IEA Bioenergy Task 40:
Country Report Germany 2011

(final draft version)

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1 General introduction

The International Energy Agency (IEA) established the Task 40 "Sustainable International Bioenergy Trade: securing supply and demand" in December 2003[1]. Currently, countries participating in Task 40 are Austria, Belgium, Brazil, Canada, Finland, Germany, Italy, Japan, the Netherlands, Norway, Sweden, the United Kingdom, and the USA.

1.1 Germany: A Brief Profile

Germany is located in the centre of Europe, sharing approx. 3,600 km of borders with 9 EU Member States, and covers an area of 357,093 km^2 (DESTATIS 2008).
In 2011, Germany had a population of 81.8 million living in 40 million households, and generated a GDP of approx. 2.6 billion $€_{2010}$. (DESTATIS 2012).

A share of approximately 31% (11 mill. ha) of the German land area is covered by forests, and approx. 20% (7.5 mill. ha) is managed forests[2]. Agricultural area covers approx. 17 million hectares (48%), of which some 12 mill. ha are arable land, and about 5 mill. ha pasture and grassland.
The agroforestry sector in Germany had a share of 1 % of the gross value added in 2010.

1.2 Overview of this Report

This report highlights the state and prospects of bioenergy utilization in Germany, covering all bioenergy sources and applications.
Section 2 gives a brief **overview** of the German energy system, and **Section 3**, briefly describes the German **policies on bioenergy**.
Section 4 presents bioenergy potentials in Germany, while **Section 5** presents the current markets of bioenergy, including production and key market segments, and **Section 6** introduces future market projections for bioenergy use.
Section 7 gives a brief overview to bioenergy prices and consumption, and **Section 8** provides data on **crossborder trade** of biomass.
Section 9 presents barriers and opportunities regarding emerging bioenergy markets and trade in Germany

Work for this report was carried out within ongoing research activities on bioenergy of Oeko-Institut and DBFZ, sponsored by the German Federal Ministry for Environment, and the Federal Ministry for Agriculture through their respective Agencies FNR and UBA.

[1] For details, see www.bioenergytarde.org
[2] The forest sector and subsequent timber and wood industries had an annual turnover of approx. 170 billion € in 2010, and employed approx. 1.2 million people.

2 The German Energy System

In 2010, Germany used approx. 14 EJ of primary energy – of that, 4.7 EJ came from oil, 3 EJ from natural gas, 1.7 EJ from hard coal and 1.5 EJ from lignite, and 1.5 EJ from nuclear (primary energy equivalent). All renewables contributed 1.3 EJ, i.e. 9% of all primary energy (AGEB 2011).
Preliminary data for 2011 indicate a total primary energy consumption of 13.4 EJ, with 4.5 EJ from oil, 2.8 EJ from natural gas, coal remaining at 3.2 EJ, and nuclear declining by some 23% due to the phaseout policy implemented after Fukushima (AGEB 2012). All renewables contributed 1.5 EJ, now representing 11% of all primary energy used in Germany.

2.1 Renewables in the German Energy System

Between 1990 and 2010, the share of renewable energy in energy supply in Germany increased more than fivefold - from 2 % to 11 % of the final energy consumption (BMU 2012).

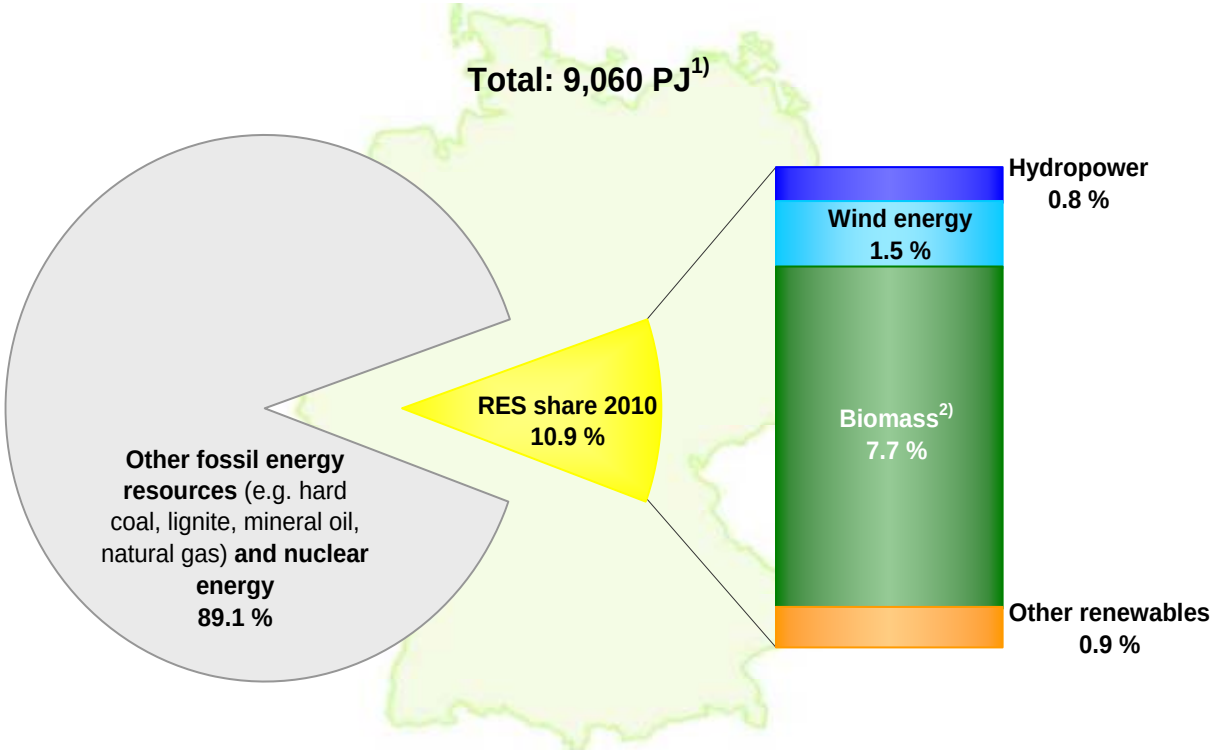

Figure 2-1: Shares of renewables in the German energy system in 2010 (BMU 2012)

While originally the main renewable energy source in the electricity sector was hydropower and use of wood for heating prevailed, nowadays advanced technologies are to be found in all application areas of renewable energies.
A mix of wind, biomass, geothermal and photovoltaic systems is deployed in the electricity sector. In the heating sector, modern pellet heating, efficient biomass heating plants, biomass heat and power stations, geothermal heating plants and solar thermal systems are increasingly replacing fossil and fuels.
Biofuels provide an important and significant contribution to reducing greenhouse gas emissions in transport, accounting for 5.8 % of the fuel consumption in the sector.

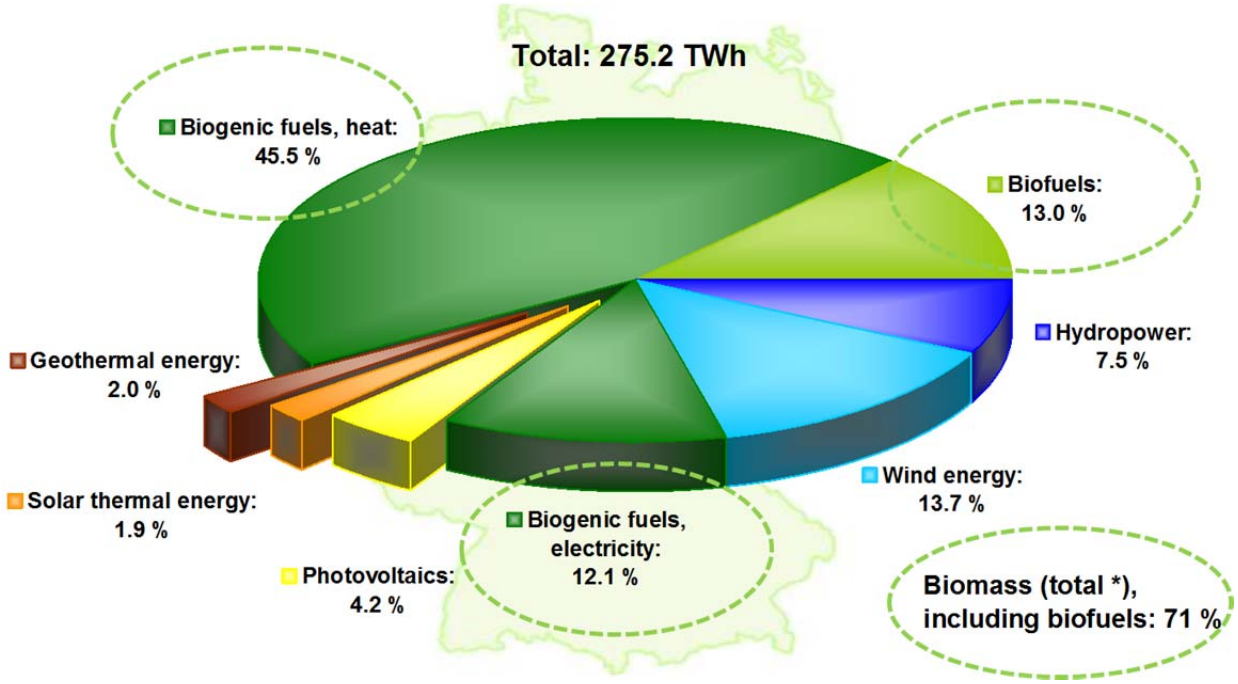

Figure 2-2: Renewable energies in the German energy system in 2010 (BMU 2012)

2.2 Renewables in the German Electricity System

Electricity generation from all renewable energy sources has increased more than five-fold, from 17 terawatt hours (TWh) in 1990 to over 104 TWh in 2010, representing more than 17% of all electricity generation. Whereas in 1990 91 % of renewable electricity was produced by hydropower, in 2010 it was only 20 % – while over 36 % derived from wind power and 32 % from biomass. In 2011, the share of all renewables in electricity generation increased even beyond 20%.

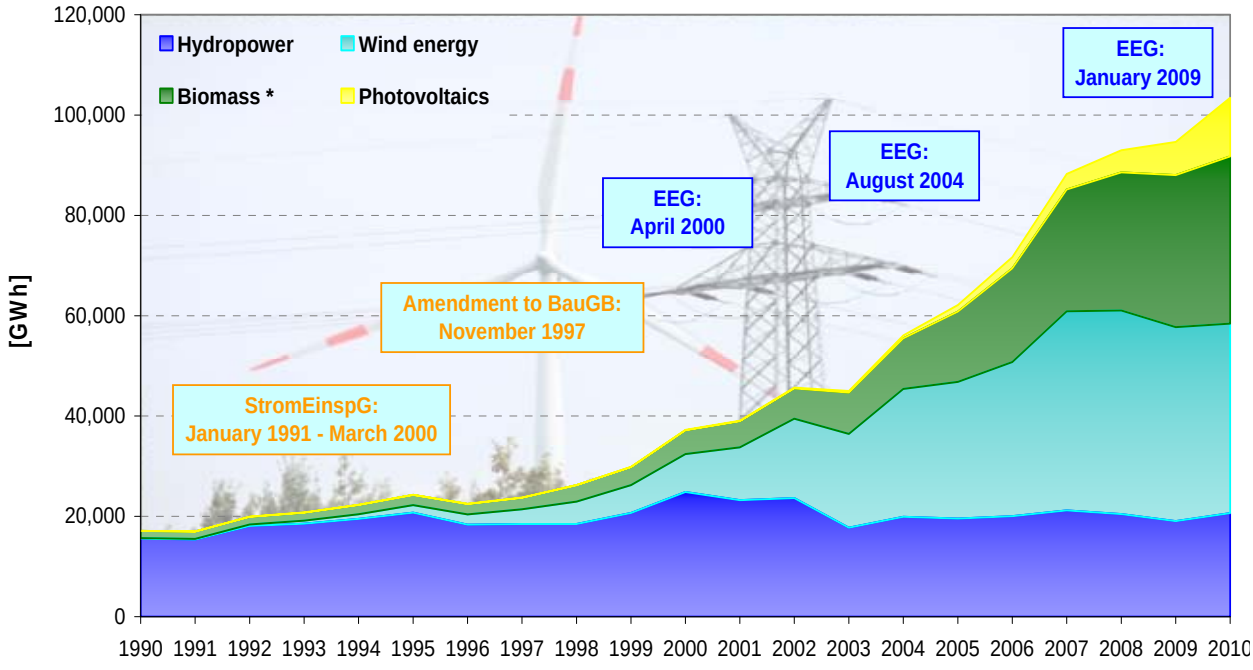

Figure 2-3: Renewable energies in the German electricity system in 2010 (BMU 2012)

The role of bioenergy in the German electricity generation is different from many other countries: biogas provides approx. 40 % of bioelectricity, followed by 35% from solid biomass.

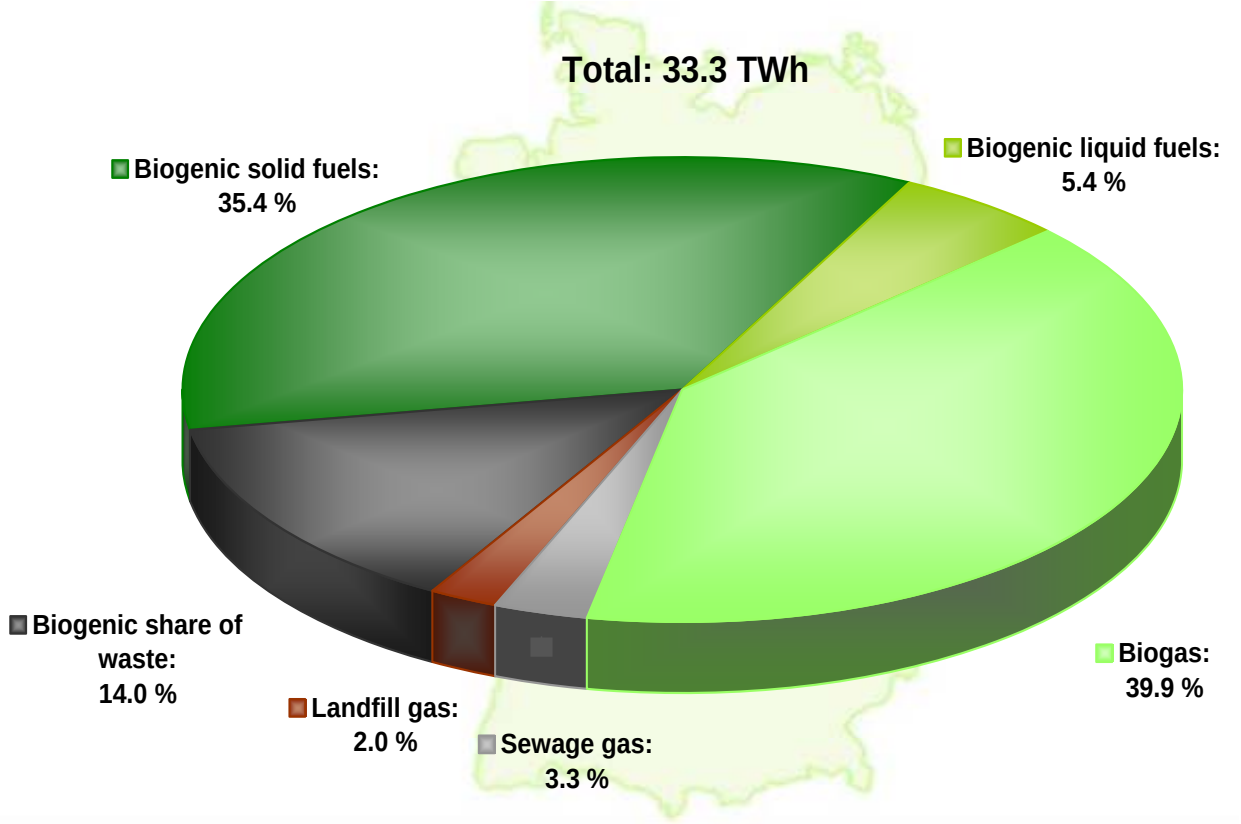

Figure 2-4: Bioenergy in the German electricity system in 2010 (BMU 2012)

2.3 Renewables in the German Heating Sector

In the heating sector, the energy supply from renewable energy sources from 1990 to 2010 more than tripled from just over 32 TWh to about 145 TWh. The use of solid biomass (mainly wood) was predominant throughout this period, and in 2010 still amounted for approximately 68 %.
If biogas, bioliquids and the biogenic share of waste are also included, use of biomass for heating purposes accounted for 92 % of all renewable resources.

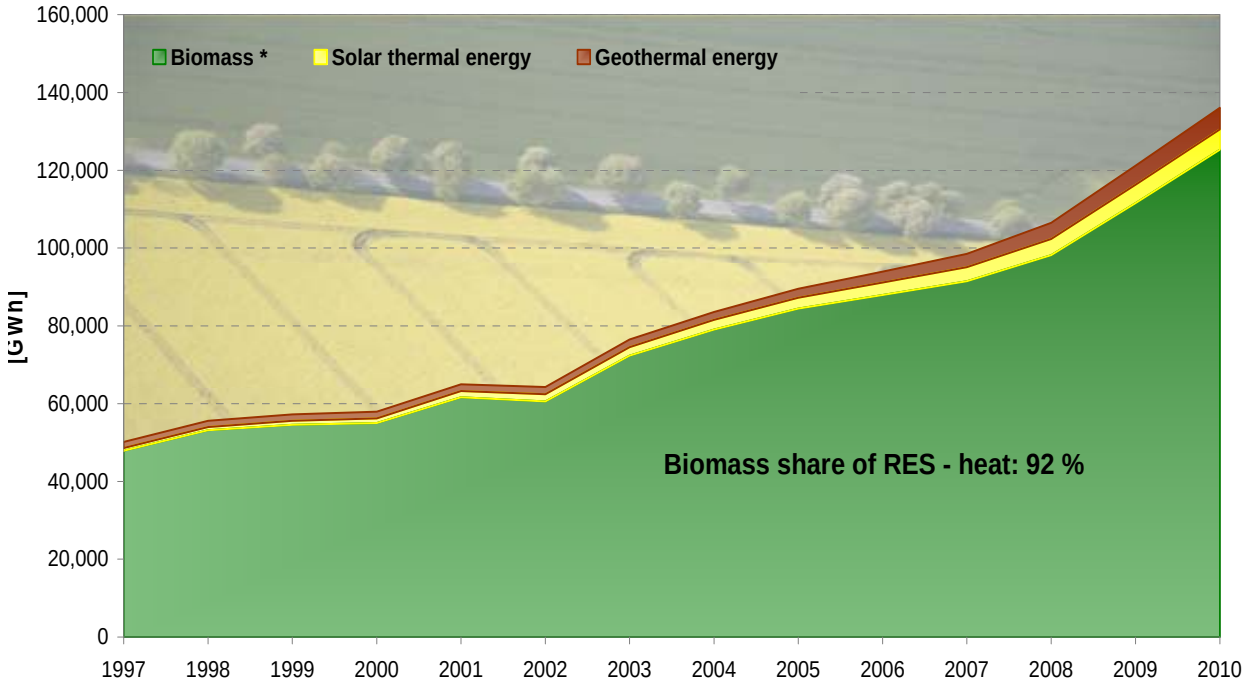

Figure 2-5: Renewable energies in the German heat system in 2010 (BMU 2012)

The role of bioenergy in the German heat sector is comparable to other countries, with solid biomass providing the major share.

