Project: BiG>East

(EIE/07/214)

Assessment of existing biogas installations in Bulgaria, Croatia, Greece, Latvia, Romania and Slovenia

Deliverable 2.1

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1 Introduction

The production and wide-range utilisation of biogas could offer many benefits for Bulgaria, Croatia, Latvia, Romania, Slovenia and Greece. The increased utilisation of biogas could be integrated to national environmental and energy action programmes in order to reduce climate relevant methane emissions and to provide an alternative energy source. The production of biogas can also help meeting waste management plans of the target countries. Biogas production based on waste such as animal manure, sludge and other wastes should be prioritised since the sustainability and environmental benefits of these methods are unequivocal. Furthermore, biogas production has the potential to increase income of farmers and decrease the need for agricultural subsidies. The plantation of dedicated energy crops for co-digestion can strengthen rural areas, especially in Eastern Europe.

On the other side, the biogas potential in these countries is very promising, especially if organic waste is used as feedstock. Waste management is a serious problem in many Eastern European countries and the utilisation of waste as feedstock for biogas production could be an effective measure to improve waste management.

However, currently the biogas market in Southern and Eastern Europe is very small. In order to support the biogas market in Southern and Eastern Europe the BiG>East project "Biogas for Eastern Europe" (contract No. EIE/07/214) is supported by the European Commission under the Intelligent Energy for Europe Programme.

One of the best measures to promote the biogas technology among decision makers and stakeholders is to prove its technical and functional feasibility. This can be done by demonstrating best practice examples and lighthouse projects of existing biogas installations, preferably within the country. Therefore, the present report aims to give an overview about the existing and planned biogas installations in Eastern and Southern Europe. Emphasis of this overview will be on number, size and location of operating or planned biogas plants in six target countries from Eastern Europe: Bulgaria, Croatia, Greece, Latvia, Romania and Slovenia.

This state-of-the-art report will provide practical information for decision makers on European, national, and regional level to get familiar with the current situation in Bulgaria, Croatia, Greece, Latvia, Romania and Slovenia. Furthermore, it will be a source of examples for potential future investors.

2 Biogas installations in Bulgaria

2.1 Renewable Energies in Bulgaria

2.1.1 Energy sector in Bulgaria

Bulgarian primary energy supply is fairly diverse, with solid fuels holding the majority share (just over a third), oil and nuclear following, with significant contribution also by natural gas. The shares of solid fuels and nuclear energy are significantly above the corresponding EU-27 average values (18% and 14% respectively). In 2004, renewable energy supply was five times greater than in 1990 and their share is close to the EU-27 average of 5%.

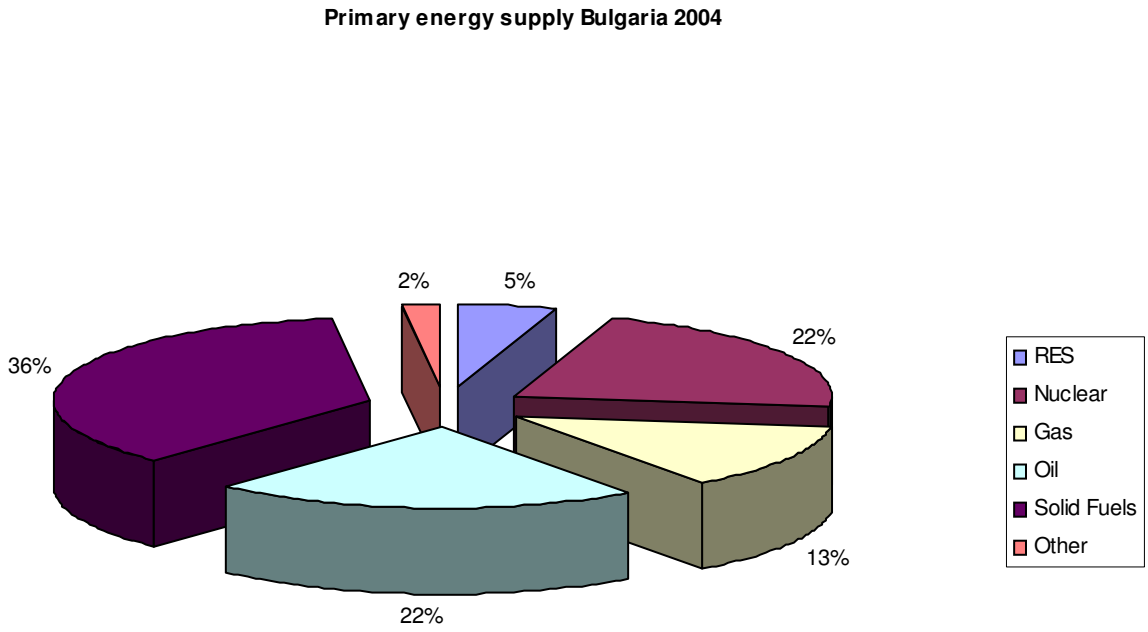

Figure 2.1 Primary energy supply, 2004. Source: National Statistical Institute

Total consumption has decreased by 33% since 1990 and this reduction is reflected mainly on the reduced supply of oil and natural gas (55% and 54% decrease respectively, since 1990).

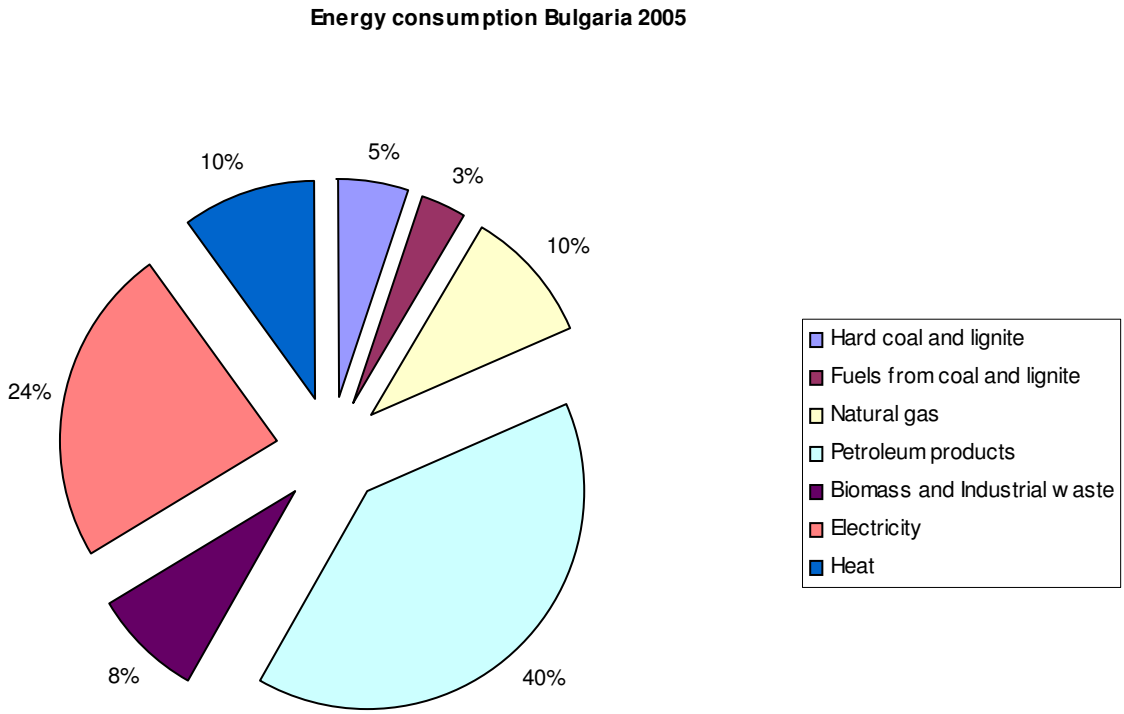

Figure 2.2 Energy consumption, 2005, Source: Statistical Yearbook 2006.

2.1.2 Electricity from renewable energy sources in Bulgaria

Bulgaria has great potential for renewable energy although it is still missing the necessary support framework and also the monopoly in the energy sector has proved to be a major obstacle to the growth of renewable energy sources (RES). Similarly, existing problems with connecting to the high-voltage network and administrative obstacles hamper the implementation of the indicative aim in the EU Accession Treaty for Bulgaria to set the 11% proportion of RES in relation to gross domestic electricity consumption.

Large-scale hydro power is currently the main source of electricity produced from renewable energy sources, but its technical and economic potential is already fully exploited (see figure 2.2). Small-scale hydro power generated a further 526 GWh. This RES displayed an average growth rate of 20 % per year between 1991 and 2004.

A total wind energy capacity of around 2 200 – 3 400 MWe could be installed. Some pilot projects have been implemented using wind power, but in absolute figures, the contribution made by wind power is minimal (2 GWh in 2004). It is planned the construction of a 100 MW onshore wind farm in Murgash peak.
Solar potential exists in the East and South of Bulgaria, and 200 MWe could be generated from geothermal sources.

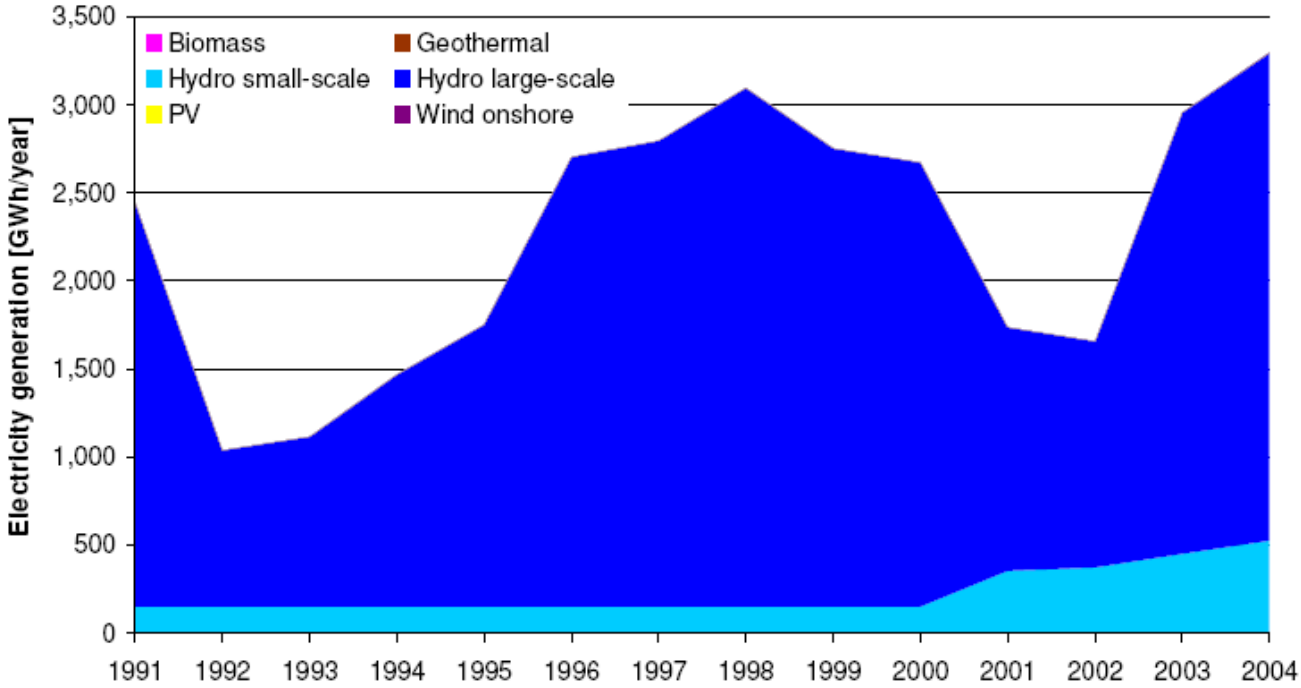

Figure 2.3 Electricity generation from renewable energy sources by type (GWh). Source: European Commission: http://ec.europa.eu/energy/res/legislation/share_res_eu_en.htm

2.1.3 Heat and cold from renewable energy sources in Bulgaria

Approximately 11% of the final energy demand in Bulgaria consists of derived heat, a share that has remained stable throughout the period 2000-2005. When including the fuels that are ultimately used for heat production, the total heat consumption is several factors higher. For example residential fuel use for heating exceeds the total final consumption of derived heat.

Biomass is the main source of heating and cooling from Renewables and exhibits an annual average growth rate of 17% over the period 1997 to 2004 (see Table 2.1). The main application is the use of firewood for space heating. In the industry biomass is used in boiler plants. Modest amounts of biomass are used for district heating and block heating. There are a few dozen of small boiler systems installed in municipal buildings (e.g hospitals and schools), in hotels and in housing blocks. Most of these boilers are in the capacity range 100-500 kWth, with a few exceptions of installations larger than 1 MWth. Most boilers were installed in the last 5 years.

