Project: BiG>East

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Guidelines for Selecting Suitable Sites for Biogas Plants

Deliverable D 6.1

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Contents

Introduction

This document was elaborated by project partners of the BiG>East project (Biogas for Eastern Europe) which is supported by the European Commission under the Intelligent Energy for Europe Programme. It provides basic guidance on how to select suitable sites for biogas production.

The document is provided ad a working document (Word) including interactive Excel tables and Word Tables which can be directly completed by interested parties.

Objectives

These Guidelines are addressed towards project developers such as SMEs, engineering companies, farming associations and individuals who strive to implement biogas plants in their home country. The Guidelines enable these target groups to undertake the necessary steps in order to define suitable sites for biogas projects in their region. Among others they should evaluate:

- ✓ Biomass availability (conventional and unconventional)
- ✓ Suitable site in respect to the use of heat, logistics etc.
- ✓ Organisational structure of the specific location.

In view to these intentions the Guidelines will define the requirements for selecting suitable sites for successful biogas plant development. Furthermore, the Guidelines will give support on how to obtain the necessary data for evaluating opportunities of biogas project development. The Guidelines should be used in context with the BiG>East Handbook which provides background knowledge about biogas production and utilisation. It is important to understand that these Guidelines purely aim to select suitable sites. They are not able to replace the pre-feasibility and feasibility analysis in which the optimum plant technology and size is determined.

Methodology background

These Guidelines are based on a top-down approach which is structured into four main analysis steps as shown in Figure 1.

Step 1: Selecting **suitable regions and available substrates**

In many European countries there exist biomass potential studies which clearly define biomass quantities suitable for biogas project development. Within the BiG>East project, potential studies are elaborated for Bulgaria, Croatia, Greece, Latvia, Romania and Slovenia. The Guidelines therefore start on the basis of these potential assessments on national or regional level. The first step is to select suitable regions for biogas production. Suitable regions are defined by the availability of biomass. Due to the low energy content per volume and large quantities it is economically and energetically usually not useful to transport liquid agricultural feedstock further than 5 km, and stackable energy crops not more than 15 km. Thus, a biogas plant should be located in a radius of less than 15 km from the available biomass sources. Also the digestate which is usually used as fertiliser for feedstock production should not be transported further than 15 km due to increasing transport costs.

Step 2: Defining **suitable neighbourhoods** within the selected region

The second step is to define suitable neighbourhoods within the selected region. Suitable neighbourhoods are defined by opportunities to sell heat[1] and to feed electricity into the grid. Transporting heat is cost intensive and energy losses are inevitable. Therefore, the biogas plant should be located in a radius closer than 1000 metres on an average to the heat user, depending on the produced heat.

Step 3: Defining **suitable sites** within the selected neighbourhood

The third step is to detect suitable sites within the selected neighbourhoods. Suitable sites are pieces of land where all devices (digesters, storage systems, CHP plants) of a biogas plant can be installed under favourable technical and legal framework conditions, such as sufficient space or good road access.

Step 4: Fulfilling **soft requirements** for the selected sites

The last step is to optimise the soft requirements at the selected sites. This includes the mobilisation of institutional support between policy and administration and to win public support for the project.

