Farmers Guide to Implementing a Biogas Project

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Content

1 Introduction

Biogas plants hold a process of anaerobic digestion to efficiently produce biogas. Biodegradable materials like manure from pig and dairy production or crop residues being in anaerobic conditions decompose into less complex substances. The resulting product of this decomposition, which is done by several types of microorganisms, is biogas. Biogas is a mixture of different gases being methane for the most part, which is as well the desirable gas for electricity and heat production due to its high calorific content. Another outcome of the process is the so called digestate. Digestate is the stabilized residue of the digested materials, which can be used as high-quality fertilizer.

The biogas production is a complex process involving not only technical aspects, but others such as planning, legal requirements all the way to biogas utilization and "public relations" to ensure that the biogas plant will not only be fulfilling all the legal criteria and being profitable, but also that it will be of an added value not only for the farmer, but as well for the surrounding region.

There are many aspects of biogas production which are the same across Europe, not depending on the location of the plant. However there are as well many country specific requirements and experiences. Those will be supplementing the step-by-step approach for the general information in the following chapters.

2 Project planning

The planning process for the construction of a biogas plant is complex and time consuming. This is due to the wide range of issues which need to be taken into account. Biogas plants planning and operation cover many areas, e.g. air and water protection, waste management, nitrogen management and energy.

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That is why the process of their preparation and implementation is quite complicated from the administrative and legal perspective. This does not cover only the requirements, but includes as well social aspects such as the communication with the public.

Hence, it is necessary for applicants and potential investors to pay special attention to the pre-implementation preparation which is rather time consuming (min. one year ideally, usually longer), but it pays off many times in the operation once put in practice. Time and energy devoted to the pre-implementation preparation are the basis for the viability of the project of a biogas plant with an operating life of approximately 20 years. An elaborated feasibility study is a key document for potential investors, and further materials will be prepared on its basis..

For the planning of a biogas plant it is recommended to take following steps:

2.1 Feasibility study

This is the main decision-making material for a potential investor which takes into account all the parameters for biogas production (such as placing the building/technological units, biomass logistics, energy and material in- and outputs, impact on environment, operation and service background of the biogas plant), and suggests optimum solutions for the construction and operation of the plant. The study should also contain a thorough economic aspect of the intention and a proposal of further steps of preparation and implementation of the project.

The study has to contain the complete spectrum and bring answers to all questions regarding the operation of a biogas plant. It should above all estimate the economic viability including investment and operation costs.

2.2 Network connectivity

The next step after the feasibility study is a timely verification of the possibility to connect to the electricity or even heat grid. Obtaining agreement of the provider is the basic condition for further steps in the implementation process in the chosen locality. If the provider disagrees, it is recommended to search a new, more suitable, locality, and try to re-obtain the agreement to connect to the local network.

2.3 Timely provision of adequate and high-quality raw materials

It is recommended to have sufficient amount of biodegradable material pre-contracted already during the planning and construction stage. It is as well advisable to have a potential estimation to avoid any shortage during the operation of the biogas plant as this could have a major influence on the viability of the plant. This potential estimation should be as well part of the feasibility study.

2.4 Timely and continuous cooperation between local authorities and citizens (raising awareness)

Another presumption is to obtain a positive stance from the local authorities and general public in the chosen locality. This will be further elaborated in the next chapter.

2.5 Biogas yield assessment

Especially in case of use of non-standard incoming raw material (substrate or mixture), it is recommended to carry out a biogas yield assessment. This way, some negative effects in the actual operation can be predicted, e.g. low biogas yield, unsuitable pH, etc. This assessment is recommended in stations where substrates will be changed.

2.6 Processing an application for investment support and project funding

There are several operation programmes and initiatives of the EU suitable to support the planning and construction of the biogas plant. There are as well country specific funding schemes either applicable for the construction stage or for example in form of feed-in-tariffs for the produced electricity during the operation. It is recommended to get in contact with responsible authorities and national associations to obtain more information about the funding schemes as the financial support received can significantly help to implement the business plan.

2.7 Project documentation

The project documentation is the major step in the biogas plant planning. There are many different requirements depending on the country specific regulations. In general it covers territorial and construction proceedings, including geodetic alignment, engineering-geological surveys, and the environmental impact assessment.

2.8 Country specific info

2.8.1 Belgium

Systems generating more than 100,000 kWh of electricity from renewable sources must be certified by an authorized body).The Flemish regulatory authority (VREG) shall assess every application for completeness and inform the applicant about missing documents and data within 2 months after receipt of an application. VREG shall communicate to an applicant whether or not he/she has the right to participate in the certificate scheme within one month after receipt of the complete application. Green certificates are allocated per month and per MWh of electricity.

In Vallony, if the quantity of non-dangerous waste treated is above 50 tons/day in settlement zone or above 100 tons/day in the others zones of the Soil Occupation Plan, an environmental impact study is required.

The authorization for network connection depends on the agreement of the local/regional electricity supply company, based on a feasibility study concerning the local grid capacity, the voltage, the situation and the facilities.

For the biogas potential estimation it is possible to use the services of Flanders Energy Agency and Biogas-e who provide a feasibility study calculator to evaluate biogas potential.

The legal background is given for one by the Licensing Environment, established by Decree of 11 March 1999, which is in force since 1st October 2002. The environmental decree created the Unique Permit, which is composed by the environmental permit and the urban permit as well. The Unique permit provides a questionnaire to be filled in and to be presented to the municipal authorities. The questionnaire requires the following information:

- Project general overview, with the owner and site coordinates
- Description of the project, surrounding area, list of land parcels, planning permission
- A Class 1 environmental study, with a list of authorisations, permissions and registrations required by the institutions
- A description of facilities and activities (NACE code, list of facilities and activities, list of raw materials used. Information relating to land use (5th part of the form on the application for planning permission)

Related legal decrees:

- Arrêté du Gouvernement wallon of 1 mars 2007 modifiant l'arrêté du Gouvernement
- wallon du 4 juillet 2002 relatif à la procédure et à diverses mesures d'exécution du
- décret du 11 mars 1999 relatif au permis d'environnement ;
- Décret du 11 mars 1999 relatif au permis d'environnement ;
- Règlement Général pour la Protection du Travail (RGPT) ;
- Code wallon de l'aménagement du territoire, de l'urbanisme et du patrimoine
- (CWATUP) .

2.8.2 Croatia

In the case of Croatia there is a big problem when it comes to the estimate of the biogas potential from farms. There is no up to date publicly available data partly because most of the potential is in the hands of a handful of big food producers that are registered in urban centres and their actual production is scattered across the country. The second problem is that the National Biro of Statistics does not publish all of its data for the public to use. The newest data published states that the Croatian biogas potential is somewhere between 3.2-11.3 and 0.7-2.1 PJ yearly according to the summery of the Big>East report on the Potential of biogas in Croatia from 2008.

The production of biogas is regulated by the Regulation on the use of renewable energy sources and cogeneration (OG 088/2012) which defines the term biogas plant and divides them by power in four categories. The categories are as follows:

- biogas plants with an installed electrical power up to 300 kW
- biogas plants with an installed electrical power from 300 kW to 1 MW
- biogas plants with an installed electrical power from 1 MW to 2 MW
- biogas plants with an installed electrical power from 2 MW to 5 MW.

According to the Law on the electricity market (OG 022/2013) any legal or physical entity that produces electricity and heat from a single unit with high efficiency can become a privileged producer of electricity and can receive the corresponding feed in tariff. The tariff itself is regulated by the Tariff system for the production of electricity from renewable energy sources and cogeneration (OG 063/2012). The feed in tariff is valid for a period of 14 years after which the electricity can be sold at the market price. The operator of the distribution

system is obliged to take in all of the produced electrical energy from a privileged producer. The feed in tariff is different for the different categories of biogas plants. For biogas plants with an installed electrical power less than or equal to 300 kW the tariff is 1,42 kn/kWh which is around 0,18 €/kWh. The feed in tariff for biogas plants with an installed electrical power ranging from 300 kW to 1 MW and from 1 MW to 2 MW is 1,2 kn/kWh or 0,16 €/kWh and for biogas plants with an installed electrical power ranging from 2 MW up to 5 MW the tariff is 1,12 kn/kWh which is approximately 0,15 €/kWh. The procedure to acquire the status of a privileged producer is regulated by the Regulation on the acquisition of the status of a privileged producer of electricity (OG 088/2012).

In order to construct and operate a biogas plant and to receive the feed in tariff for the produced electricity, 16 different permits and contracts have to be obtained. The three main permits are the location, construction and use permits. The process of acquiring the permits is usually very long due to the ineffective bureaucracy in the country. The necessary steps needed in order to construct a biogas plant and operate it as a privileged producer are described here:

0. Preparation phase – assembling and studying of input information and preparing of preliminary documents for facility construction,
1. Procuring decision on registration of energy activity,
2. Procuring preliminary energy approval for construction of energy facility,
3. Procuring decision on environmental impact assessment of intervention and/or decision on integral environmental protection conditions,
4. Procuring location permit and/or preliminary energy consent and/or concluding contract on connecting to energy network,
5. Procuring energy approval for facility construction,
6. Procuring decision and/or concluding concession contract,
7. Procuring decision on expropriation and/or decision on entry in the land register of the real estate,
8. Procuring building permit,
9. Procuring preliminary decision on acquiring the status of eligible electricity producer,
10. Concluding contract on purchase of electricity (conditioned),
11. Procuring energy consent,
12. Concluding contract on the use of the network,
13. Procuring the use permit,

14. Procuring water permit,
15. Procuring the license for carrying out energy activity,
16. Procuring decision on acquiring the status of eligible electricity producer,
17. Procuring decision on determining of domestic component in the project,
18. Procuring decision on entry of the building in the cadastral operate,
19. Procuring decision on entry into land register.

The necessary permits and the bodies issuing the permits are:

- Decision on environmental acceptability – issued by the Ministry of Environmental Protection Physical Planning and Construction (MoEPPC)
- Decision on integrated environmental protection requirements – issued by the MoEPPC
- Decision on acceptability for ecological network – issued by the MoEPPC
- Location permit – issued by the MoEPPC
- Construction permit – issued by the MoEPPC
- Operation permit – issued by the MoEPPC

The necessary energy permits are listed here:

- Preliminary energy approval – issued by the Ministry of Economy (MoE)
- Provisional grid connection authorisation – issued by the regional TSO/DSO
- Grid connection contract - signed between the investor and TSO/DSO
- Energy approval for building the plant – issued by the MoE
- Preliminary status of eligible producer – issued by the Croatian Energy Regulatory Agency (HERA)
- Power purchase agreement – the investors sighs the contract with the Croatian Energy Market Operator (HROTE)
- Grid connection authorisation – issued by the TSO/DSO
- Grid connection contract – signed between the investor and the TSO/DSO
- Energy licence – issued by HERA
- Decision on acquiring eligible producer status – issued by HERA

The technical study of connection or the Study of the optimal solution for the connection is also necessary to connect a biogas plant above 500kWel (or any other electricity producer) to the national grid. The study is produced by the Croatian national electrical energy company (Hrvatska elektroprivreda, HEP) and costs around 3000 € depending on the installed power of the plant. The study is done according to the norm EN 5016/HRN 2008.

2.8.3 Cyprus

The Cyprus Energy Regulatory Authority (CERA) has already issued 17 licenses for the construction of anaerobic digesters of farming wastes for electricity production from biogas, with total capacity of 14.9 MW and is examining two applications of 3.2MW total capacity. The development of biomass systems is illustrated in the following Figure, between 2006 and 2011 (http://www.cera.org.cy/main/data/articles/biomass.pdf).

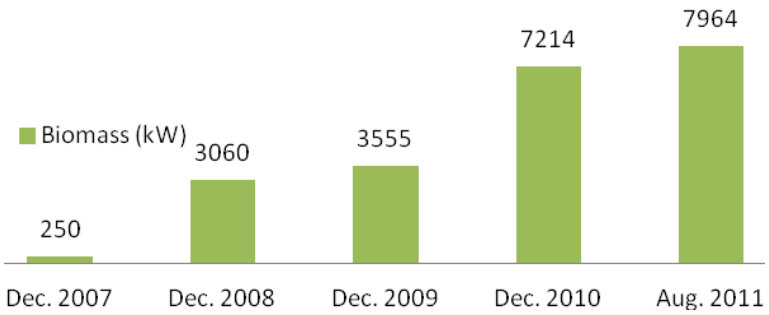

Figure 2-1: Total installed capacity (MW) of biogas plants in Cyprus.

- **Total installed capacity (June 2012):** 7,964 KW
- **Electricity production from biogas plants: 3,460 GWh**

The following map shows the location of all anaerobic digestion plants that are in operation in Cyprus as well as the planned (estimated construction by the end of 2012).

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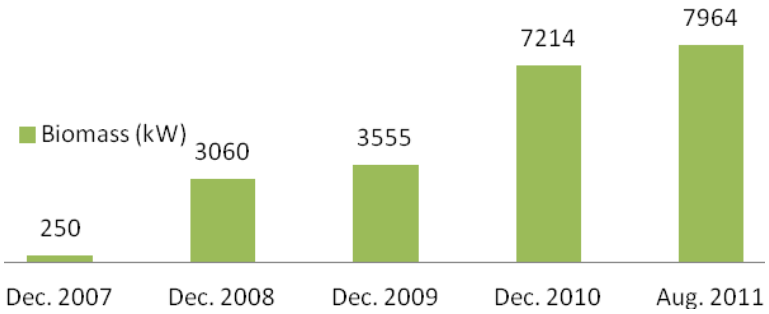

Figure 2-2: Total installed capacity (MW) of biogas plants in Cyprus.

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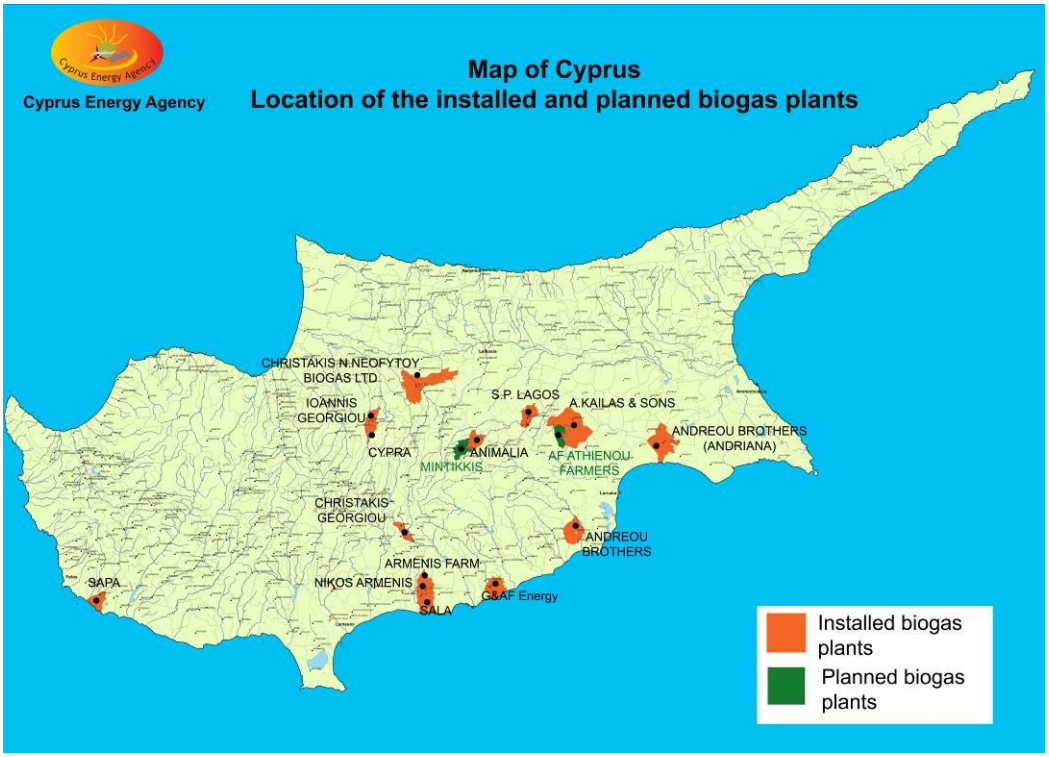


Regarding to the policy, the criteria and the process of urban control concerning applications for the installation of renewable energy applications, the Minister of Interior has published the

Direction 2 of 2006, date 19/4/2006 for energy production from RES. In this Direction 2 are determined the process and the terms for the authorization of plants for energy production from renewables.

The formal major steps regarding the permitting procedure in Cyprus for setting up a biogas plant are the following:

1) Planning Permit (In Charge: Department of Town Planning and Housing)

The applicant should apply for planning permit to the Town Planning and Housing, Ministry of Interior. The application form should be accompanied by the architectural drawings, site plans and also by the Environmental Impact Assessment study. The authorities that are involved in the planning permit (according to the provisions of Direction 2/2006) and should express their opinion during the consultation are the following:

- Ministry of Commerce Industry and Tourism
- Ministry of Agriculture, Natural Resources and Environment
- Ministry of Interior
- Ministry of Communications and Works
- Ministry of Defence
- Ministry of Health
- Cyprus Energy Regulatory Authority (CERA)
- Administrator of the British Bases (in special cases)
- Electricity Authority of Cyprus (EAC)

2) Environmental Permit (In Charge: Department of Environment)

To get the planning permit a full EIA study should be prepared. The EIA study of a project is examined by the EIA committee which is chaired by the Department of Environment, Ministry of Agriculture, Natural Resource and Environment. It is involved in the licensing of installations of energy production via the Law on the Assessment of Environmental impacts from Certain Projects. This Law N.141(I)/2005 was placed in full implementation the 2005. The EIA committee according to the provisions of the Law is consisted of representatives of:

- Ministry of Agriculture, Natural Resources and Environment
- Ministry of Commerce Industry and Tourism Department of Planning and Housing
- Ministry of Communications and Works
- Ministry of Labour and Social Insurance

- Federation of Ecological and Environmental Organizations (FEEO)
- Cyprus Scientific Technical Chamber (ETEK)
- 2 consultants

The Environmental Terms of the EIA Committee issued by Department of Environment should be forwarded to the Planning Authority. If the Planning Authority approves the project then a planning permit is issued which includes spatial planning terms and the environmental terms. There are two more permits that should be obtained from the Department of environment approximately 6 months before the full operation of the Biogas Plants: License for waste disposal according to the Water Pollution Control Law (N106 (I) / 2002 to 2009) and License for wastes management pursuant to the Waste Management Law of 2011 (N 185 (I) / 2011).

Moreover, air emissions permit is also required 6 months prior the full operation of the biogas plant, According to the Control of Atmospheric Pollution Laws 2002-2009 (N187 (I) / 2002)., where responsible department is the Department of Labour Inspection, Ministry of Labour and Social Insurance. Finally, application for a license from veterinary department is required in the cases where livestock is treated.

