Development of sustainable heat markets for biogas plants in Europe

Project No: IEE/11/025

BIOGASHEAT

European Strategy Paper on Heat Use from Biogas Plants

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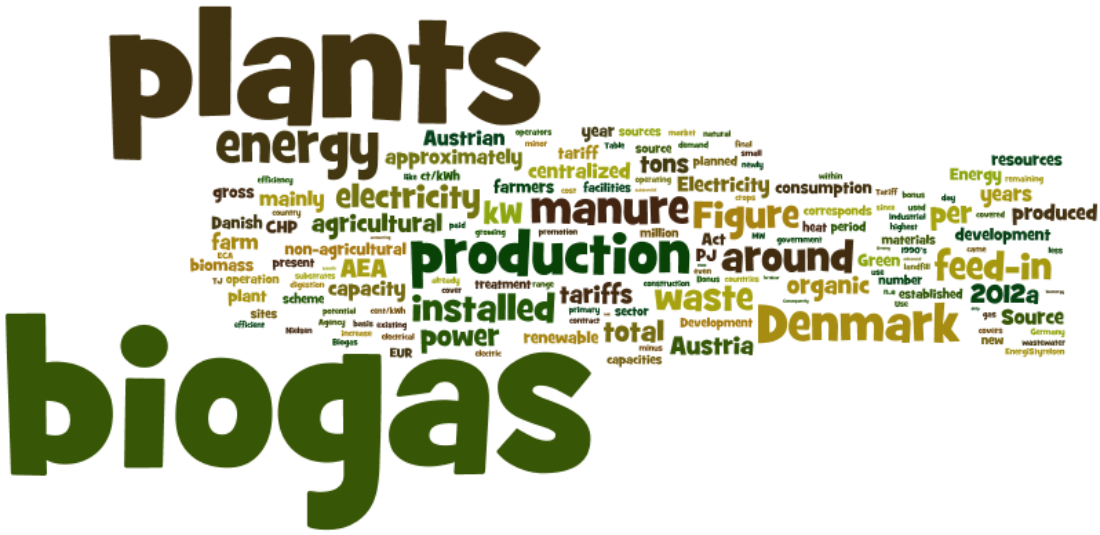
1 Introduction

Biogas production increasingly contributes to meeting energy demands in the European market. It opens new opportunities for farmers, industry and the environment as well as offers sustainable solutions to a variety of challenges we face today in the agricultural, transport and energy sectors. Energy efficiency targets are one of the major priorities and challenges on the European energy policy agenda. The EU set a goal to reduce 20% of Europe's primary energy consumption by 2020, meaning that also the biogas sector is faced with the challenge of reaching higher energy efficiency levels.

In many European countries the production and use of biogas is increasingly recognized as a sustainable option to meet the 2020 targets. However, the main focus is on the optimization of the electricity production and the use of heat is often not considered. Most biogas plants produce electricity in Combined Heat and Power (CHP) units providing opportunities to implement also different heat use concepts. Nevertheless, the use of heat from CHP units is often not taken into account and is wasted. One of the main reasons for wasting heat from CHP plants is the lacking recognition of renewable heat as a valuable source of energy by consumers and energy policy makers in many EU Member States. This leads to slow market development of renewable heating and cooling technologies, including heat recovery from CHP units in biogas plants.

The BiogasHeat project promotes the efficient use of heat from biogas plants at the European and national level. The project carries out activities in the 9 European countries - Austria, Croatia, Czech Republic, Denmark, Germany, Italy, Latvia, Poland and Romania - and creates a platform for knowledge exchange and transfer from countries with a developed biogas market.

This strategy paper was elaborated in the framework of the BiogasHeat project and provides an overview on the status quo of the heat use from biogas plants in Europe. The strategy paper focuses on existing bottlenecks in the 9 target countries of the BiogasHeat project and includes general recommendations for the policy makers on the European level.



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2 Overview on biogas markets in Europe

The biogas markets in the 9 European target countries (Austria, Croatia, Czech Republic, Denmark, Germany, Italy, Latvia, Poland and Romania) of the BiogasHeat project are very distinct. Germany, Denmark and Austria have advanced biogas markets, while other countries are in the developing phase without a significant share of biogas in the energy mix from renewable energy sources (RES).

Whereas Germany is the leading biogas producer in Europe with about 8,000 installed biogas plants, also other countries, such as the Czech Republic and Italy had a considerable market growth in the biogas sector in the last few years. However, such a positive development will not remain stable in the Czech Republic in the coming years due to low support from the policy side.

Significant developments were also made in Austria and Denmark where many biogas plants have been installed. However, their markets have remained quite stable in the last years without any substantial establishment of new biogas plants. In Denmark this situation is changing due to the promotion of the biogas sector by the government. Thus, in the next years, a significant increase in the number of installed biogas plants is expected.

A considerable growth was achieved in Latvia in 2011, however, this development was hindered when new tenders for obtaining the right to receive a feed-in tariff were stopped until the end of 2013 and later prolonged until the end of 2015. Despite a high potential, biogas activities in Croatia, Romania and Poland are still very limited with very few installed biogas plants. The slowest development in agricultural biogas production was observed in Romania. Table 1 provides an overview on the primary energy production of biogas and estimation of heat sold to the district heating network or to the industrial units in 2011.

The market developments in the different countries are heavily influenced by legal and political framework conditions. In addition, the historical development of the sector as well as other factors such as the general economic welfare of the countries, administrative procedures and access to financing led to uneven developments of the biogas sector in Europe. One of the most important factors that considerably contribute to a fast development and market growth is the application of feed-in tariffs for the sale of electricity generated by biogas production.

Table 1: Overview on the primary energy production of biogas and estimation of heat sold to the district heating network or to the industrial units in 2011 (EurObserv'ER, Biogas barometer 2012; Ministry of Economy, Republic of Croatia 2012, Energy in Croatia in 2011)

Country	Primary energy production of biogas (ktoe)	Heat from biogas plants sold to the district heating network or to the industrial units (ktoe)
Germany	5,067.6	58.0
Italy	1,095.7	29.7
Czech Republic	249.6	7.2
Austria	159.5	10.4
Denmark	98.1	28.9
Poland	135.4	14.9
Latvia	22.0	4.0
Croatia	3.1	0.8 (estimation)
Romania	3.0	-

3 Overview on heat use concepts in Europe

There is a variety of heat use concepts for biogas plants. The implementation of an optimal heat use concept for a biogas plant depends on many factors, such as location of the biogas plant, location of the potential consumers and heat demand. Heat from biogas plants can be used for heating, drying or cooling purposes as well as for additional electricity production. Table 2 provides an overview on the main heat use options which can be implemented to increase the overall efficiency and improve the economic performance of the biogas plant.

