IEE-Project
FABbiogas

BIOGAS PRODUCTION AND BIOGAS POTENTIALS FROM RESIDUES OF THE EUROPEAN FOOD AND BEVERAGE INDUSTRY

results-oriented publishable report

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BIOGAS PRODUCTION IN THE FOOD & BEVERAGE INDUSTRY

Do you eat fresh and healthy food every day? Do you heat your household in cold months and use electrical energy on a daily basis?

Do you waste some of your food? Maybe you waste around 16% of your consummations which equals 123 kg food wastes per capita annually[1]. Do you use around 3600 kWh[2] of electrical energy in your household in one year? Would you like to use renewable energy in your household?

Then your consummations are similar to this of an average European citizen and you might like the idea, that **your food wastes can be used to provide electrical energy**.

The **project FABbiogas** brings Europe a bit further to reach such goals.

The FABbiogas project aspires to change the mindsets of all stakeholders in the waste-to-energy chain by promoting residues from (FAB) food and beverage industry as a new and renewable source for biogas production.

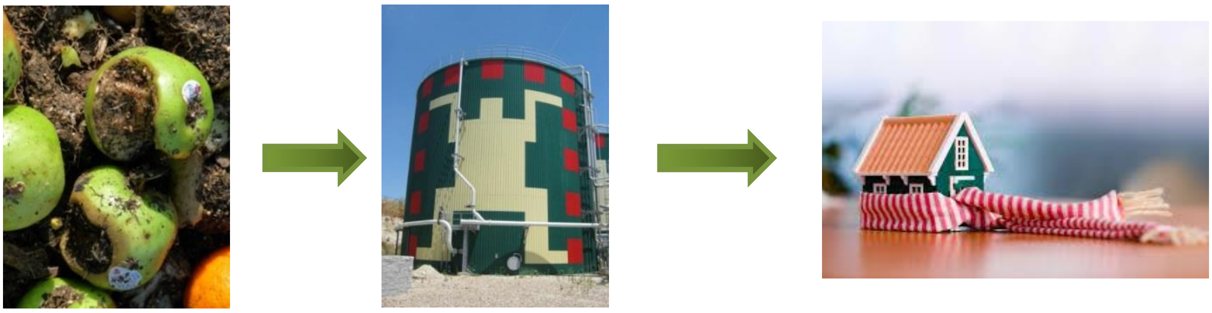

Figure 1: scope of FABbiogas project: from waste to biogas

The ongoing debate related to Europe 2020 strategy about the availability of sustainable bio-energy resources and the food-or-fuel discussion have revealed the urgency of using untapped waste streams. Anaerobic digestion of industrial waste provides a promising alternative to standard waste treatment. In this context the motivation behind the project is to further expand supplies and trigger increases in the demand for biogas/bio-methane (CHP units, transport, grid injection) from the organic fraction of FaB industry wastes. The surplus of bio-energy generation together with a reduction of greenhouse gas (GHG) emissions perfectly meets the European 2020 targets.

Project outputs will support the diversification of energy sources within FAB companies, leading to wide-spread valorisation and efficient integration of FAB residues into energy systems and boosting the realisation of a growing number of biogas projects all over Europe.

1 https://ec.europa.eu/jrc/en/news/average-eu-consumer-wastes-16-food-most-which-could-be-avoided
2 https://www.wec-indicators.enerdata.eu/household-electricity-use.html

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1 Introduction

1.1 Information on food and beverage market in Europe

The food sector is one of Europe's most important manufacturing sectors and its proper functioning plays a key role in the health and prosperity of the people of Europe.

99% of all enterprises are small and medium sized (SMEs). Nevertheless the food sector in Europe (and globally) seems to be dominated by a few large multinational companies competing in the world markets with a wide variety of products (European Commission 2009).

In 2009, the European food and beverage (FAB) industry was the second largest manufacturing sector in the EU-27 with a market share of 12.2% in value added terms. In 2014, this sector generated a turnover of € 1 trillion (6% of the EU Gross Domestic Product) and employed 4 million workers. In 2009, Germany, France, Italy, Spain and the UK accounted for 70% of the turnover for EU-27, whereas the twelve new Member States accounted for only 8.7%. Today, the EU is still the largest food exporter (19% share in world exports) and the second largest importer despite the continuous challenge of increasing food export of developing countries such as Brazil and China and established trade partners as USA, Australia and New Zealand (European Commission 2009; European Commission 2014).

Cultural differences and the different food habits in Europe provide an opportunity for innovation and the development of new products. This leads to export of high value products and the increased competition between the companies of the food processing sector. Low growth in production is a major threat to the food industry. To increase its competitiveness in the world markets the industry has to address problems such as the complexity of EU law and the administrative burdens that this imposes, access to finance, low investment in research and development and access to raw materials. EU imports are mainly commodities (European Commission 2009; European Commission 2014).

1.2 Necessity for biogas production from residues of the food and beverage market in Europe

The amount of residues generated in the manufacturing sector (FAB industry) is 5% of total food production (EUROSTAT 2006). There are three flagship initiatives of Europe 2020 to which the food sector can significantly contribute. For resource-efficient Europe incentives for healthier and more sustainable production and consumption of food is necessary. This also includes halving the amount of edible food waste disposed of in the EU by 2020 (Secretary-General of the European Commission 2013).

According to preliminary analysis, the FAB branches with the highest potential in terms of branch specific energy demand, amount of arising waste streams and costs for alternative waste treatment comprise, are among others, 1) meat and poultry processing industry and 2) brewing industry. Practical examples from these branches show the great economic and ecological saving potential when biogas technology is implemented for the treatment of waste streams.

Today, taking part in the European Emission Trading System is compulsory for FAB companies with combustion installations of a capacity greater than 25 MW. The mobilisation and extensive use of organic FAB waste as a renewable source for bio-energy production has high potential and can help secure a safe energy supply in European countries. A number of previous and ongoing projects on both, national and European level have been evaluating constraints for the realisation of biogas projects. The technological fundamentals of AD would already allow extensive use of industrial organic waste for bioenergy generation but non-technological barriers still have to be overcome. FABbiogas will focus on bridging these gaps in order to facilitate practical implementation of the existing know-how.

1.3 Scope and Ambition of the FABbiogas project

Anaerobic digestion of industrial waste provides a promising alternative to standard waste treatment. The motivation behind the project was to further expand supplies and trigger increases in the demand for biogas/biomethane (CHP units, transport, grid injection) from the organic fraction of Food and Beverage (FAB) industry wastes.

Project outputs supports the diversification of energy sources within FAB companies, leading to wide-spread valorisation and efficient integration of FAB residues into energy systems and boosting the realisation of a growing number of biogas projects in Austria, Czech Republic, France, Germany, Italy and Poland.

Figure 2: project partners in the FABbiogas project

To reach these goals, the FABbiogas project provided:

- Organisation of **awareness raising** events for biogas production from FAB waste
  - ♦ addressing all relevant target groups of FAB waste suppliers, users and policy stakeholders in order to increase the visibility of **existing best practice** and **future potentials**
- Establishment of a solid **information base** on FAB waste utilisation for biogas production **proving energy efficiency** of industrial biogas integration
  - ♦ Information compendium for a future standard on efficient use of FAB waste: handbook, videos, IT-tool
  - ♦ Set of tools and guidelines needed for a European reference standard on industrial FAB waste usage for bio-energy generation
- Establishment of **national contact points in FAB associations** in all partner countries to implement extensive biogas expertise in FAB associations
  - ♦ Establishment of decentralised knowledge hubs for industry requests about integrating the renewable bio-energy resource FAB waste
- **Identification of potentials** for FAB waste in existing biogas plants
  - ♦ conduct preliminary feasibility studies to prepare the ground for future biogas projects using FAB waste
  - ♦ Maps depicting existing waste biogas plants and FAB waste streams
  - ♦ Collection of best practice examples
  - ♦ recommendations on how to overcome barriers leading to an expected impact of comprehensive waste stream mobilisation from FAB branches
- Compilation of a **complete set of tools and guidelines** for dissemination of project results to industry stakeholders and policy makers, facilitating **cooperation between FAB industry, biogas sector and lawmakers all over Europe**

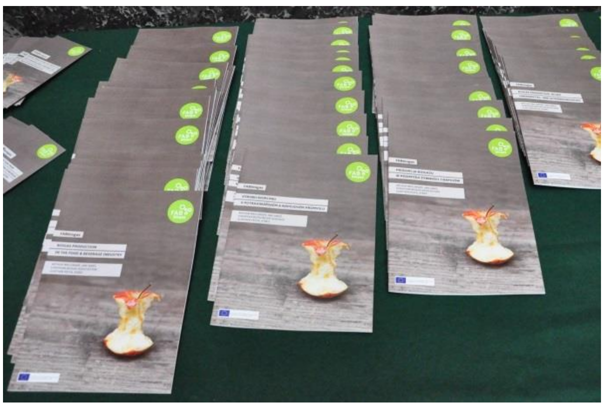


Figure 3: awareness raising and dissemination of the FABbiogas idea: using waste streams from food and beverage industry to produce biogas and thus provide heat and energy for production processes and households

2 Introduction to Anaerobic Digestion from organic FAB residues

The European Food and Beverage (FAB) industry offers a wide range of organic, microbial degradable feedstock for producing biogas by means of anaerobic digestion (AD). Basically spoken, any organic material - solid, pastry or liquid - is able to be converted into biogas by microorganisms. The technologies and techniques for anaerobic digestion are state of the art and several installations are operated all over Europe (Pesta and Niederschweiberer 2015).

Within the EC there is a large heterogeneity regarding utilisation of biogas which is mainly derived from energy crops, agricultural waste, manure and animal slurry. Austria and Germany are the most advanced, with roughly 4 500 plants treating organic wastes. Also Italy, Poland and the Czech Republic are progressing fast. In Czech Republic the electricity output from biogas utilisation rose by 65% from 2008 to 2010 reaching a primary energy output from biogas of 441.3 GWel in 2010. On the other hand in most of the other Central European countries the situation is still premature although the biogas potential is very high, especially in the waste sector. The on-going debate about the availability of renewable energy sources and a possible competition of energy crop cultivation with food production can be overcome by usage of the still untapped potentials of waste streams for the production of electricity, heat and fuel (Pesta and Niederschweiberer 2015).

The project consortium of FABbiogas collected and validated national data on biogas plants which are already installed and being operated, data on feedstock available for AD purposes and data on production sites of FAB industry (see chapter 3 Collecting of data on page 11). By sorting and validating the bulk of information most feasible branches for implementing AD installations can be found and focused on in preparing the preliminary feasibilities (see chapter 0 Biogas is the main end product and is a mixture of methane (CH_4, 50-85 vol.-%), carbon dioxide (CO_2, 15-50 vol.-%) and trace gases, e. g. water (H_2O), hydrogen-sulfide (H_2S) or hydrogen (H_2). The calorific value (c. v.) of biogas depends on its CH_4 content and varies between 4-7.5 kWh/m^{3}N. The average c. v. of 6.0 kWh/m^{3}N is equivalent to 0.62 l fuel oil (65 vol.-% CH_4) (Pesta and Niederschweiberer 2015). The produced biogas can be used in combined heat and power plants (CHP) to generate heat or energy. It is applied not only to cover the plant's own energy requirements but it can also provide several households due to its injection into the municipal energy grids (Bischofsberger 2004). Other end products of anaerobic digestion are solid and liquid residues which can be used as organic fertiliser (Khalid et al. 2011).

Most Promising Branches in the Food and Beverage Industry on page 8) (Pesta and Niederschweiberer 2015)..

2.1 Aerobic versus anaerobic treatment

Biological wastewater treatment in industrial and municipal waste water treatment plants is usually an aerobic process. The carbon mass balance of aerobic wastewater treatment with an anaerobic stabilisation of sewage sludge shows that organic carbon is lost by producing worthless CO_2 and by producing biomass and sewage sludge respectively. After stabilising the sludge surplus by AD or drying, the sludge residual needs to be treated adequately – causing additional costs. The organic carbon freight of wastewater is rather a valuable energy source than a worthless wastewater component. Due to this fact it is obvious to obtain a benefit by cleaning the wastewater and thereafter providing an energy source. Instead of spending additional energy to reduce carbon freight by aeration it is reasonable to produce biogas, a renewable energy source. The main advantage of the anaerobic process is a positive energy balance – biogas generation combined with the lower energy supply for the plant. Table 1 summarises advantages and disadvantages of both processes (Pesta and Niederschweiberer 2015).

