preferred to those on national level.

In the light of this introductory remarks for any type of instruments, we have to evaluate the existing or potential instruments, how to increase the use of energy from biomass.

First there should be identified the relevant categories of instruments. In a second step their economic, environmental and social effects will be evaluated:

14.3 Quota

The political target of a quota or a certain quantity as an instrument of environmental policy is much more precise and legally easier to control as any other instrument. Whenever there is a politically defined price or tax, it still depends on the market mechanism what will be the effect of such a measure. And there is a second advantage of quotas: After the political decision of a quota is made, it depends on market mechanism how to reach the given target. Therefore the level of market intervention of this type of instrument is lower and as competitive element of the market is still functioning, the total economic costs are considerably lower than in other cases.

In modern climate policy, the Kyoto Protocol is an excellent example to demonstrate the efficiency of a flexible quota system. The EU committed itself to reduce GHG emissions during the first commitment period by 8 %. But there is a wide range of clearly defined measures, how the concerned parties can reach their given target:

- Reduction at source — to save energy
  To increase energy efficiency
  Fuel switch from fossil to RE
- To reduce emissions in a third country
  Joint Implementation or
  Clean Development Mechanism.
- Emission trading — To buy or sell emission rights

There are serious scientific calculations, demonstrating that the Kyoto quota system, due to its flexibility, will cut the total costs by one third to one half, compared to a legislation, where every polluter has to reduce its own emissions by the requested volume at source.

Within those flexible instruments of the Kyoto-Protocol scheme fuel switch is an important approach to generate ERUs, and it seems highly attractive for biomass energy to get this climate bonus to become economically profitable.

There is an EU target of 12 % for RE of the total energy consumption for 2010 or 22 % of EU total electricity production. This political will could be transferred into national quotas with a strong positive contribution in support of the national climate policy of the 25 EU member states. So the RE quota is a measure to reach the GHG reduction quota, what demonstrates the complexity of applied instruments. It proves that there is a hierarchy of instruments, where the analysis of the different instruments applied has to prove that there are no controversial effects between them.

14.4 CHP quota

In electricity production, heat is a complementary product. Efforts are made to make best use of heat and to lower its waste. But it is not always economically attractive. Therefore a mandatory quota put a pressure to make broader use of this energy potential, which becomes more interesting, as the price of fossil energy increases.

As biomass energy plants are usually in a quite small dimension of 200 kW to 5 MW, they contribute to a decentralized energy production and are predestinated for CHP. Therefore biomass energy would profit from a CHP quota

14.5 Liquid bio-fuels

As EU has foreseen in a Directive to add 5,7 % of bio-fuels to fossil fuels, there is another quota, which will help to bring broader use of biomass and lower emissions.

14.6 Heating and cooling directive

As there are many possibilities to encourage the use of biomass for electricity production, there is a growing demand, to improve the situation in the heat sector. A biomass heat quota could be a measure to reduce the discrimination of heat, which can be identified, if measures to privilege biomass energy are restricted to electricity. As heating systems are extremely decentralized – as they can be nearly found in every building – therefore a quota for every heating unit would be completely unrealistic, but could be located at the level of energy supply. There is still a discussion going on, how incentives for a broader application of biomass for heating and cooling can be designed.

14.7 Steering by prices

The existing energy structure developed mainly on historic market development. After the World War II a long period of cheap fossil and nuclear energy triggered its increasing consumption. As it was the cheap price, who initiated to a growing consumption, it is quite logical to inverse this process and use the high prices to curve the trend: Taxation of fossil and nuclear energy, tax alleviation for RE and politically defined prices to feed in RE are the instruments applied to reach this target.

14.8 The importance of the tax base for the result

The taxation of energy based on the CO2 content will be a strong support for the climate policy targets, but it has an unequal effect within EU member countries: Those countries (or companies) producing electricity on a fossil base (in particular coal) will suffer under extremely growing costs, while those producing electricity on nuclear base are free of additional charges. As national interests are in this case extremely divergent (France nuclear/Germany coal), it is difficult for the EU Commission to present a consensus proposal.

But it is worth to remember, that there was already an agreement on this matter in 1992, when a common EU energy taxation scheme failed only due to the refusal by Great Britain, because for a common EU tax policy, unanimous decisions are needed. Otherwise an EU wide energy tax would be consisted from half energy content and half CO2 emission with an yearly increasing rate.

Second best, if no common EU energy tax scheme can be reached, a harmonized approach with variations defined on national level would be helpful. Concerning the amount of energy taxation, there is a proposal from the European Biomass Association AEBIOM, requesting a tax/fee of € 260 per ton of oil.

The proposed fee/tax system has three components:

1. A carbon dioxide fee depending on the content of carbon (emissions of carbon dioxide) in different fossil fuels. A high fee level will give stronger economic incentives to choose fuels and systems with low emissions of carbon dioxide.
2. A deduction proportionate to the amount of heat used for heating purposes and/or electricity produced. The levels for heat or electricity should be decided separately preferably with a higher level on electricity. The total deduction should be equal to the total carbon dioxide fee on a national basis. The carbon dioxide fee and the deduction create together a transfer system, where no money leaves the system.
3. A fiscal energy consumption tax proportionate to used electricity or heat. The purpose of this tax is mainly fiscal and the level could be decided individually for heat and electricity as well as country depending on the desired state income from this sector. Of course the level will influence the total energy consumption. For reasons of competition the energy consumption tax could be reduced or omitted for the industrial sector (a strong steering effect can still be maintained by means of the carbon dioxide fee).

The AEBIOM proposal is based on the Swedish experience, where the most efficient fuel switch in electricity production towards biomass in Europe can be demonstrated, but prefers evidently price steering measures instead of a quota.

The Swedish example (based on RE quota for electricity production and a tax/fee on fossil energy consumption, which is affected to the support of RE) on one side and the German example, legally based on the Erneuerbare Energien Gesetz – EEG, with politically defined feed in prices are the two most successfully applied measures. Both measures have in common that they support with an increased part of RE the EU/national climate policy target and create additional employment, as most of the necessary investment in technical equipment is produced in the national economy – but apply different categories of instruments, what proves that for the choice of RE instruments there is no right or wrong.

It is quite interesting to analyse some typical differences between quota and feed in prices: Quotas mobilize investment from the established power producers who are under the pressure to fulfill the quota. But in the case of feed in prices ecological oriented investors, motivated to invest their money in small size green energy come into play. As there is even a price incentive for small scale production of RE and in the case of wood gasification there is a real competition of inventors, to present the most efficient and robust equipment.

Another interesting difference can be demonstrated in the composition of different types of RE source. Where as quotas mobilize the only most cost efficient sources – which is in favour of biomass – a feed in price system can offer a spectrum of different prices, dependent to the production costs. This is of particular importance for solar energy, where photovoltaic electricity gets subsidized up to 0,50 €/kWh.

