CODE2
Cogeneration Observatory and Dissemination Europe

D2.6 European report on potential of ***BIO-ENERGY CHP in EU27***

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Introduction

Policy Background

The European Union is well on the way to achieve the 2020 target of 20% energy from renewable sources in gross final consumption of energy[1]. In the Energy Roadmap of 2011, the European Commission expects a rise of the renewables share to 30% in 2030 and up to 55% in 2050[2].

However, the EU is not on track to achieve the target to enhance the Union's energy efficiency by 20% until 2020. The combined production of heat and power (CHP) is a crucial technology to achieve the target. The relevance of CHP is underlined by the EU policies on cogeneration[3].

Why bio-energy CHP?

The preamble of the CHP directive (2004/8/EC) summarizes well the main advantages of combined heat and power (CHP) and why it is a priority issue for the European Union's energy policies:

> Promotion of high-efficiency cogeneration based on a useful heat demand is a Community priority given the potential benefits of cogeneration with regard to saving primary energy, avoiding network losses and reducing emissions, in particular of greenhouse gases. In addition, efficient use of energy by cogeneration can also contribute positively to the security of energy supply and to the competitive situation of the European Union and its Member States. It is therefore necessary to take measures to ensure that the potential is better exploited within the framework of the internal energy market.

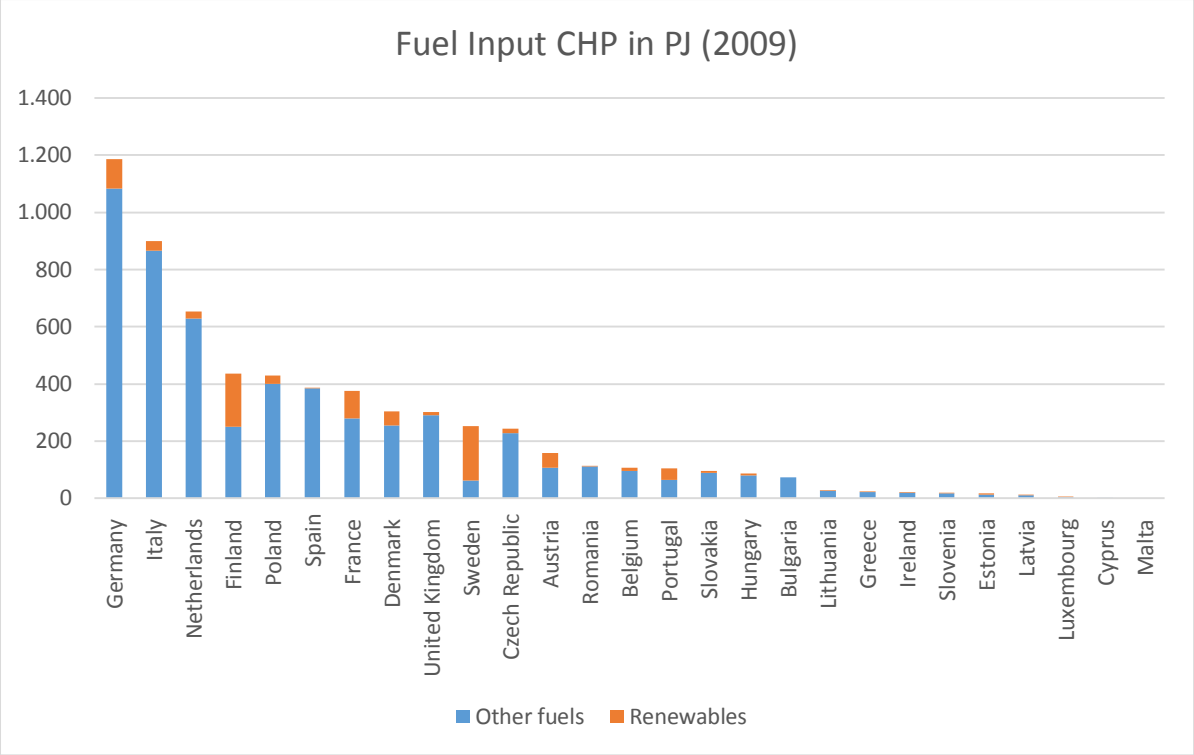
As CHP systems can be run with a variety of fuels, biomass – be it liquid, gaseous or solid – is the ideal choice to maximise the CO_2 reduction potential in CHP systems.