Table 1: comparison of aerobic and anaerobic processing (wastewater treatment)

Aerobic plants	Anaerobic plants
low organic loading	high organic loading
cold waste water	optimized operation > 33 °C
tolerates low concentration of toxic substances	no toxic substances
requires neutralisation of alcaline/sour wastewater	modest neutralisation
continous operation (except SBR)	tolerates moderate interruption
integrated nitrogen and phosphorus elimination	neglibile nitrogen and phosphorus elimination
high rates of surplus sludge	low surplus sludge
high expenses for maintenance	low expenses for maintenance
high energy consumption (current)	energetical use of biogas
low specific cost for investment	high specific cost for investment
high operating cost (sludge disposal)	low operating cost

Organic residues as secondary feedstock in resource utilisation should be preferred to energetic utilisation – but bring along some problems, due to the composition of the residues:

- Many types of residues either already contain large numbers of microorganisms or will alter quickly by means of microbial activity. Strong odours and hygienically unacceptable conditions are the result.
- The water content increases transport costs.
- The water content is also supporting microbial activities, due to perfect living conditions.
- High content of fat leads to release of foul-smelling fatty acids, due to oxidation processes.
- Enzymes are still active, like in fruits or vegetables, accelerating or intensifying the reactions involved in spoilage.

Degradation or spoilage of feedstock is not a problem for AD plants. The focus lies on the energetic content and does not demand the same high standard in quality and characteristics as necessary for producing animal feed. Figure 4 shows a scheme of sensible resource utilisation of organic residues (Pesta and Niederschweiberer 2015).

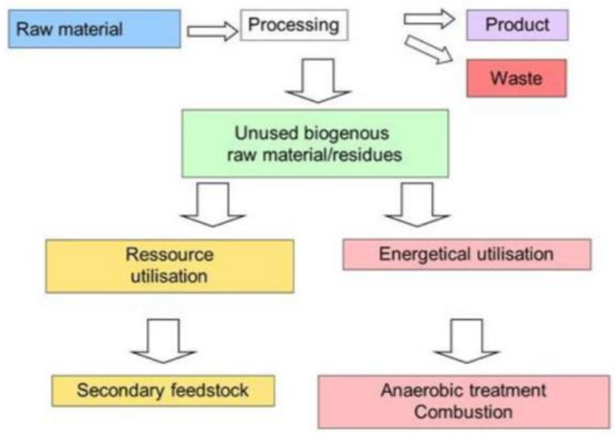


Figure 4: resource utilisation of organic residues

An AD plant is never a standalone facility. Primary feedstock processing and by-product treatment are linked closely. For a successful operation of a biogas plant with co-substrates several important facts have to be considered. Figure 5 summarises some influences on implementing an AD plant. Details have to be checked in each single application (Pesta and Niederschweiberer 2015).

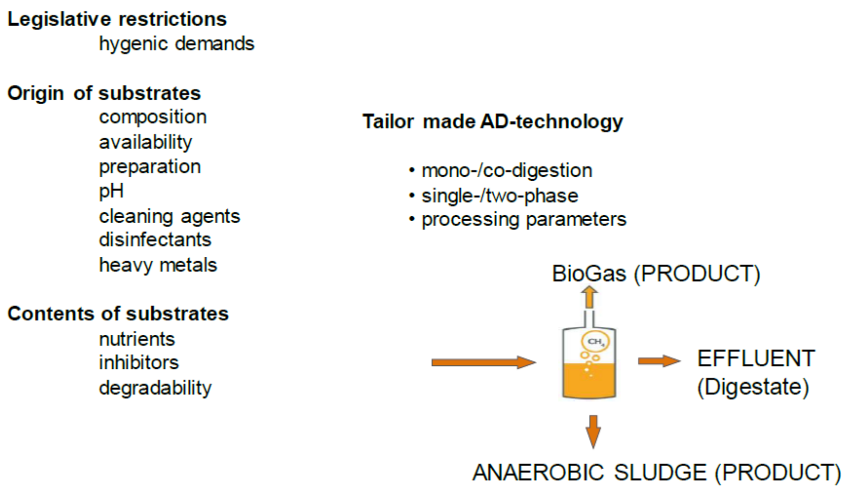


Figure 5: influences on implementing an AD plant

Legislative restrictions First of all it is necessary to become acquaintanced with legislative restrictions, technical rules and guidelines concerning the implementation of substrates in biogas plants as well as handling the effluent and digestate.

Origin of substrates High variety of sources determines the variety of compositions of substrates, physical and chemical. Even byproducts emerging of the same processing step in food and beverage production show deviations from each other, depending on the site, the feedstock, season of the year etc.

Composition of substrates Besides variation of composition the energy content of a substrate is in the focus. The energy content of a substrate is estimated by the content of organic dry matter

ODM. The organic dry matter consists out of fractions that are easily degradable (sugar), hard degradable (fat), or even not degradable (lignin). Substrate composition influences the microbial degradability and consequently the biogas and methane yield.

Laboratory analyses have to be carried out, and often digestion tests as well to ensure the appropriate substrate for AD is used and does not influence the process negatively, e. g. by an exceeding heavy metal content or detergents and disinfectants residues. A wrong addition of inhibiting substrate to the digester often leads to a rapid process break-down, followed by a longsome restart phase.

2.2 How does anaerobic digestion work?

Anaerobic digestion (AD) is a common biological process, naturally occurring in swamps, rumen and landfills (Braun 1982; Bischofsberger 2004). Anaerobic microbial conversion of organic matter into a renewable energy source, biogas, is a well-established process and state of the art. Digesting pasty or solid by-products from the food and beverage industry nowadays mainly takes place in centralised co-digestion facilities (Pesta and Niederschweiberer 2015).

In the absence of oxygen microorganisms metabolise organic compounds using several different biochemical pathways (Bischofsberger 2004). In landfills the gases methane and carbon dioxide reach the atmosphere unused and thus pollute the environment. One main reason for anaerobic digestion being environmentally useful concerns the production of methane in a closed reactor and its burning under controlled conditions (Khalid et al. 2011).

The degradation process can be divided in four interdependent main metabolic pathways - hydrolysis, acidogenesis, acetogenesis and methanogenesis - and in several further reactions (Braun 1982) (see Figure 6).

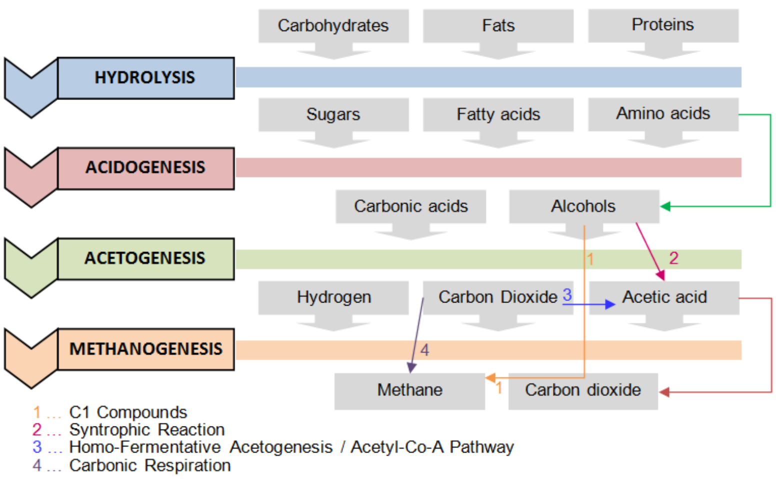


Figure 6: The degradation of organic compounds to produce biogas

Types and quality of substrates define types of design and equipment of AD facilities as well as operational parameters. AD systems differ widely for liquid substrates respectively waste water from AD systems for pasty or solid substrates. Figure 7 shows exemplary a simplified flow scheme of an

AD plant for brewery waste water, combining an anaerobic pre-treatment with an aerobic post-treatment (Pesta and Niederschweiberer 2015).

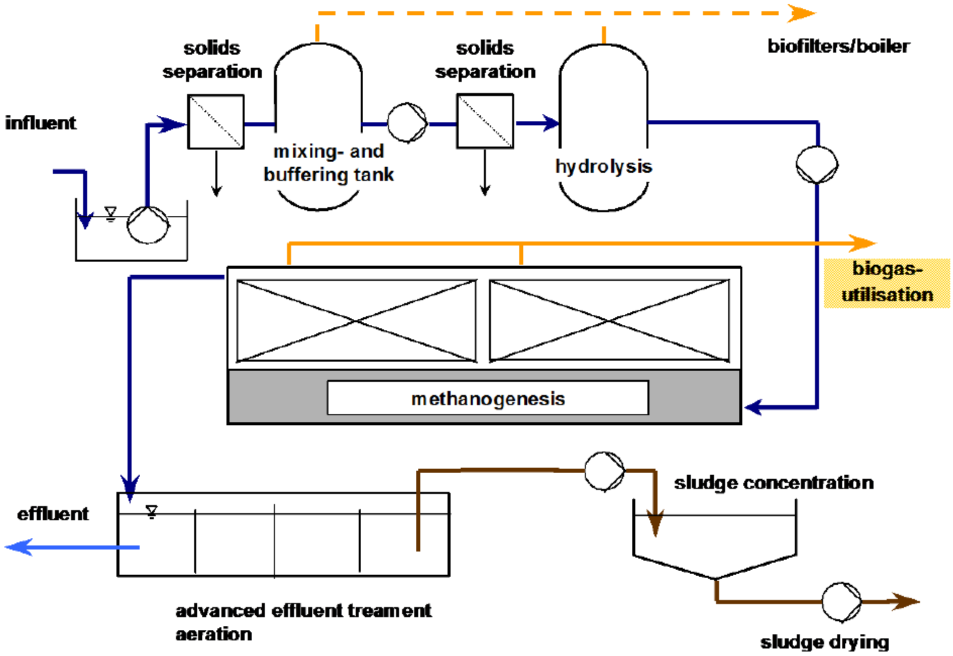


Figure 7: scheme of a two-phase AD plant, e.g. in a brewery

Biogas is the main end product and is a mixture of methane (CH_4, 50-85 vol.-%), carbon dioxide (CO_2, 15-50 vol.-%) and trace gases, e. g. water (H_2O), hydrogen-sulfide (H_2S) or hydrogen (H_2). The calorific value (c. v.) of biogas depends on its CH_4 content and varies between 4-7.5 kWh/m^{3}N. The average c. v. of 6.0 kWh/m^{3}N is equivalent to 0.62 l fuel oil (65 vol.-% CH_4) (Pesta and Niederschweiberer 2015). The produced biogas can be used in combined heat and power plants (CHP) to generate heat or energy. It is applied not only to cover the plant's own energy requirements but it can also provide several households due to its injection into the municipal energy grids (Bischofsberger 2004). Other end products of anaerobic digestion are solid and liquid residues which can be used as organic fertiliser (Khalid et al. 2011).

2.3 Most Promising Branches in the Food and Beverage Industry

The project partner ATRES (authors Gunther Pesta and Konrad Niederschweiberer) prepared a report depicting the potential of AD in the consortium's countries, not only by amount but also by branches, preferably. Besides statistics, facts and figures this report gives further information on defining potential sites for AD installations.

The report is published online on the FABbiogas website and can be downloaded here: http://www.fabbiogas.eu/fileadmin/user_upload/D6.2_atres_FABbiogas_project_report_Most_promising_branches_final_2015-11-16.pdf

Impressions on the report for most promising branches in the food and beverage industry are given in Figure 8. The report gives examples on anaerobic digestion of brewery waste water and anaerobic digestion of dairy effluents. The wastes types are characterised, possible digestion systems are described, the integration of thermal and electric energy is discussed. There is a case study on an anaerobic digestion plant for dairy wastes and a troubleshooting on specific problems of operating an anaerobic waste water treatment plant in breweries (Pesta and Niederschweiberer 2015).