Table 2: Heat use options (Rutz 2013)

Heating	Drying	Cooling	Electricity production
• District heating • Heating of stables • Heating of greenhouses • Heating for aquaculture • Heat transport in containers • Other heating options	• Drying wood, woodchips, and pellets • Drying agricultural products • Drying digestate and sewage sludge	• District cooling • Cooling of buildings • Cooling of stables • Acclimatization of food storage buildings • Process cooling	• Additional electricity production with CRC, ORC or Kalina technologies • Additional electricity production with exhaust gas turbines

Even though different options for heat use exist, the actual status of heat use from biogas plants in the BiogasHeat target countries is not satisfactory. Although some heat is used for own purposes and internal processes, the commercial heat use of biogas is rare. Furthermore, in many countries it is difficult to describe the current situation, as reliable data on the heat use in biogas plants are lacking.

In Denmark, district heating systems as well as CHP production have been highly supported by the government. Due to favourable conditions, almost 80% of Denmark's district heating is produced in combined heat and power plants that generate both heat and electricity simultaneously. Biogas is used mainly for decentralized cogeneration plants in which biogas replaces natural gas and the heat is used in district heating systems. It is remarkable that all centralized biogas plants in Denmark are connected to district heating systems and sell the heat to them.

In contrast, the biogas development in Germany was mainly focusing on the maximization of the electricity production supported by feed-in tariffs. Thereby, only some plants have established sound heating concepts. With the introduction of several legislative amendments, this situation slowly changes, especially for new plants, as a 60% heat use obligation was recently introduced. Also Austria and Czech Republic have introduced measures to increase the heat use from biogas plants. The future development in the sector will show if these measures are successful.

In some countries the heat use of biogas plants has not yet been considered in the national legislation. The current focus in these countries is on the development of legal framework conditions for the emerging biogas markets. Legislation on efficient heat use may be introduced at a later stage. It is very important to take into account lessons learnt from other countries and to consider the integration of heating concepts at the early stage of biogas market development.

4 Potential for biogas production and heat use

4.1 Austria

Biogas potential

According to BMLFUW (2011) the possible biogas potential until 2020 is about 21 PJ or 6,000 GWh final energy. Thereof 650,000 Austrian households could be supplied with electricity (assumption of an efficiency of 38% and 3,500 kWh_{el} consumption per household). Heat generated in this process could be used to provide 70,000 households with heat (assumption of an efficiency of 30% and 25,000 kWhth demand per household).

The Ökostromgesetz 2012 (Green Electricity Act 2012) stipulates until 2020 the development of additional 1,300 GWh (200 MW installed electric capacity) from biomass and biogas is aimed if enough substrates are verifiable.

Heat use

In 2008 the Ministry for Transport, Innovation and Technology (BMVIT) published results of a survey on biogas sector. In total 151 of 340 recognised biogas plants in Austria have been surveyed, which corresponds to a response rate of 44% (BMVIT 2008). Recognised plants comprise plants which are installed and have a feed-in contract with OeMAG (288 plants in the end 2011) plus plants which are under construction or in the planning phase.

The outcomes of the survey of BMVIT 2008 show that 25% of the existing biogas plants produced up to 800,000 kWh heat per year in the CHP plant. Further 30% produced between 800,000 and 5 million kWh heat per year. 5% were even beyond this number. However, 38% of the interviewees could not give proper information concerning their amount of heat produced per year. 72% of biogas plant operators stated that they partly use the heat for own use, e.g. for heating their residential buildings and farms

According to E-Control (2012) in the year 2011 about 520 GWh_{el} from biogas were fed-in to the Austrian power grid. By this time 288 biogas plants which have a contract with OeMAG were operating with a maximum capacity of 80 MW.

In 2011 the heat use potential accounted for approximately 530 GWh_{th} after deduction of 20% for fermenter heating. The calculation was carried out by e7 and ARGE Kompost & Biogas) assuming an efficiency of 36% (electric) and 45% (thermal). It was assumed that 530 GWh_{el} from biogas were fed-in to the Austrian power grid (E-Control 2012).

Currently, feed-in tariffs for electricity production range between 12.93 Cent/kWh (capacity > 750 kW) and 19.5 Cent/kWh (capacity < 250 kW). According to ÖSET-VO (2012), by expiry of the contract period tariffs are cut down towards 9.95 Cent/kWh. Austria guarantees a CHP-bonus of 2 Cent/kWh for electricity produced in an efficient CHP unit if the efficiency factor is at least 0.6 (according to 'KWK-Gesetz', § 8 Abs. 2). Also extra money for operating costs (max, 4 Cent/kWh) was granted in order to reduce the cost pressure (substrate costs and operating costs).

Main bottlenecks for increased heat use from biogas plants

Heat utilization potential from biogas plants is high. Therefore the focus should be given to combined heat and power production in existing biogas plants. For existing biogas plants the business model of district heating is very well developed. Distances to district heating networks increase. Further potential lies with various forms of drying. Also the construction of local biogas grids can be seen as a chance in future. Existing investment subsidies in heat use should be maintained, however, more funds in research (technique and heat use

models) and innovation (demonstration projects, market launch initiatives) should be available. Also funds for training are needed.

With respect to feed-in tariffs Austria strongly focused on electricity production but nowadays heat use is more and more supported. However, the time after termination of contracts with OeMAG is crucial. Thus follow-up policies represent the main bottleneck in the biogas market. Proper legal framework on heat and power tariffs and on long term contracts lead to planning reliability and enhance further investments.

Eventually, the advancement of the CHP-bonus could be considered. CHP-bonus could increase in line with rising efficiency. This would deliver an additional incentive to implement a strong heat use concept. Economic proven heat use concepts could be gathered in order to come up with a positive list. In addition, further research and communication efforts should be done. Also, injection of biomethane into the natural gas grid is a further potential business model of biogas which should be developed.