In the last few years the solar thermal system and geothermal heating are more and more used in Bulgaria, too. Currently, about 60.000 m^2 of solar collectors have been installed, especially on the seaside. Geothermal power is used mainly for local heating of small villages (municipal buildings, hotels, ect.).

Table 2.1 Heating and cooling from renewable energy sources by type (GWh)

	Penetration 1997 (*ktoe*)	**Penetration 2004** (*ktoe*)	**Av. Annual growth** (%)
Biomass heat	234	709	17
Solar thermal heat	2	2	1
Geothermal heat (incl. heat pumps)	35	40	2

Source: European Commission: http://ec.europa.eu/energy/res/legislation/share_res_eu_en.htm

2.1.4 Biofuels in Bulgaria

The biofuels market in Bulgaria is just getting off the ground. Biodiesel and bioethanol are currently produced in small quantities, although a number of facilities are being constructed. Local biofuel production should reach 350.000 MT in the next years. The biofuel industry faces challenges related to Government concerns over reduced budget revenue, and a still-significant gray market in oil and distilled spirits.
Since begin of 2007 there is permission for the use of 5 % of biofuels as additives to conventional fuels in accordance with EN590 standard. After estimation (on national level), it is assessed that over of 50 % owners of conventional fuels vehicles rely on use of biofuels (see Figure 2.3). This signifies, that alternative fuels might take higher share in the future, especially if oil costs are going to rise up increasingly.

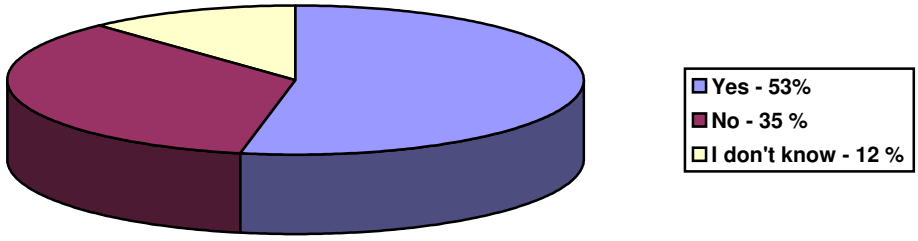

Figure 2.4 Willingness for use of biofuels from owners of conventional fuels vehicles.
Source: "SUGRE" Project, D-5.1, Training Materials for Fleet Owners:
http://www.sugre.info/docs/D5_1a_Training_Materials_for_Fleet_Owners0.doc

2.2 Current biogas status in Bulgaria

In Bulgaria there is a large potential to utilize biomass (including biogas) as an energy source. 60% of the overall land area consists of arable and agricultural lands, and approximately 30% is forest cover. At the moment there are no plants utilizing biogas from farming, yet and no refuelling stations with biogas or biogas mixture with other fuels, too. The country has the possibility to capitalize on the generation of landfill biogas (over 3 Mt of municipal solid waste per year) and other biogas sources. The biogas from landfills and from sewage water treatment plants as well as biomass gasification is applicable mainly for local industrial or energy use. Further biogas from such sources could be supplied to the methane stations for transport use in Sofia and other big towns in Bulgaria or could be fed into the natural gas grid. The greatest part from the livestock farms in Bulgaria breeds less than 10 animals. By this reason stimulation mechanism, legislative and financial supports are needed in order to encourage the farmers to produce biogas. Renewable and Alternative Energy Sources and Biofuels Act in Bulgaria was adopted in June 2007. However, there are in the act no regulations in respect to biogas yet.

2.3 Future biogas plants in Bulgaria

2.3.1 Biogas plants in construction

Biogas installation

The only biogas installation in Bulgaria (in Mesdra district) is under construction. The region is characterised with suitable infrastructure, in view of the fact, that there are available a cattle farm also an agricultural land, which will be cultivated with high-calorific maize. In the proximity exist no residential, cultural or nature areas. The owner of the installation is "Toshel-92" Ltd. The main characteristics of the plant are given in table 2.2. More detailed information is not available at this stage of the project.

Table 2.2 Main characteristics of biogas plant in Tsarevets

Name	Owner	Location	Feedstock	Biogas utilization	Utilization of digistate
Biogas Generator Toshel-92 Ltd.	AREVA TOSHEL	Tsarevets, Mesdra district	Cattle manure & maize	Electricity	Compost

Landfill gas stations

A project, which will set six regional waste disposal sites, located in Municipalities of Montana, Rousse, Pernik, Sevlievo, Silistra and Sozopol have been started in Feb. 2001 and have to be completed in Dec. 2008. Four new regional landfills (Montana, Pernik, Sevlievo and Silistra) will be located at the existing sites, whereas the new landfills for Ruse and Sozopol will be built up at new sites. Two from these landfills (in Sozopol & Montana Municipalities) will include station for purification and burning of biogas, and the landfill in Rousse Municipality will comprise a gas extraction system, which will be constructed for the abstraction of the biogas from the landfill (see Table 2.3).

Table 2.3 Landfills in construction

№	Name	Location	Feedstock	Biogas utilization
1	Montana Landfill	Montana	Municipal waste	Purification & burning of biogas
2	Ruse Landfill	Rousse	Municipal & industrial waste	-
3	Sozopol Landfill	Sozopol	Municipal waste	Purification and burning of biogas

2.3.2 Biogas projects in preparation

Biogas installation

In Dobrich district a technology park is planned, which will include small and medium family farms with biological agricultural production. The project comprises the construction of a biogas installation, fodder plant, slaughterhouse and dairy and pig farms. Some characteristics of the plant are given in Table 2.4.

Table 2.4 Biogas project in preparation

Name	Owner	Location	Feedstock	Biogas utilization
"DAB 100" Ltd	"DAB 100" Ltd.	Dobrich	Animal manure, agricultural waste	Electricity & domestic hot water

Landfill gas utilization system

In February 2008, Sofia Municipality and "Dialogue for Suhodol" Association came to agreement. Four million State funds are intended, by Investment Programme (2008-2009) - in Direction "Green System", for set up of system for utilizing of landfill gas in order to produce electrical and thermal power (CHP). In the Programme a full recultivation of the landfill and of the neighboring area, after landfill exploitation, are comprised. The planned investment for the recultivation of the landfill amounts to two million euro. The sum for full recultivation is 17.5 million euro. Picture and main characteristics of Suhodol landfill are given in Table 2.5:

Table 2.5 Suhodol landfill

Name	Owner	Location	Feedstock	Biogas utilization
 Suhodol landfill	Sofia Municipality	Sofia	Municipal waste	CHP

Sewage sludge utilization

In July 2006 Kevin Starling, the CEO of "Sofiyska Voda" AD, handed to the Sofia Mayor Boiko Borisov the three-year plan of the company. It outlines many projects to be executed, which are linked to a better work of the water and sewerage system in the Sofia Municipality and treatment of wastewaters, accorded to requirements of EU and harmonized Bulgarian law acts about the environment and waters. After an agreement with the Sofia Mayor, Director of "Sofiyska Voda" AD and European Bank for Reconstruction and Development was concluded, six million euro will be invested in a project for modernizing a wastewater treatment plant in Kubratovo, Sofia Municipality. The project includes the production of electric and thermal energy at the wastewater treatment station (see table 2.6).

Table 2.6 Waste Water Treatment Plant Kubratovo

Name	Owner	Location	Feedstock	Biogas utilization
 Kubratovo Digester Gas Plant	Sofia Municipality	Sofia	Sewage sludge	CHP

2.3.3 Map of Bulgaria with future biogas plants

Figure 2.5 Current biogas plants in construction & biogas projects in preparation

Table 2.7 Generalization of the biogas plants in construction & biogas projects in preparation in Bulgaria

Name	Location	Feedstock	Utilization of biogas	Status
Tsarevets farm	Mezdra district	Cattle manure & maize	Electricity	In construction
Dobrich farm	Dobrich district	Animal manure & agricultural waste	Electricity & domestic water	Early planning stage
Montana landfill	Montana	Municipal waste	Purification & burning of biogas	In construction
Sozopol landfill	Sozopol	Municipal waste	Purification & burning of biogas	In construction
Rousse landfill	Rousse	Municipal & industrial waste	-	In construction
Suhodol landfill	Sofia	Municipal waste	CHP	In preparation
Kubratovo WWTP*	Sofia	Sewage sludge	CHP	In preparation

Figure 2.5 Current biogas plants in construction & biogas projects in preparation

2.4 Summary Bulgaria

Interest in biogas projects in the last few years is growing in Bulgaria. However, there are no operating biogas plants yet, although the biomass potential is promising, especially if organic waste are used as feedstock. Currently two biogas projects are in preparation (Suhodol landfill and Kubratovo WWTP). One biogas project is at early planning stage (Dobrich farm). Three landfills are in process of construction and it is expected the completion to be in late 2008. Two of them will comprise a system for purification and burning of biogas. “Toshel-92” Ltd. owns an agricultural area in Mezdra district and a biogas installation is under construction in Tsarevets. There is still available a cattle farm, which manure will be utilized in the future farm in order to be produced electricity.

* WWTP = Waste Water Treatment Plant

3 Biogas installations in Croatia

3.1 Renewable Energies in Croatia

Croatia is one of the Contracting Parties in the Energy Community Treaty (Athens memorandum) by which is obliged to liberalize energy market as well as to transpose EU directives on promotion of RES-E (2001/77/EC) and biofuels (2003/30/EC). In that sense, renewable energy utilisation is described as of national interest in the Energy Act (OG 68/01, 177/04 and 76/07). The same law defines renewable energy sources and prescribes the utilisation and financial incentives for the utilisation of renewable energy sources.
In mid 2007, Croatian parliament has delivered a package of 5 sub-laws on RES electricity that provided basis for development of RES-E sector. It is consisted of support mechanisms for RES-E that are combination of feed-in tariff system with system quota obligations or minimal share of RES-E to be incentivized. In that sense, the national target for RES-E amounts 5.8% of total electricity consumption by 2010. In order to become eligible for the feed-in tariff system, one should gain a status of eligible producer.
In 2006, total installed capacities for RES electricity were 51.955 MW (excluding large hydropower plants). In the same year generated electricity was as follows: 49.13 MWh (solar), 18.96 GWh (wind), 6 GWh (biomass) and 109.57 GWh (small hydro).
Croatia is Annex B country of the Kyoto Protocol, a member of the United Nations Framework Convention on Climate Change (UNFCCC) from 1996, and of the Kyoto Protocol from 1999, which derives obligations for decreasing of green houses gasses emissions. According to the Kyoto Protocol, Croatia needs to decrease the emission of carbon dioxide (CO_2) to 0.5% by 2010 in comparison with 1990 (year with the highest emission), which would require a reduction of 4.8 t per capita.

3.2 Current biogas status in Croatia

The first biogas plant operating in Croatia is situated at Zagreb's landfill Jakuševac. "BIO MOTO" Ltd is the company responsible for management and maintenance of the biogas plant. The power plant has a 15-year agreement with national power supplier on power trade. This plant demonstrates utilization of urban biomass, with the landfill having 47 probes for collecting gasses, which originate from waste decomposition and transferring to the power plant. Gasses differ by quality and quantity but, in general, they are consisted of 50-60 percent of methane, 29-35 percent of carbon dioxide and some oxygen. The probes collect about 700 cubic meters of gasses daily. The gasses power the generator that is flexible to the quality variations of biogas. However, to reduce oscillations in biogas quality, biogas is partially processed (moisture removal) before entering the generator.

The second biogas plant that uses waste water treatment sludge as substrate started to operate in August 2007. Total installed capacity is 2x1.5 MW_{el} but the production is still in its starting phase and all energy produced is utilised for energy demand within the wastewater treatment plant.

3.2.1 Map of Croatia with existing biogas plant locations

Figure 3.1 There are two existing biogas plants in Croatia and both of them are situated in Zagreb

3.2.2 Biogas installations in Croatia

Table 3.1 Basic characteristics of biogas installations, Zagreb. Detail characteristics of the plant are given in ANNEX I

Name	Owner	Location	In operation since	Feedstock	Biogas production, Nm^3/day	Biogas utilization
 Landfill Jakuševac	"BIO-MOTO ltd"	Zagreb	2003	Municipal waste	700	Electricity
 ZOV	Zagrebačke otpadne vode ltd	Zagreb	2007	Waste water treatment sludge	n/a	Electricity

3.3 Future biogas plants in Croatia

Biogas is the least explored biomass source for energy utilization, which allows questionable information on the future development of biogas sector in Croatia.

Current legislation on RES electricity has demonstrated some difficulties in its implementation. Those difficulties are influencing biogas plants development strongly, especially in the part related to spatial planning and obtaining the location permit mandatory for registration at the RES Registry – the first step towards gaining the Eligible Producer status and benefiting from the feed-in tariff.

