Biomass role in achieving the Climate Change & Renewables EU policy targets. Demand and Supply dynamics under the perspective of stakeholders . **IEE 08 653 SI2. 529 241**

D2.1 Report on biomass market segments within the transport, heat & electricity- CHP sectors for EU27 & Member States

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Content

Preface

This publication is part of the BIOMASS FUTURES project (Biomass role in achieving the Climate Change & Renewables EU policy targets. Demand and Supply dynamics under the perspective of stakeholders - IEE 08 653 SI2. 529 241, www.biomassfutures.eu) funded by the European Union's Intelligent Energy Programme.

1 Introduction

The Biomass Futures project (www.biomassfutures.eu) aims to assess the role that biomass ***can play in meeting EU RES-D targets for 2020 and to inform policy makers at both the European and national levels***.

Bioenergy uptake in Europe has evolved swiftly over the last ten years as a function of geopolitical and environmental factors as well as market forces. Market development policies have varied between market instruments, incentives and quota systems. Member State market policies have been successful in creating steady demand and progressing towards achievement of European targets. Logistics and infrastructure are one of the immediate factors after primary market forces, such as price for alternatives, which can continue advancing bioenergy uptake.

An overview of the key demand sectors for bioenergy has been structured in this report to present the building blocks of market development.

It provides up-to-date information on the bioenergy uptake markets in EU27 in terms of their readiness and suitability to achieve high penetration levels by 2020.

2 Market trends

2.1 Biofuels

This section highlights EU 27 market trends in transport regarding penetration of biofuels and provides insights for future projections.

In the year 2000, the proportion of biofuels in liquid road transport fuels was 0.2%, in 2005 it increased to 1.1%, whilst it is anticipated to reach 7.4% by 2020 and 9.5% by 2030 (EC, 2007).

Details of biodiesel and bioethanol consumption by Member State and as EU 27 total in the years 2008 and 2009 are presented in Table 2-1.

Table 2-1 Transport biofuel consumption in the EU in 2008 and 2009

	Year 2008				Year 2009			
Country	Bioethanol (toe)	Biodiesel (toe)	Other (toe)	Total (toe)	Bioethanol (toe)	Biodiesel (toe)	Other (toe)	Total (toe)
BE	12489	86149		98638	37577	221252		258828
BG	6208	29412		35620	0	6186		6186
CZ	32461	75783		108244	51097	119809		170906
DK	4304			4304	3913	243		4156
DE	402000	2477983	377203	3257186	581686	2224349	88373	2894407
EE	1453	2777		4230	n.a.	n.a.	n.a.	n.a.
IE	17800	40000		57800	19733	54261		73994
EL		75680		75680	0	57442		57442
ES	125000	519000		644000	152193	894335		1046528
FR	403510	2020690		2424200	455933	2055556		2511490
IT		557280		557280	118014	1048988		1167002
CY		14180		14180	0	15024		15024
LV	18	1927		1945	1120	3570		4690
LT	15651	45764		61415	14091	37770		51861
LU	922	41447	477	42846	740	39915	498	41154
HU	39040	81000		120040	64488	119303		183791
MT		964		964	0	583		583
NL	130000	202000	3000	335000	138650	228886		367536
AT	54433	186645	12226	253304	64249	424901	13369	502519
PL	118794	340560		459354	136043	568997		705040
PT		132849		132849	0	231468		231468
RO		60200		60200	53274	131328		184601
SI	2370	22255		24625	1859	27993		29852
SK	6551	53070	5000	64621	6820	55041		61861
FI	73803	11441		85244	79321	66280		145601
SE	213968	129888	n.a.	343856	199440	159776	35015	394231
UK	105189	691335		796524	159000	822872		981872
EU 27	1773788	8018003	397323	10189113	2339241	9616129	137255	12092625

Although biodiesel consumption in Germany decreased between 2008 and 2009, Table 2-1 shows that it is still the largest consumer of biodiesel and of biofuels collectively. The second largest consumer of biofuels, France, increased its bioethanol consumption significantly whilst biodiesel consumption experienced a very modest increase. Important developments in eastern Member States were the significant growth in biodiesel consumption by nearly 70% in Poland and 85% in Romania, where total biofuel consumption practically trebled between 2008 and 2009.

As reported by Biofuels Barometer (2010) the largest Member State consumption markets are Germany, France and Italy as can be seen in Figure 2.2.

Increases in national consumption are generally mirrored by increased national production. This report examines production capacities in Section 4.