Usually a government is free to decide how to spend its tax income in the budget. This fiscal principle of non affectation is politically controversial, when it comes to energy taxes. Tax payers are prepared to pay an additional price for an energy tax, when they get the impression that money is spend to solve the problem. This phenomenon occurs not only in the transport sector but is also in the energy sector. The most interesting proposal in this context comes from Switzerland, where the government intended to offer an income neutral solution to reach the climate target, but intends to profit from the steering effect of high prices to reduce CO2 emissions. They calculated in a business as usual scenario an additional charge through the intended energy tax measures of 192 Sfr. per year and person. If this amount of money will be offered at the beginning of the year, the average energy consumer will be compensated for its additional energy tax. But those who reduce their consumption will benefit and those consuming above average will be punished – strictly in the sense of the Polluter Pays Principle.

Discussing state interventions, subsidies for investors play a prominent role. There are national and even regional governments in EU member states offering a certain percentage of the investment in a RE utility/plant as a grant. In the German federal state of Baden-Württemberg this grant is offered under the condition of firing wood chips from local forests. In the same state investors can get a subsidy of 50 € per ton of CO2 reduction during the whole lifecycle of the plant.

Sometimes incentive programs have perverse effects. For example is the first case, the grant will only be offered, if the subsidy is needed for the economic success of the plant. So efficient plants could not get the support, where as inefficient plants get it. As there are clear EU limits for investment subsidies in the Common Market, this instrument has to respect them.

14.9 Legislation regulatory law and standards

Long time before an official climate and RE policy was implemented, energy production had to respect a wide range of technical, safety, environmental and other rules, influencing strongly the production costs of energy. There is also a long list of proposals how to increase energy efficiency by technical standards and other legal measures. As technical standards and economic instruments have the same target, but most times the first one is are more costly, there can be recommended a clear priority for flexible economic instruments.

14.10 Research and development (R&D) Policy

Before energy technologies are ready to conquer new markets, a lot of research has to be done. This was only the case for nuclear energy, where hundreds of millions of Euros have been spent by the different national European governments since the sixties, but it is also true for today's situation of RES. But the progress made in European integration allows to reduce double work on national level, and to avoid inefficient tax expenditures and to unify R&D efforts under the roof of a consistent EU program.

Market introduction and pilot programs for new RE technology are usually hosted on national level, but at least for promotion outside Europe, it could be done on EU level. There are different technologies closed to market maturity – wood pyrolysis or gasification – as well as energy conversion from most agriculture products: wheat, corn, miscanthus, oil seed and others – and implementation of those new technologies could help to reach economies of scale in a much faster way as this could be the case on national level.

14.11 Financial Instruments

A crucial point in the decision making process to invest in a fossil or RE plant is the amount of investment needed. Generally speaking, the hard ware for RE is considerably more expensive than fossil and equipment for RE conversion frequently suffers under additional costs of small scale production. But frequently the RE energy source is cheaper than the fossil one. Therefore a political program lowering the interest rate or offering state guarantees to lower the credit risk for private banks is of eminent importance. This is especially true since Basle II rules have a restrictive effect for financing RE equipment. There is another argument, why these instruments are easier to reach as any other direct subsidies reflected in the budget. Financial facilities have only budget repercussions if they have to be paid. As German experience proves that there is an economic failure of less than 1 % of all RE investment, the risk of budget consequences is extremely low, whilst the contribution in lowering the financial charges for the investor is considerable.

14.12 Summary

The analysis of political interventions in the energy sector proofs that there is an unbelievable variety of instruments applied. As electricity for example was seen as a state monopoly, the whole sector was seen as a playing field for political decisions and market intervention. Even newer developments, seeing the energy sector as a part of competition and free market economy, do not allow to keep politics out of the game. There is a need for regulatory work, there is a need for a referee if rules and prices for access to the grid for biomass energy have to be decided. There are external cost and benefit and long term scarcity to be taken into account, which are not reflected in traditional market economy prices.

But as interventions in energy market are done on different political level and based on different political priorities – for example German coal subsidies could only be justified for their employment effects, but are strongly opposed to climate policy or RE targets – it is important to see the total effect of all applied tools. And there it becomes evident, that no consistent RE policy exists. There are areas, for example in the wind energy sector, where specific income tax incentives generated by accumulation of losses make this investment particularly interesting for top salary earner, which is politically not intended. There are also latest technological trends, which can result in an unjustified high level of subsidies.

In times of restrictive budgets, it is a challenging task to find a reasonable level of political incentives supporting RE to reach the politically given target of biomass energy increase. It should be the task of EU to look carefully to the functioning of the Common Market for RE and to avoid any distortion of competition. It is the challenge of national, regional and if communal legislators to offer complementary instruments, strengthening the incentive to reach the political target, bur not wasting taxpayers money.

Part III: LITERATURE OVERVIEW AND BEST-PRACTICE EXAMPLES

15 Literature overview

In the following an analysis of recent literature concerning the most prominent pathways for biomass conversion from different biomass sources with particular emphasis on potentials and CO_2 is carried out. Due to the vast literature in this field, this task necessarily is a selection of particular references and does not represent at complete literature review. Therefore the main literature used in this work is analysed.

1. **The role of technology development in greenhouse gas emission reduction – Case of Finland**

Lehtilä, A.; Savolainen, I.; Syri, S. (2003). Presentation at the International Energy Workshop, 24.-26.6.2003, IIASA

Abstract:

This contribution presents results from the Finnish CLIMTECH Technology programme. Projections from a total of 27 projects were used to investigate the prospects of GHG mitigation technologies in the Finnish conditions, including all emission sources and all Kyoto gases. The estimated impacts of climate change on the energy system were also taken into account in the analysis. Systematic investments in technology development were found to yield substantial benefits in the long term, by decreasing emission reduction costs and by facilitating more ambitious reduction targets. Advanced biofuel production and utilisation technologies and offshore wind power proved to have the largest potential by the 2030s. Results also indicated a clear relationship between technological development and national emission trading patterns.

2. **CO_2-neutrale Wege zukünftiger Mobilität durch Biokraftstoffe: Eine Bestandsaufnahme (CO_2-neutral ways of future mobility with biofuels: a review)**

Quirin, M.; Gärtner, S.O.; Pehnt, M.; Reinhardt, G.A. (2004). IFEU-Institut, Germany

Abstract:

The goals of this study is to get scientifically sound statements about energy and greenhouse gas balances as well as other environmental effects, estimates of the costs and the potentials of all biofuels for transportation and to identify the research needs. To attain these goals, international publications are analysed comparatively. Thereby publicly available publications are considered regarding biofuels currently available on the market (e.g. pure vegetable oil, biodiesel from rape seed, bioethanol and bio-ETBE) as well as future biofuels (e.g. BTL and hydrogen). Regarding the energy and greenhouse gas balances as well as estimates of the costs for the production of the biofuels, bandwidths have been deduced for all biofuels – subdivided after the respective raw material basis e.g. bioethanol from wheat. The band-widths were determined by adjustment, new calculation or if necessary by a new estimation of the single results of the analysed studies.

