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Biogas a secure and sustainable energy source: Obstacles and perspectives of biogas projects in Hellas

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Abstract

The paper will give an overview about the biogas status in Hellas and will attempt to illustrate the main non technological barriers that a biogas project may face during the design, development and implementation phase. The aim is to assist all the involved parties in understandings which are today the most important barriers and how they can affect the whole lifetime of a biogas project. In parallel this work can become a useful tool and help the policy makers and biogas market actors on coordinated initiatives in order to reduce, eliminate or even remove at least the most crucial of these barriers. Although the new legislative and financial framework has been improved in parallel with renewable development which is positively affected by country's very good resource potential, state policy and social conditions, there are still barriers toward wider biogas exploitation and especially for small farm scale biogas plants implementation. Such barriers are the stakeholders and public perception, awareness and experience in such schemes, the investment costs and the revenues (eg. lack of price for heat or "gate fees", externalities, development of compost market), the time consuming licensing procedure and broader institutional and regulatory issues.

Keywords: biogas barriers, socio-economic aspects, sustainability

1. Introduction

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 [1].

Renewable Energy Sources contributed 5.0% (1.68MToe) of the Greek Total Primary Energy Supply (33.5MToe) in 2007. Biomass accounted 67% and covers mainly thermal needs [2]. In 2007 about 5.9Mtoe of biogas were produced for energy uses in the European Union, nevertheless, the potential is estimated at more than 20 Mtoe. In

Hellas at the same year the Primary Energy Production of Biogas was 47.8Ktoe (the landfill gas represents 38Ktoe and sewage sludge covers 9.8Ktoe). In terms of final Energy the electricity production had a total of 175.3GWh [3]. In 2008 the installed capacity of electricity generation from biogas-biomass was 39.4MW (40.8MW during August 2009). At the same year (2008) the gross electricity generation from biogas-biomass was 176.7GWh [4].

2. 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 of nearly all kinds of organic material. 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 from farm biogas and from large co-digestion biogas plants, integrated into the farming – and food – processing structures [5].

In Hellas the picture is different as the produced biogas derives mainly from landfills, wastewater treatment plants and a couple of industrial applications. During 80's some efforts were carried out, which were abandoned after the initial operational phase. In 2007 fifteen biogas plants were in operation⁸⁷. The collection of the required data was done through a country wide field survey at biogas plants covered by CRES every year. The utilisation 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 [4]. 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.

Feedstock for Anaerobic Digestion plants can be derived mainly from three major categories (sources of wastes):

- Municipal waste (eg. landfill gas and wastewater treatment plants)
- Industrial waste (eg. dairy industries, food/beverage industries, slaughterhouses)
- Agricultural waste & energy crops (eg. cattle-pig-poultry manure, energy crops, agricultural residues).

According to the Agricultural - Livestock Survey of 2006:

- The livestock was dominated by sheeps and goats (119,355 holdings with 9,031,645 heads and 123,348 holdings with 4,986,423 heads respectively). There were also 23,437 holdings with 684,057 heads of Cattle and 34,721 holdings with 1,055,057 heads of Pigs.
- There were 1,273 holdings in Central Macedonia with more than 50 Cattle and in Thessaly there were 735 holdings with more than 50 Cattle. At the same time there were 238 holdings and 127 holdings with more than 100 pigs in Thessaly and in Western Hellas respectively.

Generally, promising areas of biogas exploitation in Hellas can be considered the following:

- Crete island,
- Lakonia,
- Evia island,

- Aitolokarnania,
- Preveza,
- Thessaly
- Central Macedonia.

According to estimates made by CRES, and based on a conservative scenario, it is estimated that the AD of manure and organic wastes from the slaughter houses and milk factories could feed CHP plants of total installed capacity of 350 MW and a mean annual electricity production equal to 1.121.389 MWh [6]. It is worth mentioning that taking into account only the breeding animals in Hellas (cattle and pigs) and based on different assumptions, several authors have estimated that the theoretical annual manure production comes up to 10-17 million tones⁸⁸.

3. Biogas Policy

There is no specific biogas policy in Hellas. The development of biogas projects and biogas exploitation falls mainly under the provisions of the general RES legislation and fiscal measurements and the country environmental and agricultural policy for waste management.

