BIOGASIN

www.biogasin.org

Did you Know that Biogas...?

INTELLIGENT ENERGY EUROPE

Contents

Coverfoto: Thomas Otto – Fotolia

Biogas is a mixture of methane, carbon dioxide, nitrogen, hydrogen and hydrogen sulphide. The desired compound is methane, but the exact composition of biogas varies depending upon the feedstock material used for its production and different parameters like temperature and acidity of the substrate. Biogas is produced by anaerobic digestion (AD) (fermentation), which means that biomass is converted by microorganisms to biogas under absence of oxygen.

AD is common to many natural environments, such as marine water sediments, or the stomach of ruminants. AD is a biochemical process during which organic matter is decomposed by various microorganisms. These microorganisms are only able to survive under anaerobic and dark conditions. Therefore, AD normally takes place in digesters, which are specially designed for this purpose. Biogas digesters are hermetically sealed from oxygen and light.

After the feedstock has been filled into the digester two principal outputs from AD are produced: biogas and digestate.

- **Biogas** produced during AD is removed from the digester and further processed. Methane is the desired energy rich biogas component. Biogas can be directly burnt in order to produce heat or for electricity generation. Purified (upgraded) biogas can be used as fuel for vehicles or injected into the natural gas grid as substitute for natural gas.
- **Digestate** is the biodegraded biomass, which is left after AD. Depending on the feedstock, it has either more liquid or more solid components. Digestate is an excellent fertiliser and has a considerable advantage compared to the original feedstock. Due to the treatment during AD, its odour is significantly reduced and nutrient characteristics for plant-uptake are improved, thus being an excellent organic fertilizer.

Generally, digesters can use many biodegradable materials. The most common biomass categories used in European biogas plants are (Al Seadi et al., 2008)[1]: animal manure and slurry, agricultural residues and by-products, digestible organic wastes from food and agro industries, organic fraction of municipal waste and catering, sewage sludge, as well as dedicated energy crops (e.g. maize, sorghum, clover).

Did you know that Biogas is ...

... a greenhouse gas saving tool?
... a tool for implementing best agricultural practice?
... a renewable energy carrier?
... a source for regional development and socio-economic benefits?

[1] Al Saedi T., Rutz D., Prassl H., Köttner M., Finsterwalder T., Volk S., Janssen R., Biogas Handbook, October 2008

Environmental friendly solution

In contrast to fossil fuels, burning biogas only releases the amount of atmospheric CO_2 that was stored in the plant during its growth. Thus, the carbon cycle of biogas is closed. For that reason, utilisation of biogas reduces CO_2 emissions and helps to avoid an increase of the CO_2 concentration in the atmosphere, which helps to mitigate global warming. Furthermore, other greenhouse gas (GHG) emissions[2], such as methane (CH_4) and nitrous oxide (N_2O) from untreated manure are reduced.

In general GHG saving due to biogas utilization can be arising by:

- **Manure management:** potential emissions saved due to CH4 utilisation of animal manure and slurry
- **Substitution effect:** Emission saved due to electricity and heat (cogeneration) production from biogas
- **Replacement of fossil fertilisers:** Emission saved due to replacement of mineral fertilisers by digestate

Livestock agriculture increases CH_4 emissions from enteric fermentation as well as CH_4 and N_2O emissions from manure management. In many countries large livestock populations play an important source of GHG emissions.

Biogas production by AD creates digestate which is the remaining biomass material after AD. Digestate substitutes untreated manure as fertiliser. Due to the fact that digestate has even better fertiliser efficiency than untreated manure, additional mineral fertilisers can be substituted. This results in GHG savings due to reduced production of mineral fertilizers.

[2] For simplicity, all GHG emissions are converted into CO_2 equivalents (CO_2-eq) which is used in this document.

Best agricultural practice

One of the main advantages of biogas production is the ability to use biodegradable waste as a feedstock for AD. A large fraction of municipal and industrial waste contains organic material, which can be used for biogas production in anaerobic digesters. This reduces the volume of waste, saves money and contributes to meeting national and European waste recycling regulations. Besides, excess of manure in intensive livestock breeding areas can be effectively used for biogas production. This is considered as one of the good agricultural practices in manure management. Furthermore, the produced digestate contributes to compliance of a closed nutrient cycle.

Digestate has improved fertiliser efficiency due to homogeneity and higher nutrient availability. It is rich in nitrogen, phosphorus, potassium and micronutrients. It can be applied on soils just like liquid manure (depending on the feedstock). Further advantages of digestate compared to manure are the reduction of odours and flies due to the biodegradation and improved veterinarian safety, since AD removes pathogens. Waste materials have to undergo an additional controlled sanitation process.