3.3.1 Biogas plants in construction

Apparently, there are at least three agricultural biogas plants in construction:

- Vrana d.o.o. at Vransko jezero (Biograd) with 1 MW installed capacity relying on cattle and chicken breeding by-products and green matter from fruits and vegetables growing
- Veterinarska stanica d.o.o. at Dvor na Uni with 1 MW installed capacity with chicken manure as main feedstock
- Osatina d.o.o. Semeljci (Djakovo) constructs three biogas plants next to its dairy cows and pig farms.

3.3.2 Biogas projects in preparation

One could not properly assess biogas plants in preparation since the investors are considering it as business secret. However, it is useful to mention those that are regularly covered by media:

- Perutnina Ptuj – Pipo, Čakovec is meat-processing industry with its own chicken's farms. The planned biogas plant was scheduled to open in 2007 but it failed. The planned capacity was 1 MW.
- Biogas plant in Slatina with adopted Environmental Impact Assessment Study. The project is still in the preparation phase.
- Agroproteinka is the only open type kafilery and the construction of biogas plant within its business as usual is just a matter of time.
- Žito lts, Osijek, is a pig farm with 4 080 sows and 33 000 piglets which considers biogas plant construction for years. Together with a German company, Axis, Žito has established Bio-plin ltd company.

3.4 Summary Croatia

Biogas market in Croatia is currently in its early stage with high dependence on the foreign sources (equipment, consultancy, know-how). The two existing biogas plants are established as by-activities within the core system (landfill and waste water treatment plant) and, as such, do not represent "pure" business venture examples in biogas production such as farm biogas plants. The first plant has different conditions in contract for purchasing RES electricity since it was established before the existing legislation. The second plant is providing energy within the waste water treatment plant and its economic viability does not depend on gaining the eligible producer status which is the condition for benefiting from feed-in tariff.

Both planned and in construction biogas plants are facing serious set backs of current legislation on RES-electricity. Nevertheless, the government and responsible ministry is fully aware of those set backs and the upgrading of the legislation is pending.

In the past year, biogas is frequently mentioned in media with "dazzling" statements on biogas potential, profitability and significance in energy sector coming from both scientific and commercial sector. It is reasonable to expect that either a success or failure of the first biogas plant venture will be covered by media with similar attention which will have significant impact on dynamics of biogas sector development in Croatia.

4 Biogas installations in Greece

4.1 Introduction

4.1.1 Country profile

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 peculiar geomorphology divided into the mainland with large mountainous areas and a vast number of islands reasons that affects to the development of energy infrastructure.

The main economic activities in Greece are shipping and tourism. A large portion of the population is employed in the public sector and services, 20% in industry and 12% in the industrial sector [1].

Between 1990 and 2005, the GDP in Greece increased by 45%, showing an average yearly rate of increase of 2.5%. In the same period, the increase in added value for all the sectors of economic activity was also significant. Added value in the tertiary sector increased by 136%, and added value in the industrial and agricultural sectors increased by 48% and 14% respectively. Consumption by households increased by 45% compared to the 1990 levels [1].

Electricity consumption in 2007 was estimated to reach 62.5 TWh, with an installed capacity of 12,500 MW of Public Power Corporation (PPC) S.A. -operated plants and 1,570 MW of auto-producers, conventional power and renewable energy sources generators [2].

4.1.2 Energy Sector

In Greece like in the most OECD countries, energy represents one of the most important and dynamic sectors of the economy. In the year 2006, gross electricity generation was about 60 TWh, of which 60% was from lignite (domestically extracted low-calorific value lignite of about 70 million tons), 16% from petroleum products (oil, mainly used by the power plants on the islands not connected to the mainland's system), 18.7% from natural gas (imported from Russia by pipeline and Algeria in the form of LNG), 14 % from hydroelectric power and 2.1% from wind power. Electricity generation has increased by 71% from 1990 when it was 35 TWh with an average yearly rate of increase of about 3.4%. The greatest increase was in the use of lignite, with a generation of 25 TWh in 1990 and 32 TWh in 2006 [1].

Renewable Energy Sources contributed 5.8% (1.8 Mtoe) of the Greek Total Primary Energy Supply (31.5Mtoe) in 2006. Biomass accounted 55% and covers mainly thermal needs [3]. Biogas from landfills, wastewater treatment plants and a couple of industrial applications contributed 36 ktoe mainly for electricity generation. The installed capacity of electricity generation from biogas was 24 MW, when the installed capacity of electricity generation from renewable energy sources was 3,894 MW. The gross electricity generation from biogas was 92 GWh (1.1% of RES electricity generation) [1]. The Analysis of the Installed capacity and the Electricity generation for the year 2006 and the evolution of electricity generation by fuel are shown in Table 4.1 and Figure 4.1 respectively.

Table 4.1 Analysis of Capacity and Electricity Generation for the year 2006 (MW)

Fuel	Net Capacity (MW)	Installed Capacity (MW)	Net Generation Total (GWh)	Gross Generation Total (GWh)
Wind	745	745	1,688	1,691
Biomass	24	24	92	92
Hydroelectric	3,125	3,125	6,745	6,774
Natural Gas	2,449	2,523	10,124.3	10,452.8
Oil Products	2,181	2,346	8,042	8,572
Lignite	4,808	5,288	29,165	32,501
Total	**13,331.6**	**14,051**	**55.856.3**	**60,082.8**

Source: PPC S.A, HTSO S.A, [1]

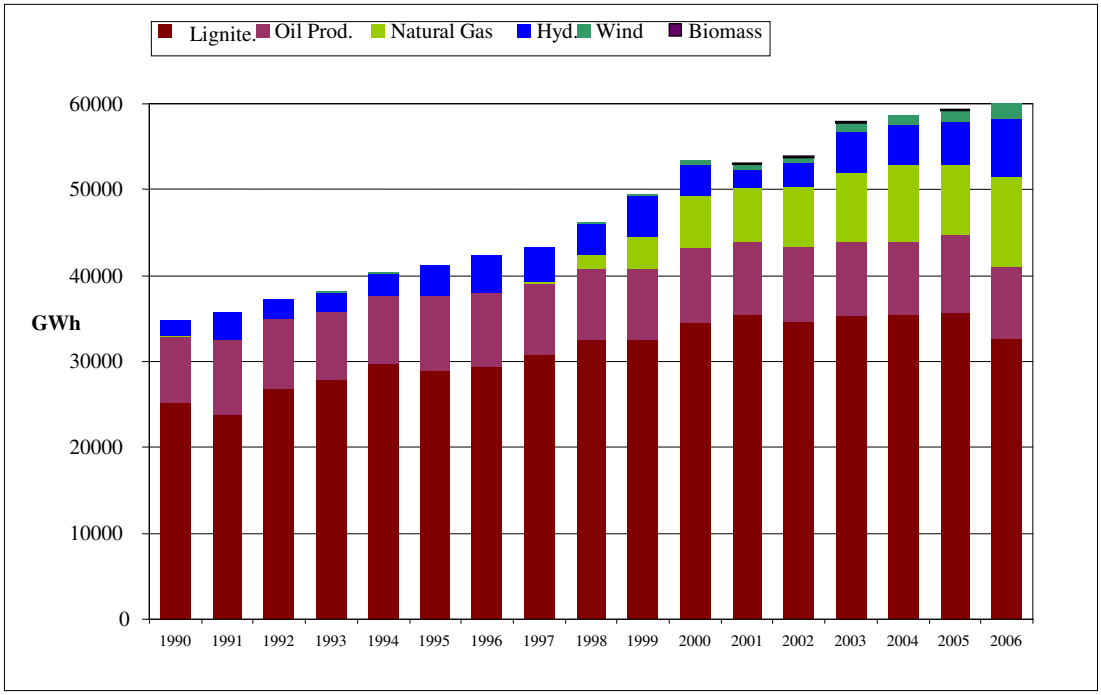

Figure 4.1 Electricity Generation by Fuel (1990-2006) Source: PPC S.A, HTSO S.A, [1]

4.2 Current biogas status in Greece

The term «biogas» hides a wide range not only in the ways in which it is valorised but also the technologies in which it is produced. Biogas can be produced using digesters or collected by the landfill sites. Currently (2007) fifteen biogas plants are in operation in Greece as it is shown in Figure 4.2 [4]. The collection of the required data was done through a countrywide field survey at biogas plants covered by CRES every year. The main characteristics of the existing plants are presented in Table 4.2. The utilization of biogas in most of these cases mainly covers heat demands of the plants. Nevertheless, the installed capacity of electricity generation from biogas was 37.4 MW and the gross electricity generation reached to 155.9 GWh [5]. The most energy was produced in the area of Athens due to the operation of the Municipal Wastewater Treatment Plant (MWTP) of Psytallia and the Sanitary landfill (SL) of Ano Liosia, which treat liquid and solid wastes respectively.

4.2.1 Map of Greece with existing biogas plants locations

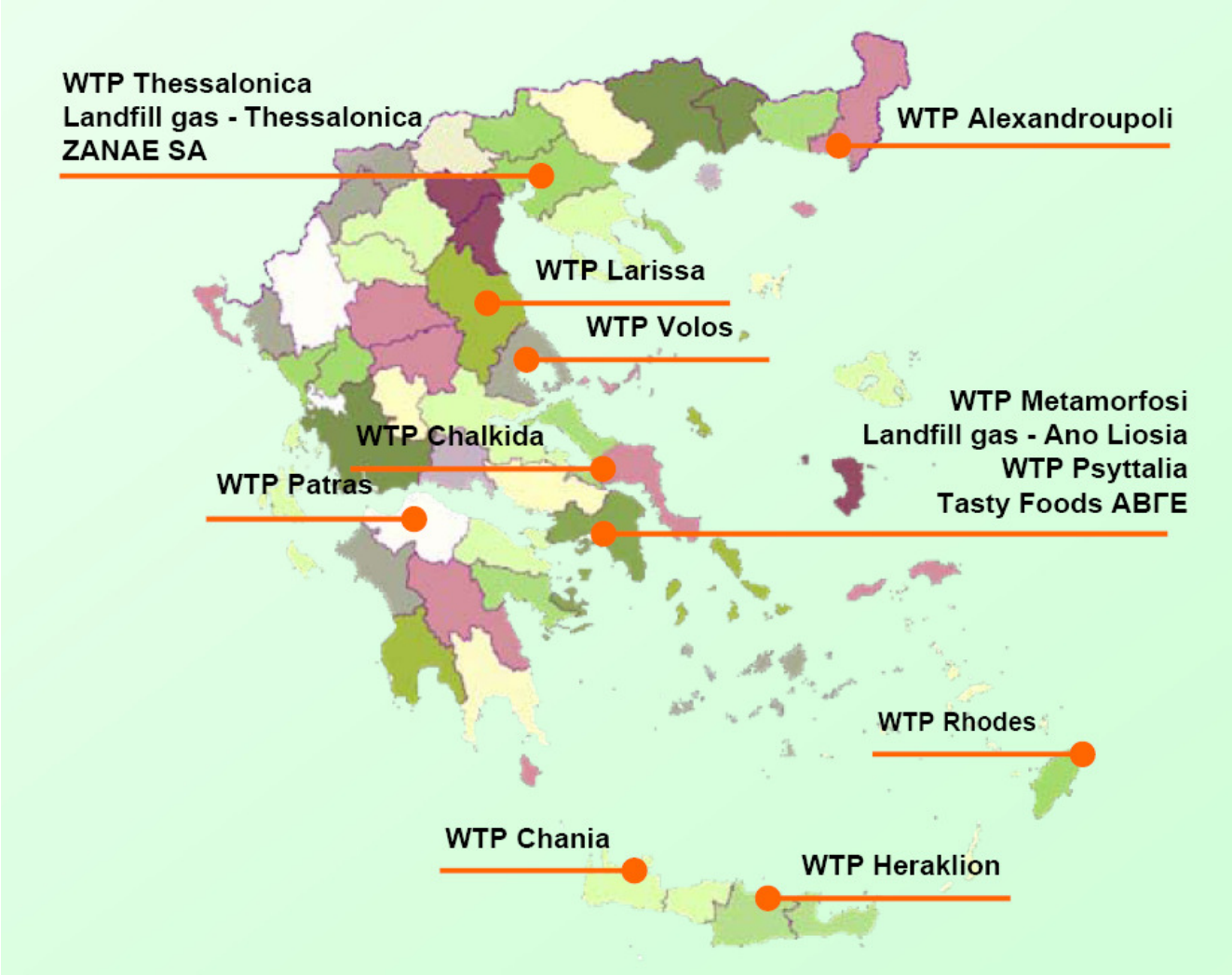

Figure 4.2 Biogas plants in Greece (in operation during 2007).

