Briefing for first stakeholder consultation on the role of biomass in the EU27 heat, electricity & CHP sectors

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Market analysis for biomass in the heat, electricity & CHP sectors

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

Within the framework of the analysis of the demand for biomass in the heat, electricity and CHP sectors this briefing aims to:

a) provide up-to-date information for the heat, electricity and CHP markets in EU27 in terms of demand, market, plant sizes, efficiencies and typical costs; and

b) define and characterise market segments for future penetration of biomass in the above markets

c) review the main key factors affecting future integration.

Policy & Legislation

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 at the end of 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 at the end of 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, and no additional action is required for residential boilers.

Electricity

All aspects regarding electricity generation 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 new Directive should be implemented by Member States by December 2010 (http://ec.europa.eu/energy/renewables/index_en.htm).

Specifically for renewable electricity generation, as defined by the directive, Member States are required to set up a system for guarantees of origin.

CHP

Combined heat and power (CHP) in Europe has actively been incorporated into the **Directive on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/62/EEC**, officially 2004/8/EC and popularly better known as the 'CHP Directive'. The directive entered into force in February 2004 and Member States have been obliged to begin its implementation since August 2007.

In summary, the 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 it, to report on, remove barriers to and track progress of high-efficiency cogeneration within the energy market.[1]

Market

Biomass for Heat

The share of biomass heat in EU27 has been calculated by AEBIOM as part of the final energy consumption (1,158 Mtoe in 2007). About 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.

Table 1. 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

On a more detailed level, EurObserv'ER (2009) released information on heat sold via a community heating network (heating plants which are either operated by industrial groups that sell off their surplus heat product, 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 1 below presents the heat sales in EU27 for 2008 based on these statistics.

At this point it should be stressed out that the figures presented in the latest EurObserv'ER report are only a part of the biomass heat in EU27 as the domestic sector which accounts for the main bulk of the 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).

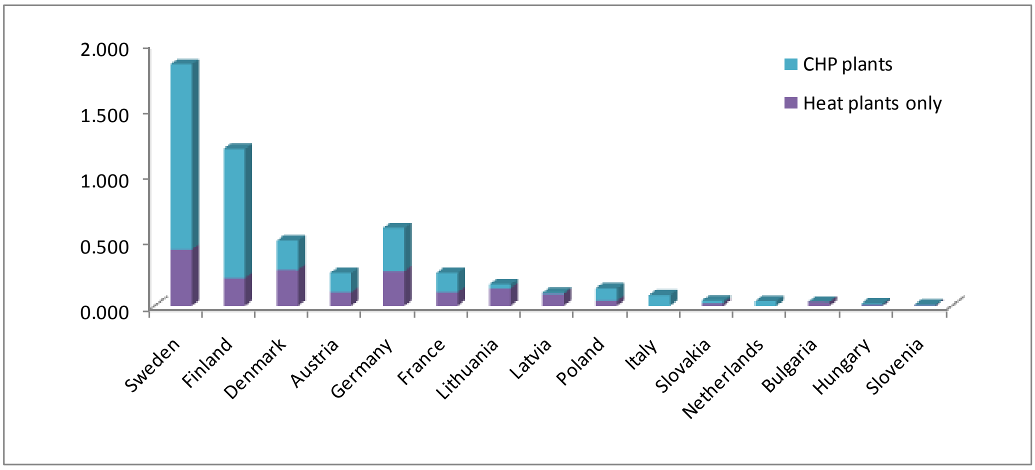


Figure 1. Heat sales in EU27 for 2008 (EurObserv'ER 2009)

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

Biomass for Electricity

According to AEBIOM, EUROSTAT and EurObserv'ER, bioelectricity production from solid biomass reached 57.76 TWh in 2008 (at 10.8%), compared to 51.8 TWh in 2007, and 20.3 TWh in 2001 when EU issued the Directive on the Promotion of Electricity from Renewable Energy Sources (Directive 2001/77/EC). Because of this Directive, significant efforts were made in almost all Member States, though still more than half the production (51.2% in 2008) is concentrated in Germany, Sweden and Finland (EurObserv'ER 2009).