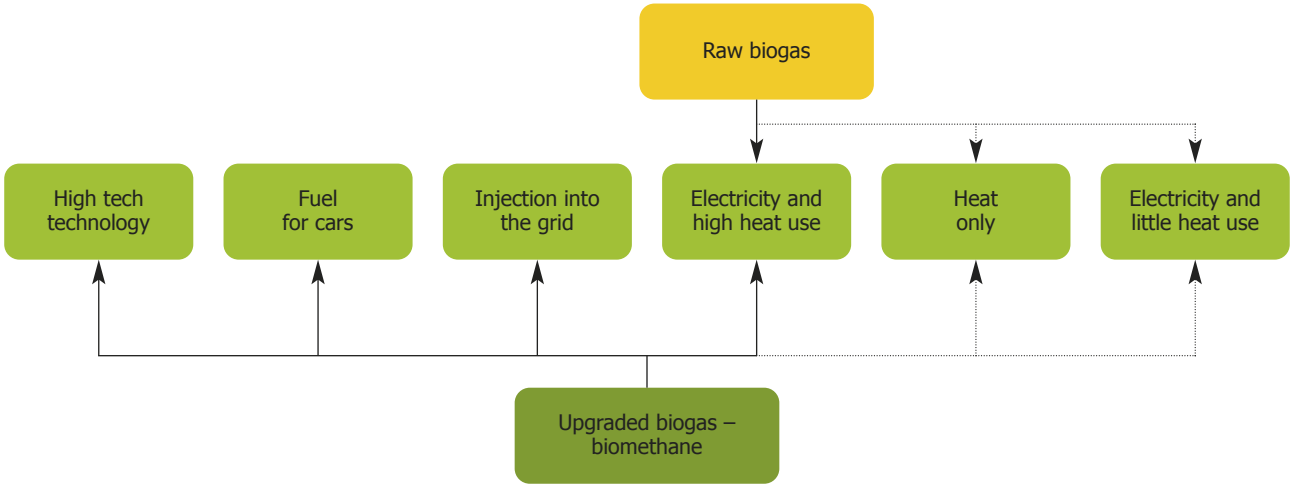
Digestate can be used as a substitute for synthetic fertilisers. Thus, additional nutrient deployment is constrained. This contributes to meeting EU directives, such as the EU Nitrate Directive.

Renewable energy production

Biogas is a fuel for several applications, including electricity, heat and transport. Efficient biogas pathways (bold arrows) are illustrated in Figure[3] below.

Biogas is currently most commonly used for electricity and/or heat production. Thereby, combined heat and power (CHP) production is preferred to electricity production without heat use and to only heat production.

Upgraded biogas is increasingly used as natural gas substitute in natural gas grids or used as vehicle fuel.



Symbole: Fotolia

[3] Source: AEBIOM, European Biomass Association, A Biogas Roadmap for Europe, October 2009

Socio economic issues

Biogas production has many social benefits and most of these are related to job creation and rural development. Especially small to medium size decentralised biogas systems may have considerable advantages in agricultural rural regions such as:

- The development of a biogas sector stimulates the establishment of new enterprises, which increases the local income and the number of job opportunities. It also increases the economic growth of the area. Biogas can contribute to revitalise rural areas by making them attractive for equipment manufacturers, investors and entrepreneurs.
- As biogas can generate electricity and heat and work as a substitute for vehicle fuel, its utilisation contributes to reducing the dependency on fossil fuels. It also contributes to energy diversification and security of energy supply.
- Biogas production and utilisation influences the socio-economic structure in rural areas. It improves the social cohesion of the local population.

The potential benefits from biogas utilisation in twenty eight regions of the BiogasIN target countries (Bulgaria, Croatia, Czech Republic, Greece, Latvia, Romania, and Slovenia) were investigated. The benefits include among others local job creation, increases rural investment, rural development, mitigation of greenhouse gas emissions, decentralised produced renewable energies, reduced water and environment pollution from leaching of nutrients. The results are summarised below. The methodology for the calculation of these benefits is shown in BiogasIn reports available at **www.biogasin.org**.

Bulgaria

Map of Bulgaria with BiogasIN target regions

The use of biogas in Bulgaria is underdeveloped despite the available resources. Biogas produced in Bulgaria, mainly by urban waste water treatment plants, is used for own and local needs and is not injected into the existing natural gas networks, nor is the electricity fed into the electrical power grid.

The Bulgarian biogas market is still at the beginning. Today, there are no agricultural biogas plants installed, even though there is huge interest from some farmers and investors. Organic municipal and agricultural waste are certainly very suitable feedstock sources in Bulgaria. However, especially the potential for energy crops is estimated very high.

In Bulgaria the biggest potential for producing biogas can be found in the North-east and South-central areas. In these areas the four BiogasIN target regions are located.

Veliko Tarnovo covers a surface of 4,662 km^2. 275,000 people are populated in the municipality, of which 24% are living in the city of Veliko Turnovo.

Haskovo is the largest of the four target regions, covering an area of 5,543 km^2 and is populated by 279,000 inhabitants. Around 34% of them are living in the city of Haskovo.

Stara Zagora covers an area of 5,151 km^2 and is populated by 389,000 people, of which 42% are living in the capital.

Jambol covers a surface of 3,336 km^2. It is populated by 141,000 inhabitants, 65% of them are living in the city of Jambol.

Biogas benefits in Bulgaria

According to the National Renewable Energy Action Plan under Directive 2009/28/EC, Bulgaria's mandatory national target for 2020 is a 16% share of energy from renewable sources in the gross final consumption of energy, including a 10% share of energy from renewable sources in the consumption of energy in the transport sector. The contribution (installed capacity, gross electricity generation) expected from biogas in Bulgaria to meet the binding 2020 targets has been estimated at 65 MW or 357 GWh (31 ktoe). Additionally, 20 ktoe is the estimated contribution (final energy consumption) of biogas for heating-cooling in 2020.

Bulgaria ratified the Kyoto protocol to the UNFCCC on August 15th, 2002. The target adopted by Bulgaria is an 8% reduction compared to the base year (1988). GHG emissions inventory for 2008 showed that the CO_2 emissions amounted to 73.5 million tones, which means a 44.6% reduction between 1990 and 2008.

