SUSTAINABLE SMALL-SCALE BIOGAS FROM AGRI-FOOD WASTE FOR ENERGY SELF-SUFFICIENCY

biogas³

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> HANDBOOK <

biogas[3]

sustainable
small-scale biogas
from agri-food waste
for energy self-sufficiency

BIOGAS³ HANDBOOK:

a tool to promote sustainable production of renewable energy from small-scale biogas plants for pursuing self-sufficiency

> AUTHORS

Remigio Berruto
Patrizia Busato
Alessandro Sopegno
Lorenzo Venudo
Daniele Rossi

> CONTRIBUTORS

Dionysis Bochtis
Angelo Caffaro
Angela Calvo
Andrea Chiabrando
Javier Claros
Cristophe Cotillon
Radomir Dyjak
Marianna Faraldi
Elisabeth Gabor
Paz Gomez
Katharina Hartmann
Małgorzata Kachniarz
Pascal Levasseur
Mar Mesas
Federico Morais
Ulf Nordberg
Mark Paterson
Gustav Rogstrand
Alexandre Rugani
Begoña Ruiz
Jaensch Volker

> BIOGAS[3]

BIOGAS[3] will promote the sustainable production of renewable energy from the biogas obtained of agricultural residues and food and beverage industry waste (agro-food waste) in small-scale concepts for energy self-sufficiency. This action will contribute to secure, sustainable and competitively priced energy for Europe by promoting new and renewable energy sources and supporting energy diversification.

This project is co-funded by the Intelligent Energy Europe Programme of the European Union, Contract Nº:IEE/13/SI2.675801.

The motivation behind BIOGAS[3] is based on the observation that, despite its multiple benefits, anaerobic digestion (AD) is not yet widely implemented in the agrofood sector, or its implementation varies extremely between the EU-27 member states. Anaerobic digestion (AD) for biogas production can be applied to organic matter such as agro-food waste. The small-scale AD concept (<100 kW_{el}), applied soundly in the appropriate locations, is a sustainable solution from the economic (energy savings due to self-consumption, waste management savings), energy (self-consumption and reduced losses due to near use) and environmental (reduced or zero transport costs, emissions and noise for substrates and digestate, emission abatement in CO_2 equivalents) point of view.

> PARTNERS

The consortium includes representatives of all key actors: agro-food industry associations (FIAB, ACTIA, TCA), research centres dedicated to agrofood industry and bioenergy (AINIA, JTI, DISAFA, IFIP), bioenergy associations (IrBEA), and training and dissemination specialist oriented to renewable energies (RENAC, FUNDEKO). It does not include any biogas technology supplier nor sellers of biogas plant components.

> INTRODUCTION

> WHERE TO FIND INFORMATION

- What is Biogas3?
- Which purpose does it pursue?
- Who is following the project?

- What is biogas?
- How can I use biogas and digestate?
- Which are the benefits for the environment?
- What are energy needs of agrofood industry?

- Are my by-products and wastes exploitable for biogas production?
- What substrates are produced by agrofood industry?
- How much energy can I obtain from my substrates?

- Which technologies I need to treat my substrates to produce biogas?
- Which technologies are available on the market?
- How can I manage the thermal energy surplus?

INTRODUCTION BIOGAS SUBSTRATES TECHNOLOGY

COMPANIES

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IMPLEMENTATIONS

LEGISLATION

- How can I reduce the costs of a biogas plant?
- Who can I ask for information on a biogas plant?
- Is there a plant supplier near by?

- How can I model a plant on my conditions?
- Can I have information about economic and engineering parameters?
- Where can I find a tool to find these information?

- Are there small-scale plants currently working?
- Are they profitable?
- How they use thermal surplus?

- How can I build a plant for my enterprise?
- Where can I find laws and permits of my country?

> WHY BIOGAS FOR AGROFOOD INDUSTRIES

Biogas3 will produce a significant impact in terms of renewable energies uptake. It will act as catalyst and replication of success, triggering decisions to invest in renewable energy production from agro-food industry waste. Total transferability is guaranteed between participant countries that cover the most relevant regions of Europe in terms of agro-food waste generation. The high relevance of the participants and their dissemination capacity will assure the high visibility of the actions, making intelligent energy technologies as widely available as possible. The trainer approach ensures impacts beyond the actual project duration.

Small biogas AD can be profitable on agro-food industry which have organic wastes with a high potential of methane production and the possibility to use efficiency using the surplus heat which comes from the co-generator and exhaust.
An association between a farm and an agro-food industry would give a great advantage in order to receive the bonus for the use of manure. The agronomic use of digestate on farm land constitutes another advantage of such association. On another hand, the management of digestate is a disadvantage for major agrofood industry because, in general, those industries don’t have land access to arable land.
Furthermore using wastage to feed digester for biogas production can be profitable to reduce costs of waste disposal.

AD is a mature technology that is well known in the municipal waste and wastewater treatment branch. It is commercially ready to use and has multiple benefits (energy savings, reduction of environmental impact, reduction of carbon footprint, etc.). The same valorisation principle can be applied to other organic residues such as waste from agriculture and food and beverage industry.

The AD technology is already applied in more than 8000 biogas plants in Germany. However, the sustainability of these plants is much better, if equipped with a CHP and located next to a external heat consumer. Only this way, expensive fossil fuels might be even substituted.

Other sustainability issue is the transport of raw materials to the plants: this transport has an high environmental impact on large-scale biogas plants.

> BIOGAS

Biogas is a combustible mix of gases produced from the fermentation of biomass. The most valuable component of biogas is methane, that can be used to produce electricity, heat and biofuel. Other molecules present in biogas are CO_2, sulphides, oxygen, nitrogen, ammoniac and water vapour.

> ANAEROBIC DIGESTION

Biogas is produced out of biomass through a biological phenomenon: anaerobic digestion. Anaerobic means that the process takes place in an oxygen-free environment. The organic material in the substrates is reduced and converted to biogas by micro-organisms.
The process consists of four steps, each of which carried out by different groups of bacteria:

- **HYDROLYSIS**: in this phase, large organic polymers such as carbohydrates, fats and proteins are broken down into smaller constituents, like simple sugars, amino acids, fatty acids and water.
- **ACIDOGENESIS**: the further breakdown of remaining components. It is done by the acidogenic bacteria which convert the material into short-chained fatty acids, alcohols, CO_2, hydrogen and ammonia.
- **ACETOGENESIS**: the organic acids are formed. They are the basis for the eventual methanogenesis. The bacteria responsible for the third phase, the acetogens are highly sensitive to temperature fluctuations. The methanogenesis itself also slowly starts during the third phase.
- **METHANOGENESIS**: methane (biogas) is formed is formed from acetate (about 70%) and 30% from CO_2 and H2 in this phase. Also CO_2 is released and, in small proportions, also water, H_2S and N_2. The content of methane in biogas typically varies between 50% and 60% depending on the substrate characteristics used.

> BIOGAS

> ENVIRONMENTAL CONDITIONS FOR BACTERIA

The process also reacts sensitively to changes (input, pH etc.) and is also easily disturbed by inhibitions (disinfectants, oxygen, sulfur, heavy metals, too high acid concentration). For that reason, the temperature of the fermenter has to be kept at a certain level in order to prevent the bacteria from being killed. In practice, a division is made between mesophilic and thermophilic bacteria. Mesophilic bacteria require temperature between 37°C and 42°C, typically approximately 38°C. For thermophilic bacteria, temperature of 50°C - 60°C or more is required. Thermophillic acts as sanitizing and is well suited for substrates such as waste produced with higher temperatures. Thermophilic bacteria are more sensitive to temperature changes than mesophilic bacteria. For that reason, thermophiilc digestion is more difficult to control.

> PROCESS PARAMETERS

There are three main parameters which describe the digestion process. These are:

- **ODM-LOAD**: It stands for Organic Dry Matter load. This represents how many kilograms of ODM per m^3 fermenter volume per day is being fed into the digester. Typically, values are between 2 to 3 kg ODM m^{-3} day^{-1}. As a rule of thumb, you can take 4 kg m^{-3} day^{-1} as a maximum value. Above that, the activity of the bacteria diminishes.

- **RETENTION TIME**: The so called hydraulic retention time is the theoretical duration that the substrate stays in the fermenter and post digester. For a continuously stirred vertical fermenter, this is a calculated value. For a plug flow fermenter, the hydraulic retention time represents the actual retention time quite accurately. Be aware of the generation time of the microorganisms; the growth rate of methanogenic bacteria is between 5 and 15 days; lower HRT will flush them out.

- **DEGRADATION PERCENTAGE**: This reflects the percentage of the total amount of Organic Dry Matter which is broken down during the retention time. Typically, this is approximately 60%. More is possible, but one would require a considerable longer retention time. In practice, a total conversion of all ODM is not realised.

> USE OF BIOGAS

Agro-food industries need a lot of electrical and thermal energy and vapour in food processes. For example cheese industries need thermal power to heat the milk, slaughterhouses need electricity for refrigerators and also a lot of hot water for cleaning.
Each sector of food-industry has an energetic need, which can be partly satisfied by anaerobic digestion technology.
Biogas produced in digesters can be used as source of energy in different ways.
Biogas can be used as fuel for a CHP installation. CHP means Combined Heat and Power and refers to the cogeneration of electric energy and heat. Basically, it is a gas powered engine with a generator connected to it. The engine drives the generator, which in turn produces electricity. As a result of the internal combustion, the gas engine also generates heat. This heat leaves the engine through the exhaust gases and the cooling liquid. By using heat exchangers, this thermal energy can be captured and used productively since the water's temperature reaches 90°C.

Instead of burning biogas in a CHP installation and generating electricity and heat, the biogas can also be fed into the gas grid (biomethane). This is especially attractive when the heat generated by a CHP cannot be used. The biogas needs to be upgraded to the same quality as the natural gas before it can be fed into the gas grid. Upgraded biogas can also be used as fuel for transportation (e.g. for fleets). At the moment, because of economic issue, small-plant cannot produce biomethane.
Biogas can also be used to generate heat for housing and industrial processes producing thermal energy with boilers.

> USE OF DIGESTATE

Digestate is the rest of the anaerobic digestion process. It contains fibers, nutrients, minerals and not degraded carbon.

Digestate can be processed in different way as aerobic treatment, drying, separation of liquid and solid fraction, composting and used as fertilizer in agriculture.
Even if each digestate is different, usually it has numerous benefits, whose most common are:

- **NUTRIENTS ARE IN MINERAL FORM**
- **LESS AMMONIUM LOSSES DURING SPREAD**
- **LESS LEACHING**
- **MORE CARBON THAN IN MANURE;**
- **LIQUID COMPOST**

The period of time that digestate must be stocked and the amount that could be spread as fertilizer are determined by each country's law.

> ENVIRONMENTAL BENEFITS

Climate change is one of the most important challenges we will have to face in the following years. The agrofood chain can help reducing the impact of climate change.

The type of energy used will determine whether our food systems will be able to meet future sustainable models.
In order to reach sustainable models, renewable energies can be used as a substitute for fossil fuels.

Agrofood systems require energy, but they can also produce it.
If excess energy is produced, it can used to earn additional profit for the owners, increasing benefits for the community (owners, providers, citizens). Furthermore also the emission from open manure storage can be avoided or minimized by biogas

Biogas plants generate agricultural, environmental and economic benefits for the operators as well as for the residents nearby:

- **ENERGY PRODUCTION FROM LOCAL RENEWABLE SOURCES (HEAT AND ELECTRICITY)**
- **REDUCTION OF GREENHOUSE GAS EMISSIONS**
- **INCOME FROM SALE OF ENERGY AND FERTILIZER**
- **CHEAP AND ENVIRONMENTALLY SAFE RECYCLING OF MANURE AND ORGANIC WASTES**
- **IMPROVED VETERINARY SAFETY THROUGH SANITATION OF DIGESTATE**
- **IMPROVED FERTILIZATION EFFICIENCY**
- **ODOR REDUCTION AND LESS NUISANCE DUE TO FLIES**

> ENERGY REQUIREMENTS OF AGROFOOD INDUSTRY

Energy demand for food and beverage industries is mainly distributed in the demand of electrical energy, thermal energy and cooling processes. Some products need an higher energy demand than others, for example milk has to be refrigerated, heated before processing in dairies and the final product could be dried or frozen.
Many European countries use fossil fuel to produce energy, biogas is a solution to reduce GHG emissions and pursuing self-sufficiency.
Energy cost is an other main feature for agrofood companies: many industries have an high demand in electrical energy, as cheese farms, meat production, bakeries and starch production. In some food chain, the energy costs are the highest factor just after the cost of the primary product itself.

Thermal energy demand is high among processes that need large amount of heat, as alcohol distilleries, malt production, dairies and canned food production.
Thermal energy is also required by food and beverage industry to sanitize equipment and tanks.

Electrical energy demand is high for processes that use low temperatures: for example cooling meat carcasses, freezing products (with an high energy expenditure for cold chain).
Biogas plants can provide cold with a CHP engine with a trigeneration system.

Steam is mainly used in processes to cook food, as cooked ham or vegetables.
Furthermore it can be used to sterilize food: for example UHT milk production.
Vapor is commonly used to sanitize equipment and tanks as well.

> SMALL-SCALE PLANTS

The predominant type of digester is the stirred vessel in continuously operation, and small scale plants are not an exception. However, small scale (<100kW$_{el}$) anaerobic digestion plants have some particularities and three different approaches are found:

- **SELF-BUILT:** Low-tech biogas plants. Those are found usually in agricultural environments. Investment and operation and management (O&M) costs are kept to a minimum, but the efficiency of the process is also reduced.

- **STANDARDISED SMALL-SCALE BIOGAS PLANTS:** There are several providers in the market specialized at standard solutions for small-scale (<100kW$_{el}$) biogas plants. Those consist in either commercial products consisting in containerized plants that are transported to the site and installed very quickly (usually <30kW$_{el}$) or turnkey small plants (30-100kW$_{el}$). Investment costs are in the medium range between the first and second approach, since they are standardized solutions.

- **DOWN-SCALED BIOGAS PLANTS:** Some "conventional" biogas plant constructors offer small-scale solutions as well. Those solutions are usually more tailor-made than the standard containerized plants, and therefore the investment costs can rise in these cases. The best technological option depends on the particular conditions of each end-user (waste characteristics, final use of the energy produced, etc.). Some of these small-scale biogas plants are not optimized in this sense since some of them do not operate continuously (they are over-dimensioned for the amount of waste available). In spite of that, payback periods are similar to that obtained with bigger biogas plants (5-8 years).

> AGROFOOD WASTE AND BYPRODUCTS

Biogas can be produced from many substrates, both agricultural residues and food processing waste.
Using by-products and wastage to feed a digester is more virtuous in an energetic and environmental way than feeding it with noble products such as energy crops.

The potential competing uses of food and beverage or agricultural waste and residues are currently four:

- **DISPOSAL AT LANDFILLS**
- **MANAGEMENT THROUGH AUTHORIZED WASTE MANAGERS**
- **ANIMAL FEED**
- **COMPOSTING/AGRICULTURAL USE**

The two first uses are not considered as competitive since they imply a cost for the company, while the use for biogas production will yield economic benefits.

However, the use for animal feed, where allowed, can be a competing use for certain waste such as brewery bagasses or fruit and vegetable waste from cooperatives.

Composting/agricultural use can be addressed as synergy, since the digestate resulting after the anaerobic digestion of waste is a suitable substrate for composting and agricultural use.

The larger amount of suitable substrates for anaerobic digestion in agro-food comes from livestock, food of animal origins industries, fruit and vegetables industries, wineries and winegrowers, oil mills and cereal industry.

Wastes are typical of the specific nature of the company but, transversal to all production/processing chains, there is the presence of unsold and/or unsalable products as waste.
Not all by-products and industry wastes can be used to feed a digester. The distinction between by-products and wastage is demanded to the single country legislation. Moreover, other parameters should be checked too, as C/N ratio, amount of NH_4 and fat quantity.
Sometimes the methane produced from two substrate separately is different from the sum of the two. It is necessary to test in laboratory the biogas potential of the biomass before planning a plant.

> SUBSTRATES

> SUBSTRATES FROM LIVESTOCK

Animal farms produce a large amount of organic matter such as manure and slurry: animal dejections are an important source of biomass for biogas plants and are one of the most currently used substrates. Manure also stabilise the microbiological process (pH buffer, minerals etc).

In particular manure and slurry from pig, poultry, bovine, sheep, goat, equine and rabbits are the most common substrates from livestock.

Manure has a good yield in biogas production; it varies depending on animal species, freshness and dry matter value. However manure and slurry have a low energy density because of the high water content and the low portion of organic dry matter.

Slurry has a lower potential in methane production than manure, but provides a great contribution in trace elements, useful for methanogenesis. Furthermore slurry has a diluent and buffer effect on the digester.

Interesting is the sludge from sewage treatment plant of cattle farms: this could be an attractive potential fermentation substrate for biogas production.

From 100 milking cow dejections, a biogas plant could produce up to 238 MWh_{el} and 360 MWh_{th} a year

From 2000 pigs dejections, a biogas plant could produce up to 248 MWh_{el} and 375 Mwh_{th} a year

From 40 cattle, 40 pigs and 300 chickens dejections, a biogas plant could produce up to 111 MWh_{el} 168 MWh_{th} a year

***INFORMATION IS THE BOXES IS TAKEN FROM SMALLBIOGAS®**

> SUBSTRATES FROM FOOD AND VEGETABLES INDUSTRY

Fruit and vegetable chain agro-food produce different by-products exploitable for biogas production from the field, to the manufacture, up to the retailers.