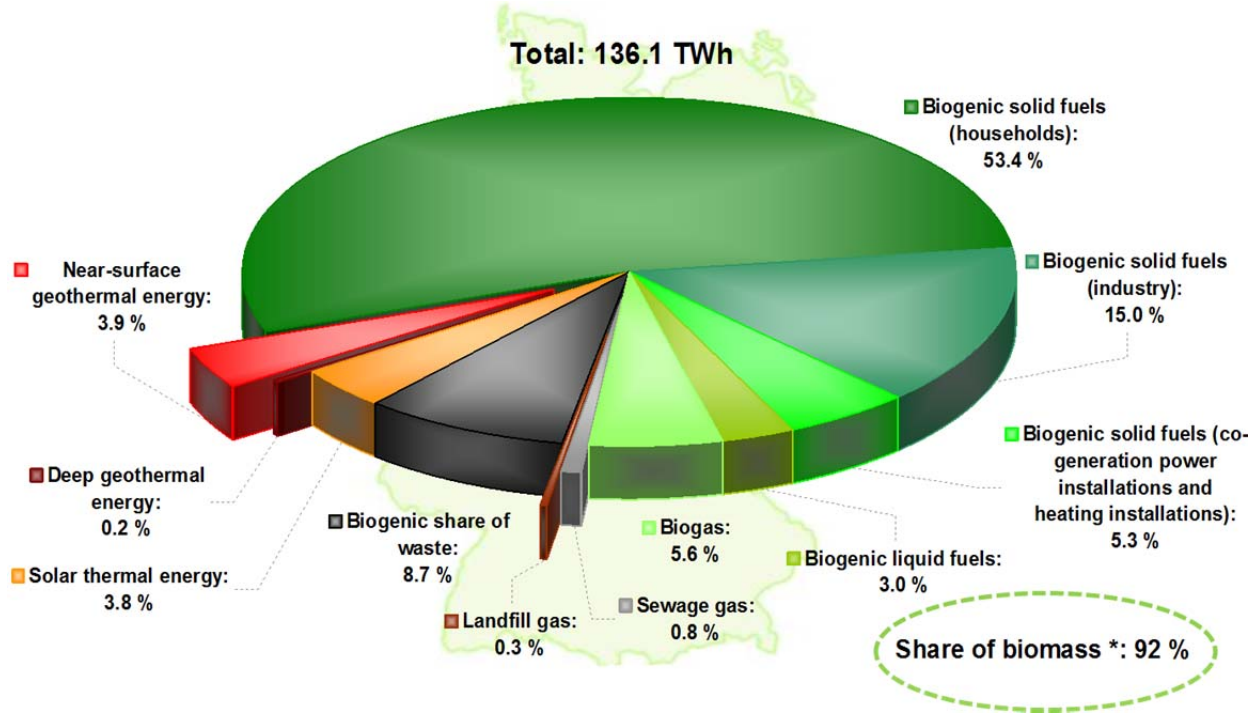

Figure 2-6: Shares of renewable energies in the German heat system in 2010 (BMU 2012)

2.4 Renewables in the German Transport Sector

The years 2004-2007 in particular recorded a boom in the use of biofuels in the transport sector, as their share in total fuel consumption rose from 0.4 % in 2000 to 7.2 % in 2007. From 2008 onwards, sales declined to 5.5 % in 2009, and rose again slightly to 5.8 % in 2010, representing an amount of 35.5 TWh. At the same time, the use of biodiesel and especially vegetable oil decreased, while consumption of bioethanol continued to grow.

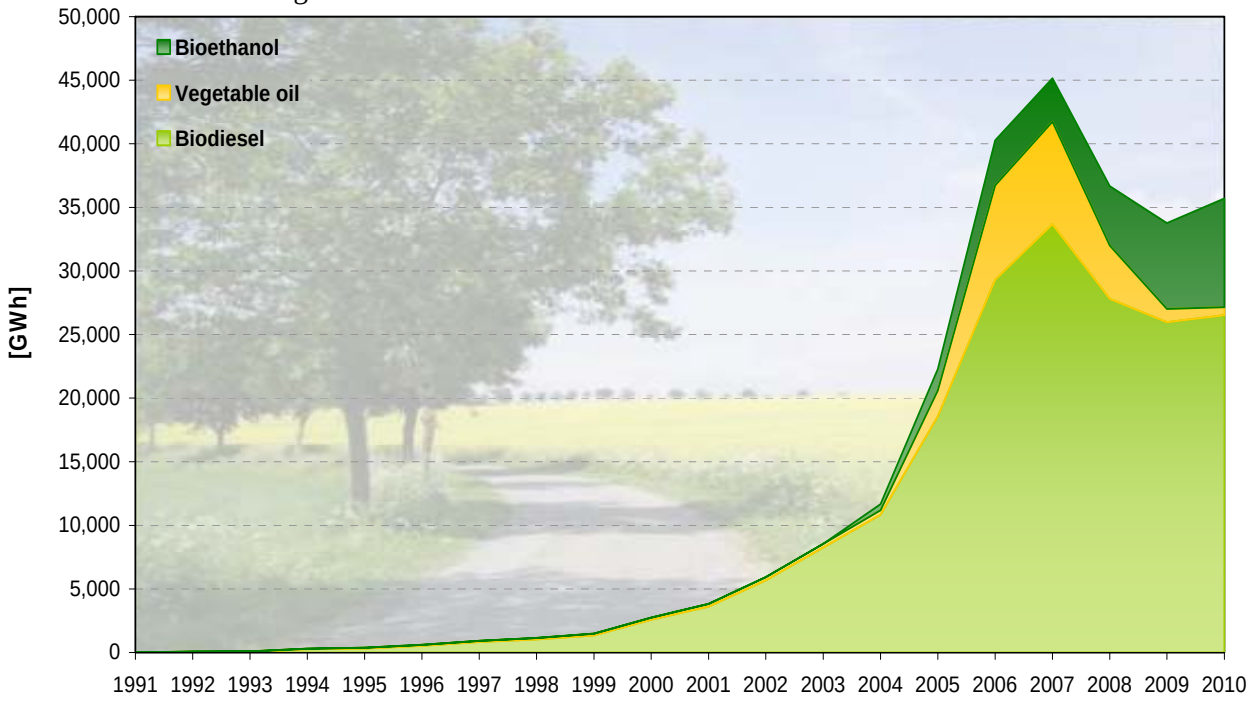

Figure 2-7: Shares of renewable energies in the German transport sector in 2010 (BMU 2012)

3 Policies on Bioenergy

Where, how and how much biomass contributes to energy supplies depends to a great extent on the legal context. There are not just considerations of regional development, planning and pollution to take into account but also laws regulating waste and fertiliser use.
In Germany, laws such as the Renewable Energy Sources Act (EEG[3]) or the Mineral Oil Duty Act forced the expansion of bioenergy through fixed payments for bioelectricity and tax relief for biofuels.
In addition to legislation, the German Federal Government is supporting the expansion of bioenergy through various research, development and market introduction programmes.
As a result, the framework conditions for using biomass as renewable source of energy have improved significantly in the last 20 years and led to a significant expansion of bioenergy in the German energy system.

3.1 Renewable Energy Sources Act (EEG)

The most important legal instrument to promote electricity production from renewable sources in Germany is the Renewable Energy Sources Act (EEG) which was first enacted in April 2000, and was revised in July 2004, June 2008, and 2009, with the lasted amendment in 2011 (coming into force on 1 January 2012).

The EEG offers fixed payments (feed-in tariffs) for every kilowatt-hour of renewable electricity supplied to the national grid. There are different tariffs according to type of renewable energy source, conversion technique and plant size. There also additional tariff elements (bonus payments) for using wood and other renewable resources that have been specifically cultivated for energy production (the “biomass bonus”), for CHP plants (“cogeneration bonus”) and for the use of innovative technologies (“innovation bonus”). The 2004 revision of the EEG’s tariff scheme which especially considered bioenergy led to a massive increase in the amounts of electricity produced from biomass.

The further improvements of the tariff scheme is expected to contribute to a further expansion of electricity (and cogenerated heat) from biogas, and from solid biomass CHP plants.

The 2009 EEG authorized the Federal Ministry for Environment (BMU) in cooperation with the Federal Agricultural Ministry (BMELV) to define sustainability requirements for the production of biomass used and the emission reductions achieved when producing electricity from biomass.

This power was used in early 2009 to introduce the Bioelectricity Sustainability Ordinance which applies for liquid biofuels used to generate electricity, and which makes the feed-in tariff biomass bonus of the EEG subject to proof that sustainability requirements have been complied with (BMU 2009b).

Depending on the further discussions on extending the EU Renewable Energy Directive (RED) to solid and gaseous bioenergy, the future amendments of the EEG might take into account respective regulation to which Germany is in favour.

3.2 Renewable Energy Heat Act

Germany’s Renewable Energy Heat Act (Erneuerbare-Energien-Wärmegesetz, or EEWärmeG) came into effect on January 1, 2009. Its provisions place owners of newly constructed buildings under obligation to use renewable energy to meet a portion of their heat requirements. Along with solar and ambient heat, bioenergy and geothermal heat may also be used.
Under the Act, bioenergy may only be used if it is generated using highly efficient technology (e.g. liquid biomass for conversion to fuel and gaseous biomass in CHP plants). For renewably generated heat, the provisions of the Act also allow building owners the option to use CHP and energy saving measures

[3] Erneuerbares-Energien-Gesetz

and to obtain heat from district heating plants if the network is fed from a CHP plant or partially supplied with renewable energy.

3.3 Market Incentive Programme for Renewable Energy

In Germany, using biomass to produce energy is – in general - more expensive than using fossil energy sources such as oil or gas where investment costs are concerned.
Not only are the plants technically more complex but they are still produced in relatively small quantities. As bioenergy could only assert itself slowly on the market despite its positive environmental effects, the Federal Government and the Federal States decided to accelerate its market introduction by various promotional schemes.
Since 2000, the Federal Government has been supporting the purchase of biomass plants such as central heating units using logs or wood pellets, biomass power stations and biogas plants through its Market Incentive Programme (Marktanreizprogramm, MAP).
This promotional scheme has given an impressive stimulus. From the beginning of the scheme until mid 2006, the BAFA[4] subsidised 70,846 small biomass plants (< 100 kW) altogether at a total cost of 126.5 million € and thereby released a total investment of 1 billion euros.
A loan scheme by the "Kreditanstalt für Wiederaufbau" (Credit Institute for Reconstruction) has assisted with 1,239 biogas plants, 1,185 biomass heating stations and 60 biomass CHP plants since it first started, representing a total investment volume of 725.5 million euros.

For the period of 201-2012, the German government made up to €500 million available for MAP to promote renewables-generated heat, including MAP research activities focusing on investments in buildings to increase the share of renewable energy in overall heat supply.

In addition, numerous biogas and biomass plants have been built in the agricultural sectors thanks to the Agricultural Investment Support Programme (AFP) of the joint scheme on "Improving the Structure of Agriculture and Coastal Protection" (GAK). The Federal government provides 60 percent of the funding for GAK measures. Applying for and coordinating promotional measures is a Länder responsibility. GAK also provides for bioenergy advisory services which are currently under review with regard to expanding their scope.

3.4 Biomethane Policy

The opportunities to feed upgraded biogas (biomethane) into the natural gas distribution grid to supply heat or being used in CHP plants and in the transport sector were improved through Germany's Gas Grid Access Ordinance (GasNZV), Gas Grid Payment Ordinance (GasNeV) and Incentives Ordinance (AregV) which were amended in 2007 and 2008 and entered into force on April 12, 2008.

The most significant changes involve the setting of a 6 % target by 2020 and a 10 % target by 2030 for Germany's gas demand to be met with biomethane.

The regulation also helps to remove barriers against biomethane grid-feed via special provisions, e.g., uniform quality standards, longer balance periods, greater scope for flexibility and special terms.

There are several activities of the German Energy Agency (DEnA) regarding biomethane: $$

3.5 Liquid Biofuel Legislation

Liquid biofuels for transport are regulated by European and national framework conditions. The EU passed Guideline 2003/30/EG in order to increase their share of the market. This commits Member States to increase the share of biofuels to 5.75 % by 2010. With the Renewable Energy Sources Directive of

[4] Federal Office of Economics and Export Control (BAFA), www.bafa.de

December 2008, a EU-wide mandatory target for renewable transport fuels was established which requires each Member State to achieve a 10% contribution of renewable transport fuels by 2020.
Under EU Guideline 2003/96/EG, member states can grant partial or full tax relief on biofuels. Biofuels were free of tax until July 2006 under the oil tax law in Germany, but now fall under the Energy Tax Law. This sets tax rates that rise year-on-year between August 2006 and 2012 until they reach the level of diesel and petrol. The agricultural and forestry sectors do not have to pay any taxes on biofuels.
There are also strict regulations about mixing biofuels in with other fuels. Fuel standards allow five percent of biodiesel to be added to diesel (DIN EN 590) and of ethanol to petrol (DIN EN 228) respectively.
Germany's Biofuel Quota Act obliges the petroleum industry to mix in set quotas of biofuels since 2007. From 2004 onwards, all biofuels for transport and heating became eligible for tax concessions. Following adoption of the Biofuels Quotas Act (Biostoffquotengesetz) by the German Bundestag (Lower House of Parliament) in October 2006, the tax concessions have been confined to pure biofuels **beyond** the quota, while admixtures to fossil fuels are supported via the biofuels quota, and tax exemptions are gradually phased-out.
In recent years, Germany saw a significant upward trend in biofuels, and by the end of 2007, biofuels already accounted for 7.6 % of total fuel consumption in Germany. Under the "Updated strategy on bioenergy" presented by BMU in April 2008, the expansion of biofuels will occur at a slower pace than previously planned, and expansion targets were adjusted accordingly. Under the new strategy, the total energy quota for 2009 under the Biofuels Quotas Act will be reduced from 6.25 %to around 5 %. The net climate protection contribution for 2020 previously envisaged in the Government draft on the Biofuels Quotas Act is to be reduced from 10 % to 7 %. The resultant national biofuel target of 17 % in energy terms (gross target) was reduced to 12 % (BMU/BMELV 2009).

3.6 General Targets for Renewable Energy

On 6 June, 2008 the German parliament enacted the new Renewable Energy Sources Act (EEG) and the Renewable Heat Sources Act (EE -WärmeG), defining the national targets: the contribution of renewables to electricity supply is to be increased to at least 30 % by the year 2020 and the contribution of renewables to heat supply is to be increased to 14 %.

3.7 Specific Targets for Bioenergy (Electricity, Heat, Biofuels)

The German government has made a clear commitment to promoting renewable energy sources and renewable raw materials. Its goals are largely a result of the EU Climate and Energy Package agreed in December 2008, and also of the outcome of a special Cabinet meeting held in Meseberg in late 2007.
The goals include:

- Increasing the share of renewable energy in electricity production to at least 30 percent by 2020.
- Using biofuels to achieve greater reductions in greenhouse gas emissions in the transport sector; from 2015, rather than being set relative to energy content, biofuel quotas will be based on net greenhouse gas reductions.
- Increasing the share of biofuels in overall fuel consumption to 7 percent of net greenhouse gas reductions by 2020 (equivalent to approximately 12 percent energy content).
- Increasing the share of renewables-generated heat from the current 6.6 percent to 14 percent by 2020.

Against this backdrop, the question arises as to how efficient, long-term socially and environmentally compatible promotion of biomass can be achieved while taking account of its availability and viability.

3.8 National Biomass Action Plan

The aim of the National Biomass Action Plan agreed between the Federal Ministries for Environment and Agriculture is to provide a holistic concept to significantly increase the bioenergy share in Germany's energy supply while adhering to sustainability criteria.
Bioenergy is an ideal choice in efforts to mitigate the effects of climate change, secure supply and promote economic development. It also serves in boosting domestic value creation – especially in rural areas.

According to the Action Plan, the development of bioenergy will be different in the demand sectors, and will show differences in the assumed increases until 2020 (see following table).
The Action Plan is – as its name implies – a plan, not a law nor legally binding in any other fashion. Still, the two key Federal ministries agreed on this "roadmap", and orient their policy development to this joint plan.

	2007		**2020**	
	all renewables	**of which bio-energy**	**all renewables**	**of which bioenergy**
Share of RE in primary energy consumption	6.7 %	4.9 %	16 %	11 %
Share of RE in end-energy	8.6 %	6.2 %	18 %	10.9 %
Share of RE in primary gross electricity consumption	14.2 %	3.9 %	minimal 30 %	8 %
Share of RE in heat supply	6.6 %	6.1 %	14 %	9.7 %

Source: BMU/BMELV (2009)

4 Biomass resources

The overall availability of biomass for energy in Germany has been subject to various studies in the last decade, with specific studies on the sustainable potential being carried out in the early 2000s (OEKO 2004; IE/BFH/OEKO 2006). The key results are shown in the following figure.

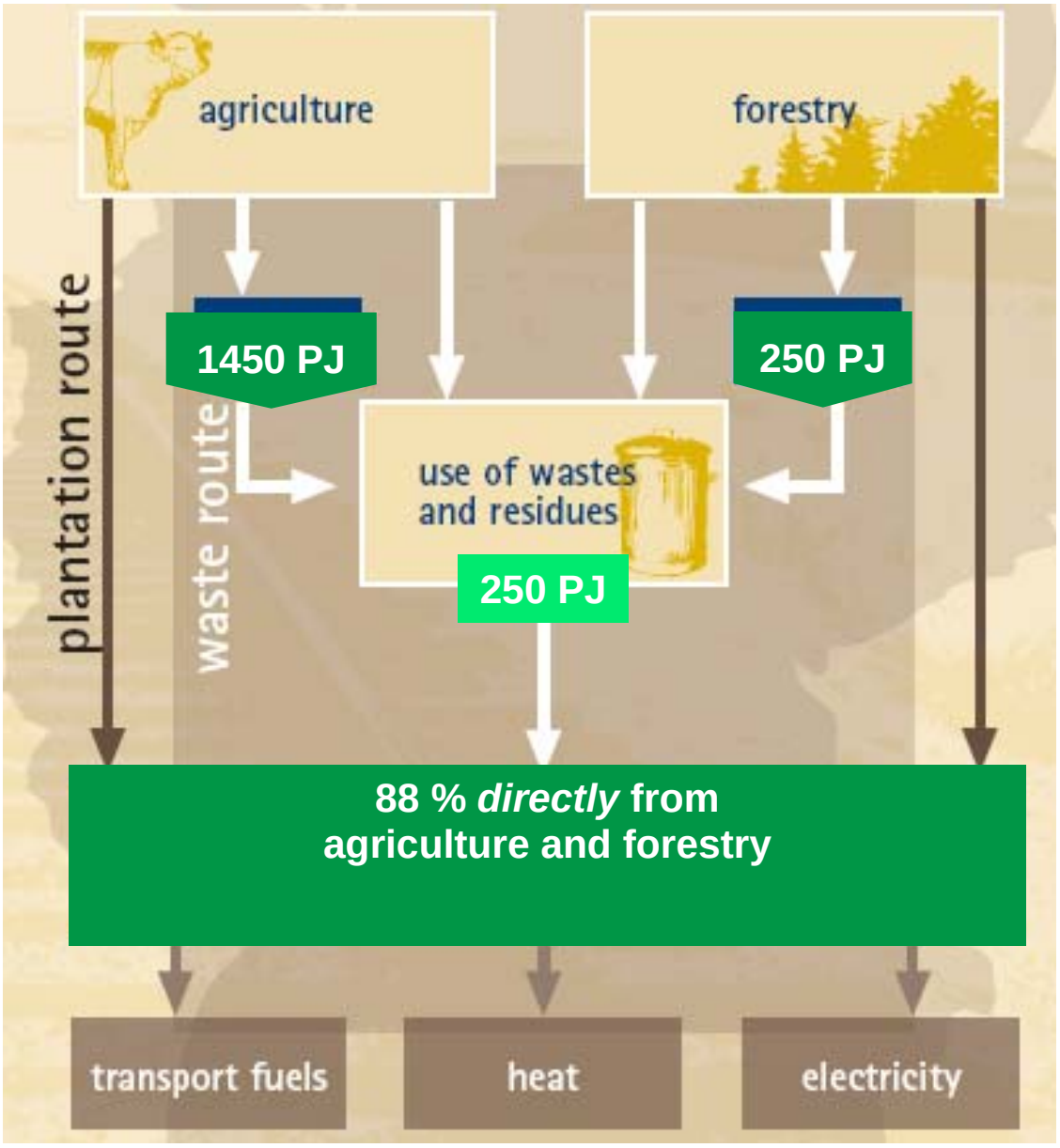

Figure 4-1: Sustainable Bioenergy Potentials in Germany by 2030 (OEKO 2004)

The domestic sustainable potential is changing in its composition of specific biomass feedstocks, as perennial feedstocks will gain drastically (see following figure).