Biogas exploitation using 100% livestock manure available in the four target areas in Bulgaria can give the following results:

Potential benefits in the target regions	Veliko Turnovo	Haskovo	Stara Zagora	Jambol
Potential emission savings ($ktCO_2$/yr)	199.5	197.8	203.6	174.6
Artificial fertilizers saving (Urea-Ammonium Nitrate) (t/yr)	2,957	2,882	2,900	2,918
Artificial fertilizers saving (Urea-Ammonium Nitrate) (€/yr)	855,313	833,833	838,941	844,213
Electricity production potential (in cogeneration) (GWh)	91	93	97	79
Biogas energy share in national renewable targets in 2020 (%)	2.9	3.0	3.1	2.5
Biogas energy share in national biogas target in 2020 (%)	4.7	4.7	5.0	4.0
Installed capacity (MW)	12.2	12.5	13	10.6
Number of biogas plants (installed capacity of 0.5 MW)	24	25	26	21
Number of new local jobs	38-232	39-237	41-248	33-202
Number of households supplied with electricity	26,293	26,648	27,923	22,716
Investment (M€)	38.4	39.2	40.9	33.3

Main results:

- Annual savings of about 775 kt CO_2 emissions or 1.06% of the country emissions in 2008.
- Contribution with 11.1% to the national renewable energy target in 2020 and with 18.4% to the national biogas target.
- Total installed capacity of about 48 MW with investment costs of M€ 152.
- About 100 new small biogas plants (0.5 MW each) creating a range of 151-919 new jobs.
- Saving of about 11,657 t/yr artificial fertilizers worth of 3,372,399 €/yr.
- 103,580 households can be supplied with electricity produced from biogas.

Croatia

Map of Croatia with BiogasIN target regions

Medimurje County is located in the very northern part of Croatia. Despite being the smallest sized county in Croatia, it is the most densely populated one. 118,000 inhabitants are living in an area of 730 km^2. The economy of Međimurje is dynamic and fast-growing, based on a long tradition in entrepreneurship and craft. 14% of the population of this export orientated region are living in rural areas. Total agricultural land covers a surface of 55,000 ha. The share of crop production on arable land is 60%, while 40% are used for cattle breeding (mostly pigs and poultry). Dominant crops are cereals, potatoes and vegetables, industrial crops and fodder.

Varazdin County is a county in northern Croatia and covers an area of 1,261 km^2. The population is about 184,000 people. 67,000 ha of the county are occupied by agricultural land out of which 67% are currently utilised.

Another important economical factor in Varazdin County is food processing industry. Agriculture and food processing industry generate employment for 12% of the active population. The advantages of biogas utilisation are considerably important for this county, as it is an environmentally friendly way of waste management and energy recovery from organic waste originated from well food processing industry.

Vukovar-Syrmia County is predominantly a plain region, which covers a surface of 2,448 km^2 and is populated by 204,000 inhabitants. Most of the area of Vukovar-Syrmia County is utilised agriculturally (150,000 ha) due to the fertile, black soil. The main agricultural outcomes are wheat, maize, sugar beet and tobacco. It is the first Croatian county to have an agricultural biogas plant operating since mid 2009. Some 20% of national biogas potential has been attributed to this county. Available base feedstock for biogas production are dairy cow and cattle manure, pig slurry and, to a lesser extend, poultry manure and slaughterhouse waste plus feedstock from food-processing industry and energy crops.

Osijek-Baranja County is predominantly a plain region suitable for agricultural development covering an area of 4,155 km^2 and populated by 330,500 inhabitants. About 258,000 ha of agricultural land are provided in the county. Cereals, industrial crops and fodder are the dominant crops produced in the arable land. The county has one agricultural biogas plant operating since early 2010 and about one third of Croatian future biogas locations have been identified here.

Biogas benefits in Croatia

Croatia is in the pre-accession period for full membership in the EU and thus also respects the obligations for 2020 of cutting greenhouse gas emissions by 20%, producing 20% of its energy from renewable sources and increasing energy efficiency by 20%. The contribution (gross electricity generation) expected from biogas in Croatia to meet the binding 2020 targets has been estimated 722 GWh.

Croatia ratified the Kyoto protocol to the UNFCCC on May 30, 2007 (entered into force on 28 August 2007). The target for Croatia is 5% reduction compared to the base year (1990). GHG emissions inventory for 2008 showed that the CO_2 emissions amounted to 31.1 million tones, which means 0.9% reduction between the base year and 2008.