These are perishable products, so they tend to generate wastage, furthermore some process create a large amount of by-products, for example peels in tomato sauce production, residues from canned and processed fruit and vegetables industry and by-products from potato processing industry and sugar industries. Other consumable biomasses for digesters are fruit and vegetables not compliant with process standards. Therefore altered or damaged agricultural products could be used to feed a digester, but they should not be rotten or held in bad storage conditions. Leaves and stems of crops could be used too, but no woody material. The major issue related to this kind of industry is due to the seasonality of the waste production. However, some substrates could avoid this issue by a further process as drying or silage (for example tomato peel silage).

From 500 tons of potato peel waste, a biogas plant could produce up to 372 MWh_{el} and 564 MWh_{th}

From 600 tons of dehydrated sugar beet pulp, a biogas plant could produce up to 527 Mwh_{el} and 799 MWh_{th}

From 3000 tons of tomato peels, a biogas plant could produce up to 908 MWh_{el} and 1376 MWh_{th}

> SUBSTRATES FROM ALCOHOL PRODUCERS

Most common substrates from this sector are brewing residues, residues from cider industry, hops and grapes peels and other wastes from distillery, grape marc and pruning residues in vineyard from wine industry.

Some of these substrates are produced in a short period of the year, as for substrates associated with wineries and winegrowers, while for distilleries or breweries the problem is less significant. As for other industries, the seasonality problem could be avoided with the conservation of substrates; an example is the silage of grape marcs.

From 80 tons of brewing residues, a biogas plant could up to 63 MW_{el} and 95 MW_{th}

From 60 tons of grape marcs, a biogas plant could produce up to 46MW_{el} and 60 MW_{th}

> SUBSTRATES FROM OIL INDUSTRY

Vegetable oil production depends largely on the climate and habits of the producer's Country.

Thereafter the kind of wastage produced depends mainly on the area where the oil millings are located.

The most common substrates are wastage and by-products from oil manufacturing of castor, peanut, rapeseed, linseed, coconut, hemp, palm, soybean, sunflower and olives.

From 100 tons of olive oil squeezing residues, a biogas plant could 240 MW_{el} and 364 MW_{th}

> SUBSTRATES FROM CEREAL INDUSTRY

Currently cereals and manure are the most commonly organic matter used to feed digester. Cereal used to produce biogas could be noble products as cereal grains or silage, but it is possible to exploit less noble products as harvesting crops waste, straw and other waste products of industrial process.
Wastage in cereal sector is mostly represented by straw from cereals, forage and oleaginous, wastage storage as dust silo waste, cereal drying process waste, discarded grains and by-products of manufacturing as rice chaff and wheat bran. Note that some of these substrates may need a pre-treatment technology.
Starch production is mostly based on cereals and it produces a large amount of by-products and wastage, since the volumes handled are very high. Substrates exploitable for anaerobic digestion from this industry are: processing wastewater, forage maize meal, sugar beet pulp and maize gluten.

From 200 tons of discarded grains, a biogas plant could produce up to 164 Mwh_{el} and 248 MWh_{th}

From 300 tons of dust silo waste, a biogas plant could produce up to 95 Mwh_{el} and 144 MWh_{th}

From 350 tons of cereal straw, a biogas plant could produce up to 202 Mwh_{el} and 306 MWh_{th}

> SUBSTRATES FROM FOOD OF ANIMAL ORIGIN INDUSTRY

Food industry related to animal origin products is very varied and creates many by-products and wastage exploitable for biogas production.

The main industries related to meat sector are slaughterhouses, charcuteries and meat producers; most common substrates are offal, rumen content, slaughterhouse animal fats and waste, sewage sludge from industrial treatment plant, bones and blood.

Another crucial sector for animal origin products is the dairy industry; most common substrates related to this industry are whey, cheese waste, fatty cream waste and milk.

Furthermore fish industry may provide by-products of manufacturing.

From 1200 tons of whey and 60 tons of unsold fresh cheese, a biogas plant could produce up to 104 MW_{el} and 158 MW_{th}

> SMALL-SCALE BIOGAS

Small scale AD is quite expensive. It seems important to note that small scale AD units have to use the simplest technologies in the aim to decrease investment cost without reducing safety, environmental and emission standards. More technologies are complicated, more maintenance and labors are necessary. To make a small biogas unit profitable, it is necessary to use a much as possible existing structures, realize self-construction, decreasing civil engineering costs and being independent on the entering substrates and use substrates as simple as possible.

> DISCLAIMER

This section contains information of companies that provide part of plants or services related to small-scale plants.
We could not include all companies in this handbook, but only the ones that took contact with partners. The choice of the companies was not involved in any kind with partner's business activities.
No payment was requested to publish the information companies provided in this handbook. We cannot guarantee that all the provided information will be published in the handbook.

> CONTENTS

In this section some information about technology are shown, the main topics are:

- **RAW MATERIAL PRE-TREATMENT**
- **ANAEROBIC DIGESTION**
- **DIGESTATE CONDITIONING**
- **BIOGAS VALORIZATION**

> TECHNOLOGY

Biogas³ consortium express gratitude to all companies involved in the project. The following plant and component providers gave a special contribution to the technology section of this handbook.

www.2-g.com

www.gruppoab.it

www.agb-biogas.com

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T&B - Die Biogasoptimierer

www.die-biogasoptimierer.de

www.uts-biogas.com

> RAW MATERIAL

> PRETREATMENT FOR LIQUID FERMENTATION

A key part of liquid fermentation system is often pre-treatment of the substrate. Together with agitation of the digesters, pre-treatment of the substrate often stands for a majority of the electricity consumption at the biogas plant. Pre-treatment often contains:

- **PACKAGING REMOVAL:** Food residues are often a potent biogas substrate. However, removal of packaging can be a challenge. For a small scale biogas plant the most complex residues (regarding packaging removal) would probably not be of interest as they are too expensive too pre-treat.

- **DISINTEGRATION:** Solid substrates such as solid manure, harvesting residues, energy crops and some residues from food industry requires disintegration to avoid process disturbance related to pumping and agitation. Disintegration can also contribute to increase the degradation rate from the substrates as it results in increased reactive surface area. Furthermore, disintegration can be a requirement to be able to full fill the regulations related to hygienisation (e.g. regulations often contain provisions for maximum particle size).

Disintegration technology can roughly be divided to wet and dry disintegration. For both cases there is often a need for a solid storage and dosage system and in many cases that system provides sufficient disintegration for direct feeding to the digester. These systems also make it possible to settle out impurities such as e.g. gravel and stones. Disintegration equipment is listed on the table below.

Wet		Dry	
Chopper pumps	Grinders	Hammer mill	Extruder
Macerators	Cutting grinders	Chain mill	Knife mill
Pump mixers		Mincer	Feed mixers

- **HYGENISATION (USUALLY PASTEURIZATION):** The reason for pasteurization is to prevent risk for cross contamination in the food production chain. Many valuable co-substrates such as residues from slaughterhouses, food residues from caterers and solid manure such as chicken manure from external farms may require pasteurization or other type of hygienisation. This is usually obtained by using a system of pasteurization tanks and a heat recovery system.

> ANAEROBIC DIGESTION

Biogas consists mainly of methane (50 - 75 Vol.%), carbon dioxide (20 - 45 Vol.%), water, hydrogen sulphide (0,01 - 0,4 Vol.%), and contains traces of ammonia, hydrogen, nitrogen and carbon monoxide. Suspended solids are possibly found.

Type of fermentation are shown below.

Wet Fermentation:

- **COMPLETELY MIXED DIGESTER**
- **PLUG FLOW DIGESTER**

Dry Fermentation:

- **PLUG FLOW DIGESTER**
- **GARAGE TYPE BATCH DIGESTER**

Aspects to consider during the feeding are the following:

Maximum daily input quantity

- **RETENTION TIME**
- **VOLUMETRIC LOAD**

Continuous input cycle

- **SMALL PORTIONS AS OFTEN AS POSSIBLE**
- **NO COMPACTION, INSTEAD FEEDING LOOSE SUBSTRATE**

Avoid changes in the substrate, environmental temperature, more than 2°C day^{-1} and inhibitors. Ensure correct flow rate to prevent overpressure

- **DEVELOP OVERPRESSURE**

> DIGESTER TYPES TECHNOLOGY:

CONCRETE DIGESTER WITH CONCRETE COVER

Advantages:

- Controllable (solid feeding...) withstand certain pressures (20 mbar)
- Simple repairing of the stirring system
- Low heat loss
- Wind protection

Disadvantages:

- No integrated gas holder
- Inner digester repair difficult
- The concrete is not absolutely gas-tight, difficult leak identification
- Space savings if installed at ground level;

CONCRETE DIGESTER WITH SINGLE MEMBRANE COVER

Advantages:

- Low-price alternative
- Simple digester revision
- Integrated gas holder

Disadvantages:

- Wind- and weather sensitive
- Not 100% gas-tight
- Difficult to determine gas level

CONCRETE DIGESTER WITH DOUBLE MEMBRANE COVER

Advantages:

- Simple digester repair and easy to determine gas level
- Integrated gas holder
- Weather proof

Disadvantages:

- More expensive than one cover
- Not 100% gas-tight
- Permanent energy consumption

HORIZONTAL DIGESTER WITH PADDLE AGITATOR

Advantages:

- Digesting high solids content
- High loading rate possible
- Little short cut flow
- Automatic sand drain
- Complete mixing
- High digester productivity and suitable for dry digestion

Disadvantages:

- High price
- Post-digestion is needed
- Limited in size

> PUMPING AND MIXING

> PUMPS FOR TRANSPORT OF FEEDSTOCK AND DIGESTATE

Two main types are used: Centrifugal and displacement pumps.
A centrifugal pump is a rotodynamic pump that uses a rotating impeller to increase the pressure and flowrate of a fluid. Centrifugal pumps are often submerged (not self-sucking).
A displacement pump causes a fluid to move by trapping a fixed amount of it then forcing (displacing) that trapped volume into the discharge pipe, they are self-sucking with a stable pressure. Flow depends on rotation speed (precise dosing).
For maintenance reasons, pumps are equipped with stop-valves, are easily accessible and ensure sufficient work room.
The function is often controlled by Programmable Logic Controller (PLC) or at least a timer. In some biogas plants, the whole transport of digestate is realised by one or two pumps, located in a central pumping station.

> REMOVAL OF SEDIMENTS AND FLOATING MATERIALS

If needed, in order to remove sediments, the floor scraper wipes sediments into an floor outlet from were the sediment is pumped into a classifier.
To remove swimming layers gas proof separation can be used. Floating material is skimmed from the surface and pumped to a sieve. Due to is construction the skimming unit is self regulating and gas proof.

> AGITATORS

Methane bacteria is unable to move, nutrients have to be brought to them, with a passive stirring due to thermal convection and bubbles released by substrate mix, but usually other system are used too:

- **MECHANICAL STIRRING**
- **PNEUMATIC STIRRING**
- **HYDRAULIC STIRRING**

Mechanical stirring is the most commonly installed (90% of biogas plants), they have different speed and different geometries (paddle stirrers, axial stirrers and submersible axial stirrers).

> DIGESTATE CONDITIONING

Digestate produced through AD is a nutrient-rich substance commonly used on agricultural land as a fertiliser, replacing synthetic fertilisers and/or soil conditioners. It contains useful quantities of major plant nutrients including Nitrogen (N), Phosphorus (P), Potassium (K), magnesium (Mg), sulphur (S) and trace elements.
The nutrient content of any digestate is a reflection of the nature of the feedstock subjected to digestion.

> SEPARATION

Digestate can either be applied to land 'whole' or separated into solids and liquids, generally referred to as 'fibre' and 'liquor'. Separating the digestate using mechanical, biological or thermal equipment can have a number of benefits that can justify the cost of the additional equipment, including:

- **SELECTIVE STORAGE OF FLOWABLE AND STACKABLE MATERIALS;**
- **IMPROVED PUMPABILITY OF SEPARATED LIQUOR;**
- **PARTITION OF NUTRIENTS AT DIFFERENT RATIOS IN THE LIQUID/SOLID PHASES;**
- **REDUCED STORAGE VOLUME OF LIQUIDS COMPARED TO WHOLE DIGESTATE.**

Separation is usually carried out at the AD facility as the two products may be sent to different outlets. As wet AD systems receive predominantly sludges and slurries, dewatering may generate relatively little solid material, with a typical ratio of >5:1 liquor: solid.

> SEPARATION TECNIQUES

- **SCREW PRESS:** compresses the digestate into a gradually decreasing screw channel between a screw shaft and screen mantle, squeezing out the liquid. Different screens and operational pressure can be used to alter the efficiency of the separation process. This method can achieve 30–38% DS. It is worth noting that screw presses tend to have a solids-capture efficiency between 10% and 40% depending on the feed characteristics.
- **BELT PRESS:** work in a similar way to screw presses, whereby the digestate is sandwiched between two tensioned belts which are passed through decreasing diameter rolls to squeeze out water. These tend to have a higher separation efficiency and are often used to produce a cake output, rather than a fibre output.
- **CENTRIFUGE:** is a high speed, high G device that uses centrifugal force to separate fine particles and liquid. Typically polymer is added to agglomerate very fine particles prior to centrifuging, with the type of polymer and dosage rate having a large influence on performance. Centrifuges should generally achieve a separation efficiency of >95% of solids, producing a cake between 18% and 35% dry solids, and a liquor of less than 0.3% dry solids

> POST-SEPARATION TECNIQUES

- **PRE-COMPOSTING:** uses aerobic bacteria which occur at the beginning of the classic composting process. These bacteria heat the digestate and remove the water content. This process may be inefficient unless supplemented with auxiliary heat, such as exhaust heat from a combined heat and power unit (CHP), or may require an agitation process due to the high thermal inertia of moist, fine particle digestate
- **VACUUM EVAPORATORS:** a relatively new technology in the UK but one that has been operational in continental Europe for a number of years, evaporation systems generally rely on two effects: first the digestate is heated using either hot water or steam; second, low pressure steam is flashed off using a cyclone separator and a vacuum pump.
  By subjecting the heated liquid to a vacuum (the pressure is reduced to below atmospheric), the boiling point of water is reduced and steam can be generated at low temperature.

> DIGESTATE STORAGE

- **CONCRETE TANKS:** like digesters, digestate tanks are cylindrical reservoirs made of reinforced concrete or timber only if storage is not covered gas-tight, which when compared to other storage facilities require only a small area.
  If necessary, these tanks can be covered gas-tight and will consist, as law requires, leak-detection in water protection areas. If desired, the resulting residual gas can be collected and used as well, and thus, the profitability of your biogas plant can be increased even further.
- **LAGOON:** an earthen basin, which is sealed by a plastic vapour barrier in the soles and slope area. An advantage of such a storing system is that it saves concrete, as it does not need any to be constructed. However, the construction of a lagoon usually requires a more spacious patch and should only be used in areas with longer distances to the groundwater. Note that in some country this technology will not be allowed in the future.

> COVER TECHNIQUES

All these methods will reduce ammonia and odour emissions.

- **SOLID COVERS:** these are the most effective techniques for reducing ammonia emissions but also the most expensive. Whilst it is important to guarantee that covers are well sealed to minimize air exchange, there must be small openings or a facility for venting to prevent the accumulation of inflammable methane gas, especially with tent structures.
- **FLOATING COVERS:** these are usually made from plastic sheets and are less effective than roofs, although they are usually less expensive. Double sheets with shrink-wrapped polystyrene are often used to avoid gas bubbles and sinking of parts of the sheet. This prevents the cover from turning during manure mixing and being lifted off by wind. Properly constructed roofs and some floating covers also exclude rainfall from the store and so increase the volume of slurry that can be stored.
- **FLOATING PLASTIC BODIES (HEXACOVERS):** floating hexagonal plastic bodies form a closed floating cover on the slurry surface. The vertical ribs in the bodies prevent the elements from being pushed one on top of the other. They may be used only in pig slurry or other liquid manures without natural crust. They are not suitable for slurries rich in organic matter.
- **NATURAL CRUSTS:** digestate normally build up a natural crust of floating organic materials. The crust will only form if the dry matter is high enough (>7%) and stirring can be minimized. The crust should cover the whole of the surface area of the manure. The store must be filled from below the crust to avoid breaking it up.
- **FLOATING CRUSTS:** the introduction of straw, granulates (light expanded clay aggregates or perlite) or other floating material on the slurry surface in tanks or lagoons can reduce emissions by creating an artificial crust.
  Straw. The most effective way is to introduce chopped straw with a self-propelled field chopper (forage harvester) at a length of about 4 cm. About 4 kg straw/m^2 should be blown into either the emptied or the filled tank by a well-instructed and experienced driver. The slurry dry matter is also increased which as a consequence raises NH_3 emissions after slurry application.
  Granulates (LECA balls/ Perlite). The introduction of granulates can be done very easily. It is more expensive than straw but only about one third as costly as a compared to a tent structure. About 10% of the material is usually lost yearly from emptying the store. Agitating one day before spreading and briefly just beforehand can help to reduce losses.