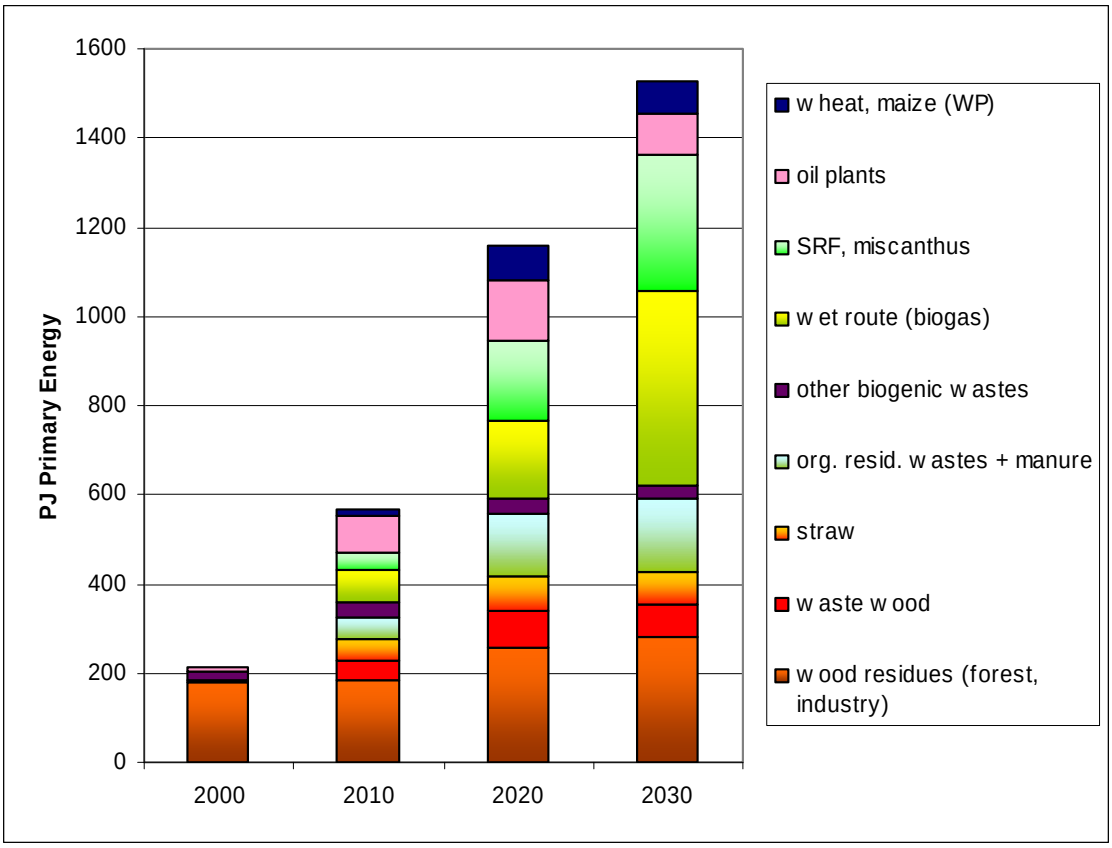

Figure 4-2: Bioenergy Feedstocks in the Sustainable Bioenergy Potentials in Germany by 2030 (OEKO 2004)

It should be noted that the shown domestic potential with regard to energy crops assumes that only the land area will be used which is “freed” from previous agricultural production due to yield increase, lacking economic competitiveness, and overall demand reduction which includes reduced exports of excess agricultural production.
The potential further **excludes** future available grassland due to the unfavourable greenhouse-gas balance of converting such land for bioenergy production.

The medium-term cost/supply curve for sustainable bioenergy in Germany was part of the analysis in the EU FP7 project “Biomass Futures” (www.biomassfutures.eu), the preliminary results are shown in the following figure (for 2020).

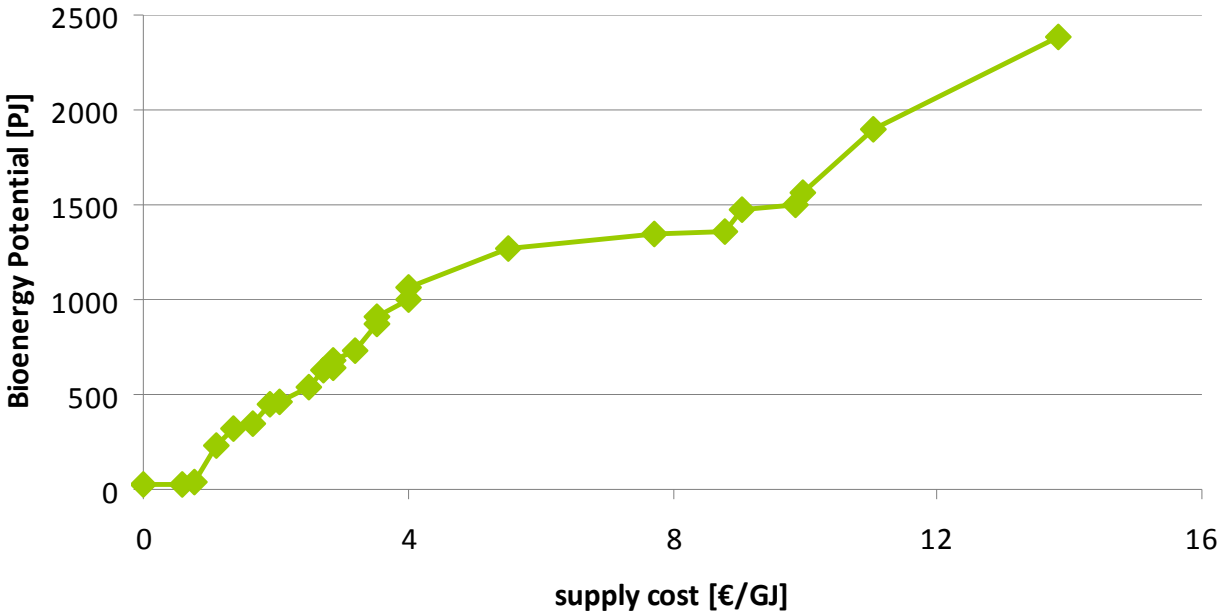

Figure 4-3: Cost and Supply of Sustainable Bioenergy Potentials in Germany by 2020 (Alterra/OEKO 2012)

As can be seen, bioenergy offers a high potential in Germany, but in the longer-term, other renewables – especially wind, geothermal and solar – will have significantly higher contributions with the exception of the transport sector where biofuels are thought to dominate until 2030.

5 Current biomass users

The following overview on the biomass use for electricity generation in Germany is mainly based on the results of a project[5] that does research on the development of the bioenergy market due the Renewable Energy Sources Act (EEG). Unfortunately, there is no central statistics in place that records the number of biomass installations and their respective capacities as well as the volumes of biomass consumed for energy-related purposes. Hence the presented figures are not total figures but do cover the majority of biomass installations etc. in Germany since the EEG is the main policy instrument promoting electricity provision from renewable sources.

Concerning biomass installations and consumption on the heating market data from biomass associations as well as market surveys is used and evaluated.

5.1 Gaseous biofuels

Gaseous biofuels (in particular biogas) are predominantly used for electricity generation as well as for the combined heat and power (CHP) generation in Germany. Biogas is mostly produced in rather small-scale installations on farms, in larger plants for bio-waste digestion and in larger landfill and sewage gas plants. Most of the biogas plants are designed for electricity generation and a corresponding feed-in into the electricity grid. In order to use the resulting heat in the best possible way biogas installations are directly built where the need of energy arises. In the recent years alternative options for biogas utilization became more popular. Technologies for the upgrading of biogas to biomethane with subsequent feed-in into the natural gas grid or the use of micro gas grids for the central conversion of biogas to electricity become more and more important.

The number of biogas plants has increased continuously in Germany since the Renewable Energy Sources Act came into force in 2000. Due to the amendments of the Renewable Energy Sources Act in 2004 and 2009, the development of biogas plants (number and installed capacity) has received significant impetus. By the end of 2010, about 5,900 biogas plants with an installed capacity of about 2,300 MW_{el} were in operation. Regarding the amendment of the Renewable Energy Sources Act coming into force at the beginning of 2012, an additional increase in start-ups of biogas plants is expected. By the end of 2011, about 7,000 biogas plants with an installed capacity of 2,700 MW_{el} are expected to be in operation (Figure 5-1) (DBFZ 2011).

[5] Deutsches Biomasseforschungszentrum gGmbH (DBFZ) (2011): Monitoring zur Wirkung des Erneuerbare-Energien-Gesetzes (EEG) auf die Entwicklung der Stromerzeugung aus Biomasse.

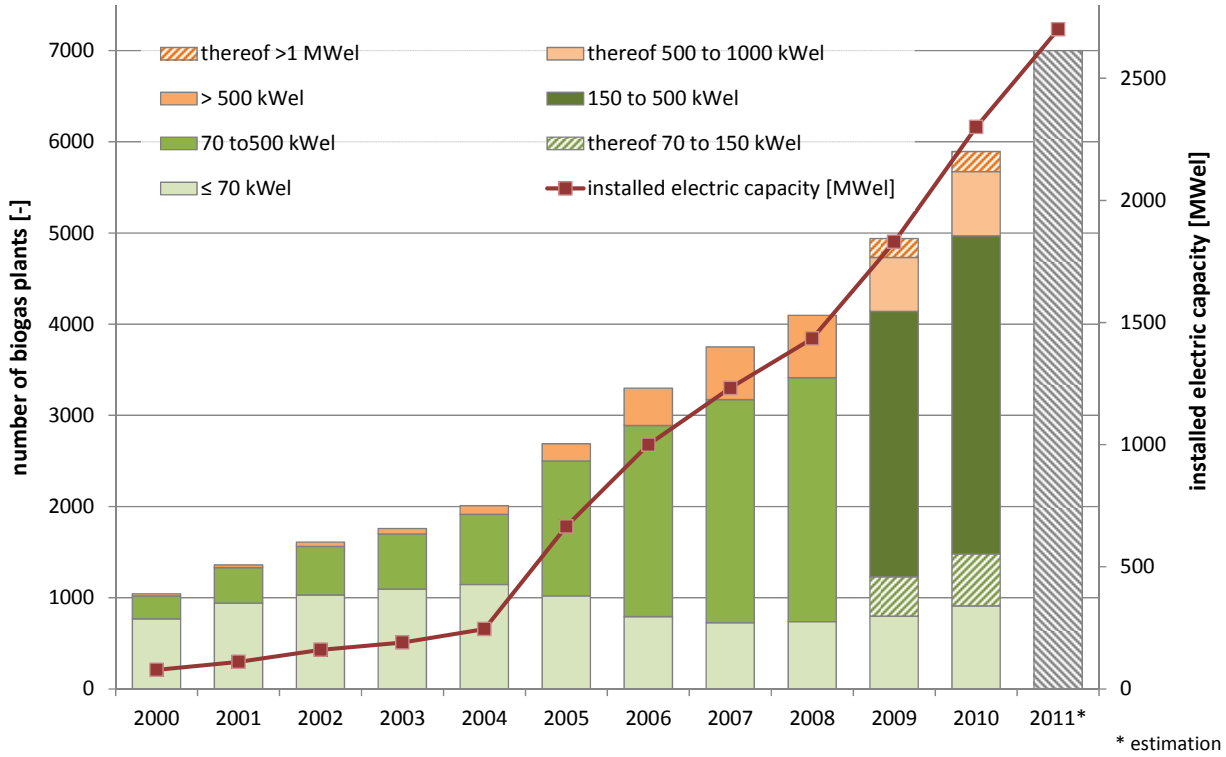

Figure 5-1: Development of biogas plants Germany (number of plants and installed electric capacity in MW_{el}), without biogas upgrading plants, landfill and sewage gas plants (DBFZ 2011)

In the past two years (2009 and 2010) the yearly number of newly installed biogas plants showed the strongest increase in the history of the EEG. This is due to the amendment of the Renewable Energy Sources Act in 2009 that considerably improved the feed-in tariffs for electricity generation from biogas. Hence, inducements for the construction of small- and medium-sized biogas plants (< 300 kW_{el}) were given. As shown in Figure 5-1 the installed electric capacity of most biogas plants lies between 150 and 500 kW_{el}. The average electric capacity of biogas plants in Germany in 2010 is about 380 kW_{el}.

Regarding the regional distribution, biogas plants are mainly built in North-western and Southern Germany. In Southern Germany biogas plants of small and medium capacity (< 325 kW_{el}) predominate, whereas in Northern and Eastern regions (Lower Saxony, Mecklenburg-Western Pomerania, Brandenburg and Saxony-Anhalt) facilities with a higher capacity (> 325 kW_{el}) predominate. Due to the amendment of the Renewable Energy Sources Act 2009 the differences have been decreasing. Figure 5-2 gives an overview of the regional distribution of biogas plants in Germany by the end of 2010.

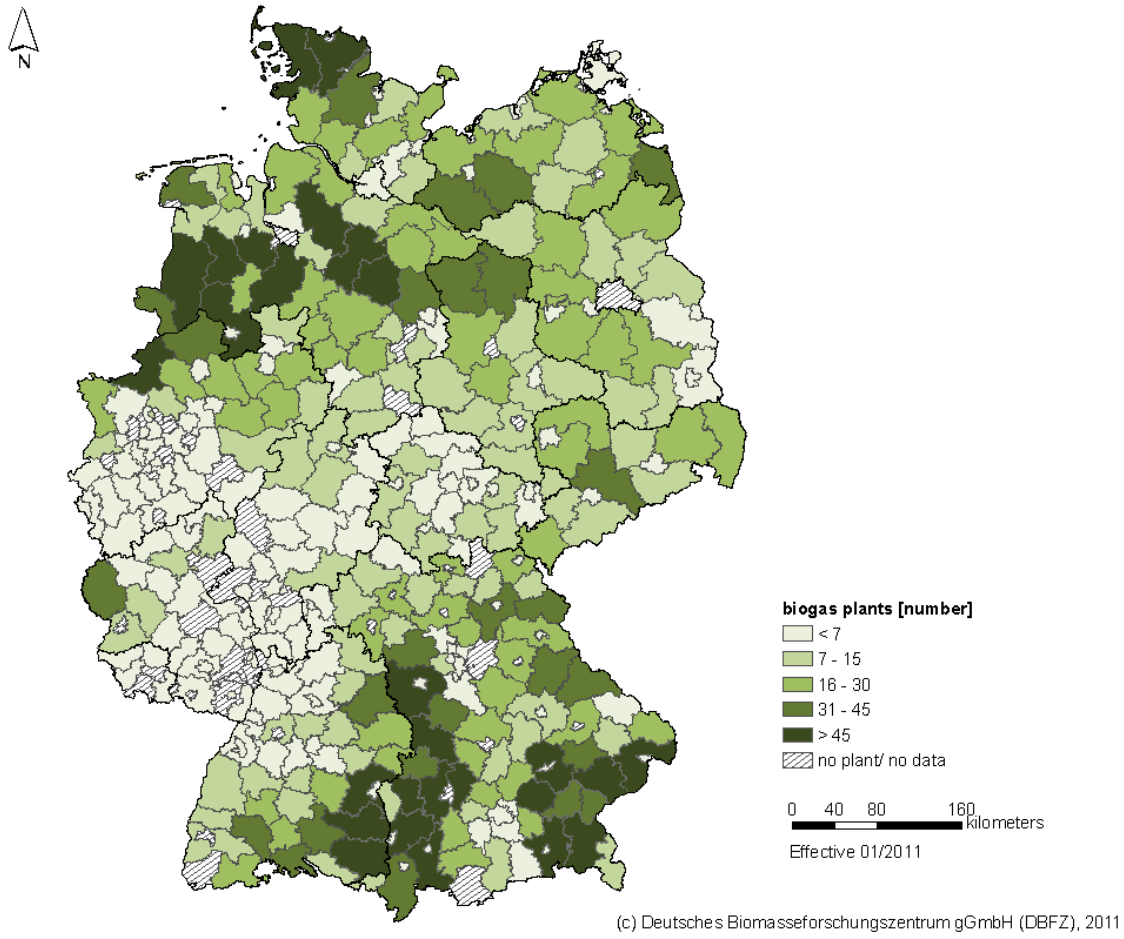

Figure 5-2: Distribution of biogas plants in Germany in 2010; reference level: administrative district (DBFZ 2011)

Besides on-site electricity generation, 50 biogas upgrading plants with an overall installed gas capacity of about 341 MW were in operation by the end of 2010. 19 new plants for upgrading biogas to biomethane with subsequent feed-in into the natural gas grid came into operation in 2010. Regarding the regional distribution, biogas upgrading plants are predominantly built in Southern Germany and Lower Saxony. The highest upgrading capacities are installed in Eastern Germany. At two plant sites in Germany the upgraded biomethane is directly used as vehicle fuel.

Table 5-1 shows the number of biogas plants and biogas upgrading plants in Germany by the end of 2010.

Table 5-1: Distribution of biogas plants (on-site electricity generation) and biogas upgrading plants (number and installed electric capacity/ upgrading capacity) in Germany by federal states in 2010 (DBFZ 2011)

	Biogas plants (on-site electricity generation)		Biogas upgrading plants	
	Plants in operation [number]	Total installed electric capacity [MW_{el}]	Plants in operation [number]	Upgrading capacity [Nm^3/h]
Baden-Wuerttemberg	709	202.8	7	2,195
Bavaria	2,030	548.9	7	4,842
Berlin	-	-	-	-
Brandenburg	190	120	4	3,870
Bremen	-	-	-	-
Hamburg	1	1	-	-
Hesse	100	37	4	1,038
Mecklenburg-Western Pomerania*	207	145.2	2	6,500
Lower Saxony	1,073	560	12	4,735
North Rhine-Westphalia	432	171	7	3,270
Rhineland-Palatinate	105	42	-	-
Saarland	9	3.5	-	-
Saxony	189	81.7	-	-
Saxony-Anhalt**	226	118	5	6,805
Schleswig-Holstein***	380	152	1	410
Thuringia	174	83.4	1	345
Germany Total	5,825	2,266.5	50	34,010

*number of production sites (biogas parks with more than one biogas plant are summarized)
**in operation and under construction
***estimated by DBFZ

Biogas plants are operated to a large extent by agricultural holdings. In general agricultural biogas plants are small- to medium-size installations with a capacity of 350 kW_{el} on average. The main substrates used in this type of plants are animal excrements as manure and dung and renewable raw materials as maize silage. The generated electricity is fed into the electricity grid. The amount of heat used in relation to the total produced amount of energy is between 25 and 40 % on average. In many cases heat is used for heating residential buildings and buildings for livestock on the farms (DBFZ 2011).

Besides agricultural biogas plants that use animal excrements and renewable resources there is a variety of digestion plants in operation that use biowaste, organic waste, or industrial organic waste (e.g. organic kitchen waste, food waste). Furthermore, organic waste like fats from fat separators or slaughterhouse

waste is used for biogas production. Currently, the utilization of biowaste as well as organic and industrial waste plays a minor role. By the end of 2010, about 120 biogas plants that exclusively or predominantly use biowaste and organic waste were in operation. According to the Federal Bureau of Statistics, biowaste or organic waste was used in a total of 301 biogas plants in 2009. That corresponds to about 5% of all biogas plants in Germany by the end of 2009 (destatis 2011a). In recent years existing composting plants have been expanded by a fermentation stage. Moreover, there are currently about 20 biogas plants that ferment process waste water from the pulp and paper industry. Biogas plants that utilize organic and industrial waste often operate with a higher installed capacity than an average agricultural plant. The average installed electric capacity is between 700 and 1,500 kW.