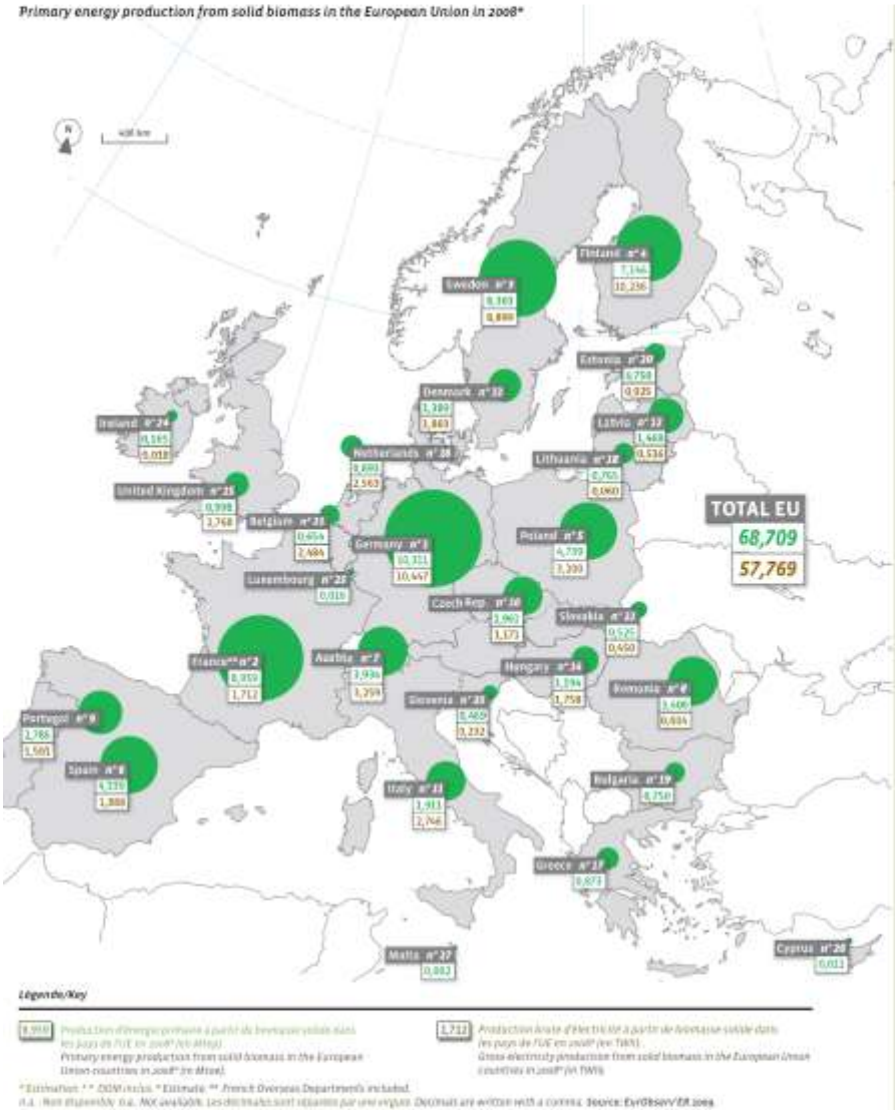


Figure 2. EU27 Primary energy production in 2008 form solid biomass (Mtoe) and electricity generation (TWh) (EurObserv'ER 2009)

Biomass electricity generation is based on three fuel types: solid biomass, biogas and the biodegradable fraction of MSW.

As can be seen in the table below electricity from biomass grew by 15-20% in the last years.

Table 2. Biomass electricity growth (2008)

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

CHP

At present, installed CHP capacity in the EU-27 is about 95 GWe, which accounts for about 11% of electricity demand. As a fuel, natural gas dominates the CHP market (about 40%), followed by coal at 27%. Renewables, mainly biomass, but also combustible waste, are becoming increasingly important having reached 10%. 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).