Currently, the penetration rate of bio-energy CHP in the CHP markets varies greatly in Europe. In Scandinavian countries with large forestry biomass resources, the penetration rate is already very high (Finland: 42,6%, Sweden: 74,9%). The EU average is at 13,7%.

1 Directive 2009/28/EC.

2 Communication 2011/885/2, p.7, p.10.

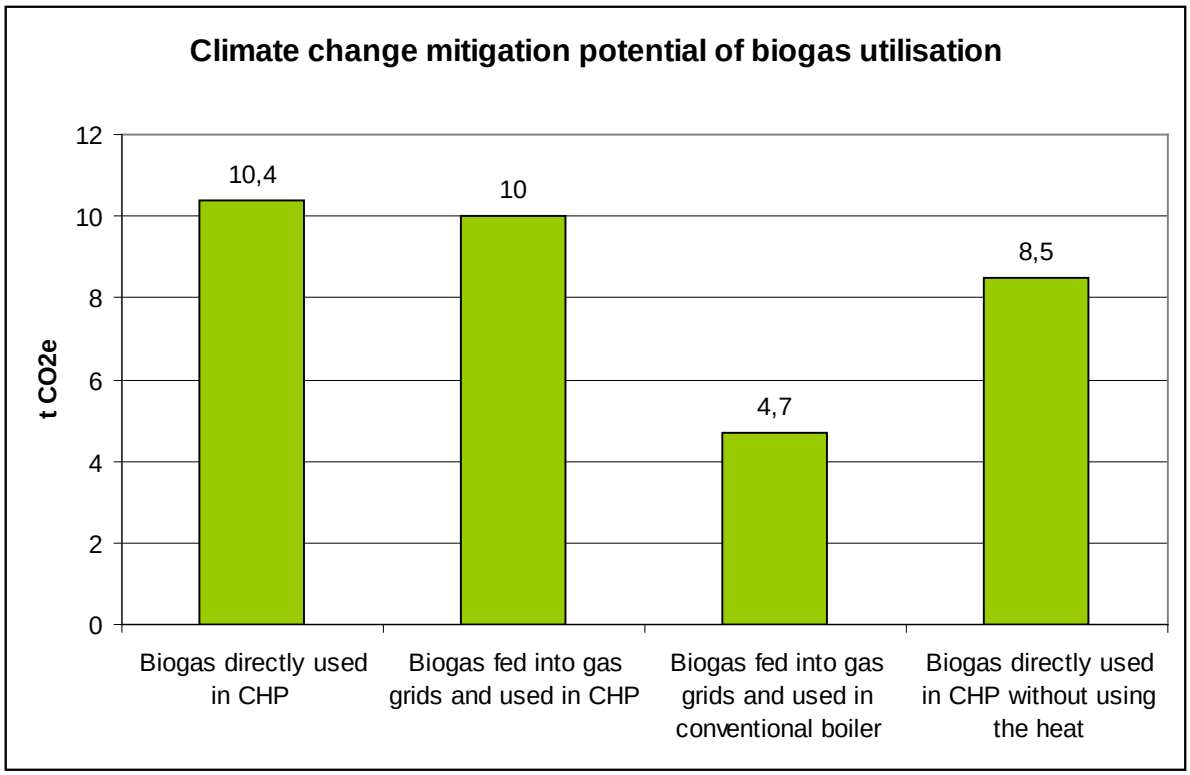
3 Directive 2004/8/EC, Directive 2012/27/EU



Source: European Environmental Bureau, Eurostat (2009)

Climate Change Mitigation Potential

The climate change mitigation potential of biomass fuels can roughly be doubled by using them in CHP systems, which clearly underlines the priority which should be given to CHP solutions. For the example of Germany, the climate mitigation potential of biogas has been assessed as follows:



Source: www.unendlich-viel-energie.de, FNR, IFEU, UBA, 1/2011

Applications of bio-energy CHP

There are various kinds of bio-energy CHP systems in operation already today. The applications vary largely in size, usage types and fuel-type used.
Although national regulatory and economic frameworks on CHP and bioenergy vary greatly between member states, it can clearly be stated that presently bio-energy CHP has its biggest potential in medium to large size applications.

In the example of Germany, the marginal costs for heat produced in micro and mini biogas CHP plants can hardly compete with market heat prices of competing heat producers. So a good business case in the current regulatory regime can normally be achieved only for biogas CHP applications > 300kWel, although there are examples of smaller systems.