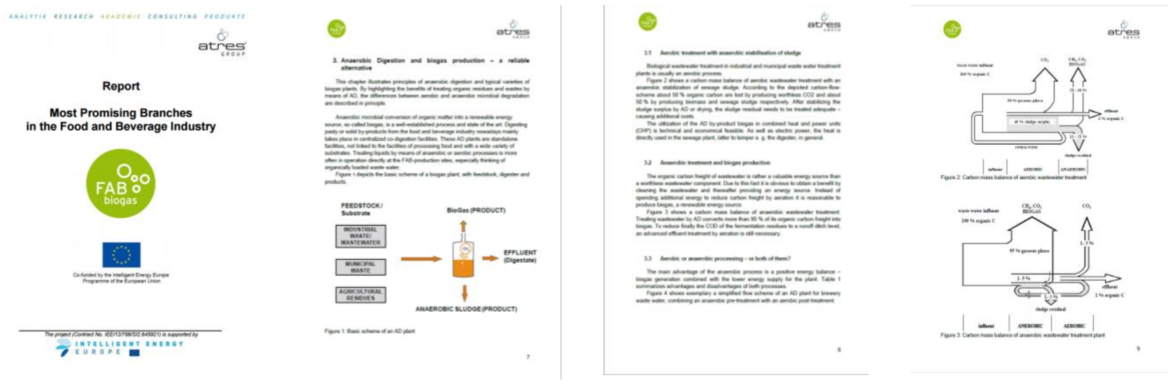


Figure 8: impression on the report for most promising branches in the food and beverage industry

The primary aim of AD in industrial applications is treatment of residues for supplying a renewable source of energy by producing biogas. Furthermore the motivation focuses on reducing treatment or disposal costs for by-products and waste water.

So, basically spoken: the most promising branches for implementing AD facilities are those matching the following parameters – as many of them as possible, at least:

- high amount of substrate available,
- high content of organic fractions,
- high microbial degradability,
- substrate available during the whole year, preferably constant,
- demand of thermal and/or electric energy in the production processes, preferably constant,
- fulfilling legislative restrictions.

These basic parameters for the decision making process are certainly linked with the substrate – in quality and quantity – but also with the thermal and electric energy demand in the production processes (Pesta and Niederschweiberer 2015).

Most promising branches for implementing AD plants are the (non-)alcoholic beverage industry, potato processing, dairies, slaughterhouses, breweries or bakeries. But not only branches or types of substrates have an influence on defining and validating the potential of an AD installation. The implementation of an AD plant into an industrial production site depends on various aspects. AD installations have to be understood as tailor made solutions for single sites. Not a simple AD system has to be installed but moreover a unique solution and concept – well designed, thoroughly engineered and reliable imbedded. Great effort needs to be taken into thoroughly conducted feasibility studies, based on validated facts and figures. Figure 9 shows a scheme of the planning phases for the implementation of a biogas plant (Pesta and Niederschweiberer 2015).

Phase and Step		***Purpose and Issues to Consider***
Feasibility Phase	Prefeasibility	Biomass quantities, calorific values, capacity, siting, energy use based on literatures values
	Decision	Decide whether to investigate further or to abort the project
	Pre-engineering	Biomass quantities, caloric values, capacity, siting, energy use in detail, based on laboratory and/or real values
Project Preparation Phase	Site-engineering	Layout of components, piping diagrammes, control system design, wiring diagramm etc.
	Preparation of Tender Documents	Detailed financial engineering, specifications, prequalification of components and tendering of documents
Project Implementation Phase	Political Decision	Decision on financial package and procedures in detail and final go-ahead
	Construction and Supervision	Construction and supervision of plant
	Commissioning and Startup	Testing of all performance specification, settlements, commissioning, training of staff and startup
	Operation and Maintance	Continuous operation and maintance of plant. Continuous procurement of spare parts and supplies

Figure 9: scheme of planning phases for the implementation of a biogas plant (Pesta and Niederschweiberer 2015).

3 Collecting of data on organic wastes and biogas in Europe

3.1 Biogas potentials in partner countries

FABbiogas project depicts an overview of the biogas market in the six partner countries: Austria, Czech Republic, France, Germany, Italy, and Poland. The following data were collected in all partner countries:

- comparison of the potential of renewable energy sources from waste from the food and beverage industry (FAB)
- identification of existing production sites of biogas from organic waste
- identification of the untapped potentials of organic waste in various industries of food and beverages
- specification of non-technological barriers that hinder development
- comparison of the use of renewable energy potential in each partner country

In March 2007, the Heads of States and Governments of the 27-EU Member States adopted a binding target of 20% renewable energy from final energy consumption by 2020. Combined with the commitment to increase energy efficiency by 20% until 2020, Europe's political leaders paved the way for a more sustainable energy future for the European Union and for future generations. Factors such as the different starting points, renewable energy potential and economic performance of each country are taken into account in the targets. The share of renewable energy in total energy production in 2010 and required targets for 2020 for six partner countries are shown in Figure 10.

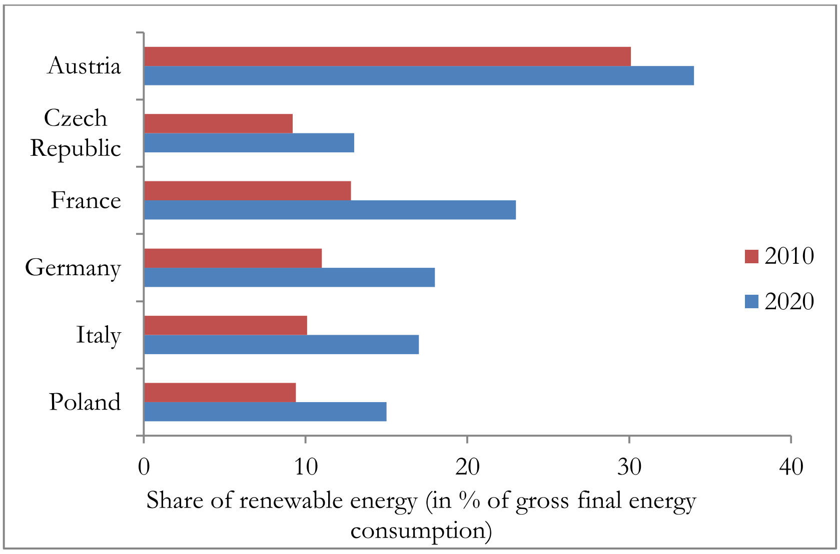


Figure 10: Share of renewable energy in total energy consumption in the partner countries

The European Landfill Directive sets mandatory targets for a three step reduction in biodegradable waste going to landfill. Set against a 1995 baseline, it requires a reduction of 25% by 2010, 50% by 2013 and 65% by 2020. It is necessary to reduce the amount of all types of waste going to landfill. Therefore, it is desirable for the European Union Members to investigate novel solutions based on the use of waste and sub-products from the food industry for renewable energy production.

Biogas is considered to be one of the key technologies both to reach EU member states targets for renewable energies in 2020 and to meet their requirements within the European organic waste management directive.

3.2 Current biogas market in partner countries

The number of biogas plants (see Figure 12) and the locations of these biogas plants (see Figure 11) in the partner countries are depicted in the following figures. Detailed information on localisation, type and amount of substrate and heat and electricity output are provided online on the fab biogas website; see link here http://www.fabbiogas.eu/en/project-results/mapping-biogas-plants-using-fab-industry-waste/.

Figure 11: locations of existing biogas plants in partner countries

France which is the largest of the six project partner countries has only 80 biogas plants on its territory. Over 70% (corresponding to 58 biogas plants) use FAB industry waste as a substrate. In 2011, the French government has published a number of new initiatives that ensure solid backing for biogas in France, including increased support for production of biogas on the basis of waste from cities, industry and agriculture and the use of biogas for electricity production, heating and distribution via the natural gas grid.

Currently there are 39 biogas plants in **Poland**. According to the Council of Ministers 2 500 biogas plants with a total capacity of 980 MWel are expected to be built until 2020. But the main reasons for discouraging of potential investors and the reason for the small number of new biogas plants are a collapse in prices of green certificates, a large reduction in wholesale electricity prices, no yellow certificates from the beginning of 2013, and the lack of the RES (Renewable Energy Source) Act. Operating starts of already constructed objects are even withheld due to above-mentioned reasons. In the first half of 2013, agricultural biogas plants processed 750 000 tons of substrates, 369 000 tons of which were waste from the food. Poland is going into a positive direction, reducing substrates like energy crops.

There are approximately 300 biogas plants in **Austria**. Since 2002, 80% of biogas plants have been operating on the basis of co-fermentation of energy crops and manure. Unfortunately, the increase in the prices of energy crops in 2007 caused a significant increase in the cost of maintenance of biogas plants, as well as numerous changes of the Eco-power law have led to a decline of the feed-in tariffs. Higher prices of energy crops, low feed-in tariffs and the insufficient usage of waste heat have led to the struggle of numerous biogas plants for their economic existence. In order to compensate rising costs of raw materials in Austria, subsidies to substrates were granted in 2008, and the amendment to the green electricity act in 2012 was expected to ensure the improvement of framework conditions. In addition, for existing biogas plants an additional maintenance surcharge, a technology bonus (injection of biomethane into natural gas grid) and combined heat and power (CHP) bonus was established.

In **Czech Republic**, the main trend in the production of renewable energy is withdrawing biogas from municipal landfills, and the use of an anaerobic purification step in wastewater treatment plants. In the Czech Republic biogas plants are mainly using agricultural residues and energy crops. Currently, there are more than 20 biogas plants, which use biodegradable municipal waste and organic industrial waste as substrates.

Germany is the market leader in biogas technology and is also Europe's biggest biogas producer. More than half of the complete European biogas energy production is of German origin. Thanks to generous subsidies, eco-friendly alternatives have become economically attractive for German power companies and local authorities. However, the German market has slumped dramatically since early 2012 forcing the German biogas industry to internationalise its business strategies. Reasons are the amended Renewable Energy Act in which compensation rates for biogas were reduced significantly with an added tightening of legal conditions. German plants now have to use at least 60% of their waste heat.

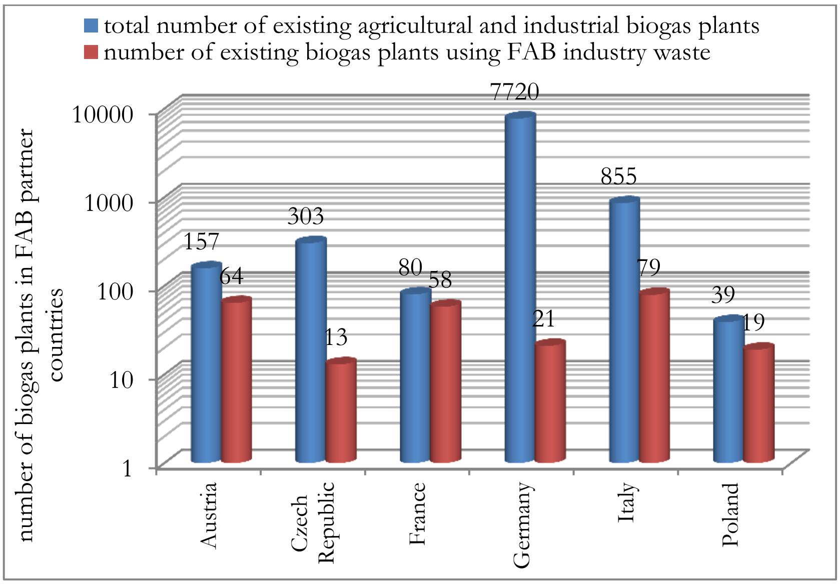


Figure 12: Number of existing biogas plants in partner countries

Due to their favourable subsidisation schemes, the already established biogas markets in Italy, the United Kingdom, the Czech Republic and the Netherlands will continue to be among the most important markets in the next five years.

Data collected from partner countries clearly show that the driving force behind the development of the biogas market to provide bioenergy is the Renewable Energy Directive (RED) which requires Member States to generate 20% of energy from renewable sources by 2020 and for 10% of transport fuels to be made up of renewable resources.

To strengthen the biogas market in Europe, FABbiogas project partners recommend further harmonisation of laws and increased pressure on energetically using residues and wastes from food and beverage industry. The five food and beverage associations/project partners represent the interests of the national FAB industry and try to improve the legal framework conditions for biogas production within the partner countries. Moreover EBA represents the interests of the European Biogas branch. The project results will be used as informative tool in contacts with the officials from the European Commission.