3) License for the production of electricity CERA (In Charge: Cyprus Energy Regulatory Authority)

In parallel to the processes described in the above paragraphs 1 and 2; the applicant should get the electricity production license. The application form should be accompanied, besides other documents, with copies of the EIA and Feasibility Studies.

4) Building Permit (In Charge: Cyprus Ministry of Interior, District Offices)

When the applicant gets the planning permit an application for building permit should be performed. Positive views from Cyprus Fire Service, Local Authorities and Water Development Department might be requested.

5) Guarantee of Origin Certificate from either TSO or DSO (In Charge: Cyprus Transmission System Operator or Distributed System Operator (in this case DSO)

An application to DSO must be performed to ensure the guarantee origin. The guarantee origin plus the building permit are needed to apply for subsidies to the Special RES Fund.

(Note: TSO issues guarantee of origin certificated for installations> 8MW, and DSO for installations<8MW).

There are as well special rules for verification of network connectivity. The "Electricity Transmission and Distribution Rules" are issued by CERA (Cyprus Energy Regulatory Authority). These rules are divided in the Transmission and in the Distribution Rules. The Transmission Rules is a text with specific procedures, regulating and controlling the Operation of the Electricity System of Cyprus, in a secured and reliable manner with the minimum cost. The Transmission Rules include the Connectivity Terms for the Transmission System (T1), which provide the minimum technical, planning and operational criteria that the Transmission System Operator has to meet at the connection point, and the minimum technical, design and operational criteria that the Users, which are connected or demand to connect to the Transmission System, have to meet.

Furthermore the Transmission Rules include the Planning Rules (T2), which determine the necessary information that the Users have to provide to the Transmission System Operator, for a strategic planning and development of the Transmission System.

The Distribution Rules determine the technical issues among the Distribution System Operator and the Users, in order to have a sufficient, well coordinated and low cost Distribution System. Users which are being connected to the Distribution System, should comply with the relevant parts of the Distribution Rules. Users should also comply with the **Electricity Market Law 2003** (Law 239(I)/2004) and with other relevant legislation which enters into force periodically.

The Distribution Rules include the Connection Terms to the Distribution System (Δ1), which provide in detail all the technical and other obligations of those who demand to connect to the Distribution System. Connection Terms to the Distribution System include specific principles and specifications regarding the electricity supply, connection methods, technical specifications and efficiency specifications. Moreover, Connection Contracts are held between the User and the Distribution System Operator, including in detail all the information about the User's connection to the Distribution System Operator and the usage of the Distribution System. This contract demands that both User and Distribution System Operator should comply with the terms of the Distribution Rules.

For each step of the permission procedures which were described previously (planning permit, environmental permit, CERA licence, building permit, Guarantee of Origin Certificate) separate and specific application form should be submitted for each license. Each Department provides the interested applicants with the published format of the application forms that are also available online. After ensuring the guarantee of origin certificate either from TSO or DSO, an application to the RES fund should follow in order the applicant to get the FiT based on the Support Schemes that are in force in Cyprus.

In order the applicant can get the FiT the following have to be included in the application form for subsidisation from the RES Fund:

1. Feasibility Study where should be included the following : a) flow chart, b) electromechanical drawings c) dimensioning of the equipment, d) grid connection network drawings, e) installation, maintenance and operation costs, f) the estimated annual energy production, g) time schedule of implementation of the project. This study has to be submitted and signed by an Engineer that is registered and qualified engineer in ETEK or other equivalent organization in the case that the engineer originates from another country.
2. Legal document of the site use (e.g. rent agreement, ownership etc)
3. Topographic plan which indicates the location of the site that is going to be used.
4. Planning permit
5. Approval for Building permit.
6. Copy the legal entity registration certificate.
7. Shareholders Certificate.
8. Certificate of non- bankruptcy.
9. Copy of the invoice where all the costs of the equipment as well as cost of installation should be included.
10. Copy of the technical specifications of the manufacture for equipment that is going to be installed and concerns the investment application.
11. EC declaration of conformity.
12. Contract to ensure the flow of raw materials depending on the investment.
13. If the project is funded from other National or European programs the necessary copies of the decision of the funding must be attached.
14. License or application to obtain exemption license from CERA about the project.

15. Certificate of acceptance of technical and connection terms issued by DSO or TSO.
16. Twenty year purchase agreement from EAC.

The following documents have to be included, after the approval of the application to the RES Fund and before the signature of the final purchase agreement:

1. Original invoices and receipts for machinery and equipment.
2. Certificate of inspection of electrical installation of the system from the Director of Electromechanical Services.
3. Certificate of inspection from TSO or DSO.
4. All the necessary permits for liquid, air or solid waste disposal from the responsible governmental departments.
5. Approval from Veterinary Services if the produced biogas come from rendering plant according to the provisions of EC 1774/2002
6. Certificate by the Engineer where the following should be verified: materialization of the entire investment, the estimated energy production, the proper functioning of the system (according to the study).
7. Building permit.

For the payment of the subsidy is necessary that the generated electricity is accompanied with a guarantee of origin certificate or cogeneration certificate depending on the investment.

The Regulatory Framework on RES in Cyprus can be divided into 4 thematic areas:

1) the Liberalization of the electricity market,

2) the Promotion of RES and Energy Efficiency,

3) the Town Planning and Housing (Permitting requirements),

4) Environmental protection.

The Laws or RAA Regulatory Administrative Acts (ΚΔΠ) that fall under each thematic area are described in brief in the paragraphs that follow:

(1) Liberalization of the electricity market

The Directive 2003/54/EC, which replaced the 96/92/EC, establishes common rules that concern the production, transport, distribution and supply of electricity. For that reason the Republic of Cyprus regulated the Electricity Market Regulation by the Law N.122 (I)/2003.

According to the provisions of this Law, CERA (Cyprus Energy Regulation Authority) and TSO (Transmission System Operator) were established. This Law also included the duties and activities of CERA and TSO, which includes the proper operation of the electricity market,

the protection of consumers and to ensure market competitiveness. This Law followed by four amendments in 2004, 2005, 2006 and 2008.

(2) Promotion of RES and Energy Efficiency

The European Directive 2001/77/EC was transposed to National Law the N.33 (I)/2003 for harmonization with the promotion of electricity produced from renewable energy sources in the internal electricity market.

This Law, pronounced as the ″Promotion and Encouragement of the Utilisation of RES and Energy Conservation″. The basic providence of this Law was to create a "Special RES Fund" for the promotion of RES and Energy Conservation investments and to establish a Committee to manage the "special RES fund". The main revenues of the fund come through imposition of levy to all electricity consumers which since July 2012 is 0, 0050 €/kWh consumed.

The Law N.33 (I)/2003 followed by two amendments in 2004 and 2005, relating with the subparagraph 3 of Article 7 of the Law, regarding the powers and duties of the Management Committee of the Special RES Fund.

The grants/subsidies are intended to provide financial incentives in the form of government grants or subsidies, encouraging the investment and use of RES. The Grants were actually derived from the Law N.33 (I)/2003 which is referred as the Law for the "Promotion and Encouragement, the Utilisation of RES and Energy Conservation" as mentioned above.

The current support scheme is valid for the period 2009-2013. However, there are annual announcement on when the applicants can submit an application for grant/subsidy. Support Schemes operate since 2004.

To comply with the provisions of Directive 2004/8/EC (Combined Heat and Power - CHP) and Directive 2001/77/EC (RES),the government of Cyprus has prepared the Laws N174 (I)/2006 and the amendment 162 (I)/2006 followed by the RAA 283/2008, 457/2011 and 155/2012 for the promotion of RES and CHP. The providences of these Laws were the creation and operation of an electronic record. Through the record, guarantees of origin of production from RES and CHP plants will be issued, transferred and/or cancelled.

The RES Directive 2009/28/EC has not yet been transposed to National Legislation.

(3) Planning Permit (Town Planning and Housing)

The definition of an integrated policy for spatial planning at national level for the RES installations in the landscape was necessary in order to achieve the national targets on the share of RES.

The Direction 2/2006 issued to guide Planning Authorities with regard to the principles, criteria and development control procedures related to the sitting of units for the production of energy from renewable resources," through the "definition of an integrated spatial policy for the installation of wind turbines, wind parks and other units for the utilisation of renewable energy resources."

Mainly aims through restrictions and conditions the aesthetic integration of RES plants in the landscape and to minimise the impacts on the wider environment, nature and land uses. The restrictions and conditions related to sensitive areas, at both National and European level (state forest, archaeological sites, network Natura 2000, etc). This particular Direction refers mainly to RES installations of wind turbines, anemometers, wind parks and solar installations. The Direction 2/2006 followed by the Circular 3/2008. The Circular 3/2008 includes specific provisions that are related with installation of small scale photovoltaic systems in buildings or on the ground and states clearly in which cases the application for planning permit is not required.

Within the guidelines of the Urban Plans and Rural Policy Statement for the protection of sensitive areas and the wider environment; some provisions included for the installation of solar water heaters. These provisions are given in the Annex E of the Urban plans (Guidelines for the aesthetics and quality improvement of the built environment). In all Urban Plans of towns and cities in Cyprus (Nicosia, Limassol, Larnaca, Paphos, Paralimni, Ayia Napa), a large renewable energy plant such as wind parks, wind turbines, solar parks etc, could not be permitted within the limits of Urban Development Plans, based on the provisions and conditions of the Direction 2/2006 of the Ministry of Interior.

The objective of the Rural Policy Statement is to create a unified and integrated framework that will be promoted, regulated, monitored and implemented during the development in the countryside (rural areas). Installations of renewable energy sources are included in the Policy

Statement in the category Projects Infrastructure. Infrastructure projects are of essential public interest, because are designed to serve human activities on large scale, to promote economic development, improve the quality of life and prevent environmental degradation.

(4) Environmental protection

The Law N.140 (I)/ 2005 provides a mandatory assessment of the impacts to the environment by the implementation and operation of certain projects and prohibits the granting of planning, permission or approval for implementing the project without taking seriously the views of the competent authority.

The criteria regarding the RES plants that need Full Environmental Impact Assessment (EIA) to get planning permission is:

a) Wind plants with installed capacity over 1 MW,
b) PVs on the ground over 100 kW,
c) Installations of hydroelectric energy,
d) Cogeneration plants,
e) Concentrating Solar Power (Solar Thermal Electricity),
f) Biomass Plants,

The criteria regarding the RES plants that need Preliminary Environmental Impact Assessment (EIA) to get planning permission is:

a) Wind plants with installed capacity 30kW-100kW

For the compliance of Cyprus legislation with a set of European directives concerning the air quality, the Law 187(I)/2002 was came into force. The purpose of this Law is to prevent, reduce and control the air pollution caused from different plants for the welfare of the population and to protect and improve the natural environment. The RAA (ΚΔΠ) 170/2004 and RAA (ΚΔΠ) 198/2008 that followed the basic law; specify the categories of the plants, the emission limits and licence requirements for air emissions. Within these RAA the biomass plants are included and therefore this licence should be obtained as well.

For the integrated prevention and pollution control (water, soil, atmosphere) from activities and plants that fall into certain categories the Law 56 (I)/2003 was established. This law is concerned with the utilization of biomass from farm waste.

The amendment of the basic Law N.153 (I)/2003 with the Law 131 (I)/2006, was made for full alignment with Directive 92/43/EEC on the conservation of natural habitats, wild fauna and flora.

Any plan or project that is under planning permission or not, which is located in a special conservation area and is not involved necessarily with the management of the area, is subject to the Environmental Authority for an environmental assessment.

The purpose of the above procedure is an Appropriate Assessment of the impact that a plan/project may cause in the area, taking into account the conservation area, and the public opinion.

The provisions of the specific law apply to the RES in case that an installation is proposed to be constructed in a special protected area. In the Direction 2/2006 is specifically define in which areas it is not allowed the installation of RES.

2.8.5 Czech Republic

The feasibility study is often carried out in compliance with grant providers chosen beforehand. The study serves the investor as a background for creating the business plan, dealing with banks, submission for planners and other documentation processers, such as EIA, energy audit, expertise. Quality of the study can be reviewed by compiling opponent expertise.

The connection to an electricity grid has been one of the major obstacles of biogas development in the past in the Czech Republic. Therefore a timely planning and communication with the grid provider is crucial.

In the Czech Republic there is a well working feed-in-tariff system, which helps to develop the production of biogas from agricultural residues. There are as well several other national programmes subsidizing the construction of biogas plant, e.g. from then Rural development fund or from the National Environmental fund.

The project documentation is given by the act No. 437/2004 about territorial planning and construction regulation. Required extent of documentation differs slightly from authority to authority.

Documentation for territorial and construction proceedings must contain a simple engineering-geological survey where digesters and reservoirs will be built, and geodetic alignment of the building site. Also, a medium air pollution source expertise, including dispersal study, and decision of the regional authority must be present in the documentation. Before compiling the actual documentation, it is recommended to visit the local construction bureau and make the responsible officer acquainted with the feasibility study. The officer should then provide the applicant with the list of all requirements and attachments necessary to apply for construction permission.

The Environmental Impact Assessment plays an important role in the decision making process. It is recommended to contract the implementation of the EIA by an experienced planning company.
The EIA is needed in the full length only if the biogas plant processes materials up to 30,000 tons/year. This is regulated by the act No. 100/2001. If the waste limit is exceeded, adequate documentation must be processed. This must always be discussed with the regional bureau, waste and EIA department. Requirements of separate offices might differ.

2.8.6 Denmark

There is an agreement between the Danish Government and the 98 local authorities that they must include at least 50 biogas plants in total in their rural planning at 2013.
When planning where to place a biogas plant, the local authorities have to take the following into consideration:

- Nearby neighbours – problems with odour. There is not any specific distance into the law but there is a rule of thumb on 300 m to nearest house and 500 m to nearest village / town
- Distance to the biomass that feeds into the biogas plant
- Distance to road of good quality
- Nature, landscape and cultural history in the area
- Distance to recipient

One should expect up to three years from the initial idea until all permissions have been given.

The major legal requirements for setting up biogas plant in Denmark are:
Laws concerning planning and placing a biogas plant

- Planloven
- Miljøbeskyttelsesloven
- Naturbeskyttelsesloven
- Biproduktforordningen
- Licitationslovgivningen
- Forsyningsdirektivet

There are as well requirements for verification of network connectivity

- Energinet has a technical requirements that has to be met
- Bekendtgørelse af lov om elforsyning

During the approval stage the environmental effect needs to be taken into consideration as well. In Denmark, the Approval from the local authorities that the biogas plant is in compliance with the environmental laws and building legislation is needed. If the biogas plants storage capacity reaches 10 tons biogas (8600 Nm^3 biogas) or more, the biogas plant also has to comply with the notice of risk (Risikobekendtgørelsen).

For the planning process it is crucial to involve all parties as early as possible. That means neighbours, local authorities, farmers, recipient etc.

2.8.7 Germany

In Germany there is a set of regulations dealing with the planning and operation of biogas plants. New biogas production plants have to conform to following rules:

- laws pertaining to water
- laws relating to construction planning
- laws relating to emission control
- Waste legislation
- Veterinary legislation

- Fertilizer legislation
- Hazardous substances legislation
- EU Directives on protection of environment
- EU Directive Nr. 1774/2002 (if animal by-products shall be fermented)
- German law and bylaw on utilization and elimination of animal by-products

Following laws and bylaws apply to biogas plants (in German)

Regulations for the area of emissions protection:

- Bundes-Immissionsschutzgesetz i.d.F. der Bekanntmachung vom 26. September 2002 – BGBl. I S. 3830
- Vierte Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Verordnung über genehmigungsbedürftige Anlagen – 4. BImSchV) i.d.F. vom 14. März 1997 (BGBl. I S. 504), zuletzt geändert durch Artikel 3 der Verordnung zur Änderung der Verordnung über Verbrennungsanlagen für Abfälle und ähnliche brennbare Stoffe und weiterer Verordnungen zur Durchführung des Bundes-Immissionsschutzgesetzes vom 14. August 2003 (BGBl. I S. 1614)
- Dreißigste Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Verordnung über Anlagen zur biologischen Behandlung von Abfällen – 30. BImSchV) vom 20. Februar 2001 (BGBl. I S. 317)
- Neunte Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Verordnung über das Genehmigungsverfahren – 9. BImSchV) i.d.F. der Bekanntmachung vom 29. Mai 1992 (BGBl. I S. 1001), zuletzt geändert durch Artikel 2 der Verordnung zur Änderung der Verordnung über Verbrennungsanlagen für Abfälle und ähnliche brennbare Stoffe und weiterer Verordnungen zur Durchführung des Bundes-Immissionsschutzgesetzes vom 14. August 2003 (BGBl. I S. 1614)
- Erste Allgemeine Verwaltungsvorschrift zum Bundes-Immissionsschutzgesetz (Technische Anleitung zur Reinhaltung der Luft – TA Luft) vom 24.07.2002 (GMBl. S. 509)
- Sechste Allgemeine Verwaltungsvorschrift zum Bundes-Immissionsschutzgesetz (Technische Anleitung zum Schutz gegen Lärm – TA Lärm) vom 26.08.1998 (GMBl. S. 503)
- Landesverordnung über Zuständigkeiten auf dem Gebiet des Immissionsschutzes (ImSch-ZuVO) vom 14. Juni 2002 (GVBl 2002, S. 280)
- Verwaltungsvorschrift des Ministeriums für Umwelt und Forsten und des Ministeriums für Wirtschaft, Verkehr, Landwirtschaft und Weinbau vom 28. Januar 1999 (MinBl. S. 208), zuletzt geändert durch Verwaltungsvorschrift vom 14. November 2005, über die Beschleunigung von immissionsschutzrechtlichen Genehmigungsverfahren und Einführung von Vordrucken für die Verfahren nach § 4 Abs. 1, § 15 Abs. 1, § 16 Abs. 1 und 4 und den §§ 8 und 9 Abs. 1 BImSchG sowie § 4 Abs. 9 TEHG

Regulations for the are water protection:

- Gesetz zur Ordnung des Wasserhaushalts (Wasserhaushaltsgesetz – WHG) i.d.F. der Be-

kanntmachung vom 19. August 2002 (BGBl. I S. 3245), zuletzt geändert durch Art. 6 des Gesetzes vom 06.01.2005 (BGBl. I S. 2)