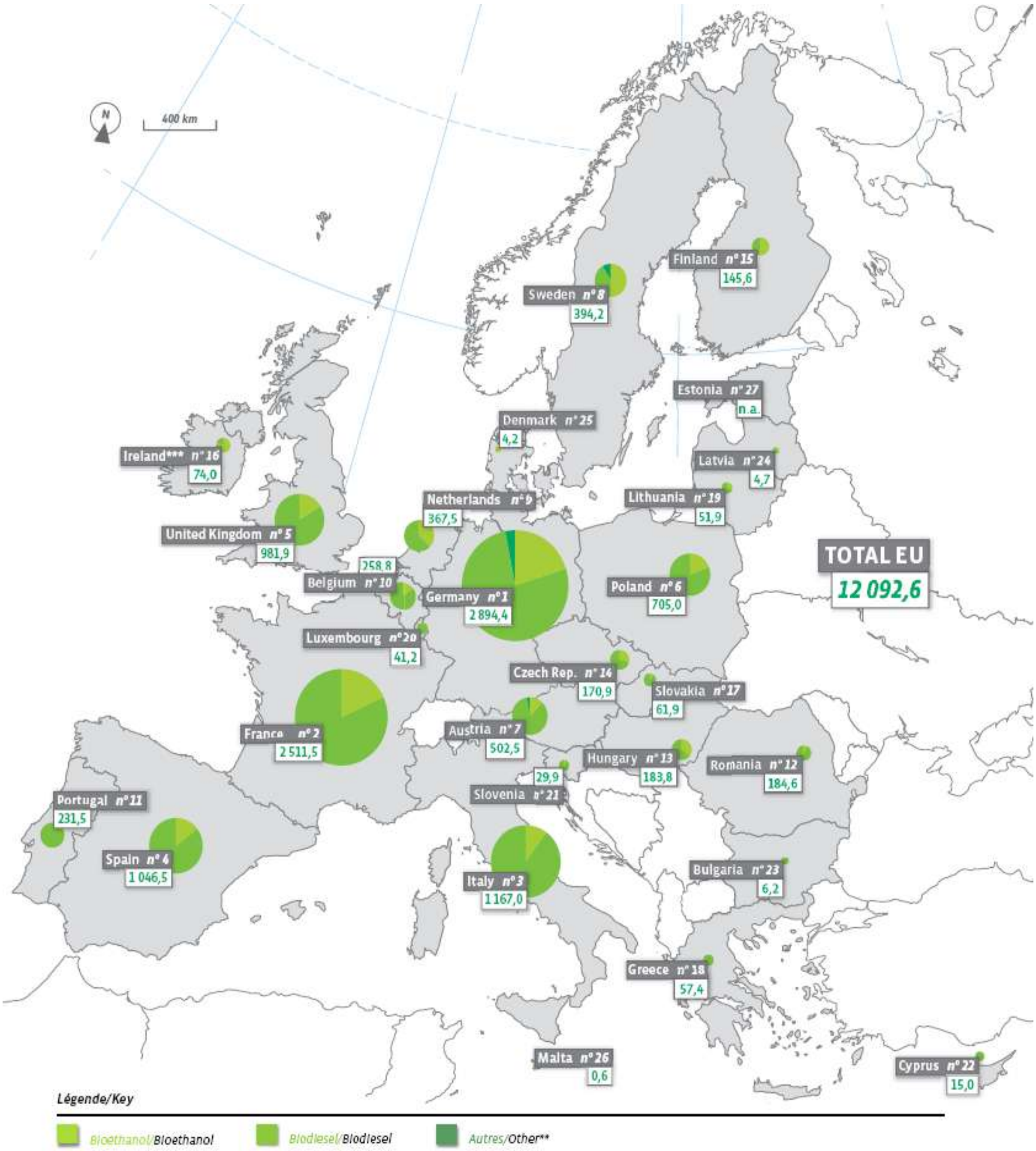


Figure 2.2: Biofuels Consumption in the EU for 2009 in ktoe with respective shares

Source: Biofuels barometer, 2010

Projected growth in production reflected in Renewable Energy Action Plans of Member States indicates that in France, for instance, ethanol production by 2020 will increase by approximately 11% and biodiesel production by 16%. For the same period in rapidly growing markets like Spain, ethanol production is projected to increase by 7% and biodiesel production by 17% (ECN, 2010). Apart from already established producers like Germany, France, Italy and the UK, biodiesel production growth in the rest of Member States until 2020 is projected to remain modest at levels below 5% (ECN, 2010).

2.2 Biomass for heat

The share of biomass-derived heat in EU27 has been calculated by AEBIOM as part of the final energy consumption at 1,158 Mtoe in 2007. Approximately 48% of the final energy demand is heat. According to these data households are the biggest consumer of heat, followed by industry and services. Heat comprises space heating, hot water and heat for industrial processes. In this market wood fuels are predominantly used for heating residential or commercial buildings. However, within this sector pellet stove markets can be distinguished from markets where pellets are used also in boilers or commercial applications. Wood fuel utilisation in small scale heating systems in Europe is currently concentrated in a small number of member states (predominantly Austria and Germany and, to a lesser extent, Italy, Finland, Belgium and France).

Table 2.2 Biomass heat by sector in EU27 (2008)

Sector	Final energy (Mtoe)	Heat	
		%	Mtoe
Industry	323	55	178
Households	285	86	245
Commerce, Services & Agriculture	173	76	132
Transport	377	0	0
Total	1158	48	554

Source: Eurostat (2009), AEBIOM calculations

EurObserv'ER (2009) has released information on heat sold via a community heating network supplied by heating plants which are either operated by industrial groups that sell off their surplus heat, managed networks or energy service undertakings. These statistics do not include industrial heat production used on site for heating factory premises, heat produced by domestic heating appliances, collectives or industrial operations not linked to the network. Figure 2.3 below presents the heat sales in EU27 for 2008 based on these statistics. It should be emphasised that the figures presented in the latest EurObserv'ER report are only a part of biomass heat in EU27 as the domestic sector which accounts for the main bulk of heat consumption is not included. Sweden, Finland and Denmark between them account for over two-thirds of the identified heat sold in the European Union member states (67.4% in 2008).

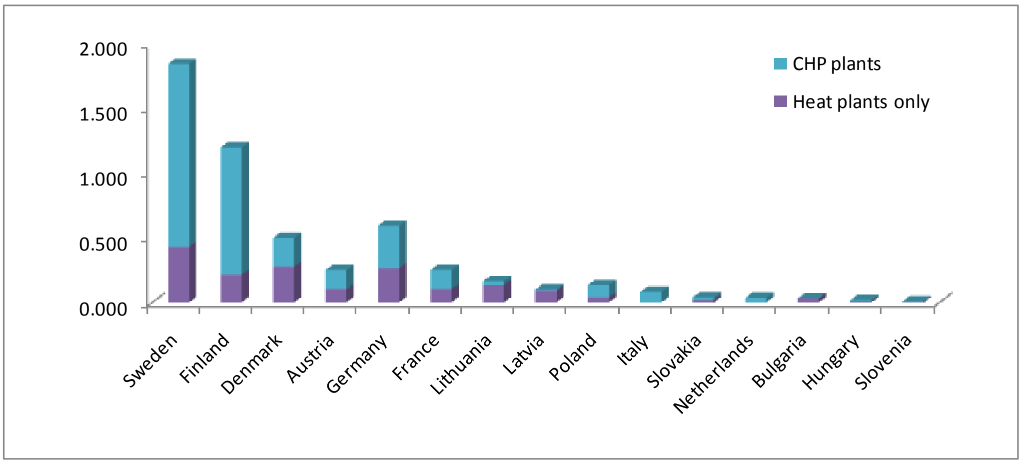


Figure 2.3 Heat sales in EU27 for 2008 (EurObserv'ER 2009)

The increase in heat sales kept pace with electricity production in 2008, which was 10.8% higher than 2007, adding a further 0.5 Mtoe. This increase followed a drop in production in 2007 given the mild winter which limited heating needs. Over two-thirds, or 67.4%, of all the heat sold in 2008 was delivered by cogeneration plants (EurObserv'ER, 2009).

2.3 Biomass for Electricity

Biomass electricity generation is based on three fuel types: solid biomass, biogas and the biodegradable fraction of MSW. According to AEBIOM, EUROSTAT and EurObserv'ER, bioelectricity production from solid biomass reached 57.76 TWh in 2008 compared to 51.8 TWh in 2007, and 20.3 TWh in 2001.