4.2.2 Biogas installations in Greece

Table 4.2 Basic characteristics of existing biogas installations (2007)

Name	Location	Feedstock type	Biogas production, Nm^3/year	Biogas utilization		Utilization of digistate
				Type	Installed capacity	
1. ZANAE SA (food industry)	Sindos plant/ Thessalonica	Effluent (liquid sewage) from the baker' s yeast factory	395,996	Building heating & part of the process heat demand of the factory	0.64MW_{th}	Fertilizer
2. TASTY FOODS A.B.Γ.E. (food industry)	Athens	Effluent from production process	91,000	Process heat	0.76MW_{th}	-
3. LANDFILL OF GREATER REGION OF THESSALONICA	Thessalonica	Municipal solid waste	665,695	Electricity	5.28MW_e	-
4. MWTP LARISSA	Larissa	Sewage sludge	350,000	Heat	0.57MW_{th}	-
5. MWTP PATRA	Patra	Sewage sludge	505,000	Heat	1.05MW_{th}	-
6. MWTP CHALKIDA	Chalkida	Sewage sludge	310,000	Heat	1.50MW_{th}	-
7. MWTP ALEXA-NROUPOLI	Alexandoupoli	Sewage sludge	300,000	Heat	0.33MW_{th}	-
8. MWTP RHODES	Rhodes island	Sewage sludge	89,925	Heat	0.35MW_{th}	-
9. MWTP HERAKLION	Crete island	Sewage sludge	1,041,514	CHP	0.193MW_e 0.53MW_{th}	-
10. MWTP CHANIA	Crete island	Sewage sludge	420,000	CHP	0.166MW_e 0.29MW_{th}	-
11. MWTP of GREATER ATHENS (Psyttalia)	Athens	Sewage sludge	20,501,000	CHP	10.35MW_e 7.14MW_{th}	-
12. LANDFILL OF GREATER ATHENS (ANO LIOSIA)	Athens	Municipal solid waste	67,612,544	Electricity	23.5MW_e	-
13. METAMORFOSI, ATHENS	Athens	Sewage sludge	1,646,500	Heat	1.63MW_{th}	-
14. MWTP VOLOS	Volos	Sewage sludge	590,000	CHP	0.353MW_e 0.7MW_{th}	-
15. MWTP THESSALONICA	Thessalonica	Sewage sludge	2,200,000	CHP	2.5MW_e 6.74MW_{th}	-

Source: CRES, 2007 (Energy Policy Division)

4.3 Future biogas plants in Greece

The development of Renewable Energy Sources has been among the major energy policy lines of Greece. It is seen as an important contribution to the improvement of the Greek environmental indicators and, in particular, to the abatement of CO_2 emissions. Legal and financial incentives are the tools of the government's strategy to support renewable energy technology investments. Furthermore, in recent year a favourable climate has been created, both in public and at the political level, for the substitution of conventional energy sources, mainly because of the environmental problems associated with their use and particularly with the greenhouse effect [6].

Biogas can be produced of nearly all kinds of organic materials. Nowadays in Europe, there are quite a few biogas process volumes at the current wastewater treatment plants, landfill gas installations, and industrial biowaste processing facilities. However, the largest volume of produced biogas will be, by 2020, originate form farm biogas and from large co-digestion biogas plants, integrated into the farming – and food – processing structures [7].

In Greece the picture is different as the produced biogas derives mainly from landfills, wastewater treatment plants and a couple of industrial applications. Although Greece has a promising potential of organic wastes and especially animal manure currently there is no farm scale biogas plant. It is worth mentioning that taking into account only the breeding animals in Greece (cattle and pigs) and based on different assumptions, several authors have estimated that the theoretical annual manure production comes up to 10-17 million tones [7,8,9,10].

Nevertheless, in the framework of the calls for permits to generate electricity by Independent Power Producers (IPPs) by the Hellenic Regulation Authority for Energy (RAE) the most applications cover landfill plants and MWTP. 37 MW is already installed, while future projects for another 12 MW from biogas plants have already received permits for power production from RAE (Table 4.3). If we take into account the announcements of the Athens Water Supply and Sewage Company (EYDAP SA) for the expansion of the biogas plant of Psytallia MWTP by 4.25 MW and two new biogas projects namely a new CHP plant in the Metamorfosi cesspool waste treatment plant and a CHP plant in the new MWTP of West Attica–Thriasio (0.19 MW), we can figure out that currently, there are some 5-6 biogas plants in Greece in different project phases. Furthermore, The Municipal Water Supply and Sewerage Company of Larissa (DEYAL) has requested a permit from RAE (October 2007) for a new biogas plant in the Sanitary Landfill of Makrychori (Parapotamos site).

4.3.1 Biogas projects in preparation

Table 4.2 Biogas projects that have received production permit from RAE [11]

Location	Permit Number	Installed capacity	Fuel
Xanthi	ΑΔ.0310	9.5 MW	Municipal solid waste
Volos	ΑΔ.805	1.72 MW	Landfill gas
Larissa	ΑΔ.0841	0.6 MW	Sewage treatment biogas

4.4 Summary Greece

During the 80's a few efforts for biogas energy exploitation applications were carried out in Greece, the feedstock for them being in principal animal excrements and wastes from food processing industries, such as oil olive mill wastes. Some of these efforts were demonstration projects that after the initial enthusiasm and insurance of scientific support were fallen into disuse. Back in late nineties (1998), there were eight operating biogas plants in Greece producing annually 20.5 million m^3 CH_4, with an energy equivalent of approximately 65TJ [9].

Currently (2007) fifteen biogas plants are in operation in Greece. The utilization of biogas in most of these cases mainly covers heat demands of the plants. Nevertheless, the installed capacity of electricity generation from biogas was 37.4 MW and the gross electricity generation from biogas was 155.9 GWh [5]. The penetration of Anaerobic Digestion schemes in Greece concerning farm scale applications (biogas exploitation form animal manure and agricultural residues) is still difficult. Currently in the framework of the calls for permits to generate electricity by Independent Power Producers (IPPs) by the Hellenic Regulation Authority for Energy (RAE) the most applications cover landfill plants and MWTP (there are some 5-6 biogas plants in Greece in different project phases).

Lignite, the main domestic fossil fuel resource of Greece, it seems that will continue to play a major role in the country's fuel mix in the future. Greek renewable development is positively affected by the country's very good resource potential and the state policy. Although the last decade, the social pressure and the economic conditions (eg. public awareness for environment protection and clean energy, gradually deregulation and liberalization of energy market, etc), the legislative framework (eg. energy and environmental policy, EU and country commitments, new law for energy matters, etc) and the financial environment have changed the picture, so that new biogas plants were constructed and operated, there are still barriers (mainly no technological) which affect to biogas exploitation and deployment in Greece (eg. public perception, experience and awareness mainly on farm scale and industrial biogas applications, lack of price for the heat production, licensing procedure, lack of "gate fees" for waste disposal, externalities like euthrophication, groundwater pollution, replacement of fossil fuels which are not assessed and monetized, etc).

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[11] Regulatory Authority for Energy (RAE), www.rae.gr

5 Biogas installations in Latvia

5.1 Renewable Energies in Latvia

There are no significant fossil fuel resources available in Latvia. Only different kind of renewable energy sources (RES) and peat are locally used. However, starting from year 2000, the peat extraction and use has rapidly decreased. Considering the existing energy situation, renewable energy sources play an important role in Latvia's primary energy balance.

The main renewable energy sources used in Latvia are biomass (mainly wood fuel) and hydro energy. Wind energy, biogas, and straw are less significant. The potential of those resources is not fully used.

According to the information obtained from the Central Statistical Bureau of Latvia, the proportion of renewable energy sources in primary energy balance was 29.1 % in 2006 (see Fig. 5.1). The main part of this (approximately 80 %) is wood fuel. Considering that available amount of hydro resources depends on meteorological conditions and water flow in rivers, the proportion of Renewables in primary energy balance is fluctuating according those factors. The share of wind and other biomass energy sources is less than 1% from all energy produced from renewable energy sources.

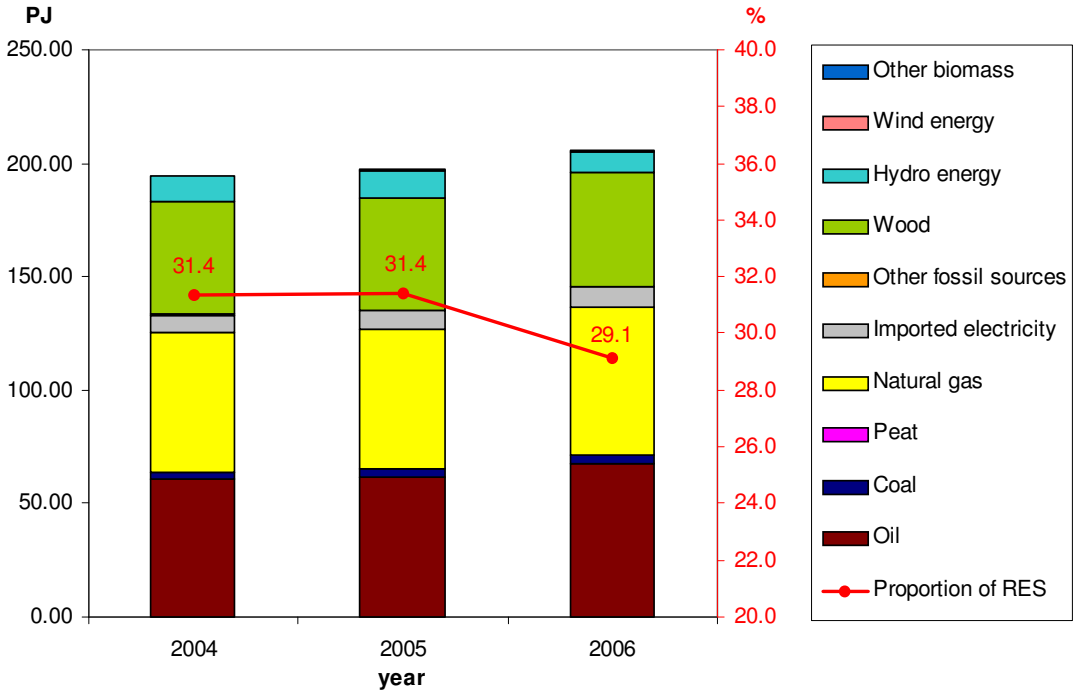


Figure 5.1 Structure of primary energy sources and proportion of Renewables in primary energy balance. Source: Central Statistical Bureau of Latvia

5.2 Current biogas status in Latvia

First investigations were done and first experimental biogas installation in Latvia were developed in 1983 when Latvia was a part of Soviet Union. At that time there was built a biogas plant with two bioreactors in swine-breeding complex "Ogre", and the biogas was used for heating and for the preparation of fodder. This biogas installation worked for several years and swine manure as feedstock was used. Installation was operated in thermophilic conditions (at temperature 54^{o}C) and has short feedstock retention time (~ 5 days).

Currently there are 3 biogas cogeneration plants in Latvia. Their total installed electricity production capacity is 7.5 MW_{el}. The cogeneration plant owned by company "Rīga Water" for biogas production uses sludge from wastewater treatment. The other two biogas cogeneration plants are installed in landfills in Rīga and Liepāja regions and use landfill gas for electricity and heat production. However, the electricity generation capacity installed in landfills is not fully used. The main reason is the shortage in biogas production amount coming from existing composition of municipal waste.

5.2.1 Map of Latvia with all existing biogas plant locations

Figure 5.2 Location of existing biogas plants in Latvia (1 - Company "Rīga Water" wastewater treatment plant "Daugavgrīva"; 2 - Municipal waste landfill "Getliņi"; 3 - Municipal waste landfill "Ķīvītes")

5.2.2 List of biogas installations in Latvia

A List of all existing biogas installations with basic characteristics of each installation is given in Table 5.1. Additional information about each biogas plant could be found in Annex II.

Table 5.1 List with basic characteristics of existing biogas installations

Name	Owner	Location	In operation since	Feedstock		Biogas production, Nm^3/day	Biogas utilization		Utilization of digistate
				Type	Input		Type	Output	
Wastewater treatment plant "Daugavgrīva"	Company "Rīga Water"	Rīga region	2004	Sludge from wastewater treatment	~70 t/day (TS=25%)	~ 11 000	CHP-plant	2.096 MW_{el}	Fertilizer
Landfill "Getliņi"	"Getliņi Eko" Ltd.	Rīga region	2002	Unsorted municipal waste	~1370 t/day	~ 50 000	CHP-plant	5.24 MW_{el}	-
Landfill "Ķīvītes"	"Liepājas RAS" Ltd.	Liepāja region	2003/2004	Unsorted municipal waste	~ 80 t/day	~ 8 800	CHP-plant	0.45 MW_{el}	-

5.3 Future biogas plants in Latvia

It is forecasted that the available biogas amount in Latvia will increase by improving the logistics and waste separation practice. Today, a number of new biogas projects are being developed and most of them are agricultural biogas projects. A map of Latvia with the locations of future planned biogas plants (marked in light blue) are given in Figure 5.3.