The role of banks is fundamental for the development of biogas sector as they provide urgently needed liquidity. However, banks are reluctant nowadays. A strong commitment from both banks and politics is crucial to revitalise the Austrian biogas market.

4.2 Croatia

Biogas potential

The biogas potential in Croatia is in discussion as it has never been calculated officially. The Croatian Energy Strategy has the aim of producing 2.9 PJ (69.26 ktoe) from biogas (technical potential) by 2020. This target is based on manure monodigestion of 20% of livestock units. Expert estimations from the Energy Institute Hrvoje Požar would be 275.15 ktoe from biogas plants running on agro-food substrates.

Biogas from landfill and waste water treatment plants was never assessed officially and as those substrates do not benefit from current feed-in system, not much interest was placed on it. In recent months, in the view of Landfill Directive (1999/31/EC) and Accession Treaty (Council of the European Union, 14409/11, LIMITE, ELARG 94, ACCTR 4, Brussels, 7 November 2011), municipal waste started to gain more attention due to the obligations on gradual decrease in the amount of biodegradable municipal waste going to landfills (75%, 50% and 35% of the total amount by weight of biodegradable municipal waste produced in 1997, by 2013, 2015 and 2020 respectively). The new Law on Waste is pending for approval in the Parliament. This law aims to place the obligation from the Treaty regarding waste management to the local and regional self-governments. The biodegradable municipal waste potential is not assessed yet.

Heat use

The Croatian biogas market is an emerging market with 9 operating plants (8.135 MW_{el}) and 45 pending projects (~70 MW_{el}) in early 2013. All biogas produced is aimed at CHP engines as feed-in tariff for electricity production is the only incentive for energy production from biogas. Most of the existing plants (66%) use the heat for the on-farm production process (heating the greenhouses, poultry houses, or pig stables). This fact leads to the wrong impression that biogas heat use concept is well developed in Croatia. Very few of the 45 pending projects have included heat use options. Since mid 2012, the new feed-in tariff mandates a minimal overall efficiency of 50% for new biogas plants to be eligible for incentive purchasing price of electricity. So far, only one biogas plant has met the condition.

Main bottlenecks for increased heat use from biogas plants

- Lack of knowledge about the different options for using biogas among decision-, policy-, strategy- and legal framework-makers
- Lack of incentives for the use of heat from renewable energy sources in general, including biogas
- Lack of knowledge among investors/developers on heat use options from CHP units of biogas plants
- Lack of transparency in the existing legislation related to the feed-in tariff regulations where it is not clearly specified how to implement the mandated >50% of overall CHP efficiency

4.3 Czech Republic

Biogas potential

The Czech biogas sector has seen during the last ten years a steep growth thanks to the gradual introduction of operational support via feed-in tariffs, green bonuses, and lately also investment grants which were allowed to be combined. Thus, it is estimated that over 300 (largely agricultural-type) biogas plants will be in operation at the end of 2013. This would be a total electrical and thermal output of 200-250 MW producing annually more than 1.5 TWh of electricity. A similar amount of heat will be produced with the thermal output of approximately 3 TWh. A large majority of biogas (at minimum 80%) shall come from purposefully grown substrates such as maize silage or whole crop silage which means annually over 2.4 million t or 80,000-100,000 ha of arable land used for biogas production.

The technical potential could be higher thanks to the fact that about 1.1 million ha of agricultural land (60% arable land and 40% grasslands) can be safely and sustainably used (i.e. not at the expense of food production or ecology) for energy production in the future (National Biomass Action Plan for 2012-2020, Ministry of Agriculture).

A significant amount of biogas could be produced from agricultural by-products and biowastes which are either still used directly as a fertilizer, incinerated as part of Municipal Solid Waste (MSW) or landfilled (over 85% of MSW is still disposed of in this way). In this segment, the disposable technical potential has been assessed at 3.9 TWh of biogas fuel energy (Užík and Slejška 2003).

Heat use

Only a small minority of agricultural biogas plants currently use the heat to a significant extent. Until the end of 2012 the location of biogas plants has been optimized for feedstock and digestate transport with no respect to potential heat use.

No statistics about nominal or actual heat use is available. However, the empirical experience has shown that the large majority of plants use the heat produced just to heat up the digestors or cover existing heat demand at a farm (e.g. stables, administrative buildings, driers for agricultural commodities). This allows to use for only 5-10% of the total heat production efficiency (technological needs of the plants are excluded).

Over ten projects in the Czech Republic include ORC systems which prove to be suitable and economic for larger plants (1 MW_{el} and more) with electric efficiency amounting to 5-20 % according to the temperature of the heat source.

To achieve a higher efficiency, several tens of projects have been designed or upgraded to provide heat also to communities or industrial customers located with a reasonable distance

from their plants (e.g. for heating schools, city administration buildings, multi-appartment houses etc.). Few of them (3-5 projects) were designed with a satellite CHP unit to be able to cover heat demand in more distant locations (generally more than 2-3 km).

The Czech state administration understands the importance of reasonable heat use from biogas installations. However, only in 2013 the policy started to provide sufficient economic stimuli for new projects to attract more investors. This was done via lowered feed-in tariffs for electricity production from biogas and increased green bonuses for highly-efficient CHP units. The expected market growth shall be, however, significantly lower than during the last 2 years when 50-60 MW of new installed capacity was added annually.

The future development of the biogas market is uncertain since the Czech policy towards RES undergoes an overhaul which may result into complete stop of operational support to new projects as of 2014 onwards.

That would make the new stipulations aimed at increased efficiency of new projects of biogas plants as approved in the Act 165/2012 last year practically ineffective. The law requests at least 50% effective use of energy for biogas plants, however only for new plants commissioned after May 2014.

The Act also introduced as of the beginning of 2013 new operational support for heat production from RES supplied to district heating systems both for new and also existing projects (about 7 €/MWh of heat). Biogas plants are, however, not eligible for it as it is considered that biogas projects received enough public support already.