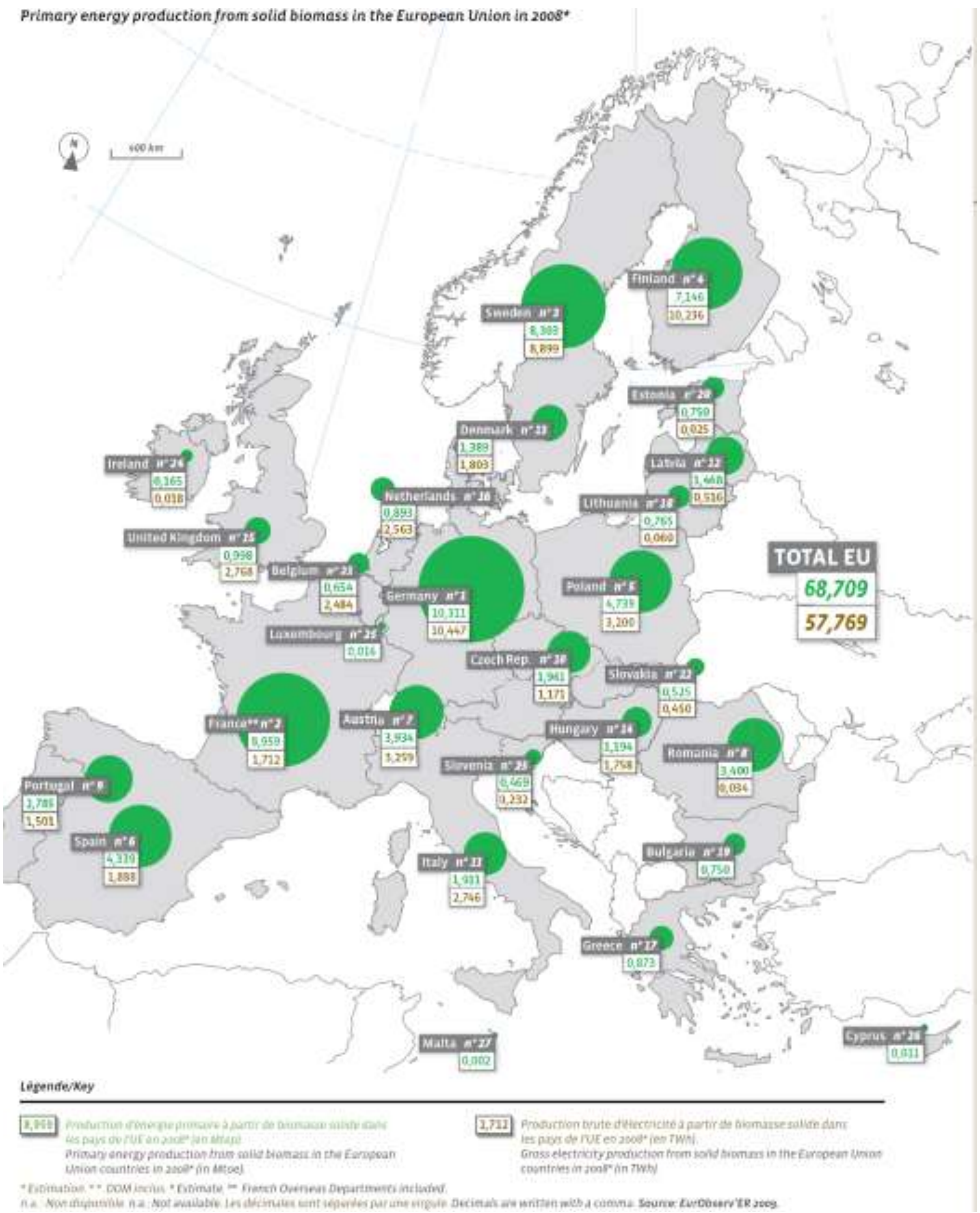


Figure 2.4 EU27 Primary energy (Mtoe) and electricity generation (TWh) form solid biomass in 2008

Source: EurObserv'ER 2009

Biomass electricity generation is based on three fuel types: solid biomass, biogas and biodegradable fraction of MSW. As can be seen in the table below electricity from biomass grew by 15-20% per year over the five year period 2002-2007.

Table 2-3 Biomass electricity growth

Region	Year	Total electricity production from biomass (TWh)
EU25	2002	48.82
EU25	2003	57.64
EU25	2004	68.84
EU25	2005	79.89
EU25	2006	89.84
EU27	2007	101.81

Sources: AEBIOM, EUROSTAT

2.4 Biomass for CHP

Combined heat and power (CHP) or cogeneration is a technology used to improve energy efficiency through the generation of heat and power in the same plant, generally using a gas turbine with heat recovery. At present, installed CHP capacity in the EU-27 is about 95 GWe, which accounts for approximately 11% of electricity demand. Natural gas dominates the CHP fuel market with about 40% share, followed by coal at 27%. Renewable sources, mainly biomass, but also combustible waste, are becoming increasingly important having attained 10% of the market. CHP systems have significant penetration in the EU industry, producing approximately 16% of final industrial heat demand. It is worth noting that cogeneration (CHP) plants, which produce heat and electricity concurrently, account for almost 63% of EU-27's bioenergy production from solid biomass (EurObserv'ER, 2009).

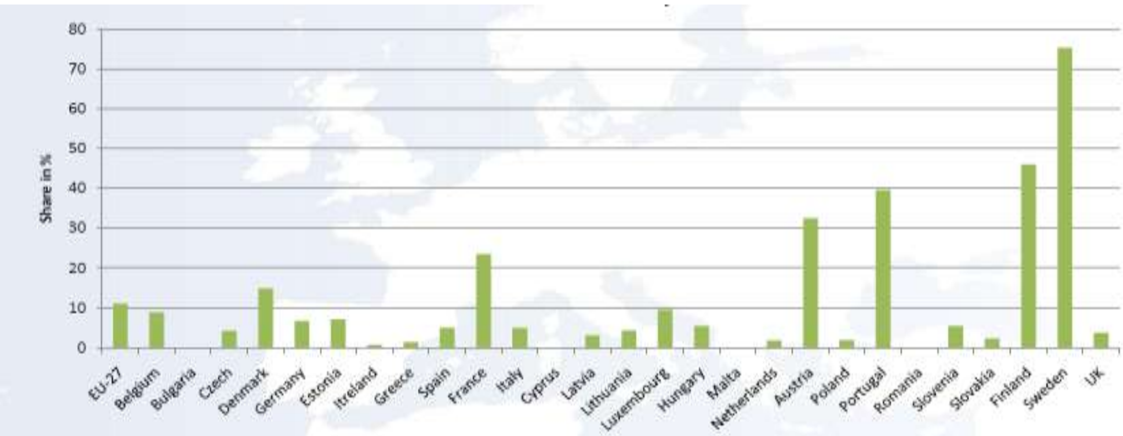


Figure 2.5 Biomass share in CHP plants in EU27 Member States (source, COGEN)

Source: Cogeneurope

Figure 2.5 shows that the highest share of biomass in CHP plants is in Scandinavia (Sweden, Finland and Denmark) and then in France, Austria and Portugal. It is worthwhile mentioning that most solid biomass CHP plants are located in countries of considerable forest industry thus woody biomass is the predominant fuel. Regarding scales, smaller capacities (<1 MWe) exist in central Europe, while larger plants (>20 MWe) are located in Northern Europe. Key conditions facilitating the market development in these countries are the existence of district heating networks and the strong support policies for respective schemes.

Projections within the baseline scenario of COGEN Europe (2010) CHP installed capacity rises gradually to 2035 at approximately 2.25% contrasting the period 2004 to 2008 at 0,5%. It expects that between 2015 and 2020 new energy efficiency legislation drives investment. Cogeneration growth is driven mainly by industrial heating demand, both for low and high grade heat applications. By 2035 there will be an additional 80 GWe of power within the European network and use is predicted to stabilise afterwards.

3 Policy

All aspects regarding generation and use of energy from renewables are included in the **Directive 2009/28/EC on the promotion of the use of energy from renewable sources** which amends and subsequently repeals Directives 2001/77/EC and 2003/30/EC. The aim of the Directive is that the EU will reach a 20% share of energy from renewable sources by 2020 and a 10% share of renewable energy specifically in the transport sector. It improves the legal framework for promoting renewable electricity, requires national action plans that establish pathways for the development of renewable energy sources including bioenergy, creates cooperation mechanisms to help achieve the targets cost effectively and establishes the sustainability criteria for biofuels. The Directive should be implemented by Member States by December 2010.