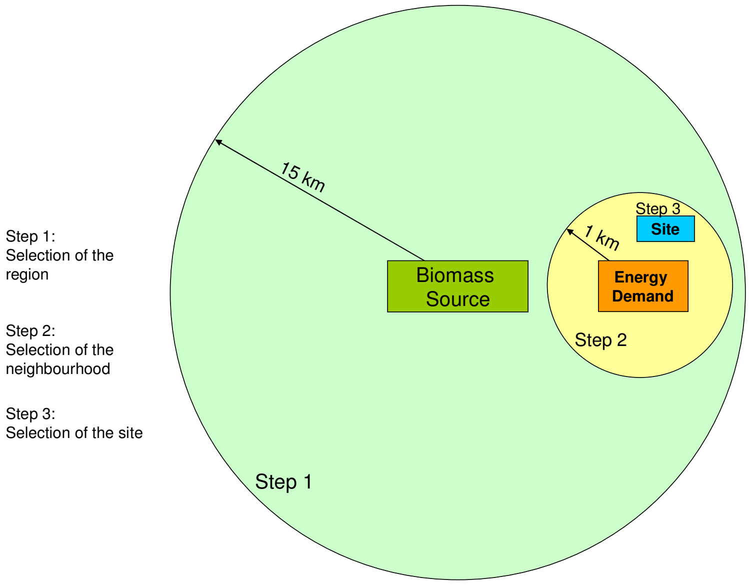

Figure 1: Site selection methodology

[1] The Guidelines are based on the assumption that the biogas is used in CHP plants in the vicinity of the biogas plant. This assumption will change in the near future when the upgrading of biogas and the feeding of biomethane into the natural gas grid becomes technically mature and economically feasible.

Examples for typical biogas plants

Typical biogas plants in Europe are operated with agricultural, industrial or municipal waste. Biogas plants are also operated with dedicated energy crops (particularly maize), but only in countries with special funding schemes like e.g. in Germany.

The produced biogas is usually used on-sit for combined heat and power generation (CHP) or only for heating purposes. First plants in Austria, Germany, Sweden and Switzerland are upgrading biogas into biomethane. Biomethane can be used as transport fuel or fed into natural gas grids. In future it will be also possible to process the biogas and sell it as valuable fuel e.g. through cleaning and feeding into the natural gas grid or through liquidisation and storage.

Due to this wide spectrum of biogas production, it is difficult to define one standard plant design. Therefore, three different types of typical biogas plants are presented as examples.

Example 1: Biogas plant for manure and dedicated to heating

The smallest type of biogas plants is a plant that only uses animal manure and gains biogas for heating purposes. Typical sizes start with 40 and go up to 80 livestock units. The technology has to be very simple and robust to require only a minimum of maintenance work.

The main idea is that the manure flows from the stable directly without pumping into a digester and from there into the end storage. The digester is heated up to 37 °C and mixed. Mixing Time is 3-8 minutes/hour depending on the amount of feedstock residues flowing with the manure into the digester. The produced biogas flows through stainless steel gas pipes into a gas balloon where it is stored at low pressures. A small lateral channel blower is used to increase the gas pressure before firing it in a modified gas burner heating system.

A typical biogas plant sized for 50 livestock units produces 62 m³ of biogas with 63 % methane content per day. The hourly output of this biogas plant is 2.6 m³/h and the continuous firing capacity is 15.6 kW.

Example 2: Cogeneration biogas plant for industrial or municipal waste

The major problem with biogas plants using industrial or municipal is related to contaminants that pollute the digestible organics. Typical contaminants are plastic bags, glass, metals or bones that have to be removed from the digestion process. A typical waste treating biogas plant has the following treating steps:

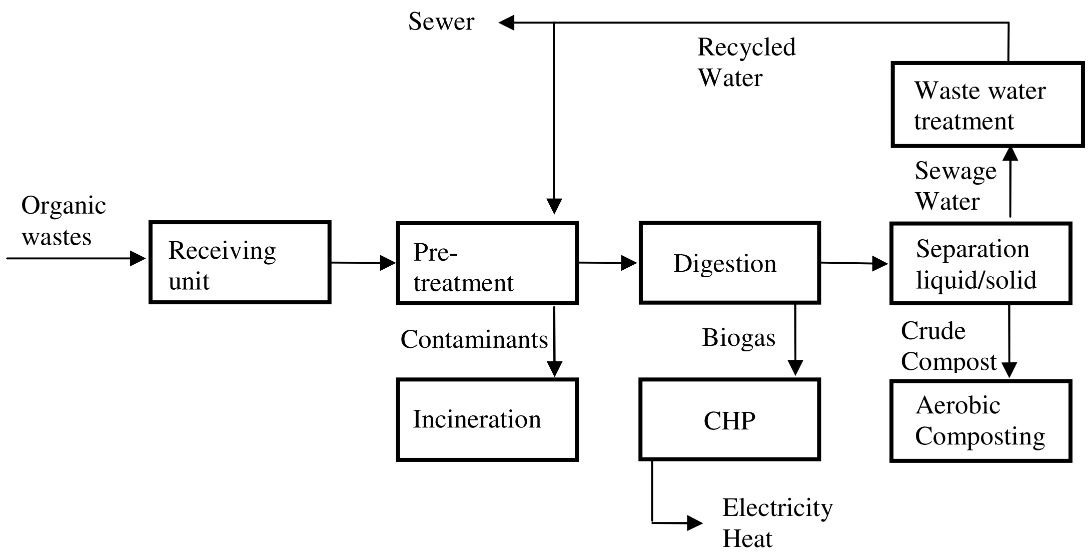

Figure 2: Block diagram of a typical biogas plant for organic waste treatment

Waste treating biogas pants are technical complex, because of the additional features for removing contaminates and the waste water treatment that often is necessary. Biogas plants for wastes start with treating capacity of 10,000 t / year and go up to more than 100,000 t / year. Typical wastes are food wastes from restaurants and cantinas, content of grease traps or slaughterhouse wastes like cow paunch.

Example 3: Cogeneration biogas plant based on energy crops

Many biogas plants particularly in Germany are currently fed by maize silage. A 500 kW_{el} biogas plant needs up to 31 t maize silage per day and the respective amount of manure. In the fermentation tanks the silage gets biologically degraded and biogas is produced. One ton maize silage converts to approximately 750 kg digestate and 200 m³ biogas with methane contents of approximately 52 %.

After a statistical retention time of 70 days or more, the digestate (digested material) is stored and can be directly applied as fertiliser. Optionally, the digestate can be also separated into a liquid and solid fraction which allows more adjusted fertilising to specific crops. The storage facility can be covered with an elastic EPDM Membrane or with a double membrane roof in order to store biogas and to avoid odour and residual methane emissions. Finally, the biogas is cooled, dried and cleaned (if necessary), and used in a combined heat and power generation unit (CHP) to generate heat and electricity.

Figure 3 shows the mass balance of a typical biogas plant based on maize silage.

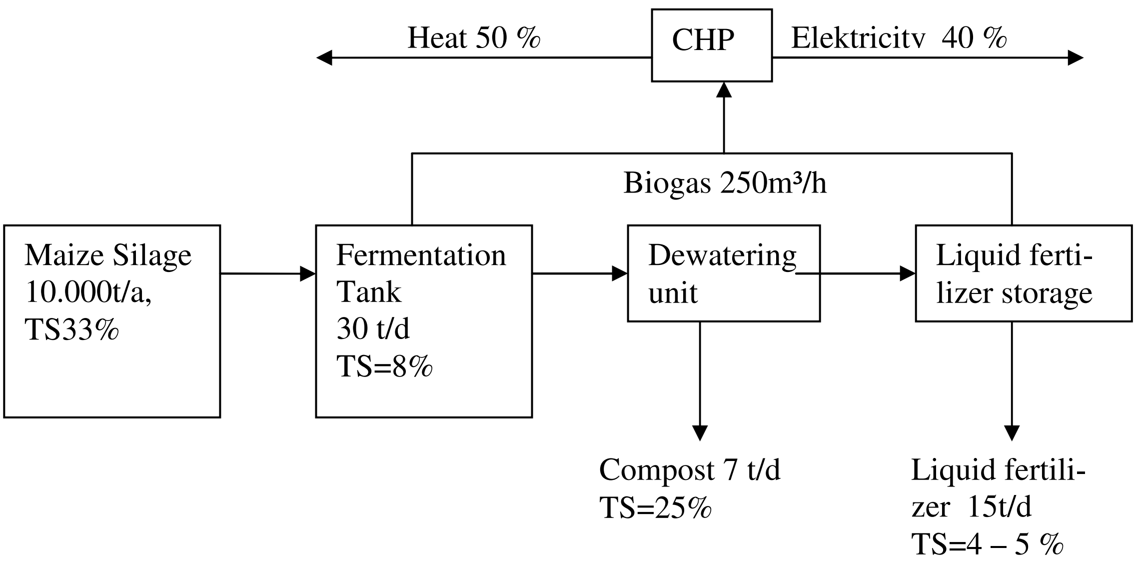

Figure 3: Block diagram showing mass balances of a 500 kWel biogas plant for maize silage

Step 1: Selecting the suitable region (radius of 15 km)

Based on the national and regional potential studies suitable biomass hubs should be defined as the very first step. Due to the low energy content per volume and large quantities it is economically and energetically not useful to transport biomass feedstock further than 15 km. Thus, site should be located in a radius of less than 15 km from the available biomass sources. If the available biomass is mostly agricultural slurry, the maximum radius of supply should be less than 5 km.