3.3 Waste streams in partner countries

There are no data publicly available from Germany and France. Special permissions would be necessary to get such data because there is high competition among companies in the same branch. The dominant waste streams from partner countries and the methane potentials are listed in Table 2.

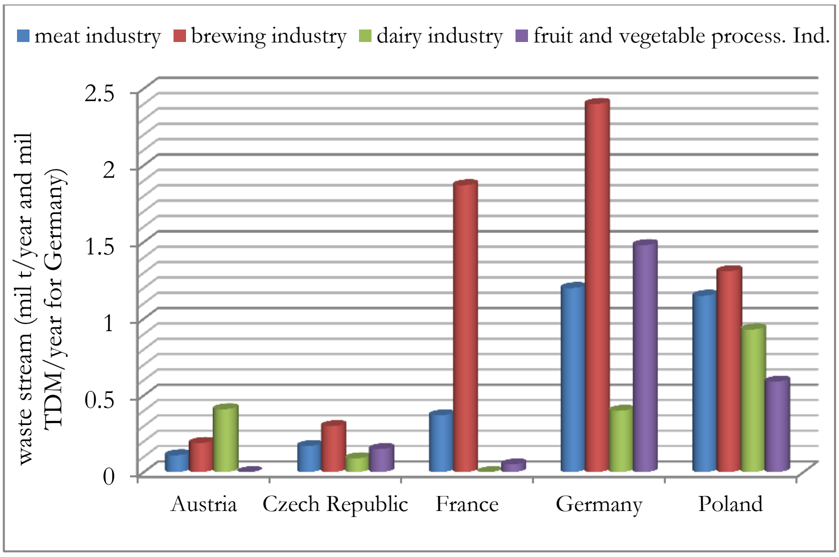


Figure 13: Comparison of the amount of waste streams from four most significant industries in partner countries

Since 2012, **France** requires companies to recycle their organic waste if they produce more than an announced threshold. This threshold was decreased from 120 tons per year since 2012 to 10 tons per year in 2016.

In 2012, **Poland** began to implement a system of segregation of waste in households. From the point of view of Polish economy, properly conducted biodegradable fraction management is necessary to meet EU requirements. As a result of compliance with the guidelines of the EU countries, landfills have to be systematically closed as they do not fulfil requirements. In addition, on 1st of January 2013 prohibition of storage of untreated waste started to be obligatory.

Also the in **Czech Republic**, the requirements of Directive 1999/31/EC enforces a gradual reduction of the amount of biodegradable waste disposal in landfills which is fixed in the Waste Management Plan of the Czech Republic. The most important potential sources of substrate for biogas production are agricultural waste and livestock manure in particular. However, up to now only 13 biogas plants use waste from FAB industry as substrate.

Table 2: Dominant waste streams in the partner countries and their methane potential

Country	Dominant waste streams	Total number of companies in Fab industry branches	Total production of waste [t/year]	Methane production potential [mil. m³/year]
Austria	Dairy Industry Sugar Industry Brewing Industry Slaughterhouses	108	1 031 968	74
Czech Republic	Waste materials from sugar industry Brewing Industry Meat industry Fruit and vegetable industry	2188	1 120 000	80
France	Beverage industry Meat industry Fruit and vegetable industry Petfood production Beet-pulp, molasses, other waste of sugar manufacture	13127	11 300 000	680
Germany	Meat and fish industry Fruit and vegetable industry Breweries and malt production Coffee and tea processing	1767	13 500 000 (t DM/year)	120
Italy	Slaughter house wastes Residues from olive pressings Residues of production of grape wine and spirits Residues from sugar production			
Poland	Fruit and vegetable processing Dairy industry Meat processing industry Brewing industry	563	4 023 000	185

Data on the dominant waste streams of the partner countries were collected and their localisations are now provided in maps (see Figure 14). Detailed information from partner countries on localisation, type of industry, amount of waste and biogas potential are provided on the FAB biogas website; see link here http://www.fabbiogas.eu/en/project-results/mapping-waste-streams-from-fab-industry/.

Figure 14: localisation of waste streams in the partner countries

In **Austria**, most companies of FAB industry are Breweries (40), dairies (30) and slaughterhouses (20). However, the largest waste stream (240 000 t /year) and also the greatest potential for biogas production comes from sugar mills (28 666 413 m^3/year).

The 20 identified slaughterhouses represent the largest ones in Austria. The estimated amount of animal by-products (blood, rumen content, gut content, fat scrubber) which can be used for biogas production is about 118 000 t/year with a methane production potential of 8 643 000 m^3/year (calculated with 73 m^3/t). One best practice example (slaughterhouse Großfurtner in Upper Austria) shows that up to 33% of the own electricity demand and up to 75% of the own heat demand of slaughterhouses can be covered using the animal by-products for biogas production. 41 breweries were identified with each a minimum beer production of 10 000 hl/year and with a total of more than 9 000 000 hl/year. This represents almost the whole beer production in Austria. The energy potential of an average brewing company (100 000 hLl beer sold/year) derived from brewery waste (brewers' spent grains and yeast, etc.) amounts to 1.79 GWh. This can account for 70% of a brewery's power requirement and 35% of its heat requirement (50 % if only heat is covered).

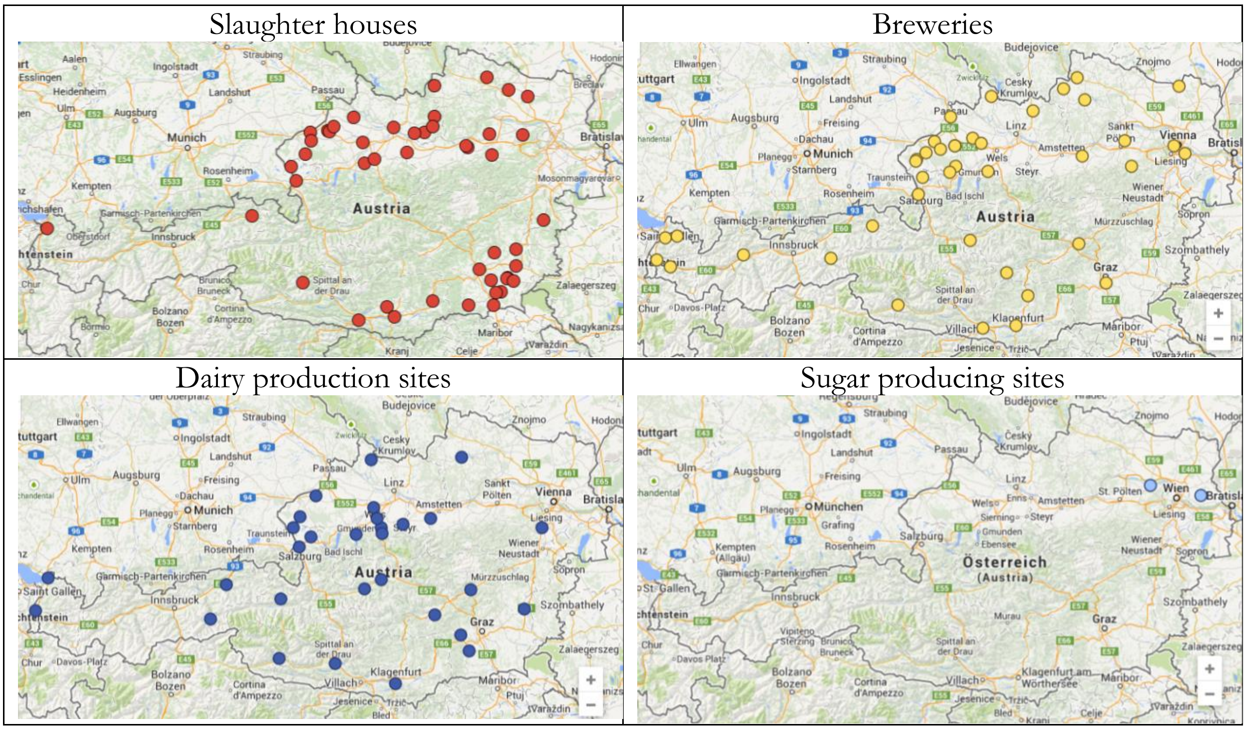


Figure 15: localisation of slaughterhouses, breweries, dairy and sugar producing sites in Austria

The 30 dairies located are processing approximately 2 780 000 t milk per year. This corresponds to the whole milk processed in Austria. The company "Berglandmilch" is the biggest dairy company with 10 dairies and a market share of 37% (1.010.000 t/year). The amount and kind of cheese production could be investigated at six dairies and so the amount of arising whey was estimated. All in all approximately 420 000 tons of whey are produced at the 6 locations with an estimated methane potential of 6 670 000 m^3/year. There is a biogas plant located at a dairy in the city of Wels (dairy from the company Berglandmilch) which produces approximately 4 500 000 kWh heat (40% of the whole heat demand) and 4 000 000 kWh electricity per year. There are two sugar refineries in Austria from the company "AGRANA Zucker GmbH" with a production capacity of 400 000 tons of sugar per year. Together the two plants are processing 2 493 000 tons of sugar beets with arising residues (beet pulp, beet leafs and beet tails) of approximately 240 000 tons per year (Bärnthaler et al. 2008).

In summary, the two most popular methods of waste (residue) management in the partner countries are: feed production and the use of waste as fertiliser. Uncommonly, waste is used for biogas production or used thermally. Least often waste is collected by recycling company or composted.

All survey participants from FAB industry stated that the permitting procedures represent a barrier for biogas market development. Thereby, the main reason for inefficient permitting procedures seems to be lack of knowledge and competence of people responsible for administrative procedures. Along with this, changes in the legislation and unstable governmental policies towards the biogas energy signals instable market and consequently higher risk for investments. Even in the countries which had favourable policy frameworks like Germany or Austria, the governmental support has decreased during the past 18 months. This had an impact on the market development.

3.4 Best practice examples

From all the data collected on waste streams and biogas plants in the partner countries, some biogas plants which can be considered best practice were chosen. The biogas plant operators were interviewed and their experience was documented on the basis of an especially designed questionnaire. According to the gained information and under agreement of biogas plant operators, fact sheets summarising the most important information were prepared. The fact sheets can be found as attachment to this report (see chapter 10 Attachment - Fact sheets of best practice examples, page 53).

If you have any further questions about the presented biogas plants, please contact our national advisory contact points (see chapter 8 Contacts and Consortium, page 51).

4 Awareness-Raising

4.1 FABbiogas events

The ultimate ambition of the FABbiogas project is the **awareness-raising of possibilities to use FAB waste streams as substrate for biogas production**. The FABbiogas project aspires to change the mindsets of all stakeholders in the waste-to-energy chain by promoting residues from (FAB) food and beverage industry as a new and renewable source for biogas production.

To reach as many stakeholders along the waste-to-energy production chain and as many new possible participants of this chain as possible, many awareness-raising events were organised. The aim was to showcase the high potential energy source of FAB waste and non-technological barriers in the application of industrial waste as a renewable energy source. By bringing together the stakeholders of the waste-to-energy production chain, FAB industry waste should be mobilised for biogas production and investments in new biogas plants will be possible. Interested participants of those awareness-raising events were connected with the national contact points and advisory services were performed (see chapter 5.2 Advisory Services, page 27). The actual impact of these awareness-raising events and following advisory services will be noticeable after a profound advisory and planning phase of about five years, when investments can be performed.