The input materials used in biogas plants in Germany are mainly animal excrements and renewable resources. The implementation of a bonus for renewable resources within the Renewable Energy Sources Act of 2004 has changed the type of substrate utilized in biogas plants. Since then the share of renewable resources has been increasing continuously. Today manure/dung and renewable resources account for more than 90 % of the biogas substrates that are used in German biogas plants referring to the mass content. According to the operators of biogas plants, the use of biowaste and leftovers amounts to about 7 % (Figure 5-3). Regarding the energy content of substrates used a shift towards the use of renewable resources can be noticed. About 80% of the energy supply from biogas results from renewable resources.

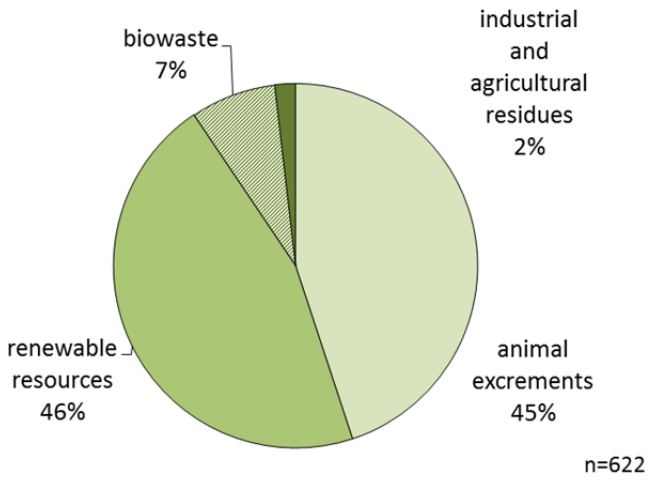

Figure 5-3: Input materials in biogas plants referring to the mass content

A differentiation of the renewable resources (energy crops) used in relation to the mass content is shown in Figure 5-4. Maize silage still dominates the use of renewable resources and accounts for about 75 % of the input of renewable resources in biogas plants. Overall maize silage plays a prevalent role in the biogas production in Germany. Grass silage contributes with a share of about 11 % to the total input of renewable resources in biogas plants. Compared to maize silage and grass silage whole-plant cereal silage and cereal grain are of minor importance. Today, sugar beet accounts for just 1 % of the renewable resources input.

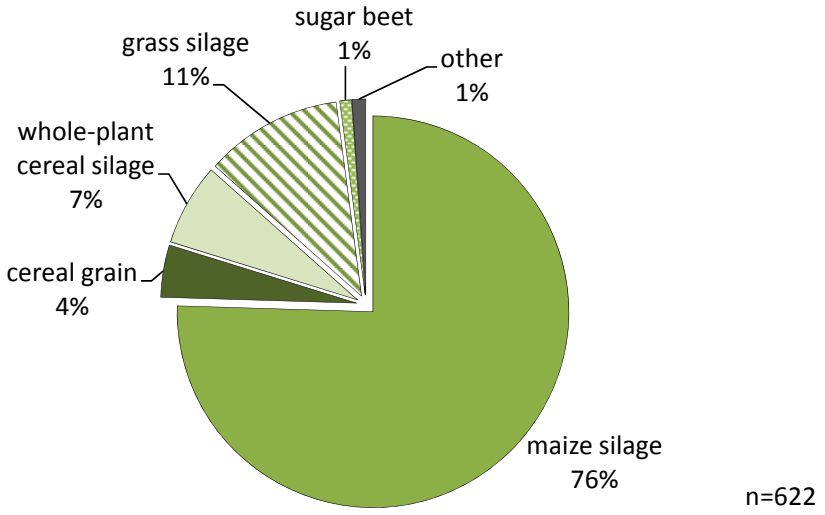

Figure 5-4: Input materials in biogas plants from energy crops, referring to the mass content

5.2 Solid biofuels

5.2.1 Solid biofuels for electricity generation

Currently, there are 249 registered combined heat and power plants with an accumulated installed electric capacity of 1,236 MW_{el} in place, which use solid biogenic matter as feedstock. These facilities are eligible for remuneration under the Renewable Energy Sources Act (EEG). Due to this act the number of bioenergy plants increased significantly in Germany. Compared to the year 2000 the number of installations has increased fivefold and the respective installed power tenfold until the reporting year 2010 (Figure 5-5).

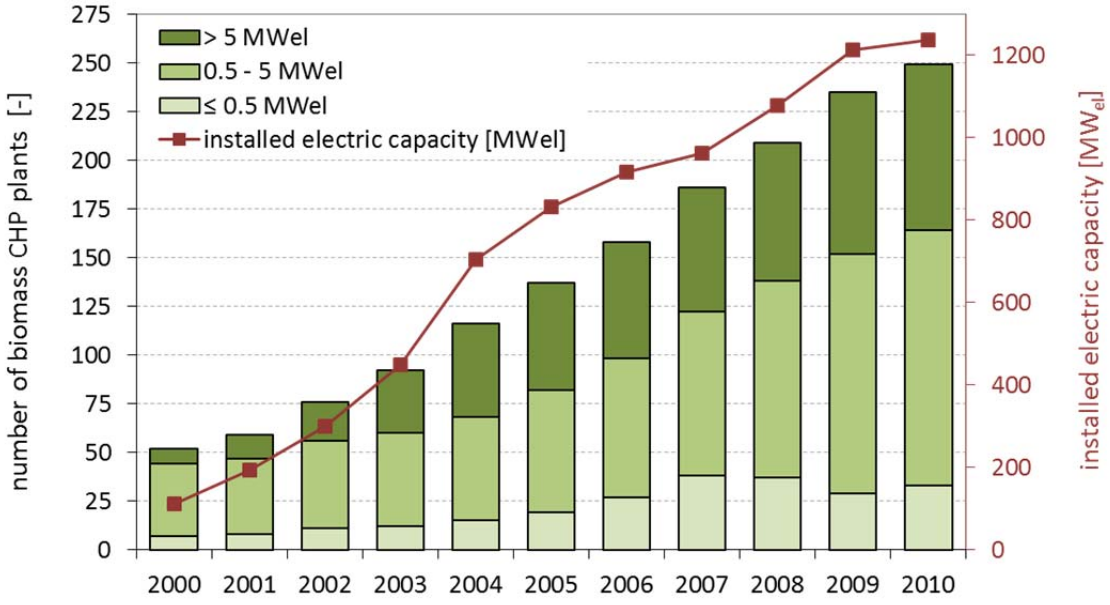

Figure 5-5: Development of biomass CHP plants in Germany (number of plants regarding classes of electric capacity in MW_{el}), without installations of the pulp and paper industry, small-scale CHP plants (< 10 kW_{el}) and wood-gasification plants

In 2010 14 plants with a total installed electric capacity of 25 MW_{el} were built. This reveals stagnation compared to 2009, where 42 new CHP plants were constructed. At the end of 2011 presumably 30 plants will be installed, most of them are already under construction, in the planning phase or in the process of permission. The overall plant capacity of the newly constructed facilities amounts to 1.8 MW_{el}. Compared to the previous year with a total plant capacity of 3.6 MW_{el} it decreased and reflects the general trend of the past years. The average installed capacity slightly decreased from 5.2 MW_{el} to 5.0 MW_{el}. The decreasing size of the installations is a consequence of the saturated market, and the type of installations particularly promoted within the Renewable Energy Sources Act. For this reason, plant operators concentrate on small to medium installations. In 2011 6 out of 14 new plants have an output < 1 MW_{el} (a total of 2.3 MW_{el}) and the remaining 8 plants are in the range of 1 MW_{el} to 10 MW_{el} (a total of 22.6 MW_{el}). Regarding the regional distribution, biomass CHP plants are mainly built in Southern Germany (Table 5-2).

In the power range < 0.15 MW_{el} no current power generation technologies are developed that could be established on a large scale. Despite possible incentives like a higher basic remuneration or a technology bonus under the Renewable Energy Sources Act, this size range only forms a very small amount of the total plant number and is not a noteworthy part of the performance capacity in total figures.

Table 5-2: Distribution of biomass CHP plants in Germany by federal states in 2010 (DBFZ 2011)

	Plants in operation [number]	Total installed electric capacity [MW_{el}]	Average installed electric capacity [MW_{el}]
Baden-Wuerttemberg	35	128.3	3.7
Bavaria	59	189.7	3.2
Berlin	1	20.0	20.0
Brandenburg	22	168.0	7.6
Bremen	0	0.0	0
Hamburg	2	21.7	10.9
Hesse	14	70.6	5.0
Mecklenburg-Western Pomerania	10	52.4	5.2
Lower Saxony	14	122.1	8.7
North Rhine-Westphalia	28	188.4	6.7
Rhineland-Palatinate	19	70.7	3.7
Saarland	2	4.2	2.1
Saxony	14	81.3	5.8
Saxony-Anhalt	11	39.2	3.6
Schleswig-Holstein	6	11.5	1.9
Thuringia	12	68.5	5.7
Germany Total	249	1,236	5.0

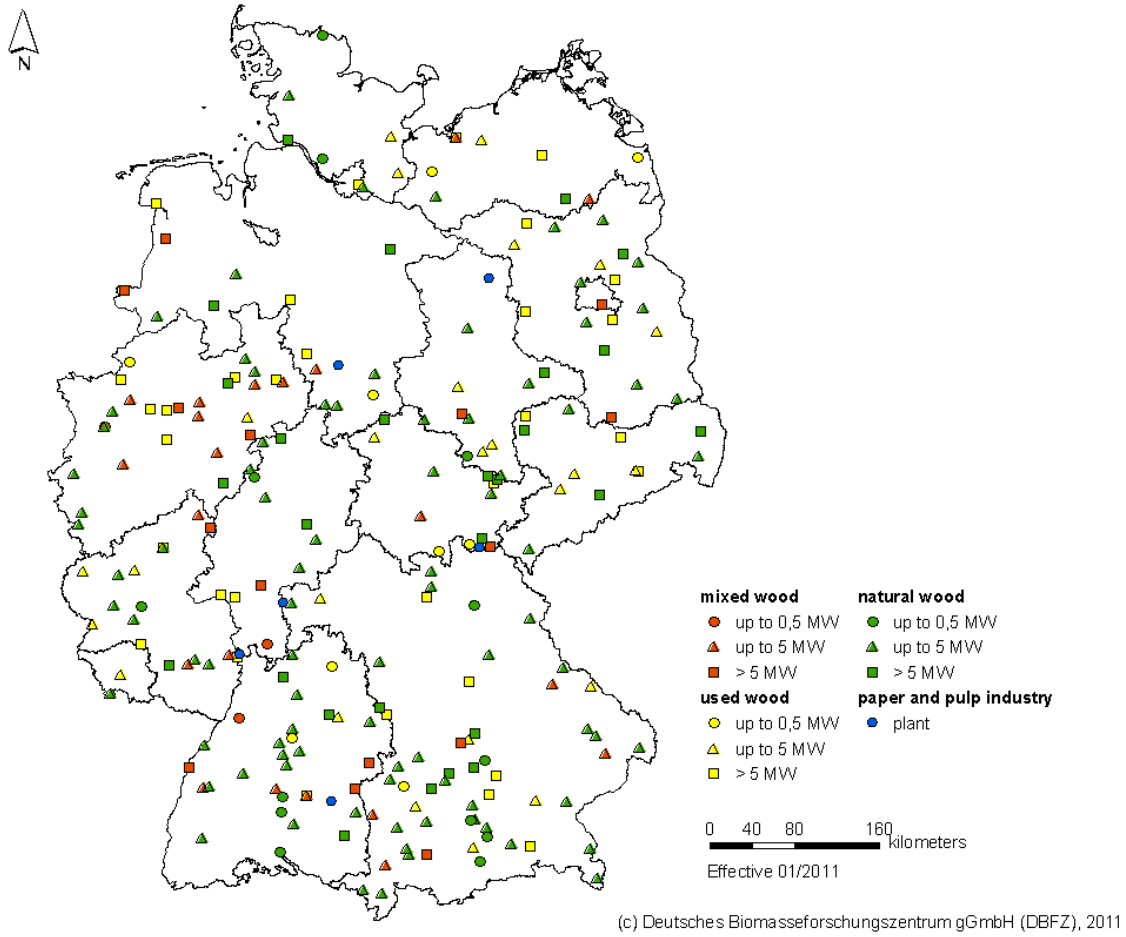

Figure 5-6: Location of CHP plants according to the performance category and the type of biomass fuel used in Germany in 2010; without small-scale CHP plants (< 10 kW_{el}) and wood-gasification plants (DBFZ 2011)

Figure 5-6 shows the distribution of CHP plants in Germany, arranged according to performance category and fuels used. The fuel section ‘used wood’ includes all used wood classes from A I to A IV. The fraction ‘mixed wood’ refers to plants, which in addition to used wood also use natural woods (e.g. landscape conservation wood, forest residues). The remaining CHP plants only use natural woods.

The majority (about 46 %) of biomass CHP plants are operated by companies of the wood processing industry including saw mills and wood composite producers, furniture producers and wood prefabricators. Plant operators of pellet productions with own wood-fired CHP plants are included within the category wood processing industry.

The second largest group of operators is utility companies (about 25 %). This includes large companies operating all over Germany and smaller, regional operators. Larger projects like the construction of new medium- to large-scale CHP plants are often financed and built by an investor- or operator alliance. These alliances can be formed by contracting companies, private investors, public or social institutions and companies from different sectors (about 14 % of the number of installations and 11 % of the installed electric capacity). Furthermore, also industries not related to wood processing industry show interest in energy generated from solid biofuels. Waste and residues management companies, animal feed producers or producers of boiler systems are examples for companies from different sectors conveying

interest. This fraction is estimated at about 15 % of the plants and 9 % of the installed electric capacity currently in operation.

5.2.2 Solid biofuels for heat generation

In Germany solid biofuels for domestic heating are mainly wood-based and predominantly applied in small- to medium-scale installations in private households, SMEs etc.. Major wood fuels for the decentralized heat supply in buildings are wood logs, wood pellets, wood chips and wood briquettes. Here, the major biomass types in terms of volumes consumed are wood logs and wood pellets. In the following these fuels are illustrated concerning the consumption and production figures as well as the number of heating systems installed.

Wood logs

Wood logs (firewood) are still the most commonly used biomass for heating in German households. Thereby it has to be distinguished between the use in central heating systems or in fireplaces. The latter is the predominating application in Germany. A study conducted by forsa and rwi surveyed and analysed the consumption of wood-based fuels in German households. A time series since 2004 until 2008 is presented in Figure 5-7. More recent data is unfortunately not obtainable in Germany. This is mainly due to the lack of central statistics on wood log installations and the corresponding consumption.

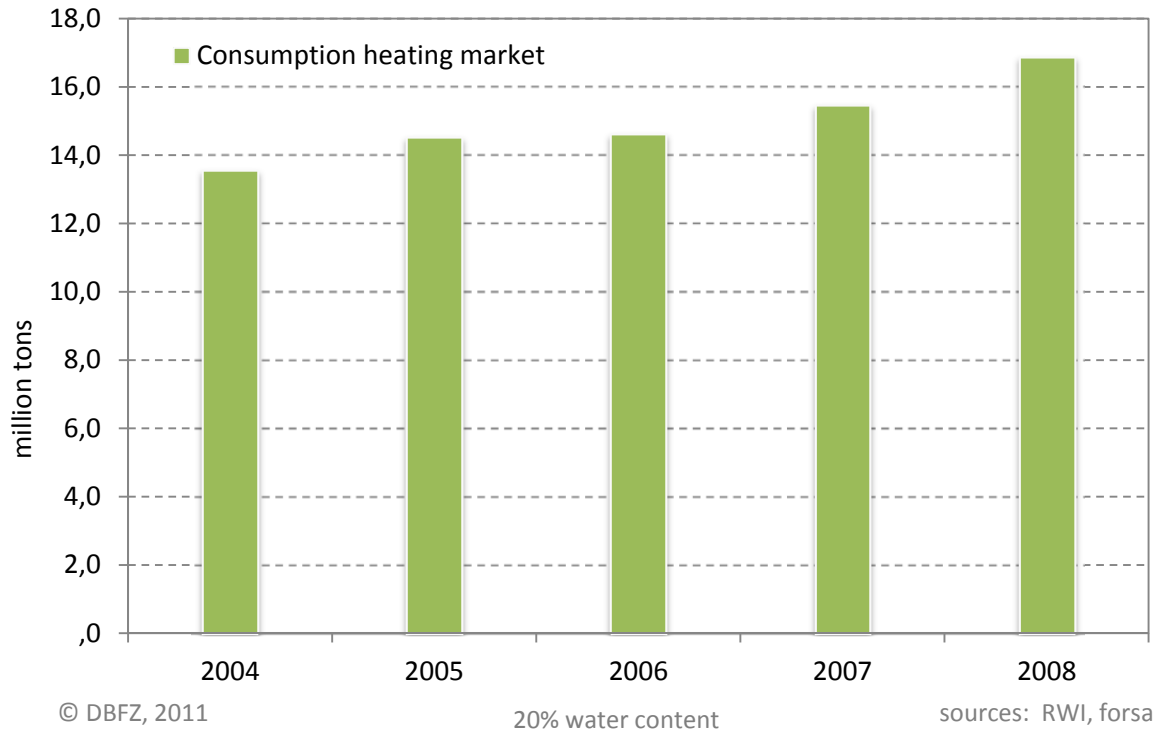

Figure 5-7: Development of the wood log consumption in Germany, 2004-2008 (rwi, forsa 2011)

Wood pellets

The number of pellet heating systems - both stoves and boilers - amounted to 140,000 units in Germany in 2010. The newly installed units during that period amounted to 15,000 units. In total more pellet boilers than pellet stoves are installed, the ratio is about 65 % to 35 %. Figure 5-8 shows the development – both on a yearly base and cumulative – from 2000 to 2010.

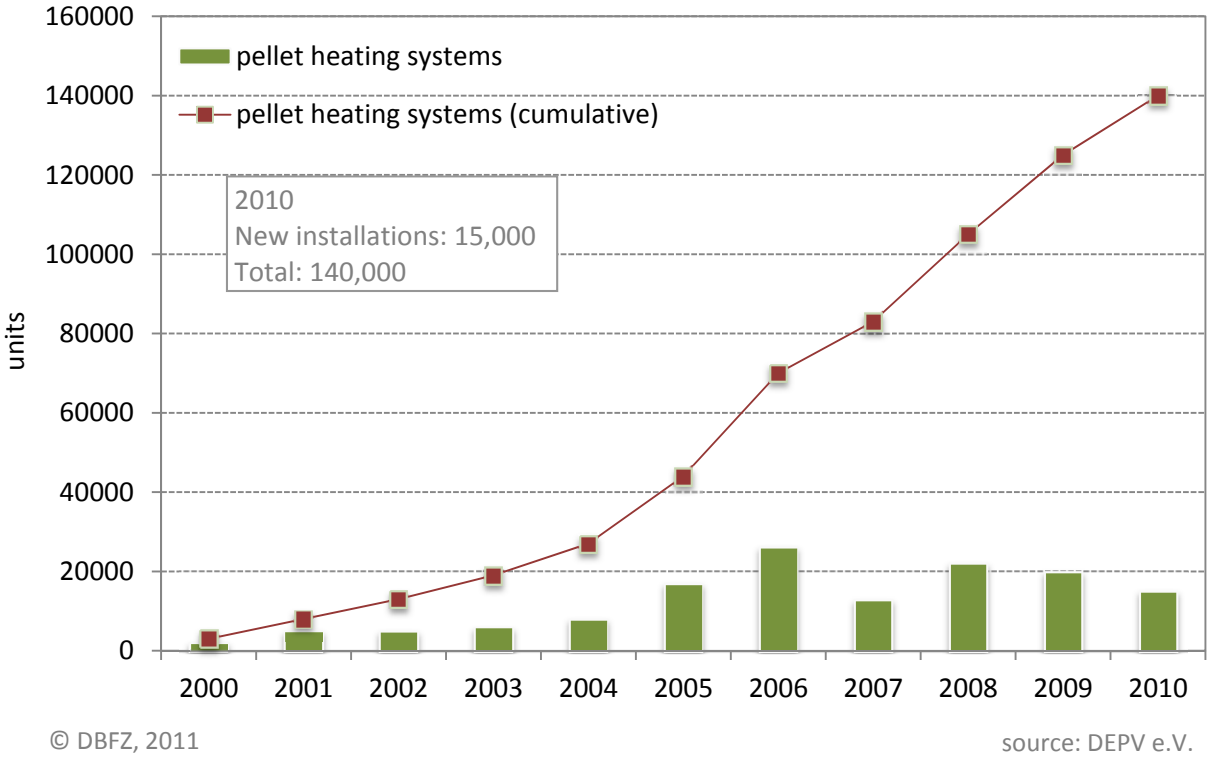

Figure 5-8: Development of installed pellet heating systems (boilers and stoves) in Germany from 2000 to 2010 (yearly and cumulative) (DEPV e.V. 2011a)

Until 2006 a steady growth can be observed. In 2005 and 2006 the sales figures increased by 60 %, however after that there was a noticeable drop with a following market recovery. The reason for this development was a depletion of the budget of the promotion programme MAP in the second half of 2006 which is a significant policy instrument to promote the use of pellet heating systems. This was reflected in a rapid decline in pellet stove and boiler sales. A further disturbance of the market could be observed in May 2010 as the programme experienced a budget freeze until July. These stop-and-go measures caused uncertainties among the investors leading to a smaller number of pellet heating systems installed in 2010.