> DIGESTATE APPLICATION

Equipment used to apply raw slurry and separated liquid onto land can also be used to apply digestate. Similarly, equipment used for spreading solid farmyard manure can also be used to spread separated solids. The application of digestate to land can be carried out by several different methods, including tractor and tanker, self-propelled tankers or umbilical cord spreading. Whichever method is used, it is good practice to inject whole digestate as odours from NH_3 volatilization can cause nuisance.

> APPLICATION RISKS

Today's technology allows accurate spreading of digestate which can be controlled and monitored using GPS satellite guidance systems coupled with flow meters, enabling the operator to match different digestate analysis to individual crop requirements and soil types. It also allows the operator to carry out field risk assessments, which are downloaded to give accurate, well-documented applications, making it easy to comply with national and regional regulations and NVZ/cross-compliance requirements.

> APPLICATION TECHNIQUES

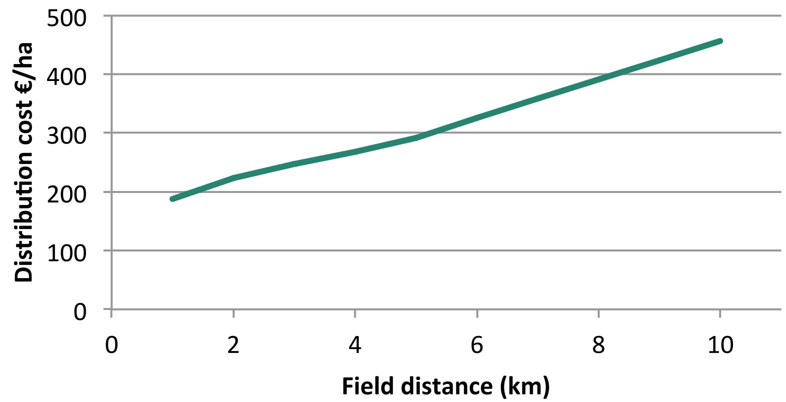
- **BANDSPREADING:** involves a flexible supply pipe connected to a tractor and applicator which drags the pipe across the field applying the digestate. It is a fast, efficient method of application with reduced compaction of land compared to tanker Spreaders, and achievable work rates of 100 m3 to 130 m3 or more per hour. Distance from the store can be overcome by adding booster pumps. Umbilicals can be used to pump directly out of the AD plant/storage site, or out of a headland nurse-tank if transportation by road is required. The main drawback of using umbilicals is a reduction in consistency of the digestate. Band applicators are the preferred method of application, as they dramatically reduce nutrient losses
- **TANKERING:** is useful when it is not possible to access the land with an umbilical. Tankering can be costly due to the limited quantity being moved per load, and ground compaction may also be an issue from the weight of the tractor and loaded tanker. Low ground pressure equipment is advisable.

> LOGISTIC ISSUES RELATED TO DIGESTATE DISTRIBUTION

The substrates after anaerobic digestion, loose part of the solid matter as a form of biogas. What remain after digestion it the digestate, with variable composition, that is function of the mix of substrates used to feed the digester. Given the case of the Bisalta farm, listed in the best cases of the handbook , we have a computation of how much digestate is really produced per year. 94% of the mass remain after anaerobic digestion. We have 8.788 tons of digestate to be distributed per year.

The average nitrogen content change as a function of the substrates as well. To make the example we use the average Nitrogen content suggested by Negri & Maggiore, 2010.
The nitrogen content is important because the there is a European and national legislation about limit in nitrogen spreading on fields. So this parameter is important because limits the amount of digestate we can distribute per ha. In this case we need to distribute on about 62 ha, equivalent to 0,62 h/kW_{el} of installed power of the plant. This number could range from 0.5 to 0,7 ha/kWe. This number has to be taken into account. The plant need to have an agreement with farmers to have enough land to spread the digestate produced.
The distribution costs per ha are increasing linearly with the distance as it can see from the figure, where cost of distribution per ha are presented as function of the distance. For a plant of a 100 kWe, with distribution at 5 km distance, the cost is about 13850 €/year, around 1,58 €/m^3, or 138,5 €/kW_{el} power of the plant.

Parameter	**Unit**	**Value**
Electric power	kW_{el}	100,00
Substrate loaded	t/year	9.300,00
Digestate production	t/year	8.788,50
Nitrogen content ([1])	kgN/ton	3,72
Total nitrogen in the digestate	KgN/year	32.693,22
Allowed Nitrogen	kg/ha	340,00
Distribution efficiency	%	0,64
Area needed	ha	61,64
Specific Area	ha/kW_{el}	0,62



> BIOGAS VALORIZATION

> GAS DRYING

Gas drying optimizes the combustion process in the CHP engine, resulting in an increased engine efficiency and lower fuel gas consumption. Reducing the contamination of engine oil with condensate will reduce the number of oil changes required and save costs. In addition certain Methyl Cyclo Siloxane components, and Ammonia are also harmful substances that are naturally partially released along with the condensate. Given that Ammonia is soluble in water, NH_3 contents are reduced during the water vapour removal / cooling & drying process.

In drying by cooling process the biogas is cooled in heat exchangers and the condensed water is separated from the gas. Normally a chiller is used for refrigeration. The condensation point can only be lowered to approx. 1°C due to problems with freezing on the heat exchangers surface. To achieve lower condensation points, the gas has to be compressed before cooling and then expanded to the desired pressure.

> H_2S AND SILOXANE REDUCTION

The major contaminant in biogas is H_2S which is both poisonous and corrosive, and causes significant damage to piping, equipment and instrumentation. The concentration of various components of biogas has an impact on its ultimate end use. While boilers can withstand concentrations of H_2S up to 1000 ppm, and relatively low pressures, internal combustion engines operate best when H_2S is maintained below 100 ppm.

- **INTERNAL BIOLOGICAL DESULFURIZATION BY ADDITION OF AIR**
- **EXTERNAL BIOLOGICAL DESULFURIZATION**
- **IRON SALTS IN ADDITION TO BIOMASS**
- **FINE DESULFURIZATION WITH ACTIVATED CARBON**
- **CHEMICAL REMOVAL (SCRUBBERS)**

> BIOGAS UPGRADING

This practice is commonly used to upgrade biogas to methane suitable as natural gas substitute and as fuel for vehicles.
The main step of the upgrading process is the removal of CO_2, in order to have a high methane concentration.
The most common methods used are the following:

- **PSA – pressure swing adsorption**
  CO_2 is separated from biogas by adsorption on a surface under elevated pressure (typical pressures range from 4 to 7 bar). Biogas usually circulates in more vessels where activated carbon or zeolite material adsorbs CO_2. When the material becomes saturated, the gas flows to the following vessel. During the process, the pressure decreases while the gas flows forward.

- **PWS – PRESSURISED WATER SCRUBBING**
  PWS is an absorption method based on the fact that CO_2 has a higher solubility in water than methane.
  In the scrubber column carbon dioxide is dissolved in the water, while the methane concentration in the gas phase increases. The gas leaving the scrubber has therefore an increased concentration of methane

- **PHYSICAL ABSORPTION WITH ORGANIC SOLVENTS**
  This method is similar to the water scrubbing, but CO_2 is absorbed with an organic solvent instead of water. Usually polyethylene glycol is used, since carbon dioxide is more soluble in this solvent than in water. In this way the process has a more efficient reaction and the plants can be smaller.

- **PHYSICAL ABSORPTION WITH CHEMICAL SOLVENTS**
  With this method CO_2 is absorbed in the liquid and reacts chemically with the amine too. The reaction is really precise, so the methane losses can be lower than 0.1%.
  The two most common solvents used in this process are mono ethanol amine (MEA) and di-methyl ethanol amine (DMEA).

- **MEMBRANES**
  Membranes seems to be promising for small-scale biogas plants with lower prices in the future. Membranes are usually made of hollow fibres bundled together that are permeable to CO_2, water and ammonia. Hydrogen sulphide, and oxygen permeate through the membrane to some extent while nitrogen and methane only pass to a very low extent. There are two main technologies available: high-pressure and low-pressure.

> BIOGAS VALORIZATION

> ENERGY MANAGEMENT

Compensation of the fluctuation in biogas production can be solved with biogas storage system. Storage can be used when production and consumption of biogas do not overlap.

For example agrofood industry may not need electrical energy during all day and can store the surplus produced. Likewise biogas can be stored when the digester produces more gas that can be used, instead of burning it by flaring. Storage systems can be temporary installations, so they are very flexible solutions.

The most common available technologies are:

- **LOW PRESSURE STORAGE:** this is the most used solution. Floating gas holders, gas bag and floating roofs are typical of this technology and operate at very low pressure (usually <138 mbar)
- **MEDIUM-PRESSURE STORAGE OF CLEANED BIOGAS:** the biogas has to be stored cleaned with these pressures, since H_2S could corrode the tank components. This solution is rarely used, since the electrical energy required for compression is quite high. (usually between 138 and 138.00 mbar)
- **HIGH-PRESSURE STORAGE OF COMPRESSED BIOMETHANE:** this storage system is used to transport biomethane to save space. Pressure between 138.000 and 350.00 mbar are used, since the compression requires a lot of energy, biomethane is always purified before compression.

> GAS UTILIZATION

As seen in the previous sections, biogas can be used in different ways in order to satisfy the energy demand. CHP engine is the best solution if both thermal and electrical energy are requested, if only thermal energy is required, boilers are the most suitable solution.

- **CHP ENGINE:** combined heat and power engines are engines that produce both thermal and electrical energy. Energy benefits of CHP are ranging up to 85% of total efficiency (electrical + thermal), the system is more valuable if compared against the supply of electricity and heat from conventional singly produced by power stations and boilers.
  CHP engine has a 28-47% efficiency in electrical energy production.
  Usually heat produced is not fully exploited by biogas plants. In the "Implementation" section, some real examples of smart heat utilization are proposed. Energy produced can be self-consumed, surplus can be sold into the national grid (electrical) and used to warm civil buildings (thermal).
  At the moment small CHP engines are quite expensive related to the bigger ones, due to economies of scale. Biogas[3] purpose is to widespread this technology and lower the prices
- **BOILERS:** this technology is suited for users that need just thermal energy. Plants with boilers for gas utilization are cheaper than CHP ones.
  These plants are designed to heat households, livestock buildings and hot water for food processes.
  Energy savings can be consistent, since thermal energy can be produced from waste and by-products instead of buying gas.
  Boiler plants are an interesting solution for cheese farm, breweries and many other food industries that need a lot of thermal energy to heat raw material.

Heat can be used to warm civil buildings too. In average, the cost for hot water pipelines, including trenches and civil engineering from the biogas unit to the heat consumer is around 200 €/linear meter for small scale AD.

For example, in France a 100 kW plant, a 100 linear meter pipeline system represents about 2% of the total investment and could be highly profitable.

> ENGINEERING AND SERVICES

Engineering and service providers may be both your plant provider or a specialized company.
A biogas plant needs attention when system is completed and during start up system, as well as the subsequent maintenance of the highest level of efficiency.
Service providers will support and help you in these stages, to ensure maximum result as soon as possible, ensuring the highest competence and experience.
This service will help you keeping the plant operating in full load, it means getting higher yields and more methane production.
Process monitoring and controlling service can be offered in different packages.

Engineers may help you during all plant's lifetime, in particular:

- **BIOLOGICAL PLANT START UP ASSISTANCE**
- **ASSISTANCE PROGRAMS TO REACH THE MAXIMUM PRODUCTION**
- **PLANNED ANALYSIS OF CHEMICAL AND BIOLOGICAL PARAMETERS**
- **MONITORING OF THE FERMENTATION PROCESS TO ENSURE HIGH PERFORMANCE OVER TIME**
- **PROFESSIONALISM TO ENSURE OPTIMAL SYSTEM PERFORMANCE**
- **ESTIMATES OF THE INDIVIDUAL PRODUCT POTENTIAL AND PRACTICAL ADVICE ABOUT NUTRITION**
- **OPTIMIZATION IN COMBINATIONS OF VARIOUS SUBSTRATES**
- **SELECTION OF THE CORRECT CO FERMENTS POWER PLANT**
- **ASSISTANCE IN EMERGENCY MANAGEMENT AND/OR CRITICAL SITUATIONS**
- **PHONE SUPPORT**
- **ASSISTANCE AT YOUR PLANT**
- **PARTICULAR AND SPECIFIC CHEMICAL ANALYSIS**
- **INDIVIDUAL ADVICE**
- **PRACTICAL ADVICE**
- **PREVENTION ACTIONS**
- **THERAPIES AND EMERGENCY MEASURES**

> PURPOSE

Biogas³ purpose is to create a network between small-scale plants stakeholders in order to widespread technologies and knowledge for energy self-sufficiency.
In the next pages some examples of plant providers are shown in order to promote the connection between client and providers.
The choice of companies is oriented to all-in-one providers, since they offer the most ordinary and complete service.

> DISCLAIMER

This handbook provides information of companies that produce small-biogas (<100 kWel) plants and services related to this technology. We could not include all companies in this handbook, but only the ones that took contact with partners. The choice of the companies was not involved in any kind with partner's business activities.

No payment was requested to publish the information companies provided in this handbook. We cannot guarantee that all the provided information will be published in the handbook. Biogas³ consortium shall not be responsible for any errors or omissions contained in the translations. All the translations were provided by a translation firm.

> WHAT YOU WILL FIND

In the following pages, you will find information about all-in-one companies, in particular:

- **NAME AND HISTORICAL HINTS**
- **NUMBER OF SMALL-PLANTS SOLD**
- **ADDRESS AND CONTACTS (EVEN A QR CODE FOR THE WEBSITE)**
- **COUNTRIES WHERE PLANTS CAN BE SOLD**
- **INFORMATION ABOUT THE SUPPLIED TECHNOLOGY**

> COMPANIES

> HOW TO SAVE SOME MONEY

It is possible to save some money when a plant is built. Ask your plant provider if you can construct by yourself or re-use any building for the plant.
If you think you are going to build a plant, see if there are other plants that use similar substrates to yours and look for a plant that suits your substrate quantity.
Some tips on how to save some money during the construction and what to ask to your provider are shown below.

Usually all that is related to anaerobic digestion is built by the all-in-one company, but many other works of civil engineer can be done by the client. For example earth-works and road-works can be done by your own.
Furthermore you could make electricity connection from the CHP engine to the grid.

Ask your plant provider if it is possible to visit existing facilities in order to compare your own state with an other business operator.

Re-using existing buildings to preparation-pits or post digester if volumes and distances are suitable enough for the plant. It is necessary that existing structures respect environmental and safety standards.

> AGRICULTURAL WASTE

Austep proposal for small – scale Plants:

- Various sizes for biogas production from 100 up to 300 kwh produced

Different typology of power plant:

- with cattle manure (sludge and manure);
- with pork manure (slurry and manure)

produced directly from the farm.

- Making the most of their supply as able to accept variation in feeding
- No commitment for areas set for cultivation of agricultural biomass and no additional purchase from the market for biomass power plant
- Making the most of their supply as able to accept variation in feeding

> INDUSTRIAL WASTE

AUSTEP designs and manufactures equipment capable of using the energy potential of butchering waste (such as rumen, intestinal packs, blood, fluids and fats) through anaerobic digestion and biogas recovery.

Benefits:

- Waste water and air treatment;
- Space optimization by using a container containing switchboard, pumps, heat exchanger and pretreatment
- No stops neither emptying;
- Minimum employee intervention and mimum mantainance

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
51 - 75	n.a.	n.a.
76 - 100	n.a.	n.a.

all-in-one

AUSTEP
YOUR WATER | YOUR ENERGY

Austep Spa
Established since: 1995

Via Mecenate 76/45 – 20138
Milano (MI) – ITALY

Tel: +39 02 509947.1

www.austep.com
info@austep.com

Number of small-scale plants sold this far: 10 - 50

> CYLINDRIC PLANT UP-FLOW TYPE MIXED

Farming that intend to gain the maximum in terms of energy and money; because, thanks to the solid fraction in the dejections, the production of biogas boosts. It is suitable also for farming with limited or interrupted availability of biomass to add for the digestion with the dejections. For this plant, too, there are many environmental advantages.

> SUPER-FLOW TYPE PLANT FOR SUPER THICK BIOMASSES

Agricultural and breeding farming that have sufficient biomass availability during the whole year, thanks to which the production of biogas boosts, as well as the electric energy produced, improving at best the performance of the process

> CHANNEL PLANT PLUG-FLOW TYPE

Essentially the farming of medium and large dimensions that wants to produce energy to use almost completely for the direct needs and, only in case of a surplus, to give it to a net operator. In addition, those who in general are forced to reduce or are sensitive to the reduction of the impact of their farming activity on the environment.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
76 - 100	500.000 – 700.000	2,5 €/h work of plant

all-in-one

ROTA GUIDO

Rota Guido
Established since: 1964

Via 1° Maggio,3 – 29017
Fiorenzuola d'Arda (PC) – ITALY

Tel: +39 0523 944 128
Fax: +39 0523 982 866

www.rotaguido.it
info@rotaguido.it

Number of small-scale plants sold this far: 10 - 50

> LINEA FARMER

The small plant FARMER is especially designed for the use of manure from agriculture. The plant size is matched to the average quantities produced.

For this purpose, the technology in the large plants is as much as possible simplified and transferred to small variants. Therefore, in the 25 – 300 kW range, the FARMER represents an opportunity allowing smaller and average-sized farms to exploit efficiently and profitably the accumulating quantities of liquid and solid manure.

The lineaFARMER is comprised only of those elements that are essential and unavoidable in a biogas power plant.