- Wassergesetz für das Land Rheinland-Pfalz (Landeswassergesetz – LWG) i.d.F. vom 22. Januar 2004 (GVBl 2004 S. 54), zuletzt geändert durch Art. 1 des Gesetzes vom 05.10.2007 (GVBl. S. 199)
- Landesverordnung über Anlagen zum Umgang mit wassergefährdenden Stoffen und über Fachbetriebe (Anlagenverordnung – VAwS) vom 1. Februar 1996 (GVBl. S. 121), zuletzt geändert durch 2. Landesverordnung vom 04.11.2005 (GVBl. S. 491)
- Landesverordnung über Anforderungen an Anlagen zum Lagern und Abfüllen von Jauche, Gülle, Silagesickersäften, Festmist und Silagen (JSGF-Verordnung) vom 1. April 1999 (GVBl. S. 102), zuletzt geändert durch Verordnung vom 25.11.2005 (GVBl. S. 522)
- Rundschreiben des Ministeriums für Umwelt und Forsten „Wasserwirtschaftliche Anforde-rungen an Anlagen zum Lagern von Jauche, Gülle und Silagesickersäften (JGS-Anlagen) vom 7. Dezember 1994, Az.: 1033-05.90
- Landesverordnung über die Eigenüberwachung von Abwasseranlagen (EÜVOA) vom 27. August 1999 (GVBl. S. 211), zuletzt geändert durch Verordnung vom 17.03.2006 (GVBl. S. 139)
- DIN 1986, Teil 30 (2003-02): Entwässerungsanlagen für Gebäude und Grundstücke - In-standhaltung, Beuth Verlag, Berlin

Regulations for the area waste treatment:

- Gesetz zur Förderung der Kreislaufwirtschaft und Sicherung der umweltverträglichen Beseitigung von Abfällen (Kreislaufwirtschafts- und Abfallgesetz) vom 27.September 1994 (BGBl. I S. 2705), zuletzt geändert durch Gesetz am 9. Dezember (BGBl. I S. 82)
- Verordnung über das Europäische Abfallverzeichnis (Abfallverzeichnis–Verordnung – AVV), Artikel 1 der Verordnung zur Umsetzung des Europäischen Abfallverzeichnisses vom 10.Dezember 2001 (BGBl. I S. 3379)
- Verordnung über die Verwertung von Bioabfällen auf landwirtschaftlich, forstwirtschaftlich und gärtnerisch genutzten Böden (Bioabfallverordnung – BioAbfV) vom 21. September 1998 (BGBl. I S.2955), zuletzt geändert durch Verordnung vom 26. November 2003 (BGBl. I S. 2373)

Regulations for the area fertilizers:

- Düngemittelgesetz vom 15. November 1977 – BGBl. I S. 2134 -, zuletzt geändert durch Art. 183 der Verordnung vom 29. Oktober 2001 – BGBl. I S. 2785 –
- Verordnung über das Inverkehrbringen von Düngemitteln, Bodenhilfsstoffen, Kultursubstraten und Pflanzenhilfsmitteln (Düngemittelverordnung - DüMV) vom 26. November 2003 – BGBl. I S. 2373 –
- Verordnung über die Grundsätze der guten fachlichen Praxis beim Düngen (Düngeverord-nung - DüngeV) vom 26. Januar 1996 (BGBl. I S. 118), zuletzt geändert am 17. Januar 2007 (BGBl. I S. 46)

Regulations for the area work safety:

- Gesetz über die Durchführung von Maßnahmen des Arbeitsschutzes zur Verbesserung der Sicherheit und des Gesundheitsschutzes der Beschäftigten bei der Arbeit (Arbeitsschutzgesetz – ArbSchG) vom 7. August 1996 (BGBl. I S. 1246), zuletzt geändert durch Art. 227 vom 31. Oktober 2006 (BGBl. I S. 2407)
- Verordnung über Sicherheit und Gesundheitsschutz bei der Bereitstellung von Arbeitsmitteln und deren Benutzung bei der Arbeit, über Sicherheit beim Betrieb überwachungsbedürftiger Anlagen und über die Organisation des betrieblichen Arbeitsschutzes (Betriebssicherheitsverordnung – BetrSichV) vom 27. September 2002 (BGBl. I S. 3777), zuletzt geändert durch Art. 439 der Verordnung vom 31. Oktober 2006 (BGBl. I S. 4207)
- Verordnung zum Schutz vor Gefahrstoffen (Gefahrstoffverordnung – GefStoffV) vom 23. Dezember 2004 (BGBl. I S. 3758, 3759), zuletzt geändert durch Artikel 4 der Verordnung vom 6. März 2007 (BGBl. I S. 261)
- Verordnung über Sicherheit und Gesundheitsschutz bei Tätigkeiten mit biologischen Arbeitsstoffen (Biostoffverordnung – BioStoffV) vom 27. Januar 1999 (BGBl. I S. 50), zuletzt geändert durch Art. 2 der Verordnung vom 6. März 2007 (BGBl. I S. 261)
- Sicherheitsregeln für landwirtschaftliche Biogasanlagen, herausgegeben vom Bundesverband der landwirtschaftlichen Berufsgenossenschaften e.V., Weißensteinstraße 70, 34131 Kassel, Stand 05.09.2002

For the connection to the electricity grid to be given, biogas plants have to close a contract for network connection with the local grid operator (he must offer the most efficient connection). German Renewable Energy Act defines obligations of network operators including rules for offers regarding network connections.

The biogas plant operator needs to provide specific documentation for the biogas plant. This is in general:

1st: documentation of the plant is a necessary part of permits (see CS planning prerequisites.

2nd: operating instruction manual

3rd: documentation of monitoring procedures

4th: operation journal (logbook)

2.8.8 Hungary

The requirements for setting up a biogas plant in Hungary are covering many areas which make and early planning very important. The major permits are listed below in bold; others are optional depending on the type and size of the plant:

- **planning permit (land use change)**
- **environmental authorisation (environmental impact assessment)**
- **effluent permit**
- waste management permit
- health & safety permits
- groundwater permit
- **digestate permission**
- **building permit**
- technical project plan
- storage permits
- fire & safety license
- geodetic license
- architectural permission
- **operational permit**
- **production permit**
- installation permit
- start-up license
- **grid connection permit**
- distribution permit
- usage permit
- green certificates
- water connection license
- safety report

The legal requirement for setting up a biogas plant are above all:

Environmental authorisation: Authority for Environment Protection

Governmental Act: 314/2005. (XII.25.):

- above 10.000 t/a waste utilization → Environmental Impact Assessment
- 10 t/day organic (animal) waste utilization → Unified environment use permit

Construction permit:

- special building → Hungarian Trade Licensing Office
- other buildings → Municipal Notary

Contract for grid connection: grid licensee

Eligibility for mandatory off-take tariff: the decision of the Hungarian Energy Office

Aggregated small plant permit: Hungarian Energy Office

- under 500 kWhel – notification responsibility
- above 500 kWhel – aggregated small plant permit is necessary

Balance group contract: MAVIR (responsible for KÁT – mandatory off-take)

According to the Act LXXXVI/2007 on Electrical Energy, and the corresponding Governmental decree 273/2007 (X.19.), households or small enterprises can install small scale plants up to 50 kVA (45 kW) connected to the public low voltage grid.

The legal background:

- Act LXXXVI/2007 on Electrical Energy.
- Governmental decree 273/2007. (X.19.) on the implementation of some provisions in the Act LXXXVI/2007 on Electrical Energy.
- Governmental decree 389/2007. (XII.23.) on the mandatory off-take and purchase price of electricity generated from waste or renewable sources or by CHP.
- Governmental decree 60/2008. (III.26.) on the Amendment of mandatory off-take and purchase price of electricity generated from waste or renewable sources or by CHP.
- Governmental decree 382/2007. (XII.23.) on authority licensing procedures for construction of electrical facilities.
- Governmental decree 289/2007. (X.31.) on the state subsidy of residential piped gas and district heat consumption.
- Governmental decree 117/2007. (XII.29.) on financial and technical terms and conditions of connection to the public utility electrical network.

Summary of required documents for planning a biogas plant:

Name of the required document	Piece of legislation requiring this document	Institution/department where to present this document	Contact details or website of the institution/department	Requirements to complete the document
- Environmental protection permission (<10000ton waste/year) - Unified environment use permission (10 or more ton animal waste/day)	Government Decree 314/2005 (XII. 25.)	Inspectorate of Environment, Nature and Water	http://www.orszagosz oldhatosag.gov.hu/ter uleti-felugyelosegek.php	1) Environmental feasibility study (based on the requirements of Annex 6 of the regulation.) 2) Environmental impact investigation as required by the regulation and Low 1995. LIII. 110. §-a (7) sub-point c), i), l) s)
Construction permit	Law LXXXVI of 2007 on electricity (VET) Government Decree 382/2007 (XII. 23)	Hungarian Trade and licencing Office (MKEH) (form 0,5 MW) /regional Technical Safety Licensing and Inspection authority	http://mkeh.gov.hu	The environmental permission is pre-requisite for construction permit. The requirements may vary and potentially includes the involvement of further specialised authorities. Further requirements are established in regulation 3/2009. (II. 4.) ÖM on fire safety for renewable energy sources including biogas.
Grid connection agreement	Government Decree 382/2007. (XII. 23.) Ministry of Economy and Transport decree 117/2007 (XII.29) on financial requirements for connecting to the public electricity grid	Distribution licensee (EON, ELMÜ, ÉMÁSZ, DÉMÁSZ)	http://www.meevet.h u/index.php?menuid= 3003	Requirements are in accordance to the rules of distribution. The procedure is the same but the procedural content (duration, availability of the grid point, technical requirements etc.) vary depending on the distribution licensee.
Small power plant license	Law LXXXVI of 2007 on electricity Government Decree 273/2007. (X. 19) (VET.)	Hungarian Energy and Public Utility Regulatory Authority	http://www.mekh.hu	Application form in accordance to the requirements of prevailing regulation.

More details are available on the website of the Hungarian Energy Office:

http://www.eh.gov.hu/engedelyezes-2/engedelyezesi-es-jovahagyasi-eljaras/villamos.html

2.8.9 Spain

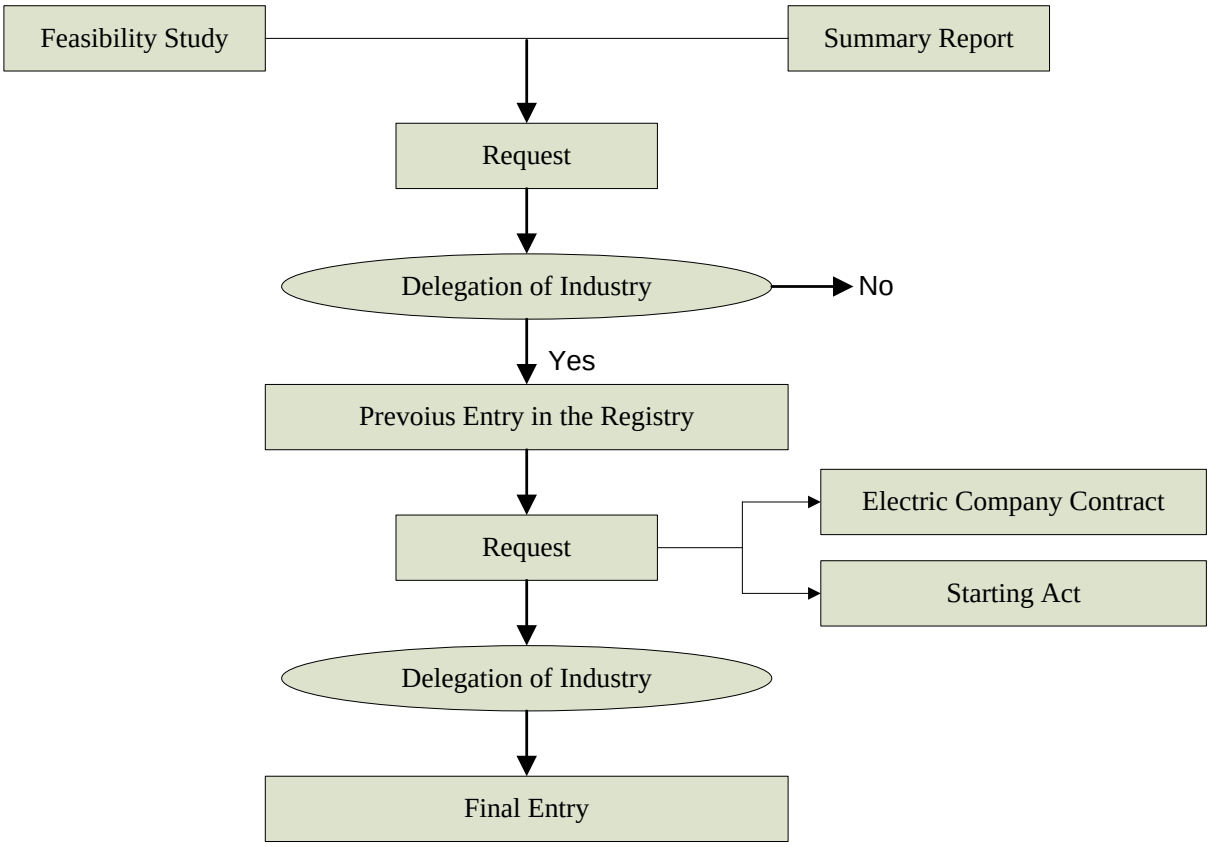
The specific requirements depend on the nature of every project, and, according to this, it is performed next to a single farm or as a project containing the management of slurries from different exploitations:

Single Projects: The design is simple; the only concrete requirement is to dispose of farms with a certain number of animals (more than 600 cows and/or more than 6000 pigs). This kind of installations, which would allow the construction of a single project are not frequent in our country.

Collective Projects: They need to join within a distance of less than 15 km, the same number or more, of animals with the same situation as the previous one. If the substratum to treat is a pig product (slurry, slaughterhouse residue, etc.), the location of the plant will have to save a distance of, at least, 1 km from inhabited places and other installations related with the pig (farms, slaughterhouses, etc.)

When it comes to the digestate management, if it is applied to agricultural soils, the project will have to dispose of a plan of livestock dejections, which has enough surface to apply it regarding the Nitrogen doses according the valid legislation.

The procedure that a biogas plant needs to follow as a central producer in special regime is shown as following:



Each community has the power of the verification and legalization of the installations.

IMPORTANT: This is the ancient procedure which comes from RD 661/2007. Nowadays, this one is abolished by RDL 1/2012, which fails temporally the bonus assignation for the production of electric energy in Special Regime.

The documentation required for setting up and operating biogas plant in Spain is as follows:

- Technical and Economical Feasibility Study
- Preliminary Project for the request of the urban compatibility, which buildings are constructed in Non Urban soils.
- Urban Permit (in Non urban soil)

Perceptual reports to the urban Licence:

  - Perceptual reports of the Hydraulic administration
  - Perceptual report of the Residues administration
  - Perceptual report of the Agricultural/livestock administration
  - Perceptual report of the Culture administration

    - Perceptual report of the Geological administration
    - Perceptual report of the Environmental administration
    - Perceptual report of the Landscape administration
- Request Basic Project of the environmental Licence (According to IPPC)
- Study of Environmental impact if required

To process the power grid

- Project/ budget for the electric connection

For more info you can view:
http://www.biogasregions.org/dump/AdmframeworkconditionsERE_82.pdf

According to *Real Decreto 324/2000, de 3 de Marzo*, which basic laws for planning pig farms are established, it is compulsory that biogas installations use residues from the pig sector (sludge, manure and slurry), and they must save a prudential distance of 1 km from other agricultural installations related with pig farms and industries and inhabited areas.

- Royal Decree RD 1429/2003 applies Community law (Regulation CE1069/2009 applicable to animal by-products not intended for human consumption and products thereof (SANDACH), requiring pasteurization or sterilization measures for residues of class II and III respectively.

The legal requirements for setting up biogas plant are:

- Urban permit
- Environmental permit (subjected to fees payments proposed by each town hall)
- Building permit (subjected to fees payments which will increase a 3-4% of the cost of the project investment)

2.8.10 United Kingdom

The process for gaining planning permission used to be quite simple in regards to an application form would be submitted, which required a simple drawing and a letter. However the process has become increasingly more complicated.

Now planning officers are reluctant to visit sites until a formal request has been made for consultation, this visit may concur a charge. Prior consultation is advisable as is also carrying

out a scoping and screening assessment. This will determine if an Environmental Impact Assessment is required. A scoping report will detail what environmental information the council will need when considering if the AD plant can go ahead. These assessments can incur high costs, so you must decide what level of assessment is needed. Planners will be looking for specific information that will demonstrate that the AD plant will not affect the quality of life of the surrounding residents and if the development is a worthwhile project.
It is always advised that you present the correct information to planners and the Environment Agency in order to have your AD plant built.
Check out the link below - http://www.biogas-info.co.uk/index.php/ad-investment-checklist.html for an AD checklist.

Before starting any major plans for an AD plant it is best to look into the grid connection available in the area. It is best to do this before you get too in-depth as it could add anything from £100,000 plus to the cost of installing AD on farm. It is best to use an independent company who specialise in renewable energy connections. If the project is guaranteed to go ahead they'll often find out in there is a viable connection near the farm and they'll act on your behalf to do the paper work and to make an application for the Point of Connection. They will then do the Contestable Work which would include the cost of the cable, transformers, attaching the electricity to the generator etc. However there is only 1 free chance to do this, so it is vital that you have done your applications and paperwork for the AD plant and before you give the go ahead for one of these companies to put the application in. These companies are listed on the Lloyds Register, they are qualified and only companies who are allowed to link to volts are allowed to be listed.
More information can be found at: http://www.lr.org/default.aspx

It is best to contact the Distribution Network Operator (DNO) Companies (http://www.nationalgrid.com/uk/Electricity/AboutElectricity/DistributionCompanies/) as they list the energy providers in each area of the UK who will be able to help accordingly. This information can also be gained during the Feasibility study but would potentially be something to look into before paying for this to be carried out. This would not be such an issue for a farm near an urban area or a grid connection but would prove a costly investment

for a rural AD plant which is not near a grid connection, has rivers, major roads, railways and canals to route across!

The DNO can take a while to get back with the information and their interest in the connection will depend on the nearest point to connect to the AD, the size, scale and energy out-put to be produced. DNO's can also be very expensive so it is best to use a company off the Lloyds Register who can do the work for you and advise you on your applications and paperwork.

From April 2012 scale energy installations built on agricultural or forestry land will be exempt from planning permission under amendments made to the English Town and Country Planning Order. This means that farmers building an AD plants on farming or non-domestic do not need planning permission. However the structure needs to be a on a ground area below 465 square meters.

The legal requirements for setting up biogas plants are:

- Planning permission.
- Environmental Permits
- Environment Assessments
- Waste Licences – permission to handle / NVZ regulations to spread digestate / know what is coming out – pasteurise to kill pathogens / diseases.
- Legal Agreements – with Network Operators –this is needed in order to export electricity and puts in Way Leaves which allows access onto land at anytime in order to access the power lines or transformers etc.
- Planning Notice – this is put up by the Council once an application has been made and gives notice to people living in the area that a Planning Application has been put in.
- Standard Regulations 15, 16 & 17 need to read and followed and should be adhered to when making a planning application. They can be found on the Environmental Agency website. http://www.environment-agency.gov.uk/business/topics/permitting/118404.aspx. If you can demonstrate that you have followed these rules then your application should go through without a problem.