The corresponding consumption of wood pellets in Germany amounted to 1.2 million tons in the heating market in 2010. Until 2006, the coverage of the national demand was dependent on imports. Since then the amount produced and demanded broke even. Figure 5-9 gives an overview on the consumption figures between 2001 and 2010.

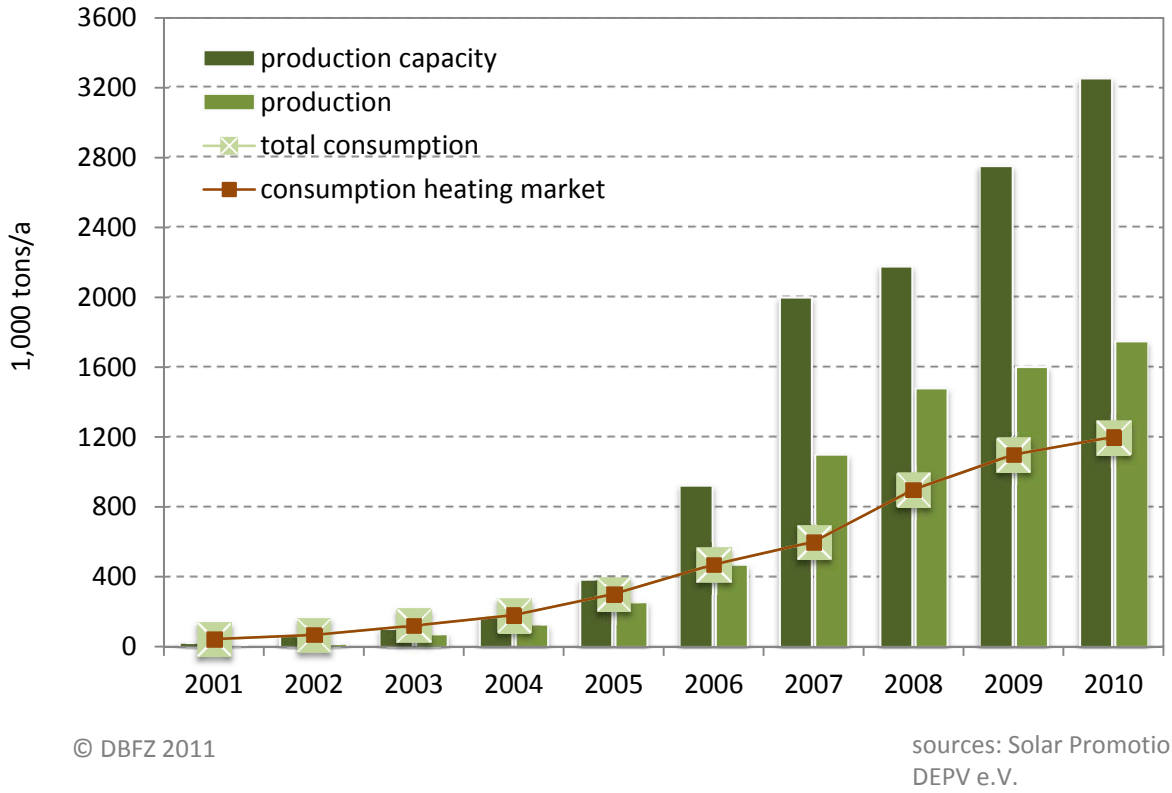

Figure 5-9: Development of the wood pellet consumption, production and production capacity in Germany, 2001-2010 (DEPV e.V. 2011b), (Solar Promotion 2010)

The production and production capacity of wood pellets in Germany is the highest one in Europe. In 2010, 63 production plants are located in Germany with a production capacity of 3.25 million tons and a respective production of 1.75 million tons. In comparison, in 2006, only half of the pellet producers were in place in Germany with a capacity of 925,000 tons. Currently, additional production plants are in the planning process. The following figure gives an overview of the distribution of the pellet production plants in Germany.

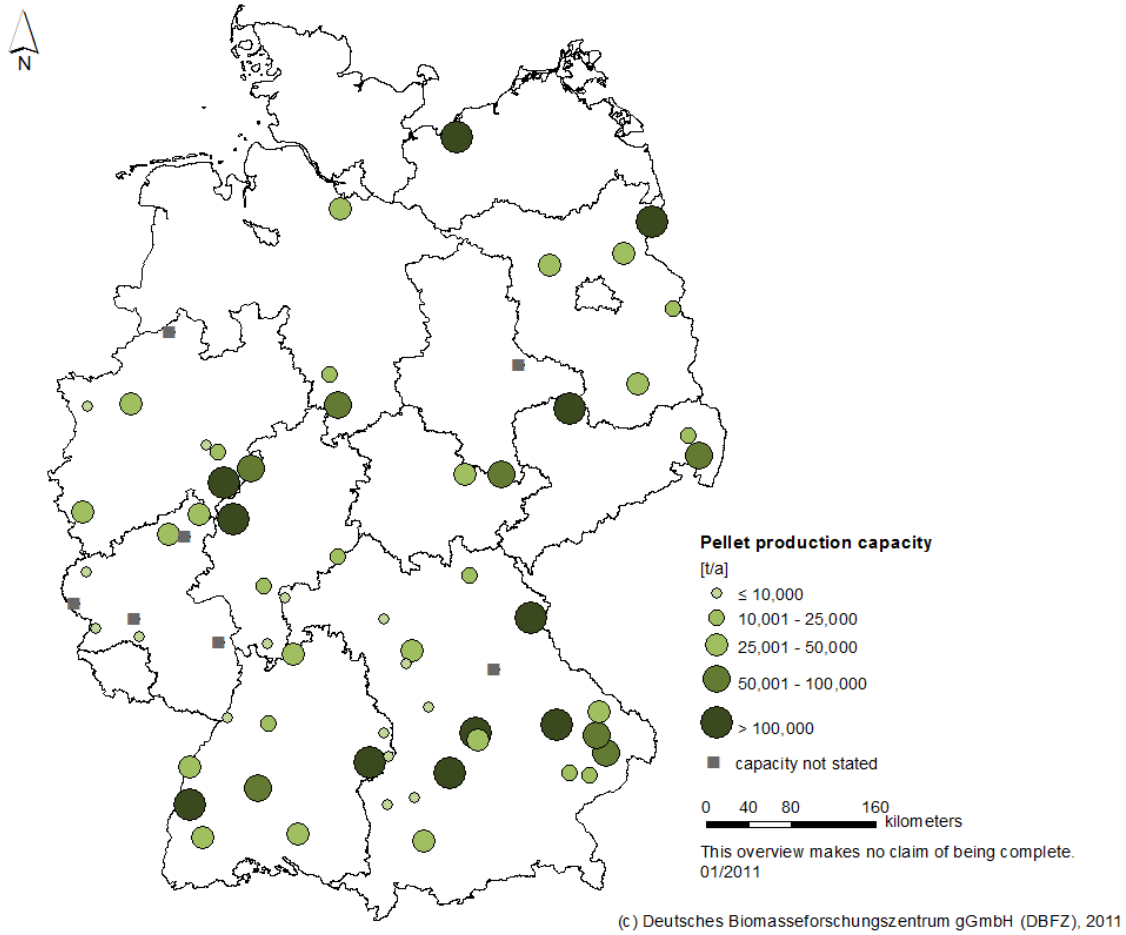

Figure 5-10: Distribution of wood pellet production plants in Germany 2010 (Solar Promotion 2010)

5.3 Liquid biofuels

5.3.1 Liquid biofuels in the transport sector

Liquid biofuels are predominantly used in the transport sector in Germany. Thereby biodiesel, bioethanol and vegetable oil play a role. Figure 5-11 shows the development of biofuel consumption in Germany from 2005 to 2010. In 2010 the total biofuel consumption was about 3.8 million tons. That corresponds to 5.8 % of the total fuel consumption in Germany. Biodiesel accounts for the highest share, whereas vegetable oil is of minor importance (FNR 2011b).

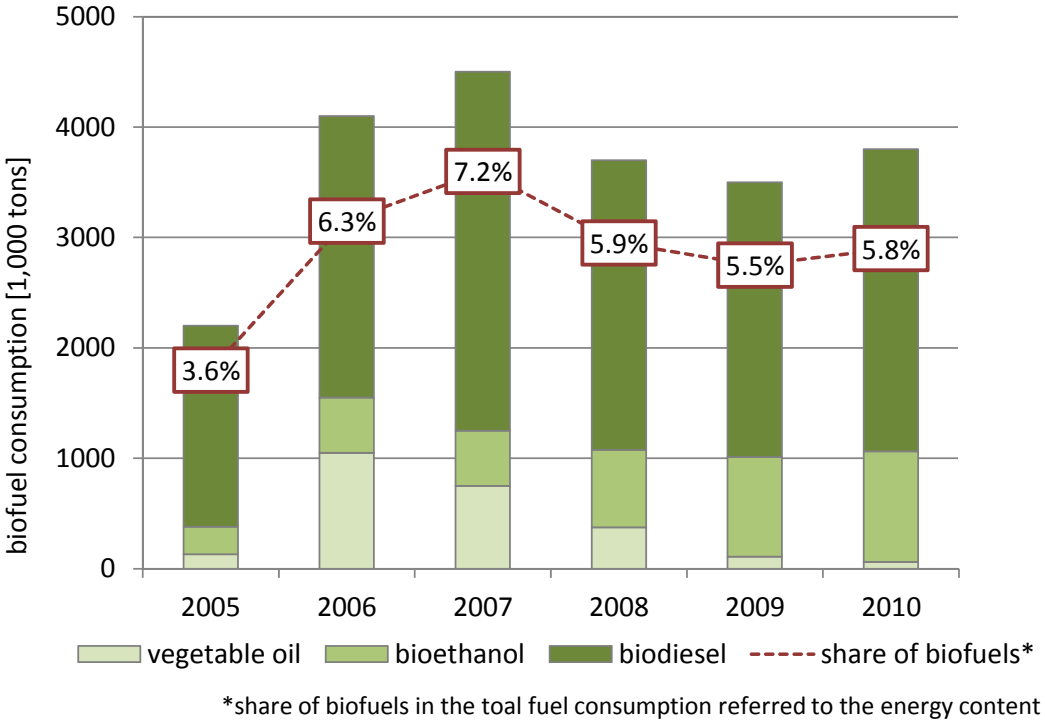

Figure 5-11: Development of the biofuel consumption in Germany, 2005-2010 (FNR 2011b)

Biodiesel

Biodiesel has the highest share on the biofuels' market in Germany. It is the only biofuel, which has a well-developed infrastructure on the German market, yet. In 2010 there were 51 biodiesel production plants in Germany in place. The total production capacity is about 5.4 million tons per annum (FNR 2011a). By the end of 2010, 37 out of the 51 plants were in operation with a corresponding biodiesel production of about 2.8 million tons per annum. The biodiesel consumption was about 2.58 million tons. Figure 5-12 shows the development of the biodiesel production, production capacity and consumption in Germany between 2007 and 2010.

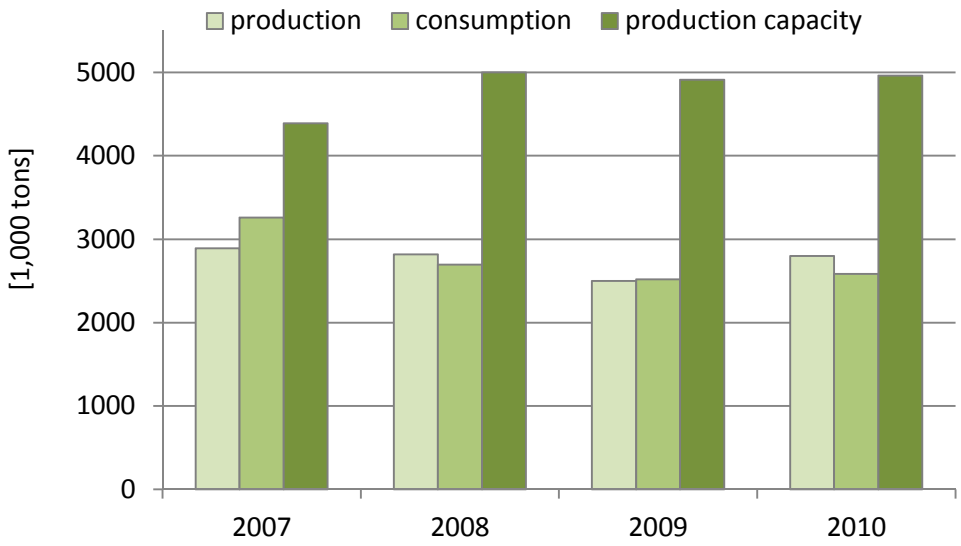

Figure 5-12: Development of the biodiesel production, consumption and production capacity in Germany, 2007-2010 (FNR 2011a)

The major share of biodiesel is used for blending of mineral oil diesel. That accounts for about 90 % of biodiesel utilization in 2009 (2.3 million tons). Next to blending, biodiesel is used as pure fuel (B100 – 100 % biodiesel) in commercial vehicles (0.2 million tons). Pure biodiesel fuel currently accounts for a small share of biodiesel utilization (about 10 % in 2009). The biodiesel consumption in Germany regarding user groups is shown in Figure 5-13.

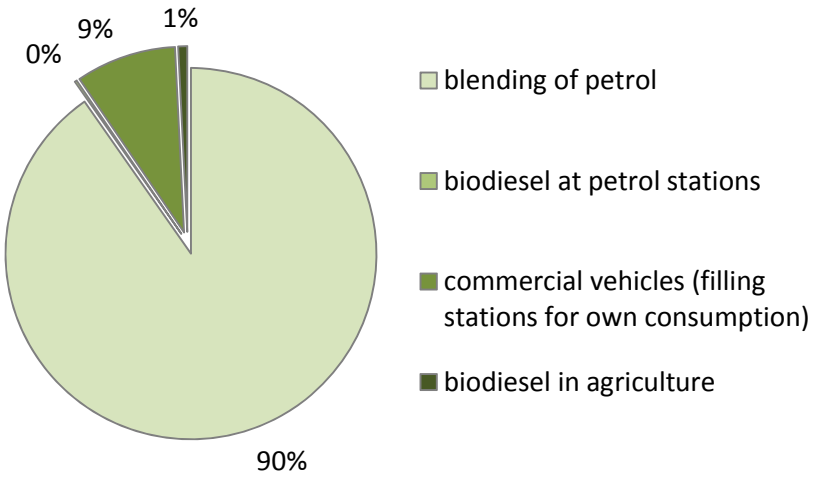

Figure 5-13: Distribution of the biodiesel utilization in Germany (FNR 2011a)

Bioethanol

Bioethanol has an increasing importance among biofuels in Germany in recent years. By the end of 2010, 13 production plants for bioethanol with a total production capacity of about 1 million tons were in operation. In 2010 a total amount of about 600,000 tons bioethanol was produced in Germany.

Bioethanol consumption was about 1.02 million tons in 2010. Ethanol and ethyl tert-butyl ether (ETBE) were predominantly used for blending of petrol. Next to blending, about 13,000 tons bioethanol were

used as bioethanol fuel E85 (85 % bioethanol, 15 % petrol) (BAFA 2011). **Fehler! Verweisquelle konnte nicht gefunden werden.** shows the distribution of bioethanol utilization in 2009 and 2010.

Table 5-3: Bioethanol utilization 2009 and 2010

	2009 (t)	2010 (t)
blending of petrol	695,000	859,000
blending of ETBE	196,000	149,000
bioethanol fuel E85	8,000	13,000

Vegetable oil

Utilization of vegetable oil as fuel has markedly declined in the past years. In 2010 about 61,000 tons of vegetable oil were used as fuel (BAFA 2011). Thereof the highest demand was in the commercial vehicle sector. Furthermore vegetable oil as fuel plays a role in the agricultural sector.

5.3.2 Liquid biofuels for electricity and heat generation

A further use of liquid biofuels like vegetable oil and biodiesel is for the generation of electricity and heat in CHP plants. In recent years the use of vegetable oil as a fuel to generate electricity has decreased in Germany. This development is on the one hand due to increasing oil prices on the world market and on the other hand due to the fact that the use of certified vegetable oil (that is sustainably produced) is required in order to be eligible for remuneration within the EEG from 2011 onwards. Especially the uncertainty concerning the availability and related additional costs for certification had a negative impact on the market. In fact, in 2011 an initial shortage of certified vegetable oil has caused a shutdown of numerous CHP plants based on vegetable oil. By the end of 2010, about 760 plants with an installed electric capacity of about 340 MW were in operation. Figure 5-14 shows the development of CHP plants based on vegetable oil in Germany from 2006 to 2010.