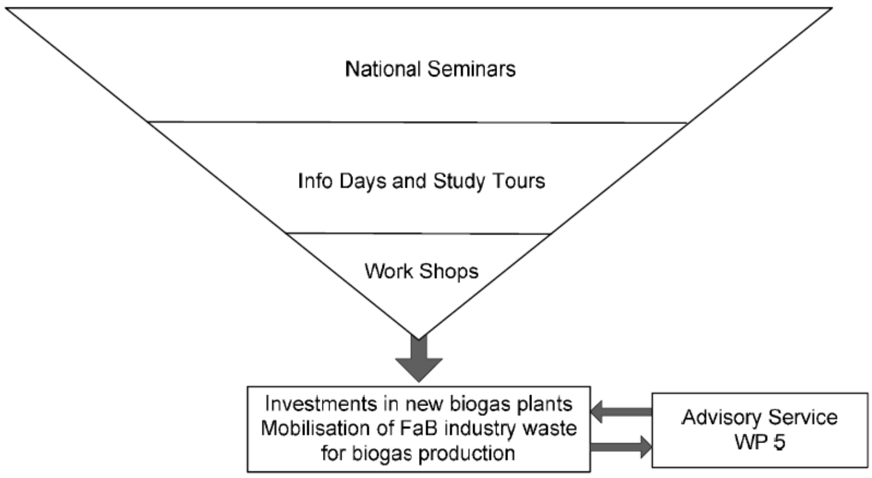


Figure 16: structure and outcome of awareness raising events

Three types of events were organised in every participating partner country (see Figure 16):

- national seminars
  - ♦ open event for a wide range of target groups interested in the topic of biogas from waste
  - ♦ all topics along the waste-to-energy production chain were covered
- info days including study tours to best practice examples of biogas plants
  - ♦ targeted to participants who are interested in getting more detailed information

- presentations on more practical topics like handling of FAB wastes, biogas yields of FAB wastes, technical and non-technical challenges to be expected, information on financing and funding programmes
- visit of one or two biogas plants, ideally implemented in a FAB company

- two workshops
  - targeted to managers from FAB companies, biogas plant operators, waste management companies and investors
  - bring together groups of producers and users of FAB wastes
  - provide and collect further information on the amounts of available wastes from FAB companies and information on free capacities on biogas plants
  - results of data collections on waste streams and existing biogas plants in the partner countries were presented using the prepared maps

In some cases, it was difficult to reach the suitable amount of participants for the events but all in all many stakeholders could be reached. The number of participants at FABbiogas awareness-raising events is depicted in Figure 17. For some events it was decided to not have English-speaking experts carrying out presentations, because of the lack of language skills and cultural resistance of companies to attend events executed in English. For other partners, notably the German-speaking and Polish countries, this was not perceived as a problem, and experts from other countries could contribute their expertise.

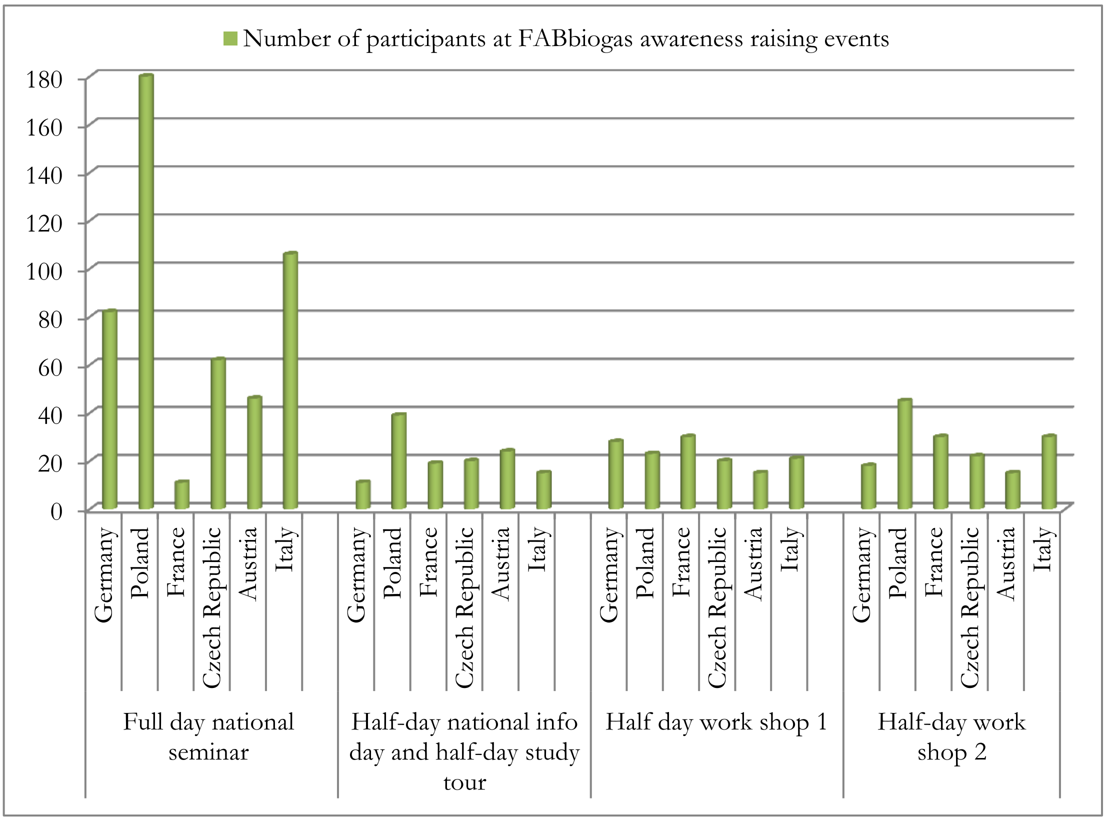


Figure 17: number of participants at FABbiogas awareness-raising events in partner countries

The composition of participants of the FABbiogas awareness-raising events was very divers; a list can be found below:

- Waste biogas plant operators
- Biogas plant operators
- Biogas plant manufacturer
- Waste management companies
- Managers of FAB companies
- Managers in meat industry
- Managers of slaughterhouses
- Global player of dairy industry
- Food federations
- Sectoral federations and competitiveness clusters
- Investors
- Policy makers
- Media
- Garman Dairy Press (Deutsche Molkerei Zeitung)

The following topics emerged to be highly at FABbiogas awareness-raising events.

- Potential problems in terms of current legislation (practical insights)
- Financing biogas utilisation in food industry
- Utilisation of FAB waste in biogas plants and the associated risks
- The real possibility of utilisation of animal waste in the Czech Republic
    - ♦ The current situation in solution of cereals with fungal contamination in food and feed production
    - ♦ the real possibility of utilisation of cereals with fungal contamination in biogas plants
- discussions on financial situation and funding
- Excursion to two sites: the structure of food companies in (Lower) Austria hinders the installation of own plants. Cooperation was discussed.
- Experts from waste community of (Lower) Austria discussed further activities for 2015/2016
- Discussion about waste reduction in food production process and/or upcycling strategies

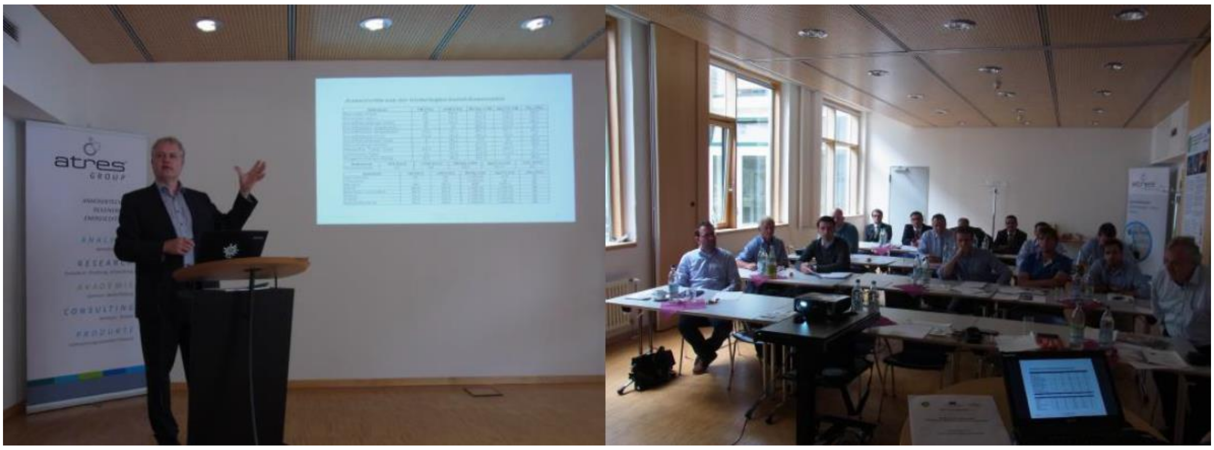
In the following, some pictures show the atmosphere at the FABbiogas awareness-raising events:

Project partner Miroslav Koberna presenting the FABbiogas project at the Czech National Seminar

Project partner Laura Marley presenting the FABbiogas project at the French Info Day

Site visit of a best practice biogas plant in the rain at the Polish Study Tour

Project partner Anna Pazera explaining the current situation in Poland and in the partner countries at the Polish workshop



Project partner Gunther Pesta welcoming the participants to the German workshop

Project partner Wolfgang Gabauer speaking about slaughterhouse waste at the Austrian Workshop

Brainstorming session led by project partner Martina Zederbauer at the Austrian Workshop

4.2 Final FABbiogas conference

To present the outcomes and results of the FABbiogas project to a broad public, the project partners got together in Brussels for a final conference organised by the European Biogas Association EBA. The final conference took place at the FLEMISH ACADEMY OF SCIENCES AND ARTS on the 2nd of September 2015 in Brussels, Belgium and was titled "*Biogas production and biogas potentials from residues of the European food and beverage industry*".

The final conference gathered over 70 participants coming from 15 countries, including Brazil. Topic of the event attracted policy officers, scientists and other stakeholders representing biogas, waste, environmental industries and public authorities. FABbiogas was fully covered by Biogas Channel that interviewed the speakers as the topic was of a crucial interest for the biogas industry. A media corner was set up to present numerous publications from FABbiogas, from the European Biogas Association and other partners on the project.

Pau Rey-Garcia of EASME, introduced the Intelligent Energy Europe (IEE) programme. This programme comes to an end by 2016 with the last projects funded as the new programme Horizon 2020 is replacing it. The programme ran since 2007 to 2014 with a budget of €730 million and funded 250+ projects. Bioenergy covered 83 projects thereof 22 projects on biogas and biomethane topics.

Emilio Font de Mora of European Union's Innovations and Networks Executive Agency (INEA), presented the Horizon 2020 programme with focus on bioenergy related projects. He explained that the Trans European Transport Network Executive Agency (TEN-T EA) was the previous executive agency that is now a part of H2020. With € 33 billion, INEA has the highest budget of all Executive Agencies.

Bernd Kuepker, policy officer at DG Energy, gave a presentation on key EU policies issues covering bioenergy. Biofuels (food and feed crop-based) will have a significant contribution to the current climate targets specified by Fuel Quality Directive and Renewable Energy Directive. He highlighted that biofuels can't come from land with high carbon stock and high biodiversity (primary forests etc.) and stressed the need for comprehensive sustainability criteria.

Günther Bochmann (BOKU University) project coordinator of FABbiogas gave an overview on the achievements of the project. He stressed the high energy potential of food and beverage industry waste.

The project partners explained the current situations in their country and their project results.

Arthur Wellinger introduced AD technologies available for various waste streams.

Gunther Pesta presented the consulting tools for the industry and feasibility studies. He showed the FABbiogas calculator that was developed during the project and will be available on the FABbiogas website (www.fabbiogas.eu). Gunther Pesta introduced also the major steps on planning to make a biogas project happen. He explained the planning phase and a timeline for the further project development.

Best practice examples were showcased by

- Thomas Meier of BioEnergy International AG (BDI): He put a special focus on a plant digesting chicken manure and chicken slaughterhouse waste.
- Erik Draber of Veolia Environnement SA: He explained several pathways and types of dairy products and waste streams, such as ice-cream, cheese and yoghurt and milk processing.
- Christian Ebner of the Austrian waste water treatment plant Zirl: He mentioned that most of the digesters on waste water treatment plants (WWTP) have free capacities for additional, external substrates. Codigestion with sewage sludge on a WWTP has the advantage that there are already experienced and qualified personnel on the spot (including analysis opportunities) and the additional investment costs are rather low.
- Thomas Maier presented another project of BDI in the Goess brewery, the largest one in Austria.

Pau Rey-Garcia as the first speaker opens the final conference in front of the audience.

Lunch break at the FLEMISH ACADEMY OF SCIENCES AND ARTS

Figure 18: impressions from the final FABbiogas conference in Brussels

5 Consulting and advisory services

5.1 FABbiogas consulting tool

One of the project results is the FABbiogas calculator in order to evaluate the economic and technical feasibility of a new biogas installation using waste materials from the FAB industry. It is an easy-to-use and fast online consulting tool allowing users to calculate the expected biogas yield from waste water and residues of the food and beverage industry. The software tool developed in this task was tailor-made to the needs of the FAB industry. Find link here: http://www.fabbiogas-calculator.eu/de/

What do I need to use the FABbiogas calculator?