Steps and approval needed for a biogas plant set-up in order to guide farmers in the process.

Name of the required document	Piece of legislation requiring this document	Institution/ department where to present this document	Contact details or website of the institution/ department	Requirements to complete the document
Procurement and Construction Plant procurement is typically initiated before seeking planning approval or in parallel, where the technology selection will likely effect the planning application. Binding contracts will be subject to the developer or owner obtaining the necessary consents.	No legislative requirement, but may be required by financing organisation, and may be necessary to inform planning application.	N/A	N/A	Fundamental principles which will apply each time and which should be incorporated into the contract: • Guaranteed annual energy output; • Scope of work by supplier; • Construction period; • Testing procedures; • Completion or take-over procedures and requirements; • Performance tests; • Operation and maintenance requirements; and • Conseque

				nces of underperforming plant.
Planning Permission Planning applications may include: • Site plan and elevation drawing • Photomontage of the digester and plant buildings • Information on grid connections • Details of emissions to air • Details of vehicle movements and access • Landscaping provision • Site management measures during construction • Details of community consultation The approval process includes statutory and public consultation and a statutory determination period.	Town and Country Planning Act 1990 in England and Wales, and Town and Country Planning (Scotland) Act 1997	The relevant Local Planning Authority	Local Authority details available at http://www.planningportal.gov.uk	Small scale AD facilities using only on-farm waste may be passed as Permitted Development, at reduced cost and avoiding public consultation, but it is recommended engaging with the local authority in the early stages to confirm this.
Environmental Impact Assessment (EIA) Submitted with Planning Application where Local Planning Authority deem it necessary.		Local Planning Authority		All large AD plants accepting over 50,000 tonnes of waste per year, or those in a sensitive location e.g. conservation areas, Green Belts,

				or in close proximity to residential areas are required to complete a EIA, others may also be required to do so.
Environmental Permit All AD plants require an Environmental Permit or Permit Exemption to operate and spread digestate. This confirms that the plant, operations, and related activities are safe and will not cause harm to the environment. The cost of application and required details vary, and all permits are subject to annual review and subsistence charge. There are three application types: • Exemptions (T24 and T25) - apply to small scale plants using non-waste feedstocks • Standard (SR2012 No. 12) – applies to plants processing less than 100 tonnes per day, and 200m form the nearest dwellings. Generic risk assessment is available to demonstrate compliance with conditions of the Standard rule permit.	Industrial Emissions Directive	Environment Agency	www.environment-agency.gov.uk National Customer Contact Centre, PO Box 54 Rotherham S60 1BY 03708 506 506	

• Bespoke – for all others Applicants must have planning permission or exemption, have a written waste management system, have a site condition report, and demonstrate technical competence.				
Distribution Use of System Contract (Electricity) Where an AD plant connects to the transmission network, the developer must enter into a connection contract with the Distribution Network Operator (DNO). This will detail the obligations to each party and the charges to be paid to the DNO for any network alternations. Note DNOs do not buy or sell electricity, see PPA below.	ROO	Evidence required by Ofgem accreditation for ROCs or FiT	Distribution Network Operators listed at https://www.ofgem.gov.uk/electricity/distribution-networks/gb-electricity-distribution-network	
Network Entry Agreement (Biomethane) Where biomethane will be injected into the national gas grid, the developer must enter into a connection contract with the Gas Transporter (GT). An initial enquiry with the GDN will detail the distance, cost and		Local Gas Distribution Network operator Health and Safety Executive	Gas Distribution Network operators listed at https://www.ofgem.gov.uk//gas/distribution-networks	

capacity of the most suitable entry point. The subsequent NEA will detail the technical and operational conditions for the connection including a specification for gas entering the grid. Biomethane injection must comply with the Gas Safety (Management) Regulations 1996 enforced by the Health and Safety Executive. Note the GT does not buy or sell gas.				
RHI Registration (Biomethane) The biomethane producer must supply: • Process schematic showing point of entry to the network, • Assurance that the biogas is derived from biomass, this may include details of source and pretreatment, • Assurance that the biomethane meets or is expected to meet all of the HSE requirements on gas safety, and consumer protection requirements regarding Gross	RHI	Ofgem	RHI.enquiry@ofgen.gov.uk 9 Millbank, London, SW1P 3GE 020 7901 7000	

Calorific Value; and • Extracts of contracts and a Network Entry Agreement with the relevant DN.				
ROO-FIT Registration All AD installations should apply to Ofgem for ROO-FiT accreditation. Firstly a generator must create an account at www.renewablesandchp.ofgem.gov.uk Via this account, the developer completes an application for accreditation, making relevant declarations. Applicants must supply the following: • Copy of planning permission or evidence of exemption for example a Certificate of Lawful Use or Development from the Local Authority. • Evidence of grid connection agreement, including grid connection offer letter, signed acceptance of that offer and evidence of	ROO and FiT Order	Ofgem	ROOFIT@Ofgem.gov.uk Renewables & CHP Team, 9 Millbank, London, SW1P 3GE 020 7901 7310	

payment, or evidence that grid connection is not required. (Note off-grid plants are not required to supply this evidence) Generators < 5MWe installed capacity must make a one off choice between the RO and FiT.				
Statement of FiT Terms To receive FiT payments the generator must approach a FiT Licensee who will register the installation on the CFR. This requires confirmation of FiT accreditation. Agreement between the generator and FiT Licensee must be made before FiT payments can be made. Includes the principle generation terms: • Tariff code, eligibility date and period • Tariff date, generation and export tariffs • Frequency of payments and details of process by which data is provided • Complaints procedure, details of	FiT Order	Ofgem		

process for switching and termination rights.				
Power Purchase Agreement (Electricity) A legal contract between an electricity generator and an electricity supplier, outlining the conditions and pricing that will govern the supplier's purchase of electricity.	No legislative requirement, but may be required by financing organisation.			
Off-take Contract (Biomethane) A legal contract outlining the conditions and pricing that will govern the gas supplier's purchase of biomethane from the producer.	No legislative requirement, but may be required by financing organisation.			

Other considerations depending on the type of plant and feedstocks include Animal By-Products Regulations, PAS 110 accreditation for digestate. It is also recommended that plants carry out a risk and hazard assessment, further information and useful links on these issues can be found at http://www.biogas-info.co.uk/index.php/regulations-qa.html

3 High-quality input material

Choice and assuring of optimum inputs are one of the fundamental presumptions of economic effective operation of biogas plant. Payoff of the plant is assured only under the condition of fluent operation, i.e. guarantee of sufficient sources of high-quality incoming raw materials for fermentation and following production of biogas. If the operator does not have inputs from own sources, it is necessary to find long term supplies of high-quality input raw materials via contracts. Using the pig and dairy manure and slurry secures constant input of this biodegradable material. However even in those cases it is necessary to include as well other materials e.g. to improve the substrate quality by increasing the share of dry matter.

Project **BioEnergyFarm** gives information on the feasibility of bioenergy and biofuels in the agricultural environment for farmers, foresters and landowners. For more information click here http://www.bioenergyfarm.eu

3.1 What kind of raw materials can be processed in biogas plants?

Biogas plants can effectively process vast range of biodegradable materials, including those which are difficult to process:

- Residues from pig and dairy production,
- Residues from other animal production,
- Residues of agricultural crop production,
- Green wastes (grass, leaves, but not wood),
- Biowaste from households and gardens,
- Food with extended expiry date,
- Biowaste from canteens, restaurants and hotels,
- Biowaste from bakeries, distilleries, breweries, sugar refineries, meat processing factories,
- Energy crops (e.g. corn, beet, hay).

Animal excrements are a suitable source for biogas production. On one side there is only relatively small production of biogas from excrements, however such production has as well many advantages. When connected to animal production, this is a secure source of material which would have to be managed in other, less efficient, ways. It contains bacteria helping the decay process in fermenters and thus increases the biogas production from other materials and the digestate from manure and slurry is a valuable fertilizer, which fulfills the nutrient cycle on the farm.

3.2 Long-term supply

Long term supply of high-quality incoming materials is essential for viability of the biogas plant. Ideally, the farmer is also the operator of the agricultural biogas plant and thus provides most, if not all, input materials himself. In case the operator depends on external suppliers, it is necessary to sign legal contracts. The contract should contain two parts. The basic part contains long term valid conditions, e.g. period of validity of the contract, standard of supplied input materials, general pricing progress, a progress when lower-quality material is supplied and under what conditions it is possible to withdraw from the contract. The other part of the contract should contain a clause enabling to state a specific kind and amount of supplied materials for the actual year, and actual price per unit.

3.3 Transportation distance of raw materials

Economic attractiveness must be taken into account when transporting input materials. In case of liquid manure, it is recommended to minimize the distance as the biogas yield is low. Ideally, the biogas plant should be placed directly on the farm, and liquid manure should be transported the simplest way.

3.4 Country specific info

3.4.1 Belgium

Straw and other energy crops can be used in addition to manure in Belgium.

Input streams (ton/y) for AD PLANTS (35)	**Manure**	**Energy crop**	**Industrial/agricultural waste (OBW)**
2008	119,400	49,350	649,100
2009	219,800	73,700	698,800
2010	415,080	148,950	848,900
working + construction	537,120	189,380	955,020

working +construction + licensed capacity	790,820	434,680	1,331,020

There are many biogas plants currently operating in Belgium since 8-10 and also 15 years. Often the biogas plants are self-sufficient with feedstock they need. This is because there are many medium/small farrms both in Flanders and in Vallony which produce all the materials on site. However there are also farmers associations who decided to install a common biogas plant cooperating in management, investment and feedstock aspects.

For the legal regulations, there is no analysis required for the owner's farm substrate. Substrate coming from other farms or industry must be mentioned in the environmental permit. The solid manure storages have to be dimensioned according to the type of manure produced. This is imposed by the Ministry.

3.4.2 Croatia

According to the census of agriculture from 2003, the average family farm consisted of 2 ha of land, and only 21% of the agricultural land in private ownership is cultivated. Businesses own an average of 159.2 ha. There are 44.560 dairy producers in Croatia according to the same source, 96% of which own less than 15 cattle, 32% of business own less than 20 cattle and only 86 of them own more than 100. In 2003 the average number of pigs on a family farm was 8, and 464 for business. 90% of the production is in the hands of 200.000 small farms, 170.000 of which own less than 10 pigs.

These numbers show the state of the agriculture in Croatia. Most of the production is in the hands of small family farms that simply don't have the capacity for a biogas plant both on the fuel input and the demand side of the equation.

The quality of biogas is regulated by the Law on the Quality of biogas (NN 141/05)

3.4.3 Cyprus

In Cyprus problems with long term supply of raw materials have been identified. The materials that do not depend on seasonality and periodic availability are those produced by the animal farms where the biogas plants are located. However, the sustainability of supply chain especially for those wastes that are available seasonably has been reported and identified as one of the major barriers of long term supply in Cyprus. Moreover, the distances for raw material transportation are a limiting factor as well. However the distances in Cyprus are

relatively small, feasibility studies have shown that the cost/benefit distance radius is about 30 km.

Also, common phenomenon is the suspension or cancellation or in some cases the total absence of supply agreements. The raw material suppliers avoid the payment of any fees for the disposal and treatments of their wastes and some others request compensation for the supply of raw materials.

3.4.4 Czech Republic

Most of the biogas plants in the Czech Republic are agricultural plants. However the major input material is corn silage as it is the material with one of the highest biogas yields.

The animal production has dropped significantly after 1989 and has not recovered ever since. This is the reason why farms with animal production are mostly having large crop production.

Newly there has been a development of grass silage production and use in biogas plants. This has been connected with the support scheme for perennial grasslands and a search for its possible utilization.

3.4.5 Denmark

In Denmark there is a common praxis of using organic waste from the food industry and households as additional material to residues from agricultural production. This waste however often requires special treatment, which is defined by the national legislation. When obtaining the national regulation, this waste can be however a very valuable additional material for biogas production.

There are three laws that concerns materials used for anaerobic digestion

- Biproduktforordningen (Bi-Product regulation)
- Slambekendtgørelsen
- Husdyrloven

3.4.6 Germany

The most common additional materials to manure and slurry in Germany are:

- Silage from Maize
- Cereals
- Silage from Grass / pasturage

- Other organic renewable and biological resources
- Catering waste
- Organic household waste
- Fat separator contents
- Residues of agricultural industries

The transport distance in Germany is dependent on substrate type - For silages short transport distances within 5 km are common. For organic industries waste the distance may be significantly longer.

To get the idea of produced biogas from different materials you can use a calculator done by a German neutral organization (in German and under German laws and conditions) (http://daten.ktbl.de/biogas/startseite.do)

3.4.7 Hungary

In Hungary, the most common materials used together with manure and slurry for biogas production are residues from:

- food industry, fruit and vegetable processing waste, distillery waste and residues,
- Slaughterhouse and meat packaging waste (e.g. rumen-, stomach-, intestine content, trimmings, expired meat products, etc.),
- wholesale market vegetable waste,
- plant cultivation waste (e.g. beet leaves, corn-stalk, rotten fruits or vegetables),
- cut grass, hay,
- energy plants grown for that purpose (e.g. maize for silage, sweet sorghum, energy grass, different types of beet, Jerusalem artichoke, etc.).

There is a risk in continuous supply when operating large scale plants, because it will be more dependent on the material sources. The availability of targeted input materials and the predictable costs of transportation should be considered in the planning phase by selecting the proper location for the plant. For example, it is cheaper to transport solid manure (e.g. from dairies or cattle farms) than liquid manure (e.g. from pig farms), so building the plant closer to the source of liquid manure is recommended.

A good example is Nyírbátor (3,5 MWh) which was the first large scale plant in Hungary and works since 2003. They are continuously working on the optimisation of the processes to reduce operating costs, researching and developing new methodologies in order to be able to feed in additional materials to the fermenter, finding additional sources of income by extracting, separating and selling components from specific input materials before processing.

3.4.8 Spain

The most common by-material in addition to manure and slurry in Spain is waste from agrifood industry, such as sludge from slaughterhouse waste industry, gelatine and glycerine. It is also frequent the use of fruit pulp which is not harnessed in other fields such as cosmetics, chemical, etc.

In Spain the experience with long-term material supply is still short, but it suggests that the constant availability of waste is a problem. The remuneration charged for waste entering in the plant has fallen.

The typical transport distance of materials for biogas production is in Spain less than 15 kilometers.

3.4.9 United Kingdom

Additional to manure and slurry in Great Britain there is the potential in using other materials as there are 534,200 tonnes of commercial waste, 382,000 tonnes from food and drink manufacturing, 136,156 tonnes in farm-based plants, 1.1M dry tonnes of sewage sludge.

Biogas Output from Various Feedstocks

Feedstock	*Biogas yield (m^3 per tonne)*	*Equivalent value (£ per tonne)*
Cattle slurry *	15 – 25	4.00 – 6.00
Pig slurry *	15 – 25	4.00 – 6.80
Poultry	30 – 100	8.10 – 27.00
Maize silage	200 – 220	25.00 – 30.00
Grass silage *	160 – 200	20.00 – 25.00
Whole crop wheat	170 – 190	30.00 – 40.00
Crude glycerine	580 – 1,000	155.00 – 270.00
Rapemeal *	600 – 650	160.00 – 170.00

*Rapemeal affects gas and how much it needs; rapemeal can act as a balancer but does affect how much the gas will need cleaning.

* There is no value on cattle and pig slurry if they are not using it. However a cost of savings made from fertiliser should be put against this.

* Grass silage – 3 cuts of silage can be made a year so the clamp would not need to be as big as for maize as it can be stored and used before the next cut is made.

Any crop grown specifically for AD is not waste (the main purpose of the plant has to be to reclaim energy).

The Environment Agency considers manure and slurry used as feedstock to be classed as wastes. The site must hold an Environmental Permit.

If feedstock material contains any food waste or any other waste which is covered by the 'Animal By-Products Regulations' then the facility will be subject to full requirements.

If other wastes such as food waste are digested on their own or with manure, slurry or crops grown for AD, then the storage and spreading of the digestate on land will require authorisation (permit/exemption).

Chicken manure is deemed to be too rich and unbalanced a feedstock due to its high nitrogen content, but does lend itself to co-digestion with other slurry wastes.

A significant proportion of AD plants did use Glycerol, but due to the licensing and paperwork associated with using it and the high cost, Glycerol is now being shipped to Europe where the regulations are lower and it can be used freer.

Securing a reliable and long term supply of a feedstock is essential to the profitable and long running of an AD plant. If a third party is involved in supplying feedstocks then a long-term contract and supply contract is vital. Units should be self sufficient in producing their own feedstocks for the AD plant, or it is essential to create a long-term agricultural contract. This would be ideally suited to an arable farmer who could incorporate growing grass or maize into their crop rotation. If you are using a finance company to build the AD plant they will want a Long-term feed contract as a pre-requisite.

It is always best to have a closed loop for the supply of feedstocks to the farm. Distances should be short and either on farm or should be coming from a neighbour. The distance the feedstock travels should be taken into consideration when looking at costings as transport will cost a lot. Domestic wastes should be the only wastes that travel a distance, but using domestic wastes bring stricter licensing laws with them.

For the input materials to biogas plant you need to follow those regulations

- Standard Regulations 15, 16 & 17 from the Environment Agency.

- Domestic Waste will need a County level application
- On-farm waste will be a District level application.

- Environmental Health Officers may also become involved due to the potential noise and odours that occur during the AD process.

4 Biogas yield from different materials

Biogas production differs significantly from kind to kind of particular input material. The amount of biogas and its composition is as well influenced by the quality of input and technology used as well as by operation parameters. Biogas yield does not only depend on character of input material (substrate) but must be evaluated under specific conditions, e.g. way of operation, temperature, retention time. That is why the same substrate can show a vast range in biogas yield.

FP5 project **3A-BIOGAS** solves the generation of energy from which could be applied, in particular, to the production of biogas for fuelling gas turbines in CHP plants or for driving fuel cells. For more information click here http://www.3a-biogas.com

4.1 What does biogas production depend on?

When assuring raw materials, it is necessary to take into account which features contribute to the biogas production the most. Measurable production of biogas is often compared to dry matter. The estimation is not always easy as the material can contain, depending on the quality, very different levels of dry matter and nutrients important for the biogas production. This is especially the case with such coherent materials as manure and slurry from dairy and pig production.

Another important quality parameter of raw materials is the so called organic dry matter. Organic dry matter is the amount of burnable substances. It is the organic dry matter that is processed with help of microorganisms and transformed to biogas.