Main bottlenecks for increased heat use from biogas plants

- Missing clear specifications of reasonable heat use options in the legal framework for being eligible for green bonus for high-efficient CHP (Czech BiogasHeat partner participates in the consultation process)
- There are no sufficient incentives for implementing heat use concepts in existing biogas plants (this issue will be hopefully addressed with help of new EU Structural Funds)

4.4 Denmark

Biogas potential

The energy potential for biogas production in Denmark is estimated to be around 40 PJ per year, which is 10 times more than the actual production of 4 PJ (Energistyrelsen 2010).

This potential is related to traditional types of biomass suitable for biogas production (Figure 1). According to the Danish Energy Agency, by using energy crops, the Danish biogas potential could realistically increase to 60 PJ per year. The use of other biomasses such as straw, marine algae and harvested biomass from natural reserves could raise this potential.

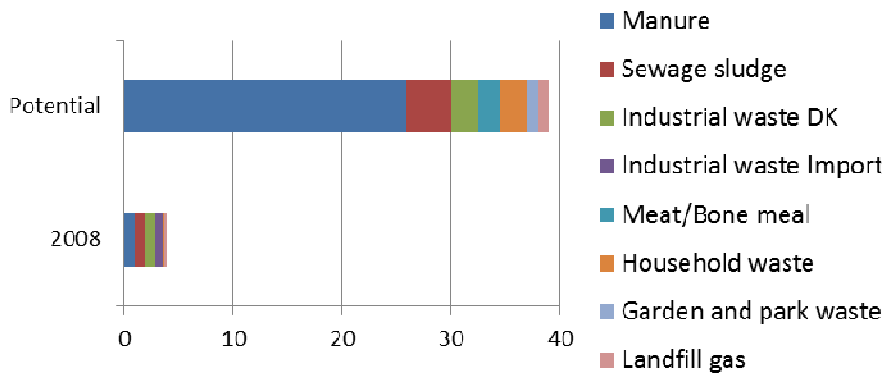

Figure 1: Danish biogas potential and biogas production in 2008 in Denmark (Data from Energistyrelsen, 2010)

Heat use

In Denmark, biogas is mainly combusted in CHP units. The heat produced is used internally for heating the digesters and in the hygienisation process, as well as externally in district heating networks. All centralized agricultural biogas plants follow this model. In most cases the CHP unit is an integrated part of the biogas plant, but in some cases the biogas is transported through low-pressure biogas pipelines of few kilometers to a satellite CHP unit, in which apart from biogas, other fuels such as natural gas or biomass can be used.

There is a strong tradition in Denmark for district heating, even in rather small villages, and these district heating grids are well suited for the distribution of heat from biogas plants as well. Heat from centralized biogas plants is distributed very efficiently in district heating grids. The heat from agricultural biogas plants is used for heating the farm, houses and stables. In the summertime however, there is often a heat surplus which is cooled in emergency coolers in order to maintain the electricity production. In general, the amount of heat used is subject to seasonal variations - in winter time almost all of the heat produced is used, while in summer some of it is wasted.

Due to favourable conditions, almost 80% of Denmark's district heating is produced in combined heat and power plants that generate both heat and electricity simultaneously.

Main bottlenecks for increased heat use from biogas plants

- In the summer period there is a heat surplus on farm biogas plants which should be used
- There is often a strong local resistance against having a new centralized biogas plant near a village. As a consequence new plants may be located far away from villages with district heating grids
- The use of heat for industrial purposes is often not economically attractive because of the Danish energy taxation system

4.5 Germany

Biogas potential

According to FNR (Fachagentur Nachwachsende Rohstoffe e.V.), the technical primary energy potential from biogas for 2020 is 500 PJ per year (FNR 2012). Thereof maximum 252 PJ per year could be produced from dedicated energy crops (NawaRo). By 2020 biogas has

a potential to produce 76 billion kWh electricity. In 2011 biogas plant operators in Germany produced roughly 18 million MWh electricity (Fachverband Biogas e.V. 2011).

The National Renewable Energy Action Plan (NREAP) indicates that in 2020, depending on the biomass source type, 23,438 GWh per year will originate from biogas (including sewage and landfill gas). The share of biogas is expected to increase at the expense of the share of solid biomass from 2% in 2005 to 15% by 2020.

The Gas Grid Access Ordinance (Gasnetzzugangsverordnung 2010) sets targets for biomethane injection into the natural gas grid by 2020 and by 2030. The target is to feed-in 6 billion m³ of biomethane per year by 2020 and 10 billion m³ of biomethane per year by the year 2030.

Heat use

There are around 8,000 operating agricultural biogas plants in Germany. Most of the biogas plants produce electricity and feed it into the power grid, whereas produced heat by the CHP units is often wasted. Even though there are good practice examples on the successful heat use from biogas plants, a broader implementation of heat use concepts is still missing. In general, no exact data on the heat use (percentage, amount, etc.) of biogas plants exist for Germany. Some databases about biogas plants are maintained by different organisations, such as the German Biogas Association, the German Energy Agency (DENA) and by the German Biomass Research Centre (DBFZ). Not all data bases include all biogas plants and are publically available. DBFZ annually monitors the development of the biogas plants which use the EEG as basis (DBFZ, 2011). According to this monitoring, DBFZ estimates the amount of used heat of biogas plants in 2010 between 5.8 TWh_{th} and 6.7 TWh_{th}.

The German Renewable Energy Sources Act (EEG 2012) obliges plant operators to use minimum 60% heat from the CHP unit or to use at least 60% manure. In addition, the law indicates preferred ways to use waste heat in the so called ‘positive list’. The waste heat can be used for the following purposes:

- Heating and cooling of buildings
- Hot water supply
- Heat injection into a local heating system with a length of at least 400 meters
- Heating supply for different industrial processes
- Heating of buildings for poultry breeding
- Heating of animal stables
- Heating of greenhouses
- Process heat for disinfection or pasteurization of fermentation residues that require sanitation or pasteurization by the applicable law
- Process heat for treatment of digestate for fertilizer production
- Use of heat to produce additional electricity, especially by ORC and CRC processes

In 2020, more than 35% of electricity will be generated through biomass in CHP units with recovery of waste heat for the use in district heating systems and for larger individual objects (NREAP). Therefore, it is expected that also biogas will be increasingly used in the heating sector.