3.1 Policy for Biofuels

Exogenous drivers such as climate change abatement commitments, self-sufficiency, energy security, air quality and similar are the most important in the shaping of biofuel policy measures. Biodiesel fuel availability and use in the European Union differs depending on each country and the accompanying measures taken. For instance, Germany used pure biodiesel fuel since 1993 (SUGRE, 2005). In 2005 the B100 market of the country was prospering, with approximately 1,900 filling stations. Due to recent modifications in the taxation system, the B100 consumption is presenting a certain decline. However, in order for the country to fulfil its commitments enshrined in EU Directives, the proportion of blends has to be over 5%, so a future possibility for Germany is to use either B7 or B7+3, which contains 7% biodiesel and 3% HVO blended to diesel oil (European Biofuels Technology Platform, 2010). B30 on the other hand, is often used in Member states such as France and the UK.

Almost half of the passenger cars that are currently available in the market run on petrol engines. These types of internal combustion engines start combustion with spark plugs and are intended to run on volatile fuels like petrol. As bioethanol is a biodegradable fuel and less toxic than petrol, it can be utilised as an alternative fuel. The European standards (EN228) as well as the Fuel Directive 2009/30/EC, amending Directive 98/70/EC, permit a 5% by volume of anhydrous bioethanol to be blended into petrol. Moreover, some of the amendments allow the use of E10 fuel, which consists of 10% anhydrous bioethanol and 90% petrol.

The Biofuels Directive 2003/30/EC set indicative targets for the deployment of biofuels in the national fuel mix of Member States starting with 2% by 2005 and 5.75% by 2010. Also, to establish a workable and acceptable exception to State Aid regulation, the Energy Taxation Directive 2004/74/EC amending Directive 2003/96/EC enables Member States to reduce excise tax on biofuels for transport. In terms of the wider acceptance of policy options, the most favoured measures have been sales obligations and tax incentives. An example of such sales obligation is the UK Renewable Transport fuels Obligation (RTFO), which requires suppliers of fossil fuels to ensure that a specified percentage of the road fuels they supply in the UK is made up of renewable fuels.

Fuel suppliers are required to provide monthly reports on the carbon and sustainability of the biofuels supplied. Fuel suppliers may "buy out" of their obligation for GBP 0.30/litre. The escalating values have been set as follows:

•2008/09: 2.5 percent

•2009/10: 3.9 percent

•2010/11: 5.3 percent

Policy mechanisms deployed across Europe to incentivise biofuel uptake are predominantly sales obligation systems or tax exemptions. The main mechanisms used by Member States are presented in table 3-1.

Table 3-1 Main biofuel policy incentives deployed in the EU

Sales obligations	Tax incentives
Austria	Belgium
Germany	Czech Republic
Finland	Denmark
The Netherlands	Estonia
Slovakia	France
Slovenia	Greece
Spain	Hungary
The UK	Ireland
	Italy
	Latvia
	Lithuania
	Portugal
	Sweden

Source: E4Tech

3.2 Policy for Biomass-derived Heat

Community legislation on energy efficiency and further environmental aspects, including particulate matter emissions, is developed mainly for residential boilers, including boilers fired by liquid, gaseous or solid biofuels, under

- The Eco-design for energy-using products directive 2005/32/EC
- The Energy labelling directive 92/75/EEC
- The recast of the Energy labelling directive proposed by the Commission end 2008, COM(2008)778, in particular Article 9 on public procurement and incentives
- The recast of the Energy performance of buildings directive proposed by the Commission end 2008, COM(2008)780, in particular Article 8 related to minimum energy performance requirements of technical building systems

These policies aim to improve the conversion efficiency of mainly residential boilers to a satisfactory extent.

3.3 Policy for Biomass-derived Electricity

According to AEBIOM, EUROSTAT and EurObserv'ER, bioelectricity production from solid biomass reached 57.76 TWh in 2008, compared to 20.3 TWh in 2001, and 51.8 TWh in 2007, when EU issued Directive 2009/28/EC on the Promotion of Electricity from Renewable Energy Sources. The entry in effect of the

Directive resulted in significant efforts in almost all Member States, although still more than half of the production (51.2% in 2008) is concentrated in Germany, Sweden and Finland (EurObserv'ER, 2009).

3.4 Policy for Biomass-derived CHP

Combined heat and power (CHP) in Europe has been incorporated into Directive 2004/8/EC on the promotion of cogeneration based on a useful heat demand in the internal energy market, amending Directive 92/62/EEC. The directive, commonly known as the 'CHP Directive' entered into force in February 2004 and Member States have been obliged to begin its implementation since August 2007. In summary, Member States are obliged to produce reports covering their analysis of the state of CHP in their own countries, to promote CHP and show what is being done to promote, report on, remove barriers to and track progress on high-efficiency cogeneration within the energy market.

4 EU supply capabilities

4.1 Supply Capabilities for Transport Biofuels

The EU has a strong domestic feedstock production and fuel processing base in addition to increasingly certified import routes.

Table 4-1 EU Biodiesel production between 2002 and 2009

Countries	Annual production Ml/yr						
	2002	2003	2004	2005	2006	2007	2008
Germany	507	805	1.166	1.88	2.998	3.255	3.175
France	412	402	392	554	837	982	2.044
Italy	236	307	360	446	503	409	670
Belgium	0	0	0	1	28	187	312
Poland	0	0	0	113	131	90	310
Portugal	0	0	0	1	102	197	302
Austria	28	36	64	96	139	301	240
Spain	0	7	15	82	111	189	233
UK	3	10	10	57	216	169	216
Slovakia	0	0	17	88	92	52	164
Others	12	46	154	268	349	604	1.068
EU-27	1.199	1.614	2.177	3.586	5.507	6.435	8.733

Sources: Biofuels Platform, 2010c; Biofuels barometer, 2010

The EU biodiesel market is affected significantly by global biodiesel trade. European producers have to compete mostly with US counterparts and traders who sell their biodiesel, also known as B99, at extremely low prices. As a result, measures favouring both domestic production and imports from other supplier countries like Argentina, Malaysia or Indonesia have been introduced by the European Commission in early 2009 to avoid unfair trade which threatens the viability of European investments (USDA, 2009).

Germany has notably one of the largest biodiesel production capabilities in the EU. The leading biodiesel companies in Germany are ADM Hamburg AG (formerly Ölmühle Hamburg AG), MUW and EOP Biodiesel AG. An overview of the development of production capacity between 2002 and 2009 is presented in table 4-1.

The major biodiesel firms across Europe and their installed capacities are displayed in table 4-2.

Table 4-2: Production capacity of leading European biodiesel producers in 2009

Company	Location	Plants in Europe	Capacity (tonnes)
Diester Industrie	France	9	2,000,000
ADM Biodiesel	Germany	3	975,000
Infinita	Spain	2	900,000
Biopetrol	Switzerland	3	750,000
Marsegllia Group (Ital Green Oil and Ital Bi Oil)	Italy	2	560,000
Entaban	Spain	3	500,000
Novaol (Diester Industrie International Group)	Italy (2 plants) Austria (1 plant)	3	480,000
Verbio	Germany	2	450,000
Cargill	Germany	2	370,000
Acciona	Spain	2	272,000

Source: Eurobserv'Er, 2010

Bioethanol is the dominant biofuel in the world, accounting for 65,000 Ml in 2008. The two leading producing countries are the United States (52%) and Brazil (37%). Although the EU is third, its production of about 2,800 Ml in 2008 is considerably smaller than the first two countries (USDA, 2009).