Figure 5.3 Location of planned biogas plants in Latvia (1 - Scholastic research farm "Vecauce" of Agricultural University of Latvia; 2 - Municipal waste landfill "Daibe"; 3 - Kalsnava distillery; 4 – Farm "Nogales")

5.3.1 Biogas plants in construction

Currently in Latvia only one biogas plant is in construction phase. This is the first agricultural biogas plant in Latvia. The plant is located at scholastic research farm "Vecauce" owned by Agricultural University of Latvia. Some basic characteristics of constructed biogas plant are summarized below (see Table 5.2):

Table 5.2 Basic characteristics of biogas plant in farm "Vecauce"

Biogas plant in farm "Vecauce"	
Farm size	~ 1000 cattle (incl. 400 dairy cows)
Land area	1804 ha
Feedstock	Manure + crops (grass and maize silage)
Planned biogas production amount	1.3 million m^3/year
Use of biogas	CHP-plant
Heat consumers	Settlement located nearby
Heat for self-consumption	~30%

The "Vecauce" biogas plant is intended to be a demonstration project for future agricultural biogas plant developers. Construction works are almost completed, however, there are some technical problems due to the lack of experience, lack of knowledge and insufficient collaboration with an experts on field.

5.3.2 Biogas projects in preparation

There are a number of Biogas projects in preparation phase:

- Biogas in Landfill "Daibe" – Owner "ZAAO Enerģija", Ltd (see Table 5.3).

Table 5.3 Landfill "Daibe

Landfill gas collection in Landfill "Daibe"	
Feedstock	Unsorted municipal waste
Planned biogas production amount	1.2 million m^3/year
Use of landfill gas	CHP-plant
Electrical capacity	160 kW_{el}
Current status of project development	Technical project – almost completed Approval procedures – in process
Future plans	In future could be installed two more engines with the same capacity Biogas could be used as vehicle fuel for company's tracks

- Kalsnava distillery – Owner "Lako", Ltd. (see Table 5.4).

Table 5.4 Kalsnava distillery

Biogas production on Kalsnava distillery	
Feedstock	Distillery solubles
Use of landfill gas	CHP-plant
Electrical capacity	4-4.5 MW_{el}
Current status of project development	Technical project – in process Approval procedures – in process Searching for partners in construction works

- Farm "Nogales"

Table 5.5 Farm "Nogales"

Biogas plant in farm "Nogales"	
Farm size	~ 300 cattle
Land area	10 ha
Land area that could be use for crop growing	30 – 50 ha
Feedstock	Manure + crops (grass and maize silage)
Planned biogas production amount	2 million m^3/year
Use of biogas	CHP-plant
Electrical capacity	4 MW_{el}
Current status of project development	Preliminary calculations – very rough Technical project – not started Electricity connection establishment procedure – in process

Currently, in Latvia, there are also some projects in a level of conception:

- Biogas plant in farm "Vidzemes putniņi" (farm size ~600 cattle, manure as feedstock could be used. Evaluated biogas production amount 600 000 m^3/year);
- Biogas plant in swine-breeding farm "Miķelāni" (manure as feedstock could be used. Evaluated biogas production is 2.5 million m^3/year);
- Biogas plant in "Alejas Group", Ltd. wood drying utility;
- Biogas plant in farm "Jaundzelves" (feedstock – manure and residues from food processing companies);
- Biogas plant somewhere in Daugavpils region (different kind of feedstock is available, resulting in biogas production amount of 3.2 millions m^3/year);
- Other

5.4 Summary Latvia

At the moment, there are only three biogas plants with cogeneration units in operation. One plant uses sludge from wastewater and two plants are installed on landfill sites. Their total installed capacity is 7.5 MW_{el}. There are no agricultural biogas plants in Latvia. However, improvements in biogas related legislative framework and in availability of financial resources, recently has increased a number of biogas projects being under construction or in preparation stage.

The current situation for agricultural biogas projects in Latvia is very promising. One agricultural biogas project (intended as demonstration project) is already under construction and some are in a preparation stage. The development of agricultural biogas projects in Latvia will largely depend on the success of this demonstration project. However, project developers should be aware to start the preparation of detailed feasibility studies and technical projects as soon as possible, in order to be ready for receiving available funding when the call for proposals will open.

6 Biogas installations in Romania

6.1 Renewable Energies in Romania

Romania has a territory of 237.500 square kilometres and has a population of 22.246.862 inhabitants (June 2008).

With an electricity consumption of 58.49 TWh (2007), Romania has a net excedent of electricity production, based on a huge hydropower system counting for almost 40 % of the total produced energy. This makes Romania one of the net electricity exporters in the Balkan region.

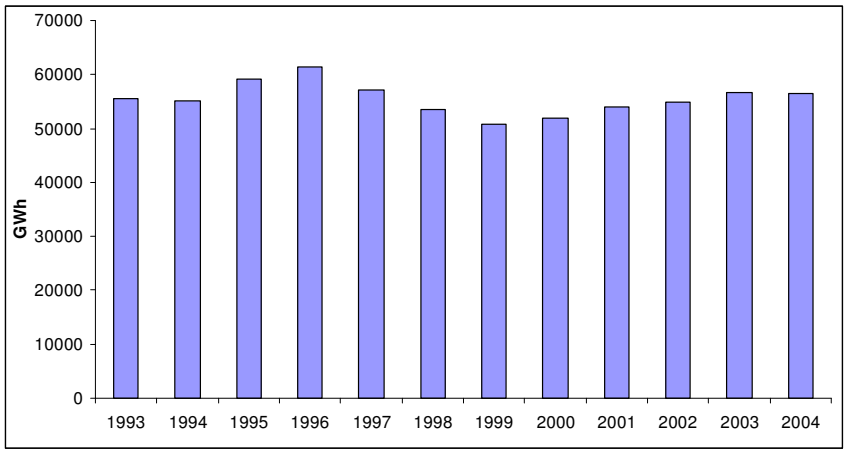


Figure 6.1 Dynamics of the energy generation in Romania

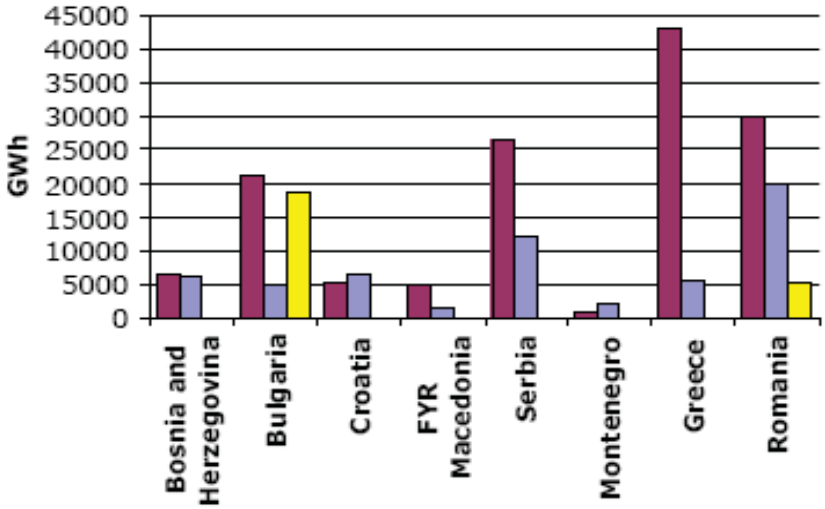


Figure 6.2 Comparative distribution of main sources of energy generation in the region

Especially due to the high investment rate (prior to 1990 in Romania) in the hydro-electrical power generation (especially large facilities), Romania follows a constant pattern of renewable energy production. No significant investments in other forms of renewable energy (biomass, wind and solar) were made after 1989. It is expected that the figures describing percentual quota of renewable

energy production in Romania to change dramatically if large hydro power plants will be excluded from the statistics.

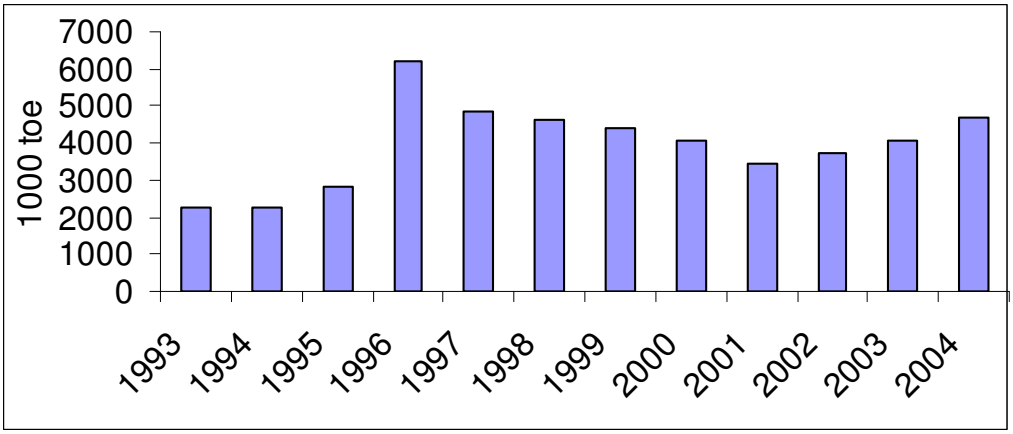


Figure 6.3 Dynamics of renewable energy production in Romania

6.2 Current biogas status in Romania

During the past six decades, Romania developed a large biogas promotion project that was designed to cover the essential steps from research stage to pilot plants and implementation to large scale. The project focused on two main directions:

1. Large capacities coupled with water treatment plants;
2. Development of facilities for use in the farming sector (including small units).

The follow up of the national plan for biogas has passed the next steps (1958-1982):

1. Research for the identification of methanogenic bacteria for animal and household waste.
2. Research for obtaining biogas from organic mud.
3. Biogas industrial type facilities developed at wastewater treatment plans. Usual capacity 2,000 m^3/day
4. Almost all major cities have been implemented the developed technology. The total biogas production capacity from this sector was estimated at 85,000 m^3/day (30 million m^3/year).
5. Pilot facilities for animal waste with a capacity of 30 m^3/day
6. Pilot semi industrial capacity for biogas production from pig farms with a capacity of 580 m^3/day
7. Development of small capacities (households) for biogas production. Capacity 5-10 m^3 but also 20, 30, 40 and 50 m^3/day.
8. Anaerobic digestion of biodegradable wastes from pig farms. Typical capacities were around 7,000-8,000 m^3/day

The results of the 30 year program was the development of a total of 400 facilities, with a total energy production of 0.18 TWh/year.

The main drawback of this project was the fact that the owner was the State, through the state owned companies. After the fall of the regime in 1989, a long process of reorganisation,

privatisation and liquidation of those companies occurred, having as result a gradual depreciation and disassemblement of the biogas facilities. Virtually, no plant from the 400 developed still existed in 2008.

6.2.1 Map of Romania with existing biogas plant locations

Timid efforts for promotion of biogas were done by NGO's, private company and State Agency starting with 2006. At the moment, no more than 2 plants, both with a pilot type status exist in Romania.