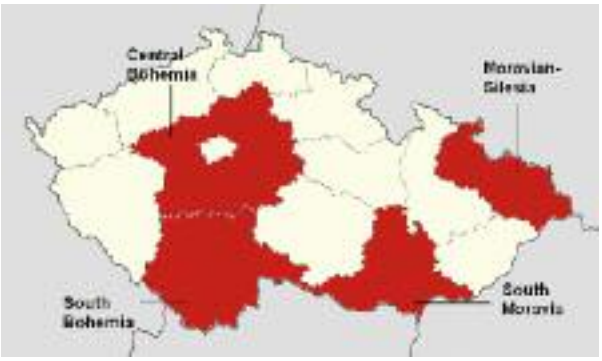
Biogas exploitation using 100% livestock manure available in the four target areas in Croatia can give the following results:

Potential benefits in the target regions	Međimurje	Varaždin	Vukovar-Srijem	Osijek-Baranja
Potential emission savings ($ktCO_2/yr$)	23.7	29.5	49.4	92.1
Artificial fertilizers saving (Urea-Ammonium Nitrate) (t/yr)	75	126	244	418
Artificial fertilizers saving (Urea-Ammonium Nitrate) (€/yr)	21,786	36,377	70,622	120,857
Electricity production potential (in cogeneration) (GWh)	15	19	34	55
Biogas energy share in national renewable targets in 2020 (%)	0.2	0.3	0.5	0.9
Biogas energy share in national biogas target in 2020 (%)	5.9	7.5	13.4	21.7
Installed capacity (MW)	2.0	2.6	4.6	7.4
Number of biogas plants (installed capacity of 0.5 MW)	4	5	9	15
Number of new local jobs	6-38	8-48	14-87	23-140
Number of households supplied with electricity	3,590	4,554	8,145	13,245
Investment (M€)	6.3	8.0	14.3	23.2

Main results:

- Annual savings of about 195 kt CO_2 emissions or 0.6% of the country emissions in 2008.
- Contribution with 2% to the national renewable energy target in 2020 and with 48.4% to the national biogas target.
- Total installed capacity of about 17 MW with investment costs of M€ 52.
- About 33 new small biogas plants (0.5 MW each) creating a range of 52-314 new jobs.
- Saving of about 863 t/yr artificial fertilizers worth of 249,641 €/yr.
- 29,533 households can be supplied with electricity produced from biogas in CHP plants.

Czech Republic



Map of the Czech Republic with BiogasIN target regions

The Czech Republic is within the top 10 biogas producers in the European Union. 2009 the Czech Republic produced a primary energy output from biogas of 129.9 ktoe (kilo t oil equivalent), which equates 441.3 GWhel. This represents the electric power consumption of about 100,000 four-person households during one year[4]. The Czech Republic shows a rising tendency in energy production from biogas plants. From 2008 to 2009, the electricity output from biogas utilisation rose by 65%.

South Bohemian Region is located in the south-western part of the Czech Republic. It covers an area of 10,057 km^2 and has 636,000 inhabitants, of which 35% are living in rural areas. The area is active in agriculture and fish farming.

South Moravian Region is located in the south eastern part of the Czech Republic, covering an area of 7,195 km^2. 1,147,000 people are living in South Moravia. Agricultural land comprises more than 60% of the Region's total area, of which 83% is arable land.

Central Bohemia Region is located in the western part of the Czech Republic, occupying a surface of 11,015 km^2. It is populated by 1,230,700 inhabitants. Close ties with the capital city in the geographic centre of the region characterise its socio-economic structure. The majority of employees are working in manufacturing sectors and agriculture.

Moravian-Silesian Region lies in the northeast of the Czech Republic. It covers an area of 5,427 km^2, of which more than 50% is agriculturally utilised land. Moravia-Silesia is the most populated region in the Czech Republic with more than 1,250,000 inhabitants.

[4] The calculation grounds on an assumed electric power consumption of 4,500 kWh/a

Biogas benefits in Czech Republic

The National Renewable Energy Action Plan for the Czech Republic suggests a target of a 13.5% share of energy from renewable sources in gross final energy consumption and the fulfilment of a target of a 10.8% share of energy from renewable sources in transport in gross final energy consumption. The contribution (installed capacity, gross electricity generation) expected from biogas in Czech Republic to meet the binding 2020 targets has been estimated to 417 MW or 2,871 GWh (247ktoe). Additionally, 167 ktoe is the estimated contribution (final energy consumption) of biogas for heating-cooling in 2020.

Czech Republic ratified the Kyoto protocol to the UNFCCC on November 15, 2001 (entered into force on 16 February 2005). The target for Czech Republic is 8% reduction compared to the base year. GHG emissions inventory for 2008 showed that the CO2 emissions amounted to 141.4 million tones, which means 27.2% reduction between the base year and 2008.

Biogas exploitation using 100% livestock manure available in the four target areas in Czech Republic can give the following results:

Potential benefits in the target regions	**South Bohemia**	**South Moravia**	**Central Bohemia**	**Moravian-Silesia**
Potential emission savings ($ktCO_2/yr$)	476.2	231.7	406.2	186.5
Artificial fertilizers saving (Urea-Ammonium Nitrate) (t/yr)	13,069	7,516	12,209	5,183
Artificial fertilizers saving (Urea-Ammonium Nitrate) (€/yr)	3,780,622	2,174,092	3,531,745	1,499,337
Electricity production potential (in cogeneration) (GWh)	255	118	213	100
Biogas energy share in national renewable targets in 2020 (%)	2.3	1.1	2.0	0.9
Biogas energy share in national biogas target in 2020 (%)	25.4	11.7	21.2	9.9
Installed capacity (MW)	34.2	15.8	28.6	13.4
Number of biogas plants (installed capacity of 0.5 MW)	68	32	57	27
Number of new local jobs	107-651	50-301	89-544	42-255
Number of households supplied with electricity	74,959	34,583	62,558	29,364
Investment (M€)	107.5	49.8	89.8	42.2

Main results:

- Annual savings of about 1,300 kt CO_2 emissions or 0.92% of the country emissions in 2008.
- Contribution with 6.3% to the national renewable energy target in 2020 and with 68.2% to the national biogas target.
- Total installed capacity of about 92 MW with investment costs of M€ 289.
- About 184 new small biogas plants (0.5 MW each) creating a range of 288-1,750 new jobs.
- Saving of about 37,976 t/yr artificial fertilizers worth of 10,985,796 €/yr.
- 201,464 households can be supplied with electricity produced from biogas.