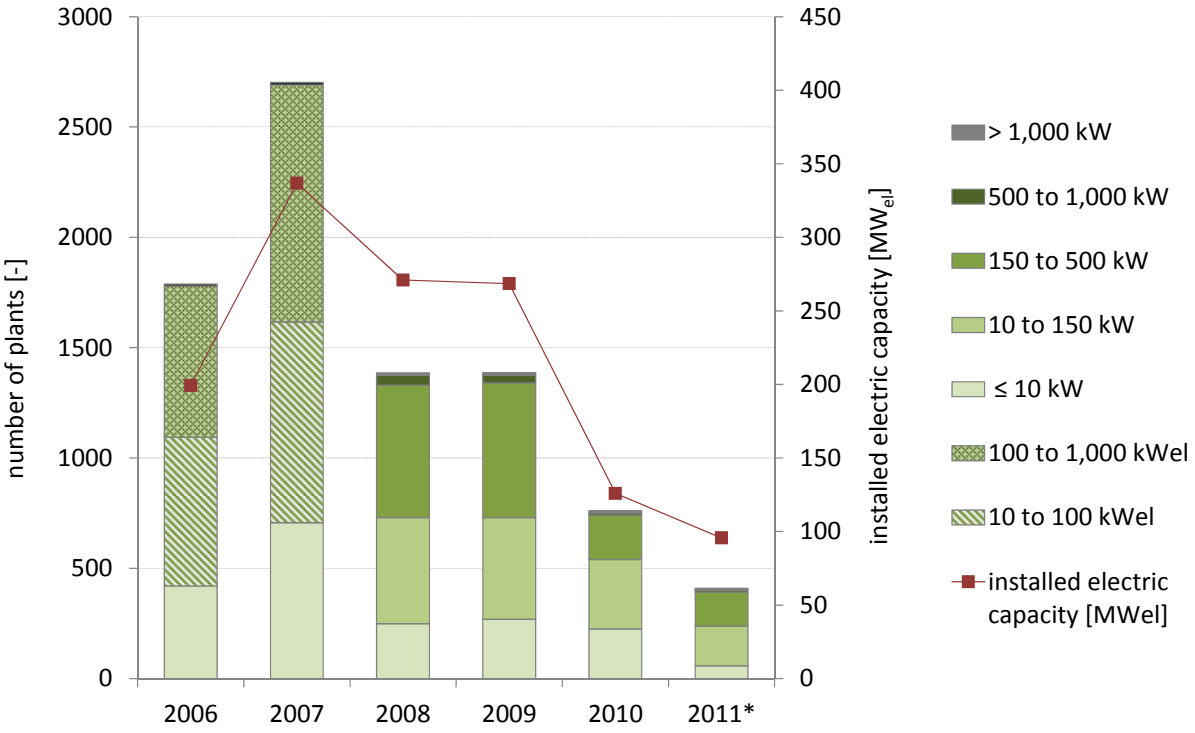

Figure 5-14: Development of CHP plants based on vegetable oil in Germany, 2006-2010 (number of plants and installed electric capacity)

A total vegetable oil consumption of 240,000 tons is estimated for 2010. Thereof palm oil plays the most important role. CHP plants of small capacity predominantly operate with rapeseed oil as fuel. Other liquid biofuels as soybean oil, sunflower oil as well as biodiesel (FAME, RME) play a rather minor role for CHP plants (DBFZ 2011).

6 Expected future energy use of biomass

6.1 Electricity generation

On the 1st of January 2012 the latest amendment of the Renewable Energy Sources Act comes into force (BRD 2011). The new regulation will have a large impact on the future expansion of the electricity generation of biomass. However the extent is hard to estimate due to profound changes within this act.

In 2010 the electricity generation of biofuels has increased to 29 TWh (Figure 6-1). The development of liquid and solid biofuels has not achieved the set targets within the nREAP at last. On the one hand this is due to the decrease of the electricity generation from liquid biofuels caused by a higher vegetable oil price. On the other hand the electricity generation of solid biofuels has grown marginal at last, because the potential of waste wood is widely exhausted in Germany. Instead the electricity generation of gaseous biofuels has more than fulfilled the aims of nREAP. Considering the development until 2020 the electricity generation from gaseous biofuels is expected to be rather moderate and the electricity generation from liquid biofuels is going to drop to zero. Electricity generation based on solid biofuels will increase moderately. In total the electricity provision from biomass will increase up to 42 TWh corresponding to the nREAP level.

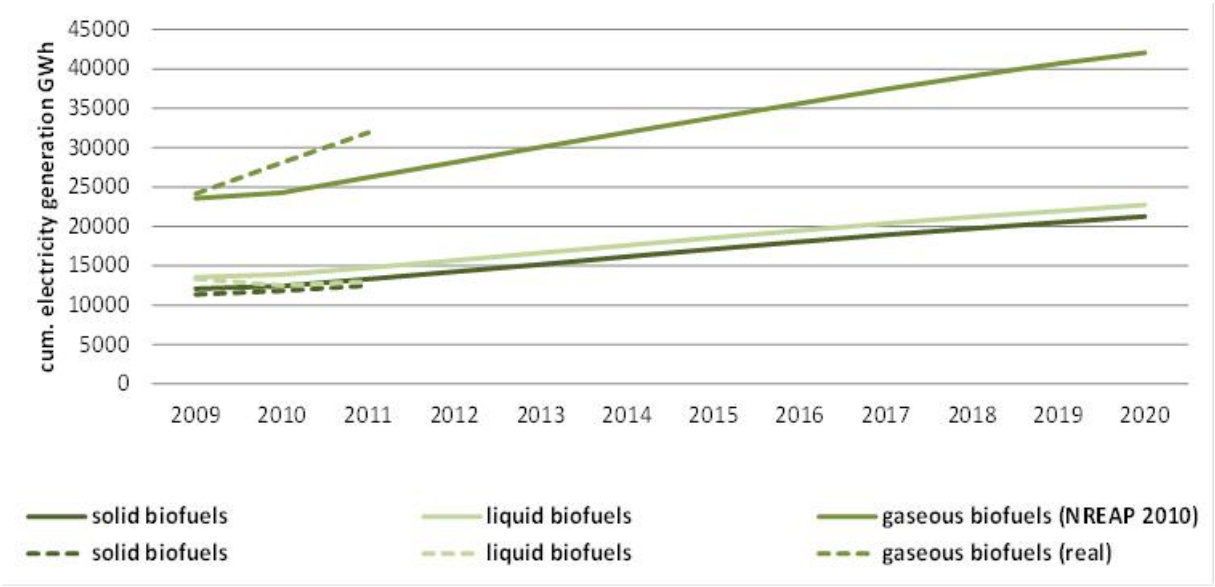

Figure 6-1: Electricity generation from biofuels until 2011 and the targets of the nREAP until 2020, (BMU 2011), (DBFZ 2011), (BRD 2010)

6.2 Heat generation

The heat utilization from biomass will increase to 132 TWh in 2020 (not including landfill gas, sewage gas and the biogenic part of waste). Especially the heat generation from biogas will increase strongly from 7.6 TWh in 2010 to 19.7 TWh by 2020. There biogas and biomethane CHP plants will make the major part. This is mainly due to the requirement within the EEG 2012 that newly built biogas CHP plants have to fulfil a minimum heat utilization rate of 35 % and of 60 % respectively, and biomethane CHP plants a rate of 100 %. For new solid biofuel plants a minimum heat utilization of 60 % applies.

Because the construction of such plants is expected to be rather moderate, the heat generation will also increase only moderately.

6.3 Transport sector

Until 2020 the consumption of biofuels will increase from 3.8 million tons p.a. in 2010 to 5.1 million tons p.a. in order to achieve the 10 % target of renewables in the transport sector. The experience of recent years shows, that 2nd generation biofuels (BTL) did not enter the market as expected. Therefore the main increase will be achieved by an increasing use of bioethanol (ETBE, E85) and hydrotreated vegetable oil from palm oil. Moreover, the utilization of biomethane will increase. If the electromobility will not get into the market, as estimated, there could be a higher increase by natural gas vehicle and thereby a higher increase by biomethane utilization.

Table 6-1: Expected biofuel consumption in the German transport sector in 2020 (DBFZ 2010)

Biofuel	consumption 2010 (tsd. t./a)	consumption 2020 (tsd. t./a)
FAME (fatty acid methyl ester)	2,582	2,779
Bioethanol	1,161	1,562
HVO (hydrotreated vegetable oil)	n/a	641
Vegetable oil	61	53
Biomethane	n/a	95
Total	3,804	5,130

7 Biomass prices

Statistics on the prices as well as the price development of the different biofuels are gathered and published regularly in Germany. Thereby the data is not gathered centrally by the Federal Statistical Office (destatis) as it is practice for conventional energy sources but rather by research institutions and associations. This fact reflects the still missing attention and significance of the bioenergy sector what is of course also due the smaller market share of bioenergy among the energy sources used in Germany. However, it has to be mentioned that in 2010 initial efforts to include bioenergy carriers in the federal statistics could be observed. For instance a wood pellet price index has been established.

In the following the prices for the main biofuels are presented. Concerning the heating market which is characterized by mainly small-scale users (private households, small- to medium-sized companies) the prices include all transportation costs to the final consumer and exclude VAT. The time series date back until 2002/2003 and indicate, if available, the figures until 2010.

7.1 Solid biofuels

7.1.1 Wood pellets

In Germany, wood pellets are primarily used in the heating sector in small- to medium-scale installations (stoves and boilers). Thus, the prices presented here reflect the prices for certified wood pellets (ENplus quality).

Market data on wood pellets price development on the German market is mainly gathered by two associations; the central network for marketing and development of agricultural resources in Germany (C.A.R.M.E.N. e.V.) and the German energy pellet association (DEPV e.V.).

C.A.R.M.E.N. e.V. provides monthly prices based on information from pellet retailers. For price calculations, C.A.R.M.E.N. e.V. refers to a purchase quantity of 5 tons delivered within a radius of 50 km. DEPV e.V. refers to a purchase quantity of 6 tons delivered within a radius of 100 to 200 km. Figures have been available for the years 2003 to 2010.

In Germany the wood pellet prices have been fairly steady with price levels of 160 to 180 €/ton (excl. VAT) till 2005. In 2006 prices started to rise with a peak price of 245 €/ton (excl. VAT) in December. In the following years such a peak did not recur and prices have been rather stable even though at a higher level. In general, seasonally variations with higher prices during the heating period and lower prices in summer can be observed. During 2010 the prices for wood pellets ranged between 204 and 219 €/ton (excl. VAT). The average wood pellet prices from 2003 to 2010 are shown in Figure 7-1. The values are average prices derived from the prices provided by C.A.R.M.E.N. e.V. and DEPV e.V.. In 2010 the monthly average prices for wood pellets ranged from 204 to 220 €/ton (excl. VAT).

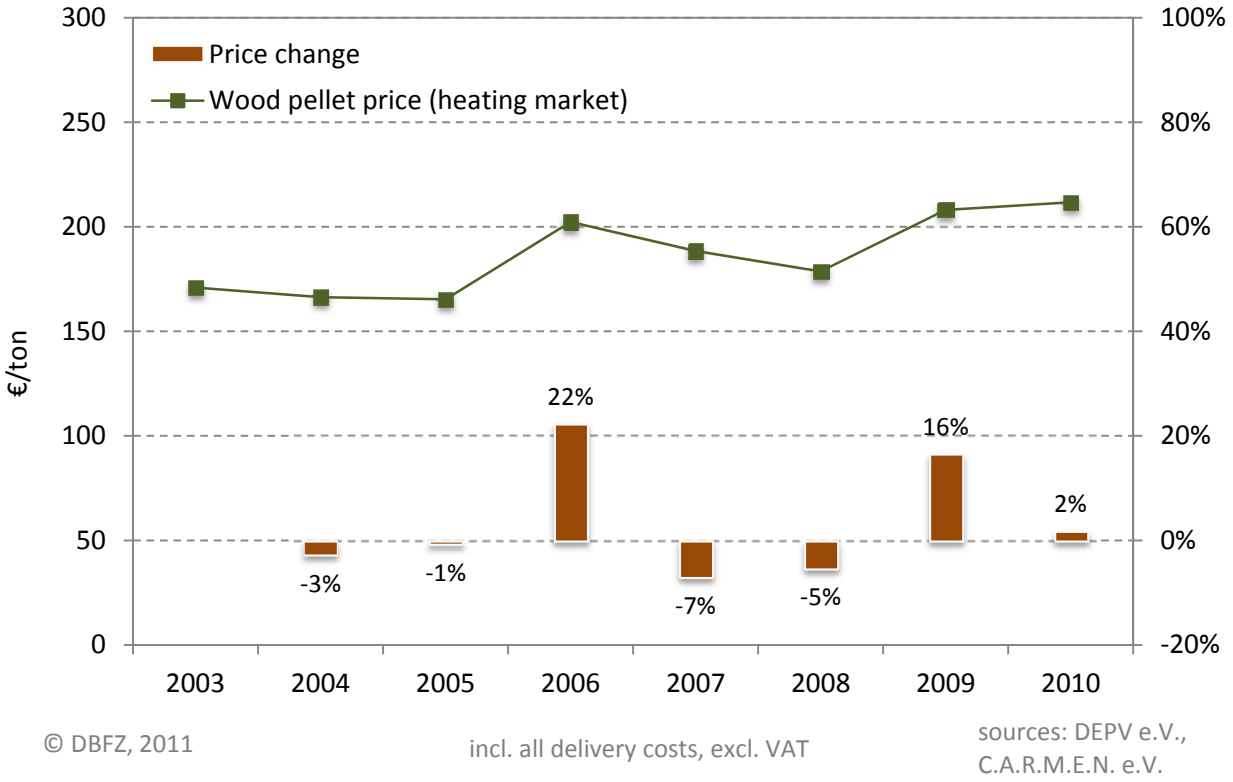

Figure 7-1: Wood pellet price development in Germany from 2003 to 2010, (C.A.R.M.E.N. e.V. 2011a), (DEPV e.V. 2011c)

7.1.2 Waste wood

Information on the price development of waste wood is provided by the scientific journal European economic service (EUWID). The magazine publishes quarterly the prices for the four different categories, that is, qualities of waste wood: I – untreated wood, II & III – wood treated with paint and glue, IV - wood treated with preservatives.

The time series from 2002 to 2010 is shown in Figure 7-2. The prices for each category have steadily risen, in particular for category IV since 2002. This is mainly due to the increased energetic use of waste wood which is promoted by the Renewable Energy Sources Act (EEG). However, in 2010 a stagnation of the prices can be observed. A reason for this is seen in the problem of the economic viability of heat and power plants due to the increased prices of this wood fuel. The ranges for the average prices for the different categories of waste wood during the year 2010 are: A I 23.6 to 26.5 €/ton; A II/III: 14.1 to 14.4 €/ton; A IV 11.8 to 12.1 €/ton (all excl. VAT). However considering the minimum and maximum prices the ranges are as follows: A I 8.4 to 40.3 €/ton; A II/III -2.4 to 31.9 €/ton; A IV -11.9 to 31.9 €/ton.

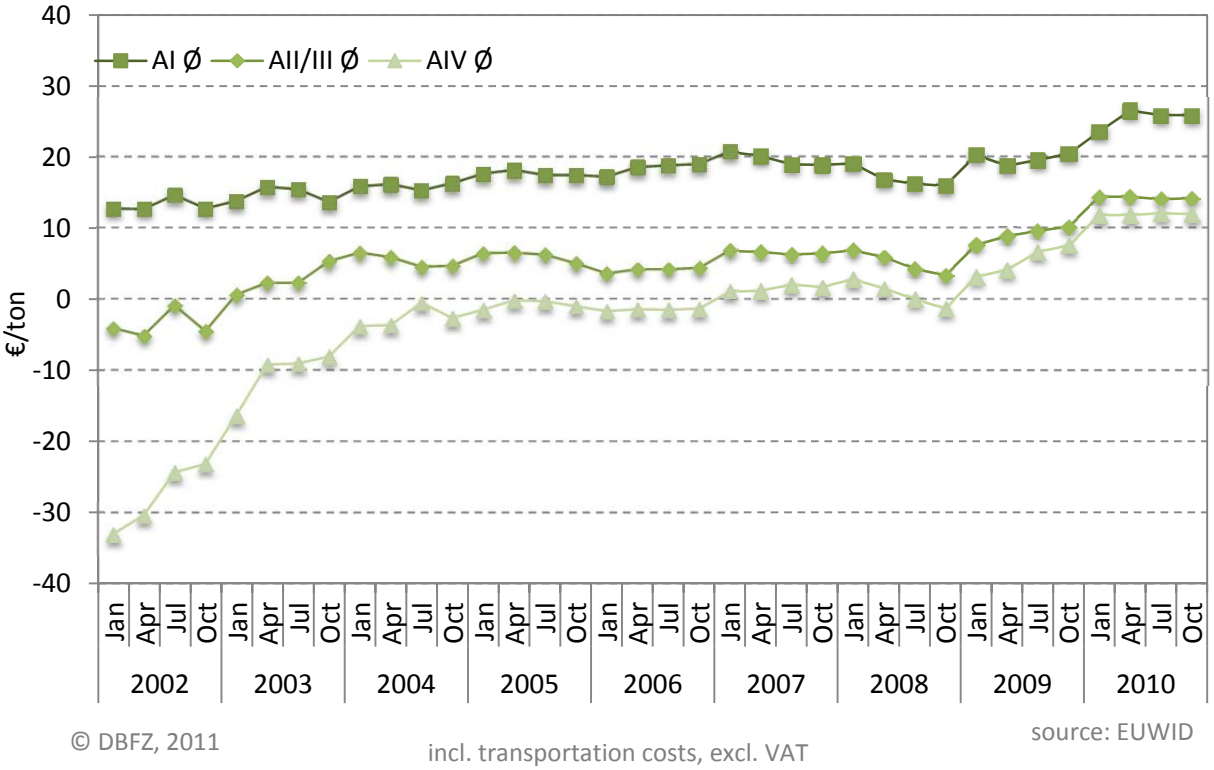

Figure 7-2: Wood waste price development in Germany from 2002 to 2010, (EUWID 2011a)

7.1.3 Wood chips

Market data on the wood chips price development on the German market is gathered by the associations the central network for marketing and development of agricultural resources in Germany (C.A.R.M.E.N. e.V.). Quarterly, the institution publishes the prices for a purchase quantity of 80 cubic meters of wood chips from forest material delivered within a radius of 50 km and a water content of 35 %. The wood chips are used for heat generation in small- to medium-scale installations mainly in private households.

Since the prices have been recorded in 2003 a steady price increase can be noted. Overall a price increase of 100 % could be observed. In 2010 the average prices for wood chips ranged between 76 and 85 €/ton (excl. VAT). The time series from 2003 to 2010 is shown in Figure 7-3.

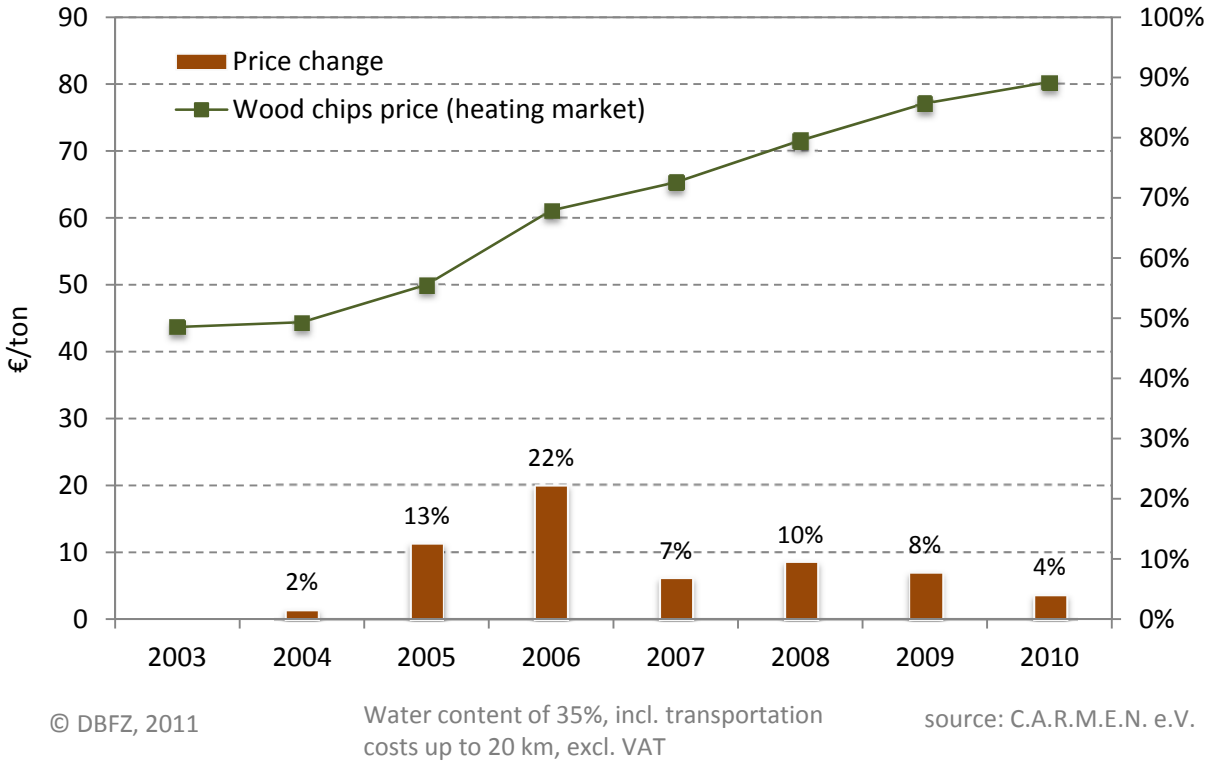

Figure 7-3: Wood chips price development in Germany from 2003 to 2010, (C.A.R.M.E.N. e.V. 2011b)

7.1.4 Wood logs

The Technology and Support Centre (TFZ) publishes biannually the price development of wood logs. The prices refer to the supply of 6 stacked cubic meters (stere) of hardwood made from oak, beech or ash; delivered within a radius of 10 km.