- You need the volume flow of your waste water
- You need the mass flow of your waste residues

In a prepared input screen you can choose the type of waste water and waste residues in your plant. Adjustment of parameters is easily possible. Just by clicking “calculate” the FABbiogas calculator gives you the expected biogas yields of your individual substrate.

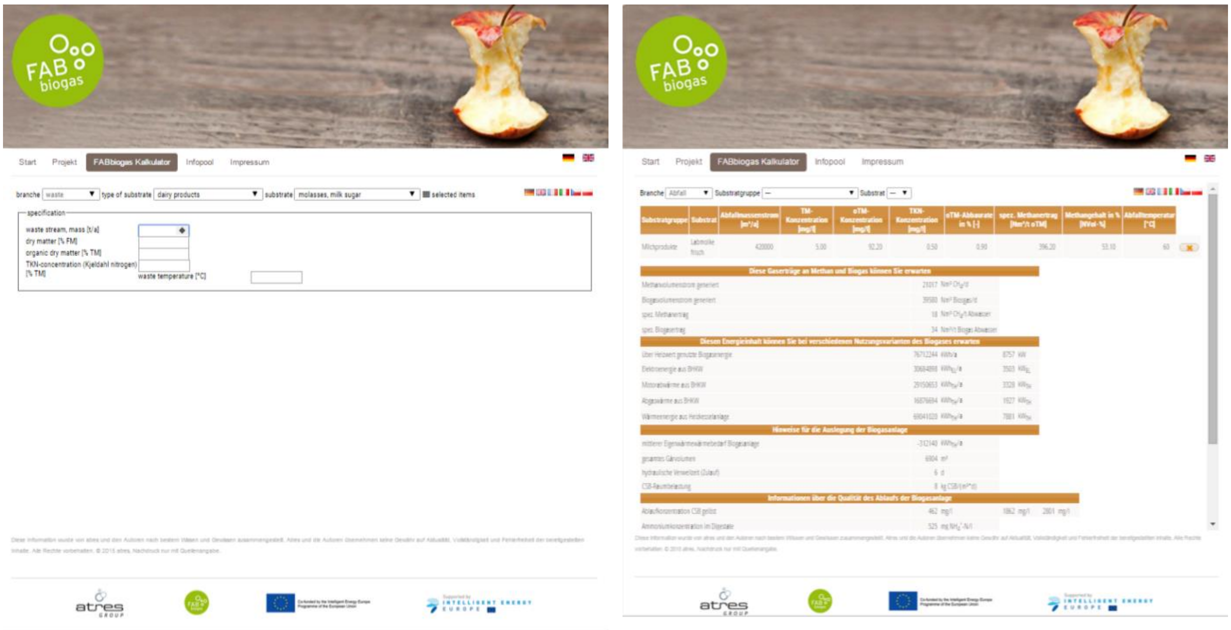


Figure 19: impressions of the FABbiogas calculator

5.2 Advisory Services

The national project partners ANIA, Cluster, FEDERALIME, PK CR, ECOPLUS and TUL developed a tailor-made Advisory Service and are able to provide a competent national contact point for companies/investors interested in biogas production from FAB industry waste.

One employee from each national FAB association (ANIA, Cluster, FEDERALIME, PK CR and ECOPLUS) compulsory attended an external biogas training course. In the partner countries there were already existing biogas trainings offered by EBA members (national biogas associations) or other regional consulting organisations. This training course lasted approx. three days and trained the participants to biogas experts who can prepare basic preliminary feasibility studies. An example for a confirmation of participation on biogas training course is shown in Figure 20.

Through the external training of one biogas expert in each FAB association, the availability of a substitute person and the connection between the advisory contact points, the know-how on this topic is sustainably implemented. The Contact Points ensure Advisory Service and supporting beyond project duration for the target groups.

IBBK

ATTENDANCE CERTIFICATE

The present certificate is conferred to

Silke STEINER

for his/her active participation in the

International Biogas Operating and Engineering Course
Stuttgart - Germany, September 16- 20, 2013

This event was organized by the IBBK Fachgruppe Biogas GmbH (International Biogas and Bioenergy Centre of Competence) in cooperation with State Institute of Agricultural Engineering and Bioenergy of the University of Hohenheim – Stuttgart. The course had 40 hours. Main topics were:

- Report on the current situation and prospects of frame conditions for biogas technology in Germany and Europe
- Decision criteria for a biogas plant
- Introduction into design, planning and process engineering
- Welcome to the seminar
- Introduction into plant technology
- Introduction into calculation and feasibility studies
- Substrat-Input, Gas yield according to the substrates - Choosing the right Substrate
- Fundamentals of biological process control
- Measurement and data record for process optimisation
- Process monitoring and trouble shooting
- In Situ Process Control
- Process and external heat and gas engineering
- Biogas specific building materials
- Planning and designing of stirring and mixing technology for digesters, mixing pits and storage
- Safety features of biogas plants and equipement
- Ecological manure management
- Cogeneration to heat and power – Gas utilisation
- Results of current research projects and their relevance for the planning of biogas stations
- Visit at the laboratories of the University
- 1/2-day field trip with practical excercises to day-to-day maintenance at an agricultural biogas plant

Stuttgart, September 20, 2013

Dipl. Agr.-Biol. Michael Köttner
IBBK Fachgruppe Biogas GmbH, CEO

Prof. Dr. Thomas Jungbluth
University of Hohenheim, Head of the State Institute

Figure 20: Typical certificate issued by training organisation

During the last years, legislative restrictions concerning waste treatment and environmental protection were aggravated. Among others companies of the food industry were forced to think their waste-management over, including wastewater management. It became not only unpopular to produce organically high loaded wastewater but also very expensive.

The primary aim of AD in industrial applications depicts a single substrate treatment for supplying a renewable energy source by producing biogas. Furthermore the motivation focuses on reducing treatment or disposal costs for by-products and waste water.

All in all 148 advisory services were performed. The number of conducted advisory services per country is depicted in Figure 21.

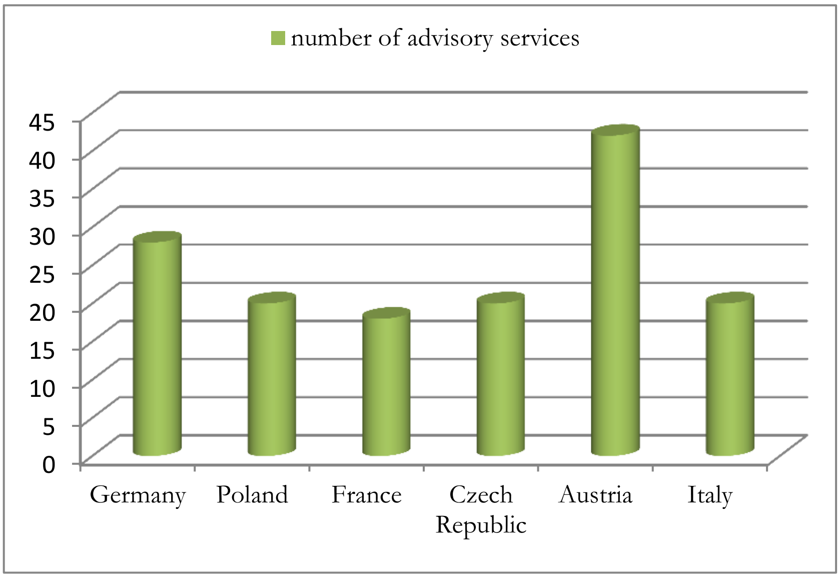


Figure 21: number of conducted advisory services by project partners

The offered Advisory Service provided basic calculations on potential assessment (biogas yield from arising waste streams), economic feasibility (profit from biogas production, estimations on investment and running costs) and technological feasibility (installed el. capacity, plant size). Topics discussed at such advisory services were:

- Free capacities of nearby waste treatment plants (and actualisation of maps)
- Possible substrate providers (and actualisation of maps)
- Financial information and funding
- Financing of modernisation and expansion of existing biogas plants
- Discussion of possible usage of food wastes
- Discussion of logistical problems such as storage of substrates, usage of digestate
- Discussion of branch-specific problems (anaerobic digestion of substrates, storage of substrates, usage of industrial waste water)
- Biogas potential of branch-specific substrates and discussion about co-substrates
- Lack of specialists
- Invitations to FABbiogas awareness-raising events

Table 3: number of advisory services performed in different industry branches, 148 in total

industry branch	Germany	Czech Republic	Poland	France	Italy	Austria
agrifood				1	2	3
animal feeding						1
bakery products	1	2				1
beverage industry		2				3
bioenergy industry			1			
biogas industry	4		4			
biomass processing industry			1			
biowaste processing industry			10		1	
brewing industry	2	1		2		1
chocolate production / confectionary trader		1		1		
coffee trader				1	1	
convenience						1
dairy products	6	5		2		2
egg production						1
energy agency			1			
energy provider				1	1	
exhibitor					1	
fish production		1				
food additives						2
food processing industry					1	2
food traders	1			4	2	
frozen food		1		2		
meat industry	1	4		2	3	4
media			1			
milling industry						2
mushroom production						1
not given				2	3	
oil seeds / oil waste						3
plant oil		1				
poppy seeds						1
potato products		1				1
research and consulting	8		2		3	
restaurant chain				1		
slaughterhouse waste						1
sugar industry				1	2	
technical service industry	4					
vinegar production						1
waste cooperation	1					9
wine production		1				2
sum	**28**	**20**	**20**	**20**	**20**	**42**

Table 3 lists the number of advisory services performed for different industry branches. These numbers are also depicted in Figure 22.

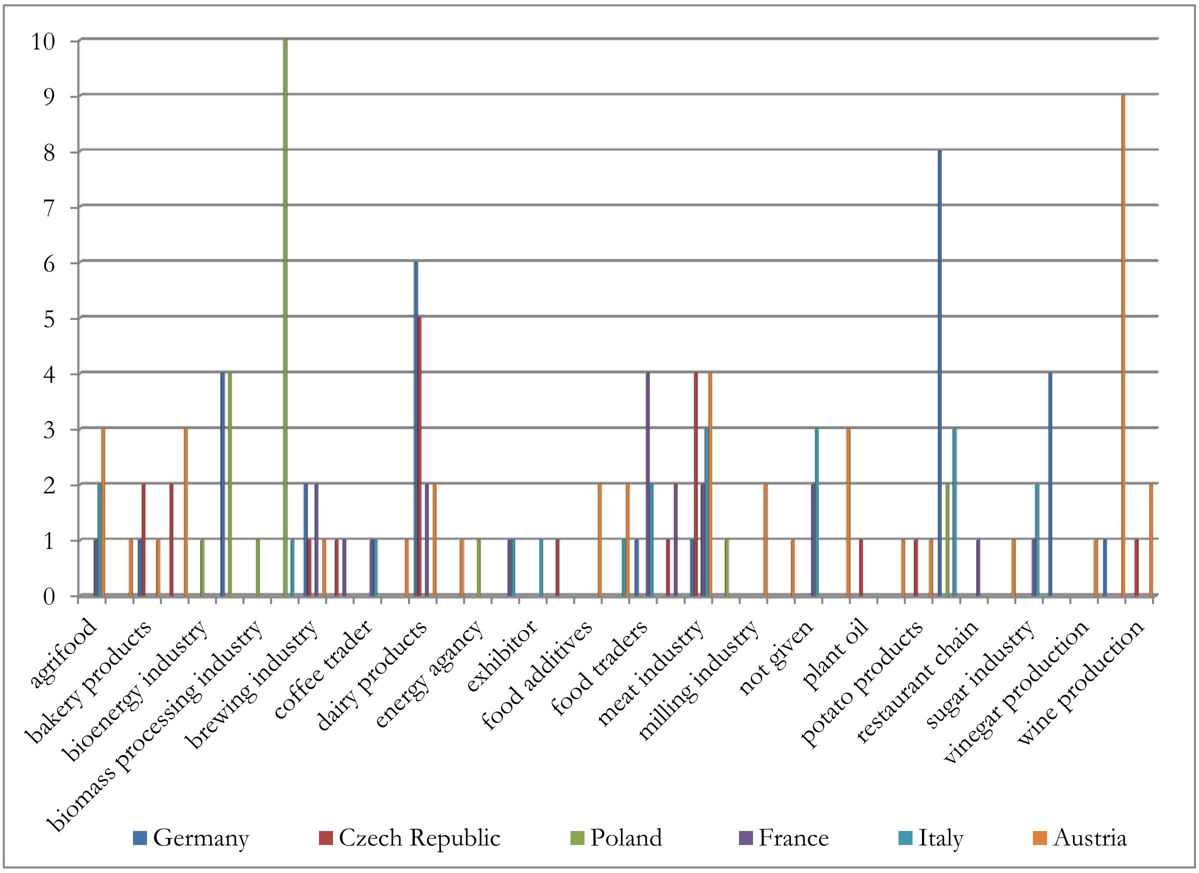


Figure 22: number of advisory services performed in different industry branches

5.3 Feasibility studies

Interested participants of the workshops were invited to undergo a tailor made Advisory Service and provide their data. Thus FABbiogas partner ATRES could identify potential sites for biogas production and prepared preliminary feasibility studies. Good results of the feasibility studies show the high potential of organic waste in specific FAB branches and will trigger investments at the investigated locations. All in all, 19 preliminary feasibility studies were prepared and their potential calorific energy production in [kWh/a] is shown in Figure 23. Within the preliminary feasibility studies (results shown in Figure 24) following aspects were evaluated:

ASSESSMENT OF POTENTIALS As first step of the studies data of the arising waste in the investigated FAB companies were collected. Most important parameters are the amount and quality to estimate the biogas potential of the arising waste/substrate.