4.2 Biogas production estimation

The overview of potential biogas production based on known raw materials reachable for purposes of processing in the biogas plant should be already part of the feasibility study. To

obtain accurate estimates of biogas production from a particular material, it is possible and recommended to carry out tests in a laboratory. Some on-line calculators are available for a first estimation on the biogas production potential as the ones seen in the Geronimo 2 web portal (http://energy4farms.eu/biogas-calculator/) and in the IEE project Bioenergy Farm (http://www.bioenerqvfarm.eu/en/the-portal/scans/ADPC).

4.3 Optimum composition of raw material mixture

A digester, where the process of anaerobic digestion takes place, can be compared to a stomach where incoming materials are processed with help of several kinds of microorganisms and biogas is produced. Thus we speak of a vital process that is sensitive to quality and change of optimum conditions, especially constant temperature and pH. Fault "nutrition" and unsuitable conditions may lead to reduction of biogas production or even to termination of the digestion processes.

To sustain optimum operation processes, it is necessary to keep a uniform composition of incoming materials, and to change materials only slowly within months. The rate of flexibility differs of course with each particular technology.

4.4 Country specific info:

4.4.1 Cyprus

For the preparation of the National Action Plan for Biomass in 2008, a survey has been contacted from the Energy Service, Ministry of Commerce, Industry and Tourism in order to determine the biomass potential in Cyprus. This survey highlighted a remarkable biomass potential of animal manure and slurry form the pig and dairy farms in Cyprus. Furthermore in the technical report "Estimation of the National Potential of Cogeneration in Cyprus" there is an analysis of the energy potential from biomass with case studies. In addition, surveys about the biomass potential have been contacted by the Cyprus Federation of the Biogas Producers and by individual investors.

The Biogas Production in Cyprus is based mainly on Pig Manure, chicken Manure, Cow Manure, Slaughter house waste, Boucher Waste, Glycerin, used cooking oils and residues and mainly from mixures from those materials. The biogas production estimate is 25.000.000 m3 Biogas/Year. The 6% Organic matter in the input substrate is the optimum mixture. Below

this percentage it is reduced the capacity usage and below this it is reduced the efficiency of decomposition and risks overloading.

In Cyprus there is a lack of fresh water supply and therefore a non satisfactory production of renewable crops.

4.4.2 Czech Republic

There are several tools informing about biogas production and calculating the amount of produced biogas from different materials. A simple tool giving a major overview of a biogas plant and enabling basic calculation of biogas production from manure and slurry can be found here: http://www.bioplyn.cz/bs_vypocet.htm

4.4.3 Germany

There have been several studies done dealing with biogas yields from different substrates. Here are some of the examples:

- http://www.energieverbraucher.de/de/Erneuerbare/Biomasse/Biogas__1090/ContentDetail__5998/
- http://www.mp.haw-hamburg.de/pers/Watter/Stud-Projekte/Biogascampus/Biogascampus.pdf
- http://www.unendlich-viel-energie.de/de/bioenergie/detailansicht/article/105/potenziale-der-bioenergie.html

4.4.4 Spain

For the calculation of biogas potential from different materials under the specific conditions in Spain, this calculator can be used: http://www.giroct.net/ca/el-centre

In Spain due to lack of fresh water and the characteristics of agriculture, not much maize is grown and therefore not much silage is produced from this kind of crops. There is although, a very important fruit and citrus agriculture which has a lot of subproducts which would be suitable for becoming co-substrates for the biogas production process. Also, there is a lot of variation among regions in Spain (driven by very diverse climate zones), which makes the availability of materials for the digester very different between different parts of the country. A common practice in plants around Spain is to use a mixture with around 60% manure plus other materials such as food waste, glycerine, slaughterhouse waste etc. In table 1, prices and yields from several different feedstock materials are shown for Spain and in particular for Catalonia. As it is observed, animal waste is the most economically accessible material, a part from sewage sludge (for which you are paid for digesting in biogas plants if it comes from

water treatment plants), and agricultural materials are expensive. Note that costs for the animal waste are based on the cost of transportation of the manure or slurry, taking into account human resources and energy consumption.

Feedstock	Cost per ton (€)	M3 Gas per Ton	kW el per Ton
PIG SLURRY (m^3)	6	20	40
COW MANURE (m^3)	6	65	120
POULTRY MANURE (m^3)	6	75	150
RAY-GRASS SILAGE	60	125	250
MAIZE SILAGE	65	190	380
FORAGE SILAGE	60	-	-
OATS	218	570	1140
BARLEY	235	527	1054
SEWAGE SLUDGE	- 24	224	448

Prices and biogas production yield for different feedstock materials in Spain. Source: Daniel Barios/IRIS

4.4.5 United Kingdom

For the calculation of biogas potential specific for United Kingdom you can use a tool done by the NNFCC, which have a cost calculator on their website. However you need to be a member to access this information.

http://www.nnfcc.co.uk/tools/economic-assessment-of-anaerobic-digestion-technology-and-its-suitability-to-uk-farming-and-waste-systems-ad-cost-caculator-tool-nnfcc-10-010

5 Timely and continuous cooperation with local authorities and citizens

Reaching a positive stance with local authorities and public is one of the key presumptions of implementing a biogas plant in a chosen locality. This should be treated in the initial phases of the project. To be in good books with locals is an investment that pays off. Insufficient awareness from the public may cause negative perception of the whole project, and may jeopardize its implementation. In some cases, the project may become means of local political activities.

Project **BIOGASACCEPTED** creates tools for increasing biogas acceptance by the general public as well as for addressing regional actors and consumers, plant operators, neighbours and local politicians. For more information click here http://www.profactor.at/biogasaccepted/index.php?id=2&L=0.

GreenGasGrids project brings public and private biomethane stakeholders together in order to reduce the most hindering barriers and jointly setting up strategies for the promotion of biomethane injection and utilisation for heat, electricity and vehicle fuel. For more information click here http://www.greengasgrids.eu

5.1 Cooperation with local authorities and citizens

Already when planning, the investor must take into account critical questions raised by neighbours and bureaus. Key to success is a correct relation with the public. Investors should not underestimate this fact. They should care for timely and standing communication with local authorities and citizens, and good relationships with them. The later the investor starts with communication the higher the risk is for the whole project.

Also insufficient awareness of public means a big problem. Prejudice or bad experience with some other installations (not necessarily biogas plants) can spread very fast. The most often negative critics are:

- fear of problems with unpleasant odours
- fear of high load of traffic
- fear of noise and emissions
- wrong information that input materials are burned in stations and thus dangerous emissions rise, etc.

These fears do not necessarily mean the termination of the whole project. However, if the public do not feel to be taken seriously enough and emotions prevail over facts, the project can become means of political powers fight. Popular initiatives may provoke local authorities to adopt a negative stance on the whole project, e.g. by signing petitions.

Investor should timely act in such a way to precede negative progress:

1. In the initial phase, make local authorities and political representatives acquainted with the construction project
2. closest neighbuors should be addressed and made acquainted with the project
3. wider public to be addressed, e.g. by media
4. raising public awareness must be carried out continuously

5.2 Country specific info

5.2.1 Belgium

In Flanders there is a good way of cooperation among farmers and between farmers and authorities. Biogas-e (Flanders biogas Agency) and REA (Renewable Energy Agency) represent a good opportunity for stakeholders to be in contact with government grants, conditions and new legislation aspects. In Wallon Region there is a strict cooperation mainly between universities and government, this should lead to the possibility to starts in new biogas projects and feasibility study

5.2.2 Croatia

There are no specific laws regarding biogas plants in Croatia, instead they are covered by the laws on the use of renewable energy and cogeneration. According to the Gas market law (NN 40/07) biogas is equivalent to natural gas and all rules regarding natural gas are valid in regards to biogas. The quality of biogas in transport is regulated by the Law on biogas in transport (NN 65/2009).

5.2.3 Cyprus

In general in Cyprus the biogas plants are located in the area of the farms therefore there is no public opposition at least not for the AD plants. There is the “not in my back yard syndrome” mainly for farms and not for the biogas plants, as are considered environmental friendly

developments. There is however a lack of information in Cyprus regarding the biogas utilization, especially on the owners of the farms.

The way of informing citizens about the biogas plan are given in the framework of Aarhus Convention and related EU Directives.

5.2.4 Czech Republic

The public relation is very important in the Czech Republic when planning and operating the biogas plant. This has been proven on several negative and positive cases in the past.

As there have been several cases of not well working biogas plants where it came to air and water pollution caused by the plant operators, there public awareness has significantly increased. This is an issue which is necessary to address the best by early communication with the neighbours, providing them with all relevant information and organizing for example study visits to already well running biogas plants.

5.2.5 Denmark

The cooperation between authorities and citizens in Denmark on the topic of biogas production is overall good. As a major difficulty the long process for applying for all the permits could be addressed.

It could be of great benefit to hire a person that is used to negotiate and know the rules. It is also very important as stated earlier that you involve all parties / interest groups as early in the process as possible.

When informing the citizens, there is as well a regulation defining the required info which has to be distributed among them.

5.2.6 Germany

The cooperation between authorities, citizens and biogas operators is in Germany on a very high level. This has developed from the experience that timely dissemination helps to prevent any negative tensions. As well due to the fact that Germany has a well developed biogas market, citizens had already the chance to get to know the technology and its benefits in advance.

When planning larger plants and in special cases it is required to publish the plans of the biogas plant and to ensure the civic participation in the permit procedure.

5.2.7 Spain

There is little experience of cooperation, due to the small number of projects. Anyway, there is an important reference**:** The Valle de Ultzama project. For more information you can visit the web site:
http://www.bioenergyinternational.es/noticias/News/show/biogas-en-ultzama-gestion-de-purines-y-produccion-eficiente-de-energia-433

There is a good example of well done public relations during the planning and operation of a biogas plant in Spain. More info about the good example in Valle de Ultzama can be found here: http://www.valledeultzama.com/empresas-en-el-valle/bioenergia-ultzama/

On the other side an example of how a lack of communication can lead to major difficulties in Spain can be presented through the case of Armentera's Town Hall, which did not access to give municipal and building permit to install a biogas plant that already had all the administrative permits and even an agreement with the Town Hall (previous government) to give hot water to 60 houses of the village.

Any project involves a process of public exhibition during which any citizen can file claims.

5.2.8 United Kingdom

It is really very important that the farmer should engage with the local community so they have a good understanding of what you are planning on doing. Most negativity comes from lack of education and understanding. Most concerns would be about noise and odours.

Most people will comment on a planning application if they are unhappy with the application. Most concerns are about the increased noise, traffic and potential odours that could potentially come with the AD plant. There are also concerns, in some cases, that Public Rights of Way may be restricted or animals using the PRoW will be scared during the building and use of the site. However these concerns can be rectified by educating the local community on what you are planning to do. Hence it is important to ensure that you work alongside the community and with the Environment Agency, Natural England and the Planning Authorities.

Once a planning application has been received the council need to inform the local community, this is done via a planning notice which will appear in the local paper, on the council web site and a notice will be put on posts around the locality. This lays out what the application is for and gives the chance for the local community to appeal.

6 Reliable and certified technology

Each biogas plant is unique in its own way. The choice of a particular technology depends on implied mixture of substrates, local conditions, fermentation temperature regime, use of fermented outputs, etc. Investors should decide on the basis of the feasibility study which proposes the optimum technology for the implied composition of biomass.

The **Bio-methane Regions** is a project which seeks to promote anaerobic digestion and biogas upgrading technology, along with market development of the resulting biomethane for grid injection and vehicle usage. For more information click here http://www.bio-methaneregions.eu.

The **SEBE** project aims at coordinated further development of biogas utilization, technology and transnational competence knowledge centre within the CENTRAL program area. For more information click here http://www.sebe2013.eu.

The **Smart-Tank** project will develop a reliable thermophilic AD system with closed-loop control that will give a clear technology differentiated product and offer many benefits to farmers. More info: http://www.smart-tank.eu

6.1 Basic distinction between various biogas plant technologies according to the original dry matter

Based on the amount of dry matter in processed incoming substrate two basic types of biogas plant technologies can be distinguished: The wet and dry digestion.

Wet digestion usually uses vertical digesters, and the material in these contains apx. 12% of dry matter. That means that before entering digesters, materials containing higher amount of dry matter (manure, beddings, various kinds of silage and hay) are diluted by liquid manure or process water already separated from fermented sewage. Pig slurry is on the other side a material with low dry matter and an addition of other materials to optimize the level of DM is

recommended. Excessive amount of straw (even the shredded one) or even sawdust-based beddings may cause severe process problems in moist technologies, e.g. mixing system failure, formation of encrustations, pump blockage, etc. Hence, it is necessary to thoroughly consider the used technology, mixing systems, raw materials preparation so that the process can function flawlessly. Nowadays, most applications are based on wet technologies.

6.2 Temperature regime of the fermentation process

In order to reach a steady production of biogas, a stable temperature must be kept in the digesters. There are two temperature zones used, the so called mesophilic zone with temperature around 37 °C and the thermophile zone with temperature around 55 °C. In spite of the fact that the digestion process runs faster and theoretically better under the temperature of 55 °C, most of agricultural biogas plants use the mesophilic regime. There are several reasons, e.g. lower amount of heat is needed to keep the temperature level, process is less vulnerable to temperature fluctuation caused by accidents, start of the process is easier because bacteria contained in animal excrements is used to temperatures around 37 °C. Thermophile regime is recommended for more complicated industrial technologies or for rotting out tanks in sewage plants as higher temperatures dissolve fat better.

6.3 How to choose the correct technology?

The choice of a particular technology depends on implied mixture of substrates, local conditions, fermentation temperature regime, use of fermented outputs, etc. Investors should decide on the basis of the feasibility study which proposes the optimum technology for the implied composition of biomass.

Choice of technologies is also influenced by the price of its implementation, however, reliability of the station together with reduction of unplanned costs should also be considered. Investors should address several potential suppliers in the selection procedure. Investors should also clearly define basic demands and assumed parameters of the biogas plant. All offers must initiate from the same parameters.

Potential suppliers should describe the following in their offers:

- references of existing implementations of digestion technology and combined heat and power unit,

- guarantee of operation stability and biogas yield, including references of implemented stations (period of operation and biogas yield should be 7500 hours per year, ideally 8000 hours per year),
- service conditions, including unplanned outage plan, description of warranties, e.g. charges for unplanned outages and reparations, guarantee of profit lost,
- post-warranty service and professional help when putting the station into practice,
- assumed operating life.

Potential investors must also have sufficient insurance coverage in case of accidents caused by construction and construction deadline must be stated. Another criterion for selection of a suitable supplier is experience and references given by operators of a chosen technology.

6.4 Country specific info

6.4.1 Belgium

There is no special technology being used specifically for Belgium. Only due to the strict regulation of the digestate nitrogen content requirement, farmers need to invest more in digestate treatment systems using a very big part of heat produced with cogenerators to feed evaporator systems and drying digested matter.

The most common technology is used in Belgium is anaerobic digestion in Horizontal digesters fed with cow manure mixed with straw in mesophilic digestion.

6.4.2 Croatia

There are currently 6 biogas plants in operation in Croatia that are considered privileged producers, in other words, they are using the feed-in tariff, with another 5 plants that have signed the contract but are yet to start distributing electricity. All but one of them are 1MW plants with the only exception being a biogas plant at the chicken farm Rosulje with an installed power of 135 kW.

Table 1 List of biogas plants in croatia, information taken from http://www.hrote.hr/hrote/obnovljivi/sklopljeniUgovori.aspx

Biogas plant	Installed power [kW]
Ivankovo	1000
Ivankovo 2	1000
Tomašanci	1000
Tomašanci 2	1000

Rosulje	135
Mala Baranjevina 2	1000
Donji Miholjac	1000
Viljevo	1000
Mala Baranjevina 1	1000
Landia-Gradina	1000
Pisarovina	1000

All of these plants use a gas engine in combination with waste heat utilization. There are no laws or regulations that specify a minimal efficiency of biogas plants, only cogeneration plants.

6.4.3 Cyprus

There is no country specific technology that is used in Cyprus. In common practice is the theoretical residence time of about 20 days with the digester temperature 38 ° C (mesophylic anaerobic digestion). The waste collection in collection tanks, Anaerobic Digesters and then processing and combustion of biogas before its burning is cooled to 15 ° C to be dried is the usual way of biogas production and utilization in Cyprus.

There are 11 biogas plants in Cyprus that utilise, among other raw materials, farming wastes. The mean capacity of a biogas CHP unit is estimated at 500kW. Currently (June 2012) the installed capacity of the biogas plants connected to the grid is 7,964 MW and the 11 plants is 3.460.000 kWh per month.

The legal requirement for biogas technology is given by the implementation of the Directive 2004/8/EC in Cyprus which has been achieved with the Law N.174 (I)/2006 for the Promotion of Cogeneration of Electricity and Heat.

Basic providence of law is the regulation of certification of electric energy that is produced from high efficient CHP, with the guarantees of origin. Furthermore, the law includes measures that ensure the access priority in the grid for electricity produced from high efficiency CHP.

6.4.4 Czech Republic

There has been a major development of biogas production in the Czech Republic. The technology predominantly used is the wet fermentation in the mesophilic regime.

At the beginning of the year 2012, there have been 264 biogas plants with the total power output 167,67 MW (source: Energy Regulatory Office).

The use of process heat is rather seldom in the Czech Republic. This is has the influence on the overall efficiency of the biogas plant. This will change significantly from year 2013, where a major drop in the subsidy support for biogas production is planned.

New biogas plants will have to implement such technologies, which will increase the efficiency to obtain operation subsidy.

As the plan for the biogas production given by the government has been already reached in advance, the feed-in-tariffs for electricity from biogas will get to a minimal level. This will cause a major challenge for biogas operators to use such technology, which will still be able to produce sufficient amount of biogas, electricity and heat to keep the biogas plant economically viable.

6.4.5 Denmark

The basic statistic for Denmark is as follows:

- 65 farm biogas plants produce 1.107 PJ biogas
- 20 Central biogas plants produce 1.907 PJ biogas

6.4.6 Germany

Most biogas plants are based on a flow-through system with pumpable substrates. Digester size and staying time of substrates depends strongly on which sort of substrates are used (only manure 30 days, mixture of manure and silage from maize 90 days).

Size of biogas plants is mostly defined by the generator power of their CHP. Depending on classification steps within the feed-in tariffs given by law, there are lots of biogas plants up to 150 kW, then up to 500 kW. Over all biogas plants in Germany the average is 420 kW (installed).