The price for wood logs has been rather stable since recording. An upward movement began in 2006 reflecting an intensified usage of firewood as fuel what is promoted within the market incentive programme (MAP). Thus, the price has increased by roughly 25 % from 2003 till 2007. The time series from 2003 to 2010 is shown in Figure 7-4.

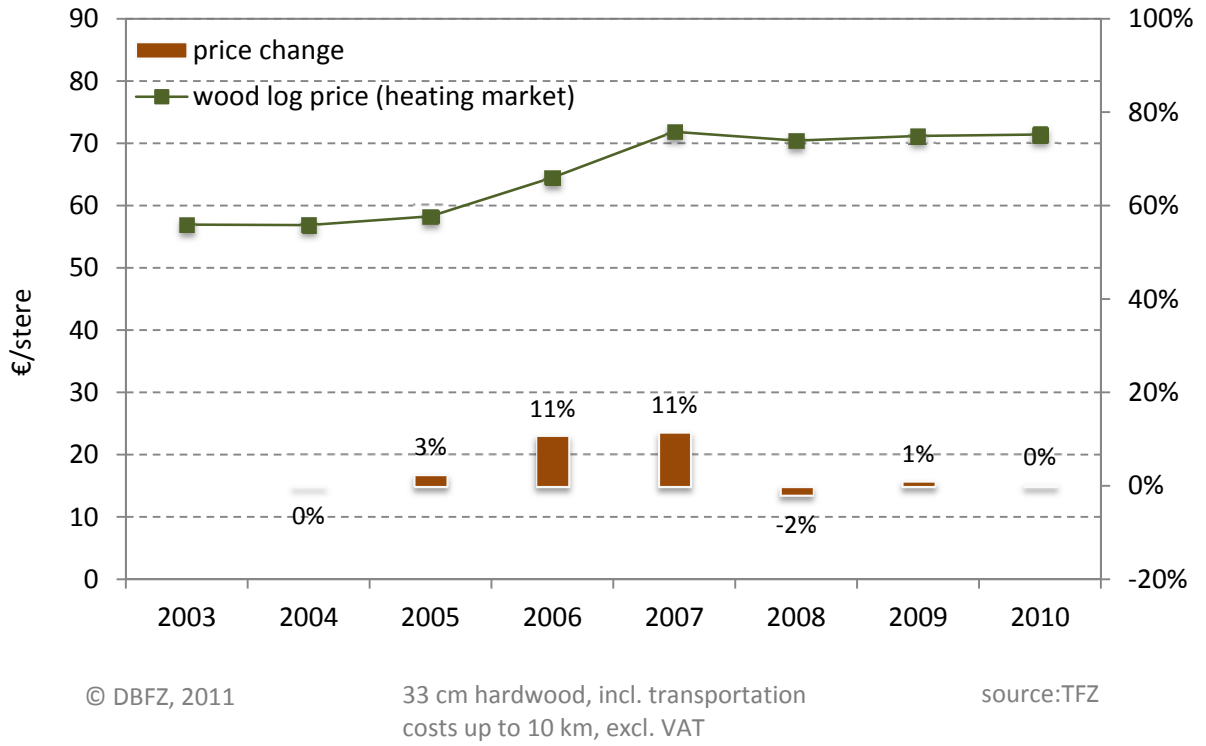

Figure 7-4: Wood log price development in Germany from 2003 to 2010, (TFZ 2011)

7.1.5 Sawdust

The scientific journal European economic service (EUWID) publishes every two to three months a market review on saw mill residues used e.g. in the wood products industry and for the production of the energy carrier pellets.

The times series dates back until 2007 as shown in Figure 7-5. Over the past years the price for sawdust has risen constantly with a drop in 2008. The reason for the overall price rise is seen in the increasing demand e.g. in the wood pellet production and hence an increasing competition among the different industries using saw mill residues as input material. In 2010 the price range was between 10 and 14.5 €/m^3.

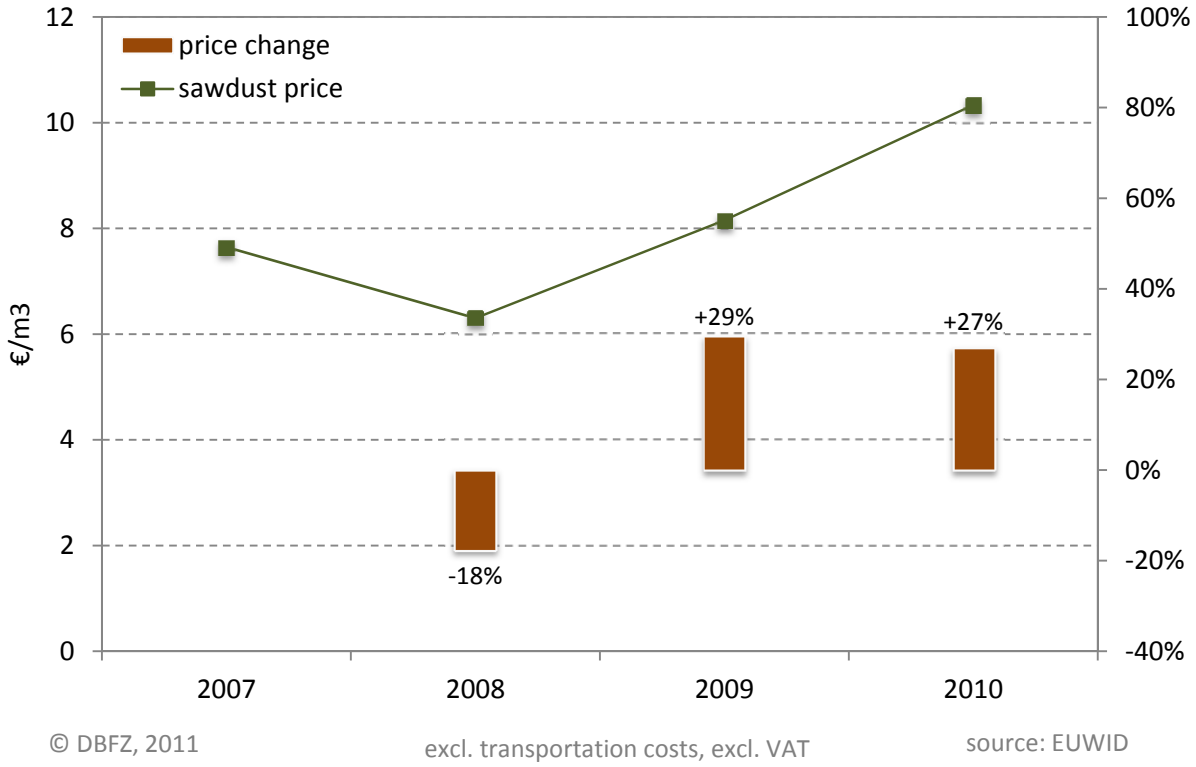

Figure 7-5: Sawdust price development in Germany from 2007 to 2010, (EUWID 2011b)

7.2 Liquid biofuels

7.2.1 Vegetable oil

Until 2007 the prices for vegetable oil remained nearly at the same level over the past years as shown in Figure 7-6 below. However, in 2007/2008 a sharp increase due to a higher demand on the world market could be noted. While the average price for rapeseed oil was 540 €/ton (fob Germany) and for palm oil 340 €/ton (cif Netherlands) in 2005, the prices have doubled until the mid of 2008 and were above 900 €/ton for rapeseed oil (fob Germany) and above 640 €/ton for palm oil (cif Netherlands). This was followed by a decline in the second half of 2008 and another sharp increase during 2010.

Sun flower oil and rapeseed oil are the most expensive vegetable oils; in comparison palm oil is by far cheaper. In 2010 the prices for rapeseed oil were between 660 €/ton (at the beginning of the year) and 1,070 €/ton (at the end of the year), for sunflower oil between 667 €/ton and 1,060 €/ton, for soy oil between 663 €/ton and 1,015 €/ton and for palm oil between 607 €/ton and 900 €/ton.

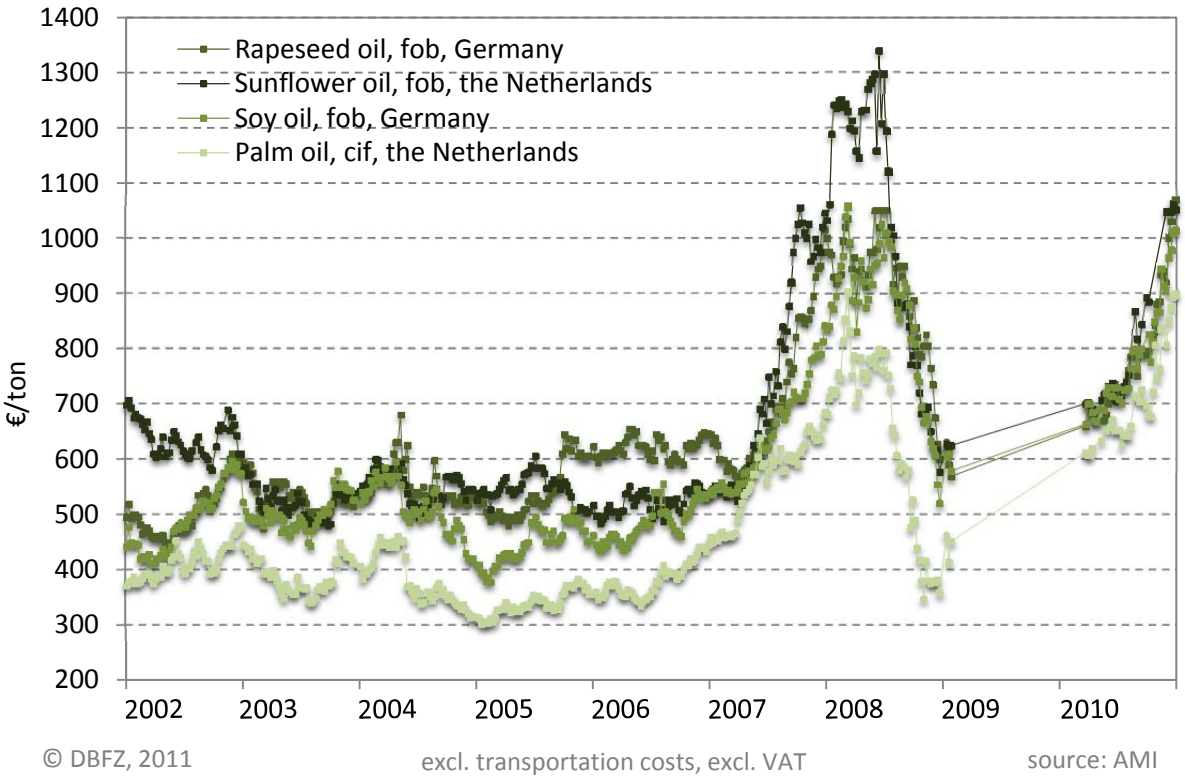

Figure 7-6: Vegetable oil (rapeseed oil, sunflower oil, soy oil, palm oil) price development in Germany from 2002 to 2010, (AMI 2011)

7.2.2 Biodiesel

The prices for biodiesel (end consumer prices) have been stable in Germany in the years 2005, 2006 and 2007. In 2008 prices have experienced a tremendous growth what was due to the increased prices for the raw material vegetable oil (palm oil and rapeseed oil). During that year the biodiesel price has increased by 50 % compared to the reference year 2005. In 2009 the price returned to the 2005/2006 level. Over the last year the average price was 960 €/ton. The time series from 2003 to 2010 is shown in Figure 7-7.

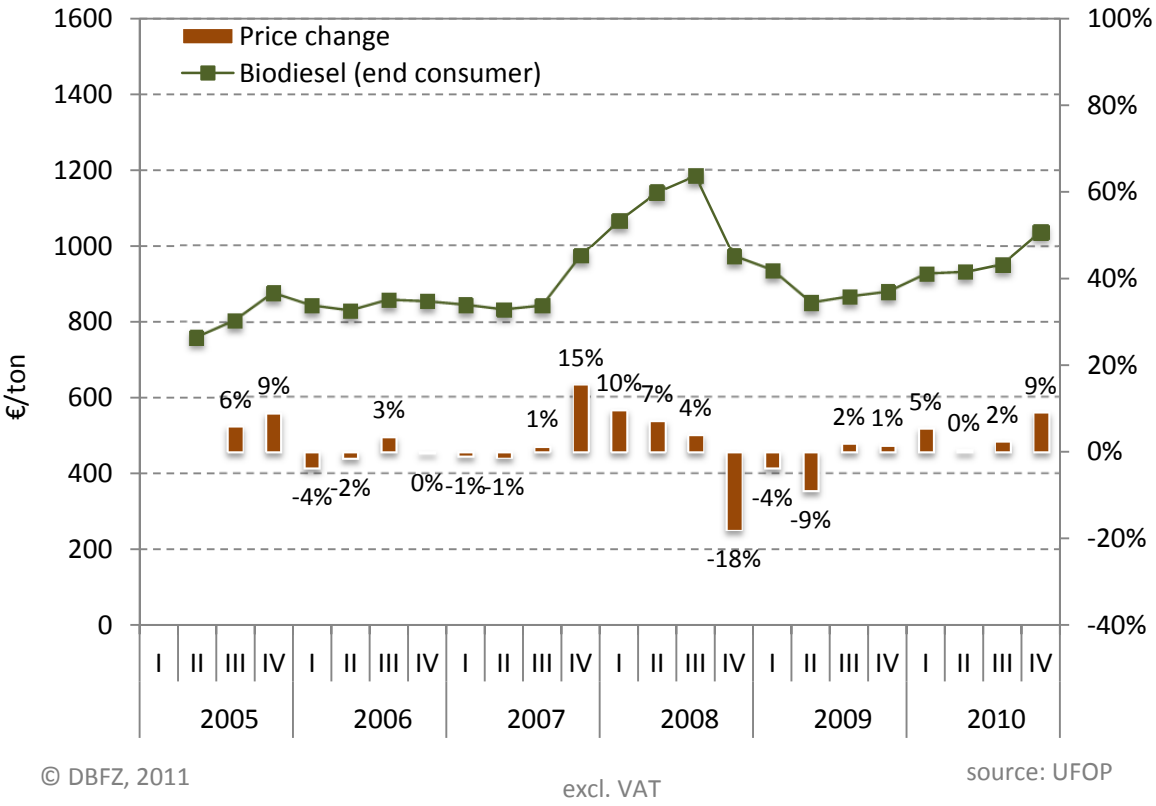

Figure 7-7: Biodiesel price development in Germany from 2005 to 2010, (UFOP 2011)

7.2.3 Bioethanol

In Figure 7-8 the development of the world market price for bioethanol from 2005 to 2010 is presented. After a price drop in 2006 the price level has again increased until 2010. From 2006 to the end of 2010 the price level has risen by about 60 %. The average price amounted to 458 €/m^3 in 2010.

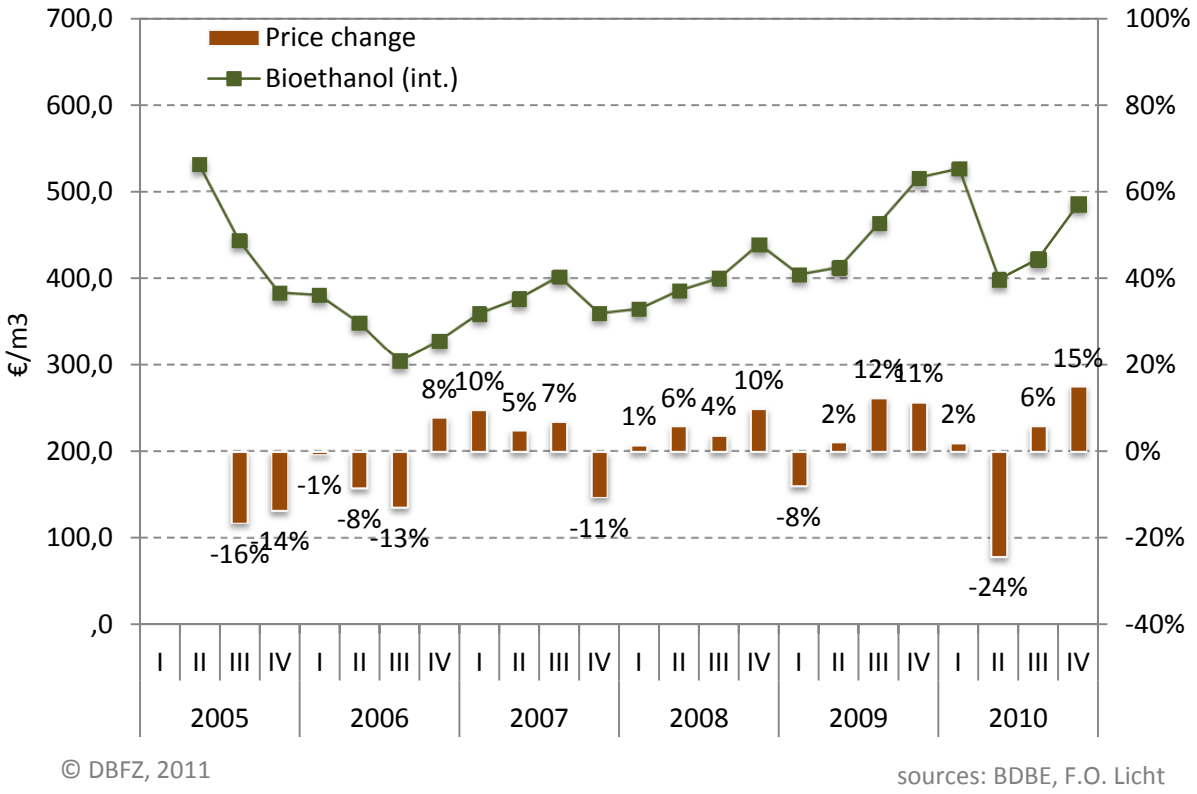

Figure 7-8: Bioethanol price development in Germany from 2005 to 2010

8 Biomass import and export

In the following, trading streams and corresponding trading volumes for biomass, which is directly traded for energy-related biomass use, are illustrated. This category includes in particular wood pellets, fuel wood, waste wood, vegetable oil, biodiesel and bioethanol on the German biomass market. Thereby, the major import and export streams in terms of volumes and the number of trade relations are for wood pellets and waste wood among the solid fuels and for biodiesel and bioethanol among the liquid fuels.

8.1 Solid Fuels

8.1.1 Wood pellets

From the total wood pellet production volume in Germany, it is estimated that about 75 % are intended for the heating market (certified wood pellets) and the remaining for power plants for electricity generation. The majority of the certified pellets is consumed within the country (over 90 %), however the pellets used for power generation are entirely exported. This is due to the fact that wood pellets are not used in power stations in terms of co-firing in Germany, yet.

The main export countries for industrial wood pellets are the United Kingdom, Sweden and Denmark. With respect to the trade of certified wood pellets the main trading partners are Italy, Austria, Denmark and the UK for exporting and Denmark, Russia, the Baltics, Czech Republic and Austria as well as Belarus (a rather new trading partner) for importing. In the past the trade of wood pellets mainly took place with bordering countries as Austria and Czech Republic. However, imports originate increasingly from Eastern European countries like the Baltics and Belarus. Here, it can be noticed that also industrial wood pellets are imported for re-export to other European countries.