Also concerning the primary energy factors (PEF) and the GHG emissions, the size of the bio-CHP system plays an important role. In the example of biomethane CHP systems, the PEF can decrease down to zero for systems of 300kWel or larger due to the much better coefficient of performance (COP) of larger CHP systems.

Therefore the application of choice for bio-energy CHP systems presently lies clearly on medium to large size systems.

Resulting from the economic frameworks mentioned, the majority of bio-CHP applications has so far been realised in district heating contexts or by autoproducers. But successful realisations also exist in residential contexts.

Fuel types for bio-energy CHP

Generally speaking, a great variety of biomass can be used for bio-energy CHP applications. The most commonly used ones in Europe are currently bio-methane and wood (residues). However, examples exist also for applications with other biofuels, e.g. colza oil. Technological progress will enhance the range of bio-fuels to be used in CHP systems in the future.

Since long supply routes increase the fuel costs significantly, the choice of fuel will normally be strongly connected to the (regional) availability of a certain fuel, as local and regional resources will be most price-competitive. At the same time, the constant availability of the respective resources in sufficient amounts has to be ensured.

As bio-energy CHP is explicitly suitable to reduce the GHG emissions in heat and electricity generation, it is important not to lose this advantage through emissions induced by transport, when the biomass resources are being imported.

In the future the competition between traditional and energy farming is likely to increase and biomass imports face great challenges due to unresolved sustainability issues, further biomass types, which are currently not in the general focus, will be become increasingly interesting. The project Biomass Futures[4] identified in different scenarios amounts of cost-efficient, sustainably achievable biomass resources on member state level in Europe.

[4] Alterra, IIASA: „Atlas of EU biomass potentials: Spatially detailed and quantified overview of EU biomass potential taking into account the main criteria determining biomass availability from different sources“, 2012.

	2010	2020 (Sustainability Scenario)	2030 (Sustainability Scenario)	Cost-efficiently available
	ktoe	ktoe	ktoe	
Agriculture				
Dedicated Perennial Cropping (woody)		21.742	9.043	yes
Dedicated Perennial Cropping (grassy)		29.879	27.774	yes
Manure	56.815	46.724	49.852	yes
Straw		49.287	47.495	yes
Woody residues of fruit trees etc.		10.106	8.836	yes
Forestry				
Round wood	56.735	56.115	56.115	no
Additionally harvestable round wood	41.046	34.973	35.595	no
Primary forestry residues	20.285	18.738	18.769	no
Landscape care wood	9.073	11.417	11.004	yes
Secondary forestry residues				
Saw Dust	4.496	4.984	5.597	yes
Other sawmill residues	9.072	10.093	11.316	yes
Tertiary forestry residues				no
Black Liquor	6.223	16.751	8.742	yes
Post consumer Waste	7.593	8.793	9.839	yes
Industrial wood residues	4.637	5.461	6.488	yes
Paper Cardboard	13.874	14.295	13.068	no
Waste				
Grassland cuttings on road verges	1.098	1.142	1.160	yes
Animal waste	2.775	2.881	2.904	yes
Municipal Solid Waste (MSW)	6.371	8.871	7.247	yes
MSW landfill	22.140	13.320	11.160	yes
Common sludges	7.768	8.078	8.214	yes
Fats and Oils	2.099	2.135	2.159	no

Source: Biomass Futures, 2012

The analysis shows that in a time perspective until 2030, the availability of sustainably produced biomass will decrease. Furthermore, several biomass resources, e.g. round wood, are too expensive to be used as a fuel for energy production. At the same time, there are several cost-efficient biomass types for which significant amounts are and will be available for bio-energy purposes.

Approach for potential analysis

EU Potential for Bio-energy CHP

The goal of this analysis is to estimate the uptake and thus the implementation potential, not the theoretical maximum potential, for bio-energy CHP in the 27 EU-member states (MS) until 2030.

To this end, the following main sources have been used to arrive at country specific potentials:

1. EU energy trends to 2030[5] (based on PRIMES data)
2. National Renewable Energy Action Plans of the MS[6]
3. Atlas of EU biomass potentials (Project Biomass Futures)[7]

The approach chosen to perform this bio-energy CHP potential analysis and the basic assumptions are as follows:

Scope and assumptions

The theoretical potential for bio-energy CHP is seen as the 100% fuel switch to bio-fuels in existing CHP systems – in district heating (DH) as well as in industry. The aim of this study is to project the country specific penetration rate of biomass fuelled CHP systems in the CHP markets by 2030 with a milestone 2020.