European bioethanol offer originates in 17 EU Member States that have been producing since 2008, notably Spain, Belgium, Finland and Austria. The port of Rotterdam plays a dominant role in bioethanol trade, as it receives and forwards the bulk of imports into the UK, Sweden and the Benelux Countries (USDA, 2009). In 2008, according to the European Union of Ethanol Producers the production of bioethanol fuel reached the 2,257 million litres, while the estimation of European Bioethanol Fuel Association was 2,816 million litres (EurObserv'ER, 2008; eBio, 2010).

In 2010, bioethanol production is anticipated to further increase, driven mainly by the national policies of Member States and growing demand for biofuels. This increase is predicted to be more evident in the UK, Belgium, the Netherlands and Luxembourg.

France is the leading European bioethanol producing country. Quotas granted by the French Government and additional tax exemptions, to integrate 7% of biofuels into the market by 2010, are expected to foster even more the production of bioethanol (USDA, 2009).

Although bioethanol production firms are part of agri-food markets, and mainly sugar and starch industries such as Tereos and Cristal-Union, other firms such as German group Südzucker and Spain's Abengoa Bioenergy, can be mentioned as significant industry stakeholders in bioethanol production (Biofuels Platform 2010b; Biofuels barometer 2007). The leading bioethanol firms and their capacity are displayed in table 4-3.

Table 4-3: Production capacity of major European bioethanol producers in 2009

Company	Location	Plants in Europe	Capacity (millions of litres)
Tereos	France (6 plants) Belgium (1plant) Czech Rep. (1 plant)	8	857
Abengoa Bioenergy	Spain (4 plants) France (1 plant)	5	776
Crop Energies	Germany (1plant) France (1plant) Belgium (1pant)	3	760
Cristanol	France	4	540
Agrana Group	Austria (1plant) Hungary (1plant)	2	410
Ensus pic	UK	1	400
Verbio AG	Germany	2	355
Agroetanol	Sweden	1	210
IMA (Bertolino Group)	Italy	1	200
Wratislavia Bio (Wroclaw)	Poland	1	170

Source: Eurobserv'Er, 2010

The EU possesses a broad base of feedstock production and although it is estimated that it could agronomically satisfy all its domestic feedstock demand, some import routes are kept to reduce price pressure on European supply (USDA, 2010). Table 4-4 lists the crops in the main feedstock-producing countries.

Table 4-4 Biofuel feedstock in main producing countries

Feedstock	Countries
Rapeseed	Austria, France, Germany, Spain, Ireland, Italy, Luxembourg, Netherlands, Sweden, UK, Cyprus, Czech Republic, Lithuania, Latvia, Malta, Poland, Slovenia, Slovakia
Wheat and barley	France, Germany, Spain, Finland, Ireland, Sweden, Lithuania, Latvia, Poland, UK
Sugar beet	Belgium, France, Germany
Ligno-cellulosic crops	Austria, France, Germany, Netherlands, Sweden, UK
Maize	Austria, Belgium, Bulgaria, Czech Republic, France, Germany, Greece, Hungary, Italy, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain
Sunflower seed	Austria, Belgium Bulgaria Czech Republic Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Romania, Slovakia, Slovenia, Spain, Sweden, UK

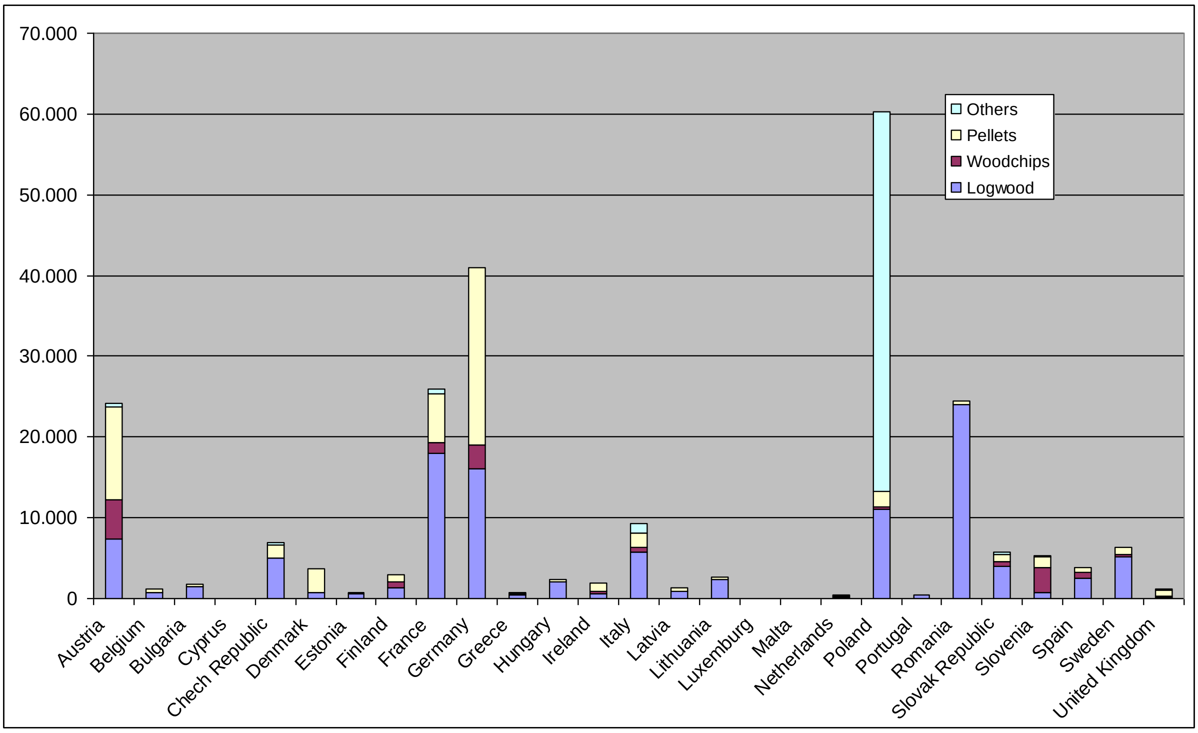
Sources: MEACAP, 2007; AEBIOM, 2009

4.2 Supply Capabilities for Biomass-derived Heat

The heat generated in European power plants is typically not used; Europe wastes more heat than it consumes (AEBIOM, 2009). In the domestic sector, insulation is often of poor standard.

Altogether, the European heating system is highly inefficient and offers many possibilities of improvement. Since heating is the most important sector for bioenergy and the current policy environment is favourable to renewable electricity, there are good prospects for biomass-derived CHP as well as heat or electricity applications (AEBIOM, 2009).

Figure 4.1 Domestic heating boilers by fuel by country



Source: AEBIOM, 2009

As shown in Table 4-5, the established applications such as logwood boilers are most widespread in Romania, with 24,000 units. Newer applications gaining market penetration such as pellet appliances are mainly represented in Germany with 22,000 units, nearly half of the 56,850 units in the EU27, and Austria as a distant second market with 11,000 units. The differences between final conversion devices and their significance in the market can be appreciated from Table 4-6 below.