Main bottlenecks for increased heat use from biogas plants

Many biogas plants are placed in the areas where heat use concepts cannot be implemented as potential heat consumers are too far. The 60% heat use obligation will change this situation for new plants as site selection and heat use concepts will be taken into account

already in the planning phase. However, the new obligation creates bottlenecks as well. In case a biogas plant operator loses his heat consumers, the feed-in tariff is not paid anymore. The EEG 2012 foresees no measures how to tackle such situations and reduce the risk for biogas plant operators.

The development of district heating networks is essential for heat use from biogas plants. There are two state support programmes for the development of heating networks: BAFA (Bundesamt für Wirtschaft- und Ausfuhrkontrolle) and KfW (Kreditanstalt für Wiederaufbau). However, the weakness of such support programs is that the requirements are changing quite often and the budget is limited.

In general, the heating market still lacks legislative improvements. For example, heat use concepts have to be considered only for new biogas plants, whereas older biogas plants are not obliged to use their heat. In addition, older biogas plants have a potential for optimization and should consider heat use concepts. Therefore, proper incentives could improve this situation.

4.6 Italy

Biogas potential

The National Action Plan for Renewable Energy (PAN, 2010) foresees the growth of biogas sector up to 1,200 MW_{el} of installed power, and a production of 6 GWh electric power. The production of thermal energy from biogas up to 2020 is not specified. According to the estimation conducted by a working group formed by technicians of the Italian Biogas Consortium (CIB) together with associations (Agroenergia, Aiel, Aper, Cia-Italian Agriculture Confederation, Confagricoltura, Crpa, Dal Distretto Agroenergetico Lombardo and Fiper ed Itabia) the biogas potential expressed in the PAN is underestimated and could be about 400 MW_{el} higher than the defined target for 2020 (in total 1,600 MW_{el}).

Heat use

Italy is the third country in Europe for the production of biogas. However, the country still is unable to release all its potential regarding heat use. Until now heat is not yet fully recognised as a primary source for energy efficiency. Also, there is no official data on the heat use from biogas plants.

Besides the feed-in tariff for the production of electricity, the national regulation recognizes a prize of 40 €/MWh for high-efficiency CHP with nitrogen recovery or a prize of 30€/MWh if the produced heat is used for district heating. However, heat use from biogas plants is not obligatory, but optional.

Main bottlenecks for increased heat use from biogas plants

- Most biogas plants are placed in remote areas where heat use concepts cannot be implemented as potential heat consumers are too far
- Large investments are required for high technology plants with high efficiency CHP, nitrogen recovery or district heating
- Lack of promotion of heat use concepts
- Lack of integrated projects in cooperation between farms and companies for the use of heat

4.7 Latvia

Biogas potential

Several studies indicate that the potential of biogas production in Latvia is somewhere between 1,076 and 3,256 GWh/year. AEBIOM has evaluated that the total biogas potential with 5% of land use and 35% of manure use in Latvia is 0.28 Mtoe, corresponding to 3,256.4 GWh. In the biogas production and development program 2007-2011 it was identified that 179.25 million m^3 of biogas could be produced annually corresponding to about 1,075.5 GWh/year. Different studies from the scientists of the Agricultural University of Latvia show a biogas potential from 2,025.7 GWh up to 3,105.7 GWh per year. Another detailed biogas potential study that was implemented in Latvia with the support of the BiG>East project shows that about 1,856 GWh of energy from biogas could be produced every year.

The comparison of different biogas potential study results and the biogas 2020 target for Latvia is given in the Figure 2 below:

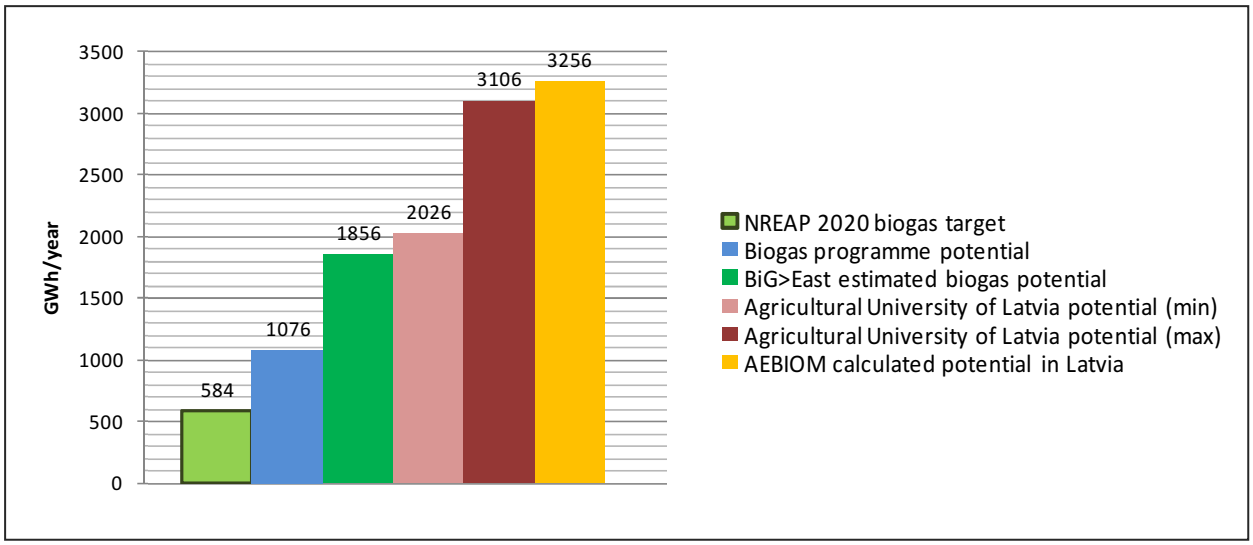

Figure 2: Biogas target and potentials in Latvia

Heat use

Most biogas plants operating in Latvia are using biogas in CHP units thus generating both - electricity and heat. Since only electricity is supported by the feed-in tariff, heat is considered as a by-product. Moreover, one of the highest feed-in tariffs in Europe in combination with investment grants, allow Latvian biogas plant operators to run their business profitably even without sound use of heat. Usually a part of the heat is used on site to heat the digesters and to provide heating for farms and local buildings, but most of the heat is wasted.