Biomass supply

In general all kind of organic substances can be used for biogas plants. The different input materials however strongly differ in the energy content and digestion suitability which affects biogas yields. For instance, the biogas yield for maize silage is 202 m³/t (33 % DM) and for cow manure it is 25 m³/t (8% DM). However, the methane content of biogas from cow manure is about 8 % higher (60 %) than the methane content from maize silage (52 %).

Suitable substrates for biogas plants and anaerobic digestion can be separated in two main groups which can be both combined with each other:

- **Agricultural products**: agricultural animal excretions, agricultural side products and energy crops
- Industrial and municipal **organic waste**[2]

The main differences between these two groups are the following:

- Agricultural products are only available during and after the harvesting season and for this reason require large and expensive storage logistics
- Agricultural products are more homogenous in quality and contain less contaminants. Thus, digestion of agricultural products is easier to stabilise and digestate can be generally used as fertiliser.
- While the purchase prices for agricultural products increase steadily, the waste substrates often are supplied against a discharge fee.

In the following paragraphs different feedstock types are briefly described. More information about suitable biomass can be found in the BIG>East Handbook and in ANNEX 1.

Energy Crops

Among the most important energy crops for biogas plants are:

- Maize
- Clover
- Grass
- Cereals
- Sweet sorghum
- Sudan grass

The biomass productivity of these energy crops strongly depends on soil quality and climate as well as on fertiliser and pesticide applications.

[2] Agricultural waste becomes industrial waste through the channelling through one main production process.

Apart from the cultivation of these main season crops, they can be also planted between the main cultivation seasons. A frequently used combination in Germany is corn with rye (early harvest of corn, then rye over the winter, harvested in April / May, then space used for corn). Other interesting interim crops are:

- Clover, peas or beans
- Winter wheat (whole plant silage)
- Sweet sorghum
- Sudan grass (as mentioned)

For instance, a farmer in Odenwald, Germany uses winter barley (whole plant silage) and combined it with sudan grass. He was very content with the yield (appr. 8 Mt per ha).

Biomass supply from animal excretions and agricultural side products

It is possible to supply biogas plants with agricultural side products. One big group are the residues within the harvesting process (e.g. straw), grass from set aside land and landscape maintenance. The main feedstock types are animal excrements from cattle, pigs and chicken breeding farms.

Biomass supply from industrial and municipal organic residues

Main sources for industrial and municipal organic residues are the food processing industry as well as municipal solid waste. It is obvious that the spectrum of possibilities here is very large. The waste substrates often have much more energy content than the agricultural resources.

More background information on the possible biomass supply can be found in the BIG>East Handbook.

Recommendations

It is recommended to have sufficient biomass available for the biogas plant you plan. In a fist step you should assess the amount of biogas you could obtain from the biomass sources you have at hand. For the second assessment you should calculate the amount of biogas available for your specific plant. For defining the possible biogas yield the calculation tool for biomass sources in the Appendix can be used.

A first estimation on the biomass demand can be calculated by using the Excel table which is imbedded into the Appendix of this Word Document. In this table the available amount of biogas per year can be inserted and the corresponding biogas yield is calculated automatically.

This important calculation tool can be found on page 19 of this document.

The following strategies have proven valuable for obtaining the required biomass:

Information Acquisition:

Stakeholders to obtain knowledge about the availability of biomass are:

- Mayors and stakeholders in the public municipality
- Farmers and managers of farming associations
- Biomass traders and food processing industries
- Also biomass associations could be valuable partners

A successful strategy could also be to organise an information event on biogas with a biogas specialist and invite all potential stakeholders to participate.