The total export volume for 2010 is estimated at 715,000 tons and the import volume at 270,000 tons. Overall Germany is a net exporter country.

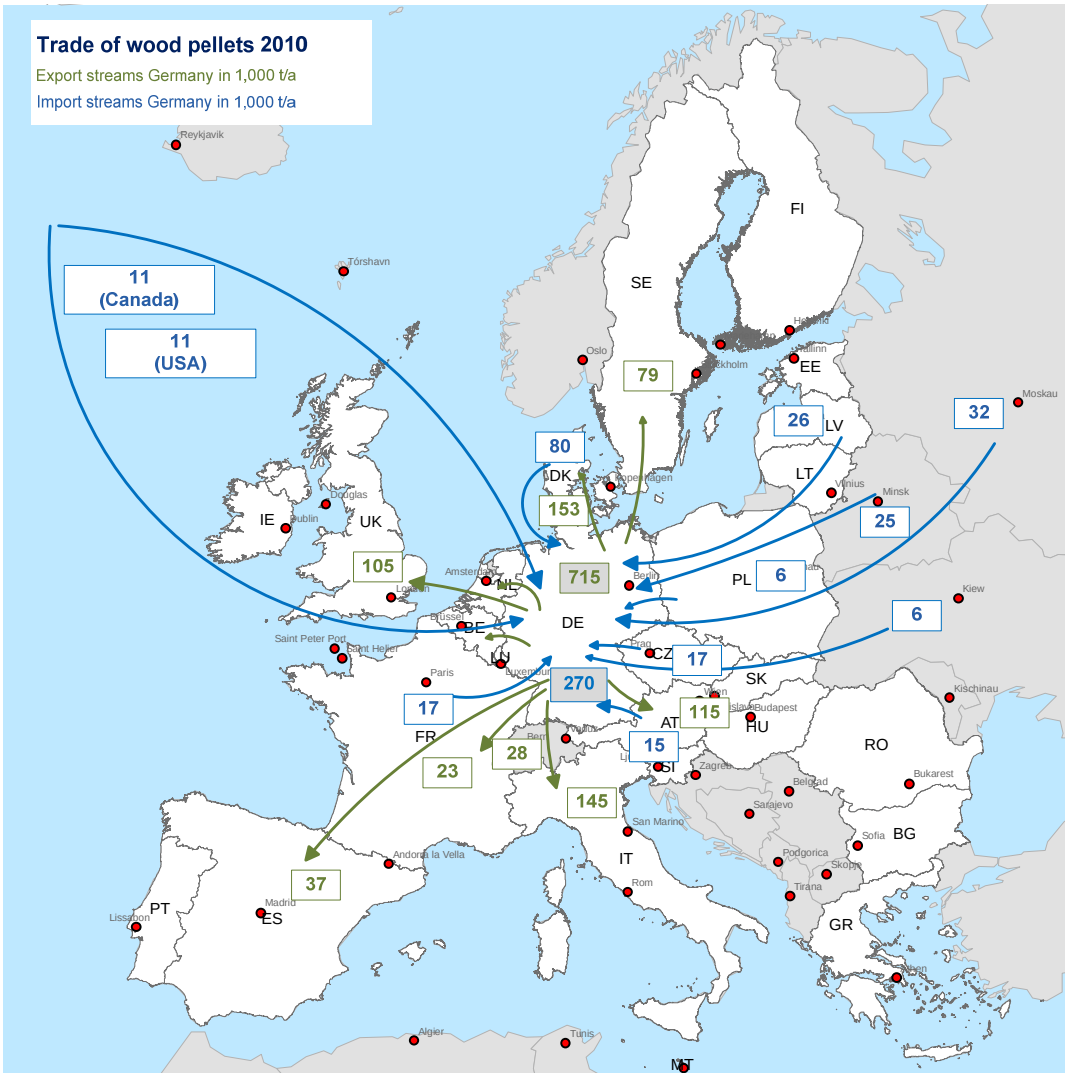

Figure 8-1: Trade of wood pellets: import and export flows in Germany in 2010, (destatis 2011b)

8.1.2 Waste wood

Germany is a net importer of waste wood. The greatest volumes come by far from the Netherlands with an import volume of 478,000 tons amounting to 63 % of total imports. In contrast, the quantities exported, predominantly to the Netherlands, are very little. The reason for this high demand for waste wood in Germany the use of waste wood for electricity and heat production is promoted within the Renewable Energy Sources Act. Overall the trade of waste wood mainly takes place with bordering countries what is mainly due to the question of the economic viability of long-distance transportation of waste wood. The map in Figure 8-2 emphasises that fact and summarizes the main trading flows.

The total import volume for 2010 is estimated at 755,000 tons and the export volume at 12,000 tons.

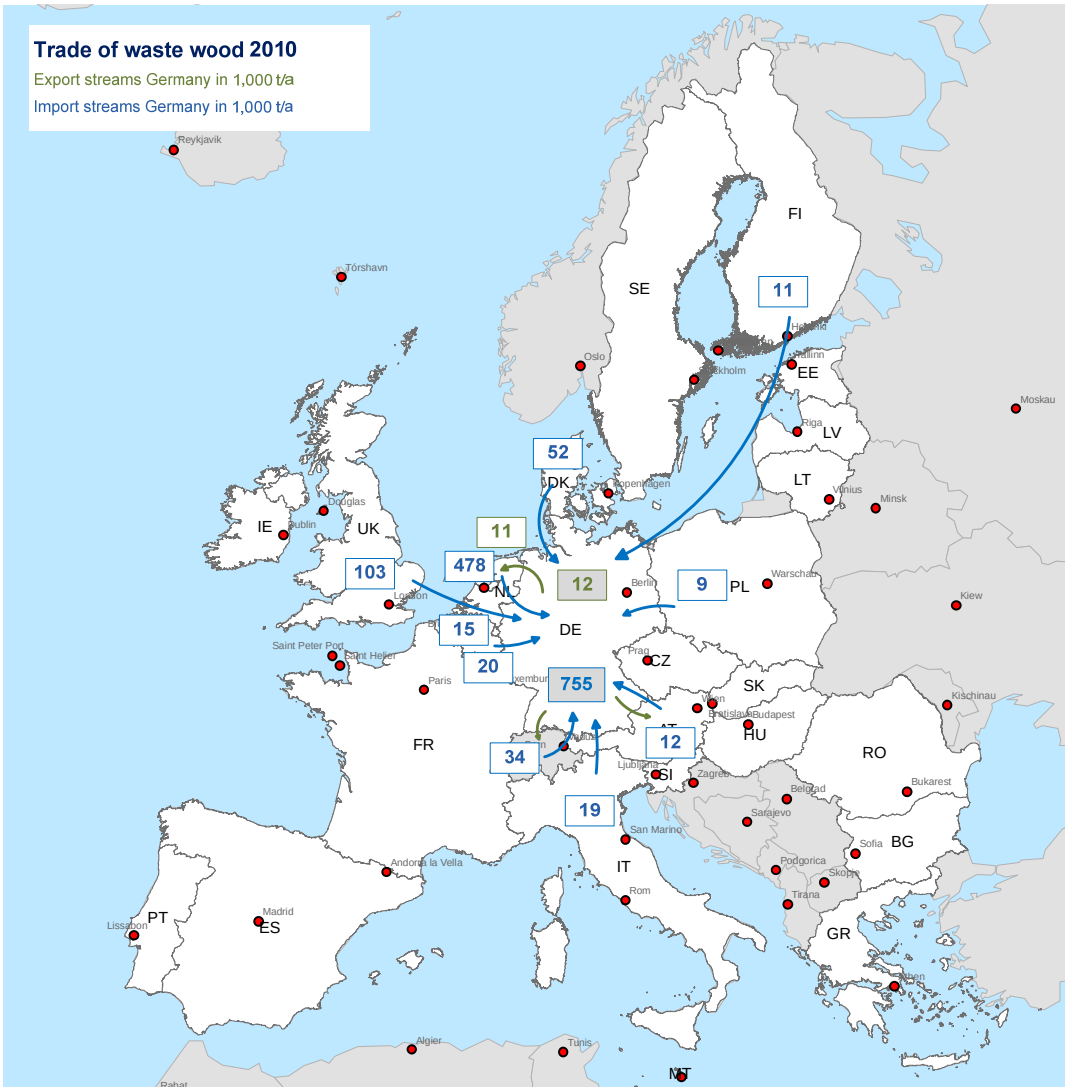

Figure 8-2: Trade of waste wood: import and export flows in Germany in 2010, (UBA 2011)

8.2 Liquid fuels

8.2.1 Biodiesel

In 2010 992,000 tons of biodiesel have been imported and 918,000 tons have been exported, hence Germany has a negative trade balance. The main trading partner is the Netherlands from where over 80 % of the volume is imported. Thereby the majority of the traded biodiesel is processed through the Amsterdam-Rotterdam-Antwerp port, the largest deep sea port in Europe. Countries of origin are mainly Argentina and Indonesia. Further significant import amounts come from Belgium. Considering the exporting flows Poland, the Netherlands, Belgium and France are the main receiving countries. Overall the trade of biodiesel happens primarily with bordering countries (Figure 8-3).

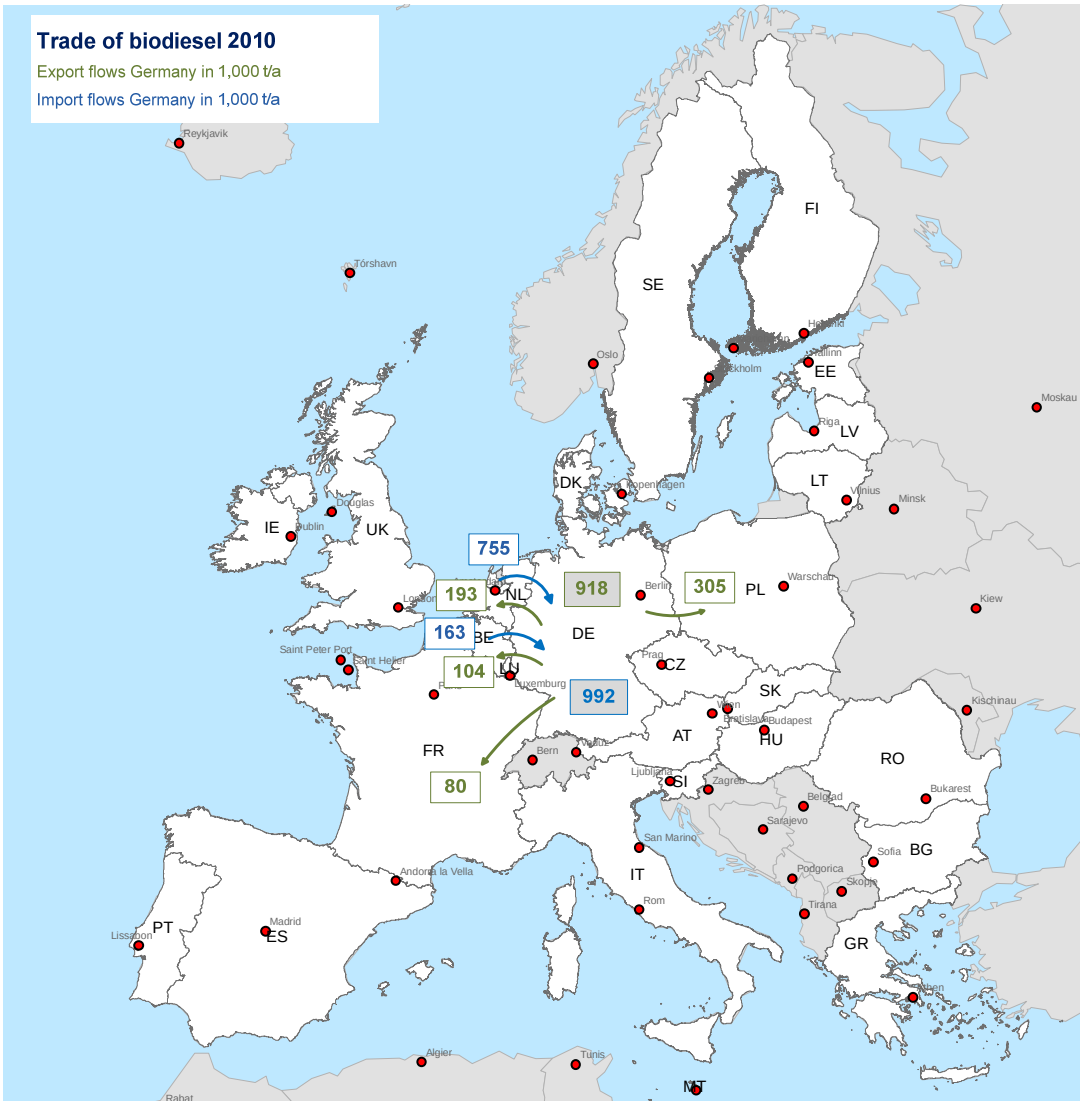

Figure 8-3: Trade of biodiesel: import and export flows in Germany in 2010, (destatis 2011c)

8.2.2 Bioethanol

Figure 8-4 shows the total amounts (energy-related and material use) of bioethanol traded in Germany. The data is prepared by the Federal Bureau of Statistics and is only available in an aggregated form. In 2010 about 1.34 million tons of bioethanol have been imported of which ca. 25 % are used as fuel. The majority is used in other industries as material use as well. Main trading partners are the Netherlands, Belgium and France and Poland. Thereby the majority of the traded bioethanol is processed through the Amsterdam-Rotterdam-Antwerp port. Country of origin is in particular the U.S.. Germany is a net importer of bioethanol.

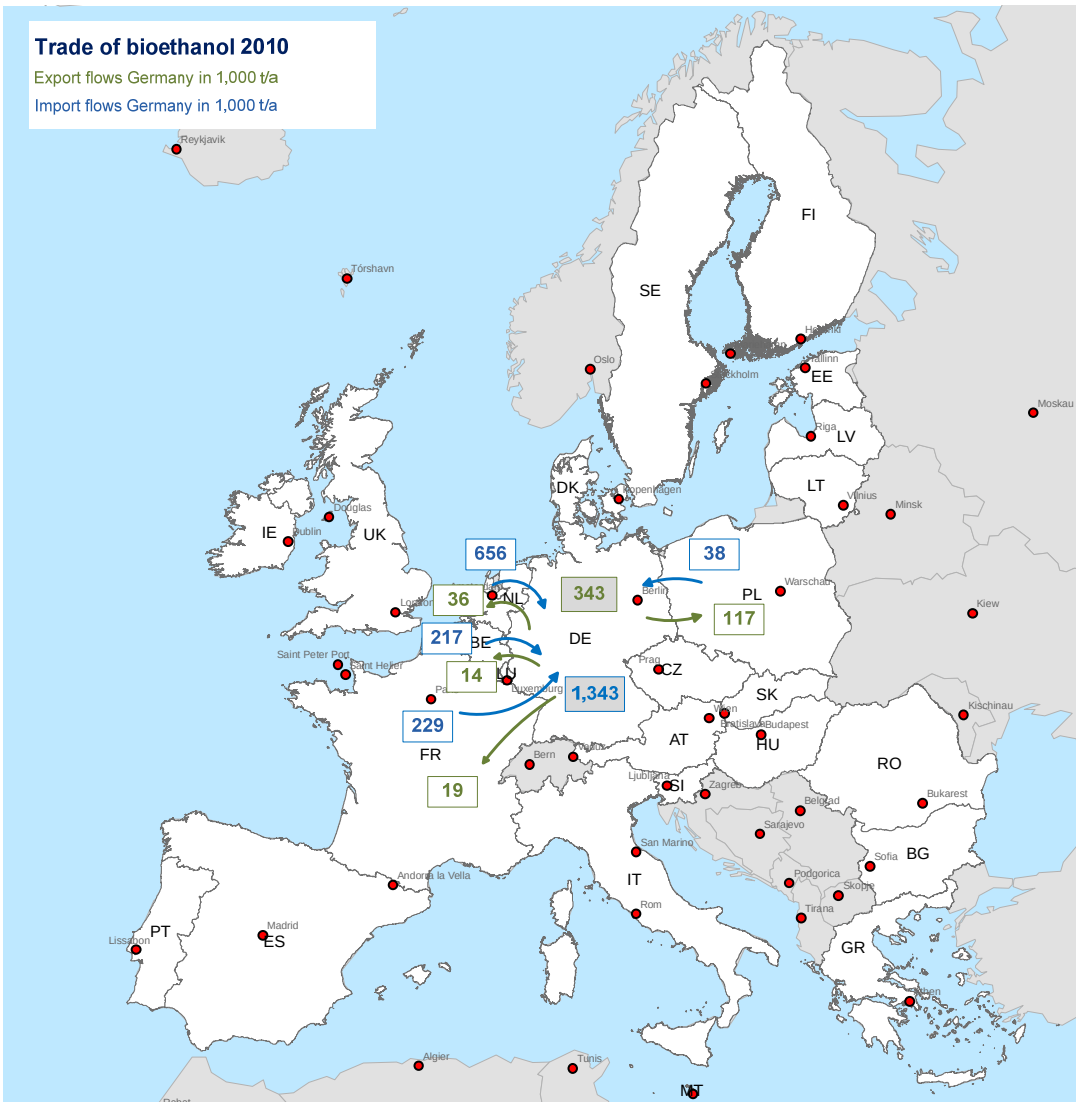

Figure 8-4: Trade of bioethanol: import and export flows in Germany in 2010 (aggregated: energy-related and material use), (destatis 2011d)

9 Barriers and opportunities

Significant impacts on the international trade of biomass arise essentially from the national policy framework and, related to it, existing biomass sustainability criteria, availability of biomass commodities, and their related transportability.

In the following, the focus concerning opportunities and barriers related to biomass trade is on the particular national policies and guidelines on bioenergy use in Germany. It is described how these measures can affect the international biomass trade both in a positive and negative way.

Liquid biofuels

The Renewable Energy Directive (2009/28/EC) provides the framework for a sustainable use of liquid biofuels in the transport and electricity sector in Europe. In Germany this directive has been transposed into national law through the biofuel sustainability ordinance (Biokraft-NachV) for the transport sector and the biomass electricity sustainability ordinance for the electricity sector (BioStrom-NachV). This legal framework asks for additional requirements in the cultivation of biomass as well as the production and trade of liquid biofuels. Certification systems verify the compliance with the requirements imposed. For certain countries and biofuel producers, primarily producers of palm and soy oil, these guidelines can be an export barrier to the European Union and Germany since additional criteria must be fulfilled. At the same time certification provides the opportunity to achieve a greater acceptance among the population for the energy-related use of biomass. Moreover, it can be noticed that since the introduction of certification systems a share of the certified vegetable oil is also demanded from other industries for material use what creates a new market.

Solid biofuels

The electricity provision from biomass is mainly legally supported by a feed-in tariff system the Renewable Energy Sources Act (EEG) in Germany. Within the latest amendment of the EEG which becomes effective in the beginning of 2012 it is aimed at the preparation of possible sustainability criteria also for solid and gaseous biofuels. Especially for the operation of larger solid biofuel installations that need to import fuels it can pose a barrier.

Gaseous biofuels

Gaseous biofuels for electricity generation, in particular biomethane, are also promoted within the EEG. However, this support measure only applies to biomethane produced in Germany. This benefit for nationally produced biomethane can bring a barrier for imports. If biomethane is used in transport or heating, this barrier is not applicable, though. Furthermore, the EEG benefit for biomethane-based electricity generation is “capped” with regard to size: beyond 20 MW_{el}, the EEG does not apply anymore. Therefore, using biomethane in larger powerplants – either in dedicated plants or via cofiring – has opportunities with regard to the European Emission Trading System (ETS), depending on the price of CO_2 certificates. The higher the CO_2 price, the higher the incentive to use biomethane.

So far, demand for biomethane in the different sectors is rather small, and more biomethane is produced than consumed in Germany.

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