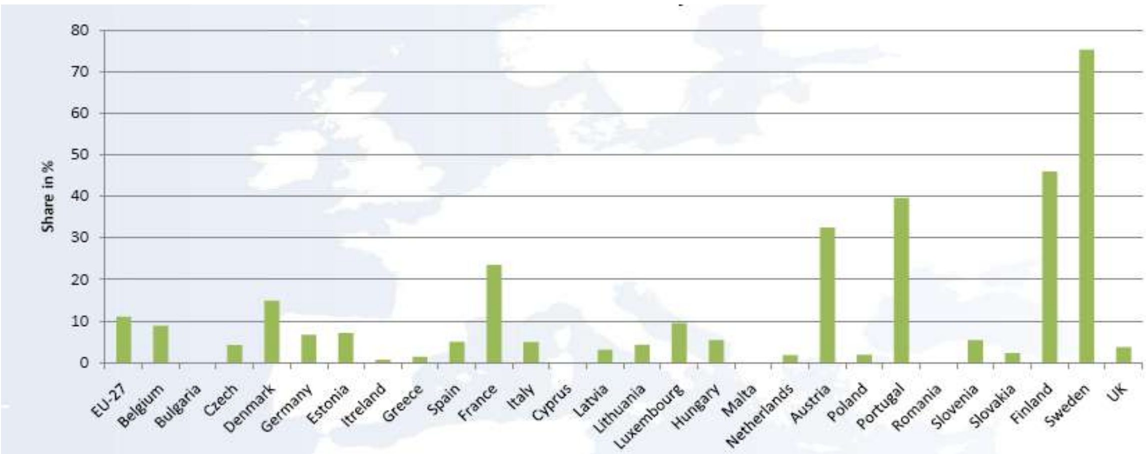


Figure 3. Biomass share in CHP plants in EU27 Member States (source: Cogeneurope).

Figure 3 shows that the highest share of biomass in CHP plants are in Scandinavia (Sweden, Finland and Denmark), in France, Austria and Portugal. It is worthwhile to mention 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 issues facilitating the market development in these countries are the existence of district heating networks and the strong support policies for respective schemes **Error! Reference source not found.**.

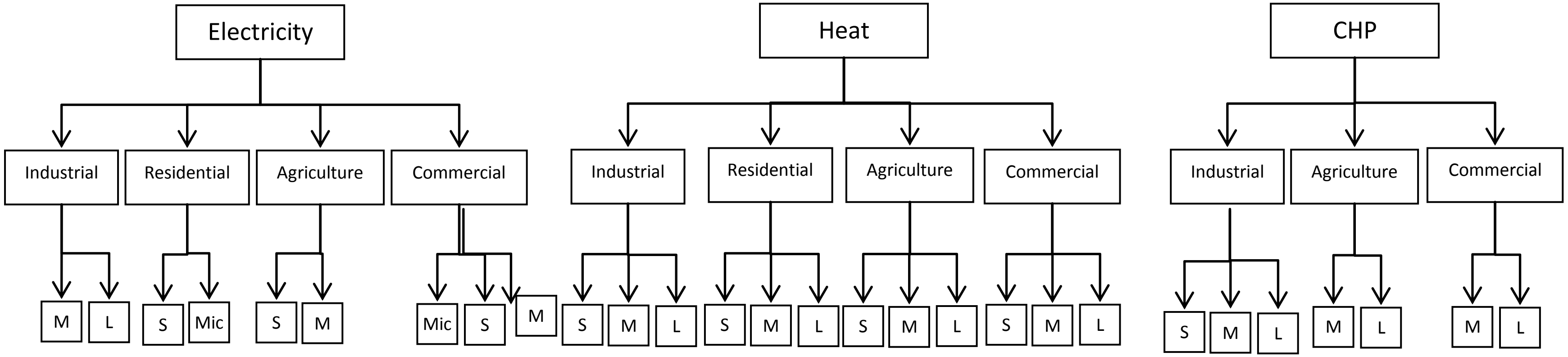
Within the European Strategic Energy Technology Plan (http://setis.ec.europa.eu), the baseline scenario assumes further growth in this segment, to about 23% by 2030. Important growth is assumed in biomass-based CHP, mainly in district heating (DH) but also in industry. In the Strategic Plan the estimated 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 assumption is that biomass CHP installations represent approximately 2/3 of the total installed capacities of biomass based power plants.

Plant size, efficiencies & typical costs

Market segment	**Typical plant size (MW)**	**Efficiency: heat, electricity (%)**	**Typical costs**		**Comments**
ELECTRICITY/ CHP			Investment costs €/Kw$_{h/el}$	O&M costs €/(kW$_{h/el}$*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	

Market Segments

EU27 electricity, heat and CHP market segmentation



- Mic- micro
- S – small scale
- M – medium scale
- L – large scale

Electricity

The structure of final electricity consumption in the EU-27 is shown in Figure 4, broken down by major end use sector. 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%.

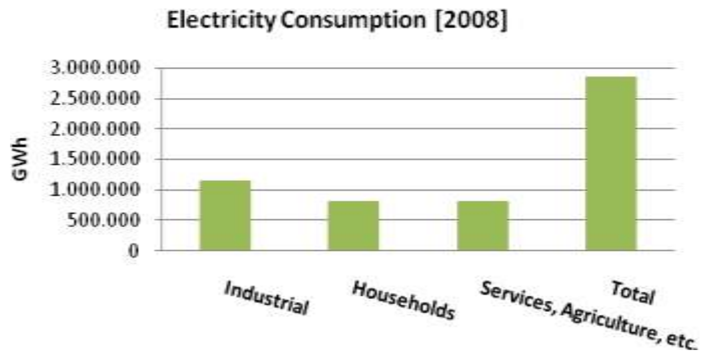


Figure 4: Structure of final electricity consumption in the EU-27 for 2008

Electricity consumption by Industry

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

Here consumption is defined as the quantity of electricity consumed by households, covering all use of electricity for space and water heating and all electrical appliances.