Supply specifications:

It is very important to be very precise towards the biomass supply specifications. The biomass has to be specified in detail concerning the quality, quantity and availability over the year. Furthermore, the supply structures have to be based on long term cooperation schemes in which the supply obligations are precisely determined in quantity and quality. Moreover, the biomass prices are to be fixed in long-term perspective. **Without these biomass supply contracts the project contains strong economic risks in the future and also the bank and private financing is very difficult to be obtained.**

Possibilities to involve biomass suppliers into the project:

Very positive experiences were made in project structures in which the biomass provider is not in a pure supply position but shareholder and equal partner in biogas venture itself. This means that the biomass supplier directly benefits from the economic success of the biogas plant operation. One option for this could be that the biomass supplier becomes shareholder in the company which operates the plant. If not enough equity is available for such an investment a possible solution could be that part of the biomass supply over the years is not paid in cash but transferred into a company share. This means through the delivery of biomass the supplier step by step gets property on the plant itself.

Plant size and economy of scale:

The economy of scale applies to biogas projects only up to certain scale. In many practical surveys specific investment costs decreased until a certain point and raise again for larger installations. For the moment, the 300 to 700 kW_{el} plant size seems to be the most cost effective. Small plants on a farm scale level have a lesser investment risk, but smaller cash flow, as they are designed according to the sources of available substrates in ownership of the biogas plant operator. On the other side, the larger the plant the more risks can be found in the biomass supply, however the cash flow as a criteria of a favourable investment can be higher. The following two recommendations can be given:

- The delivery of at least 80 % of the required biomass should be fixed through long term contracts or in ownership
- As a sustainable dimension, the overall potential of biomass on a farm scale level and in the region should outnumber the required biomass at least by the factor 4

If biomass has to be obtained on the waste or the energy crop market the distance from other biogas plants or plant projects should be at least 30 km, otherwise market conflicts about the biomass supply are inevitable.

Utilisation of digestate

The biogas plant produces significant amount of biogas digestate. The quantity depends on the kind of biomass which was fed into the fermenter. The lower the biogas yield from a specific biomass source is, the larger the amount of digestate is generated in the fermenter. However, the conversion of organic dry matter into biogas reduces the volume of substrate after the digestion and increases its specific weight.

Digestate as fertiliser

In general, biogas digestates have good fertilizer qualities with a high viscosity, strong mineral nitrogen, better plant and soil compatibility, odour reduction, reduced weed seeds and pathogens. The discharge of the digestate which originates from animal excrements, energy crops and other agricultural organic residues has no restrictions concerning hygiene and contaminants. When it is landspread directly only the legislation concerning nutrients mostly nitrogen and phosphorus have to be considered according to EU and national legislation. In most European countries a strict nitrogen limit of 170 kg/ha*a has to be kept for fertilizer which derives from animal origin. In order to keep to that spreading is prohibited in some of the winter months (in Germany from 15. November to 15th February) and a respective storage time of at least 6 months is already in effect or will be in the near future, especially in so called nitrogen vulnerable zones with a high activity in animal husbandry.

However, if industrial and municipal waste is used as a substrate national and EU legislation for biowaste comes into effect, which puts limits to landspreading. Above that wastes from animal origin such as food waste and fatty residues from slaughterhouse and restaurants have to meet the EU standard for hygiene and need to be kept at 70 °C for one hour, which is stipulated in the EU regulation 1774/2002. This regulation together with some national legislation e.g. biowaste ordinance prescribes procedures how to deal with the input substrate, process and the digestate concerning nutrients, contaminants and pathogens. In order to mitigate the impact of legislation bigger biogas and composting plants for biowaste digestion join a quality certification association which imposes self control of the treatment system.

If sewage sludge is used in the biogas plant, the digestate falls under the national sewage sludge legislation which has to be taken into account.