TECHNOLOGICAL FEASIBILITY Based on the results of the potential assessment the most important technological parameters can be evaluated. These are parameters like electrical installed capacity, dimension and retention time of the digesters and kind of pre-treatment equipment like grinders or sterilisers.

ECONOMIC FEASIBILITY Based on the potential assessment, technological feasibility and the legal framework an economic preliminary feasibility study could be conducted.

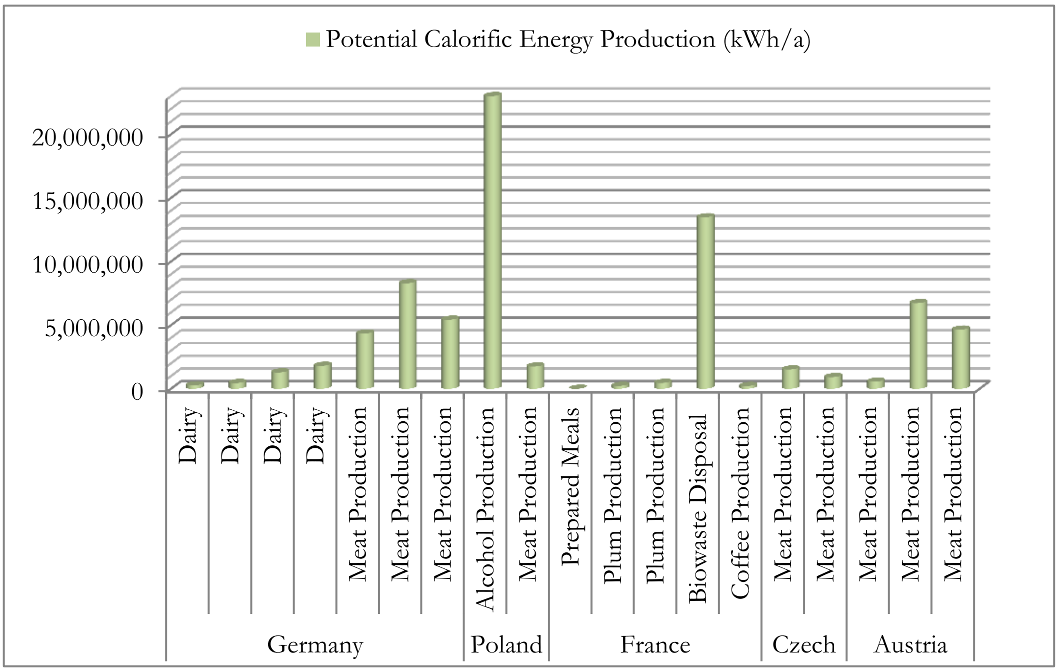


Figure 23: potential calorific energy production calculated in the feasibility studies

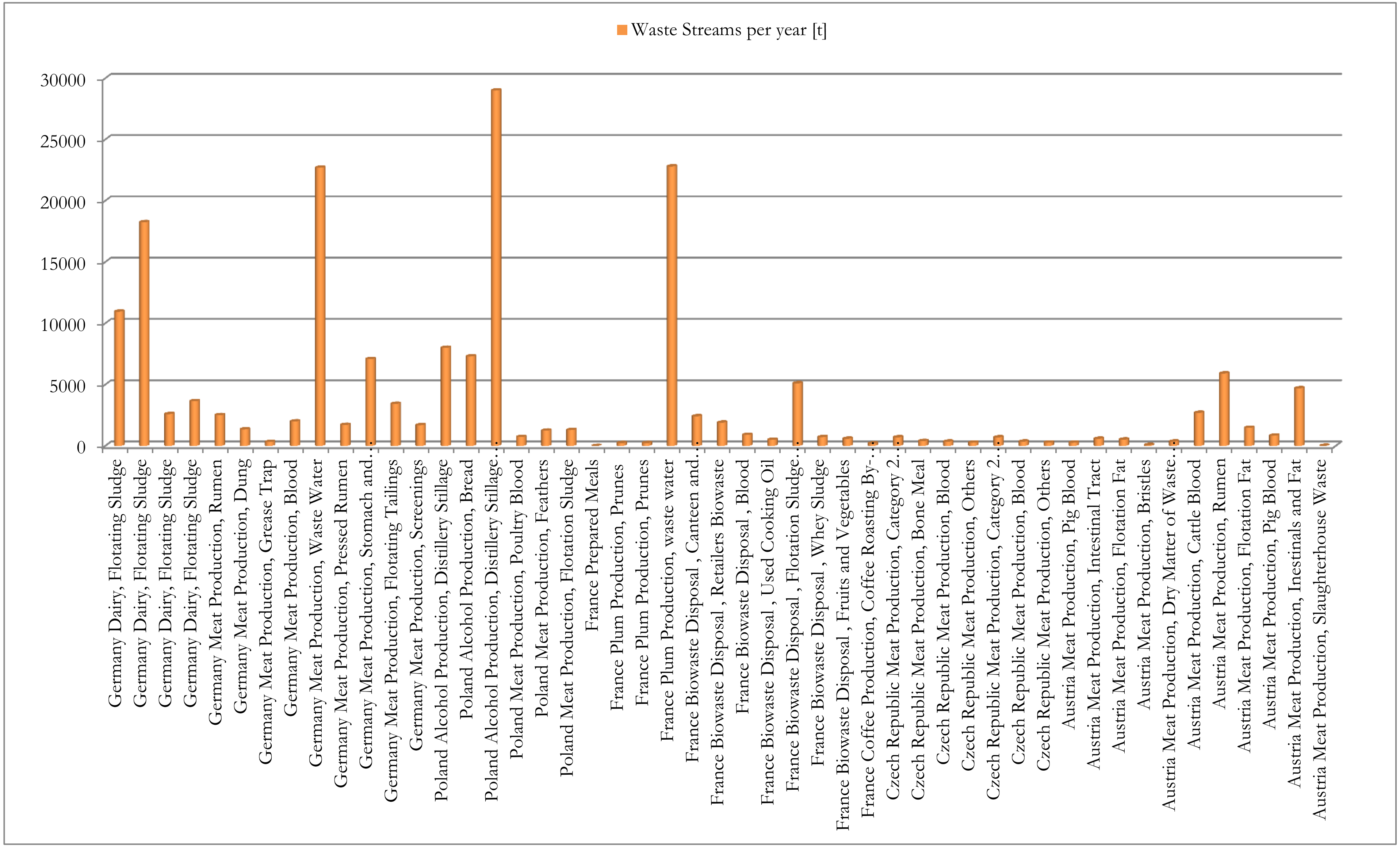


Figure 24: Waste streams of branches in different countries per year

Table 4: Collection of publishable results from preliminary feasibility studies

Country	Branch	Waste Streams per year	Potential Biogas Production (m^3/h) (dry gas)	Potential Calorific Energy Production (kWh/a)	Potential Electric Power CHP (kW)	Potential Higher Heating Value (kW)	Comments
Germany	Dairy	10.950 t Floating Sludge	5.40	272,493	12	34	Aerobic waste water treatment plant is being planned, the surplus sludge is intended to be digested anaerobically
	Dairy	18.250 t Floating Sludge	9.00	454,156	21	57	
	Dairy	2.600 t Floating Sludge	22.71	1,285,061	56	162	Flotating plant is being planned, the surplus sludge is intended to be digested anaerobically
	Dairy	3.650 t Floating Sludge	31.88	1,804,028	78	228	-
	Meat Production	2.510 t Rumen, 1.350 t Dung, 325 t Grease Trap, 2.000 t Blood, 22.700 t Waste Water	80.00	4,341,699	198	548	-
	Meat Production	1.714 t Pressed Rumen, 7.081 t Stomach and Intestinals of Pigs, 3.431 t Flotating Tailings, 1.692 t Screenings	153.00	8,290,749	379	1,047	Solid waste treated in a stirred reactor
	Meat Production	341.070 t Waste Water	108.00	5,429,869	248	686	Waste Water Treatment Plant
Poland	Alcohol Production	8.000 t Distillery Stillage, 7.300 t Bread, 29.000 t Distillery Stillage after Extension	482.00	23,203,935	1,060	2,930	Big extension of production is planned
	Meat Production	730 t Poultry Blood, 1.250 t Feathers, 1.300 t Flotation Sludge	31.00	1,750,229	74	221	High nitrogen freight
Czech	Meat Production	700 t Category 2 Material, 400 t Bone Meal, 354 t Blood, 270 t Others	25.27	1,518,395	63	173	Low process temperature (30 °C) due to critical high concentration of ammonia
	Meat Production	700 t Category 2 Material, 354 t Blood, 270 t Others	16.88	916,802	42	116	Mesophilic process

Country	Branch	Waste Streams per year	Potential Biogas Production (m³/h) (dry gas)	Potential Calorific Energy Production (kWh/a)	Potential Electric Power CHP (kW)	Potential Higher Heating Value (kW)	Comments
France	Prepared Meals	too less waste -> less than 500 kg	-	-	-	-	Dispose it at an existing biogas plant
	Plum Production	230 t Prunes	5.60	227,839	10	29	-
	Plum Production	230 t Prunes, 22.800 t waste water	9.25	461,264	21	58	Negative energy balance due to high energy demand for heating the waste water with a low COD
	Biowaste Disposal	2.420 t Canteen and Restaurant Residues, 1.900 Retailers Biowaste, 900 t Blood, 500 t Used Cooking Oil, 5.100 Flotation Sludge from Slaughterhouse, 720 t Whey Sludge, 590 t Fruits and Vegetables	247.86	13,473,455	615	1,701	Thermophilic process, high diversity in substrates, expansion planned to double the amount of substrates
	Coffee Production	200 t Coffee Roasting By-Products	4.11	214,707	10	27	High nitrogen freight
Austria	Meat Production	266 t Pig Blood, 585 t Intestinal Tract, 522 t Flotation Fat, 73 t Bristles, 360 t Dry Matter of Waste Water	10.40	556,936	26	72	-
	Meat Production	2.700 t Cattle Blood, 5.911 t Rumen, 1.478 t Flotation Fat, 840 t Pig Blood, 4.700 t Inestinals and Fat	116.00	6,731,749	284	850	Combination of two slaughterhouses
	Meat Production	12.515 t Slaughterhouse Waste	87.20	4,647,218	218	602	-

6 Dissemination

6.1 Website

http://www.fabbiogas.eu/en/home/

Most important for **raising awareness and promoting** a topic like the **production of biogas from wastes of food and beverage industry** is dissemination of gained results. All project results, except confidential information such as advisory services, can be found on the FABbiogas website. Find information on mapping of biogas plants using FAB industry waste, mapping waste streams from FAB industry, best practice examples and information on our events under the following links

- http://www.fabbiogas.eu/en/project-results/
- http://www.fabbiogas.eu/en/download/
- http://www.fabbiogas.eu/en/home/latest-news/

Figure 25: examples for information and reports on the FABbiogas project which is available online

6.2 FABbiogas folder

The FABbiogas website also provides its own download section; see link here http://www.fabbiogas.eu/en/download/. General information like the project folder (see Figure 26) but also specific information such as national reports and international reports assessing the biogas production from FAB industry waste in partner countries can be found online.