Greece

Map of Greece with BiogasIN target regions

Greece is located to the south-eastern edge of Europe, occupies an area of 132,000 km^2 and has a population of 10.96 million according to the 2001 census (66% of which live in urban areas).

Greece has a developing biogas market. The theoretical biogas potential is very high especially of organic wastes and animal manure. The utilisation of biogas in most of the existing biogas plants, cover mainly heat demands of the plants For the year 2008 the installed capacity of electricity generation from biogas was 39.4 MW (40.8 MW in December 2010) and the gross electricity generation reached to 176.7 GWh [Hellenic Transmission System Operator].

Larissa covers a surface of 5,381 km^2 and is populated by 279,300 inhabitants. The area is the most important agricultural region in Greece with 3,472 km^2 agriculturally used land. Livestock-farming plays an important role in Larissa, too.

Aetolia-Acarnania occupies an area 5,461 km^2. The population of the Prefecture is 223,000 inhabitants. Aetolia-Acanarnia is a mountainous area, as only 20% of its surface is in a plain. However, 2,121 km^2 are used agriculturally, producing both, crops as well as livestock products.

Preveza is the smallest of the four Greece target regions, covering a surface of 1,036 km^2. It is populated by 19,000 inhabitants. Only 33% of its total area is in a plain. 306 km^2 of the total area of Preveza are used agriculturally. Additionally livestock farming is an important economical factor in this region.

Evia is the second largest island and has a total extend of 4,167 km^2. The population of the section is 215,000 inhabitants, of which 41% are living in rural areas. Evia provides 1,707 km^2 agricultural areas. The main form of farming represents the extensive sheep breeding in the mountainous regions.

Biogas benefits in Greece

The National targets for RES until the end of 2020, based on Directive 2009/28/EC, are set as follows:

a) contribution of the energy produced from RES to the gross final energy consumption by 20%,
b) contribution of the electricity produced from RES to the gross electricity consumption to a share of at least 40%. According to the Ministry of Environment decision (Α.Υ/Φ1/οικ.19598, October 2010) the desired installed capacity of biomass was set to 350 MW.
c) Contribution of the energy produced by RES to the final energy consumption for heating and cooling to a share of at least 20%.

According to the provisions of the National Renewable Energy Action Plan the estimation of total contribution in electricity (installed capacity, gross electricity generation) expected from biogas to meet the binding 2020 targets is 210 MW and 895 GWh. Greece ratified the Kyoto protocol to the UNFCCC on May 31, 2002 (entered into force on 16 February 2005). The target for Greece is 25% increase compared to the base year. GHG emissions inventory for 2008 showed that the CO2 emissions amounted to 126.9 million tones, which means 20.34% increase between the base year and 2008.

Biogas exploitation using 100% livestock manure available in the four target areas in Greece can give the following results:

Potential benefits in the target regions	**Larissa**	**Aitoloa-karnania**	**Preveza**	**Evia**
Potential emission savings ($ktCO_2/yr$)	190.8	237.8	99.1	60.1
Artificial fertilizers saving (Urea-Ammonium Nitrate) (t/yr)	13,963	18,346	4,501	7,220
Artificial fertilizers saving (Urea-Ammonium Nitrate) (€/yr)	4,039,165	5,307,186	1,302,169	2,088,714
Electricity production potential (in cogeneration) (GWh)	70	84	35	17
Biogas energy share in national renewable targets in 2020 (%)	0.3	0.3	0.1	0.1
Biogas energy share in national biogas target in 2020 (%)	1.0	1.2	0.5	0.3
Installed capacity (MW)	9.4	11.3	4.7	2.3
Number of biogas plants (installed capacity of 0.5 MW)	19	23	9	5
Number of new local jobs	29-179	35-214	15-89	7-43
Number of households supplied with electricity	16,340	19,638	8,122	3,961
Investment (M€)	29.5	35.4	14.9	7.2

Main results:

- Annual savings of about 588 kt CO_2 emissions or 0.92% of the country emissions in 2008.
- Contribution with 0.8% to the national renewable energy target in 2020 and with 3% to the national biomass/biogas target. The theoretical electricity generation in the selected areas can cover more than 70% of the biogas target for 2020 (895 GWh).
- Total installed capacity of about 28 MW with investment costs of M€ 87.
- About 55 new small biogas plants (0.5 MW each) creating a range of 87-526 new jobs.
- Saving of about 44,031 t/yr artificial fertilizers worth of 12,737,233 €/yr.
- 48,061 households can be supplied with electricity produced from biogas.

Latvia

Map of Latvia with BiogasIN target regions

The Latvian biogas sector only provides little energy per inhabitant compared to other European countries. The primary biogas energy production in 2009 was 4.3 toe (t oil equivalent) per 1,000 inhabitants (compared to 51.5 toe per 1,000 inhabitants in Germany). Thus, the overall energy output from biogas in Latvia is 9.7 ktoe, or 45.0 GWhel. However, this is an increase of 16.6% compared to 2008. 45.0 GWh electricity equates the annual consumption of 10,000 four-person households[5].