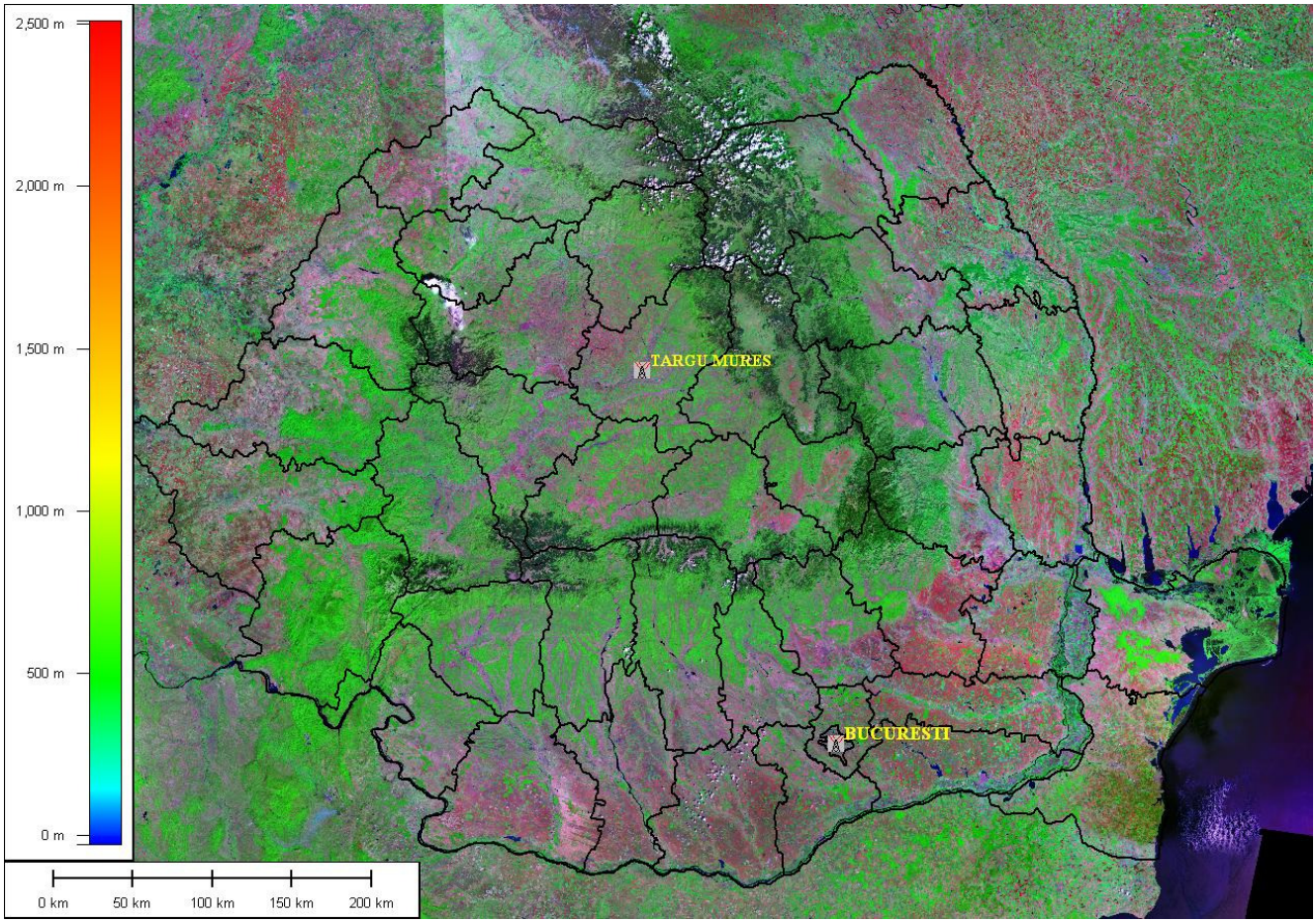


Figure 6.4 6.2.1 Map of Romania with the two existing biogas plant locations

6.2.2 List of biogas installations in Romania

Table 6.1 List with basic characteristics of existing biogas installations. Additional information about each biogas plant can be found in Annex III.

Name	Owner	Location	In operation since	Feedstock		Process temp. °C	Biogas prod. Nm^3/day	Biogas utilization		Digistate utilization
				Type	Input tonnes/day			Type	Output	
Tg. Mures WWTP	Municipality of Tg. Mures city	Tg. Mures	2001	Sludge from the waste water treatment plant	10	34-36		Heat power	711KW_t 455KW_e	waste
Bucuresti	ISPCAIA	Bucuresti	1980	Animal manure	2	35	800			

6.3 Future biogas plants in Romania

In Romania, currently no biogas plants is constructed (June 2008). There is also no biogas projects in preparation at the moment. However, the show-cases developed by Mangus in the framework of the BiG>East project are very promising opportunities for the implementation of future biogas plants in Romania.

6.4 Summary Romania

The research in Romanian biogas sector started 60 years ago. During this period Romania developed a large biogas promotion project that was designed to cover the essential steps from research stage to pilot plants and implementation to large scale. Nevertheless, no plant from the 400 developed exists anymore in 2008.
Some efforts for the promotion of biogas were done by NGO's, private company and State Agency after 2006. At the moment no more than two plants exist in Romania. No biogas plants are in construction or preparation till June 2008.

Reference

Vasile Nikolic, 2005, Producerea si utilizarea biogazului, Chiminform Data

7 Biogas installations in Slovenia

7.1 Renewable Energies in Slovenia

The Primary Energy Consumption of Slovenia was in 2005 307 PJ or 85.000 GWh and 90% of energy came from fossil fuels and nuclear sources. Share of RES was 7%.

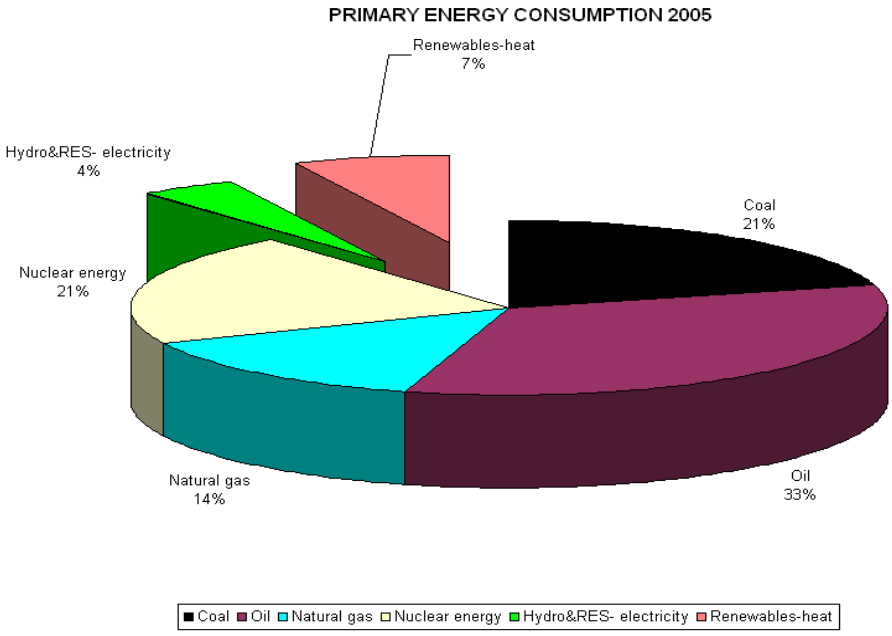


Figure 7.1 Primary energy consumption, Slovenia 2005

According to the National Energy Programme Slovenia plans to:

- Increase RES in primary energy balance 9% -> 12% by 2010;
- Increase RES in heat supply 22% -> 25% by 2010;
- Increase electricity produced with RES from 32 % in 2002 ->33,6 %;
- Increase biofuels in transport to 5,75 % by 2010.

Biogas from agriculture was not exploited before 2006 since there were only few biogas power plants in operation, three of them on farms. Total installed capacity in 2008 is/will be around 5 MW_e. Contribution of these plants can not be measured yet since many of them started operating in the middle of 2007 and some of them are not yet fully in operation.

On the long term (2020-2030) we expect that total capacity will be around 20-40 MW. However, our Ministry does not share the same opinion. In National Energy Program from 2004 they had foreseen only 2 MW of installed capacity until 2020. Their forecast and electricity produced from all RES can be seen in the picture below (see figure 7.2).

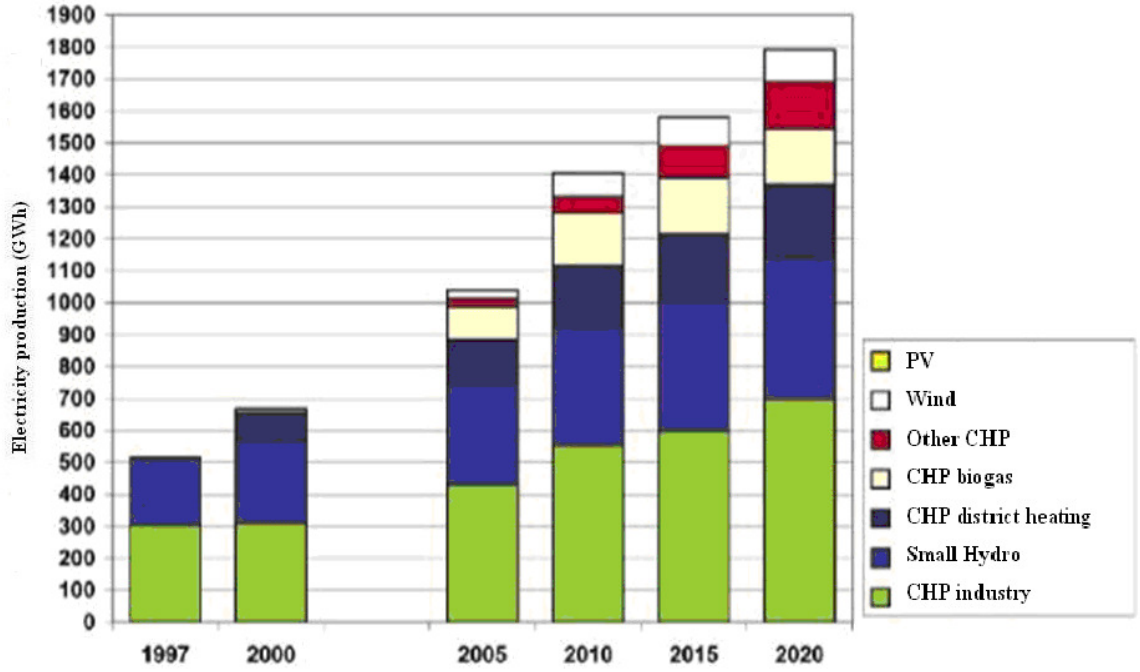


Figure 7.2 Electricity production (GWh), Slovenia 2005. Source: National energy program 2004

The electricity production with all RES producing electricity is supported trough the feed-in tariff system. This system is foreseen for independent qualified producers1 from which distribution companies2 have to buy electricity on fixed prices electricity from qualified producers of electricity (Official Gazette RS, no. 25/02) and with Decree on prices and premiums for purchase of electricity from qualified producers (Official Gazette RS, no. 75/06). Uniform annual prices for the purchase of electricity from qualified producers and uniform annual premiums (when independent qualified producer sells at uniform annual premium he get paid a sum of adequate premium and market price, which is not necessary higher as uniform annual price) for electricity that the producers are selling individually to the end consumer or via distributor are shown in the table below.

Table 7.1 Uniform annual prices and premiums for selling electricity produced in biogas power plants

Type of QPP regarding the primary energy source	Power capacity	Uniform annual price (cent€/kWh)	Uniform annual (cent€/kWh)
Other QPP3		12,09	8,33
QPP or heating plant using communal waste4	Up to 1 MW inclusive From 1 MW up to 10 MW inclusive	5,32 4,95	1,56 1,20

Source: Official Gazette of RS, No. 75/06.

Uniform annual prices and uniform annual premiums do not include VAT. It is foreseen that the prices will be changed once a year with government decree, taking into account the inflation and

1 Independent qualified producer is a producer which in single object of production produces electrical energy with above average exploitation of cogeneration of heat and power or if he in economically and environmentally adequate way exploits wastes or RES.
2 Prices of electricity sold to the industrial consumers are set in individuals contracts with them and are market oriented. Prices for household and small consumers are set fixed and set from the government.
3 Power plant using as input other kind of RES, which is not fossil or nuclear. **QPP using biogas from animal waste belong to this group.**
4 QPP and heating plant using communal waste include also QPP using biogas and QPP using gas from communal purifying plant

other relevant factors. Uniform annual price and premium is valid for 10 years, however it is decreased by 5% after 5 years of operation and for additional 5% after 10 years of operation.