In this report, the results of the energy and greenhouse gas balances as well as the estimates of the production costs of biofuels are presented. Regarding the results of the other environmental effects, the estimates of the potentials and the future development of biofuels as well as the research needs of all listed topics, we refer on the booklet. Therein a complete nterprettation for all biofuels is given.

3. **Greenhouse gas balances of biomass and bioenergy systems – IEA Task 38**

http://www.energytech.at/(de)/iea/results/id1980.html

Abstract:

The objective of this Task 38 is to assist in the implementation of forestry, land-use and bioenergy options to reduce greenhouse gas emission through methodological work.

4. **Ökologisch optimierter Ausbau der Nutzung erneuerbarer Energien in Deutschland (Ecologically optimised extension of Renewable Energies utilisation in Germany)**

Editor: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

Elaborated by several national institutes

Abstract:

Elaboration of a framework to support an ecologically optimised extension of Renewable Energies utilisation in Germany.

Tasks with reference to biomass:

- Technical and economical characterisation of all technologies relevant for provision of biomass heat and power and in part of biofuels. Also the aspect of “potentials” is taken into account.
- Analysis and assessment of all environmental impacts resulting from those technologies using the method of ecobalances. Additionally, criteria of nature conservation are included.
- Assessment of different paths of extension of Renewable Energies from an ecological and economical point of view taking into account scenarios of overall energy system development in Germany. Strategies for an ecologically optimised extension are developed based on further social and economic aspects.
- Analysis of political frame conditions and of possible instruments to reach the identified goals of extension. Description of possible measures.

5. **Stoffstromanalyse zur nachhaltigen energetischen Nutzung von Biomasse (Material flow analysis with regard to a sustainable energetic utilisation of biomass)**

Fritsche et al. (2004) (Ökoinstitut), Verbundprojekt gefördert vom BMU im Rahmen des ZIP

Abstract:

Analysis of possible future developments in energetic biomass utilisation based on scenarios. Development of a concept for energetic utilisation of biomass potentials in Germany which meets ecological demands.

Tasks:

- Systematic analysis of "Stoffströme (material flows)" including effects on environment, costs and employment in the field of energetic use of biomass.
- Compilation of a technology database for energetic use of biomass which is publicly available.
- Elaboration of "Lebenswegvergleiche" (provision of heat, power, biofuels; ecological and economical effects)
- Identification of potentials available for a more widespread use of biomass
- Elaboration of scenarios describing future energetic use of biomass in Germany
- Development of recommendations for action (policy)

Results:

- Biomass and other renewables may contribute to a certain degree to the sum of energy carriers in Germany.
- Up to the year 2030 renewable energies will contribute up to 22 % to the national energy demand. Biomass will be the main actor with a share of 14 %.
- The analysed scenarios "Environment", "Biomass" and "Sustainability" are always more positive with regard to costs, employment and emission of greenhouse gases compared to the reference system.

6. Nachhaltige Biomassenutzungsstrategien im europäischen Kontext (2. Zwischenbericht) (Sustainable strategies for biomass utilisation within the European context, 2. Interim Report)

Thrän et al. (2004) (Institut für Energetik und Umwelt, Projektleitung)

Auftraggeber: BMU

Abstract:

The Interim Report comprises the analysis of the initial situation relevant for future development of the European (biomass) markets. Focus will be on the EU 28. However, limited data availability has to be taken into account.

An overview on the frame conditions is given with regard to energy policy, agricultural and foresty policy within Germany and additional European Countries.

The actual use of biomass is described and an overview on relevant market structures is given. Focus is on biofuels due to dynamic development within this sector.

Additionally, biomass potentials are analysed on national and European level. The potentials are assessed with regard to the expected development in European biomass trade. For energy crops a comprising methodological approach is used and presented exemplary for some EU-countries.

Finally, the results are summarised and conclusions are drawn on future markets for biomass and flows of trade. These aspects will be elaborated within the next project phase.

7. Biomass production potentials in Central and Eastern Europe under different scenarios (Draft final report to WP3 of the VIEWLS project)

Van Dam, J., Faaij, A., Lewandowski, I. (2004) (Copernicus Institute for Sustainable Development, Department of Science, Technology and Society, Utrecht, The Netherlands)

Abstract:

The EU has set ambitious targets to increase the use of Renewable Energy Sources from which a large part has come from biomass. To meet these targets, a large amount of biomass resources is needed which requires large areas of land in the EU. This article discusses a methodology and results for a regional biomass potential assessment in Central and Eastern European Accession countries (CEEC). The biomass potential assessment is implemented for a defined set of scenarios. The scenarios are based on the main drivers in Europe relevant for agriculture and land use change, i.e. World Trade Negotiations or Common Agricultural Policy. The methodology for the biomass potential assessment is based on land use changes over time. A certain amount of land is needed to meet the required production for food (derived from agricultural crops and livestock) and wood products. The surplus available land can possibly be used for biomass production. Result of the biomass potential assessment are available on a Nuts-3 region level in the CEEC for different scenarios. As the concept of large-scale biomass production is only feasible when production is profitable for the stakeholders involved, price and cost-relations are included in the assessment. Final deliverable are cost-supply curves from different sources (energy crops, residues) and scenarios for the CEEC.

16 "Best-practice" examples

Information on best-practice examples for the use of biomass is available from many sources, such as:

- Best Practice Projects Yearbook 1997-2000 (http://europa.eu.int/comm/energy/res/publications/yearbook_en.htm)
- OPET Network publications: pilot projects, best practice projects (http://www.bit.or.at/opet/opet_p.php)
- OPET-Austria: Best-practice Beispiele für den Einsatz von Energietechnologien (http://www.eva.ac.at/opet/bestpractice.htm)
- Several Conferences on national and international level (e.g. European Biomass Conference and Exhibition)
- Examples based on "The European Wood energy road" (http://www.itebe.org/portail/affiche.asp?arbo=2&num=195)

In the following selected best practice examples will be presented to demonstrate the various fields of biomass utilisation. However, the variety of best practice examples across the EU 25 is vast and numerous of examples are available in the fields of power, heat, biogas and biofuel production and utilisation. The selection tries to present examples from each path of utilisation, such as power, heat, CHP and for different biomass resources, e.g. wood, straw etc. Additionally, the list of best-practice examples shall represent countries of the EU 15 as well as those of the EU+10.

The list of best practice examples claims no right of completeness.