Recommendation

For the utilisation of digestate it should be made clear:

- If agricultural products are used, the waste can be landspread as fertiliser. In this case the national legislation has to be analysed for the quantities and time sequences the fertiliser is permitted on the agricultural land.
- If industrial and municipal organic residues are used, the biogas digestate can be landspread as well but certain legislation is putting limits to this possibility through the EU and national biowaste and sewage sludge legislation in addition to the fertilizer legislation. In this case the biogas sludge can be dewatered and the solid fraction incinerated or be brought to a landfill. The liquid fraction a waste water treatment has to be installed.

Step 2: Selection of the biogas neighbourhood (radius of 1 km)

Today, in most biogas stations the produced biogas is used directly on-site. It is most common to burn it in engines which produce electricity and heat (CHP Combined Heat and Power). However, in some specialized applications the biogas is only used for heating purposes.

Sale of electric energy

The possibility to sell the electricity has to be analysed in view to technical and a legal aspects:

Technically, the typical current of an electric generator for biogas plants is 0.4 kV. In this low current the transport of electricity is connected to huge losses and thus should be restricted to an absolute minimum. Thus, a transformation station is needed. It enhances the voltage to 10 – 20 kV. The transformation station requires a space of 15 m^2.

In this voltage the electricity can be transported longer distances and can be fed into the (national) electrical grid. The distance to the connection point with the grid should be as short as possible[3].

In most cases the biogas station will feed electricity into the grid, but also take electricity from the general grid. The reason for this are supporting schemes for renewable energies which in many countries pay higher prices for the sale of renewable electricity then the electricity from the grid would cost.

Legally, the sale of electricity all over Europe is subject to certain legal restrictions. The detailed analysis of the required allowances and permissions will be done in the pre-feasibility analysis. For the site selection it is sufficient to clarify if Independent Power Production (IPP) is generally allowed.

Sale of heat

The sale of the heat generated in the biogas engine is vital for the economic prosperity and environmental balance of the biogas station. Thus, the biogas site has to be selected in view to the potential heat use.

For a 500 kW$_{el}$ plant the amount of usable heat sums up to 600 kW$_{th}$ (flow temperature 80 degree, generated in the engine cooling circle). In summer months this full heating load is available for external use. In the winter months one third of this heating load is needed for the operation temperature of the fermenter. Thus, in the winter period only 400 kW$_{th}$ are available for other purposes.

The biogas station is also able to produce high temperature and quality heat (around 200 °C) by installing an oil based high temperature circulation[4].

In order to select suitable customers for heat sale, the following issues should be taken into consideration:

[3] Ideally, the respective country has a legal framework in place which gives prority access to renewable energy to the public grid and connections fees only have to be paid to the nearest connecting point.

[4] For certain purposes e.g. the drying of biomass the exhaust steam of the entinge can only be used directly.

- Most suitable are customers who have a steady heat demand all over the year. This is the case for industrial purposes and agricultural production facilities (e.g. pig and poultry breeding). Private premises are less suitable as clients do consume less heat in summer, when the biogas plant has the largest heat bulk available.
- It is possible to create own heating demand in summer e.g. through the installation of a drying facility for agricultural and wood products.
- It is important for the economical feasibility of the site that the heat is sold at reasonable prices. When the biogas heat is used to replace heating devices which currently operate on crude oil or natural gas, a sufficient price for the heat can be obtained, which still is slightly lower than the one for fossil fuels. The detailed calculation of the heating price is part of the feasibility analysis.
- The possible heat client has to be analysed for their individual financial strength and its long-term presence on-site.

Sale of biomethane

In future it will become more and more attractive upgrade biogas to biomethane quality. The advantage of biomethane is that it can be fed into natural gas grids and/or used as transport fuel. However, the technology to upgrade biogas is quite complex and cost intensive. If future biogas plant operators plan to feed biomethane into natural gas grids, the distance from the biogas plant site to the grid has to be considered.

More details on biogas upgrading and feed is available as Task 2.5 Report (Biogas purification and assessment of the natural gas grid) of the BiG>East project.