7.2 Current biogas status in Slovenia

7.2.1 Map of Slovenia with all existing biogas plant locations

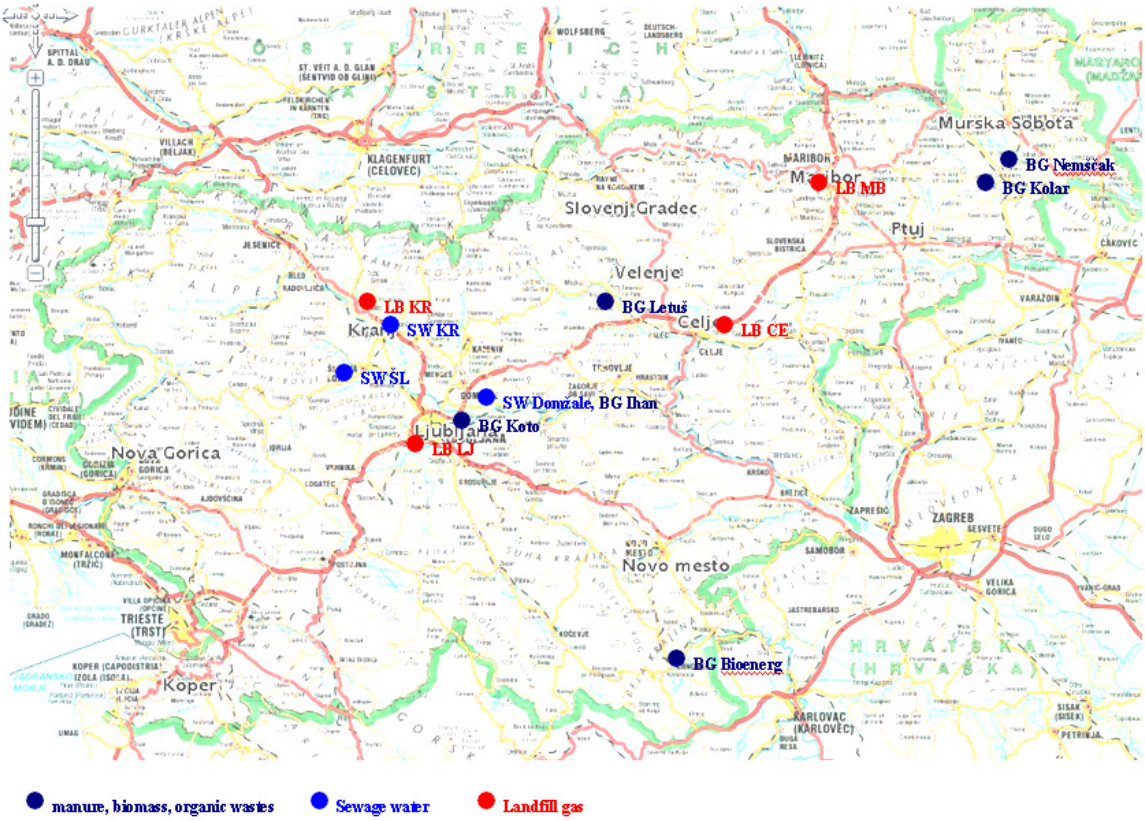


Figure 7.3 Existing biogas plant locationsin Slovenia

7.2.2 List of biogas installations in Slovenia

Table 7.2 Basic characteristics of existing biogas installations

Name/Sign	Location	Feedstock	Biogas utilization		Total power
			Type	Output	
BG Ihan	Farm Ihan	manure, sludge	electrical power	526 kWe	
					526 kWe
BG Bioenerg	Bioenerg	organic waste	electrical power	1.460 kWe	
BG Koto	Koto d.d.	organic waste	electrical power	526 kWe	
					1.986 kWe
BG Kolar	Farm Kolar	manure, corn silage	electrical power	835 kWe	
BG Letuš	Farm Letuš	manure, corn silage	electrical power	124 kWe	
BG Nemščak	Farm Nemščak (Panvita)	manure, corn silage	electrical power	825 kWe + 625 kWe	
					2.409 kWe
SW ŠL	Škofja Loka	sewage water	electrical power	120 kWe	
SW Domžale	Domžale –Kamnik	sewage water	electrical power	250 kWe	
SW KR	Kranj	sewage water	electrical power	150 kWe	
					520 kWe
LG LJ	Barje in Ljubljana	landfill gas	electrical power	2.248 kWe	
LG MB	Maribor - Pobrežje	landfill gas	electrical power	625 kWe	
LG CE	Bukovžlak (near Celje)	landfill gas	electrical power	469 kWe	
LB KR	Tenetiše (near Kranj)	landfill gas	electrical power	469 kWe	
					3.811 kWe
					9.252 kWe

7.3 Future biogas plants in Slovenia

7.3.1 Biogas plants in construction or preparation

Table 7.3 Basic characteristics of planned installations

Location	Feedstock	Biogas utilization		Total power
		Type	Output	
Farm Cvek	manure, corn silage,…	electrical power	2.100 *kWe*	
Ptuj	manure, corn silage,…	electrical power	1.460 *kWe*	
Domžale	manure, corn silage,…	electrical power	1.000 *kWe*	
Ilirska Bistrica	manure, corn silage,…	electrical power	1.100 *kWe*	
Arja vas	manure, corn silage,…	electrical power	1.400 *kWe*	
Pivka	manure, corn silage,…	electrical power	1.400 *kWe*	
Mlajtinci	manure, corn silage,…	electrical power	2.100 *kWe*	
Gea	manure, corn silage,…	electrical power	342 *kWe*	
Motvarjevi	manure, corn silage,…		835 *kWe*	
				11.737 kWe
Velenje	landfill gas	electrical power	150 *kWe*	
Nova Gorica	landfill gas	electrical power	625 *kWe*	
				775 kWe
				12.512 kWe

7.4 Summary Slovenia

Exploiting biogas from agriculture and also from landfill gas and wastewater treatment plants is rather new approach in Slovenia. First installations were on two bigger farms and the interest has increased after the feed-in law was introduced in 2002. Since then the biogas use is promoted by higher price of the produced electricity. Mainly the bigger farms and their investors saw an opportunity for building a biogas plants and the result is that they are planning larger plants, 1 MWe and above. Also almost all potential biogas plants that are currently in preparation or in construction phase are larger than 1 MWe.

However, last year we were faced (like the whole EU) with high increase of the agricultural prices, especially for maize. Many of the new or potential biogas plant depend on the input from the market and the economy has changed. This is problem mostly from bigger plants.

8 Conclusion

The present report clearly shows that currently the biogas market in Bulgaria, Croatia, Latvia, Romania, Slovenia and Greece is very low.

Bulgaria has excellent natural conditions for development of the agricultural and forestry sector. The favourable climate for the production of different crops and the existence of agricultural lands and animal farms contribute towards well-development agriculture and animal husbandry. This provides an opportunity for development of biomass potential for the production of biofuels and biogas, providing that the necessary stimulation mechanisms are laid down in legislation. Despite of interest in biogas projects is growing in the last few years there are no operating biogas plants in Bulgaria, yet. Howeverm, interest in biogas projects in the last few years is growing in Bulgaria. Currently, one biogas plant is under construction and seven are in the planning phase, most of them are landfill sites.

The biogas market in Croatia is in its early stage with high dependence on foreign sources such as equipment, consultancy and know-how. In Croatia, the first two biogas plants were already installed and a few are currently planned and constructed. However, due to set backs of current legislation on RES-electricity, most biogas projects were rather challenging.

The biogas market in Greece is slightly more developed. Currently, there are 15 biogas plants in operation in Greece. The produced biogas mainly comes from agro-industrial effluents, sewage sludge and MSW landfills. Furthermore, there are some 5-6 biogas plants in Greece in different project phases and most applications cover landfill plants and MWTP.

Due to the available biomass resources, the biogas potential of Latvia is very promising, but at the moment, there are only three biogas plants for waste material with cogeneration units in operation. There are no agricultural biogas plants existing in Latvia. However, the current situation for agricultural biogas projects in Latvia is very promising. One agricultural biogas project (intended as demonstration project) is already under construction and some are in a preparation stage.

The situation in Romania is different since it has a track of biogas research and production since many years. Research in the biogas sector in Romania started more than 50 years ago. In late 1970's, the first industrial biogas plant was implemented. In the late 1980's many small and large-scale biogas plants were in operation, but after 1990, interest and investment decreased dramatically. Today, the number of large pig and cattle biogas units is decreased significantly and only very few projects have been developed and implemented after 1990. No plant from the 400 developed exists anymore in 2008. Some efforts for the promotion of biogas were done by NGO's, private company and State Agency after 2006. No biogas plants are in construction or preparation till June 2008.

Exploiting biogas from agriculture and also from landfill gas and wastewater treatment plants is rather new approach in Slovenia. First installations were implemented. Also almost all potential biogas plants that are currently in preparation or in construction phase are larger than 1 MWe. However, last year, Slovenia was faced (like the whole EU) with high increases of agricultural prices, especially for maize. Many of the new or potential biogas plant depend on the input from the market and the economy has changed. This is problem mostly from bigger plants.

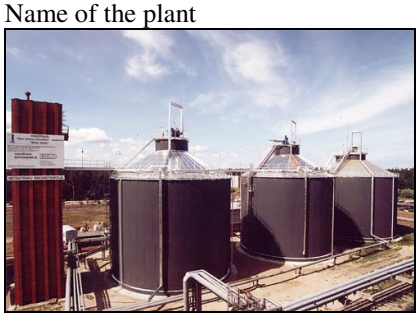
In conclusion it must be summarised, that the development of new biogas projects, especially agricultural biogas plants and waste treatment biogas plants, in Bulgaria, Croatia, Latvia, Romania, Slovenia and Greece will largely depend on legislation and policies on the one hand, and on the other hand on the success of the demonstration projects.

ANNEX I – Existing Biogas installations, Croatia

№1	Characteristic, Unit	*Data/Value*
	GENERAL	
1	Name of the plant	**Bio Moto Ltd.** 
2	Location of the plant /Region, Town or Village/	Landfill Jakuševac, Zagreb
3	Operator	HROTE: Croatian energy market operator
4	Contractor	Bio Moto ltd
5	Operation start-up /Date of Commissioning/, *year*	2003
	TECHNICAL CHARACTERISTICS	
6	Biogas production /Actual value/, *Nm^3/day*	700
7	Raw Material /Type of digestion substrates, feedstock/	Municipal waste
8	**Utilization of biogas:** Pure methane for import to the national grid; Thermal power; Electrical power; CHP-plant/gas boiler	Electric power
9	**Output /Net value/:** *Nm^3/hour or* *kW_{th};* *kW_{el};* */CHP/, kW_{el} and kW_{th}*	Installed capacity 2 MW
10	**Output /Gross value/:** *Nm^3/hour or* *kW_{th};* *kW_{el};* */CHP/, kW_{el} and kW_{th}*	6 GWh_{el}
	ECONOMIC CHARACTERISTICS	
11	Investment costs /Total Capital Requirement/, *EUR*	3.8 m € (in 2003)
	ENVIRONMENTAL CHARACTERISTICS	
12	Utilization of digistate (E.g. fertilizer, compost, incineration)	n/a
13	Land Used, m^2/production unit (*m^2/Nm^3 Methane/hour, m^2/kW_{el}, m^2/kW_{th}*)	n/a
14	Average transport distance, *km*	n/a
	COMMENTS & DETAILS	
15	Any additional information, considered useful or interesting	

№2	Characteristic, Unit	*Data/Value*
	GENERAL	
1	Name of the plant	**Zagrebačke otpadne vode ltd.** 
2	Location of the plant /Region, Town or Village/	Zagreb
3	Operator	none
4	Contractor	Zagrebačke otpadne vode ltd
5	Operation start-up /Date of Commissioning/, *year*	August, 2007
	TECHNICAL CHARACTERISTICS	
6	Biogas production /Actual value/, *Nm^3/day*	n/a
7	Raw Material /Type of digestion substrates, feedstock/	Waste water treatment sludge
8	**Utilization of biogas:** Pure methane for import to the national grid; Thermal power; Electrical power; CHP-plant/gas boiler	Electric and thermal power
9	**Output /Net value/:** *Nm^3/hour or* *kW_{th};* *kW_{el};* */CHP/, kW_{el} and kW_{th}*	Installed capacity 2x1.5 MW_{el}
10	**Output /Gross value/:** *Nm^3/hour or* *kW_{th};* *kW_{el};* */CHP/, kW_{el} and kW_{th}*	n/a
	ECONOMIC CHARACTERISTICS	
11	Investment costs /Total Capital Requirement/, *EUR*	n/a
	ENVIRONMENTAL CHARACTERISTICS	
12	Utilization of digistate (E.g. fertilizer, compost, incineration)	n/a
13	Land Used, m^2/production unit (*m^2/Nm^3 Methane/hour, m^2/kW_{el}, m^2/kW_{th}*)	n/a
14	Average transport distance, *km*	n/a
	COMMENTS & DETAILS	
15	Any additional information, considered useful or interesting	The first and only modern waste water treatment plant in Croatia.