1. District heating network with wood in Slovenia

DISTRICT HEATING IN Železniki CITY	**Country/Region** Slovenia
General description/Overall Concept of the project The aim of the project was to replace an old and un-efficient wood biomass boiler with a new one, which considerably raises the efficiency of district heating plant and reduces emissions to the environment at the same time.	
Ecological aspects District heating in city of Železniki, which is owned by enterprise "Toplarna Železniki" has three wood biomass boilers. The older one, WIENERDAMF was installed in 1970 and supplied heat for wood processing enterprise Alples; later also for some parts of Železniki city. That was the first district heating plant using wood biomass in Slovenia. The second boiler EMO-OMNICAL (10 MWth) was installed in 1978 when the new boiler room was build. To existing district heating network some new enterprises (DOMEL, NIKO) were connected as well as public buildings (school, kindergarten, bank, restaurant, swimming pool, post office, shops,..), 65 residential buildings and 350 appartments. The whole network measures 4440 m now. The third biomass boiler produced by URBAS ENERGIETECHNIK (6 MW) was installed in 1998 and replaced one of the older boilers. Wood chips, wood waste and sawdust are used as a fuel.	
Economical aspects Project costs: 573.891 EUROs Primary energy supply of Železniki city is as follows: • 62% from wood biomass, • 24% from solid fuels, • 14% from fuel oil.	
Social aspects No specific information	
General Remarks and Assessment Enterprise "Toplarna Železniki" delivered 14,488,976 kWh of heat in year 2000: • 67% to industry, • 21% to apartments and residential buildings, • 12% to public buildings.	

Source: http://www.eva.ac.at/enercee/slo/supplybycarrier.en.htm

2. Heating plant with biomass in Sweden

<table>
<tr><td>LOW-EMISSION BIOMASS HEATING PLANT</td><td>Country/Region
Höör near Mlmö, SE</td></tr>
<tr><td colspan="2">General description/Overall Concept of the project
The municipality of Höör in Southern Sweden decided to invest in a new heating plant for the town centre. Biomass was the preferred source of fuel as it had already proven to be readily available and economically viable in Sweden.</td></tr>
<tr><td>Plant
The biomass furnace has a capacity of 2.5 MW. The combination of cleaning and condensing of the flue gas added a further 0.3-0.6 MW, depending on the energy content of the bio fuel.</td><td>(Bio)fuel:
No special information</td></tr>
<tr><td colspan="2">Ecological aspects
If the annual heat output of the biomass plant were to be supplied from LPG boilers, approximately 1,200 tonnes of LPG would need to be used, which would increase the emissions of carbon dioxide by about 3,000 tonnes.</td></tr>
<tr><td colspan="2">Economical aspects
The total investment was SEK 11 m (€1.2m). The electrostatic precipitator cost SEK 1.6 m (€180,000), for which the Swedish National Energy Administration gave a grant of SEK 380,000 (€42,000). The payback period for the plant is approximately 4 years.</td></tr>
<tr><td colspan="2">Social aspects
No specific information available</td></tr>
<tr><td colspan="2">General Remarks and Assessment
The authorities set up strict emission permits as the plant is located in the city centre close to residential areas and a school. To meet these low emissions requirements the plant has been built based on new technology developed by Petro Ett AB (previously Ekotrans Termik AB) and Ermatherm AB.</td></tr>
</table>

Source: BEST PRACTICE PROJECTS YEARBOOK 1997-2000, S. 142

3. Heating plant with wood chips in Germany

WOOD-FIRED BIOMASS HEATING PLANT AT A FORMER MILITARY BASE	**Country/Region** VERDEN, DE
General description/Overall Concept of the project The Verden biomass heating plant building consists of two parts. The first part is a warehouse where the wood fuel is stored and fed to the boiler. The plant utilises softwood from forest thinning and waste wood. The wood store has been dimensioned so as to ensure, that during cold winter days, sufficient stocks to cover a full week's operation can be held. The other part of the building accommodates the boiler house. The plant uses two grate-fired boilers with a thermal capacity of 1 MWth each. They are equipped with hydraulic wood feeding and ash removal systems. A gas-fired boiler covers peaks in the demand for heat and it is also used when the heat demand is less than the minimum output of one wood-fired boiler (e.g. in summer). Due to the thermal insulation of the building, the total thermal capacity of the plant is only used a few days per year.	
Plant Total installed thermal capacity of wood-fired boilers [kWth] 2,000 Peak load gas boiler thermal capacity [kWth] 1,200 Length of heat distribution network [m] 1,200 Input of wood chips from the forest [m3/year] 5,000 Input of wood chips from waste disposal [m3/year] 5,000 Combustion chamber temperature [°C] 700-900 District-heating network temperature [°C] 80-90 Water content of the fuel wood [%] 35	**(Bio)fuel:** wood chips from waste disposal
Economical aspects Total investment costs for the wood-fired heating plant including the heat distribution network amounted to € 1,840,000. The main investor in the project was Verden Municipal Services. The project received a subsidy of € 445,000 from the national government's Renewable Resources Agency (FNR, Fachagentur Nachwachsende Rohstoffe). The project was also partly financed by a subsidy of € 345,000 from the federal state of Lower Saxony (Renewable Energies subsidy programme). The Lüneburg local authorities also gave the project financial support in the form of a loan. The project has enabled fossil fuels for energy generation to be substituted. The plant also contributes to the reduction of emissions of CO_2 by 1,213 tonnes a year.	
Social aspects No specific information	
General Remarks and Assessment The project has the potential to serve as a model for other projects in northern Germany. Experience regarding the influence of large biomass power plants on the availability of waste wood can also be useful for other projects. In the south of Germany and Austria, there are already a considerable number of similar installations.	

Source: BEST PRACTICE PROJECTS YEARBOOK 1997-2000, S. 103

4. Heating plant with waste wood chips in Germany

WOOD-CHIP HEATING PLANT	**Country/Region** Vrees, DE

General description/Overall Concept of the project

The area of Vrees, known as the “Village of 1,000 oaks”, produces large quantities of waste wood, which is difficult to utilise economically. In 1994 the municipality of Vrees decided to set up a district-heating network to supply heat to a new housing area from a heating plant running on wood chips. The plant came into operation in 1997. The relatively short reach of the supply network and the low supply density due to fact that the homes in the area were houses rather than flats meant that several innovative technical and organisational measures needed to be developed for the Vrees biomass plant. These included, for example, the “Partner Concept” agreement for the maintenance and repair of the plant. The wood-fired installation fits in well with Vrees’s environmental friendliness objectives, and the municipality also has several wind and solar power installations and a fuel-cell system. The plant also contributes to climate change mitigation, sustaining local forests, and promoting the sustainable development of rural regions. The Vrees biomass plant is part of the “Exponel” tourism project and also a recognised decentralised project of the Hanover Expo 2000.