Valmiera Region covers a surface of 2,373 km^2 and it is populated by 57,583 inhabitants. About 37% of the territory is covered by agricultural land. The main economical activity in the region is agricultural production, while industrial and service activities are more concentrated in Valmiera city.

Madona Region is the second biggest region in Latvia and covers an area of 3,349 km^2, populated by 41,662 inhabitants. 37% of the territory is used agriculturally. The main economical activities in the region are forestry, wood processing, agriculture, tourism and trading.

Gulbene Region is one of the smallest regions in Latvia, providing an area of 1,873 km^2. It is populated by 25,496 inhabitants and agricultural areas cover 35% of the surface. The main economical activities in Gulbene region are related to agriculture, forestry and wood processing.

Aluksne Region occupies a surface of 2,243 km^2 and it is populated by 23,926 inhabitants. 29% of the region is covered by agricultural areas. The main economical activities in Aluksne region are related to agriculture, trade and wood processing.

[5] The calculation grounds on an assumed electric power consumption of 4,500 kWh/a.

Biogas benefits in Latvia

According to the National Energy Action Plan, under Directive 2009/28/EC, Latvia's RES targets up to 2020 is: 1) by 2020, the share of renewable energy in total gross final energy consumption to be increased to at least 40% and to increase it gradually thereafter; 2) by 2020, the share of renewable energy in the transport sector must reach at least 10% of gross final energy consumption for transport and to increase it gradually thereafter. The contribution (installed capacity, gross electricity generation) expected from biogas in Latvia to meet the binding 2020 targets has been estimated to 92 MW or 584 GWh (50 ktoe). Additionally, 49 ktoe is the estimated contribution (final energy consumption) of biogas for heating-cooling in 2020.

Latvia ratified the Kyoto protocol to the UNFCCC on May 30, 2002 (entered into force on 16 February 2005). The target for Latvia is 8% reduction compared to the base year. GHG emissions inventory for 2008 showed that the CO2 emissions amounted to 11.9 million tones, which means 54.1% reduction between the base year and 2008.

Biogas exploitation using 100% livestock manure available in the four target areas in Latvia can give the following results:

Potential benefits in the target regions	**Valmiera**	**Madona**	**Gulbene**	**Alūksne**
Potential emission savings ($ktCO_2/yr$)	15.6	15.4	8.7	7.1
Artificial fertilizers saving (Urea-Ammonium Nitrate) (t/yr)	764	774	445	368
Artificial fertilizers saving (Urea-Ammonium Nitrate) (€/yr)	220,948	223,962	128,739	106,588
Electricity production potential (in cogeneration) (GWh)	24	25	14	12
Biogas energy share in national renewable targets in 2020 (%)	0.3	0.4	0.2	0.2
Biogas energy share in national biogas target in 2020 (%)	13.3	13.6	7.7	6.5
Installed capacity (MW)	3.2	3.4	1.9	1.6
Number of biogas plants (installed capacity of 0.5 MW)	6	7	4	3
Number of new local jobs	10-61	11-64	6-36	5-31
Number of households supplied with	10,272	10,509	5,970	5,000
Investment (M€)	10.1	10.5	5.9	5.1

Main results:

- Annual savings of about 47 kt CO_2 emissions or 0.4% of the country emissions in 2008.
- Contribution with 1.1% to the national renewable energy target in 2020 and with 41.1% to the national biogas target.
- Total installed capacity of about 10 MW with investment costs of M€ 32.
- About 20 new small biogas plants (0.5 MW each) creating a range of 32-191 new jobs.
- Saving of about 2,351 t/yr artificial fertilizers worth of 680,237 €/yr.
- 31,751 households can be supplied with electricity produced from biogas.

Romania

Map of Romania with BiogasIN target regions

Romania represents one of the weakest biogas markets in the European Union. However, it shows a rising tendency. The amount of primary energy produced by Romanian biogas plants more than doubled between 2008 and 2009. In 2009, the energy produced by biogas plants equated 1.3 ktoe, which stands for an electric energy output of 1.0 GWhel.

Buzau County is located in the western part of South Romania. It occupies a surface of 6,103 km^2 and is populated by 488,763 inhabitants, of which 59% are living in the rural areas (most of the employed population is working in agriculture). The county is characterised by isolated complex industrial centres and vast cropping and vine areas.

Vrancea County is located north from Buzau County and occupies a surface of 4,857 km^2. It is populated by 392,619 inhabitants, of which 62% are living in the rural areas (about 49% of the employed population working in agriculture). The county provides vast cropping and vine areas.

Giurgiu County is located in the southern part of Romania, occupying an area of 3,526 km^2. It is populated by 283,408 inhabitants, 69% of which in the rural areas (about 58% of the employed population working in agriculture). The surface consists entirely of plain. The southern part of Giurgiu County has access to the Danube.

Teleorman County covers a surface of 5,790 km^2 and a population of 413,064 inhabitants. 66% of the people in this county are living in the rural areas (about 59% of the employed population working in agriculture). The surface of Teleorman County consists entirely of plain. To the south it is bordered by the Danube.

Biogas benefits in Romania

According to the National Energy Action Plan, under Directive 2009/28/EC, Romania's target by 2020 is the share of renewable energy in total gross final energy consumption to be increased to 24%. The contribution (installed capacity, gross electricity generation) expected from biogas in Romania to meet the binding 2020 targets has been estimated to 195 MW or 950 GWh (82 ktoe).