A significant fraction of the current stock of single-dwelling heating systems is in need of maintenance, upgrading or full replacement. Annual sales of heating appliances reached 3.78 million units in 2007. Direct heating stoves represented the largest share of the sales with 1.3 million units. The more complex indirect heating boiler systems only reached 0.31 million units sold (AEBIOM, 2009). Given that heating with wood fuels is much cheaper than heating with fuel oil (AIEL, 2010); there is a significant opportunity for biomass feedstocks to capture substantial parts of the replacement market.

Table 4-6 European market shares per appliance type per heat application

Appliance groups	Stock (1,000 units)	Sales in 2006[1] (1,000 units)
Fireplace	32,000	1,698
Cookers	7,594	464
Stoves (incl. pellet stoves)	35,901	1,333
Boilers <50kW	7,217	234
Boilers 50- 500 kW	629	77

Source: AEBIOM, 2009

An example of how supply of biomass feedstock for efficient heating appliances has evolved over the recent past is the trend for pellets production and production capacity. Actual European production has grown from 2.6 million tonnes in 2005 to nearly 6.3 million tonnes in 2008, whereas capacity utilisation has been constant or even declined during the economic downturn as can be observed in Table 4-7 (AEBIOM, 2009).

Table 4-7 EU27 pellet production capacity and actual production

	2007 (kilotonnes/year)	2008 (kilotonnes/year)
EU27 pellets production capacity	8,583	11,283
EU 27 pellets actual production	5,782	6,294

The contribution of renewable biomass to district heating has been modest but there are instances that are widely regarded as worthwhile examples to follow in terms of self-sufficiency, energy security, achievement of renewable targets and resource efficiency through the enhanced use of waste.

The district heating system of the city of Copenhagen covers its base load with energy from waste incineration. Table 4-8 shows how Denmark has achieved three times the EU average amount of per capita district heating provision and has the third highest use of biomass and the highest use of waste feedstock.

[1] Working paper of Bio Intelligence Service, 2009

Table 4-8 the contribution of biomass and waste to district heating

	Heat Sales in 2007	Heat sales per capita in 2007	Combustible renewables for DH in 2007	
	Mtoe	toe/capita	Biomass	Waste
EU 27	**72,72**	**0,15**		
Austria	1,46	0,18	4%	8%
Belgium	0,00	0,00	-	-
Bulgaria	0,00	0,00	-	-
Cyprus	-	-	-	-
Czech Republic	3,47	0,33	-	-
Denmark	2,47	0,45	17%	20%
Estonia	0,63	0,48	28%	-
Finland	2,60	0,49	12%	-
France	1,92	0,03	27%	-
Germany	6,41	0,08	10%	-
Greece	0,05	0,00	-	-
Hungary	1,08	0,11	-	-
Ireland	0,00	0,00	-	-
Italy	N.A.	N.A.	18%	-
Latvia	0,59	0,26	15%	0.1%
Lithuania	0,69	0,20	16%	-
Luxembourg	0,00	0,00	-	-
Malta	-	-	-	-
Netherlands	0,51	0,01	-	-
Poland	10,20	0,96	5%	-
Portugal	0,00	0,00	-	-
Romania	1,61	0,30	-	-
Slovak Republic	0,35	0,18	2%	-
Slovenia	0,29	0,01	4%	-
Spain	-	-	-	-
Sweden	4,06	0,25	47%	17%
United Kingdom	0,00	0,00	-	-

Source: AEBIOM, 2009

4.3 Supply Capabilities for Biomass-derived Electricity

Biomass electricity generation in Europe is based on solid biomass, biogas and biodegradable fraction of MSW. As can be seen from Figure 4-1 electricity from biomass in the then EU25 grew more than 10% between 2005 and 2006 and the trend was repeated between 2006 and 2007.

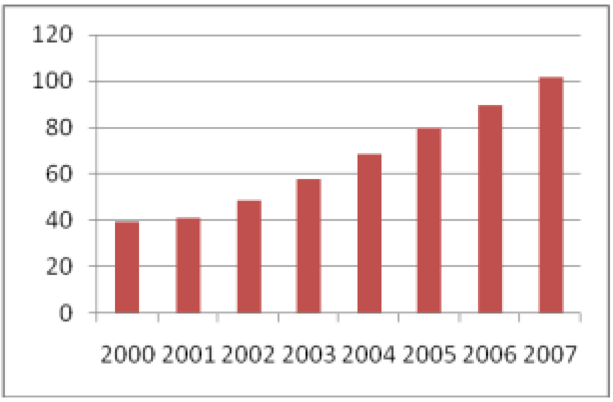


Figure 4-2. Electricity Generation from biomass (TWh) in EU25 (Aebiom, 2009)

4.4 Supply Capabilities for Biomass-derived CHP

Normal feedstock specifications of the more established technologies require processing steps such as chipping, drying and grinding. As for the combustion systems themselves, in the power range from 0.5 MW to > 100 MW push grate furnaces, fluidised bed combustion and injection furnaces are used. The gasification of biomass, the subsequent gas cleaning and further use of the gas is not yet applied commercially. It operates a pilot plant, more plants are planned (OBV, 2010).

There are significant capabilities in the European market for CHP generation from biomass. Three main technologies used in Biomass CHP plants. In steam processes combustion heat raises steam from water to drive a steam turbine, which can operate economically from a capacity of 1MWe. In Organic Rankine Cycle (ORC) processes an organic working medium such as silicone oil is used, due to its lower boiling point, instead of water. This technology is used at plant capacities of 1 MWe or slightly less. Stirling engines are used up to a power class of 100 kWe with helium mostly used as working gas (OBV, 2010).

The cogeneration industry has manufacturing plants in 12 EU Member States and a world-leading indigenous technology, knowledge and skills base, including innovative micro-CHP (COGEN Europe, 2010). Modern high-efficiency cogeneration guarantees an average of 20%-25% primary energy savings compared to separate production, with a minimum of 10% savings guaranteed by European law. The technology and know-how exist to achieve high efficiency wherever new systems are planned. Denmark, for example, has an integrated approach to heat and electricity planning and supply. CHP feeding District Heating networks supplies 46% of the Danish heat market, and 43% of total electricity generation (COGEN Europe, 2010). The efficiency of the electricity system from production to end use is in excess of 65%, which is a clear 20 percentage points above the European average, reinforcing the idea that an integrated approach greatly improves efficiency (COGEN Europe, 2010).

5 Economic viability

5.1 Economic viability of biofuels

Studies prove that bioethanol in the EU area is considered competitive when oil prices are about US$70, whereas for Brazil this price is about US$30 (Demirbas, 2009). Although the price for biodiesel is related to crude oil prices, bioethanol is mainly linked with sugar prices. That is how bioethanol prices did not follow the increase in fossil fuel prices over the last three years. Consequently, the mixture of gasoline with ethanol was an attractive alternative during 2008. In the same year the overall EU production increased about 55%, reaching 2.8 billion litres of bioethanol (eBIO, 2009).

The basic cost components for the biofuel mix for the years 2005 and 2010 are presented in Table 5-1, while projections are made for the next 20 years, using the results of BIOTRANS model (VIEWLS, 2005).