The data source chosen are the projected figures for heat demand from CHP and DH (Source: PRIMES) as published in the EU Energy Trends to 2030, Reference Scenario[8]. In countries, for which specific energy trend data for CHP was available (e.g. Germany[9]), these were chosen instead of the PRIMES data.

Coming from the current level of bio-energy CHP utilisation[10], the underlying assumption is that the markets for bio-energy CHP will develop in line with the projections for renewable energy utilization as stipulated in the EU Energy Roadmap (30% in 2030). These figures are then further adapted on country level. For this purpose, the national target figures *Biomass for Heating* (2015 and 2020, own extrapolation for 2030) as laid down in the member states' National Renewable Energy Action Plans (NREAP) are being applied to determine the growth curve of the developments until 2030. In countries, for which specific bio-energy CHP projections are available (e.g. Germany[11]), these were chosen instead of the PRIMES data.

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5 European Commission, DG Energy: "EU energy trends to 2030"; 2009.

6 Energy Research Centre of the Netherlands, European Environment Agency: "Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States"; 2011.; no figures available for Romania

7 Alterra, IIASA: „Atlas of EU biomass potentials: Spatially detailed and quantified overview of EU biomass potential taking into account the main criteria determining biomass availability from different sources", 2012.

8 Reduced by the share of non-CHP heat according to IEA and EUROSTAT statistics.

9 In the case of Germany, figures provided by the Federal Environmental Office (Umweltbundesamt, UBA) for the CODE2 project are being used instead of the PRIMES figures.

10 European Environmental Bureau: "Fuel input to CHP plants in EU-27 and EEA countries in 2009" (EUROSTAT), 2012.

11 DLR et al.: "Langfristszenarien und Strategien für den Ausbau der erneuerbaren Energien in Deutschland bei Berücksichtigung der Entwicklung in Europa und global", 2012.

In a further step, the bio-energy CHP penetration curve is modified by assessing the national frameworks for biomass fuelled cogeneration with a score card[12]. In this scorecard, the following aspects have been assessed and weighed:

- Legislative environment
- Suitability of heat market for switch to bio-energy CHP
- Share of Citizens served by DH
- National supply chain for biomass for energy
- Awareness for DH and CHP

Applying the scorecard results then results in the projection of the bio-energy heat demand from CHP and DH (in ktoe) for 2020 and 2030.

To cross-check, whether the projected demand can be satisfied with cost-efficient biomass available within the MS, the demand figures are compared with national biomass availability figures as published by the project "Biomass Futures" in the Atlas of EU biomass potentials (2012)[13]. Due to the ongoing discussion in the EU about sustainability criteria for bio-energy, the figures from the Atlas' sustainability scenario were chosen, which take into account not only existing legislation but assumes stricter sustainability rules to be applied in the future. As the Biomass Futures project also investigated price-levels, the figures used here describe a rather conservative assumption of biomass availability per country. It is assumed, that the technology to use the different sorts of cost-efficient biomass resources (largest groups: straw, manure, perennial cropping, forestry residues, waste) for CHP purposes will be available.

Areas not covered

Although being important factors for the future development of bio-energy CHP markets, due to limited availability of data the following aspects have not been incorporated in the potential this analysis:

- Small-scale CHP
- Trigeneration
- Regional or local biomass availability
- Biomass imports

[12] Score ratings by member state CHP experts.

[13] Assumptions for arriving at the available biomass for bioenergy CHP: 65% of available biomass used for heating; CHP factor 0.8.

Bio-energy CHP potential in EU-27

25 member states[14] have been assessed with the approach described and are summarised each in a 1-2 page country report.

For the European Union, an overall assessment was established by aggregating the individual country figures. As country specific frameworks and policies are important aspects, which were assessed through the scorecards, this section is not depicted in the EU summary.