Romania ratified the Kyoto protocol to the UNFCCC on March 19, 2001 (entered into force on16 February 2005). The target for Romania is 8% reduction compared to the base year. GHG emissions inventory for 2008 showed that the CO_2 emissions amounted to 145.9 million tones, which means 47.6% reduction between the base year and 2008.

Biogas exploitation using 100% livestock manure available in the four target areas in Romania can give the following results:

Potential benefits in the target regions	**Buzau**	**Vrancea**	**Giurgiu**	**Teleorman**
Potential emission savings ($ktCO_2/yr$)	330.3	217.4	194.7	316.7
Artificial fertilizers saving (Urea-Ammonium Nitrate) (t/yr)	8,540	5,782	4,716	8,027
Artificial fertilizers saving (Urea-Ammonium Nitrate) (€/yr)	2,470,560	1,672,750	1,364,176	2,322,030
Electricity production potential (in cogeneration) (GWh)	212	140	124	202
Biogas energy share in national renewable targets in 2020 (%)	0.3	0.2	0.2	0.3
Biogas energy share in national biogas target in 2020 (%)	4.4	2.9	2.5	4.2
Installed capacity (MW)	28.5	18.8	16.7	27.1
Number of biogas plants (installed capacity of 0.5 MW)	57	38	33	54
Number of new local jobs	89-541	59-357	52-316	85-515
Number of households supplied with electricity	150,595	99,640	87,989	143,347
Investment (M€)	89.4	59.0	52.3	85.2

Main results:

- Annual savings of about 1,059 kt CO_2 emissions or 0.73% of the country emissions in 2008.
- Contribution with 1.1% to the national renewable energy target in 2020 and with 14.0% to the national biogas target.
- Total installed capacity of about 91 MW with investment costs of M€ 286.
- About 182 new small biogas plants (0.5 MW each) creating a range of 285-1,730 new jobs.
- Saving of about 27,066 t/yr artificial fertilizers worth of 7,829,517 €/yr.
- 481,572 households can be supplied with electricity produced from biogas.

Slovenia

Map of Slovenia with BiogasIN target regions

The primary energy output from biogas in Slovenia rose by 59% between 2008 and 2009. This is a considerable strong increase, which lead to an electric power generation from biogas utilisation of 68.8 GWhel in 2009. This amount of electric energy covers the annual consumption of more than 15,000 four-person households .

Pomurska region in the north eastern part of Slovenia covers a surface of 1,337 km^2 and residues 123,500 inhabitants. It is predominately an agricultural region with field crops representing over ¾ of the total utilized agricultural area, twice as much as the Slovene average. However, its geographical position and inferior infrastructure influence the region's economic power negatively.

Savinjska region, named after the Savinja River, stretches along the valley that lies to the east of central Slovenia. 260,000 inhabitants live in this region, covering an area of 2,384 km^2. Forests cover almost 57% of the region's surface, while 40% or 70,000 ha are used agriculturally. The main agricultural product is cereals for the production of grains and forage. Farming is dominated by mixed livestock and pasture livestock farming.

Gorenjska region, which is almost entirely alpine, measures 2,137 km^2 and is populated by 203,000 inhabitants. 26% of the surface of the region consists of agricultural land, which is characterized both by its developed livestock and forests exploitation. Furthermore, Gorenjska region is one of the most economically developed regions of Slovenia with a strong and diversified industry, handicrafts and tourism.

Spodnjeposavska region is the smallest of the four target regions with an area of 1,031 km^2 and 78,400 people living in it. Thanks to the favorable natural conditions for agricultural activity this region still characterizes as rural. The primary agricultural sector is livestock farming. Spodnjeposavska provides the largest share of electricity production of all Slovenian regions. This is in the first place due to the only Slovenian nuclear power plant, located here.

Biogas benefits in Slovenia

According to the National Energy Action Plan, under Directive 2009/28/EC, Slovenia's target by 2020 is the share of renewable energy in total gross final energy consumption to be increased to 25%. The contribution (installed capacity, gross electricity generation) expected from biogas in Slovenia to meet the binding 2020 targets has been estimated to 61 MW or 367 GWh (32 ktoe).

Slovenia ratified the Kyoto protocol to the UNFCCC on August 2, 2002 (entered into force on 16 February 2005). The target for Slovenia is 8% reduction compared to the base year. GHG emissions inventory for 2008 showed that the CO2 emissions amounted to 21.3 million tones, which means 4.6% increase between the base year and 2008.

Biogas exploitation using 100% livestock manure available in the four target areas in Slovenia can give the following results:

Potential benefits in the target regions	**Pomurska**	**Savinjska**	**Gorenjska**	**Spodnje-posavska**
Potential emission savings ($ktCO_2/yr$)	175.0	251.5	98.7	53.7
Artificial fertilizers saving (Urea-Ammonium Nitrate) (t/yr)	5,569	3,444	1,521	1,242
Artificial fertilizers saving (Urea-Ammonium Nitrate) (€/yr)	1,610,905	996,350	440,048	359,324
Electricity production potential (in cogeneration) (GWh)	58	114	62	27
Biogas energy share in national renewable targets in 2020 (%)	1.2	2.3	1.2	0.5
Biogas energy share in national biogas target in 2020 (%)	12.2	23.9	13.0	5.7
Installed capacity (MW)	7.8	15.3	8.3	3.6
Number of biogas plants (installed capacity of 0.5 MW)	16	31	17	7
Number of new local jobs	24-148	48-291	26-158	11-69
Number of households supplied with electricity	13,445	26,285	14,279	6,269
Investment (M€)	24.5	48.1	26.1	11.4