Table 5-1 Cost components of biofuel mix

Cost category	2005 €/GJ	2010 €/GJ	2015 €/GJ	2020 €/GJ	2025 €/GJ	2030 €/GJ
Conversion	2.0	2.3	2.7	3.1	3.3	3.6
Crops	3.3	3.3	3.1	2.7	2.4	1.9
Distribution	0.4	0.5	0.5	0.6	0.7	0.8
End-use	0.6	0.6	0.5	0.5	0.5	0.4
Residual waste	0	-0.6	0	0.5	0.7	0.8
Transport	0.8	0.8	0.8	0.8	0.8	0.8
Total	7.1	6.9	7.6	8.2	8.4	8.3

In general, when demand for biofuels increases considerably, it causes a relative increase in feedstock prices and hence in biofuels cost. The production costs of biofuels differ noticeably between developing and developed countries, for the latter being at approximately three times higher than oil prices in 2007 (Demirbas, 2009). Consequently, numerous countries, including European members, have enacted supporting policies, subsidies or tax exemptions, aiming to increase biofuels production and consumption. In fact, Scandinavia is an example of where the production of bioethanol prospers due to the existing mandates.

5.2 Economic viability of heat, electricity and CHP

Note that current costs for the latest bioenergy technology still have significant potential to achieve increasing returns of adoption, learning by doing effects, economies of network (the more users of a particular infrastructure such as district heating, the more benefits accrue to individual users), and scale economies. Table 5-2 highlights details of technical trends and other market developments that will allow bioenergy to be better able to compete with the scale economies of incumbent technology.

Table 5-2 Plant sizes, efficiencies & typical costs (Viewls, 2005/ E4Tech, 2008)

Market segment	**Typical plant size (MW)**	**Efficiency (heat, electricity)**	**Typical costs**		**Comments**
ELECTRICITY/ CHP			Investment costs €/$Kw_{h/el}$	O&M costs €/($kWh_{h/el}$*yr)	Various technologies are used for power generation in existing cogeneration systems (Combined Heat and Power - CHP) and the produced heat is used in different forms and on different temperature levels. The average overall efficiency in EU CHP industry is around 70%, while average electrical efficiency is less than 25%. However, overall efficiency of newly installed CHP systems varies from 60 to 90% while electrical efficiency is about 30-55%. Further increases of electrical efficiency are expected, particularly also for gas turbines, but also internal combustion engines and steam turbines. At present biomass is mainly, although not necessarily, restricted to steam turbine CHP units.
Co- firing	10- 50	35- 40	790- 930	15- 23	
Dedicated steam cycles	5- 25	30- 35	2150- 3570	25- 34	
Integrated gasification combined cycle (IGCC)	10- 30	30- 40	2500- 5000	0.11- 0.13	
Gasific. + engine CHP Stirling engine CHP	0.2- 1 < 0.1	25- 30 11- 20	3000- 4000 5000- 7000	0.11 0.13	
Micro small sized CHP units	20 kWe				Installations above 20 kWe represent a steadily growing market and they have features similar to conventional larger scale CHP. On the other hand, micro-CHP units below 20 kWe (based upon Stirling engines, Organic Rankine Cycle (ORC) engines, internal combustion engines, fuel cells, micro-turbines) have not had much impact on the market. A major issue with all of these micro-CHP technologies is the need for mass production manufacturing technologies, otherwise the unit costs will be excessive.
District Heating – Cooling					Major user of CHP, with some 70% of the heat distributed in this way in Europe being supplied by cogeneration.
HEAT					There is still the potential for further expansion in this important market. It should be noted that DH in Europe has reached a 10% contribution to the total heat demand, with an annual turnover of approximately 20 billion €. District Cooling is still in its early stages of growth, having a market share around 1-2% (2 to 3 TWh cooling) in Europe.
Biomass (Medium-scale unit)	5	0.87	390 - 420	17 - 19	
Biomass District heat (Small-scale unit)	0.5 - 1	0.85	475 - 550	20 - 22	
Biomass District heat **(**Large-scale unit)	10	0.9	800	50	
Biomass District heat (Medium- scale unit)	5	0.88	1200 - 1500	55	
Biomass -non-grid heat (log wood)	0.015 - 0.04	0.75 - 0.85	255 - 340	6 - 10	
Biomass -non-grid heat (wood chips)	0.02 - 0.3	0.78 - 0.85	340 - 610	6 - 10	
Biomass -non-grid heat (pellets)	0.01 - 0.25	0.85 - 0.9	390 - 530	6 - 10	

There is considered to be a large inherent cost improvement potential in biomass-generated power and heat as volumes and experience grow, in the order of 15 to 40 percent compared to present levels (ECF *et al*., 2010). Realising the improvements will be challenging but would make biomass competitive with coal and gas in a broad range of applications at a carbon dioxide price of €30 to €50 per tonne in 2020 (ECF *et al*., 2010).

6 Infrastructure and Logistics

6.1 Biofuel production and distribution infrastructure

Costs for the transportation of biofuels are calculated by taking into account the domestic distances covered, which are taken as a fixed number, and the international distances, which derive from real approximations. In most cases, transportation costs are a 10% approximately of the overall costs, and have the potential for a further reduction by burden sharing (VIEWLS, 2005). Possible requirements for modification of the refuelling infrastructure, meeting the standardization and safety requirements posed by the car manufacturers concerning the use of different levels of biofuels blends.

Low blends of biofuels are an opportunity in order to introduce environmentally friendlier fuels in road transport more promptly, without needing to adapt vehicles or to modify the existing infrastructure. In fact, all filling stations in Sweden and Germany distribute E5 at present. High blends of bioethanol, due to their significant differences with fossil fuels, necessitate certain changes to the engine technology as well as modifications to the fuelling infrastructure.

6.2 Heat, Electricity and CHP infrastructure

One of the important advantages of woody biomass is that it can easily be stored, transported and used with flexible load and applications where and when heat energy is needed. Two particular segments where biomass use could be scaled up are the energy-generation industry and small-scale heating applications. The energy-generation industry consists of large companies with important infrastructure elements already in place and the capacity to make large investments. Because biomass in energy generation largely displaces coal, it is more effective in reducing carbon emissions than biomass in direct use heating, where it displaces oil and gas (ECF *et al*., 2010). Smaller-scale direct-use heating has the advantage of a high direct conversion efficiency of approximately 80 per cent. Given European renewable energy targets formulated in terms of final energy consumption, direct-use heating would allow the achievement of targets with the lowest possible total amount of biomass (ECF *et al*., 2010). However, it remains clear that both segments still require scaling up and the right policy framework to enable a wider infrastructural or, rather, in the case of stand-alone applications, supply chain development.