In November 1997, the European Commission published a White Paper entitled «Energy for the future: renewable sources of energy». The paper sets an ambitious goal of doubling from 6 to 12% the share of renewable energies in the total energy demand (20.1% for Hellas). Biomass should produce more than 80% of the total RES additional contribution by 2010. Agriculture is expected to produce more than 50% of the additional Renewable Energies to be implemented by 2010, through energy crops and use of residues and the Biogas (livestock, sewage treatment, landfills) target for 2010 is 15Mtoe. Thus, important efforts particularly concentrated on farmers have to be undertaken in order to realise this objective because the farmers'

⁸⁷ Nielsen J. and P. Oleskowicz-Popiel (2007): The future of Biogas in Europe: Visions and Targets until 2020, European Biogas Workshop The Future of Biogas in Europe – III, Esbjerg, Denmark.

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⁸⁷ CRES Energy Policy and Planning Division Database.

decision to become involved in biomass is essential.

According to the Greek Ministry of Development estimations reflected to its national reports regarding the penetration level of RES the installed capacity required for 2010 in order for the target to be achieved, is presented in Table 1 [7]. For biomass, the installation requirements to meet these targets are 103 MW (0.81TWh or 1.13% of RES share in 2010).

Table1: RES installation requirements to meet the 2010 target.

	Requirements in installed capacity by 2010, in MW	Energy generated in 2010 in Twh	Percentage share of every renewable energy source in 2010
Wind parks	3,648	7.67	10.67
Small-scale hydro	364	1.09	1.52
Large-scale hydro	3,325	4.58	6.37
Biomass	103	0.81	1.13
Geothermal	12	0.10	0.14
Photovoltaics	200	0.20	0.28
Total	7,652	14.45	20.10

Source: Ministry of Development

According to article 1 of the Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport «This Directive aims at promoting the use of biofuels or other renewable fuels to replace diesel or petrol for transport purposes in each Member State, with a view to contributing to objectives such as meeting climate change commitments, environmentally friendly security of supply and promoting renewable energy sources». The Directive sets indicative targets for biofuels and other renewable fuels share of 2% until 31-12-2005 and 5.75% until 2010. These targets are based on the basis of energy content, of all petrol and diesel for transport purposes. The Directive was adopted in the Greek legislation by the Law 3423/2005. It is estimated that the biodiesel and bioethanol required satisfying the needs of Hellas according to the principles set in Directive 2003/30/EC, for the year 2010 is approximately 148,000t and 390,000t respectively [8].

The EU's climate and energy policy sets the following ambitious targets for 2020:

- greenhouse gas emissions reduction from developed countries by 30% and it has already committed to cut its own emissions by at least 20% compared to 1990 level.
- a mandatory target of a 20% share of energy from renewable sources in overall Community energy consumption by 2020 and a

mandatory 10% minimum target to be achieved by all Member States for the share of biofuels in transport petrol and diesel consumption by 2020, to be introduced in a cost-effective way.

- cutting energy consumption by 20% by improving energy efficiency.

The national overall target for the share of energy from renewable sources in gross final consumption of energy in 2020 has been set to 18% (Annex 1 of Directive 2009/28/EC).

In parallel, The 2nd National Programme for Climate Change was developed and adopted in 2003 (Ministerial Council Act 5/27-2-2003) with an aim to establish a set of policies and measures to reduce greenhouse gas emissions. The aim of the Programme was for Hellas to fulfill its national obligations under the Kyoto Protocol during the commitment period 2008-2012 (that is to limit the increase of greenhouse gas emissions to 25% during that period compared to base year emissions).

The main actions foreseen by the 2nd National Programme were:

- Further penetration of Natural Gas (NG) in all energy demand sectors and electricity generation, including combined heat and power generation (CHP).
- Promotion of Renewable Energy Sources for electricity and heat production
- Energy saving in industry and the residential – tertiary sector.

Policies used to promote renewable energy development are described also in the revised Greek National Programme for Climate Change, which estimates realistic CO₂ savings of 4.5 Mt CO₂-eq from the increased use of Renewables [9]. Based on the Law 2741/1999 the Special Spatial Plan for RES was prepared by the Ministry of Environment not only to stress the priority of RES but also to show the priority for sustainable development (JMD 49828/2008, OG2464/B/08). The Plan establishes guidelines and rules for the siting of RES plants and gives directions to the other planning levels such as regional or local level. Furthermore, it has special provisions and references to the RES categories like wind parks or hydropower plants. For biogas plants the most suitable sites are considered those located near to the «feedstock» production and availability. The Plan excludes some areas and land uses and gives some general criteria but doesn't recommend specific sites for biogas exploitation (eg. like in wind parks).