Recommendation

For the selection of a suitable site you should analyse and evaluate the following criteria and compile it in the following tables:

Sale and Purchase of Electricity:

Site name:	Figure	Comments
Distance to the general electric grid in meters:		
Voltage of the general electric grid nearby in kV:		
Space for transformation station on-site in m^2:		
Distance to the natural grid network		
Space for a gas cleaning station in m^2		

Use of Heat

This Excel table is included in the Word document; the figures in the kW column are examples and can be changed, they are interlinked with each other:

	kW	Brief description of heat use (incl. temperature demand)	Distance to heat customer in meters
Planned plant size in kWel	400		
Heat Supply Total in kWth	500		
Heat Supply Summer	500		
Heat Supply Winter	330		
Heat Demand 1 in Summer			
Heat Demand 1 in Winter	150		
Heat Demand 2 in Summer			
Heat Demand 2 in Winter			
Heat Demand 3 in Summer			
Heat Demand 3 in Winter			
Remaining Heat Load Summer	500		
Remaining Heat Load Winter	180		

Step 3: Selection of the Biogas Site itself

Requirements towards the biogas plant site

The characteristics of the plant site itself strongly influence the technical and economic feasibility of the project. Thus, the site itself has to be selected with upmost care along the following criteria.

Required size of the site

Biogas plants are space intensive. A 500 kW_{el} biogas plant requires 4000 m². This space is needed for the fermenters, the gas storage, electric generator and auxiliary facilities.

If the biogas plant is operated on agricultural products the dependency on harvesting seasons requires a storage space of additional 5400 m². This figure is valid if energy intense biomass like maize is used. If less energy intense biomass is used (e.g. manure), even larger storage is required. Because of the high investment for such a storage shed, it has to be carefully evaluated if the storage facilities of the producing farming units could be used. In this case the biomass supply for the biogas plant would be stable over the year through a "just in time delivery".

Moreover, the collection of the digestate requires on-site storage. In many countries the digestate can only be brought on the fields during the summer season. In this case, a storage facility for the winter has to be created. Such a storage facility for a 500 kW_{el} plant requires additional 4000 m^2.

Adequate road access

The biogas plant requires a steady supply and has an outflow of large quantities of biomass. Thus, a good road access is compulsory, namely:

- Direct access to a main roads
- Safe opening to the street which is suitable for heavy vehicles

Site characteristics

In the view of landscape protection it is recommended to prefer old industrial sites for the biogas plant instead of green fields. In any case it has to be ensured that the soil quality is suitable for the site construction. This means that

- No soil contamination is to be expected under the surface.
- No instable underground conditions are predominant and require large additional investment to stabilise the biogas constructions.

Possible neighbourhood conflicts

Emissions, particularly smell and noise emissions can not be avoided. Thus, the site has to be selected in view to possible conflicts with neighbouring areas. For analysing these potential conflicts a legal and a real level should be scrutinised:

On the **legal** level it should be analysed:

- Is any legal planning instrument enforced which prohibits the installation of a biogas plant?
- Is any legal planning instrument enforced which defines using purposes in this neighbourhood that might create conflicts (e.g. residential areas, areas of cultural heritage or nature protected areas)?
- Does any national legislation exists which creates certain prerequisites for biogas plants?

On the **real** level it should be analysed:

- Are there residential areas in the proximity (this should be analysed in view to the prominent wind direction)
- Are there areas of natural or cultural importance in the proximity?

Property rights of the selected site

The selected site has to be analysed for its ownership structure. Many biogas investors and financing banks request that the site is transferred into the property of the biogas operating company. Thus, it is necessary to choose a piece of land which has a clear ownership structure. The owner of the land should either be the future operator of the biogas plant or should be willing to sell or lease the ground to the biogas plant operating company. Preference should be given to public land. The municipality in most cases has an own interest that investment is done locally and therefore is willing to offer the land at fair prices.