7 Consumer readiness for uptake

7.1 Uptake Readiness for Biofuels

According to the Baseline Scenario of the "European Energy and Transport Trends to 2030" (EC, 2007), oil consumption in the transport sector in 2030 is anticipated to be 20% higher relative to 2005, whereas the whole of transport activity over the same period is projected to increase by 45%. For road transport, energy needs are expected to increase with an annual rate of 0.8%. Diesel for road transportation is projected to reach the share of 60% by 2030, compared to 30% approximately for gasoline. In general, when using biodiesel B5 the modification of vehicle technology is not required and the majority of car manufacturers accept this fuel type. Nevertheless, vehicle adaptation by using relevant parts is indispensable when pure biodiesel B100 or even B10 is used. Existing commercial cars designed for Euro 5 emission criterion, as well as passenger cars meeting Euro 3, are compatible with B100 fuel unlike Euro 4 diesel vehicles. However, since 2009, vehicle manufacturers do not fully approve pure biodiesel for the newly introduced car engines.

Low-blend biofuels are an opportunity to introduce greener fuels more promptly without the need for vehicle adaptation or modification of the existing infrastructure. Low blends can be deployed without any engine adjustments. All the filling stations in Sweden and Germany currently distribute E5 ethanol blend, whereas higher blends of 15% and 20% can still be compatible with European exhaust gas instructions and operate without engine modification. Moreover, E10 blend is compatible with almost all vehicles except only for direct injection (DI) gasoline cars with first generation fuel injection systems provided with rails made of aluminium (European Biofuels Technology Platform, 2010).

High blends of bioethanol, due to their significant differences with fossil fuels, necessitate certain changes to the engine technology as well as modifications to the fuelling infrastructure. Flexi Fuel Vehicles (FFV), are recently developed vehicles capable of running on either petrol only, or any blend of the two fuels in the same fuel tank. Indeed, whatever fuel mix is chosen, the proportion of bioethanol in the fuel is detected by a sensor, and then the information is sent to the FFV engine, which is designed to adapt accordingly.

E85 is the highest bioethanol blend available on the market, because of the difficulties encountered when starting a gasoline engine fuelled by pure bioethanol, particularly in low temperatures. As opposed to gasoline vehicles, the materials used in FFVs are compatible with bioethanol, unlike the metallic and rubber based ones used normally. The calibration system of the engine is also modified. One implication of bioethanol cars is the higher frequency with which they need to be serviced, as bioethanol does not lubricate the engine in the same way as gasoline, hence the oil filter needs replacement more often.

Sweden is one of the leading actors in the bioethanol market with 160,000 bioethanol cars. Since 2008 it is also permitted to retrofit gasoline vehicles to bioethanol in Sweden, with the restriction to meet the same emissions standards after the retrofitting (Biofuels Cities, 2008a). Taxi Stockholm is running its fleet on bioethanol, as E85 is easily refuelled in almost every filling station without any special financial restrictions.

FFVs are mostly available in Sweden but also in Germany, Netherlands, UK and France. With the initiative of the car manufacturer Ford in the year 2000 about 2,000 medium sized FFV units, Ford Focus Flexi Fuel, were brought into market. This resulted in the rapid growth of FFV to account today for 140,000 in the whole of Europe, both in fleets and as private ownership. In 2008, approximately 250,000 new passenger cars were recorded in the Swedish market, among which 68% were FFV/E85 (Biofuels Cities, 2008b). Moreover, the launch of legislation making compulsory the establishment of a fuel pump for biofuels at every petrol station is the reason why Sweden is the leading European country in the distribution and end use of E85.

7.2 Uptake Readiness for Heat

Europe is using about 90 Mtoe of oil and more than 170 Mtoe of natural gas for heating purposes every year for households and services (Eurostat, 2009). Conversion from existing fossil fuel heating systems to wood fuels heating systems can play a significant role in reducing the dependence of Europe on oil and gas imports. Heat consumption in the EU-27 was 45.59 Mtoe in 2007, which was a 5% decrease from 47.95 Mtoe in 2006. The major part of heat consumption occurs in Austria, France, Germany, Italy, Poland, Finland and Sweden together accounting for 83% of the European reported heat consumption in 1980 and 60% in 2007. Over the same period, heat consumption has declined in Hungary and Poland as older heat plants have been closed and replaced with decentralized heat in some areas. Growth has been particularly strong in Austria, Denmark, Finland, France, Iceland, Portugal and the United Kingdom.

These data do not refer to the consumption of heat produced in industrial premises or service industries for their own use. In this section heat consumption refers to heat sold to third parties by both main activity producers and energy autoproducers. In 2007, about 39% of third party heat consumed in EU countries was used in the industrial sector, about 21% in the residential and about 11% in the commercial/public services sector.

Currently, there are around 203 million households in Europe. Only a small share of heating systems installed in Europe today are state-of-the-art. The majority of domestic heating systems are clearly obsolete and should be replaced immediately on account of their poor energetic performance. It is estimated that approximately 8.2 Million (2007) wood biomass boilers of up to 500 kW are installed in Europe, over 90% of which are boilers of up to 50 kW (AEBIOM, 2009). In the Baltic States and Eastern European countries, fossil fuel heating systems are still the most widespread. In some countries, e.g. Poland, the use of coal-boilers is still very common. The replacement of existing heating systems offers an opportunity to reach the RES targets.

The highest potential for wood fuel heating appliances to penetrate existing markets is likely to be in Eastern European and Baltic countries. In addition, wider market penetration should be stimulated in Mediterranean countries, where the use of wood boilers is still in early stages. Moreover, pellet stoves also offer fairly low investment costs while producing significant amounts of renewable heat and they could be acquired by households with lower incomes. (AIEL, 2010)

7.3 Uptake Readiness for Electricity

Final electricity consumption is dominated by industry and households, which together accounted for almost 70% in 2008, with services, agriculture and other sectors accounting for the remainder. Overall, electricity consumption continues to be dominated by industry, which accounted for 40% of the total in 2008; households accounted for 29% and the service-agriculture sector also accounted for 29%.

Electricity consumption in industry covers all industrial sectors with the exception of the energy sector, like power stations, oil refineries, coke ovens and all other installations transforming energy products into another form. Electricity consumption of households is defined covers all use of electricity for space and water heating and all electrical appliances.

Electricity consumption of Services, Agriculture and other sectors covers quantities consumed by small-scale industry, crafts, commerce, administrative bodies, services, except transport, agriculture and fishing. As explained in Section 6.2 there are compelling reasons in all three sectors to further deploy bioenergy systems in alignment with the existing and emerging EU policy mechanisms.

7.4 Uptake Readiness for CHP

CHP applications have had increasing acceptance in response to economic and policy drivers. Heat delivered from CHP plants may be used for industrial or space-heating purposes in any sector of economic activity including the residential sector. CHP thus reduces the need for additional fuel combustion for the generation of heat and avoids the associated environmental impacts, such as CO_2 emissions (Eurostat, Combined Heat and Power Production in the EU, 2001, SAVE Program).

Within the European Strategic Energy Technology Plan (http://setis.ec.europa.eu), the baseline scenario assumes further growth in this segment, to about 23% by 2030. Important growth is assumed in biomass-based CHP, mainly in district heating (DH) but also in industry.

In the Strategic Plan the estimated maximum potential for the installed capacity of biomass CHP in the EU-27 is up to 42 GWe by 2020 and 52 GWe by 2030. These CHP capacities would generate about 4.7% and 5.3% of projected EU gross electricity consumption by 2020 and 2030 respectively. Moreover, the plan assumes that biomass CHP installations represent approximately two thirds of the total installed capacities of biomass-based power plants.

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