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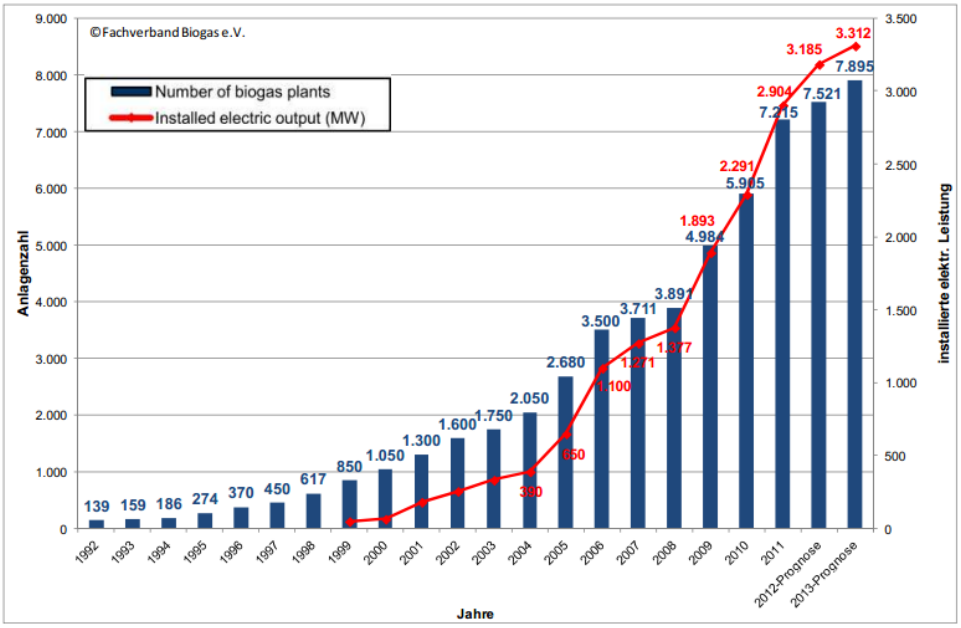
Biogas Segment Statistics 2011

Development of the number of biogas plants and the total installed electric output in megawatt [MW] (as of 6/2012)



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Biogas Sector Statistics at a Glance

	End of 2010	End of 2011	Forecast for 2012	Forecast for 2013
Number of plants (of these feeding biomethane)	5.905 (45)	7.215 (80)	7.521 (100)	7.895 (120
Installed electric output in MW	2.291	2.904	3.185	3.312
Net electricity production in MWh per annum	15 Mio.	18,4 Mio.	21,57 Mio.	22,43
Homes supplied with biogas-based electricity	4,2 Mio.	5,3 Mio.	6,2 Mio.	6,4 Mio.
Proportion of electricity consumption in %	2,5	3,03		
Turnover in Germany in €	5,1 Billion	6,9 Billion	6,7 Billion	7,2 Billion
Jobs	39.100	54.000	48.500	51.800
Export rate in %	10	10	30	36

Source: Fachverband Biogas e.V.

6.4.7 Hungary

In Hungary biogas plants with biogas production in mesophilic system are mostly used. The average size of a biogas plant is with the power outcome 500 – 600 kWhel.

6.4.8 Spain

There is no specific Spanish technology. Mostly a Danish and German technology is being implemented. There are enterprises that have created joint ventures with enterprises of these nationalities and they are installing their technologies. There are no special technologies used in Spain that differ from other countries, apart from varying the amount and type of materials used as feedstock for the digester.

The kind of digester tank used is the one with complete mixture, with mechanical agitation. The most used technology is the wet, mesophilic anaerobic digestion with a manure input of around 60%.

Most of the plants in Spain are between 250-500kW, which is the typical size of active plants. However, there are also bigger installations, above 500kW, and smaller installations, of around 100kW. These smaller plants are becoming more and more interesting for solving a manure problem for farmers and providing them with heat and energy since selling electricity to the grid is not viable economically at the moment in Spain.

Currently there aren't any legal requirements defining the efficiency of the technology. With the previous regulation of the production of electricity in special regime (currently abolished) there was an efficiency add which let to increase the bonus. These add was calculated as following:

$$\text{Add or efficiency} = 1{,}1 * \left(\frac{1}{\text{REE}_{\text{min}}} - \frac{1}{REE_i}\right) * C_n$$

REEmin = minimum equivalent electrical performance of the technology

REEi = equivalent electrical performance accredited by the plant

Cn = cost of raw material calculated in accordance with the formulation in Article 8 of the Order ITC/1660/2009 of 22 June, establishing the methodology for calculating the rate of last resort for natural gas (published in the BOE -Official State Bulletin- quarterly)

The Equivalent electrical yield to tap into the special regime was:

For biogas > 50% (> 1MW)

> 45% (≤ 1MW)

+ add for efficiency

6.4.9 United Kingdom

The most efficient companies in the United Kingdom look towards German examples for their technology as the correct way to achieve AD.

There are 2 types of system: wet and dry. The most common in this country is the wet system. Although AD has been around for hundreds of years in the management of sludge waste in the water authorities it is still relevantly new to agriculture. The wet system is most common as our feedstocks are wet and are made up of a combination of crops and slurry. There is 1 dry based system in the UK and this is based on an enclosed composting system.

There are 4 key sizes of AD plants. Small farm-fed would typically be found on an individual dairy farm, 75 – 150 kWe, a large farm-fed typically as a large livestock or mixed farm, co-digesting with crops would be between 150 – 500kWe, small waste-fed would be an industrial fed plant possibly co-located with a food processing factory which would be between 500 – 1,000kWe and then there would be a larger commercial waste-fed plant which would be between 1 – 5MWe.

The main level of on-farm AD plants are 300kWe – 1MW with the main interest coming from arable farms. One reason for this is that is a guaranteed income even if the crop fails, or the break crop in a rotation can be harvested and used as a feedstock. It takes away the unknown of selling crops on the open market.

There is no legislation on the legal requirements for the technology; however there will be a requirement from the people funding the project who will want their money back as soon as possible. You would be looking for a minimum efficiency of 90% of the overall plant with there being the need of efficiency of CHP to produce heat and electricity:

- Technical availability – 90%
- Electricity – 40% minimum
- Heat – 42% minimum
- = 82% energy conversion.

If the AD plant is fed correctly then there should be at least 90% technical availability. This means it should be run for 90% of the time at 82% efficiency.

For further information, it is recommended to check with Defra (Department for Environment, Farming and Rural Affairs) and DECC (Department Energy and Climate Change) what the current rules are.
Historically there has been the opinion that crops should NOT be grown to into an AD plant but should be going into the food chain. However there is now a better understanding that maize is a good break crop in an arable system which can then go into the AD plant.

7 Optimizing investment and operation costs

Use of already existing premises is advantageous when building biogas plants. It is necessary to consider the real extent of use when building a new biogas plant. Thorough choice of a supplier is essential for the optimization of a future operation. Not only lowest price is a key factor when deciding, but also a perspective of total costs and profits determine the viability of a project. Minimization of faults, unplanned outages and energy consumption, together with the maximization of working hours and electricity production are fundamental for the economics of a project.

7.1 Using existing infrastructure

Speaking of infrastructure when building a new biogas plant, we usually mean the use of already existing built up sites, roads, storage tanks, local sewage and drinking water networks, storage spaces, etc.
Using the existing infrastructure can significantly influence the investment cost. When implementing the biogas plant at dairy or pig farm, many parts of the farm can be already used for the plant. This is especially the case of storage capacities for the substrates and digestate in the space where manure used to be kept. As the regulation (e.g. Nitrate directives) for digestate and manure storage are in most of the countries similar, there is no need to plan any extra storage capacities.

7.2 Choosing a supplier responsibly

A key factor of the complex process of construction and operation of a biogas plant is the thorough selection of a supplier. Comparison of offers by individual potential suppliers should not result only in the choice of an offer with lowest investment costs, but also the perspective of total costs and profits determining viability of a project should be considered.

At the very beginning, it is recommended to decide for one way of biogas plant operation – assisted or supplied. Assisted way of operation means using own specially trained and qualified staff. Supplied way means that external suppliers intervene directly. Suppliers guarantee by contract a yearly amount of produced energy.

7.3 Machinery failure rate and maximization of machinery operation

Machinery failure rate has an impact on the whole economics of the project as it shortens the yearly period of operation and requires additional costs, which changes cash flow of the whole project. Machines with highest failure rate are the rotating ones, such as motors, pumps, mixers etc., and the combined heat and power unit. Any failure of technology can cause major economic losses. Some of the parts can be exchanged only with major influence on the biogas production which can lead to lower or even to termination of the production.

Hence, it is strictly vital to keep operation instructions, especially when using digesters and combined heat and power units. The Minimum operation period is also a very sensitive parameter in the economics of the project. Economic viability of the biogas plant depends on the maximization of energy production, thus, operation time should not fall under 8000 hours per year.

7.4 Minimizing energy consumption of a biogas station

Operation costs (fuel, transport, energy consumption, etc.) significantly influence fruitfulness (economic profitability) of the project. Especially energy consumption of mixers, pumps and driving mechanisms is very high. Another significant cost is water consumption.

There are many ways of energy saving. The modern biogas plant should encounter those ways and address them already during the planning stage. Investors must seek an alternative when energy consumption is acceptable and income is optimized.

7.5 Impact of investment and operation costs on economic parameters

Investment costs are depending on many parameters already mentioned in the previous chapters.

Higher investment costs are sometimes righteous when they result in lowering operation costs or rising profits. They can be for example:

- lowering energy consumption by using a more efficient technology
- improving logistics
- obtaining technologies and materials with longer life-time
- investment in all-year use of heat
- investment in operations capable to process more types of materials

As important those costs for the planning stage are, the crucial part for the viability of the biogas plant will be the operation costs. Those can be to some extent calculated beforehand when implementing the feasibility study but as many parameters differ significantly during the life cycle of the biogas plant, it will be difficult to meet the set calculation. The costs for substrates will have major influence when using external materials and also the level of feed-in-tariffs or purchase prices for electricity and possibly as well heat.

Changes of operation costs in time may be caused by the following:

- increasing inputs price (more than could be compensated by yearly 2% growth in prices of electricity)
- legislative intervention and regulation requirements
- uncertainty in harvesting amounts in the specific year
- change in contract relationships during operation period
- both technical and use aging of technologies and necessity of their renovations, replacing, etc.

7.6 Country specific info

7.6.1 Belgium

There is no subsidy for the planning and construction of biogas plants. If in the years before governments could grant subsidies in biogas first investments, now farmers enjoy only feed-in tariffs that are calculated in an omni-comprehensive tariff for the electricity selling.

There is a feed-in-tariff system provided in Belgium in form of green certificates for electricity selling. Each kWh of electricity is paid adding the green certificate to the market electricity price.

The total cost of a Biogas plant in Belgium is estimated to be around 4,000 – 4,500 € per kWe installed. This includes the costs of a co-generation system for both heat and electricity production and adding also the cost of digester and other security and managing systems.

The operation costs are about 2% of the investment required every year for the maintenance of the facility. Then about 2 persons for 5-6 hours every day are estimated to be required for a medium-size plant in Belgium for about a 150 - 250kWe power engine.

7.6.2 Croatia

There are no subsidies specifically aimed at the construction of biogas plants in Croatia. There are funds and loans that can be used for the utilization of renewable energy sources in general. The Croatian Bank for Reconstruction and Development provides a loan with a reduced interest rate of 4% for 75% of the investment. The Fund for Environmental Protection and Energy Efficiency can also help finance such projects.

A fee for renewable energy sources was introduced in 2007. An additional 0.0089 kn/kWh was added to all electricity bills, this fee was reduced to 0.005 kn/kWh in 2010. The collected funds are used to finance the feed-in tariffs for renewable energy sources and cogeneration plants. In the case of biogas plants these tariffs are 1.3837 kn/kWh for plants with an installed power of 1MW or less, and 1.1992 kn/kWh for larger plants. These tariffs are corrected yearly based on the consumer price index.

According to the Law on the Electrical Energy Market, section 8, the operator of the transmission system or the operator of the distribution system is obligated to take all of the produced electrical energy form privileged producers. The process of becoming a privileged producer is regulated by a sub law introduced in 2007, the Guideline for the use of Renewable Energy and Cogeneration. The process is very slow and overly complicated and the government is currently working on the simplification of this procedure. Once the process is completed a contract is signed which ensures the feed-in tariff for a period of 12 years.

7.6.3 Cyprus

By implementing sub-measure 1.5.2 ("Management of waste in agricultural holdings", Agriculture Development Programme 2007-2013 for Cyprus of the Department of Agriculture), the modernisation and the environmental upgrading of piggeries, dairy sheds and poultry farms/slaughterhouses is expected via investments for projects aiming at the sound environmental and waste management.

This support covers 50% of the eligible expenditure in Less Favoured Regions and 40% in the remaining regions. The support is between €40.000 and €400.000 for the systems of organic treatment of waste, producing electricity or and biogas or composting. It is applicable for piggeries, dairy sheds and poultry farms. The annual heat and electricity ability of the plant should not exceed the corresponding annual average heat and electricity consumption in the farm facilities.

The construction costs in Cyprus are apx. 400-500 thousand euro per 100 kW and 2-2,5 million euro per 1MW.

For the operation costs of the biogas plant is crucial the feed-in-tariff system. The FiT is at the moment €0,135 per kWh **(0% Grant on investment)** for 20 years contract.
There is a bonus of 1,71 eurocent/ KWh-electricity in case the electric energy is being produced from high efficiency cogeneration units of electricity and heating or and cooling or in case the conversion of the biomass is done with thermo-chemical procedures (dry fermentation, gasification, etc).

The maintenance cost for biogas plants have been estimated to be 2 eurocents per produced kWh. Other operation costs are the purchase of materials and their transportation cost.

7.6.4 Czech Republic

There are many incentives for the support during the planning and construction stage of a biogas plant. These incentives are mainly regulated by the agriculture, energy and economic promtion ministries. Each one controls their own funding and subsidy schemes and a consultation with each one of them is advised in order to successfully plan a biogas plant project.
There are as well several programmes as the Rural development program, which can be of a great help when financing the plant. Another possibility is using the Operational

environmental program where a subsidy of up to 40 % of the planned construction costs could be received.

The feed-in-tariff has led in the past to a major development of biogas in the Czech Republic. The purchase prices are being set by the Energy Regulatory Office (www.eru.cz). As the electricity production from biogas has already reached in the year 2012 the target set for the year 2014, major cuts in the feed-in-tariff and in subsidy systems for biogas are expected.

7.6.5 Denmark

A subsidy for biogas plant construction can cover up to 30 % of the total costs. The average cost is 1.33 million Euro for a 400 kW_{el} biogas plant depending on hardware, which means major costs savings when receiving the subsidy.

The operating costs are given by the feed-in-tariff which is 15.33 Euro / GJ consisting of:

- 10.53 Euro / GJ
- 3.47 Euro / GJ that will decrease when the price of natural gas rises
- 1.33 Euro / GJ which will decrease with 0.27 Euro per year from 2016 to 2020

There is little known about the operation cost of farm biogas plant and the cost of central biogas plants varies a lot!

7.6.6 Germany

There is no general construction subsidy for Germany as a whole. However there are subsidy systems implemented by state and regional authorities.

German Renewable Energies Act defines a very large scale of cases in which subsidies are granted (on all renewable energies). Its object is giving financial startup aids for limited time periods for all kinds of renewables – Dependent on differences between cost of generating electricity and market price of electricity.
The table below shows the actual feed-in tariffs in the laws version from 2012

Leistungs-klassen	Grundvergütung[a)b)]	Einsatzstoff-vergütungsklasse I[b)]	Einsatzstoff-vergütungsklasse II[b)]	Vergütung für Ver-gärung von Bioabfällen[f)]	Gasaufbereitungsbonus[g)]
≤ 75 kW	25 ct/kWh[c)]				3 ct/kWh bis 700 Nm³/h 2 ct/kWh bis 1.000 Nm³/h 1 ct/kWh bis 1.400 Nm³/h Nennleistung der Gasauf-bereitungsanlage
≤ 150 kW	14,3 ct/kWh	6,0 ct/kWh	8,0 ct/kWh	16 ct/kWh	
≤ 500 kW	12,3 ct/kWh	6,0 ct/kWh	8,0 ct/kWh	16 ct/kWh	
≤ 750 kW	11,0 ct/kWh	5,0/2,5[d)] ct/kWh	8,0/6,0[e)] ct/kWh	14 ct/kWh	
≤ 5.000 kW	11,0 ct/kWh	4,0/2,5[d)] ct/kWh	8,0/6,0[e)] ct/kWh	14 ct/kWh	
≤ 20.000 kW	6,0 ct/kWh	0,0 ct/kWh	0,0 ct/kWh	14 ct/kWh	

Source: Biogas e.V.

With increasing size of biogas plants the specific investment in EURO/kW is decreasing.
Small scale biogas plants (75 kW) are build for 5,000 to 6,500 EURO/kW
Middle scale biogas plants (350 to 500 kW) are build for 4,000 to 5,000 EURO/kW
Big scale biogas plants (>1,000 kW) are build for 2,500 to 3,500 EURO/kW

Running a biogas plant in ongoing process needs time for

- feeding the digester,
- making several system controlling,
- documentation.

A 500 kW biogas plant based on manure and renewable crops needs around about 5 h/day. That means about 1,800 h/a; in cost 36,000 EURO/year (20 EURO/h wage).

7.6.7 Hungary

The average costs for biogas plant construction is 350 000 Euro / 100 kWh - including planning, permissions, technology.

The subsidy for biogas plant construction can be received from two major sources:

KEOP – Environment and Energy Operative Programme
As part of the action plan 2011-2013, KEOP-4.4.0 is available for proposals in renewable energy based electric, combined heat/electric and biomethane generation/production.
The maximum, non-refundable support is 70% - from 1 million to 1 000 million HUF.

Note: it is suspended; new supporting methods are under preparation.

ÚMVP – New Hungary Rural Development Programme
The total of 200 000 million HUF is available for proposals in rural development including farms.
Note: it is suspended; new supporting methods are under preparation.

Operating a biogas plant is expensive due its innovative manner. The cost of the operation may increase caused by the following factors:

- A plant larger than 500kW must be operated by giving and keeping a schedule, which needs expertise from the staff.
- The biogas production is based on biological processes, which needed to be monitored regularly. There are cost effective laboratory solutions in Hungary for examinations, but instead of this, the operators are often asking help from the technology providers, whose services are usually based on foreign, expensive laboratories. Not surprisingly, this is the first cost which is "saved" during operation, but without continuous monitoring the biological processes can turn to an irreversible degenaration.
- Unexpected errors – can endanger the entire operation of the plant.
- The maintenance cost can reach the 50% of the total operational cost. The reason is that there are a few service providers in the field only and they are not competing to lower the service fees. Possible solution for saving is to make non-specific maintenance with own stuff and only the special parts should be maintained by experts.
- Another factor which affects the costs is the price of the input materials. Valueless waste materials become an expensive good as some interest arises.