- Pre tank: usually already existing
- Technical container "PLUG & PRODUCE": pump system, automation and display, desulphurisation technologies, heat exchanger and distribution
- Fermenter and pressure accumulator of the biogas and gasometer
- CHP unit: for engine & generator
- Storage tank: usually already existing

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
25 – 50	150.000 – 300.000	2.500 – 5.000
51 – 75	300.000 – 400.000	5.000 – 7.500
76 – 100	400.000 – 600.000	7.500 – 10.000

all-in-one

BTS
part of TS energy GROUP

BTS Biogas Srl/GmbH
Established since: 2008

Via San Lorenzo, 34 – 39031
Brunico (BZ) – ITALY

Tel: +39 0474 370119
Fax: +39 0474 552836

www.bts-biogas.com
info@bts-biogas.com

Number of small-scale plants sold this far: 10 - 50

> WASTE AND BY-PRODUCTS

Biogas Engineering since 2005 managed almost 30 biogas projects dealing with different materials, such as animal manure, silage, vegetal and animal waste/by-products, Organic Fraction of Municipal Solid Waste. Plant size ranges between 60 and 1.500 kW electric power; small scale plants construction is a remarkable peculiarity of our company, since the beginning of the activity. Recently Biogas Engineering managed low environmental impact with reinforced grounds constructions.
Biogas Engineering's peculiarity is providing specific biogas systems tailored for every customer's needs, depending on the company. Anyway, some small-scale "standards" could be proposed in agro-food waste environment: 63 kW and 100 kW electric power plants match two common size of biogas engines. The choice of technology depends on the biomass feed-stock and the specific needs of the customer. Animal waste could be managed providing thermal pre-treatment. The plant could be divided into 4 main sections:

- Feeding system
- Anaerobic digestion (single-stage digester)
- Biogas treatment and heat exchanger
- Digestate post-treatment

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
63	330.000 – 400.000	15.000 – 20.000
100	475.000 – 575.000	17.000 – 23.000

all-in-one

BIOGAS ENGINEERING S.r.l.
TECNOLOGIE PER L'AMBIENTE E RECUPERO ENERGETICO

Biogas Engineering Srl
Established since: 2005

Via Corte Ferrighi, 11 – 36025
Novanta Vicentina (VI) – ITALY

Tel: +39 0444.760571
Fax: +39 0444.760530

www.biogasengineering.it
federico.gavagnin
@biogasengineering.it

Number of small-scale plants sold this far: 10 - 50

> ENVIFARM COMPACT

Big technology, small format with an output of 75 kWel and upwards, EnviFarm compact plants score with maximum efficiency and minimum installation space. The flexible compact plants require especially little space when installed in steel containers and can not only be used for pure slurry operation, but can also be fed with any type of biomass.

Technical special features:

- cHp container: from 75 kW_{el} including peripheral technology containers.
- technical container: insulated 20" steel high-cube container containing pump technology and control room or insulated 40" steel high-cube container with hood, mixing area including Kreis-Biogas dissolver and pump technology, screw and slide technology and control room (depending on feeding system)
- Feeding system/mixing technology: Kreis-Biogas-Dissolver, vertical mixer or direct feeding of slurry.

The advantages at a glance:

- Compact biogas plants in container design from 75 kW_{el} and upwards
- Low investment and maintenance costs
- Easy and time-saving installation using modular prefabricated components – permanently installed technical building not required

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
76 – 100	600.000 – 800.000	5.000 – 40.000

all-in-one

EnviTec Biogas

EnviTec Biogas Italia Srl
Established since: 2007

Via J. Monnet, 17 – 37136
Verona (VE) – ITALY

Tel: +39 045 8969813
Fax: +39 045 8969818

www.envitec-biogas.it
info-it@envitec-biogas.com

Number of small-scale plants sold this far: < 5

> IPF 100

The POWER FARM plants, very compact, consist in digesters in reinforced concrete, result of the constructive experience of Corradi & Ghisolfi, with casting slab or gasometrical cover with wooden substructure, both with high thermal insulation to ensure stable process temperatures all year round and reduce loss of heat for any other use or enhancement.
The plant engineering part is supplied in a container previously assembled at our workshops, as well as the cogeneration unit.
This solution allows the construction and commissioning of the plant in record time. The attention to quality and reliability of the plant engineering part is combined with the desire to minimise plant self-consumption to ensure the best energy efficiency. The systems are fully automated and therefore allow to minimise the risks associated with errors in management. The supervisory system allows to control and file all production data.
The IPF 100 is

designed for biological processes in single stage with short retention times (less than 40 days) fed mainly by sewage directly from the breeding farm receiving tank. Any addition of ensilage or by-products is carried out from the pre-tank and sent to the digester after mixing and homogenisation. PFP 100 is suitable for plants up to 100 kW.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
76 – 100	400.000 – 800.000	5.000 – 15.000

all-in-one

Corradi&Ghisolfi

Corradi&Ghisolfi Srl
Established since: > 12 years

Via Don Mario Bozzuffi 19
26010 – Corte dé Frati (CR)
ITALY

Tel: +39 0372 93187
Fax: +39 0372 930045

www.corradighisolfi.it
info@corradighisolfi.it

Number of small-scale plants sold this far: < 5

> MITO

To profit by becoming energy producers is the tangible proposal that IES BIOGAS makes to small and medium-sized livestock farms. Even yours. Today and right away.
You don't need to have huge plants, as biogas plants are more contained, today more than ever, and have high efficiency and greater development. IES BIOGAS has called them MiTO. They range from 100 to 300 kW.

Exclusive advantages:

- Low costs for feeding the plant
- Biogas generated by manure and agricultural by-products
- Maximum benefits from the law-provided incentive
- Biologically stable process due to the organic matrix used
- (micro and macro elements, buffering capacity)
- Perfectly integrated in your farm
- 100% Made in Italy
- "Turnkey" construction
- Completely "custom-made"
- Plants ad technologies at the highest level
- High continuity performance
- Superior efficiency
- Easy to manage
- Maximum safety
- Minimum operating costs
- Renewable energy production without changing the agricultural structure of the farm

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
n.a.	n.a.	n.a.

all-in-one

IESBIOGAS NUOVA ENERGIA DALLA NATURA

IES Biogas
Established since: 2008

Via T. Donadon, 4 – 33170
Pordenone (PN) - ITALY

Tel: +39 0434 363601
Fax: +39 0434 254779

www.iesbiogas.it
info@iesbiogas.it

Number of small-scale plants sold this far: n.a.

> AGRIPOWER

- IDROPULPER grants great homogenization of mixtures even with different biomasses.
- Pre-warning of mixture avoids having thermal shock at the entrance and simplify the anaerobic process.
- Using prime quality materials grants long duration.
- Various bypasses and spare parts help in case of failure so that the plant never stops working.
- The mixing system is a low-consumption one, although it can concentrate its power on the surface or at the bottom.
- The control program improves the given capacities and reduces biomass consumption.
- Your investment is proportioned to the plant profitability.
- Transforming zootechnical wastewater into stable organic material reduces odour emissions and allows to perform a nitrogen reduction treatment.

> PLANTS

The plants Idro provides are: saccogas, silogas, bovigas, piugas, u-biogas and idrogas. Ask idro experts to find the best solution for your needs

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
51 - 75	400.000 – 500.000	15.000 – 20.000
76 – 100	500.000 – 600.000	20.000 – 25.000

all-in-one

Idrodepurazione Srl
Established since: 1977

Via Comina, 39 – 20831
Seregno (MB) – ITALY

Tel: +39 0362 27511
Fax:+39 0362 2751511

www.idro.net
info@idro.net

Number of small-scale plants sold this far: 10 - 50

For farms, Manni Energy offers the possibility to produce electricity and thermal energy using waste of animals and vegetables. With your Manni Energy biogas installation, your farm will become free-standing in terms of energy requirements!

> ADVANTAGES:

- Simple plane management;
- Wide fermentation volumes;
- Reliable quality of MAN cogenerator engines;
- New technologies for monitoring and plant management with programmed maintenance alerts;
- Biologic system for filtering and desulfurization the biogas;

> MANNIEASY

Engine power of 64 kW_{el}, annual electrical energy produced 512.000 kWh and 650.000 thermal kWh.

> MANNISMART

Engine power of 100 kW_{el}, annual electrical energy produced 800.000 kWh and 1.113.000 thermal kWh

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
51 – 75	480.000 – 650.000	2.500 – 3.500
76 – 100	595.000 – 700.000	3.000 – 4.500

all-in-one

Mannienergy Energie rinnovabili

MANNIENERGIE
Established since: 3 – 6 years

Via Augusto Righi, 7 – 37135
Verona (VE) – ITALY

Tel: +39 045 8088911
Fax: +39 045 581254

www.mannienergy.it
info@mannienergy.it

Number of small-scale plants sold this far: 5 - 10

> EUCOMPACT®

A simple, powerful and profitable plant. It is simple and flexible and it suits every company needs. The digester can be fed with different combinations of biomass (from 0 to 100% animal dejections).
In function of the plant diet, there are different size of cogeneration engine (from 50 up to 100kW) and two size for digester (200 and 400 m^3)

Advantages:

- Simple installation and easy start: EUCOmpact comes to the client after being completed in factory and compliant to safety and quality standards;
- It fills little spaces;
- Flexible use of biomasses;
- Tested technology and Viessmann quality;
- Great profitability.

> COCCUS®MINI

Plants for small farms, the plant is made by a fermenter with a volume between 500 and 1200 m^3 and an all-in-one-mini container.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
51 – 75	300.000 - 450.000	n.a.
76 – 100	450.000 – 600.000	n.a.

all-in-one

IMPIANTI ED ENERGIA

Irci Spa
Established since: 1976

S.P. 258 Marecchiese, 60
47865 - Pietracuta di S. Leo
(RN) - ITALY

Tel: +39 0541 923550
Fax: +39 0541 92 34 14

www.ircispa.com
info@ircispa.com

Number of small-scale plants sold this far: n.a.

> PLANT LAYOUT

Sebigas plants are made by 5 main components:

- Pre-tank: studied to receive biomass in the first step of the plant, mix and pump them into the digester.
- Digester: the volume of the digester is related to the hydraulic retention time in order to digest completely all the substrates.
  Digester is connected to a double layer accumulator pressure switch.
  The heating system takes the thermal energy from the cogenerator through a corrugated stainless pipe system placed inside the digester for a greater yield.
- Mixing system: it is the result of deep studies of fluid dynamics. Mixers are pull-out and made of high quality materials, with advanced rotating systems that optimize electrical consumption.
- Container: a compact solution that holds cogenerator engine with biogas treatment system and thermal energy recover. Pumping systems for hot water distribution and control panels.
- Control system: monitoring and management are easily handled with sensors that control process parameters. This system ensures an high level of system automation.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
76 – 100	Around 650.000	Around 25.000

all-in-one

SEBIGAS

SEBIGAS (Gruppo Maccaferri)
Established since: 2008

Via Santa Rita, 14 – 21100
Olgiate Olona (VA) – ITALY

Tel: +39 0331 428 441
Fax: +39 0331 428444

www.sebigas.it
info@sebigas.it

Number of small-scale plants sold this far: 5 - 10

> ANAEROBIC FILTER DIGESTER

MATHEOZ is a small−scale anaerobic digestion process using livestock effluents (from one farm) and producing electricity and heat from biogas micro −cogeneration. MATHEOZ technology uses removable elements including the combination of two digesters (anaerobic filter) allowing a maximal biogas production in a minimal hydraulic retention time (two to three times shorter than classical anaerobic digestion). MATHEOZ investment costs are limited (7−10 € / Watt) so as to reach a significant return on investment, even with a small unit (35kW).The process can be used for liquid effluents (farm or AFI) from 2 to 10% DM or use upstream a phase separator.

> ADVANTAGES

- use of an aerobic filter digester in a container with no needs of mixing technologies
- Reuse of preexisting tanks
- Very few civil engineering and concrete works
- Automated and autonomous process for an easy supply and exploitation
- Liquid based digestion technology with a low energy consumption
- Highly landscape−integrated technology with limited bulk
- The process requires only one pump (1kW).
- Forecast labor time is between 240 to 480 hours/year.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
36	360.000 – 400.000 call included	17.000 – 22.500

all-in-one

agréoledéveloppement

AGREOLE DEVELOPPEMENT
Established since: 3-6 years

17 Allèe Evariste Galois – 63170 AUBIERE - FRANCE

Tel: +33 (0)9 82 41 61 20

www.agreoledeveloppement.fr
contact@agreoledeveloppement.fr

Number of small-scale plants sold this far: < 5

> SEPARATED BIOLOGICAL REACTIONS

ARKOMETHA provides two kinds of technology, a dry one named "ARKOMETHA" and a liquid one called "NOVIS".

The common point to all the process proposed by ARKOLIA ENERGIES is that each one isolates the hydrolysis step of the rest of the process, in order to facilitate and optimize it. This technology improves the degradability of substrates and reduces residence times while the potential for biogas production is increased.

NOVIS process is an automated proven system existing since a long time. That process works with a large range of organic substrates (around 12% of dry matter in digester).

The ARKOMETHA process works with 18-30% of dry matter. Compared to a continuous liquid technology, the volume of digester is divided by two and the biogas potential is improved of 20-30%.

Self-construction can be done by the project leader excepted everything that relates to the technical process: construction represents around 30% of the total investment cost, 50% for material and 20% for project engineering or grid connection.

ARKOLIA ENERGIES develops other containerized process adapted to small-scale AD units: process ARKOBLOC, quick to install, standardized and just a few construction needed (concrete slab).

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
ARKOMETHA 76 - 100	800.000 – 1.300.000	40.000 – 55.000
NOVIS 76 – 100	800.000 – 1.200.000	40.000 – 55.000

all-in-one

arkolia ENERGIES

ARKOLIA ENERGIES
Established since: 3-6 years

ECOPARC Départemental, 65 rue de la Gariguette – 34130 SAINT AUNES - FRANCE

Tel: +33 (0)4 6740 4703

www.arkoliaenergies.fr
asfiligoi@arkoliaenergies.fr

Number of small-scale plants sold this far: 10 - 50

> ONLY FARM PROJECTS

ARIA ENERGIES designs and builds small scale biogas units only on farm. That supplier acts on the project from the feasibility study to the maintenance of the unit during its operation.
ARIA ENERGIE prefers the operations where the farmer will participate in the building. Strictly hand key operations are not those that attract them the most. Their achievements have vocations to be operated by the farmer and not by service providers. ARIA focus on operations using organic farm waste and discourage the use of energetic crops and the use of external waste.

Two kinds of process are proposed: the classic liquid technology and the dry one named SILOGAZ. The liquid technology is used when the substrate can be pumped (slurry) and the dry one when the substrate can be manipulated with mechanical forks.

The main concerns from ARIA ENERGIE are to realize farm biogas units manageable per a farmer and adapted to the size of the farm and available effluents.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
25 - 50	n.a.	n.a.
51 – 75	n.a.	n.a.
76 – 100	n.a.	n.a.

all-in-one

ARIA ENERGIES
Established since: more than 12 years

ZA Ballufet 5 – 31300
TOULOUSE - FRANCE

Tel: +33 (0)5 34 56 93 07

www.aria-enr.fr
aria@aria-enr.fr

Number of small-scale plants sold this far: 10 - 20

> TECHNOLOGY

The aim of EVALOR is to bring environmental effective and sustainable solutions to farmers, collectivities and agro-food industries.
One of the main business of EVALOR is to valorise organic effluents. They developed their own biogas unit process with a common liquid technology.
Upstream of the digester, a premix pit is installed with a crushing system of incoming substrates to improve the biodegradability, reduce the size of the digester and the stirring power accordingly. Use a premix pit avoid installing an expensive hopper and decrease maintenance.
Digesters are made in concrete with a simplified mechanical agitation and a single membrane biogas coverage.
The CHP is in a container for a quick assembly. Self construction and the reuse of existing structures is clearly recommended.
A biogas unit is not considered as an answer to Nitrogen or Phosphorus in excess. EVALOR has developed a lot of treatment process adapted to farm or AFI to treat N and P. Some of those treatments can use the heat produced with the CHP engine (NEW) and represents a good way to valorise the thermal energy in vulnerable area.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
51 – 75	550.000 – 750.000	n.a.
76 – 100	750.000 – 900.000	n.a.

all-in-one

evalor
Terre > Eau > Energie

EVALOR
Established since: more than 20 years

1 rue Georges GUYNEMER
22440 – PLERIN – FRANCE

Tel: +33 (0)2 9674 5657

www.evalor.fr
julien.mansuy@evalor.fr

Number of small-scale plants sold this far: < 5

> MOBILE AND SCALABLE

This patented technology named "ERibox" can be installed on a farm or in a rural town, in a range from 500 to 5000 tons of organic waste per year (10 to 100 kW electric). ERibox is a dry process (10 to 40% of Dry Matter) which consists in the addition in series of several digesters. Each digester is managed independently and alternately to maintain a continuous biogas production. The retention time is around 30 days which means with 4 digesters one digester has to be loaded and unloaded by mechanical forks each week. For construction, just a concrete slab is necessary. All pipelines connections are installed above ground, the ERibox system can be reconfigured easily to evolve with the farm. If the amount of entering matters grows, the owner will be able to add digesters to adjust its capacity of digestion.