ANNEX II – Existing Biogas installations, Latvia

№1	Characteristic, Unit	*Data/Value*
	GENERAL	
1	Name of the plant  *Picture from: www.rw.lv (Riga Water, Ltd.)*	**Wastewater treatment plant "Daugavgrīva"**
2	**Location of the plant /Region, Town or Village/**	Dzintara str. 60, Rīga, Rīga region, Latvia
3	Operator	Rīga Water, Ltd.
4	Contractor	
5	Operation start-up /Date of Commissioning/, *year*	2004
	TECHNICAL CHARACTERISTICS	
6	Biogas production /Actual value/, *Nm^3/day*	~ 11 000
7	Digester's Structure /Steel; Concrete; Orientation/	Vertical
8	Digesters Number	3
9	Raw Material /Type of digestion substrates, feedstock/	Sludge from wastewater treatment
10	Input, /Actual value/, *t/day*	~ 70 (TS = 25%)
11	**Utilization of biogas:** Pure methane for import to the national grid; Thermal power; Electrical power; CHP-plant/gas boiler	CHP-plant
12	**Output /Net value/:** *Nm^3/hour or* *kW_{th};* *kW_{el};* */CHP/, kW_{el} and kW_{th}*	2.096 MW_{el}
	ECONOMIC CHARACTERISTICS	
13	Investment costs /Total Capital Requirement/, *EUR*	
14	Operational costs, *EUR/year*	
	ENVIRONMENTAL CHARACTERISTICS	
15	Utilization of digistate (E.g. fertilizer, compost, incineration)	Fertilizer
16	Land Used, m^2/production unit (*m^2/Nm^3 Methane/hour, m^2/kW_{el}, m^2/kW_{th}*)	
17	Average transport distance, *km*	
	COMMENTS & DETAILS	
18	Any additional information, considered useful or interesting	425 m^3 of biogas are annually used for self-consumption

№2	Characteristic, Unit	*Data/Value*
	GENERAL	
1	Name of the plant    *Pictures from: www.getlini.lv (Getliņi Eko, Ltd.) and Ekodoma, Ltd.*	**Landfill "Getliņi"**
2	Location of the plant /Region, Town or Village/	"Getliņi", Salaspils, Rīga region, Latvia
3	Operator	Getliņi Eko, Ltd.
4	Contractor	
5	Operation start-up /Date of Commissioning/, *year*	2004
	TECHNICAL CHARACTERISTICS	
6	Biogas production /Actual value/, *Nm^3/day*	~ 50 000
7	Raw Material /Type of digestion substrates, feedstock/	Unsorted municipal waste
8	Input, /Actual value/, *t/day*	~ 1370
9	**Utilization of biogas:** Pure methane for import to the national grid; Thermal power; Electrical power; CHP-plant/gas boiler	CHP-plant
10	**Output /Net value/:** *Nm^3/hour or* *kW_{th};* *kW_{el};* */CHP/, kW_{el} and kW_{th}*	5.24 MW_{el} 1.36 MW_{th}
	ECONOMIC CHARACTERISTICS	
11	Investment costs /Total Capital Requirement/, *EUR*	25.21 mil.USD (in prices of 1999)
12	Operational costs, *EUR/year*	
	ENVIRONMENTAL CHARACTERISTICS	
13	Utilization of digistate (E.g. fertilizer, compost, incineration)	
14	Land Used, m^2/production unit (*m^2/Nm^3 Methane/hour, m^2/kW_{el}, m^2/kW_{th}*)	
15	Average transport distance, *km*	
	COMMENTS & DETAILS	
16	Any additional information, considered useful or interesting	Investment costs are calculated for whole landfill development project, including construction of landfill gas collection system. From installed 5 CHP engines 3-4 are operating together. Each engine requires biogas input of 524 m^3/h. The methane content of produced biogas is between 50-55%. About 10% of biogas is used for self-consumption. In winter season only 30% of heat is used for heating. The left of heat is not used. In future it is planned to develop waste separation plant where heat could be used for drying.

№3	Characteristic, Unit	*Data/Value*
	GENERAL	
1	Name of the plant  *Picture from: www.liepajasras.lv (Liepājas RAS, Ltd.)*	**Landfill "Ķīvītes"**
2	Location of the plant /Region, Town or Village/	"Ķīvītes", Grobiņa parish, Liepāja region, Latvia
3	Operator	Liepājas RAS, Ltd.
4	Contractor	
5	Operation start-up /Date of Commissioning/, *year*	2003/2004
	TECHNICAL CHARACTERISTICS	
6	Biogas production /Actual value/, *Nm^3/day*	~ 8 800
7	Raw Material /Type of digestion substrates, feedstock/	Unsorted municipal waste
8	Input, /Actual value/, *t/day*	~ 80
9	**Utilization of biogas:** Pure methane for import to the national grid; Thermal power; Electrical power; CHP-plant/gas boiler	CHP-plant
10	**Output /Net value/:** *Nm^3/hour or* *kW_{th};* *kW_{el};* */CHP/, kW_{el} and kW_{th}*	0.45 MW_{el} 7.364 MW_{th} (incl. torch capacity)
	ECONOMIC CHARACTERISTICS	
11	Investment costs /Total Capital Requirement/, *EUR*	14.437 mil.EUR (in prices of 2001)
12	Operational costs, *EUR/year*	
	ENVIRONMENTAL CHARACTERISTICS	
13	Utilization of digistate (E.g. fertilizer, compost, incineration)	
14	Land Used, m^2/production unit (*m^2/Nm^3 Methane/hour, m^2/kW_{el}, m^2/kW_{th}*)	
15	Average transport distance, *km*	
	COMMENTS & DETAILS	
16	Any additional information, considered useful or interesting	Investment costs are calculated for whole landfill development project, including construction of landfill gas collection system. In future when amount of available landfill gas will grow, it is planned to increase electricity production capacity up to 1 MW_{el}.

ANNEX III - Existing Biogas installations, Romania

№1	Characteristic, Unit	*Data/Value*
	GENERAL	
1	**Name of the plant**	**Tirgu Mures Waste Water Treatment Plant**
2	Location of the plant /Region, Town or Village/	Tirgu Mures, Waste Water
3	Operator	RA AQUASERV public utility company Tirgu Mures
4	Contractor	GEVEKE MOTOREN BV. Equipment Supplier; RAPID PROIECT SRL Tirgu Mures. Subcontractor of the Consultant.
5	Operation start-up /Date of Commissioning/, year	October 1997-May 2001 construction duration 3,5 years
	TECHNICAL CHARACTERISTICS	
6	**Biogas production /Actual value/**, Nm^3/day	
7	Digesters Number	2
8	**Digester's volume /Capacity/,** m^3	4000
9	**Process temperature**, °C	34-36
10	**Raw Material** /Type of digestion substrates, feedstock/	Sludge from the waste water treatment plant
11	**Input, /Actual value/**, t/day	
12	Input, /Design value/, t/day	
13	Input, /Animal manure/, %	
14	**Utilization of biogas** - Pure methane for import to the national grid; - Thermal power; - Electrical power; - CHP-plant/gas boiler	Thermal power/Electric power
15	**Output /Net value/** - Methane for import to the national grid, Nm^3/hour or - Thermal power; kW_{th}; - Electrical power, kW_{el}; - Electrical and Thermal power /CHP/, kW_{el} and kW_{th}	None; $711KW_{th}$ $455Kw_{el}$
	ECONOMIC CHARACTERISTICS	
16	Investment costs /Total Capital Requirement/, EUR	1,062 m €
17	Operational costs, EUR/year	n/a
	ENVIRONMENTAL CHARACTERISTICS	
18	**Utilization of digistate** (E.g. fertilizer, compost, incineration)	n/a
19	Land Used, m^2/production unit (m^2/Nm^3 Methane/hour, m^2/kW_{el}, m^2/kW_{th})	
20	Average transport distance, km	0
	COMMENTS & DETAILS	
21	Any additional information, considered useful or interesting	The installation was made possible due to non reimbursement financial support by the Dutch government. The name of the project was "Dutch Drinking Water and Wastewater Project" and it was implemented over a period of almost 4 years. The main objectives of the projects were: To reduce the energy consumption at the Drinking Water Treatment Plant (DWTP) and Wastewater Treatment Plant (WWTP) by reducing the power consumption and by using the biogas resulted from the sludge digestion to generate electrical and thermal energy at the WWTP, respectively. This installation is the first one build in Romania after 1990. Prior to the 1990 a significant number of biogas installations were in use in many localities all over Romania. Three types (based on the total volume of produced biogas) have been most used: I) small: 5-10 m3; II) medium: 25-50m3; III) large: between 100 and up to 2000m3. The information available for this facilities is scarce (1)

I) Small Units

	Characteristic, Unit	*Data/Value*
	TECHNICAL CHARACTERISTICS	
1	**Biogas production /Actual value/**, Nm^3/day	1,6-3,2
2	Biogas production /Design Value/, Nm^3/day	
3	Digester's Structure /Steel; Concrete; Orientation/	Concrete
4	Digesters Number	1
5	**Digester's volume /Capacity/,** m^3	5-10
6	**Process temperature**, °C	Cryophilic
7	**Raw Material** /Type of digestion substrates, feedstock/	Animal manure
8	**Input, /Actual value/**, t/day	
9	**Utilization of biogas** - Pure methane for import to the national grid; - Thermal power; - Electrical power; - CHP-plant/gas boiler	13,16 - 26,33 GJ/year thermal
10	**Output /Net value/** - Methane for import to the national grid, Nm^3/hour or - Thermal power; kW_{th}; - Electrical power, kW_{el}; - Electrical and Thermal power /CHP/, kW_{el} and kW_{th}	
	ECONOMIC CHARACTERISTICS	
11	Investment costs /Total Capital Requirement/, EUR	n/a
12	Operational costs, EUR/year	n/a
	ENVIRONMENTAL CHARACTERISTICS	
13	**Utilization of digistate** (E.g. fertilizer, compost, incineration)	
14	Land Used, m^2/production unit (m^2/Nm^3 Methane/hour, m^2/kW_{el}, m^2/kW_{th})	
15	Average transport distance, km	0
	COMMENTS & DETAILS	
16	Any additional information, considered useful or interesting	

II) Medium units 25-50 m^3

	Characteristic, Unit	*Data/Value*
	TECHNICAL CHARACTERISTICS	
1	**Biogas production /Actual value/**, Nm^3/day	23,7-47,4
2	Biogas production /Design Value/, Nm^3/day	30-60
3	Digester's Structure /Steel; Concrete; Orientation/	Concrete
4	Digesters Number	
5	**Digester's volume /Capacity/,** m^3	25-50
6	**Process temperature**, °C	Mezofil
7	**Raw Material** /Type of digestion substrates, feedstock/	Animal manure
8	**Input, /Actual value/**, t/day	
9	**Utilization of biogas** - Pure methane for import to the national grid; - Thermal power; - Electrical power; - CHP-plant/gas boiler	Thermal power
10	**Output /Net value/** - Methane for import to the national grid, Nm^3/hour or - Thermal power; kW_{th}; - Electrical power, kW_{el}; - Electrical and Thermal power /CHP/, kW_{el} and kW_{th}	
11	Output /Gross value/ - Methane for import to the national grid, Nm^3/hour or - Thermal power; kW_{th}; - Electrical power, kW_{el}; - Electrical and Thermal power /CHP/, kW_{el} and kW_{th}	182,8-365,7 Gj/year
	ECONOMIC CHARACTERISTICS	
12	Investment costs /Total Capital Requirement/, EUR	n/a
13	Operational costs, EUR/year	n/a
	ENVIRONMENTAL CHARACTERISTICS	
14	**Utilization of digistate** (E.g. fertilizer, compost, incineration)	
15	Land Used, m^2/production unit (m^2/Nm^3 Methane/hour, m^2/kW_{el}, m^2/kW_{th})	
16	Average transport distance, km	0
	COMMENTS & DETAILS	
17	Any additional information, considered useful or interesting	

III) Large units between 100 and up to 2000m^3

	Characteristic, Unit	*Data/Value*
	GENERAL	
1	**Name of the plant**	
2	Location of the plant /Region, Town or Village/	Bucuresti/ Institute for studies, design and construction in agriculture (ISPCAIA)
3	Operator	ISPSCAIA
4	Contractor	
5	Operation start-up /Date of Commissioning/, year	n/a
	TECHNICAL CHARACTERISTICS	
6	**Biogas production /Actual value/**, Nm^3/day	
7	Biogas production /Design Value/, Nm^3/day	800
8	Digester's Structure /Steel; Concrete; Orientation/	Concrete/
9	Digesters Number	2
10	**Digester's volume /Capacity/,** m^3	750
11	**Process temperature**, °C	35
12	**Raw Material** /Type of digestion substrates, feedstock/	Animal manure
15	**Input, /Actual value/**, t/day	
13	**Utilization of biogas** - Pure methane for import to the national grid; - Thermal power; - Electrical power; - CHP-plant/gas boiler	Thermal power
14	**Output /Net value/** - Methane for import to the national grid, Nm^3/hour or - Thermal power; kW$_{th}$; - Electrical power, kW$_{el}$; - Electrical and Thermal power /CHP/, kW$_{el}$ and kW$_{th}$	
	ECONOMIC CHARACTERISTICS	
15	Investment costs /Total Capital Requirement/, EUR	n/a
16	Operational costs, EUR/year	n/a
	ENVIRONMENTAL CHARACTERISTICS	
17	**Utilization of digistate** (E.g. fertilizer, compost, incineration)	
18	Land Used, m^2/production unit (m^2/Nm^3 Methane/hour, m^2/kW$_{el}$, m^2/kW$_{th}$)	
19	Average transport distance, km	0
	COMMENTS & DETAILS	
20	Any additional information, considered useful or interesting	