The feed-in tariff in Latvia is given for the electricity that is generated from renewable energy sources (Cabinet Regulation No.262) and for the electricity generated in high efficiency CHP plants (Cabinet Regulation No.221). Biogas plant operators can choose under which regulation to apply. Most of the plants are operating under regulation No.262 where efficient heat use is not required.

Main bottlenecks for increased heat use from biogas plants

Biogas plants that are operating under Regulation No.221 are subject of heat use efficiency requirements. The drawback of Regulation No.221 is that the efficient heat use is defined as obligation to sell heat to the end user. Heat used for the self-consumption (e.g. for heating

the digesters) is not considered as a part of efficient heat use. Moreover, so far there were no real control mechanisms in place for checking the conformity of existing biogas plants in regard to fulfilling the heat use efficiency criteria.

The second group of biogas plants that were constructed without being obliged to use heat efficiently has already come to the point where efficient heat use is necessary for the overall economic feasibility of the biogas plant. Biogas policy makers should help these biogas plant operators by minimizing current bottlenecks in terms of:

- Introduction of changes in existing district heating legislation to allow district heating system operators benefit from using heat generated from biogas or to give advantage for biogas as fuel over natural gas
- Developing alternative uses of biogas besides CHP - to provide real opportunities for the injection of upgraded biogas into the natural gas grid, and to establish the framework conditions for biomethane use in transport

4.8 Poland

Biogas potential

There are two noteworthy documents which estimate the biogas potential in Poland. The first one is an expertise commissioned by the Institute of Renewable Energy for the Ministry of Economics. It puts the economic potential of energy from biogas at 204 PJ by the year 2020. This includes silages at 81 PJ, agricultural waste at 45 PJ and industrial waste at 26 PJ (Wiśniewski 2007). Another expertise has been carried out in 2010 internally by the Ministry which is a bit less optimistic. The Ministry of Economics estimates the theoretical potential of biogas production at 5 billion m^3 per annum by 2020 under the assumption that an additional area of 700,000 ha would be used for energy crops. Because of that assumption it is unlikely that Poland will indeed achieve such a high production rate by 2020. The Ministry of Economics seems to be aware of that and presents a real biogas potential calculation, which put the annual production in 2020 at about 1.7 billion m^3 (850 ktoe or 35.6 PJ).

Heat use

Almost all biogas plants in Poland are equipped with CHP units generating both heat and electricity. Because of the remote siting of the plants most of the generated heat is used locally for the AD (Anaerobic Digestion) process. Some plants have even deliberately changed their process temperature from mesophilic to thermophilic in order to waste less of the produced heat. The rest of the heat is used for heating nearby farm buildings if such exist. The second common use is drying digestate for pelletization.

It is to be noted, that unlike in most EU countries, the support system is based on renewable portfolio standards instead of feed-in tariffs. Heat use in Poland is thus rewarded by yellow certificates - assets which are issued to the heat producer by the Energy Regulatory Office (URE).

Main bottlenecks for increased heat use from biogas plants

The support scheme in the form of yellow certificates for heat from high-efficiency biogas CHPs was introduced in 2008 and was supposed to work until 31 March 2013. Before its expiry the Ministry of Economics was supposed to carry out an assessment of the results of the running scheme and to propose changes or introduce a new scheme. None of this was implemented and as a result yellow certificates expired leaving CHP plants running on gas without any incentives. There exists a draft amendment to the Energy Law which stipulates a new kind of CHP certificate, but the date of enacting it is being pushed further away every

few weeks. As a result biogas CHP plants work in a state suspension when it comes to revenues from heat generation. Further bottlenecks are:

- Lack of support system coupled with uncertainty about the future of the planned schemes
- Most plants are sited in remote locations, too far away from existing heat demand and district heating networks

4.9 Romania

Biogas potential

Romania has a huge potential for primary energy production from biomass (including energy crops). There are several areas well suited for biogas production, especially in the South and South-Eastern part of the country, where around 23-26 million t of suitable feedstock for biogas production is available. This potential is based on energy crops (17 million t), 6 million t are available from agricultural waste and the rest comes from municipal waste and sludge waste. These data were elaborated in 2009 in the IEE project Big>East available in the report on 'Estimation of the potential feedstock availability for biogas production in Eastern Europe'.

In late 80's more than 30 million m^3 biogas were produced in a number of small-capacity biogas plants. In 1994 almost 0.06 TWh of energy were produced from biogas, compared to 0.18 TWh/year generated in 1980. The actual situation is very difficult to assess as data on the biogas facilities are scarce and no reports at national level are available.

Currently, the entire production of biogas is from industrial and municipal landfills and slurries. There are no operational agricultural biogas plants in Romania. Despite the high potential in terms of biogas production from agricultural sources, Romania has the lowest biogas production in Europe.

Main bottlenecks for increased heat use from biogas plants

- The first and the most important bottleneck is the confusion in legislation regarding the number of green certificates allocated. In the new legislation (approved after more than 10 years of discussions) biogas has received 2 green certificates for each MWh produced. 1 additional green certificate is provided if the electricity is produced in a high performance cogeneration unit or if energy crops are used.
- Biogas should be also considered as an important source for the achievements of the national targets. In addition, the contribution of biogas should be incorporated into the national energy policy. There is a neeed to review and specify the policies for heat as well as ways to use it for the consumers.
- A lack of suitable measures exists in national strategies and action plans on energy for the thermal energy sector development. The integration of specific measures for biogas cogeneration is needed.
- There is no stimulation of initiatives promoting biogas production. There is a lack of experience and know-how, therefore capacity building for potential investors and for policy makers is necessary.

5 Biogas 2020 targets

The Renewable Energy Directive 2009/28/EC (RED) established a European framework for the promotion of renewable energy, including biogas. The Directive requested Member States to develop National Renewable Energy Actions Plans (NREAPs) in which they define clear goals for biogas production by 2020. In the NREAPs the goals on biogas primarily focus on the electricity production. An overview on the targets for the electricity production from biogas is shown in Table 3. Out of 9 analysed countries (Denmark, Czech Republic, Italy, Latvia, Romania, Germany, Austria, Poland and Croatia) Germany, Italy and Denmark showed the most ambitious goals for the electricity production from biogas.