That standardized process seems quite adapted to small scale AD on farm with solid manure. Prices indicated below don't include the concrete slab. ERIGENE tests also the essential characterization of substrates for projects of customers in its laboratory.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
10	120.000 – 150.000	6.000 – 9.000
25 – 50	250.000 – 480.000	19.000 – 29.000
51 – 75	480.000 – 640.000	24.000 – 27.000
76 – 100	640.000 – 800.000	25.000 – 35.000

all-in-one

ERIGENE SA
Established since: 3-6 years

19 rue Pierre WAGUET – 60000 BEAUVAIS - FRANCE

Tel: +33 (0)3 6419 4717

www.erigene.com
contact@erigene.com

Number of small-scale plants sold this far: < 5

> DIGESTER SILO

VALOGREEN is a French company specialized in the design and construction of biogas plants on farm.
The approach is to provide to the agricultural community effective solutions to make biogas units accessible for breeders and farmers.
VALOGREEN developed a process named VALOKIT which is a range of biogas plants of small and medium powers in liquid process, adapted to the management of effluents from farms.

The process Valokit consists in:

- an upstream micro crushing in a premix tank to make the substrate more accessible to bacteria. Valokit can treat substrates up to 25% DM. Solids substrates are incorporated in that pit, homogenized and diluted with the liquid digestate recirculation.
- a digestion structure in a galvanized steel silo to decrease investment cost (construction, concrete).
- no mechanical stirring inside the digester to make the maintenance easier. The unit uses only the recirculation of biogas and digestate.

VALOGREEN was awarded in 2013 to the SPACE fair for the VALOKIT process.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
51 – 75	450.000 – 700.000	30.000 – 35.000
76 – 100	650.000 – 890.000	45.000 – 55.000

all-in-one

valogreen

VALOGREEN SAS
Established since: 1-3 years

4 rue de la vignette – 60240
REILLY – FRANCE

Tel: +33 (0)9 8144 8667

www.valogreen.fr
info@valogreen.fr

Number of small-scale plants sold this far: < 5

> WIS GROUP – A NEW GENERATION

Specialising in scalable Farm Biogas plants 50kWe – 150kWe

- Innovative modular design – controls and pumping equipment is factory built and fully tested in portable, containerized units for quick build and less on-site labour
- Primary feed stocks - cattle/pig slurry and any crop silage as the primary co-ferments
- Multiple feed stocks - to take advantage of seasonality as different feed stocks become available at different times of the year.
- Easy to deploy , fast commissioning time
- Maximum operating efficiency (>90% uptime)
- Top Quality, World class components: mixers, pumps, macerators, blenders, gas cleaning equipment and Combined Heat and Power (CHP) engines
- Easy maintenance with full web based monitoring and technical back-up
- Can utilise exixting slurry storage facilities if possible

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
50 – 150	800.000 – 1.200.000	20.000 – 35.000

all-in-one

Williams Industrial Services

WIS Group
Established since: 1989

Units 5-7, Hydepark Commercial Centre, 10, Hydepark Road, Mallusk, BT36 4PY, IRELAND

Tel: +44(0)2890838999
Fax: +44(0)2890842211

www.wis-group.com
sales@wis-group.com

Number of small-scale plants sold this far: < 5

> CONTAINER BIOGAS PLANT BK-1

The container biogas plant is completely automated and designed for the processing of waste on farms. It is made of stainless steel and, depending on the input and the power plant configuration, it reaches 5 to 50 kW.

Main units of the device:

- Support chassis integrated inside a 40 ft marine container (made of painted structural steel)
- Input chamber with grinding agitator and scales
- System of feeding screw conveyors moving the material from the input chamber to the digester
- Digester with spiral-bladed shaft, hot water jacket and temperature and level sensors
- Piping system with flow meter and pump to supply liquid manure
- Piping system with pump to supply the device's water jacket
- Control system consisting of electric and electronic devices inside a control cabinet on the side of the machine
- Composite panel cladding with access door providing access inside the device
- Fixed protective guards and housings

Capacity: ca. 29,000 m3/year
Digester volume: ca. 30 m3
Biogas space: ca. 6 m3 + capacity of the flexible tank
Installed power: 20 kW

Nominal power (kW)	Price range (€)	O&M cost (Euro/year)
25 - 50	100.000 – 130.000	n.a.

all-in-one

MEGA
MASZYNY DLA PRZEMYSŁU SPOŻYWCZEGO

MEGA Sp. z o.o.
Established since: 1996

Przemysłowa 52, 24-200
Bełżyce – POLAND

Tel: +48 81 516 20 03
Fax: +48 81 517 22 63

www.megabelzyce.pl
biuro@megabelzyce.pl

Number of small-scale plants sold this far: <5

> GÜLLEKOMPAKT

Rating: 30-75 kW

Input: 100% slurry

The vertical digester is fed from the pre-pit by means of a slurry pump. The low dry-matter content of the slurry have the advantage that a simple submersible motor-driven agitator is sufficient to provide adequate mixing of the substrate, and also enable short dwell times of 25 to 30 days only. Depending on the distance, the substrate is fed into the existing fermentation residue store just through an overflow by gravity or by means of a manure pump.

> GÜLLEWERK

Rating: up to 120 kW.

Input: 80% solid and liquid agricultural manure; 20% agro-industrial residues, fodder remains, re-growth material.

It is delivered by truck and connected to the existing slurry system. It is equipped with the "Vielfraß" in order to utilise solid and regrowth material.

Advantages: Ideally suited for the fermentation of all silages, also grass and manure; Economical in own energy consumption; Time saving by means of large receiving capacity; Uniform, automatic feeding with interval control – also available with scales; Solid screw-feed construction.

Nominal power (kW)	Price range (€)	O&M cost (Euro/year)
25 - 50	280.000 - 300.000	20.000 - 25.000
51 - 75	300.000 - 450.000	22.000 - 27.000
76 - 100	450.000 - 680.000	23.000 - 29.000

all-in-one

agriKomp

agriKomp Polska sp. z o.o.
Established since: 2010

Marciniaka 43,
63-500 Ostrzeszów, POLAND

Tel. +48 693 199 951

www.agrikomp.pl
info@agriKomp.pl

Number of small-scale plants sold this far: 10-50

> CONTAINER AGRICULTURAL MICRO BIOGAS PLANT KMR-7

The transportable container-based micro-scale biogas plant has been designed in a way enabling easy adaptation for individual location conditions. Input materials may comprise by-products of agricultural and livestock operations (e.g. dung, pig and cow manure, plant production residues, energy crops) or agricultural and food processing by-products as well as household waste. Content of dry organic matter in the input materials: from 5 to 15%.

Main technical parameters:

- a rectangular, welded and air-tight carbon steel tank (inside dimensions: 2.5 x 2.5 x 12 m;
- cubic volume of the tank: 75 m^3, effective capacity approx. 60 m^3;
- an external layer of thermal insulation, box profile sheet sheathing;
- a biogas tank integrated with the fermentation chamber (mounted on the chamber roof);
- an internal heating system ensuring correct process temperature;
- an overflow system for removal of digestate;
- an innovative solution for the fermenting material mixing system (without an agitator);
- a possibility to integrate the chamber with the CHP system;
- biogas production from 3.5 to 5 m^3 per hour (methane 55%)

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
10	75.000 – 100.000	3.000 – 6.000

all-in-one

eGmina, Infrastruktura, Energetyka Sp. z o.o.
Established since: 2006

Złota 54, 45-643 Opole
POLAND

Tel/Fax: +48 77 416 70 84
Mobile: +48 662 389 472

www.egie.pl
kontakt@egie.pl

Number of small-scale plants sold this far: < 5

> MOBIGAS

The MobiGas biogas plant is an all-in-one system which uses the 3A-Biogas dry fermentation technology. The plant consists of one technical container (a control room, a cogeneration unit, a percolate tank, a gas tank, a gas analysis system, a compressor, pumps, etc.) and three fermentation containers (digesters). The system of digesters can be expanded by adding new digesters (up to max. 9), thus boosting the system's energy potential through increasing the production of biogas, while managing a greater amount of waste. The plant is connected to an electricity network of low voltage.

The biogas is used directly on the site in a technical container that contains a CHP system which converts biogas into electricity and heat. The processed material (digestate) from the digesters undergoes aerobic stabilization.

The total area needed for the operation of the plant is imately 400 m2 (a concrete slab, 20x20 metres), of which about 100 m2 goes under the biogas plant container. The remaining 300 m2 is used for loading and unloading the containers. Each container has dimensions of about (LxWxH) 8x3x3 meters.

Nominal power (kW)	Price range (€)	O&M cost (Euro/year)
25 - 50	Around 400.000	n.a.

all-in-one

EkoInnowacje

Manufacturer: Pöttinger Entsorgungstechnik GmbH
AUSTRIA

Distributor:
EkoInnowacje Sp. z o.o.
Leśna 2, 42-286 Koszęcin
POLAND

+48 608 403 047

www.ekoinnowacje.net
biuro@ekoinnowacje.net

Number of small-scale plants sold this far: 5-10

> AGRICULTURAL MICRO-BIOGAS PLANT

2 integrated tanks, working capacity 60 m3, featuring internal heating and stirring systems, are manufactured and assembled in the plant and then transported to the place of operation with ordinary road vehicles (with a semi trailer/ platform).

The PEHD digester tank manufactured using SPIRO technology meets ring stiffness standard SN4.

The mixer with pump transporting the substrate to digesters and a co-generator with an electric connection are inside the container; on top of the container there is a buffer (membrane) biogas holder.Biogas is gathered in an external sealed plastic container.

The micro-biogas plant is modular. It may consist of multiple modules, each comprising 2 digesters placed vertically on a slab foundation, a container with dosing system and a low-power co-generator (8-12 kW).

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
8 – 12	100.000 – 250.000	n.a.

all-in-one

MIKROBIOGAZ Sp. z o.o.
Established since: 2013

ul.Ligocka 103, bud.8; 40-568
Katowice - POLAND

Tel: +48 695 200 189

www.mikrobiogaz.pl
wojciechkurdziel@mikrobiogaz.pl

Number of small-scale plants sold this far: < 5

Dabar is specilized in the designing and building of biogas facilities optimizing the use of the biogas produced and obtaining the best results. Dabar can help to the customer in all the stages of the process of the life cycle of the plant, from the feasibility, going through design, financing, purchasing, building, commissioning, training, maintenance, operating, etc. We can offer all the services together in a turnkey project, or just hiring our services in the stages the customer can think is better for its needs.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
25 – 50	150.000 – 250.000	15.000 – 17.500
51 – 75	250.000 – 350.000	17.500 – 20.000
76 – 100	350.000 – 550.000	20.000 – 23.000

all-in-one

dabar INGENIEROS

Dabar Ingenieros C.B.
Established since: 6-12 years

C/Luis García Berlanga no11 pta 1
46023 – Valencia – SPAIN

Tel: + 34 963220544

www.dabaringenieros.com
info@dabaringenieros.com

Number of small-scale plants sold this far: < 5

Ecobiogas is a young and dynamic engineering company specialized in the biogas sector with a highly prepared team of workers who cover all areas related to biogas. We consider biogas a renewable energy with a bright future. Our company has built 9 biogas plants in Spain which means the 30% of the total electric power installed in Spain from biogas obtained in agro-industrial digesters.

Its founders were the first in Spain who developed successfully a biogas plant in crop-livestock sector, operating since 2006. Own biogas plant helps us to improve day by day in experience and knowledge.

Our services are:

- Processing subsidies
- Assistance in obtaining capital and financing
- Preliminary calculations of profitability and technical and economic studies
- Permits and approvals
- Conception, planning and design
- Tendering and commissioning Plant construction - turnkey projects
- Start up and monitoring of the biological process
- Maintenance and support in the operation of the plants
- Comprehensive advice on biogas

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
76 - 100	300.000 - 500.000	10.600 - 14.000

all-in-one

ECOBIOGAS
especialistes en plantes de biogàs

ECOLOGIC BIOGAS S.L.
Established since: 6-12 years

Plaza Mayor 12 B – 25245
Vila Sana – SPAIN

Tel:+34 973 070 608
Fax:+34 973 606 001

www.ecobiogas.es
info@ecobiogas.es

Number of small-scale plants sold this far: 5 - 10

BIOVEC it's one Spanish engineering company leader in agriculture biogas plants in Spain and have participate in more that 10 installations

Team of experience engineers providing services and specific solutions for each project.

The aim it's to transform the resources from slurry, and agriculture or food industry residues into energy and quality fertilizer.

Our solutions cover all the stages of design, construction and supervision of the projects related to biogas and organic wastes.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
51 - 75	200.000 - 300.000	20.000 - 35.000

all-in-one

biovec ingeniería ambiental

Biovec Medio Ambiente S.L.
Established since: 6-12 years

Calle Aviador Franco 5 – 12540
Villareal – SPAIN

Tel: + 34 964 524 965

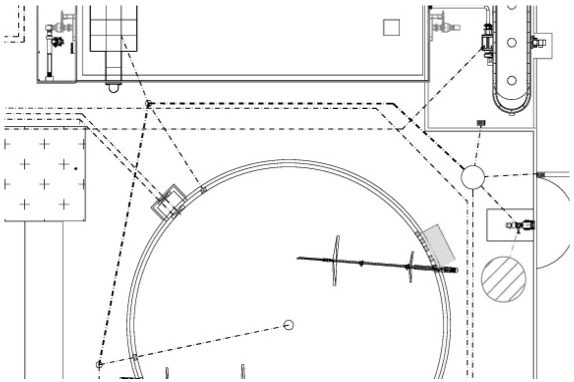
www.biovec.net
info@biovec.net

Number of small-scale plants sold this far: <5

Engineering company specialized in Biogas Plants of agro-industrial and livestock waste. The scope of services covers from the design, project and licensing, construction, up to the commissioning of the plant, thus providing and end-to-end service. The kind of contract is agreed with the customer: Project Management, Procurement Management, Turnkey, etc., always ensuring quality, time and price. INPER have delivered a 500 kW plant under turnkey modality, and have other projects on different stages in the north of Spain.

The company is associated with ARDITECNICA, which is another Spanish engineering company, for the execution of the projects.

Both works in partnership with German technologists for the design and technical cooperation.



Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
n.a.	n.a.	n.a.

all-in-one

Inper
Ingeniería Para Energías Renovables

INPER S.L.
Established since: 6-12 years

Calle Rafael Calvo 30 – 28010
Madrid – SPAIN

Tel: +34 917001624
Fax: +34 913197628

www.inpper.es
ialburquerque@inpper.es

Number of small-scale plants sold this far: <5

> BERT

Bert is an on site power producer using unused biomass as “fuel”. Food production has usually food waste / waste water containing biomass that can be used as “fuel”. Bert produces biogas that could be used directly to produce heat, hot water, or electricity for onsite use. The small foot print of bert makes it possible to fit nearly all industrial sites. The small size of the fermenter, starting from 200m³ makes bert nearly economical on all industrial food production sites. Biomass from food production is frequently a cost on the P&L, with bert this cost will disappear. Bert is a factor to stabilize energy cost of the user.

> Bio4Gas EXPRESS

Bio4Gas EXPRESS develops and operates cost effective small biogas plants to use unused biomass energy.

Our AD system is designed for liquid input material as:

- Livestock manure (slurry and muck)
- Effluents and process liquids (farm & industry)
- Food loss (organic agricultural waste)
- Food waste (household, commercial, industry)
- Animal by-products (abattoir waste)

Dry biomass can be liquified.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
30 - 250	350’000 – n.a.	20‘000 – n.a.

all-in-one

bert GÜLLE-VEREDELUNGSANLAGEN
www.bio4gas.eu

Bio4Gas EXPRESS GmbH
Established since: 2010

Kolpingstraße 26 – 86916
Kaufering – GERMANY

Tel: +49 (0) 8191 33 11 510
Fax: +49(0) 8191 33 11 512

www.bio4gas.eu
info@bio4gas.eu

Number of small-scale plants sold this far: > 40

> INDUSTRIAL WASTE AND PRODUCTION RESIDUALS

The production of foodstuffs and beverages generates a huge amount of organic residuals or organically high polluted waste water which are usually predestinated for anaerobic digestion and Energy production.
Such plants must be always designed as tailor-made solution to find the requirements of the factory, because the self-processing of production residuals now comes to be a part of the production process. Only a well and carefully designed Plant gives the successful and safe operation without any risk for the key production.
Interfaces between the production process and the biogas plant are manifold:

- Collecting and disposal of the residuals.
- Utilization of the generated Energy.
- Processing of the digestion residuals.

We are well experienced experts over more than 20 Years know-how for applications in food and beverage industry like:

- Distilleries and Breweries
- Dairies and Cheese Producers.
- Fruit Vegetable or Potato Processors.
- Drying plants for Herbs and Onions.
- Slaughterhouses and Beef Producers.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
n.a.	n.a.	n.a.

all-in-one

INNOVAS – Innovative Energie und Umwelttechnik GbR
Established since: 1994

Margot-Kalinke-Strasse 9
80939 - Munich – GERMANY

Tel: +49 (0) 89 16 78 39 73
Fax: +49 (0) 89 16 78 39 75

www.innovas.com
info@innovas.com

Number of small-scale plants sold this far: n.a.

> IDEA WITH A GREAT FUTURE: COMPACT BIOGAS PLANT UP TO 150 KW

The technology of the Kleinvieh biogas plant with Genset up to 150 kW, entry system for solids and manure, pumps, heating and control station is housed in a standard 40 'container. This space-saving solution allows implementation of the biogas plant also at limited space capacities.