Plant

The central unit of the plant in Vrees is a special grate-firing biomass boiler. The construction and the insulation of the combustion room enable an almost adiabatic combustion process. The peak load is covered by means of an additional oil/gas boiler.

Nominal biomass boiler capacity [kW] 450
Peak oil/gas boiler capacity [kW] 350
Fuel heat capacity [kW] 500
Fuel use [kg/h] 220
Operation temperature [°C] 99
Maximum operation temperature [°C] 120
Operation pressure [bar] 3 or 6
Boiler efficiency [%] 80
District-heating network main pipe length [m] 2,490
District-heating network house pipes length [m] 1,452
Network losses (with regard to wood) [%] 7

(Bio)fuel:
Wood chips

Economical aspects

The total investment costs of the project were €741,373. An total of €281,211 was provided through a loan from the ERP Environment and Energy Saving Programme. The Ministry of Agriculture in Lower Saxony gave a grant of €255,646. The German Federal Environmental Foundation supported the project financially through a subsidy of €100,725. A total of €102,258 was drawn from Biowärme Vrees’s own capital.

Social aspects

No information

General Remarks and Assessment

The installation is able to use relatively large wood chips (with a diameter of 100 mm and a length of 500 mm), which means a wood shredder is not needed.

The plant uses several innovative and cost-cutting technologies to control and regulate the biomass fired installation and its connection to the district heating network and the consumer systems.

Source: BEST PRACTICE PROJECTS YEARBOOK 1997-2000, S. 105

5. Heating plant with straw in Denmark

STRAW-FIRED POWER STATION	Country/Region Haslev, DK
General description/Overall Concept of the project The power plant was designed to be able to burn only straw. Cigar burner for Hesston bales, fabric filter Developer : Völund Owner: Sjaellandske Kraftvaerker I/S and I/S Fynsvaerket	
Plant Power output: 5 MW_{th}, 13 $MW_{el.}$ Capacity: 5,3 000 tonnes of straw per hour	(Bio)fuel: Straw with moisture content between 10 and 25 %
Ecological aspects No specific information	
Economical aspects Plant: 100 Mill. DKK	
Social aspects No specific information	
General Remarks and Assessment No specific information	

Source: Stroh als Energieträger, http://www.videncenter.dk/gule%20halm%20haefte/Gul_Tysk/halm-DE00.pdf

6. Power station with straw in the United Kingdom

ELY STRAW-FIRED POWER STATION	**Country/Region** Sutton, Cambridgeshire, UK
General description/Overall Concept of the project Elean Power Station is the first straw fired installation in the U.K. and one of the largest of its kind in the world. Located in Sutton (near Ely, in Cambridgeshire) and covering an area of approximately 4.5 ha, construction began in September 1998 and finished in December 2000. It has been estimated that the energy supplied by the plant is equivalent to that used by 80,000 homes.	
Plant The plant has a net power output of 36 MW at 33kV and generates about 271.5 GWh of electricity a year. It has a capacity of 200,000 tonnes of straw per year	*(Bio)fuel*: Straw It was designed to be able to burn other bio-fuels and up to 10% natural gas.
Ecological aspects Emissions are kept at a minimum, and are as much as 50% less than the values that might be expected from a conventional fossil-fuel power station.	
Economical aspects Plant: Total cost: €96 m.	
Social aspects 50 long-term jobs have been created directly by the installation.	
General Remarks and Assessment • The about 200,000 tonnes of straw per year are supplied by farmers and contractors located within a 50-mile (80 km) radius. • It has been estimated that the annual amount of energy produced is enough to supply 80,000 homes (or two towns the size of Cambridge) and the plant is expected to be operative for 20 years.	

Source: BEST PRACTICE PROJECTS YEARBOOK 1997-2000, S. 145

7. Combined heat and power (CHP) plant with wood in Austria

BIOMASS-FIRED CHP PLANT based on a screw-type engine Cycle	**Country/Region** Hartberg, AT
General description/Overall Concept of the project The main objective of the project was the demonstration of a new small-scale biomass combined heat and power technology applicable for the power range of 200 – 1.000 kWel., based on a screw for biomass fuels.	
Plant The district and process heating plant, which is equipped with a water tube stem boiler with a nominal thermal capacity of 18 MW_{th}, started its operation in 1987 and supplies process and district heat consumers via a steam and a hot water network of pipes. In order to obtain a more efficient utilisation of the biomass fuels used by producing not only heat but also electricity, a steam superheater and a screw-type engine were implemented into the heating plant in 2003.	*(Bio)fuel*: Bark, wood, chips, sawdust, etc.
Economical aspects The total investment costs of the project amounted to about 2,56 Mio. €. Taking 5.000 full load operating hours per year, a biomass fuel price of 0,015 €/kWh, a funding rate of 0 %, a payback time of 13 years and an interest rate of 6 % p.a. into account, the specific electricity production costs calculated for the 730 $kW_{el.}$ screw-type engine process in Hartberg amount to approximately 0,138 €/$kWh_{el.}$	
Social aspects No specific information	
General Remarks and Assessment Technological targets of the project were to evaluate the overall and the electric efficiency of the innovative screw-type steam engine process. A further key objective was the demonstration of the insensitiveness of the screw-type engine to steam quality fluctuations. Additionally, it was part of the activities to improve design and performance of the individual components during the monitoring phase, which contributes to overall plant efficiency and cost effectiveness by reducing costs of production, operation and maintenance.	

8. CHP plant with waste wood and organic rankine cycle process in Austria

CHP-PLANT BIOSTROM	**Country/Region** Fussach, AT
General description/Overall Concept of the project Innovative biomass-CHP-plant with cooling system based on waste-wood	
Plant Biomass combustion – ORC-process – low temperature absorption engine	*(Bio)fuel*: Waste wood
Ecological aspects Thermal energy from the biomass: 43.500 MWh/a Electrical power from the biomass: 8.250 MWh/a Cooling energy from the biomass: 18.000 MWh/a	
Economical aspects Plant: investments costs 7,99 Mio €	
Social aspects No information	
General Remarks and Assessment The owner of the CHP-Plant is the „Biostrom Erzeugungs GmbH“. The plant is a national demonstration object and contents some innovative terms and processes. The project is an excellent example to show firstly how to use waste to earn electrical and thermal energy and secondly how to work together (industry and community)	

9. CHP plant with wood and organic rankine cycle process in Austria

Biomass-fired CHP Plant based on AN ORC PROCESS	**Country/Region** Admont, AT

General description/Overall Concept of the project

In 1999, a biomass-fired combined heat and power (CHP) plant based on an Organic Rankine Cycle (ORC) process, was implemented at the STIA timber processing factory in Admont. The objective of this project was to supply energy to, both the timber processing factory, and the local Benedictine monastery. It also substitutes fossil fuels and reduces emissions. The STIA factory used to cover its process and space heat demand with one biomass-fired and two oil-fired furnaces. Three oil-fired furnaces provided heat to the Benedictine monastery. As these old combustion units no longer complied with technical standards, STIA timber processing factory decided to replace them with a new completely biomass-based system.