Electricity consumption of Services, Agriculture, etc.

Final energy consumption in services, agriculture, etc., covers quantities consumed by small-scale industry, crafts, commerce, administrative bodies, services with the exception of transportation, agriculture and fishing.

Heat

Heat consumption in the EU-27 was 45,593 Mtoe in 2007, which was a 5% decrease from 47,956 Mtoe in 2006. About 81% of the European countries reported heat consumption occurs mainly in 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, while 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 undertakings 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 autoproducers. In 2007, about 39% of third party heat consumed in EU countries was used in the industrial sector (Table), about 21% in the residential and about 11% in the commercial/public services sector.

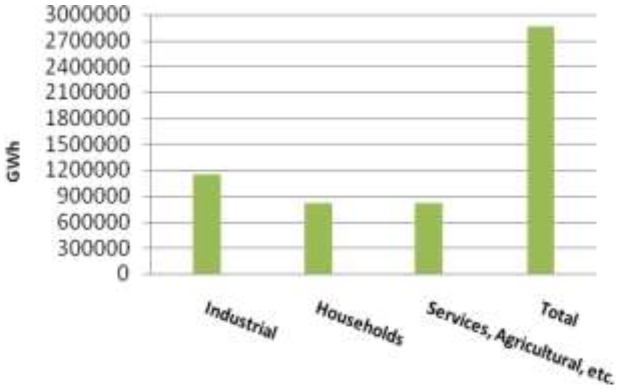


Figure 5: Structure of heat consumption (only heat sold to third parties) in EU27 for 2007

Combined Heat and Power (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. Heat delivered from CHP plants may be used for process 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 CO2 emissions (Eurostat, 2001).

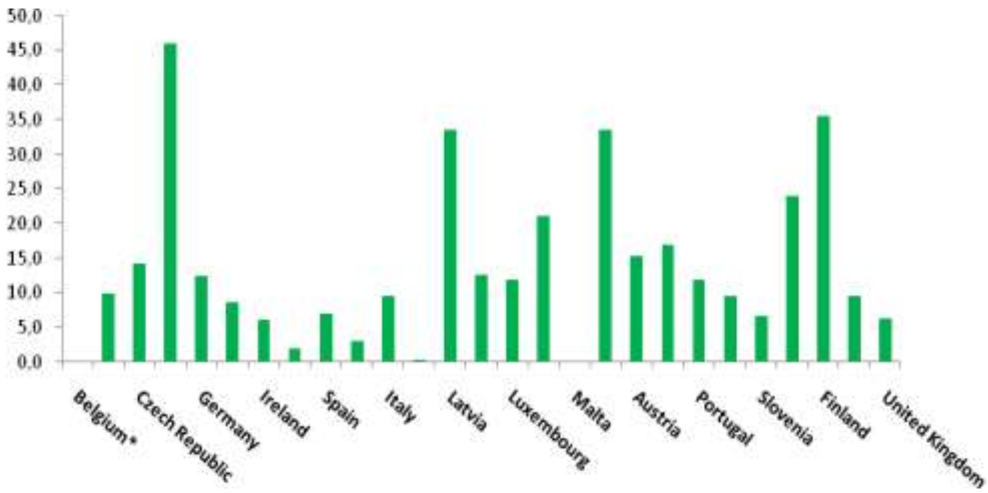


Figure 6: EU CHP Generation [2008]