Kleinvieh has a web-based online Controlling with live data collection. The monitoring comprises the continuous automatic transmission of over 50 Parameters per plant.

All system functions can be controlled via an included tablet. The data are collected centrally and allow quickly and efficiently determination of the cause of any problems and it's resolution. In difficult circumstances, additional monitoring technology can be applied, eg current rate of gas production, or the current pH in real-time.

> MODULAR CONCEPT

The system is modular, so that it can be adapted to the specific needs of the customers by adopting differently designed concept or additional components..

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
75 – 150	n.a.	n.a.

all-in-one

kleinvieh
macht auch Watt

CJB Energieanlagen GmbH & Co.KG
Established since: 2005

Lohberg 10 – 49716
Meppen – GERMANY

Tel: +49 (0) 5931 883870

www.kleinvieh.eu
info@kleinvieh.eu

Number of small-scale plants sold this far: < 5

> WELTEC BIOPOWER

Founded in 2001, WELTEC is one of the pioneers of the constructors of biogas plants. Based on the modern approach of experienced engineers, the company from Vechta, Germany with its expertise of a staff of close to 80, offers complete biogas plants from one source and has developed to a leading constructor of biogas plants in the world.

As the hydrogen sulphide and ammonia compounds contained in biogas corrode unprotected parts, WELTEC builds the digesters from stainless steel. This ensures a long useful life of the plant.

By means of its comprehensive services, WELTEC ensures the technical and economic stability of the biogas plants. The CHP service guarantees stable output, the biological supervision ensures continuous monitoring of the relevant parameters, and systematic repowering makes sure that the biogas plant is always up to date.

One of the main strengths of WELTEC is the ability to deliver individual and flexible solutions worldwide – from compact plants to large computer-controlled plants in the megawatt range, waste recycling plants, and biogas parks with gas processing technology.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
n.a.	n.a.	n.a.

all-in-one

WELTEC BIOPOWER

WELTEC BIOPOWER GmbH
Established since: 2001

Zum Langenberg 2 – 49377
Vechta – GERMANY

Tel: +49 (0) 4441 999 78-0

www.weltec-biopower.de
info@weltec-biopower.de

Number of small-scale plants sold this far: > 50

> SAUTER BIOGAS SYSTEM

The centerpiece of the Sauter Biogas system is the spraying onto the surface instead of stirring the whole contents of the digester as a means of agitation. This means that liquid material from the bottom of the digester is pumped up and sprayed onto the surface of the digester contents. Experience showed us that this is a way to obtain homogenization efficiently, easily and in a crisis-proof manner.

The Sauter Biogas system forms the basis of a very simple set up. It consists of a digester and a gas-tight digestate reservoir when necessary. Due to the limitation on maximum two tanks there is no need for an elaborate and vulnerable network and the whole plant remains simple and easily manageable.

All technical equipment is located in a single container to the digester. Everything is easily accessible and fixtures such as a stirrer or heating conductor etc. which usually have a high maintenance level become unnecessary.

Moreover the control system is automated. The loading with raw material is to take place every, or every other day. Furthermore daily inspection is recommended. But with its hardwearing technology and the noncritical volumetric loading the process has a high stability and high flexibility concerning its kind of feedstocks.

Nominal power (kW)	Price range (€)	O&M cost (Euro/year)
50 – 100	350.000 - 700.000	10.000 – 30.000

all-in-one

SAUTER
BIOGAS GMBH

Sauter Biogas GmbH
Established since: 2010

Am Berg 1, - Klipphausen
01665 – GERMANY

Tel. +49 (0)351-658 774-0
Fax. +49 (0)351-658 774-14

www.sauter-biogas.de
info@sauter-biogas.de

Number of small-scale plants sold this far: 5 - 10

> INNOVATION IS THE KEY TO PRODUCE BIOGAS

MT-Energie is one of the leading producers of high efficient Anaerobic Digestion plants, biogas upgrading and injection systems.
We offer the whole variety of technologies and knowledge that serve the conversion from biomass to biogas-energy with a particular focus and experience in the farming sector. Our systems are designed to process a wide range of organic substrates including food wastes.

MT-Energie can count on a wide expertise: 650 AD plants built worldwide and 30 gas upgrading systems in Europe. This can give confidence for the delivery of bespoke solutions to farmers and landowners, food-waste processors, waste management companies, project developers, investors and all professionals who want to produce energy using organic materials.

> YOUR NO.1 FOR SERVICING

Our services include a professional biological process laboratory and fully computerised system control with help available 24/7-365 days per annum. MT-Energie offers its products in various European countries.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
51 – 75 and bigger	n.a.	n.a.

all-in-one

MT-ENERGIE
Biogas-Technologie

MT-Energie GmbH
Established since: 2001

Ludwig-Elsbett-Straße 1
27404 - Zeven – GERMANY

Tel: +49 (0) 4281 9845-0
Fax: +49 (0) 4281 9845-100

www.mt-energie.de
info@mt-energie.com

Number of small-scale plants sold this far: > 50

DynaHeat-HPE developed an universal biogas plant for 50 – 350 livestock units intended for serial production. Since 2012, this product line has been complemented with a dry fermenter of the same size for approximately 1,000 m³ of residual materials with a dry matter content (DS) >25.

The advantages of the biogas plants are: serial production, low space requirement, flexible setup, low energy consumption and cost effectiveness due to a series of special design elements and processes.

Another building block, the actual core competence of DynaHeat-HPE is the development of speed modulating miniature block heating works. Currently DynaHeat-HPE is developing three types of block heating works in a power range from 3–12 kWel, from 9–25 kWel, and from 15–50 kWel. These block heating works are an important part of biogas plants.

DynaHeat-HPE grants the option of an efficient and economic decentralized production of energy by using agricultural waste material, sewage purification plants or industrial waste. This is an important contribution to the European energy revolution and an outstanding benefit to the customer .

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
10 - 75	250.000 – 700.000	4.000 – 15.000

all-in-one

dynaheat | hpe

DynaHeat-HPE GmbH & Co.KG
Established since: 2012

Eichenweg 1 – 86573
Obergriesbach - GERMANY

Tel: +49 (0) 8251 888423-0
Fax: +49 (0) 8251 888423-50

www.dynaheat-hpe.com
info@dynaheat-hpe.com

Number of small-scale plants sold this far: 5 - 10

> SMALL AND MEDIUM BIOGAS PLANTS BY BWE BIOGAS-WESER-EMS GMBH & CO. KG

- Turnkey biogas plant meeting the highest quality standards
- 2 types of construction: space-saving pot-in-pot system or system with two digesters
- Size varies from 50 kWel to 250 kWel
- Flexible substrate input from manure to energy crops
- Reliable and long proven technology
- Low odor emissions digestate
- Low biogas potential digestate

> SYSTEM ENGENEERING

- High gas storage capacity
- Longer retention
- Scheduled completion due to prefabricated components
- Expandable construction system
- Efficient operation guaranteed

> PROFITABILITY

- Running time: 8500 h/a, substrate input for 8760 h/a
- High load factor >95 %
- Realistic gas yield for planned input substrate
- Low mantainance and operation costs

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
75 (substrate: cattle manure)	585.000	14.125

all-in-one

biogas weser-ems GmbH & Co. KG

bwe biogas-weser-ems GmbH & Co. KG
Established since: 2000

Zeppelinring 12-16 - 26169 Friesoythe – GERMANY

Tel: 04491 / 93 800 - 0
Fax: 04491 / 93 800 - 44

www.biogas-weser-ems.de
info@biogas-weser-ems.de

Number of small-scale plants sold this far: > 50

> UDR-TECHNOLOGY AND ITS COMPONENTS FERMENTATION AT THE HIGHEST LEVEL

With innovative solutions offers Energie-Anlagen Röring the possibility to optimize the total efficiency from anaerobic fermentation plants. The core is the UDR-System, a fermentation which is based on fixed-bed technology. To bionic principles organic material is converted into usable electrical and thermal energy. Owing to the patented UDR-MonoTube-Technology all efficiency- and achievement-increasing measures can be transformed in consideration with economy.

This can be raised additionally with further very innovative components. The high-performance wet-disintegrator PlurryMaxx cuts and mill the substrate surface purify for an improved fermentation.

With the intelligent agitator CircumMaxx sinking- and surfacemats are avoided. The unique combination of agitator direction and -strength make possible a 3-dimensional mixing in any container geometry.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
n.a.	n.a.	n.a.

all-in-one

RÖRING ENERGIE-ANLAGEN

Energie-Anlagen Röring GmbH
Established since: 2006

Rudolf-Diesel-Straße 3b – 48691 Vreden – GERMANY

Tel: +49 (0) 2564 3949390

www.energieanlagen-roering.de
info@energieanlagen-roering.de

Number of small-scale plants sold this far: > 100

> ENVIRONMENTAL TECHNOLOGY / BIOGAS

Based on the company's many years of experience in turnkey construction projects and its traditional know-how in engineering, structural steel, pipework and plant manufacture the SCHACHTBAU NORDHAUSEN GmbH realises environmental technology projects for over 20 years. The classic area of activity of the biogas division includes the following services:

- Project development, planning, permission, turnkey execution, commissioning and repowering of biogas plants, as well as maintenance
- Plant construction, pipeline construction (steel, stainless steel, PE) as well as delivery and assembly of partial equipment and components for any kind of plant size
- Construction / manufacturing of special components

> IN-HOUSE PRODUCTS FOR BIOGAS, SEWAGE GAS AND WASTE TREATMENT PLANTS

- Steel-digester with central agitator (d/h-ratio ≤ 1)
- Solid matter shredder and dosing feeder (MOLARES and MULTIFLOOR)
- Technical container (incl. heat exchanger, pumps and process control system)
- Stainless steel components for all kinds of application (pipe fittings, condensate collectors, high and low pressure safety valves, etc.)

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
75 – 100	850.000	14.125

all-in-one

SCHACHTBAU NORDHAUSEN

SCHACHTBAU NORDHAUSEN GmbH
Established since: 1898

Industrieweg 2a - 99734 Nordhausen - GERMANY

Tel: +49 (0) 3631 632463
Fax: +49 (0) 3631 632578

www.schachtbau.de
biogas@schachtbau.de

Number of small-scale plants sold this far: 5 - 10

> SNOW LEOPARD PROJECTS

Snow Leopard Projects is a small family business with a unique technology, based in lower Bavaria.
The high performance biogas plants are able to cope with even the hardest and most complicated to handle feedstock.
The development of this technology is only possible because the company takes great pride in a steady improvement of its product through research and development projects.
Besides the technological improvement, creating regional added value is a huge motor that drives Snow Leopard Projects for achieving the very best possible solution for every client.

> REFERENCE PLANTS

Our plants are successfully implemented and running in countries all over the world.
Rwanda: 1 HPTC Biogasplant
India: 2 HPTC Biogasplants
Kenya: 5 HPTC Biogasplants
Zanzibar: 1 HPTC Biogasplant
Tanzania: 1 HPTC Biogasplant

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
10	99.000 – n.a.	n.a.

all-in-one

SNOWLEOPARD

Snow Leopard Projects GmbH
Established since: 2011

Marktplatz 23 – 94419
Reisbach – GERMANY

Tel: +49 (0) 8734 939770
Fax: +49 (0) 8734 9397720

www.snow-leopard-projects.com
info@strohvergaerung.de

Number of small-scale plants sold this far: 10 - 50

Midroc Europe is a comprehensive partner in the areas of properties, construction, industry and environmental technology. Our goal is to make our customers more competitive and to contribute to a better future through the implementation of sustainable solutions and innovation. Our operations are international, with Sweden as base. Midroc has 3000 employees and turnover in 2013 was SEK 4.3 billion.

As for biogas Midroc have designed and built two farm based plants for biogas production in Sweden. Both plants are equipped for combined heat and power production. Our design is based on terms like durability, flexibility and reliability. Other than complete plants we can be support you with control systems, CHP-units, flares and other complex parts.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
50 – 100	n.a.	n.a.

all-in-one

MIDROC

MIDROC ELECTRO AB
Established since: > 12 years

Svampgatan 2 - 57343
Tranås - SWEDEN

Tel: +46 10 471 33 09

www.midroc.se
info@midroc.se

Number of small-scale plants sold this far: < 5

> RETHINKING BIOGAS TECHNOLOGY

We supply customized next-gen biogas solutions aimed at strengthening economies and environmental efforts everywhere. By combining Swedish textile know-how with versatile and worldwide biogas R&D (Europe, South and Southeast Asia, Africa, South America), we are able to offer waste-to-energy biogas reactors made of advanced fabrics and designed for outstanding cost effectiveness.
By ensuring high productivity throughout the full lifetimes of our systems, we provide the complete service of reliable biogas production. This promise is upheld not least by our expert support personnel, employing vast local university and enterprise competencies.
Most important, however, is the extreme durability of our reactor material and its readily available customization possibilities, as well as the unique scalability we achieve through prefabrication and quick reactor installations.

> RELIABLE WASTE-TO-ENERGY INVESTMENTS

Our biogas systems offer trustworthy, simple, and decade-spanning biogas production, with quick payback (≤ 2 years) and scale-up (≈2 days) times. In short, we offer new, cost effective possibilities.

Nominal power (kWel)	Price range (€)	O&M cost (Euro/year)
25 - 50	n.a.	n.a.

all-in-one

FOV Biogas
Swedish cleantech
rethinking biogas technology

FOV Biogas
Established since: 6 - 12 years

Norrby Långgata 45, Box 165,
SE - 50114 - SWEDEN

Tel: +46 (0)33-20 63 33
Fax: +46 (0)33-20 63 50

www.fovbiogas.com
fredrik.johansson@fov.se

Number of small-scale plants sold this far: n.a.

> SMALLBIOGAS

Smallbiogas is a web application that allows you to analyze the technical, economical and environmental feasibility of small-scale biogas plants. To this effect, the tool generates a comprehensive report that will serve you in making decisions.

It provides four steps:

- **SELECT THE SUBSTRATE OR WASTE**
  The system gives you the chance to select the type and amount of substrate provided. This material is the raw material for biogas production.
- **INDICATE INTENDED USE OF BIOGAS**
  We need to include in the analysis the intended use of the resulting biogas (heating, use as vehicle fuel, electricity, etc.). Please, choose the option that you consider the most appropriate based on your profile and smallbiogas will take care of the rest.
- **INDICATE INTENDED USE OF DIGESTATE**
  Once the biogas has been generated, there is an output material called digestate, nutrient-rich (nitrogen, phosphor, etc.) that it can be recycled for agricultural use. Smallbiogas will give you the chance to select the case that applies to your plant.
- **VIABILITY REPORT**
  As end result, smallbiogas generates a complete technical report that allows you to analyze the viability of a small-scale biogas plant and that will serve to support decision making.

In the following pages some models of biogas plants models made by DISAFA are shown. Three plant size are offered: 30 kW_{el}, 60kW_{el} and 100 kW_{el}, with different agrofood industries and technology (wet and dry).

> REPORT

Models shown in the following pages are purely for information. Italian subsides were used for economy parameters in these models. Reports made with the same substrates and technology, may show different results in different counties, since the tool calculates parameters based on each country contribution politics. A comparison between country is shown at the end of this section

> WET - 30 kW_{EL} MODEL

A model for a cheese farm was studied. Available substrates are dejections of one hundred milking cows (manure and slurry) and industrial by-products and waste of the cheese production from the hundred cow milk (cheese whey and cheese waste). These substrates are used to feed a wet technology digester. Biogas produced is used as fuel in a CHP engine, that provides electrical and thermal energy sold into the grid.

Plant and economic data are shown below.

Substrates introduced every year in the digester are:

- **785 t OF MILKING COW MANURE**
- **1.507 t OF MILKING COW SLURRY**
- **819 t OF WHEY**
- **6 t OF CHEESE WASTE**

Annual amount of waste introduced in the digester (fresh matter)	3.117 t $year^{-1}$
Annual amount of waste introduced in the digester (dry matter)	391 t $year^{-1}$
Annual amount of waste introduced in the digester (dry organic matter)	319 t $year^{-1}$
Volume of the digester	401 m^3
Hydraulic retention time	45 days
Gross methane production (annual)	77.753 Nm^3 year
Use of biogas	Cogeneration
Installed power of the CHP engine	30 kW
Electrical energy obtained from the CHP engine	232 MWht $year^{-1}$
Thermal energy obtained from the CHP engine	352 MWh $year^{-1}$
Total amount of digestate produced (fresh matter)	2.953 t $year^{-1}$

Total investment	290.000 €
Biogas plant	208.000 €
Biogas valorization system	82.000 €
Income (sale or use of energy and digestate)	57.150 € $year^{-1}$
Expenses (O&M, staff, transports, substrates)	20.100 € $year^{-1}$
Payback period	7,8 years
Savings of CO_2 emissions	90 t $year^{-1}$

> WET - 60 kW_{EL} MODEL

A model for a livestock farm with different animal species was studied.
Available substrates are dejections of 140 cattles (manure and slurry), 3000 chickens and 200 fattened pigs.
These substrates are used to feed a wet technology digester. Biogas produced is used as fuel in a CHP engine, that provides electrical and thermal energy sold into the grid.

Plant and economic data are shown below.