Main results:

- Annual savings of about 579 kt CO_2 emissions or 2.72% of the country emissions in 2008.
- Contribution with 1.3% to the national renewable energy target in 2020 and with 5.2% to the national biogas target.
- Total installed capacity of about 35 MW with investment costs of M€ 110
- About 70 new small biogas plants (0.5 MW each) creating a range of 110-666 new jobs.
- Saving of about 11,776 t/yr artificial fertilizers worth of 3,406,627 €/yr.
- 60,277 households can be supplied with electricity produced from biogas.

Conclusions

The EU has set a series of demanding climate and energy targets to be met by 2020, known as the "20-20-20" targets. These are:

- a reduction in EU greenhouse gas emissions of at least 20% below 1990 levels,
- 20% of EU energy consumption to come from renewable resources,
- 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency.

According to the latest Summary EU GHG inventory report of 2010, total GHG emissions, without LULUCF (Land Use, Land-Use Change and Forestry), in the EU-27 decreased by 11.3% between 1990 and 2008 (627 million tonnes CO2-eq). Emissions decreased by 2.0% (– 99 million tonnes CO2-eq) between 2007 and 2008. Emissions in 2008 for the EU-27 were 12.3% lower than emissions of 1990. The overall greenhouse gas emissions in CO2-eq (excl. LULUCF) in 2008 amounted 4,939.7 million tones.

Renewable energy sources will play a crucial role to meet the EU binding 2020 targets and biogas is one of them. All target countries and regions have a significant GHG emission savings. According to BiogasIN assessment about 4,543.14 kt CO2 eq can be saved, which represents the 0.8% of the total GHG emissions of the BiogasIN target countries for the year 2008.

In 2009, 8.3 Mtoe of primary energy produced in the EU from biogas and 25.2 TWh of electricity (Eurobserv'er, 2010). In the 28 target regions 0.883 Mtoe of primary energy can be produced by biogas and the electricity generation from the biogas theoretical potential (using 100% livestock manure in a CHP plant) amounted to 2,389 GWh or 9.5% of the electricity generation in 2008 in the EU.

Biogas projects have high investment costs and the revenue comes mainly from the pricing tariff system for electricity production for RES. The theoretical total installed capacity was assessed about 321 MW and the investment would be about one billion Euros.

Digestate has improved fertiliser efficiency due to homogeneity and higher nutrient availability. Utilization of digestate as fertilizer can replace the use of mineral fertilizes and has at least economic and environmental dimension. In the 28 selected regions of BiogasIN establishing the best agricultural practice for manure management (Nitrate Directive) result in artificial fertilizers savings of 135,721 t/yr (Urea-Ammonium Nitrate) worth of about 39 million Euro per year.

In the case of small farm scale plants the part time employment of the farmer can give benefits and parallel new income opportunities. The implementation of biogas plants can increase direct or indirect the jobs during the all project phases and lifetime and for the needs of BiogasIN projects it was assessed that about 640 new small biogas plants (0.5 MW each) can be established in the selected areas creating a range of about 1,000 - 6,100 new jobs.

According to the German Biogas Association (Fachverband Biogas e.V.) and Eurobserv'er, the biogas sector in Germany has created about 17,000 jobs in 2010. Today, there are around 6,000 biogas facilities installed in the German countryside. Also central and Eastern European countries, with still substantial agriculture sectors, can benefit from biogas development as it contributes direct to rural income generation.

www.biogasin.org

Welcome to the BiogasIN project

BiogasIN aims to create a sustainable biogas market in Central and Eastern Europe (CEE): Bulgaria, Croatia, Czech Republic, Greece, Latvia, Romania, and Slovenia, by:

- Highlighting biogas benefits for local communities
- Streamlining permitting procedures for biogas investments
- Adjusting and creating new financing schemes for biogas investments

Expected results from the project will be increased biogas investment activities in the target countries and beyond.

Project Partners

WIP Renewable Energies (WIP), Germany

European Biogas Association (EBA), Belgium

Fraunhofer (IWES), Germany

Centre for Renewable Energy Sources and Savings (CRES), Greece

Czech Biogas Association (CzBA), Czech Republic

EKODOMA, Latvia

Energoproekt, JSC (ENPRO), Bulgaria

Razvojna agencija Sinergija, Slovenia

Trinergi Grup (TG), Romania

BIOGASIN

www.biogasin.org

Co-ordinator

Energy Institute Hrvoje Pozar
Savska cesta 163
Zagreb, Croatia
www.eihp.hr

Contact

Biljana Kulisic
bkulisic@eihp.hr
Tel: +385 1 6326 269
Fax: +385 1 6040 599

This brochure "Did you know that Biogas …?" is a deliverable (D2.7) of the BiogasIN project (Sustainable biogas market development in Central and Eastern Europe; Contract No. IEE/09/848). BiogasIN started in May 2010, runs for 30 month and is supported by the Intelligent Energy – Europe (IEE) programme.

This brochure is edited by CRES and WIP with input of and in cooperation with the BiogasIN project partners.

INTELLIGENT ENERGY EUROPE