Most of the operation costs can be calculated easily according to the size of the plant: maintenance costs, wages, general costs. The difference between the income + savings and the operating cost results the amount of money can be spent for input materials and for redemption if there is a loan. Deviating from this logic can drive the investor to a trap.

A calculation example:
Taking 1 MWh power of CHP as the base of calculation, the following annual costs are applied:

Type of cost	Business model		
	self-financing	discount price	market price
input materials	200 000 €	400 000 €	530 000 €
wages (4 employees)	30 000 €		

maintenance	15 000 €		
fuel	30 000 €		
other	12 000 €		
Nitrogen supplement	50 000 €		
Total costs	**337 000 €**	**537 000 €**	**667 000 €**

Detailed calculations are in this Hungarian presentation available at the following link demonstrating three kind of business model: http://www.bitesz.hu/dokumentumtar/biogaz/a-biogaz-uzemek-gazdasagossaga/download.html

Currently the mandatory off-take tariff is the only economic incentive.

The system for feed-in-tariff is given by the **KÁT** (Mandatory Off-Take – still available, but METÁR will replace it soon)

Government Regulation: 389/2007. (XII.23.) states the mandatory feed-in tariffs of energy generated from waste, CHP and renewable sources.

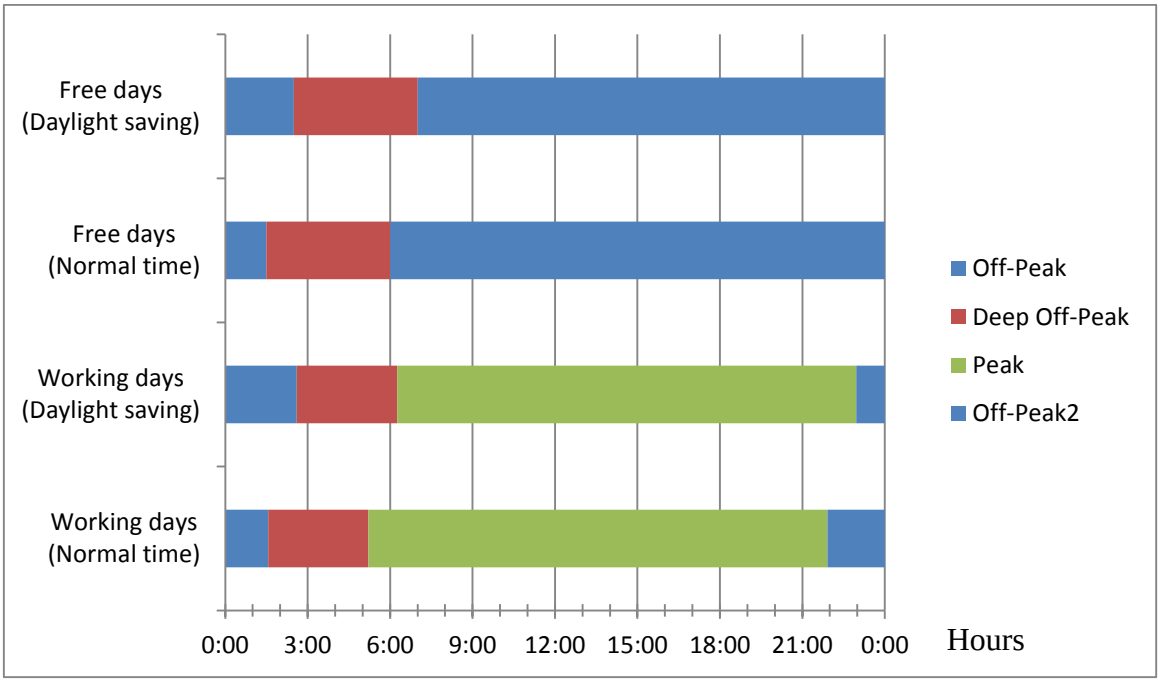
Feed-in tariffs in 2011 for green energy based on specific periods in a day (HUF / KWh)

	Peak	**Off-Peak**	**Deep Off-Peak**
For plants <= 20 MW (except: solar plants)	33,35	29,84	12,18
	approx. 11 Eurocent	approx. 10 Eurocent	approx. 4 Eurocent

The main disadvantages are: low tariff in every period and dividing the off-peak period to two parts where the deep segment has very low tariff. Biogas plants which don't have gas storage capability must operate continuously, so generating electricity in this period is extremely unprofitable.

In case of plants with higher than 500KWhel power, it is mandatory to create and follow a production plan (schedule). If the generated power is outside of the predefined thresholds the penalty is 5Ft/kWh.

The time zones for calculating different feed-in tariffs:



7.6.8 Spain

There are no subsidy schemes for the construction of biogas plants implemented and neither exists a feed-in-tariff to cover the operation costs. This makes an investment of biogas plant, which is in Spain between 1.5 and 2 million €, rather difficult (http://www.aebig.org/documentos/futuro_biogas.pdf).

To approach the cost of working it is considered 1 c€/kWh for the cogeneration engines, on the basis of the electricity produced and a 1,5% per year of the total investment regarding repairs, maintenance, administration and insurance:

- 7€/MWh of engine maintenance, etc.
- 3.500-4.000€/year insurances

To approach the cost of the personnel it is considered a dedication of 25% of a person, plus a lineal increase of a person for each 200kW of potency of the installation, with an average cost of 45.000€/person·year

For more information you can visit:
http://www20.gencat.cat/docs/icaen/06_Relacions%20Institucionals%20I%20Comunicacio/04_Publicacions/Arxius/01_Produccio%20biogas.pdf

7.6.9 United Kingdom

Access to finance is often cited as the major barrier to AD uptake, so it is therefore extremely important that your business plan is 'water tight'. So it therefore really important to take advise on your business plan before looking at finance.

Investment is difficult to estimate but typically looking at £4000 – 6000 per kW installed. It would be £6000 for a smaller plant and £4000 for a larger plant.

The ADBA has created a template which outlines the information required by potential investors at each stage of the process. This is the ADBA Due Diligence Template and can be found on their website: http://www.adbiogas.co.uk/ta_content.asp?id=71. ADBA have also launched its Farmers Consultancy Service which gives a free 30 minute consultation, information about this can be found at www.adbiogas.co.uk/ta_content.asp?id=83

When looking at the running costs of an AD plant you need to take the following into consideration:

- Depreciation of machines
- Depreciation of premises
- Purchase of feedstocks
- Water costs
- Energy costs (% of electrical energy)
- Staff
- Biological support
- Insurance cover
- Servicing of the heat and power plants
- Servicing and renewal of machinery and plant.

These costs can come to an estimate of £469,342 based on a 500kW plant using crops and slurry. (Information from EnviTec Biogas).

There is a well working feed-in-tariff system in Great Britain.

Feed in Tariff (FiT) - $\leq$ 250kW = 14.0p/kWh

$\geq$500kW = 13.0p/kWh

>500kW = 9.4p/kWh

Table A: Listing of all Generation Tariff levels for the current period		
Anaerobic digestion	≤250kW	14.7
Anaerobic digestion	>250kW - 500kW	13.6
Anaerobic digestion	>500kW	9.9

Table from http://www.fitariffs.co.uk/eligible/levels/ and are eligible from 1st April 2012 to the 30th June 2012.

Other sources of incomes from the operation of biogas plant can be obtained from:

- Renewable Heat Incentive (RHi) = 6.8p/kWh (though this is very complex and is still not finalised).
- Renewable Obligation Certificates (ROCs) = 2 ROCs/MWh
- Renewable Transport Fuels Obligation to encourage suppliers of vehicle fuel to use renewable sources.

Funding is available, however it must be noted that FiTs and grants do not go together and that usually you can only get one or the other. So check before you apply for them which would be best for you in the long-term.

- Enterprise Finance Guarantee (EFG)

Aimed at SMEs unable to obtain a normal commercial loan, EFGs between £1000 and £1m are available through accredited lenders until 31 March 2015.
http://bit.ly/HqyQsO

- Anaerobic Digestion Loan Fund (ADLF)

A £10m fund to support the development of new AD capacity in England providing loans from £50,000 to £1m, over a maximum terms of five years.
www.wrap.org.uk/farming_growing_and_landscaping/ad_loan_fund.html

- eQuip

Established by WRAP, eQuip offers recycling companies help to lease machinery by guaranteeing the future residual value. Due to European state aid rules, eQuip cannot support projects claiming FiTs.
http://bit.ly/HwQ5sm

- The Carbon Trust / Siemens Financial Services

Carbon Trust Implementation and Siemens Financial Services offer leases, loans and other financing options from £1000 upwards with no maximum.
http://bit.ly/HxJ899

- Enterprise Investment Scheme

Designed to help smaller higher risk trading companies to raise finance by offering a range of tax reliefs to investors who purchase new shares in those companies.
www.hmrc.gov.uk/eis/

- The Local Energy Assessment Fund (LEAF)

DECC has made money available to finance projects that increase understanding and uptake of energy efficiency and renewable energy technologies and help make energy supply secure and affordable.
http://bit.ly/H2PWeS

There are now many finance companies who are wishing to invest in on-farm AD plants. Developers are looking for projects, this can be a good way of getting involved with AD on the farm as it can take a lot of the hassle out of the process while giving a solution to waste management and potential income source. There are different options from these companies such as:

- 5 year buy in / buy out scheme, this is especially good if you do not want to be financing against the farm.
- Negotiate to share a percentage of the profit.
- They build the plant and then rent the land it sits on off the farmer.
- Enter into a feed supply contract with the farmer to guarantee a long-term crop.
- They may employ the farmer as chief operator.
- Companies looking to develop AD plants include:
    - Tamar - http://www.tamarenergy.net/
    - Hallwick Energy - http://www.hallwickenergy.com/
    - Agri Energy - http://www.agrienergy.co.uk/

For a good operation of biogas plant it is recommended to ensure that preventative maintenance is taken out to save on cost of new parts for machinery and also to avoid the plant stopping as it this could stop electricity production for weeks.
Costs will be saved on buying fertilisers in as the digestate can be used on the land.

A 500kW AD plant can grow 500 acres of crops for the AD plant, this will therefore have a fixed income from that land. This will offer financial security with 325% of costs fixed in a crop rotation. This will help in uncertain times of either wet summers of drought, both of which the UK is experiencing depending where you are in the country.

8 Choosing the suitable combined heat and power unit

Combined heat and power unit could be called the heart of the biogas plant since its effective operation is crucial for the economic feasibility of the project. Hence, the choice of the unit must be very careful. One of the main criteria is a high electrical efficiency which determines which amount of electricity is produced from each m^3 of biogas. It is recommended to obtain combined a heat and power unit from respected producers which assure high service standards under acceptable economic conditions. Should a unit be purchased from a producers without a reputation, the producer/supplier must provide valid legislative certificate and guarantee for servicing the units. This must be contract-based.

8.1 Basic types of combined heat and power units

The most common use of biogas is combined production of electricity and heat in heat and power units. The units present the most significant source of income in the biogas plant operation.

8.2 Efficient production of electric energy

A crucial issue is electric efficiency as shown in heat and power unit data. It states the percentage of energy contained in biogas that will be transformed to electricity. Investment in

an effective heat and power unit pays off since the unit has a long life cycle and an average yearly use of 8000 hours brings a fast return rate.

8.3 Providing high-quality service

Experience show that to reach a successful biogas plant operation, investors should use those heat and power units which have top parameters, especially electric efficiency, and which are provided with high-quality, operative and financially acceptable service.

When choosing a supplier of combined heat and power unit, investors should request the following:

- service background in the specific country,
- references of up to date implementations of combined heat and power units and stability of their operation (duration of usage),
- guarantee of operation stability of the combined heat and power unit (7500 hours per year, ideally 8000 hours per year),
- service conditions, including list of all reparations and maintenance throughout the life time of combined heat and power units, and duration of separate reparations and maintenance,
- service and maintenance costs (price and life time of some parts of combined heat and power units can differ – typical example are sparkling plugs or oil refills),
- procedure during unplanned outages or unreliability of the combined heat and power unit, including total engine failure (list of warranties, e.g. charges for unplanned outages or reparations),
- possibility of professional help when putting the operation into practice,
- expected life time of the operation.

8.4 Country specific info

8.4.1 Belgium

Biomethane connection is not available in Belgium. Thus a cogeneration system is required, in order to have some gains from biogas in this country. Heat is essential, as already said, because of the high amount required for the digestate drying system.

Average efficiency is high and reaches about 80% full load percentage in a biogas cogeneration plant. Bio-methanisation, maybe would increase this data.

8.4.2 Croatia

There are three district heating power plants in Croatia, two in Zagreb with a combined installed electrical power of 402 MW and one in Osijek with an installed electrical power of 42 MW. There are also three small cogeneration plants in private hands with a total power of 10.493 MW.

A possible barrier for a greater spread of this technology is the relatively low price of both electrical and heating energy and the state of the district heating system. The system is very old and suffers considerable loses of energy greatly reducing its overall efficiency.

8.4.3 Cyprus

The annual thermal energy of the biogas plants in Cyprus is approximately 20.400.000kWh$_{th}$. The heat of the biogas plant is used for the heating of the plant facilities during winter and at the anaerobic digester. It is estimated that only the 50% of the thermal energy is being utilized.

The energy production (from biogas plants) that was entered the grid in 2011 was 39.712.314kWh, while the corresponding amount in 2010 was 24.801.956kWh. Biogas plants cover the needs of the farm facilities in electricity and the excess of the produced electricity enters the grid.

Two types of combined heat and power units are quite typical in Cyprus:

- Engines powered 100% by biogas
- Dual fuel engines (90% biogas, 10% other fuel, usually diesel)

The average total efficiency of the biogas plants in Cyprus is around 76%:

- 38% average efficiency in electricity
- 38% average efficiency in heat

8.4.4 Czech Republic

Most of the biogas plants rely on the German technology. There are several planning and construction companies with a good service background and good references. This ensures a technical stability for the biogas production.

The overview of biogas plants and the used technologies can be viewed on an interactive map of biogas plants implemented by CZ Biom: http://biom.cz/cz/produkty-a-sluzby/bioplynove-stanice/

8.4.5 Denmark

Most of the farm biogas plants produce heat and electricity. It is crucial for the economy that there are recipients for the heat as well for the electricity.

Some biogas plants sell the biogas direct to a central heating plant but produces also heat and electricity for own use (eg. for house and process heat).

The central heating plants have experienced some challenges with some of the old engines. It seems like there at times is too much sulphur in the biogas and has to be cleaned first. Also biogas is saturated with steam which can harm the engine if not dried first.

The average efficiency is 40% for electricity and 50% heat.

The use of heat is very developed. The typical use of heat is in the house and stables but also selling to neighbours, schools etc.

8.4.6 Germany

German renewable energy act encouraged CHP using biogas. All biogas plants in Germany are using at least one CHP fuelled with biogas to ensure the digester heating. Heat overflow is used in drying-processes, heating of buildings, process heat in industries.

Usually all produced electricity is fed into the grid, because buying the electricity to run the biogas plant is cheaper than using the own electricity from the CHP.

Typical technology in Germany is the cogeneration of electricity and heat. Lately, there has been as well a major development in the biomethane injection into the gas grid.

Common CHP units fuelled with biogas have an efficiency of 35 to 41 % electricity and 50 to 60 % heat. German renewable energy act in the version of 2012 requires a heat use of 60 % of

the produced heat (25 % from this is calculated for digester heating). Heat use must be documented.

8.4.7 Hungary

The most common utilization of biogas is burning it in CHP engines, which produces heat and electricity at the same time. Part of the heat is used for the digesters and for pre-processing of input materials, if necessary. The remaining heat is used only on a small number of plants for buildings, stalls, etc. In some special cases, no CHPs are used, but the biogas is transferred to separate locations to use it for heating larger buildings, see the example at the city of Kaposvár.

The typical technology used is CHP. The equipment mostly comes from Austria and Germany but nowadays there are plans to import components or complete installations from China.

The average efficiency of CHPs in Hungary is between 80 and 95%. However the heat is not used in most of the cases. Utilising biogas for cooling is very rare.

8.4.8 Spain

Currently, the few biogas plants existing have to lose the thermal energy due to the lack of customers and due to the location of the plant: in dairy farms there is not a huge thermal consumption, while in pig farms, even having consumption, the installations are small and for this reason biogas plants must be installed in distances higher than 1 km from the exploitation.

Basically only 25 % (in winter) of the heat produced by the plant is being used to keep the working temperature at mesophilic range. The rest of the heat is lost. There are some exceptions of heat use, but those are rather rare.

8.4.9 United Kingdom

AD plants in the UK are not generating heat, we are using the soley to create electricity and help with waste management. Some heat maybe used on a farm system to heat the home of pig units. Under the Renewable Heat Incentives there are actually no incentives to use this heat. If there were grants to put pipes in to get the heat to the local community it would be much more wide spread.

The average efficiency with the plants is 90% technical and 82% waste efficiency.

9 Waste heat recovery

The process heat produced during the combustion of biogas in the co-generation unit can be used for heating other processes in the biogas plant or for heating surrounding buildings, stalls of animals or e.g. for drying of crops. Such use may majorly influence the economic viability of the plant. It might be as well be directly or indirectly required by the national legislation, to use the process heat. Direct requirement can be given by the list of ways in which the process heat can be used or will be supported. The indirect way defines for example the overall efficiency of a biogas plant, which can be then reached only by the use of heat.

Already the feasibility study should predict some perspective usage of this surplus/waste heat. This must be proposed as a separate business plan. Its correct timing depends on local demand for this type of energy, price, availability of funding, etc.

BiogasHeat project addresses the problem of how to efficiently use the heat from biogas plants. For more information click here http://www.biogasheat.org.

EU-AGRO-BIOGAS project is aimed at the development and optimisation of the entire biogas value chain – to range from the production of raw materials, production and refining of biogas to the utilisation of heat and electricity. For more information click here http://www.eu-agrobiogas.net

9.1 Using waste heat in the process itself

When burning biogas in combined heat and power units, it comes to a significant production of heat energy from cooling engine systems, oil, filling mixture, etc. Proportion of heat produced by cooling and heat from exhaust gases is approximately. 50:50.

Heat consumption for actual processes in biogas plant depends mainly on heat loss of digesters, type of temperature process of digestion (mesophilic or thermophilic), and on the

possible hygienzitaion of incoming materials. Heat consumption for technological heating up in biogas plant is between 20-40%, strongly depending on the location and time of the year.

9.2 Further possibilities of using waste heat

The surplus heat from the biogas plant can be used to replace some of the heat used for heating houses and other buildings as e.g. animal stalls at the farm. The combination of a biogas plant at the farm and the use of waste heat brings another positive effect of such combination. This is the most sustainable and economically viable way of biogas production with a short way for inputs and short ways of the outputs, in this case the process heat.