The project was the first demonstration within the European Community of a biomass-fired plant based on the ORC process. Previously ORC processes had mainly been used in geothermal installations and not in biomass- based systems.

Plant

The plant uses sawdust and chemically untreated wood residues as fuel for its thermal boiler.
Biomass input [tonnes] 5,000
Nominal capacity of the thermal oil boiler [MW_{th}] 3.2
Nominal capacity of the hot-water boiler [MW_{th}] 4.0
Nominal electric capacity of the ORC process [kW_{el}] 400
Nominal thermal capacity of the ORC process [MW_{th}] 2.25
Auxiliary electricity consumption [W/kW] 10-13
Thermal efficiency of the thermal oil boiler [%] 70-75
Thermal efficiency of the hot-water boiler [%] 89
Thermal efficiency of the ORC process [%] 80
Electrical efficiency of the ORC process [%] 18
Overall thermal efficiency of the plant [%] 98
Thermal and electrical losses [%] 2

Economical aspects

The total investment costs for the biomass-fired CHP plant (excluding the hot-water boiler system) came to about €3,200,000 including monitoring and dissemination costs. The project was partly financed by the Austrian Kommunalkredit AG, which contributed €890,000. The European Commission supported the project within the framework of the Thermie programme by a grant of €576,991. The rest of the project costs was financed by own capital and bank loans. The operation and maintenance costs of the project amount to €381,000 per year, of which 67% are biomass fuel costs. The costs for maintenance and manpower are relatively low. The revenues of the project consist of heat sales to the STIA wood-processing factory and to the monastery and electricity supply to the local utility. The payback period for the project is expected to be about 7 years.

Social aspects

No specific information

General Remarks and Assessment

The new CHP plant substitutes fossil fuels at the Benedictine monastery and STIA wood-processing factory as well as electricity from fossil fuels by replacing the original five oil-fired combustion units. The oil-fired units at STIA are now only used as a stand-by. Furthermore, the new installation implies lower gaseous and particulate emissions, thus contributing to climate change mitigation and improvement of the air quality in the region. The emission reductions are about 68% CO_2 (2,800 toe/year), 86% SO_2 (15 toe/year), 48% NO_x (11 toe/year), 44% Total Organic Compounds (4 toe/year), 77% CO (21 toe/year), and 75% dust (10 toe/year).

Source: BEST PRACTICE PROJECTS YEARBOOK 1997-2000, S. 75

10. Biomass gasification plant (CHP) in an integrated system in Austria

<table>
<tr><td>BIOMASS GASIFICATION PLANT (CHP)</td><td>Country/Region
Güssing, AT</td></tr>
<tr><td colspan="2">General description/Overall Concept of the project
In Austria, the high efficient production of electricity and heat from organic feedstocks in small, decentralised power stations was first realised in Güssing by implementing of a new fluidised bed combustion process.</td></tr>
<tr><td>Plant
Fuel input power 8.000 kW
Electrical output 2.000 kW
Thermal output 4.500 kW
Electrical efficiency 25,0 %
Thermal efficiency 56,3 %
Electrical/thermal output 0,44
Total efficiency 81,3 %</td><td>Biofuel:
Solid biomass</td></tr>
<tr><td colspan="2">Ecological aspects
No information</td></tr>
<tr><td colspan="2">Economical aspects
Investment cost 10 Mio €
Funding (EU, national) 6 Mio €
Operation cost / year 10 to 15 % of investment costs
Price for heat (into grid) 2,0 €-cents/kWh_{th}
Price for heat (consumer) 3,9 €-cents/kWh_{th}
Price for electricity 16,0 €-cents/kWh_{el}</td></tr>
<tr><td colspan="2">Social aspects
No information</td></tr>
<tr><td colspan="2">General Remarks and Assessment
For the next plant a 25 % reduction of investment costs can be expected due to the gained experience and learning at the demonstration plant. Furthermore, the operation costs will be reduced essentially. This will be done by aiming at an unmanned operation and an reduction/optimisation of operation means (bed material, precoat material, scrubber liqued, etc.).</td></tr>
</table>

Source: http://www.tuwien.ac.at/forschung/nachrichten/a-guessing.htm

11. Biomass gasification plant (CHP) in Finland

BIOMASS CFB GASIFIER CONNECTED TO A STEAM BOILER	**Country/Region** Lahti, Fi
General description/Overall Concept of the project The successful experience in developing the advanced Foster Wheeler Circulating Fluidised Bed (CFB) combustion system subsequently led to the development of the CFB Gasification Technology in the early 80's. The driving force for the development work was the dramatic increase in oil prices during the oil crises of that time. The primary advantage of CFB gasification technology is that it enables the substitution of expensive fuels (e.g. oil or gas) with cheap solid fuels. The aim of the Kymijärvi Power Plant gasification project is to demonstrate on a commercial scale the direct gasification of wet bio fuel and the use of hot, raw and very low calorific gas directly in the existing coal fired boiler. The gasification of bio fuels and co-combustion of gases in the existing coal-fired boiler offers many advantages such as: recycling of CO_2; decreased SO_2 and NO_x emissions; efficient utilisation of bio fuels and recycled refuse fuels; low investment and operating costs; and, utilisation of existing power plant capacity.	
Plant The atmospheric CFB gasification system is simple. The system consists of a reactor where the gasification takes place, a uniflow cyclone to separate the circulating bed material from the gas, and a return pipe to feed the circulating material to the base of the gasifier. When the gasification air enters the gasifier below the solid bed, the gas velocity is high enough to fluidise the particles in the bed. At this stage, the bed expands and all the particles are in rapid movement. The gas velocity is so high that many particles are conveyed out of the reactor and into the uniflow cyclone. In the uniflow cyclone, the gas and circulating solid material flow in the same direction – downwards – both the gas and solids are extracted from the bottom of the cyclone, which is different from how a conventional cyclone works.	*(Bio)fuel*: The Kymijärvi power plant went into operation in 1976. Originally, the plant was heavy oil fired, but in 1982 the plant was modified for coal firing. In 1986, a gas turbine generator set was installed at the plant. In the gasification project the biomass gasifier was connected to the coal-fired boiler. Gasification enables the utilisation of locally available low-price bio fuels and recycled refuse fuels (REF), with the equivalent energy content of 300 GWh (180,000 tonnes) annually, thus reducing the plant's annual coal consumption by up to 30%.
Economical aspects The total investment for the whole plant (including the fuel preparation and gasification plant) was approximately €11 m. The project received a €3 m grant from the EU's Thermie programme.	
Social aspects No information	
General Remarks and Assessment The project is part of the Thermie European demonstration programme.	