Currently, among others, there are two main state financial-support instruments that provide substantial public subsidies to RES investment projects:

- The so-called «National Development Law» (Law 3299/2004 as was modified by law 3522/2006, Article 37, Official Gazette 276 A', December 22, 2006)
- The Greek Operational Programme for Competitiveness, one of the eleven (11) National and the thirteen (13) Regional Operational Programmes, in which the Third Community Support Framework (CSF III; 2000-2006) for Hellas is divided (the Operational Programme “Competitiveness & Entrepreneurship” is scheduled to continue for the period 2007-2013).

The new law for RES (Law 3468/2006, «Generation of Electricity using Renewable Energy Sources and high-Efficiency Cogeneration of Electricity and Heat and Miscellaneous Provisions», OG 129/A/06 as it was modified by Law 3734/2009 «Promotion of cogeneration of two or more useful forms of energy and miscellaneous other provisions», OG 8/A/09) is dedicated to the promotion of RES and in order to speed up the licensing procedures and to reform the electric energy production from renewable energy sources. The law sets the new environment in the electricity generation, the guaranteed market price is increased and the market time expands from 10 to 20 years. Furthermore, the licensing deadlines are being reduced. The new pricing tariff system for electricity production from RES and CHP systems set a tariff of 73€/MWh (€80.14/MWh for the year 2008) for the most of RES.

The impact and effects of the implementation of these policies are not yet visible especially in biogas project implementation.

4. Barriers to biogas projects

Renewable Energy Sources (RES) seems to have an essential and important contribution to the Greek Energy System the years to come. In parallel the last decade a favorable climate has been created for the substitution of the conventional energy sources (fossil fuels) as they contribute to the greenhouse effect and their use is associated with a series of environmental problems. Thus, RES becomes more and more important in the State Energy agenda.

The implementation of biogas projects demands careful planning, taking into consideration technical, social (information of all involved

parties) environmental and financial factors. Some times is difficult to develop a biogas project due to the variation of the sites characteristics and feedstock availability. But in most of the cases the non technological barriers are referred as the most crucial for the project development.

Although social pressure, economic conditions and legislation improved the framework for biogas production, there are still barriers to overcome in Hellas, especially for the materialization of small scale biogas plants. Among the main barriers one can identify the stakeholders and public perception, awareness and experience in such schemes, the investment costs and the revenues (eg. lack of price for heat or “gate fees”, externalities, development of compost market), the time consuming licensing procedure and broader institutional and regulatory issues.

- **Awareness:** Nowadays there is still lack of knowledge and adequate information not only to the farmers but also to the industries (owners) and the general public about the possible energy exploitation of wastes, their final uses (eg. electricity, heat, injection to the natural gas grid, transport fuel) and benefits.
- **Costs and revenues:** Biogas projects still need high investment costs. Taking into consideration that project financing remains a major concern and the revenue comes mainly from the new pricing tariff system for electricity production for RES these type of projects have high payback period.
- **Market issues:** Although there is a mature “Energy Market” in Hellas the development of a full liberalized electricity market suffered a delay.
- **Institutional & Regulatory issues:** The new RES law (law 3648/2006) sets a new reality in the electricity generation, and among others, simplifies the licensing procedures. Despite this, the regulatory and institutional framework for the promotion of biogas must further be improved taking into consideration the needs for environmental protection and the promotion of energy exploitation and efficiency (eg. Kyoto Protocol, EU Directives like 2001/77/EC, 2009/28/EC, 2003/87/EC, 96/61/EC).

5. Initiatives to support Biogas

5.1 Market roadmap

Besides the technical or other form of barriers it is even more important to identify barriers related to market and dealing among others with financial and administrative issues. The proposed actions

to overcome such barriers comprising the market roadmap for the promotion of biogas projects are described in the following paragraphs:

- **Feedstock availability:** Agricultural and animal wastes are a matter of special concerns due to the high potential and their spatial distribution almost all over the country. In some cases there is still lack of knowledge about the technical potential of wastes in a certain area and their biogas exploitation alternative. Parameters like stable supply of raw material and feedstock composition are fundamental for the biological process and biogas production. The seasonal production of some wastes like agro-industrial residues (eg. citrus processing industries, or olive oil mill residues) is crucial for the successful implementation of a biogas scheme and needs very careful examination. In such cases long-term contracts between biogas plant operators and feedstock suppliers must be guaranteed and the use of different wastes (eg. agro-industrial waste with animal manure) is necessary (Co-fermentation with other raw material).
- **Energy Market issues:** Apart to the need of Full Liberalization of the Electricity Market, elimination of end users barriers is needed (eg. development of heat market, biogas use as a transportation fuel, injection to the natural gas grid, compost etc).
- **Costs and revenues:** Biogas projects still need high investment costs. Taking also into consideration that a) project financing remains a major concern, b) the revenue comes mainly from the new pricing tariff system for electricity production for RES, c) externalities are not assessed and monetized, d) there is no "gate fees" in Hellas, e) the «polluter pays» principle is not efficiently applied, further improvement of the financial and economical instruments for the support of RES and especially biogas project are needed (eg. examination of differentiation of public funds, introduction of tradable green certificates, higher electricity price according to the form of Biomass). This will attract new biogas projects.

5.2 Policy roadmap

- **Commitment:** in political level a stronger commitment concerning the exploitation of biogas as a sustainable energy and environmental choice is needed. This commitment will affect the other levels too (eg. regulatory, institutional, administrative, financing etc).

- **Awareness, Public acceptance and participation:** Public Awareness in all levels is needed accompanying by stakeholders training and support. Furthermore, a biogas plant must be adapted to the particular regions and must be accepted from neighbors and the general public. Thus apart from its economical and technological viability a biogas plant must have also "environmental and social compatibility" based on thorough examination of the project and public awareness and participation.
- **Legislative framework for biogas:** Although the new RES law (law 3648/2006) sets a new reality in the electricity generation, and among others, simplifies the licensing procedures, the regulatory and institutional framework for the promotion of biogas must further be improved (eg. further administrative simplification and coherence, specific legislation concerning biogas, one-stop-shop process).
- **Energy price:** Although the new pricing tariff system for electricity production from RES and CHP systems set a tariff of 73€/MWh (€80.14/MWh for the year 2008) for biogas plants the electricity prices are rather low. A higher electricity price must be examined based on the form of Biomass (there is no differentiation according to biomass form).
- **Strategic Biogas Plan:** The penetration of Anaerobic Digestion schemes in Hellas concerning farm scale applications (biogas exploitation from animal manure and agricultural residues) is not still mature. A Strategic biogas Plan must be incorporated within the National and Regional Energy and Environmental Policy. The Agricultural Policy (Ministry of Agricultural Development and Food), Environmental Protection (Ministry of Environment) and Energy Investments (Ministry of Competitiveness) concerning biogas exploitation should be further coordinated.

6. Conclusions

Lignite, the domestic fossil fuel country resource seems that will dominate in the future fuel mix, but further RES penetration is a necessity and a milestone. Biogas is an energy carrier which can be used for several energy applications (eg. electricity generation, heat production, combine heat and power production, transport fuel, injection to the natural gas grid). Biogas exploitation can contribute to the energy, agricultural and environmental policy.

Apart from its energy content Anaerobic Digestion can play an effective waste management method, providing a natural high quality fertilizer and environmental protection (reduces emissions of particulate matter and NO_x & contributes to GHG mitigation).

The use of agricultural material such as manure, slurry and other animal and organic waste for biogas production has, in view of the high greenhouse gas emission saving potential, significant environmental advantages in terms of heat and power production and its use as biofuel. Biogas installations can, as a result of their decentralised nature and the regional investment structure, contribute significantly to sustainable development in rural areas and offer farmers new income opportunities [10].

The European Parliament resolution of 12 March 2008 on sustainable agriculture and biogas: a need for review of EU legislation (2007/2107(INI)) stresses among others that producing agrofuels from waste should not become a goal in itself; reducing waste should continue to be a priority in the environmental policy of the European Union and in that of Member States and Emphasises that biogas production based on animal manure, sludge and animal and organic waste should be

prioritised as the sustainability and environmental benefits of these methods are unequivocal.

In Hellas it is estimated that Anaerobic Digestion of pig manure (35% of the total breeding animals in 2010 and 50% of the total breeding animals in 2015 respectively) can reduce greenhouse gas emissions by 60,000t CO₂-eq in 2010 and 83,000t CO₂-eq in 2015 [9].

It is worth mentioning that in the framework of the calls for permits to generate electricity by Independent Power Producers (IPPs) by the Hellenic Regulation Authority for Energy (RAE), five applications for such permits (biogas plants) were submitted during 2008-09 for agricultural and industrial biogas projects (installed capacity of approx. 9.5MW).

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