The Member States also estimated a total contribution (final energy consumption) expected from biogas technology to meet the binding 2020 targets in heating and cooling sector. An overview on the targets for heating and cooling production from biogas plants is shown in Table 4.

Table 3: Installed capacity (in MW) and gross electricity generation (in GWh) expected for biogas production

	Units	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
AT	MW	98	98	99	99	100	100	101	101	102	102
	GWh	556	559	561	564	567	570	573	576	578	581
CZ	MW	182	212	254	284						
	GWh	935	1,329	1,597	1,865						
HR	MW										32
	GWh										242
DK	MW	30	38	50	67	95	134	180	231	287	349
	GWh	229	284	382	518	7,21	1,010	1,326	1,683	2,076	2,493
DE	MW	2,523	2,680	2,837	2,985	3,126	3,267	3,399	3,531	3,660	3,796
	GWh	14,933	15,966	16,998	18,008	18,946	19,884	20,798	21,678	22,543	23,438
IT	MW	528	602	677	752	826	901	976	1,051	1,125	1,200
	GWh	2,518	2,907	3,296	3,685	4,074	4,463	4,853	5,242	5,631	6,020
LV	MW	21	31	44	62	64	68	73	78	84	92
	GWh	130	186	266	376	393	421	451	484	526	584
PL	MW	100	120	140	180	230	280	380	480	730	980
	GWh	410	492	574	738	943	1,148	1,558	1,968	2,993	4,018
RO	MW	10	20	50	90	125	160	170	180	190	195
	GWh	50	95	240	440	600	770	820	865	920	950

Table 4: Heating and cooling production from biogas (final energy consumption in ktoe)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
AT	15	16	16	16	16	16	16	16	16	16
CZ	90	125	147	168	183	192	199	205	208	211
DK	62	66	73	81	92	109	124	138	153	165
DE	992	1,072	1,152	1,232	1,312	1,388	1,464	1,540	1,616	1,692
IT	33	41	52	66	83	105	132	167	211	266
LV	14	20	28	38	39	40	42	44	46	49
PL	98	131	165	198	231	275	320	364	408	453
RO	1	3	5	7	10	14	16	18	19	20

However, the implementation of the 2020 goals faces challenges. In the Czech Republic, the biogas market experienced a rapid development during 2010 and 2012. At the end of 2012, the electricity production from biogas (incl. landfill gas and sewage gas) amounted to 1.4 TWh and it is expected that in 2013 it might reach 1.6-1.7 TWh. This would outpace the biogas target set in the National Renewable Energy Action Plan by 60-70%. As of 2015 Czech Republic has no further biogas targets and it is a rather negative signal for the entire biogas industry in the country.

According to the Danish Energy Statistics, in 2011 the electricity and heat generation from biogas were 343 GWh (1.24 PJ) and 29 ktoe (1.22 PJ) respectively (Energistatistik 2012). Electricity production is therefore a bit higher than estimated in the interim trajectory in the Danish NREAP (Table 3), but the heat production is around half (Table 4). The growth of biogas production in the last years is far from being fast enough to meet the 2020 objectives. An increase from the actual biogas production of around 4 PJ to about 24 PJ would be required to meet the requirement. According to the Danish Biogas Association, this would require the construction of additional 40 to 50 large biogas plants. To stimulate the biogas production and to reach the 2020 objectives, the new Danish Energy Agreement 2012-2020 includes several support mechanisms. The most important mechanisms are an increase in the feed-in tariff, the introduction of a subsidy for the sale of biogas to the natural gas grid, and the establishment of a task force to study and support specific biogas projects. If there is not enough development of new biogas projects until the end of 2013, the parties behind the Energy Agreement will discuss further options.

In Austria due to the new ÖSG 2012 (Ökostromgesetz - Green Electricity Bill) public support has become more attractive again. Due to the long term guarantee of feed-in tariffs, the CHP bonus and premiums it is expected that new biogas plants will be developed in upcoming years. Until 2020 the ÖSG 2012 aims at development of additional 1,300 GWh from biomass and biogas. This figure is realistic only if banks are willing to grant loans to potential investors. If further biogas plant operators quit their business the biogas 2020 targets are at risk.

In 2012 Germany reached 3,352 MW installed capacity from biogas plants. A number of biogas plants reached 7,515 in 2012 (7,175 biogas plants in 2011). In 2012 Germany has installed more biogas plants than targeted in the NREAP (672 MW in addition) (Fachverband Biogas e.V.). Actually, the planned installed capacity of biogas plants in 2013 is estimated to be around 3,530 MW meaning that Germany will implement the target for 2018 already this year. However, the growth rate has slowed down in the last 1.5 years due to uncertain political decisions on the future of the EEG.

According to a survey conducted by CRPA (Centro di Ricerca Produzioni Animali), the number of biogas plants operating in Italy were 587 in the end of 2011 and 937 in the end of 2012 (estimation based on the data of 87% of plants, Informatore Agrario, 2013). The total amount of power to be supported during the next years for the production of power from all kind of biomasses will be as follows: 170 MW in 2013, 160 MW in 2014 and 160 MW in 2015. At the moment there is no regulation for the period 2015 to 2020, therefore this gap creates a huge uncertainty among investors.

In order to comply with Directive 2009/28/EC Poland has created a National Renewable Energy Action Plan (NREAP) in 2010. The NREAP states that by the end of 2020 a total capacity of the biogas plants should be 980 MW, including agricultural, landfill and waste-water treatment plants. By the end of 2012 around 211 biogas plants were operating with an installed capacity of 141 MW (including agricultural, landfill and waste-water plants). 32 plants thereof are agricultural biogas plants (around 36 MW installed capacity).

According to the 2009/28/EC Directive, the share of renewable energy sources in final energy consumption in Latvia should be increased from 32.6% in 2005 to 40% in 2020. In order to reach this target, Latvia has developed a National Renewable Energy Action Plan (NREAP) where different measures for RES support have been provided. Support measures mostly address the electricity sector. It is expected that biogas will significantly contribute to reaching the RES 2020 target in the electricity sector. According to the NREAP, biogas capacities will gradually increase, reaching a capacity of 92 MW_{el} and providing 584 GWh of electricity from biogas in 2020 (Table 3). The total electricity generation from biogas in 2012 was 209 GWh from 37 operating biogas plants (installed capacity 42 MW_{el}). The progress of the Latvian biogas market in the future will depend on the national RES support policy that is currently under revision by the Ministry of the Economics of Latvia.