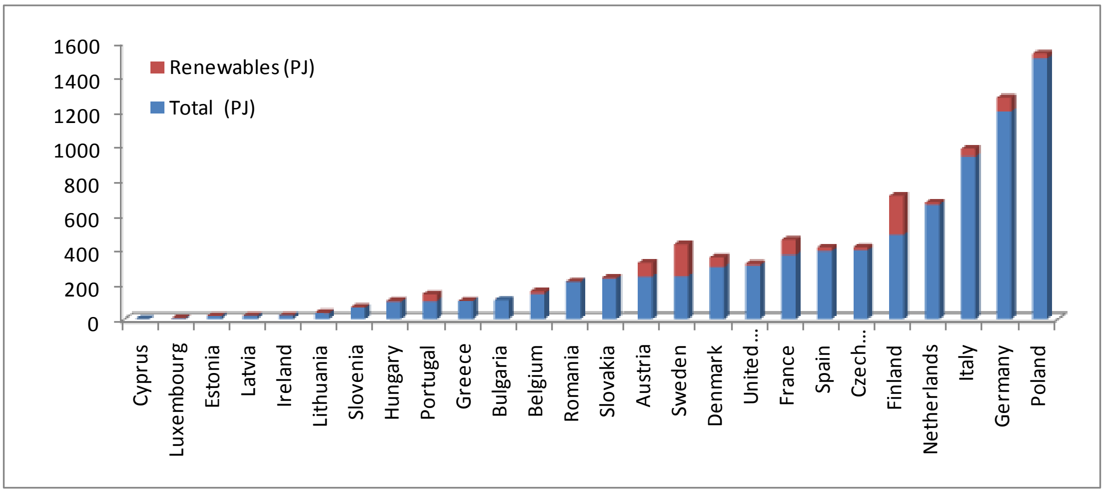


Figure 7: Fuel input into CHP [2008]

References

1. Eurostat, 2001. Combined Heat and Power Production in the EU, SAVE Program
2. EurObserv'ER 2009. Solid Biomass Barometer. 2009. www.eurobserv-er.org/pdf/baro194.asp
3. AEBIOM. www.aebiom.org Accessed 11th October 2010.

Key factors

BIOMASS FUTURES project (www.biomassfutures.eu)
Name:
Company:
Email address (if you wish to receive info from the Biomass Futures project):

Questionnaire on key factors affecting the deployment of biomass in the heat, electricity & CHP sectors
You can also download the form from our site and email it to: c.panoutsou@imperial.ac.uk

We are interested in your comments and suggestions. Please take a few minutes to complete the following table.

Please rate the importance of the factors described below using 1-5.

1	2	3	4	5
Very low	Low	Average	High	Very high

KEY FACTORS AFFECTING BIOENERGY PLANTS (Heat & Electricity)				
		Co-firing	**Dedicated plants**	
			Small scale	*Med.- Large*
Technical	Technology reliability and maturity Conversion efficiency Biomass quality Biomass quantity and logistics of supply Space availability Modularity and standardization Load following option Cofiring-dual fuel option Amenity issues (noise, odours, emissions)			
	On-site blending of biomass with the primary fuel prior to co-milling has proved to be the least capital intensive approach, and is currently the most popular method Higher steam temperatures give more efficient steam cycle~35% Lack of flexible and robust handling combustion technology			
	Financing new technology is an equity risk Barriers to getting planning permission. So most generating plants in the planning phase are using conventional combustion Gasification - high capital cost, less proven technology			

		Co-firing	Dedicated plants	
			Small scale	*Med.- Large*
Economic	Energy prices (with and without tax/subsidy) Growth in prices of oil and gas The cost of biomass fuel versus the income from ROCs and the avoided costs of coal and carbon allowances Heat/ Electricity selling price Cost of electricity (avoided cost) Subsidies Investment and development costs Operating and maintenance costs Biomass vs fossil fuel costs Grid connection costs Access to loans-cost of capital Cost of system connections for small, renewable generators			
	Large scale co-firing is one of the most efficient and low cost methods. Existing plants have written down their capital costs and reduce O&M cost / kWe Project risk increase with co-firing ratio and fuel quality			
	Potential income stream for farmers Local economic activity related to employment opportunities Competitive/expensive cost per tonne of CO2 saved? High initial cost of wood burning plant. Planning, design, authorisation, construction and commissioning of new plants can take a number of years and involve significant cost, i.e. small biomass plant > £4000/kWe Banks unwilling to commit capital for new build over entire project life Lack of type approval means that due diligence is expensive for leaders			

		Co-firing	Dedicated plants	
			Small scale	*Med.- Large*
Organisational	Reliability of incentives The targets for renewables 2010 and 2020, respectively. Lack of joining-up in Government/Regulator – Different ministries within a country have different agendas and policy objectives. Biofuel security of supply Biofuel price volatility Organizational capability Administrative issues and planning Challenge of balancing short-term consumer interests and environmental agenda Rules for bio-waste to energy & fuels Biomass quality standards Electricity market structure			

	Limits from co-firing: -The maximum proportion for co-fired plants - The proportion of biomass from energy crops Off-site blending rules for co-firing can hamper commercial options			
	Grant schemes that subsidise new plants Complex and fragmented grant aid and support structure, short application deadlines, academic appraisal panels, rates vary between schemes Grant schemes can distort rather then develop markets No link between grants and value of carbon saved Planning procedures require careful coordination among different authorities. Planning – the impact of public perception on planning applications.			

Thank you!

The BIOMASS FUTURES team