Substrates introduced every year in the digester are:

- **903 t OF PIG MANURE**
- **33 t OF CHICKEN MANURE**
- **1.541 t OF MILKING COW MANURE**
- **2.939 t OF MILKING COW SLURRY**
- **434 t OF MAIZE SILAGE**

Annual amount of waste introduced in the digester (fresh matter)	5.850 t $year^{-1}$
Annual amount of waste introduced in the digester (dry matter)	847 t $year^{-1}$
Annual amount of waste introduced in the digester (dry organic matter)	695 t $year^{-1}$
Volume of the digester	870 m^3
Hydraulic retention time	51 days
Gross methane production (annual)	153.000 Nm^3 year
Use of biogas	Cogeneration
Installed power of the CHP engine	60 kW
Electrical energy obtained from the CHP engine	463 MWh $year^{-1}$
Thermal energy obtained from the CHP engine	702 MWh $year^{-1}$
Total amount of digestate produced (fresh matter)	5.641 t $year^{-1}$

Total investment	466.000 €
Biogas plant	322.000 €
Biogas valorization system	144.000 €
Income (sale or use of energy and digestate)	114.100 € $year^{-1}$
Expenses (O&M, staff, transports, substrates)	56.400 € $year^{-1}$
Payback period	8 years
Savings of CO_2 emissions	176 t $year^{-1}$

> WET - 100 kW_{EL} MODEL

A model for a milking cow farm was studied. Substrate used to feed the digester are mainly animal dejections (slurry and manure), some maize silage is added too. This plant works almost exclusively on livestock dejections.

Plant and economic data are shown below.

Substrates introduced every year in the digester are:

- **2.610 t OF MILKING COW MANURE**
- **9.263 t OF MILKING COW SLURRY**
- **196 t OF MAIZE SILAGE**

Annual amount of waste introduced in the digester (fresh matter)	11.619 t $year^{-1}$
Annual amount of waste introduced in the digester (dry matter)	1.519 t $year^{-1}$
Annual amount of waste introduced in the digester (dry organic matter)	1.228 t $year^{-1}$
Volume of the digester	1542 m^3
Hydraulic retention time	46 days
Gross methane production (annual)	254.935 Nm^3 year
Use of biogas	Cogeneration
Installed power of the CHP engine	100 kW
Electrical energy obtained from the CHP engine	762 MWh $year^{-1}$
Thermal energy obtained from the CHP engine	1.154 MWh $year^{-1}$
Total amount of digestate produced (fresh matter)	10.900 t $year^{-1}$

Total investment	726.000 €
Biogas plant	511.000 €
Biogas valorization system	215.000 €
Income (sale or use of energy and digestate)	187.400 € $year^{-1}$
Expenses (O&M, staff, transports, substrates)	77.500 € $year^{-1}$
Payback period	6,5 years
Savings of CO_2 emissions	305 t $year^{-1}$

> DRY - 30 kW_{EL} MODEL

A model for a brewery was studied. Fermentable substrates are brewing grain residues and milking cow manure.
Biomass is used to feed a dry technology digester. Biogas produced is used as fuel in a CHP engine, that provides electrical sold into the grid and thermal energy used in the process.

Plant and economic data are shown below.

Substrates introduced every year in the digester are:

- **280 t OF BREWING GRAINS**
- **74 t OF MILKING COW MANURE**

Annual amount of waste introduced in the digester (fresh matter)	354 t $year^{-1}$
Annual amount of waste introduced in the digester (dry matter)	276 t $year^{-1}$
Annual amount of waste introduced in the digester (dry organic matter)	254,5 t $year^{-1}$
Volume of the digester	160 m^3
Hydraulic retention time	100 days
Gross methane production (annual)	76.600 Nm^3year
Use of biogas	Cogeneration
Installed power of the CHP engine	30 kW
Electrical energy obtained from the CHP engine	228 MWh $year^{-1}$
Thermal energy obtained from the CHP engine	346 MWh $year^{-1}$
Total amount of digestate produced (fresh matter)	194 t $year^{-1}$

Total investment	135.000 €
Biogas plant	54.000 €
Biogas valorization system	81.000 €
Income (sale or use of energy and digestate)	56.300 € year^{-1}
Expenses (O&M, staff, transports, substrates)	12.400 € year^{-1}
Payback period	3 years
Savings of CO_2 emissions	77 t year^{-1}

> DRY - 60 kW_{EL} MODEL

A model for a milling industry was studied. Available substrate are harvesting crops waste (discarded grain and dust silo waste), vegetable waste from the milling industry like wheat bran and dejections from livestock farm.

These substrates are used to feed a digester, biogas produced is used as fuel in a CHP engine, that provides electrical and thermal energy for company self-consumption.

Plant and economic data are shown below.

Substrates introduced every year in the digester are:

- **302 t OF WHEAT BRAN**
- **50 t OF DISCARDED GRAIN**
- **43 t OF DUST SILO WASTE**
- **3.580 t OF MILKING COW SLURRY**

Annual amount of waste introduced in the digester (fresh matter)	3.975 t $year^{-1}$
Annual amount of waste introduced in the digester (dry matter)	686 t $year^{-1}$
Annual amount of waste introduced in the digester (dry organic matter)	593 t $year^{-1}$
Volume of the digester	747 m^3
Hydraulic retention time	55 days
Gross methane production (annual)	152.845 Nm^3 year
Use of biogas	Cogeneration
Installed power of the CHP engine	60 kW
Electrical energy obtained from the CHP engine	457 MWh $year^{-1}$
Thermal energy obtained from the CHP engine	692 MhW $year^{-1}$
Total amount of digestate produced (fresh matter)	4.294 t $year^{-1}$

Total investment	241.000 €
Biogas plant	99.000 €
Biogas valorization system	142.000 €
Income (sale or use of energy and digestate)	112.500 € $year^{-1}$
Expenses (O&M, staff, transports, substrates)	82.400 € $year^{-1}$
Payback period	8 years
Savings of CO_2 emissions	156 t $year^{-1}$

> DRY - 100 kW_{EL} MODEL

A model for a slaughterhouse was studied. Available substrate are waste from processing of animal carcasses (offal and fat), sewage sludge from industrial treatment plants and cereal straw from harvesting crops waste.

These substrates are used to feed a digester, biogas produced is used as fuel in a CHP engine, that provides electrical and thermal energy for company self-consumption.

Plant and economic data are shown below.

Substrates introduced every year in the digester are:

- **2.913 t OF RUMINAL CONTENT**
- **2.407 t OF SEWAGE SLUDGE FROM TREATMENT PLANTS**
- **49 t OF SLAUGHTERHOUSE FAT**
- **633 t OF CEREAL STRAW**

Annual amount of waste introduced in the digester (fresh matter)	6.002 t $year^{-1}$
Annual amount of waste introduced in the digester (dry matter)	1.121 t $year^{-1}$
Annual amount of waste introduced in the digester (dry organic matter)	922 t $year^{-1}$
Volume of the digester	1.163 m^3
Hydraulic retention time	52 days
Gross methane production (annual)	254.898 Nm^3 year
Use of biogas	Cogeneration
Installed power of the CHP engine	100 kW
Electrical energy obtained from the CHP engine	762 MWh $year^{-1}$
Thermal energy obtained from the CHP engine	1.154 MWh $year^{-1}$
Total amount of digestate produced (fresh matter)	6.989 t $year^{-1}$

Total investment	541.000 €
Biogas plant	326.000 €
Biogas valorization system	215.000 €
Income (sale or use of energy and digestate)	187.500 € $year^{-1}$
Expenses (O&M, staff, transports, substrates)	106.400 € $year^{-1}$
Payback period	6,5 years
Savings of CO_2 emissions	273 t $year^{-1}$

	PAYBACK PERIOD (years)						
WET Model (with CHP)	Italy	Spain	Ireland	France	Sweden	Germany	Poland
30 kW no subsidies self consumption	no data*	no data*	no data*	no data*	no data*	no data*	no data*
30 kW no subsidies sale of energy	4,56	>15	11,40	>15	>15	>15	>15
30 kW 30% subsidies self consumpotion	no data*	no data*	no data*	no data*	no data*	no data*	no data*
30 kW 30% subsidies sale of energy	3,19	>15	7,98	11,01	>15	10,54	13,36
60 kW no subsidies self consumption	8,80	8,29	>15	>15	>15	14,14	>15
60 kW no subsidies sale of energy	5,33	>15	13,30	>15	>15	14,37	>15
60 kW 30% subsidies self consumpotion	6,16	5,80	12,26	>15	>15	9,90	>15
60 kW 30% subsidies sale of energy	3,73	>15	9,31	12,90	>15	10,06	>15
100 kW no subsidies self consumption	10,94	6,47	12,79	>15	>15	9,01	>15
100 kW no subsidies sale of energy	7,00	>15	10,17	>15	>15	9,09	>15
100 kW 30% subsidies self consumpotion	7,66	4,53	8,96	>15	>15	6,31	>15
100 kW 30% subsidies sale of energy	4,90	>15	7,12	11,71	>15	6,37	>15

	PAYBACK PERIOD (years)						
DRY Model (with CHP)	Italy	Spain	Ireland	France	Sweden	Germany	Poland
30 kW no subsidies self consumption	3,56	3,08	4,83	5,94	10,27	7,57	3,82
30 kW no subsidies sale of energy	2,25	6,40	3,82	2,90	9,97	6,68	3,09
30 kW 30% subsidies self consumpotion	2,49	2,15	3,38	4,16	7,19	5,30	2,68
30 kW 30% subsidies sale of energy	1,58	4,48	2,67	2,03	6,98	4,68	2,16
60 kW no subsidies self consumption	>15	>15	>15	>15	>15	>15	>15
60 kW no subsidies sale of energy	3,15	>15	>15	8,34	>15	>15	>15
60 kW 30% subsidies self consumpotion	>15	>15	>15	>15	>15	>15	>15
60 kW 30% subsidies sale of energy	2,21	>15	>15	5,84	>15	>15	>15
100 kW no subsidies self consumption	no data*	no data*	no data*	no data*	no data*	no data*	no data*
100 kW no subsidies sale of energy	3,73	>15	10,93	11,21	>15	11,72	>15
100 kW 30% subsidies self consumpotion	no data*	no data*	no data*	no data*	no data*	no data*	no data*
100 kW 30% subsidies sale of energy	2,61	>15	7,65	7,85	>15	8,21	>15

* the defined needs of energy are higher than the production of energy from biogas (the software SmallBiogas does not generate results in such cases)

> BEST CASES

In the following pages three different size plants are shown. Examples are purely for information; small-biogas plants are currently working all over Europe, these were chosen for a smart-energy utilization.
These digesters are currently working and you can get some information about real existing plants, as substrates used, costs, energy production and utilization, expenditures and incomes.
In discussions strengths and weaknesses of the plant and technology are shown.
Best cases shown in the following pages are related to primary production, since there are very few small-scale biogas plant of food industry at the moment. The purpose of Biogas³ is to promote and widespread this technology.

The best cases offered refer to:

- **50 KW_{el} PLANT IN FRANCE**
- **75 KW_{el} PLANT IN GERMANY**
- **102 KW_{el} PLANT IN ITALY**

> DISCLAIMER

Examples shown below are small-biogas plants cases suggested by partners.
The choice of the companies was not involved in any kind with partner’s business activities.
No payment was requested to publish the companies and plant provider information given in this handbook.

> SUBSIDIES

Note that every country has a different subsidy politic management for biogas plants.
Best cases offered in the following pages may have received subsidies different from the ones you can get in your country or may have received subsidies from previous subsidies contribution.

> IMPLEMENTATIONS

> BEST CASES – 50 KW$_{EL}$

SSCEA Robin - Farm - Liquid technology - 50kW CHP engine

Supplier: BiO4GAS

The farmer operates an AD plant (liquid technology), built in 2013, with a 50 kW$_{el}$ CHP engine (working average power: 43kW), 1.162.000 kWh produced in 1 digester (600 m^3). 10.000 m^3/year of pig slurry is incorporated in the digester. The originality of that AD unit is the substrate is only pig slurry, which has a low biogas potential.

That AD unit produce 368.000 kW$_{el}$ and 588 000 kWh$_{th}$, used to heat breeding buildings. No brewing is necessary: a convection system is used between the substrate and the hot water around the digester and sufficient to induce a movement of the substrate inside the digester and optimize the digestion (O&M economy).

To increase the biogas potential of the slurry, this is only fresh slurry which is incorporated in the digester: a flushing system is used under animals in buildings which permit to evacuate quickly the slurry. Fresher is the slurry, higher is the biogas potential because the organic matter has no time to degrade in methane before entering the digester (biogas potential of a fresh slurry would be 2.5 times higher than a stored slurry).

The supplier of that technology (Bio4gas) is a specialist for small scale AD units. The CHP engine is a turnkey deliverable, all containerized for specific powers (25kW, 50kW, 80kW, 100kW).

The investment at SCEA Robin is around 480.000€ (100’000€ for the CHP engine), 10.000 €/kW$_{el}$. Subsidies from French government and environmental agencies are around 29% (7.000 €/kW$_{el}$ after subsidies). The investment is not sustainable without subsidies. Charges per year are around 17.500€ and income around 85.000€ (69.000€ for sale of electricity and 16.000€ with fuel economy). But we need to be careful with the amount of the charges because the biogas unit has been started on April 2013, so the feedback is quite low in term of operating and repairing costs.

> DISCUSSIONS

That kind of biogas units present some interests:

- only one kind of substrate (no pre-mix with other substrates which simplify organization and labour)
- no dependencies of external substrates (self-sufficiency)
- use of thermal energy to heat breeding buildings (in that case an economy of fuel around 16.000€).

Nevertheless, without subsidies, that investment is not sustainable, even with the electrical income. After some discussions with the supplier Bio4gas, he told us that a decrease of 15% on all the investment costs will be done now, thanks to quantity reasons and the development of that kind of biogas units.

That technology can be interesting, especially with the 2011 electricity feed-in tariff and with the decrease of 15% on the investment. The low need of labour is something highly sought for farmers who want to “stay” farmer, and not become biogas providers.

> BEST CASES – 75 KW$_{EL}$

Farm in Gießen (Germany) - Liquid technology - 75kW CHP engine

Supplier: Bio4Gas Express GmbH

Using renewable energies for self sufficiency is part of the concept of two farmers in Gießen, Germany. They run a farm with 420 dairy cattle. Their concept for the future: conditioning of manure.

The livestock units consist of 290 dairy cows, 300 young cattle and 50 breeding bulls, placed in three stalls. Additionally the farm cultivates 400 ha arable land and 200 ha grassland. The farm is run by both brothers together with their families, five employees and one trainee.

Since September 2013, the farm owns a manure conditioning plant. The digester of the plant holds 600 m^3, the CHP plant has an installed capacity of 75 kW. The pre-digester is filled every three days and the plant takes the manure automatically from the pre-digester. Each year almost 11.000 m^3 of slurry are introduced in the digester.

The CHP engine unit produces 630 MW$_{el}$ and 740 MWh$_{th}$ each year.

With the CHP plant the produced gas is used to heat three residential buildings on the farm and is sufficient for German winter. Therefore it is possible to save around 10.000 liters of heating oil every winter. In future one of their neighbors will be provided with the surplus of heat. All of the produced electricity is fed into the national grid.

The total investment for this plant was around 500.000 €, the investment was fund by farmer resources, with an estimated payback period of 6 years.

> DISCUSSIONS

This biogas plant has some interesting points:

- Large amount of land where to spread digestate;
- thermal energy is valorised for household heating;
- All susbtrates are produced in the farm;

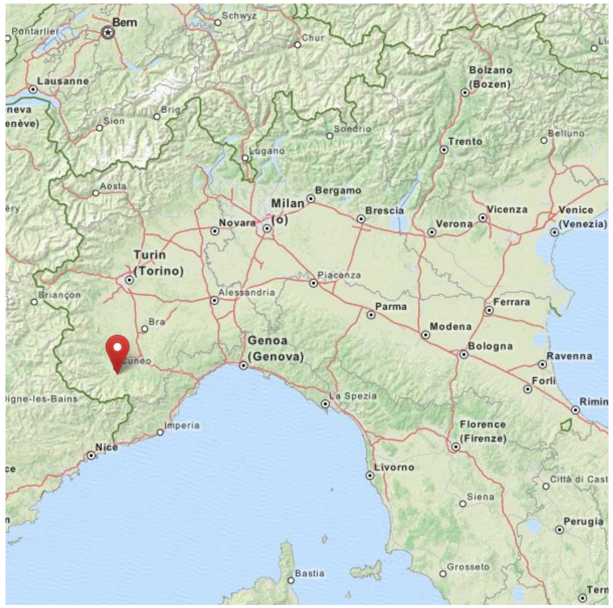
> BEST CASES – 102 KW$_{EL}$

Boves Farm (Piedmont, ITALY) - Liquid technology - 102kW CHP engine

Supplier: Rota Guido Srl

The farmer operates an AD plant (liquid technology) with a 102kW$_{el}$ CHP engine (2g-cenergy). The plant consists a concrete digester with one chamber and operates in mesothermic environment. Milking cow slurry and manure are mostly used to feed the plant (98%) and a small part of is silage is used too.

Each day 19 m^3 of slurry, 6 tons of manure and half ton of silage are fed into the digester.



Biogas is processed before being used by CHP engine with microbiological desulphurization, physical dehydration, refrigeration from 37°C to 7°C and carbon filters.

The CPH engine produces 881.400 kW$_{el}$/year and works for 8.706 hours.