Source: BEST PRACTICE PROJECTS YEARBOOK 1997-2000, S. 93

12. Biogas plant for manure in Denmark

<table>
<tr><td>NYSTED BIOGAS PLANT WITH CHP-UNIT</td><td>Country/Region
NYSTED, DK</td></tr>
<tr><td colspan="2">General description/Overall Concept of the project
The biogas plant in Nysted is constructed and owned by the cooperative Nysted Biogas A.m.b.a.. The plant is located in the village Kettinge in Lolland. The cooperative’s main goal from the plant was to utilise the biogas potential of manure and other biomass in an environmentally friendly way and to set up a financially profitable and ecologically sound solution to the problem of the storage, handling, and distribution of manure.</td></tr>
<tr><td>Plant
Biogas production
• Planned 2.2 m Nm^3/yr
• Actual (2000) 2.9 m Nm^3/yr
• Actual (2001) 3.1 m Nm^3/yr
Digester capacity 5,000 m^3
CHP-unit
• Heat, capacity 1,300 kW
• Electricity, capacity 1,000 kW
• Efficiency, total 89 %
Gas/oil boiler, capacity 2,500 kW</td><td>(Bio)fuel:
manure and other biomass</td></tr>
<tr><td colspan="2">Economical aspects
Plant: investments costs: The total investment was DKK 43.7 m (€ 5.9 m). The biogas plant accounted for about DKK 32 m (€ 4.3 m).</td></tr>
<tr><td colspan="2">Social aspects
No information</td></tr>
<tr><td colspan="2">General Remarks and Assessment
Experience from the operation of the plant shows that care needs to be taken over the design when building biogas plants.</td></tr>
</table>

Source: BEST PRACTICE PROJECTS YEARBOOK 1997-2000, S. 83

13. Biogas CHP plant for organic waste in the Netherlands

VAGRON BIOGAS CHP PLANT	**Country/Region** Groningen, NL
General description/Overall Concept of the project Since 1987, VAGRON has been processing municipal and comparable industrial wastes from Groningen at its waste separation facility. The 10-year Waste Programme that began in 1992 suggested that separation and anaerobic digestion combined with incineration might be an attractive alternative for municipal waste processing in the Netherlands to deal with the problems of the waste separation system at the time. However, due to the low environmental efficiency and high cost of this system, the city of Groningen decided to stop separate collection of municipal waste in the city centre from January 1st 2000. As a result, VAGRON decided to add an organic waste washing-digestion installation to its existing plant. This installation means municipal waste no longer needs to be kept separate by the public for depositing in separate bins. Instead, the plant mechanically separates the organic fraction from the “grey” waste.	
Plant This biogas is used as fuel for a series of gas engines producing heat (3 MW_{th}) and electricity (2.5 MW_{el}). The plant itself utilises most of its own heat production and one-third of the electricity generated.	*(Bio)fuel:* Organic waste
Economical aspects The investment costs for the entire waste separation installation came to €23.5 m, which was financed by private companies. The technical lifetime of the plant has been estimated at 20 years.	
Social aspects No information	
General Remarks and Assessment The objectives of this project were to achieve higher levels of materials recycling, better utilisation of the energy content of municipal waste, and reduction of the amount of waste needing to be landfilled or incinerated.	

Source: BEST PRACTICE PROJECTS YEARBOOK 1997-2000, S. 119

14. Biogas plant for organic waste in Germany

BIOGAS PLANT CONSTANCE	**Country/Region** Constance, DE
General description/Overall Concept of the project The biomass plant in Constance uses wastes from farms, food and also waste from the countryside. The gas produced after the anaerobic digestion of the wastes is burned in a traditional CHP installation. The plant is outside the city, there is no user for the thermal energy near the biogas plant. The solution of that problem is to store the energy in silicat-containers and carry them to the user of the thermal energy.	
Plant Electrical power: 165 kW Thermal energy: 350 kW Need of biomass: 4.100 t/a Biogas production: 500.000 m³/a Gained electrical power: 1.000 MWh/a Own use: 100 MWh/a Gained thermal energy: 1.600 MWh/a Own use: 130 MWh/a Organic garden compost: 1.100 t/a	*(Bio)fuel:* Organic waste from farms, food and countryside
Ecological aspects No specific information	
Economical aspects Costs: 1.070.000 € Costs per year: 20.000 €/a Costs for receiving the waste: 0 - 40 €/t	
Social aspects Need of personal: two half worker The project is promoted by the "Bundesministerium für Wirtschaft" (195.000 €) Loan: 570.000 € (Internationalen Bankhaus Bodensee AG)	

15. Biogas power plant for poultry waste in the UK

<table>
<tr><td>POULTRY-LITTER POWER STATION</td><td>Country/Region
THETFORD,UK</td></tr>
<tr><td colspan="2">General description/Overall Concept of the project
The Fibrowatt Thetford poultry-litter power station is one of the largest plants producing power from biomass in Europe and one of the three of similar characteristics existing in the U.K. (all of which were built by the same developer). The other plants are at Eye in Suffolk (12.7 MW, opened in July 1992) and Glanford North Lincolnshire (13.5 MW, opened in November 1993). It is also the largest NFFO (Non - Fossil Fuel Obligation) scheme existing in the U.K. at present.
The project was awarded a NFFO3 contract in 1994, and construction began in August 1996. The plant was commissioned in October 1998.</td></tr>
<tr><td>Plant
The plant has an output of 38.5MW of electricity (estimated, according to the plant’s managers, to be sufficient to supply a town of around 93,000 homes- ten times the size of Thetford) and consumes approximately 400,000 tonnes per year of poultry litter complemented with other organic fuels. By way of comparison, it is worth noting that the calorific power of poultry litter when used as a fuel is about a half that of coal.</td><td>(Bio)fuel:
poultry litter complemented with other organic fuels.</td></tr>
<tr><td colspan="2">Economical aspects
Senior debt €91 m
Junior debt €12.8 m
Subordinated debt €3.3 m
Ordinary share equity €3.3 m
Total €110.4 m</td></tr>
<tr><td colspan="2">Social aspects
No information</td></tr>
<tr><td colspan="2">General Remarks and Assessment
The process is a traditional one, organised in several steps. First, poultry litter is collected in covered lorries from nearby farms and delivered to the plant. The fuel is delivered to a 4000 m^2 hall (fuel hall) specially designed for this purpose.</td></tr>
</table>