Recommendations

For the selection of a suitable site the following tables can be used:

Available space

Site name:	Figure	Comments
Space for Biogas Plant (in m2)		
Space for the storage of biomass on-site:		
Space for the storage of biomass at the producer		
Space for the sludge storage		

Sufficient Road Access

Site name:	Figure	Comments
Distance to intersectorial road (in km)		

Additional site requirements

Site name:	Yes	No	Comments
Site access for trucks possible			
Soil contamination is unlikely			
Soil is suitable for industrial construction			
Planning instrument prohibits biogas plant on – site			
Planning instruments foresees residential, cultural or nature protected areas nearby			
Residential, cultural or nature areas exist in the proximity			

Ownership structure

Site name:	
Who is the owner of the selected site:	
Will the owner also be the operator of the biogas plant	
Is there a basic possibility to buy the land	

Step 4: Optimising soft requirements for the selected site

Favourable soft requirements

The feasibility of a selected site strongly depends on a set of so called soft requirements which cannot be overestimated in their importance.

Political support

The installation of a biogas plant is always a political issue. This is due to the strong attention renewable energies find in the public and in the media. Moreover, biogas plants carry the danger of neighbourhood conflicts and thus the development of such a project is well recognised within a local community.

It is very important for the successful project development and implementation that significant support can be found between the stakeholders on municipal and regional level.

Available know-how for biogas operation in the region

The gas yield and with that the economic success of a biogas plant strongly depends on the expertise in the plant operation. Existing plants show that the energy yield can be increased by up to 25 % if the plant is well operated and maintained. On the other side it is often not economically feasible for smaller biogas operations to employ an experienced technical manager for the plant operation.

Thus, it is important to analyse if there are already individuals or companies in the region who have experience in successful biogas plant operation.

Moreover, the work on-site can become much more efficient, if the plant operation can be combined with another business of similar profile, such as an agricultural association, a food processing industry or a biofuel producer.

Committed project developer

The project development for a biogas plant can be long and cumbersome. For this reason it is very important to have a committed project developer in the region. This person should have a good basic understanding for the economic and technological items of a biogas plant and should be well rooted in the region. Such a person can increase the chance of a successful project development significantly.

Recommendation

Mobilisation of political support

Political support does not come by itself. It has to be built through a long and careful communication process in which the economic and environmental benefits of the project for the region itself should be clearly marked. It also is important to inform the political decision makers as well as the direct neighbourhood early about the biogas project. Particularly helpful has been proven to organise a joint excursion in which a successful operating plant can be visited as "Best Practice" or other informative events.

Securing the expertise for plant operation

Many national and European programmes offer training opportunities for biogas operators. Consequently, a person with the possible technology background should be found and trained.

Local project developer

Particularly for young people renewable energies are a very interesting option to find a career perspective in their own region. Thus, for the project developer should be searched by contacting multipliers in policy and regional SMEs. A good perspective could also be to contact the next high-school for young workers who are looking for a job.

Support and additional information can be obtained from

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Appendix:

Biogas Yield Analysis from various Feed-stock			
Biomass Sources	biogas yield in m3 / t	Available tons per year	Available biogas yield per year (m3)
Apple laitance	13	0	0
Wheat laitance	28	0	0
Cow Manure	35	0	0
Pig Manure	37,5	0	0
Melasseschlempe	37,5	0	0
Potato laitance	56,5	0	0
Cow droppings (fresh)	56,5	0	0
Loppings	62,5	0	0
Chicken Litter	66	0	0
Potato peelings	66	0	0
Horse manure (fresh)	74	0	0
Pic Manure (fresh)	85	0	0
Apple pomace	87	0	0
Sugar beets leaves	90	0	0
Vegetable waste	90	0	0
Beer Pomace	94	0	0
Clover	94	0	0
Sheep manure (fresh)	100	0	0
Swath (1st Cut)	100	0	0
Potato Haulm	110	0	0
Chicken litter (solid)	112,5	0	0
Coffee Pomace	125	0	0
Whey	151	0	0
Grass Silage	175	0	0
Fruit pomace	187,5	0	0
Organic kitchen waste	203	0	0
Cereal straw	225	0	0
Leaves	280	0	0
Maize Straw	307	0	0
Melasse	334	0	0
Waste wheat	360	0	0
Hay	398	0	0
Waste fat	400	0	0
Rape oil residues	449	0	0
Old bread	475,5	0	0
Backery waste	660	0	0
Waste flour	751	0	0
Waste grease	800	0	0