Part of the electrical energy produced is self-consumed for slurry pre-treatment and company’s needs (8-11%), the rest is sold into the grid for 0,28 €/kW$_{el}$.

This farm has an efficient system to valorise the heat produced by the CHP engine.

Heat is used for substrate pre-treatment, to warm up digester and farmer house and provides warm air for the hay dryer.

The total investment for this plant was around 800.000 €, while operation and management costs are 20.000 €/year for operating costs (without farmer work and substrate cost, since they are self-produced) and 20.000 €/year for a full service provided by the biogas plant constructor.

Subsidies from Italian government and environmental agencies are on energy produced. In this case each kW_{el} is paid 0,28€. Since the authorisation of the plant was received before January 13, it gets the old subsidies Italian rules, all-encompassing feed in tariff of 0,28€/kW for plants with a nominal power value below 1MW.

> DISCUSSIONS

This biogas plant has some interesting points:

- it works mostly with agrofood residues, only 2% of energy crops are used;
- thermal energy is valorised and is not wasted;
- no dependency on external substrates, since they are produced in the farm;

This investment is not sustainable without subsidies, furthermore this plant has an higher income from old subsidies compared to the new ones.
With the old subsidies the company gets 280 €/MW, the new one is 236 €/MW (plant with <300 kW of nominal power and at least 70% of by-products) with an other 10 €/MW for CHP engine.

> WEBSITE

For further information you can see the “Success Stories” section on biogas 3 website **WWW.BIOGAS3.EU**, where more working plants are shown. You will find examples of best cases in more countries and sizes.

> LAW

Information about each partner's country law is listed.
European law purpose is to protect water and soil from pollution, so a correct use of digestate to avoid nitrate leaching and groundwater is necessary.
Maximum emissions, storage capacity, safety requirements, incentives to valorize heat produced and risk to the public are regulated.

Small-scale plants technology is not largely widespread in all EU countries, so the legislation may vary (as for self-constructed plants or usable by-products and waste).

For more information you can visit the website of Biogas3, where a detailed legislative and financial framework for all the countries involved in the project can be found.

> LEGISLATION

FRENCH LEGISLATION

> GENERAL ORIENTATIONS

EMAA plan "Energie Méthanisation Autonomie Azote"

> PROJECT CREATION

Article 1832 à 1870 du code civil
Article L.311-1 du code rural
Articles L421-1 et suivants, R421-1 et suivants et A423-1 et suivants du code de l'urbanisme

> WASTE LEGISLATION

- Responsibility of the waste producer
  Article L.541-2
- Biowaste management
  Article 26 du décret n°2011-828
- Waste transport
  Article R541-49

> SUBSTRATES

- Animal by-products
  CE n 1069/2009
- ICPE nomenclature
  Amount of substrates
  rubrique 2781

> BIOGAS

- ICPE nomenclature
  Biogas storage, rubrique 1411
- Use of biogas, rubrique 2910
  Feed-in tariff
  Arrêté du 19 mai 2011(electricity)
  Arrêté du 23 Novembre 2011
  (injection of biomethane)

> DIGESTATE MANAGEMENT

- Spreading
  Nitrates regulation 91/676/CEE
  5th french national action program (Arrêté du 23 Octobre 2013 + regional variations)
- Digestate normalization
  NFU 44-051
  NFU 44-095

> TO KNOW MORE

- www.ademe.fr
- www.ineris.fr
- www.legifrance.gouv.fr
- agriculture.gouv.fr/Plan-Energie-Methanisation
- ADEME, Le cadre réglementaire et juridique des activités agricoles de méthanisation, 2012, 82p.

ITALIAN LEGISLATION

> MAXIMUM EMISSIONS (CH_4, NH_3)

DL.gs 152/2006, parte V

> STORAGE CAPACITY

91/676/CEE, Nitrates regulation

DL.gs. 152/2006, parte III (sulle acque), art. 138

> SAFETY REQUIREMENTS

DL.gs. 81/2008 del 9/4/2008

Direttiva 94/9/CE del 23/3/1994 (ATEX), recepita con DPR n. 126 del 23/3/1998 e con DLgs 233 del 12/6/2003

> INCENTIVES RELATED TO USE OF HEAT

DM MISE FER del 6/7/2012

> USE OF DIGESTATE

DLgs 152/2006, parte IV, atr. 183-184 bis, 185

Legge 134/2012 art. 52 Bis – il digestato è un sottoprodotto

> REGISTER OF GREEN FERTILIZERS TO COMMERCIALISE THEM

Regolamento 2003/2003/CE

Recepita con DLgs 75/2010 per maggiori dettagli

> IMPLICATIONS TO NUTRIENT BALANCE OF SOIL

91/676/CEE, Nitrates Regulation

> NITRATE LEACHING

91/676/CEE, Nitrates Regulation

> RISK OF EMISSION OF METHANE AND AMMONIA DURING APPLICATION

91/676/CEE, Nitrates Regulation

> ODOUROUS COMPUNDS

Codice civile

> TRANSPORT SYSTEM

Codice della strada, DLgs 285/1992 del 30/04/1992 e successive modifiche e integrazioni

> RISK TO THE PUBLIC (PATHOGENS, ALLERGENS, HEAVY METALS)

Regolamento 1069/2009/CE sui SOA (sottoprodotti di origine animale)

> MAXIMUM NITROGEN DOSES (CROP FERTILIZATION)

91/676/CEE , Nitrates Regulation

DLgs 152/2006, parte III (sulle acque), art. 112-utilizzazione agronomica

> PERIOD OF USE

91/676/CEE , Nitrates Regulation

DLgs 152/2006, parte III (sulle acque), art. 112-utilizzazione agronomica

> PERIODICAL ANALYSIS (AGRICULTURAL USE)

91/676/CEE , Nitrates Regulation

DLgs 152/2006, parte III (sulle acque), art. 112-utilizzazione agronomica

> SYSTEM TO APPLY INTO THE SOIL

91/676/CEE , Nitrates Regulation

DLgs 152/2006, parte III (sulle acque), art. 112-utilizzazione agronomica

GERMAN LEGISLATION

> MAXIMUM EMISSIONS (CH_4, NH_3)
Art. 1 Policy (Richtlinie) 2001/81/EG concerning national Emission limits (NEC-regulation)
National Immission protection right (Immissionsschutzrecht § 1
Abs. 1 BImSchG (§§ 3, 33 f. of39. BImSchV)

> STORAGE CAPACITY
EG91/676/EWG, Nitrates regulation
Düngegesetz (DüG)
Düngemittelverordnung (DüMV)

> SAFETY REQUIREMENTS
Bodenschutzgesetzgebung (BBodSchV)
Lebensmittel- und Futtermittelrecht (LFGB), BioAbfV, AbfKlärV, DüMV

> REGULATIONS RELATED TO USE OF HEAT
Kraft-Wärme-Kopplungsgesetz (KWK-Gesetz, §3 Abs. 2; §4 Abs. 1, 4)
EEG 2014 (§23)

> USE OF DIGESTATE
Kreislaufwirtschaftsgesetz (KrWG)
Bioabfallverordnung (BioAbfV)
Düngegesetz (DüngeG)
Düngemittelverordnung (DüngemittelV)
Düngeverordnung (DüngeV)
Verordnung über das Inverkehrbringen und Befördern von Wirtschaftsdünger (WDüngV),Verordnung über den Nachweis des Verbleibs von Wirtschaftsdünger (WDüngNachwV)
VO (EG) 1069/2009, TierNebV

> REGISTER OF GREEN FERTILIZERS TO COMMERCIALISE THEM
DüMV, DüV, WdüngV, WDüngNachwV, BioAbfV

> IMPLICATIONS TO NUTRIENT BALANCE OF SOIL
EG91/676/EWG, Nitrates Regulation
Bundes-Bodenschutzgesetz (BBodSchG)
Bundesnaturschutzgesetz (BNatSchG)
Düngegesetz (DüngeG)

> NITRATE LEACHING
EG91/676/EWG, Nitrates Regulation
Wasserhaushaltsgesetz (WHG, §2, 44, 47)
Oberflächengewässerverordnung (OGewV)
Grundwasserverordnung (GrWV)

> RISK OF EMISSION OF METHANE AND AMMONIA DURING APPLICATION
DügemittelV (§6-Schadstoffgrenzwerte Contamination limits)
Bundes-Immissionsschutzgesetz (BImSchG)

> ODOUROUS COMPUNDS
Bundes-Immissionsschutzgesetz (BImSchG, §3)
Codice Civile (gute landwirtschaftliche Praxis)

> TRANSPORT SYSTEM
Düngemittelverkehrskontrolle (DVK)
Verordnung über das Inverkehrbringen und Befördern von Wirtschaftsdünger (WdüngV)

> RISK TO THE PUBLIC (PATHOGENS, ALLERGENS, HEAVY METALS)

VO (EG) 1069/2009, TierNebV (Veterinärrecht)
Bodenschutzgesetzgebung (BBodSchV)
Lebensmittel- und Futtermittelrecht (LFGB), BioAbfV, AbfKlärV, DüMV

> MAXIMUM NITROGEN DOSES (CROP FERTILIZATION)

EG91/676/EWG, Nitrates Regulation
Düngeverordnung (DüV)

> PERIOD OF USE

EG91/676/EWG , Nitrates Regulation
DüMV, DüV, WdüngV, WDüngNachwV

> PERIODICAL ANALYSIS (AGRICULTURAL USE)

EG91/676/EWG, Nitrates Regulation

> SYSTEM TO APPLY INTO THE SOIL

DüMV, DüV, WdüngV, WDüngNachwV, BioAbfV

POLISH LEGISLATION

> BIOGAS PLANT LOCATION

Act of 27 March 2003 on Spatial Planning and Land Development

Act of 7 July 1994 on Building Law

Regulation of the Minister of Agriculture and Food Economy of 7 October 1997 on technical conditions which should be met by agricultural buildings and their location

> ENVIRONMENT AND SANITARY ISSUES

Act of 27 April 2001 on Environmental Protection

Act of 3 October 2008 on providing information on the environment and environmental protection, public participation in environmental protection and on environmental impact assessment

Regulation of the Council of Ministers of 9 November 2010 on types of projects likely to have significant effects on the environment

Act of 14 December 2012 on Waste

REGULATION (EC) No 1069/2009 of 21 October 2009 laying down health rules as regards animal by-products and derived products not intended for human consumption

> USE OF BIOGAS

Act of 10 April 1997 on Energy Law

Regulation of the Minister of Economy of 18 October 2012 on the specific scope of duties to obtain certificates of origin and present them for redemption, pay substitution fees, and purchase electricity and heat generated from renewable sources of energy, and the duty to confirm data concerning the quantity of electricity generated from renewable sources of energy

Regulation of the Minister of Economy of 26 July 2011 on the method to calculate data presented in the application for a certificate of origin from cogeneration, and the specific obligation to obtain and present to redeem these certificates, pay the replacement fee and to confirm the data on the electricity output from high-efficiency cogeneration

> USE OF DIGESTATE

Act of 14 December 2012 on Waste

Act of 10 July 2007 on Act on fertilizers and fertilization

Regulation of the Minister of the Environment of 27 September 2001 on the catalogue of waste

Regulation of the Minister of Environment of 5 April 2011 on R10 recovery process

Regulation of the Minister of Agriculture and Rural Development of 16 April 2008 on the detailed method of application of fertilizers and training on their application

Regulation of the Minister of Agriculture and Rural Development of 18 June 2008 on the implementation of certain provisions on fertilizers and fertilization.

SPANISH LEGISLATION

> ENVIRONMENTAL REGULATIONS

Law 22/2011 on waste.

Law 1481/2001 on landfills.

Law 16/2002 on Integrated Pollution Prevention and Control (IPPC).

Royal Decree 949/2009 GHG emissions and Plan for biodigestion of animal slurry.

> USE OF DIGESTATE

Royal Decree 506/2013 on fertilizers.

Royal Decree 261/1996 on nitrogen from agricultural sources.

> USE OF BIOGAS

Royal Decree 413/2014 on electricity production from renewable sources.

Order IET/1045/2014.

> SANITARY REGULATION

Royal Decree 1528/12012 on animal by-products.

IRISH LEGISLATION

>Animal By-Products Regulations
http://www.agriculture.gov.ie/agri-foodindustry/animalbyproducts/applicationformsconditionsforabpprocessingoperations/

>Nitrates Regulations
http://www.agriculture.gov.ie/ruralenvironment/environmentalobligations/nitrates/

>Waste Management Licencing and Permitting
http://www.epa.ie/licensing/waste/#.VGvEUvmsWgx

>Renewable Energy Feed In Tariff (REFIT 3)
http://www.dcenr.gov.ie/NR/rdonlyres/718E8541-7ADD-4FB2-A471-B6081C435625/0/REFIT3BiomassTermsandConditions2012.pdf

>Electricity Generation Licencing
http://www.cer.ie/electricity-gas

SWEDISH LEGISLATION

> ENVIRONMENTAL CODE

SFS 1998:808. Law from 1 January 1999 with the aim of promoting sustainable development. Control the environmental permit process

> THE ENVIRONMENTAL EXAMINATION REGULATION

SFS 2013:251. The Environmental examination Regulation replaces in large parts of previous regulation on environmentally hazardous activities and health (1998: 899), FMH, whose former annex is now included in the new Regulation. However, there are some parts of the FMH still there. The Environmental Regulation became effective June 18, 2013.

> PLANNING AND BUILDING ACT

SFS 2010:900. Law regulating the planning of land, water and construction. Includes provisions for planning permit. Need for planning permit will be determined in each case for farmers based on biogas plant is seen as an integral part of agriculture and if a plan in detail exist over the area. In other cases always require planning permit is needed.

> THE LAW OF FLAMMABLE AND EXPLOSIVE GOODS (LBE)

SFS 2010:1011. Law that will reduce the damage caused by fire or explosion caused by flammable or explosive goods. Applied usually in conjunction with a building permit. Anyone who professionally handling biogas should generally have permit for it, some exceptions exists. The law should be followed regardless of whether permits are required.
Electrical cables: Always requires permit according to the LBE. The rights to mount cable over another's property, this is written as entered in the land registry. Alternatively civil agreement is established.

> EU REGULATIONS APB

EG nr 1069/2009 and 142/2011. Establishes rules for human and animal health related to the use of ABP. Biogas plants that make biogas from animal by-products must be approved by the Swedish Board of Agriculture. As a general rule, the biogas plant should have sanitation equipment. SBA grants any exceptions. If animal production are at the biogas plant shall it be a certain distance from those if other material than just from the own animals are used.

> SEVESO – LAW ON MEASURES THE PREVENTION AND LIMIT THE CONSEQUENCES OF SERIOUS CHEMICAL

SFS 1999:381. There is limits how much biogas may be stored at the biogas plant for the law to apply. The law is not actual if the plant stored less than 10 tons of biogas.

> THE WORK ENVIRONMENTAL ACT

SFS 1977:1160. Contains requirements on how the work should designed to be safe. AFS 2000:42, SÄIFS 1995:3.

> THE ACT ON PROTECTION AGAINST ACCIDENT (LSO)

SFS 2003:778. Is about how to conduct and documents a systematic fire prevention

> THE FRAMEWORK DIRECTIVE ON WASTE

2008/98/EG. Becomes applicable if waste is digested in the plant. In
most cases are not agricultural products and animal husbandry classified as waste. An operator who intends to treat the waste must have a permit for this and it is treated in the environmental permit for the biogas plant.

> ENVIRONMENTAL IMPACT ASSESSMENT (MKB)

Directive 2011/92/EU. Determines that plants with capacity for more than 100 tons of material per day requires a permit and environmental impact assessment. In Swedish law adopted 40.10 points on gas fuel and about 90150-160 licensable biological treatment of waste always lead to a significant environmental impact, which means that increased consultation and EIA is required (Section 3 Regulation 1998: 905 on Environmental Impact Assessment).

> IED – INDUSTRIAL EMISSION DIRECTIVE

The former IPPC Directive will be replaced by the new IED directive which means some changes in permit processes for facilities classified as IED plants. It is not directly applicable for those who produces gas, but above all for greater combustion and waste facilities. Includes so-called BAT conclusions on Best Available Technology, should not be confused with the Environmental code Best Available Technology

> EUROPEAN BIOGAS FAIRS

RWM NEC BIRMINGHAM
IN PARTNERSHIP WITH CIWM
RESOURCE EFFICIENCY AND WASTE MANAGEMENT SOLUTIONS

UK AD & BIOGAS

POLLUTEC

BIOGAS
INTERNATIONALE JAHRESTAGUNG
UND FACHMESSE

cereals
The Arable Event

IFAT
resources. innovations. solutions.

SPACE

Energy Decentral
Internationale Fachmesse für innovative Energieversorgung

SOMMET de l'ELEVAGE

BioEnergy Italy
Biomasse e Rinnovabili

AGRI TECHNICA
The World's No.1

SIMA
SIMAGENA SIMAVIP
MONDIAL DES FOURNISSEURS DE L'AGRICULTURE ET DE L'ÉLEVAGE
PARIS INTERNATIONAL AGRI-BUSINESS SHOW

ufi Approved Event
AGRA

nextgen
the future of energy

Biogaz Europe

FIERAGRICOLA
International Agricultural Technologies Show
SERVIZI PER L'AGRICOLTURA

EuroTier
The world´s top event for animal production

LE SALON DE TOUTE LA FILIÈRE BIOGAZ
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