The investment to the heating system might significantly increase the investment costs; however a successfully implemented project may mean a significant contribution to the economic efficiency of the whole biogas plant. The calculation of such use should be part of the feasibility study.

Possibilities of using waste heat:

- heating in buildings in nearby surroundings, especially on the farm premises,
- heat supplies to the district heating system and heating in residential houses,
- use for stalls of animal production,
- use in other business operations, such as drying technologies (e.g. wood driers, corn driers, sawdust driers, etc.), pellet/briquette production, drying halls of loose biomass, stations for thermophilic animals and fish, green houses, etc.

9.3 Country specific info

9.3.1 Croatia

Some investors have acknowledged the possibility of the use of waste heat from their biogas power plants in their production process. For example the biogas plant Ivankovo located on a dairy farm uses the waste heat from the production of electrical energy for the process of drying of manure and hay. The waste heat from the plant Tomašanci is used in an absorption cooler.

9.3.2 Cyprus

Of the 11 licensed biogas plants in Cyprus it is produced approximately 1.700.000 kWh thermal energy per month. The thermal energy is used to heat the anaerobic digester and for the heating needs of the animals during the winter months. Nearly 50% of the heat energy is not utilized.

The possibilities of tele-heating and tele-cooling should be further examined in Cyprus.

9.3.3 Czech Republic

When considering supplying heat from a biogas plant to a district heating system it is necessary to follow the regulation given by the legislative act No. 458/2000. It is recommended to contact a professional advisory agency that has necessary experience with similar procedures. Successful usage of surplus heat is a positive contribution to economic efficiency of a biogas plant.

The efficiency of biogas plants in the Czech Republic is rather low. This is given by the seldom use of waste heat. For the development of biogas production in the CR, the level of feed-in-tariffs has been crucial. Those have been high enough to keep biogas plant economically viable only by selling the produced electricity. With the new requirements this will change significantly and there will be the need to find new ways of heat utilization.

One example of good heat recovery can be the biogas plant Mikulčice. The plant is processing mostly manure from dairy and cattle production from nearby farms. As the other activity of the company is a fruit and vegetable production and further processing of food products, they are using the process heat from biogas plant for drying those materials. This brings significant costs savings and increases the economic viability of the biogas plant.

9.3.4 Hungary

A good example of waste heat recover in Hungary is in Magyar Cukor Zrt. at Kaposvár. The biogas is generated by digesting beet slices – the remainder of sugar production – and green waste (grass) from the city. The first two digesters started to work in 2007 and the biogas is used to generate the necessary heat for the beet processing thus partly replacing more expensive solutions. The company is working on to be totally independent from natural gas usage by 2013.

The latest development is heating the water in the public spa of the city, Kaposvár. The biogas is transferred via a 1,2 km long pipeline to the spa. With this solution, the spa saves the total annual cost of heating, which was 60 million HUF (approx. 200 000 Euro) before.

Related articles (Hungarian):

- Video about the construction of the first two digesters: http://www.keptelenseg.hu/keptelenseg/biogaz-uzem-epites-kaposvar-54471
- Some info about the future plans: http://zoldtech.hu/cikkek/20110217-biogaz-cukorgyar
- Video about the pipeline to the spa: http://www.kaposvarmost.hu/videok/kaposvar-most/2012/05/24/biogaz-vegig-a-sarga-uton_1895.html

9.3.5 Spain

A good example of heat recovery in Spain can be shown on the biogas plant in Vilasana (Lleida-Catalonia). It is using the thermal energy to heat a greenhouse (only in winter). The data of this plant is as following:

Treatment capacity:

- 11.000 m³ of slurry
- m³ of organic residues

Two digesters of 1.300 m³

- Electrical potency of the engine 382 kW
- Thermal potency of the engine 315 kW

Year average production (8.000 hours working)
3.050.000 kW of electricity
2.500.000 kW of thermal energy

9.3.6 United Kingdom

For Great Britain a good example of heat recovery could be the case of Kemble Farms. They are using their heat for the dairy, staff homes and holiday cottages.

For more info visit: http://kemblefarms.co.uk/?cat=3

10 Digestate as a high-quality fertilizer

The substrate residue of the digestion process in biogas plants is stabilized liquid material, the so called digestate, which can be used as a high-quality organic fertilizer. The digestate use in connection with crop production can bring a major added value of the biogas production. By the use of digestate, the nutrients, which have been withdrawn from the soil during the crop harvesting can in this way be returned to the soil and improve its chemical and physical composition.

The use of digestate is however strictly regulated by national laws. For the application of digestate several criteria have to be fulfilled as the limits of heavy metals and other hazardous substances, rules about the timing of the application etc.

The aim of **BIOPROS** project is to gain knowledge about the economic, ecological and technical feasibility of SRPs for different local conditions and market requirements and to transfer this know-how to their SME members (farmers, biomass processors, engineers, decisions makers). This will contribute to promote SRP biomass production between SMEs throughout Europe and abroad. Main focus will lay on the safe and efficient application of wastewater and sludge to guarantee high yields and a sufficient treatment performance without any negative environmental or hygienic impacts. For more information click here http://www.biopros.info

10.1 Digestate – high-quality fertilizer

Fermentation products, which rise from anaerobic digestion, should be used as organic fertilizer. Compared to classic organic fertilizers (raw liquid manure), digestate has several advantages:

- reduction of unpleasant odours,
- pathogen concentration is significantly reduced,
- germinative activity of weed seeds is reduced,
- caustic effect of raw liquid manure on crop-plant is reduced,

- amount of easily decomposable carbon is reduced while desirable forms of organic carbon remain,
- digestate contributes to improved resistibility of crop-plants and lower consumption of pesticides.

The use of digestate brings also a cost reduction to farmers as it replaces the costs for mineral fertilizers.

The use of liquid digestate as fertilizer is moved from post-harvest period to vegetation period in EU as nitrogen contained in the fertilizer has fast effect and good organoleptic features.

10.2 Country specific info

10.2.1 Belgium

Digestate use as fertilizer could represent a problem in case of a lack of sufficient arable land. Often farmers with livestock (Cattle, cows..) don't have a lot of hectares to cultivate. This represents a big problem because of the high digestate nitrogen content. Digestate treatment is made by two steps:

- A first solid-liquid separation process using centrifuge
- A second separation drying liquid fraction and producing clear water.

Also a biological system for liquid fraction is used, removing nearly the 90% of nitrogen from liquid part.

Solid fraction is used as fertilizer, but often farmers have to find other fields in the nearby where distribute the digestate.

The Nitrate directive currently in force in Flanders aims to reduce pollution of groundwater and surface water by nitrate from agricultural sources (50 mg NO_3/l) and then to prevent new pollution.

Policy:

- **Manure decree (1991) and revisions (1995, 2006, 2011)**
- **Manure Action Plans (I, II, III and IV)**

Especially for farmers, these are the main aspects to take in account:

- Fertiliser restrictions are based on N and P

- Assessment at level of the individual field: max. residue in the fallow = 90 kg N/ha
- Manure Bank = control + advice
- Derogation for crops with high nutrient uptake (grass, maize, sugar beet) under well defined conditions

10.2.2 Czech Republic

The legislative act No. 156/1998 about fertilizers states that all fertilizers must be registered and tested by an official body. In order to register the fertilizer it has to meet the following limits:

Risk elements [1)]	**Limit**
Hg	max. 1,0
Cd	max. 2
Pb	max. 100
Cr	max. 100
Cu	max. 100
Zn [2)]	max. 300
Ni	max. 50
Mo	max. 5
As	max. 10

1) in 1mg in $1kg^{-1}$ of dried sample, 2) max. 400 for standardized digestate

Digestate produced by anaerobic digestion in agricultural biogas plants is considered as standardized organic fertilizer. The digestate has to be registered according to the above mentioned law only in the case of use elsewhere than for the own need. Otherwise there is no registration needed.

The handling of the digestate is also given in the Czech Republic by the act No. 254/2001 about waters. It states rules for digestate handling especially in connection to ground water safety.

Solid and liquid digestate must be stored according to the public notice No. 274/1998 about storage and use of fertilizers under conditions for manure and liquid manure. It is forbidden to

apply digestate on wet, snowed or frozen soil. Application of digestate is subject to evidence of used fertilizer according to the public notice No. 274/1998.

10.2.3 Denmark

The common praxis in Denmark considering the digestate is that the farmers who deliver manure get the digestate back and use it as a fertilizer. The benefit is that the requirements for utilisation are the same as from manure even though utilisation of digestate is more beneficial.

The legal requirements for digestate use as fertilizer are basically the same as for manure. But if the biogas plant has more than 25% of its input as not manure (measured in weight) there has to undertake analyses for heavy metals and pollutants such as PAH, DEHP etc.

10.2.4 Germany

In most cases the digestate is used as liquid fertilizer. Some operators are testing drying digestate and intend to sell it as dry fertilizer.

The legal requirements for digestate use as fertilizer are defined by specific Fertilizer legislation and Waste legislation.

10.2.5 Hungary

The most common way of utilization of digestate in Hungary is the application as liquid fertilizer on fields.

Unfortunately, the different regulations regarding the categorization of the digestate are not harmonized and there is no exact definition for it anywhere. Due to this situation, it can happen that different local authorities will treat it differently.

- Digestate spraying out permit: Agricultural Office
- Waste handling permit: Authority of Environment Protection

- Manure = animal by-product, if not processed in a waste management facility
- Digestate = treated as fertilizer if used directly, but becomes waste if processed further, e.g. composting

Rule: two examinations annually before spaying out and reporting about the use.

Legal background:

- Governmental decree 50/2001. (IV.3.) on the agricultural use of wastewater and wastewater sludge
- FVM decree 36/2006. (V.18.) on the permission, storage, use and distribution of yield enhancing materials
- FVM decree 59/2008. on the detailed rules of the action programme for the prevention of water against nitrate contamination caused by agricultural activities
- FVM decree 90/2008. on the details about creating soil prevention plan
- KVVM decree 23/2003. (XII. 29.) on biowaste management and the technological requirememnts of composting
- KÖM decree 16/2001. (VI.18.) about waste registry

10.2.6 Spain

Digestate is usually applied directly to soil. Although in some cases the solid liquid separation and subsequent composting takes place.

Many projects have been stopped by lack of administrative support. Social pressure is very high (for ignorance of the technology and the benefits of biogas) and this causes a rejection by the municipal authorities. Excessive bureaucracy makes the cost of processing is so high that many projects die trying.

The digestate shall comply with following values in order to be applied as fertilizer.
Minimum requirements for organic waste to be applied on soil:

Parameter	required value
Total organic matter (MOT)	>40% on dry matter (sms)
Nutrients: N, P, K	N total + P total + K total >2% sms
pH	beteewn 4,5 - 8,5
Heavy metals (EPT)	Table 2.1

Maximum concentration of heavy metals in organic waste:

Metal	Limit values mg/kg dry matter	
	pH soil <7	pH soil >7
Cadmium	20	40
Copper	1000	1750
Nickel	300	400
Lead	750	1200
Zinc	2500	4000
Mercury	16	25
Chromium	1000	1500

We must also respect the decree ″136/2009 of 1 September, approving the program of action applicable to vulnerable areas in relation to nitrate contamination originating from agricultural sources and management of livestock manure". In which marks the maximum value of N applied per hectare, which cannot exceed 170 kg N / ha.

10.2.7 United Kingdom

The organic content of the digestate dramatically improves soil condition holding in moisture and encouraging worm activity. It is really a win-win situation when using digestate. It is taken up quickly be the plants and a marked improvement can be seen.

A 500Kw plant could have a £50 – 60,000 of fertiliser value on its digestate value or in other words a £50 – 60,000 saving on buying in fossil fuel based fertilisers. Developers will often negotiate to off-set the cost of the maize crop against this to off-set costs. The larger the AD plant the more digestate will be produced so it is vital that there is somewhere for it to go – ideally this will be to the neighbouring landowners who may be providing the break crop feedstock. It is therefore essential to have a good relationship with neighbouring and arable farms.

Digestate should be analysed before being spread on the field although the digestate has been pasteurized it will still need to have some licensing depending on the ingredients that went into the AD plant. It is therefore vital that the PAS110 – a recommended standard – is met. It creates an industry specification against which producers can check that the digested materials are of consistent quality and fit for purpose.
(http://www.insource-energy.co.uk/tl_files/insource-energy/PDFs/PAS110.pdf)

The rate the digestate is applied to soil must not exceed crop requirements and must consider the soil analysis and cropping history of the field. In most situations the spreading rate will be determined by the phosphate content of the digestate product and soil phosphate index.

As with the recycling to land of all other waste streams, timing of application and the areas that receive applications should be in accordance with agricultural best practice codes and NVZ (Nitrate Vulnerable Zones).

11 Further possibilities of using biogas

Biogas is a very good source of energy. The major advantage is the easy handling and the possibility of storing biogas for later electricity and heat production. There are however as well other ways of biogas utilization, which will be gaining more importance in the following years. Above all, the possibility of purifying biogas to reach the level of natural gas has been developing recently. This type of gas is called biomethane and may be used the same way as natural gas. It can be as well injected to the regular gas grid and used at other places. Other possibility of biogas use is for example the transport.

The **Baltic Biogas Bus** project will stimulate cities and regions around the Baltic Sea to use biogas driven buses. The project aims to show cost effective solutions on biogas production as well as distribution and use in buses. For more information click here http://www.balticbiogasbus.eu.

IEE project **UrbanBiogas** is about promoting the use of organic urban waste for biogas production in 5 European cities in order to inject biomethane into the natural gas grid and to use it in transport http://www.urbanbiogas.eu.

The main goal of **LIFEBIOGRID** project is to demonstrate the feasibility of producing a substitute natural gas (bio-methane) from biogas. For more information click here http://www.lifebiogrid.es

11.1 Biogas purification and biomethane production

Biogas plants can also contain technology for purifying biogas. Purified biogas has actually the same features like natural gas (more than 95% methane), and can be used in gas pipes or as a fuel when it meets all legal requirements. The biogas use as a fuel might be beneficial for the farmer to run the machinery needed for animal and crop production and for operation of the biogas plant.

Investment costs of biogas purification are slightly higher compared to the combined heat and power unit. However, this investment is based on calculations of fuel prices which are nowadays higher than prices of electricity or heat.

11.2 Country specific info

11.2.1 Belgium

In order to reach higher energy efficiency in the whole country, and being not such a big, wide country, Belgium could find a shining example in the near Netherlands, where there are many cattle and pigs livestock and where government started a good policy in biogas development. A raw gas purifying system is expensive, but it would permit farmers to increase the efficiency and the economical convenience of their plant. This could be reached only thanks to the government's support. Decision makers should start going towards higher energy efficiency, establishing grants for the initial installation of a biogas refining plant, also providing gas grid transportation service instead of a gas grid connection which could lead difficulties in connection points distances. If biomethane companies could store a 80-85% refined biomethane and transport it to their site before refining it at the last 96%, farmers could spend less money for the refining plant, government could spend less in electricity feed-in tariffs, becoming less dependent from natural gas importation. The whole country would have a very high benefit from this technology.

11.2.2 Cyprus

There are currently no other ways of biogas use in Cyprus.

11.2.3 Czech Republic

Even though, the use of methane for transport is well developed in the Czech Republic, the use of biogas has not developed yet.

Similar situation is with the production of biomethane and the injection to national gas grid. Even though, the gas grid is well developed, there have been no incentives supporting the production of biomethane. This has been given as well by the economical viability of biogas plants, which has been secured already by the electricity production.
The new concept by the Ministry of Industry and Trade however plans to support the production of biomethane in form of green bonuses.

11.2.4 Germany

In Germany a growing number of biogas plants are injecting biomethane (= biogas upgraded to natural-gas quality) into local gas grids (120 plants estimated in 2013).

11.2.5 Hungary

An example of further use of biogas can be presented on the example of Zalavíz Zrt. (http://www.zalaviz.hu). The upgraded biogas (biomethane) is produced from sewage sludge and used as car fuel. The company also have an agreement with the city of Zalaegerszeg to provide this fuel for buses in the public transportation.

Related links (in Hungarian):

- http://zoldtech.hu/cikkek/20110901-metangaz-uzemu-autok
- http://zoldtech.hu/cikkek/20111016-biometan-busz

There is no implementation for injection into the natural gas grid yet.

11.2.6 Spain

In Spain there are currently two biogas refining plants both from landfills, which purify biogas for transport use. There is currently no grid injection from biogas farms due to the high economic cost, administrative barriers and high technical requirements.

There are, nonetheless, national research projects on biogas refining technologies for transport use, and its practical application in vehicles. There are as well other technologies being developed by research projects such as one focused on developing fuel cells using methane from biogas as an input, which could be a very good usage for biogas. It would provide clean energy in an efficient way without burning the gas. It has also other advantages such as no

noise, low space requirements and although it is at an experimental stage, it could be a very feasible solution for biogas plants in farms.

12 Summary

Biogas production from manure and slurry from dairy and pig farms has many advantages. To unlock the potential it is necessary to overcome several difficulties which can cost a lot of effort, finances and time. Althouh this is an uneasy way, it pays off in many ways. It brings new sources of income for the farmer, saves operating costs and helps to make the economy of the farm more stable and viable.

It is necessary to keep in mind all the listed aspects of biogas production from the very beginning to prevent any difficulties during the implementation process. As presented, the national conditions and requirements differ in some of the points majorly. For this reason it is always advisable to collect all possible information about the experience of nearby farmers who already implemented a biogas plant and to contact relevant public bodies for more information. The selection of a company with a good background in the country and with good references will be crucial for the planning, construction and possibly as well the operation of the plant.

The viability of the biogas plant does not depend only on the electricity production, but is of a much more complex matter. The more side effects of the biogas plant, such as heat recovery, digestate as fertilizer or biogas purifying, you use, the bigger chance the plant has to become a good added value to your animal production.

13 Source of information

Additional to the sources listed already in the text have been used following materials

13.1 Croatia

- Law on the Electrical Energy Market: http://www.hep.hr/opskrba/propisi/zakonOenergijiIzakonOtrzistuElektricneEnergije.pdf
- Big>East project: http://www.big-east.eu/
- Potential of biogas in Croatia: http://www.big-east.eu/downloads/IR-reports/ANNEX%202-9_WP2_D2.2_Summary-Croatia-HR.pdf
- HROTE: http://www.hrote.hr/
- Law on biofuels in transport: http://narodne-novine.nn.hr/clanci/sluzbeni/2009_06_65_1454.html
- Law on the gas market:http://narodne-novine.nn.hr/clanci/sluzbeni/297778.html

- Law on the quality of biofuels: http://narodne-novine.nn.hr/clanci/sluzbeni/290173.html
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