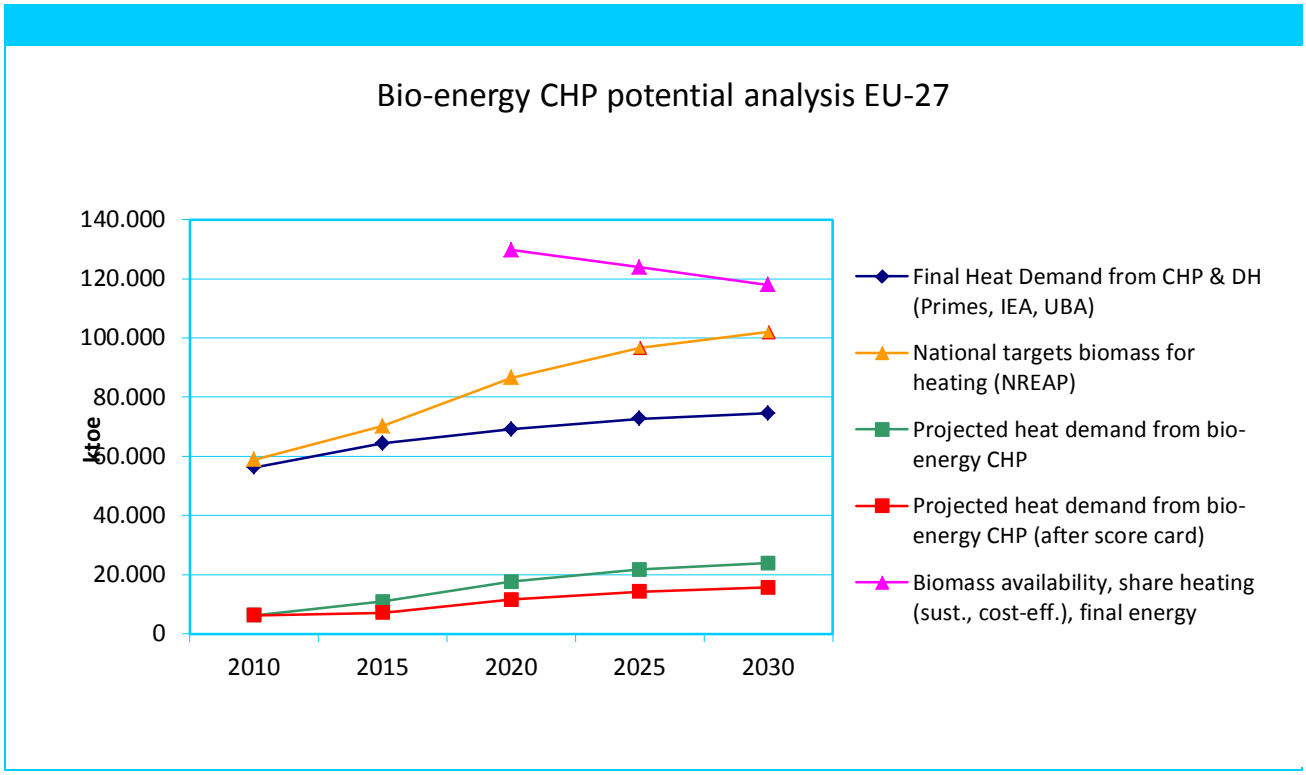
Analysing the overall picture from the member state level bio-energy CHP potential analyses, the following trends and conclusions can be made:

- There will be a steady increase of CHP applications in the EU until 2030
- The strong increase in biomass for heating as stipulated in the MS's NREAPs will also support the development of bio-energy CHP
- The expected penetration rate of bio-energy CHP in CHP markets is expected to reach 23% in 2030 (up from 11% in 2009)
- The framework conditions – politically, economically, regarding awareness – for (bio-energy) CHP vary greatly throughout EU
- Under optimum framework conditions on national level, the penetration rate could reach 33% in 2030
- For the projected development, sufficient cost-efficient and sustainably produced biomass resources are available on a national level for further growth of bio-energy CHP. Again, the situation varies greatly between member states. In densely populated countries the nationally available biomass resources may fall short of the demand.
- To maximise the potential, technological progress towards the use of the whole range of biomass fuels should be promoted

[14] France: still in discussion with experts; Malta: insufficient data, no (foreseeable) relevance for CHP

Bio-energy CHP potential analysis EU-27

Figures (projections)	2010	2020	2030
Final heat demand from CHP and DH (PRIMES, IEA, UBA), ktoe	56.233	69.056	74.465
(Projected) heat demand from bio-energy CHP and DH (after score card), ktoe	10.967	14.015	17.664
Bio-energy penetration rate in CHP markets (2009: EEA, Eurostat)	19,5% (2009)	20,3%	23,7%
Biomass availability, share heating (sust., cost-eff.), final energy (Biom. Futures), ktoe		129.756	117.868



EU-27 figures are aggregated from the 27 MS figures of the respective items.