In Croatia the NREAP is in draft stage. It is estimated that around 2.9 PJ or 69.26 ktoe could come from biogas by 2020. That would amount to approximately 30 MW installed capacity (Development of Energy Sector of Republic of Croatia OG 130/09) which is about one third of the existing and pending biogas projects.

6 Review of EU legislation

Energy Roadmap 2050 (COM2011/885)

The Roadmap seeks to develop a long-term European framework in which national policies could be more effective. It recognizes that renewable heating and cooling are vital to decarbonisation by stating that ‘A shift in energy consumption towards low carbon and locally produced energy sources and renewable energy (e.g. solar heating, geothermal, biogas, biomass), including through district heating systems, is needed.’ However the roadmap does not mention any further guidelines on how to enable the shift towards increased heating and cooling utilization from RES, including biogas.

Renewable Energy Directive (RED 2009/28/EC)

The Directive recognises that ‘the use of agricultural material such as manure, slurry and other animal and organic waste for biogas production has, in view of the high greenhouse gas emission saving potential, significant environmental advantages in terms of heat and power production and its use as biofuel. Biogas installations can, as a result of their decentralised nature and the regional investment structure, contribute significantly to sustainable development in rural areas and offer farmers new income opportunities’. It also indicates that member states should consider mechanisms for the promotion of district heating and cooling from energy from renewable sources.

However, heat use from biogas plants or efficiency requirements are not mentioned and promoted in the Directive. This means that Member States are not obliged to implement any changes in national policies to enhance energy efficiency of biogas plants.

Energy Efficiency Directive (2012/27/EG)

The Directive promotes energy efficiency and aims particular at delivering energy savings on the heating and cooling market with district heating and cooling. This Directive should be transposed into national laws by mid 2014.

According to the Directive Member States will carry out a Comprehensive Assessment (CA) of the potential for high-efficiency cogeneration and district heating and cooling. As part of the CA Member States will develop a Cost-Benefits Analysis on CHP/DHC at national level. A Cost-Benefits Analysis will also be done at installation level to analyse the possible use of waste heat. Where a potential has been identified, 'Member States shall take adequate measures for efficient district heating and cooling infrastructures to be developed and/or to accommodate the development of high-efficiency cogeneration and the use of heating and cooling from waste heat and renewable energy sources'. It is important to note that the comprehensive assessment will also deal with the use of Renewable Energy Sources. This assessment should be finalised by Member States by December 2015.

The Directive does not set any minimal national efficiency targets for cogeneration, however the European Commission might call for a binding target if members states will not implement its 2020 savings target in 2014.

7 Policy recommendations

Biogas can significantly contribute to the renewable energy 2020 targets and beyond. Biogas can be converted to electricity and heat or upgraded to biomethane. In addition, digestate from biogas plants can be used as biofertilizer. However, the potential of biogas is not yet fully exploited in many Member States despite its high potential in terms of available agricultural resources.

In general, RES support in the Member States is focused on electricity production whereas efficient use of heat is hardly taken into account. According to the NREAPs, more than 1/5 of the EU's heating consumption in 2020 is expected to come from renewable sources. It is expected that the share of RES in heating and cooling will increase from 10.2% in 2005 to 21.3% in 2020. In 2020 biomass should represent 17.2% of heating and cooling consumption (EREC 2011). Sustainable heat use from biogas plants can significantly contribute to the share of RES in heating and cooling. However this requires a clear direction of Member States towards efficient use of primary energy from biogas. More focus on releasing the potential of RES, including biogas, in the heating and cooling sector is missing in the European and national policies.

Recommendations:

Following the bottlenecks identified on the national level and the needs declared by the national stakeholders there is a number of recommendations for the European level:

On the use of biogas in general

- National 2020 targets for the development of the biogas sector have proven to be unambitious and unsustainable in various countries. It would be helpful if the European Commission would push for an *ambitious but realistic revision of the national targets*.
- Currently, there are no clear biogas targets for the time after 2020, but in order to foster the sustainable development it is crucial to define them. Therefore, the European Commission should include corresponding paragraphs in the relevant dossiers that urge the Member States to define *binding biogas targets for 2030 and 2050*.
- To ensure that these targets are reached Member States need to implement sustainable and predictable support measures. In the short-term the European

Commission could urge the Member States to *create stable framework conditions*. In the long-term the definition of *future binding biogas targets could be linked to the development of a corresponding and binding support scheme*.

- Secured supply with adequate resources plays a major role in planning, building and running biogas plants. Whereas energy production must not interfere with food or feedstock production, *European policies should not discriminate against the utilization for energy production*.

On the use of heat from biogas

- Generally, the use of waste heat from CHP must be promoted more. Therefore, the European Commission should adjust its strategies and *consider the whole potential of heat use for energy efficiency, energy security and phasing-in of RES*. Future binding biogas targets should include *realistic, but ambitious heat utilization targets*.
- Accordingly, a comprehensive assessment under the Energy Efficiency Directive 2012/27/EU should also consider the use of biogas as a strategic source for District Heating and Cooling and look into the use of heat from biogas. This should also include the development of a fair positive/negative *list for national heat use* from CHP plants which includes various possibilities such as DHC and on-site utilization.
- With view to the Member States it would be helpful if the European Commission pushes for harmonized efficiency targets for heat use from (biogas) CHP plants.
- Support schemes on heat use must be sustainable and predictable. Therefore, the *binding support schemes should include clear rules on support measures*, i.e. feed-in tariffs linked to efficiency, *and documentation needs*, i.e. utilization plans, but also safety measures for operators in case of changing demands.
- The European Commission is asked to push for *heat use plans for future CHP plants as well as for existing ones*.
- To support schemes for the development of biogas CHP plants it is also necessary to *support the development and construction of distribution* networks. Therefore, the European Commission should revise its energy network development plans and take the potential of heat distribution into account. Accordingly, the European Commission could urge Member States to revise their network strategies and consider heat distribution as sustainable alternative to other heating options.

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