Source: BEST PRACTICE PROJECTS YEARBOOK 1997-2000, S. 147

16. Biogas plant with farm and industrial waste in Ireland

ANAEROBIC CAMPHILL COMMUNITY	**Country/Region** Ballytobin, IR
General description/Overall Concept of the project Ireland is considered to be among the countries of the EU with the greatest potential per capita for farm biogas. However, despite this potential, it was not until 1999 with the construction of Camphill digestion plant, that a decentralised anaerobic digestion plant was created in this country. The main aim of the project was to test the development and operation of a centralised anaerobic digestion plant in Ireland in order to study the feasibility of using farm and industrial (from the agro-food industry) wastes as the basis of a profitable renewable energy enterprise. The installation is located in the Ballytobim Camphill Community (a residential therapeutic centre for disabled children and adults, located within a 20 acre farm).	
Plant Wastes feeding the digester come from farms and food-processing industries (a creamery and brewery) located close to the plant. The gas produced after the anaerobic digestion of the wastes is burned in a traditional CHP installation. The solid effluent resulting from the process is composted and sold as organic garden compost.	*(Bio)fuel*: Feasibility and industrial wastes
Economical aspects Total cost of the project was €140,000. It was financed by the Irish Government and by the European Commission through the Horizon Programme, LEADER II Community Initiative and the ALTENER programme (having received €70,000 within the framework of this contract).	
Social aspects No information	
General Remarks and Assessment The electricity produced from waste treatment is used to meet the energy requirements (both heat and power) of the 90 people living in Ballytobin Camphill Community, estimated to be 150,000 kW of electricity and 500,000 kWh of primary energy for heating per year. Moreover, employment in a rural enterprise has been created for people with disabilities.	

Source: BEST PRACTICE PROJECTS YEARBOOK 1997-2000, S. 107

17. Heating and cooling with biomass in Portugal

BIOMASS POWERED HEATING AND COOLING NETWORK AT A HOTEL	**Country/Region** Alfândeda da Fé, PT
General description/Overall Concept of the project Taking in account the abundance of the particular renewable energy resource (almond shells) and the concern for environment protection in a tourist region, the promoter (AlfândegaTur Company) took the decision to develop a project for the rational use and exploitation of the resource. Furthermore, the project aimed to avoid the consumption of conventional energies (thereby reducing emissions) and to demonstrate that the use of almond shells as a fuel can be an alternative or complementary energy supply.	
Plant The project was promoted by AlfândegaTur (a tourism company) and envisages the use of almond shells, a locally available biomass resource, to provide heat and cooling at a hotel. For this purpose a system was installed comprising a 300 kW boiler running on almond shells, and a 100 kW propane gas boiler as a backup energy source. The installation also includes a solar system (60 m2) and a 220 kW absorption chiller. The system also comprises domestic hot water storage tanks and units for air conditioning. The Agência Municipal de Energia de Sintra (AMES) collaborated with AlfândegaTur during project implementation and also carried out dissemination activities.	*(Bio)fuel*: almond shells
Economical aspects • Total investment: €274,338 • Co-financing: 50% from Programa Energia • Payback period: 8.7 years	
Social aspects No information	
General Remarks and Assessment The project was promoted by AlfândegaTur with the collaboration of AMES.	

Source: BEST PRACTICE PROJECTS YEARBOOK 1997-2000, S. 129

18. Integrated energy production from biomass combined with pellet production in Germany

<table>
<tr><td>BIOMASS POWERED CHP PLANT including PELLET PRODUCTION PLANT</td><td>Country/Region
Freiburg/Buchenbach, DE</td></tr>
<tr><td colspan="2">General description/Overall Concept of the project
The former fossil fuel based energy provision of the sawmill in Dold/Buchenbach has been replaced by a new bioenergy concept. The bioenergy concept comprises a CHP-Plant which fires sawmill residues. Power is fed in the public grid (compensation according to Renewable Energy Sources Act).
Additionally, a pellet production plant has been built (start of production 2005). The waste heat of the CHP-Plant serves to dry the wet sawdust. Thus an integrated concept of heat/power production and of pellet production has been installed.
In October 2004 the “Biozentrum Cold/Buchenbach” received the “Deutscher Contracting Award 2004” because of the overall concept and the integration of wood pellet plant and CHP-Plant.</td></tr>
<tr><td>Plant
• Boiler output 11 t/h
• Electrical capacity 1.2 MW_{el}, Thermal capacity 9 MW_{th}
• Amount of Biofuel 20 000 t/a
• Fully automatic continuous operation (8 000 ha/a)
• Efficiency 85%
Pellet Plant (start of production: 2005)
• Pellet production: 35 000 t/a
• Utilisation of 28 000 MWh heat</td><td>(Bio)fuel for CHP-Plant:
Natural sawmill residues (bark, saw dust, pieces of wood, strands)</td></tr>
<tr><td colspan="2">Ecological aspects
CO_2-mitigation CHP-Plant: 17 000 t/a
The first phase of implementation resulted in a 40% reduction of the heat amount compared to the situation before.</td></tr>
<tr><td colspan="2">Economical aspects
Investment costs CHP Plant: 5.2 Mio. €, Investment costs pellet plant: 3 Mio. €</td></tr>
<tr><td colspan="2">Social aspects
No specific Information</td></tr>
<tr><td colspan="2">General Remarks and Assessment
Very innovative project which additionally includes contracting.
The project is part of an integrated concept which developed 5 components relevant for an integrated cycle of biomass provision and utilisation:
• Co-operation with wood industry, forestry and agriculture
• Decentralised CHP
• Integrated Pellet Production Plant
• Trade and logistics
• Contracting with pellets.</td></tr>
</table>

Source: Kaier, EC Bioenergie GmbH (2004), http://www.dold-holz.de/

19. Production of liquid biofuels from biomass in Germany

Biofuel production plant CHOREN	**Country/Region** Freiberg, DE
General description/Overall Concept of the project CHOREN is the first commercial biomass-based plant to produce CHOREN Fuel (biomass-fuel). The project was launched in October 2003 and the start of the production is planed for the year 2005	
Plant CHOREN developed the Carbo-V®-technology, an innovative process to gain synthetic biofuel. The plant is able to use a few kind of organic material. The important output is the CHORENFuel® but you either get electrical power and thermal energy.	*(Bio)fuel:* *biomass of any kind*
Ecological aspects The plant has a capacity of 5,000 to 13,000 tonnes of biofuels per year and delivers fuel for 10.000 cars.	
Economical aspects Many experts expect, that at the end of the 21th century there are no more fossil fuels available. Because of this, methods have to be developed to produce fuels based on renewable materials. CHOREN began at the 90th to develop the technology for this project.	
Social aspects Effects on employment: 65 persons get work	
General Remarks and Assessment The bio-fuel is known under the trademark "**SunFuel" -** *made by CHOREN.* The project is promoted by the "Bundesministerium für Wirtschaft" (5,5 million euro) and the automobile industry (DaimlerChrysler AG and VW; each one million euro).	

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