Figure 26: FABbiogas folder

6.3 FABbiogas handbook

Of course, it is also possible to download a pdf version of the FABbiogas handbook in English and national languages of the project partner countries. See link here: http://www.fabbiogas.eu/fileadmin/user_upload/Download/fabhandbook_web.pdf

Figure 28 gives impressions on the FABbiogas handbook. The handbook is for FAB industry managers, BP operators, waste management companies, policy makers. It is …

- ✓ **it is** a useful instrument for basic orientation
- ✓ **it is** a presentation tool for FABbiogas project's output
- ✓ **it is** a synoptic and brief publication

The table of contents of the handbook is shown in Figure 27 the most important contents are:

- General overview on biogas in the FAB sector in Europe - status quo, potential, main barriers x challenges) + FaB industry waste common potential
- Technological solutions for the treatment of waste and waste waters in the FAB industry including gas utilisation
- General description of most promising FAB industry branches for biogas production
- Current status and potential in biogas sector within participating countries
- Basic evaluation criteria for AD feasibility
- Best practice examples

Content

Figure 27: table of contents of the handbook

Figure 28: FABbiogas handbook "biogas production in the food & beverage industry” by Arthur Wellinger and Jan Jares (European Biogas Association) and Gunther Pesta (ATRES)

6.4 Media

FRENCH INTERVIEW on opportunities of the food and beverage industry: Hubert François, President-Director General of Salins du Midi group, talks about opportunities and challenges for French food companies considering anaerobic digestion as a means of biowaste treatment. (Spoken in French).

Find link here: http://www.dailymotion.com/video/x2i5jht

Figure 29: French interview on opportunities of the food and beverage industry

BIOGAS CHANNEL is the first and only web video channel dedicated to biogas in all its applications. Its mission is to promote correct and up-to-date knowledge on the subject of biogas, widening the debate and giving space and voice to the main players on the global market. The content is carefully selected based on the quality of the sources and the soundness of experiences. The international scope of the contributions and continual updating in line with the changes in legislation and the market are distinctive factors. The channel also strives to create an increasingly interactive and personal dialogue, with direct links to social networks and a chance for users to interact. It aims to become a true gateway to a community.

Link to the [Biogas Channel](http://www.biogaschannel.com/en/about-us/): http://www.biogaschannel.com/en/about-us/

Information and interviews on the FABbiogas topic by biogas channel:

- **THE GREENEST BREWERY IN AUSTRIA IS POWERED WHOLLY BY BIOGAS:**

Thomas Maier on the greenest brewery in Austria is in Göss and is wholly powered by biogas from production waste, such as sediment, starches and sewage. The biogas is partly conveyed to the boilers and partly to the 450kW cogenerator, which also produces the thermal energy that services the industrial process. The biggest challenge was in making sure that the fluctuation of the matrices does not negatively affect the system's operation: http://www.biogaschannel.com/en/video/industry-and-wwt/5/greenest-brewery-austria-powered-wholly-biogas/1048/?utm_source=estero&utm_campaign=b840118fb9-Newsletter_October_2015_10_29_2015&utm_medium=email&utm_term=0_a3a27f4f2c-b840118fb9-80942553

- **HOW TO CHOOSE THE RIGHT CONSULTING TOOL FOR YOUR SYSTEM:**

Gunther Pesta on Anaerobic digestion in itself is not a complex technology. The most challenging part is identifying the solutions that suit the peculiarities of each system. Different types of consulting tools are available on the market, from online tools to services by professionals. Pesta illustrates the parameters to be considered for an effective choice:

http://www.biogaschannel.com/en/video/anaerobic-digestion/8/how-choose-right-consulting-tool-your-system/1047/?utm_source=estero&utm_campaign=b840118fb9-Newsletter_October_2015_10_29_2015&utm_medium=email&utm_term=0_a3a27f4f2c-b840118fb9-80942553

- **A POTENTIAL 85 MILLION M3 OF METHANE PER YEAR FOR THE POLISH FOOD&BEVERAGE INDUSTRY:**

Anna Pazera on 85 million m^3; this is the bio methane production potential originating from industrial waste from the Polish food sector. Despite the slack period the biogas market is going through, there is no lack of will by the food and beverage industries to use their own production waste to generate power and heat. The number of biogas from industrial waste production plants in 2014 were 19 with growth envisaged over the coming years:

http://www.biogaschannel.com/en/video/landfill/6/potential-85-million-m3-methane-year-polish-foodbe/1039/?utm_source=estero&utm_campaign=b840118fb9-Newsletter_October_2015_10_29_2015&utm_medium=email&utm_term=0_a3a27f4f2c-b840118fb9-80942553

- **TECHNOLOGY FOR TREATING DAIRY INDUSTRY BY-PRODUCTS**

There are two technologies available on the market for treating dairy industry by-products: granular and non-granular. How they work and a practical example are shown by Erik Draber.

http://www.biogaschannel.com/en/video/industry-and-wwt/5/technology-treating-dairy-industry-products/1073/?utm_source=estero&utm_campaign=e884b2a257-Newsletter_Biogas_Channel_November_201511_26_2015&utm_medium=email&utm_term=0_a3a27f4f2c-e884b2a257-80942553

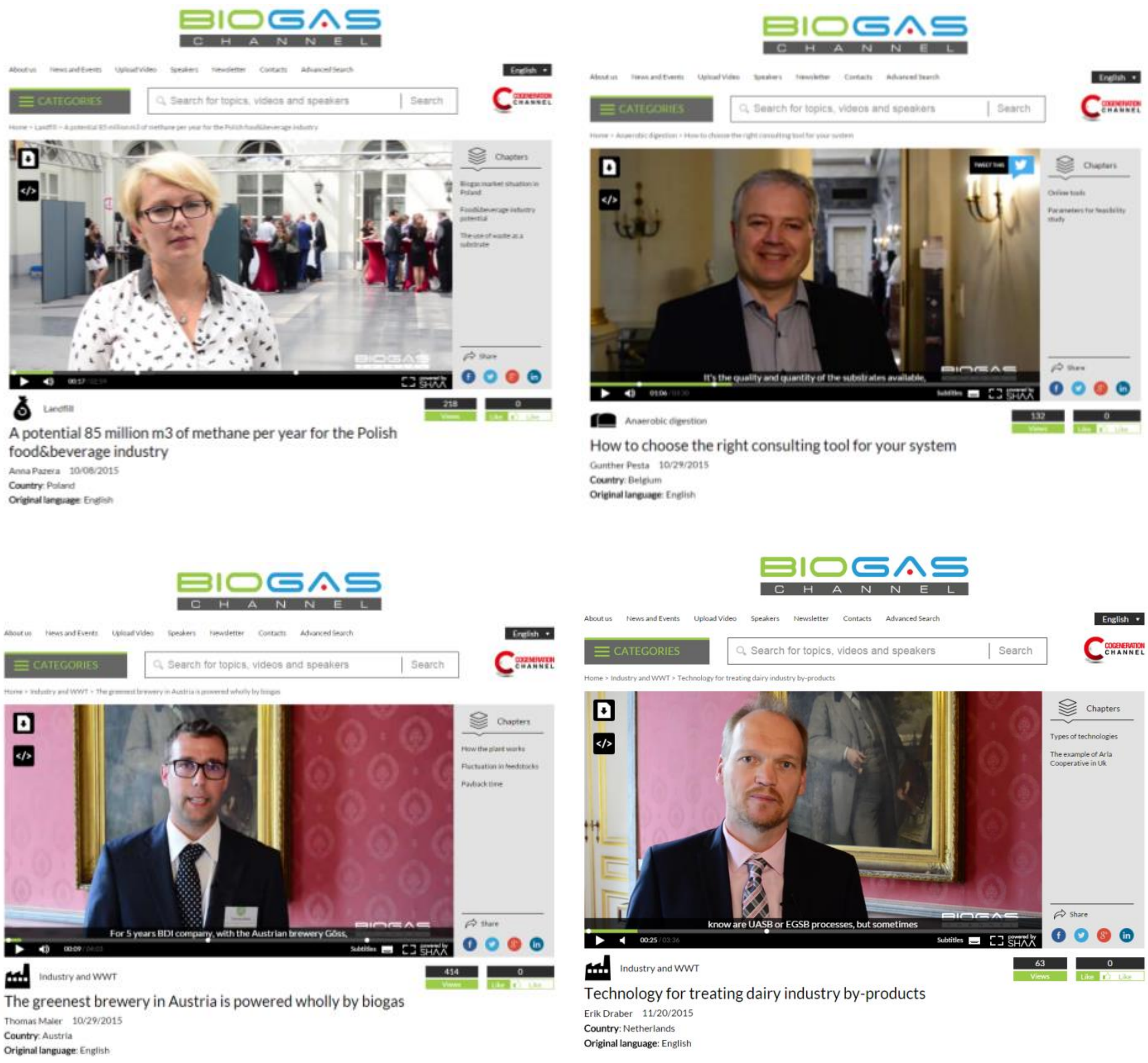


Figure 30: interviews by Biogas Channel with the Biogas experts Anna Pazera, Gunther Pesta, Thomas Maier and Erik Draber

6.5 Dissemination activities of FABbiogas partners

Table 5: WP 8: Communication / Dissemination by CO1 BOKU

Task 3: Information flyer and digital newsletters	Task 4: Articles for national and international newspapers / journals	Task 5: Presentations at national and international events	Others	Planned Communication and Dissemination activities
Received 500 flyers; distributed approx. 470 at BOKU, Biomass Conference Kopenhagen, Biomass Conference Graz, Biogas Conference Nürnberg, Conference BiogasScience2014, FABbiogas workshops St. Pölten, Newsletter at website of Bioprocess-Control (on topic of International FABbiogas seminar in Brussels), Internal newsletter at BOKU University on International FABbiogas seminar in Brussels	Published article on IFA and BOKU website	Poster presentation at Biomass Conference in Kopenhagen; oral presentation at side event at Fachverband Biogas in Nürnberg; oral presenation of FABbioas project for a UNIDO project in Graz, oral presentation at final conference of IEE project BiogasHeat in Brussels; oral and Poster presentation at BiogasScience2014 conference in Vienna, oral presentation for IEE BiogasHeat project in Paris (at DALKIA), oral presentation of FABbiogas results at workshop of EU project SINERGIA in Marseille; 5 internal presentations at BOKU for international delegations (e.g. from Peru) and at internal meetings, Poster presentation at "Biogas15" conference in Vienna	-	Article on FABbiogas project results in national newspapers. dissemination of fact sheets of best practice examples (WP2); further dissemination of the flyer, handbook, FABbiogas calculator

Table 6: Communication / Dissemination by CB2 EBA

Task 3: Information flyer and digital newsletters	Task 4: Articles for national and international newspapers / journals	Task 5: Presentations at national and international events	Other Communication and Dissemination activities	Planned Communication and Dissemination activities
-	Published article/project description on EBA website; Article in EBA annual report 2013	FAB Presentation of Wolfgang Gabauer on Company Advisory Council in January 2014, Contribution of two of EBA's members (Josef Pellmayer) at the German national seminar in September and participation in the discussion round (Arthur Wellinger)	International Seminar in spring/summer 2015	further dissemination of the handbook and FABbiogas calculator

Table 7: Communication / Dissemination by CB3 ATRES

Task 3: Information flyer and digital newsletters	Task 4: Articles for national and international newspapers / journals	Task 5: Presentations at national and international events	Other Communication and Dissemination activities	Planned Communication and Dissemination activities
Receifed 700 FABbiogas flyers; distributed flyer at: Agritechnica, fair, Fachverband Biogas, fair Nürnberg, GIZ delegation Indonesia, GIZ delegation Ghana, Tansania, IFAT 2014	article, presentation and link at the company website ATRES	poster presentation at Agritechnica, fair, poster presentation at Fachverband Biogas, poster presentation at IFAT 2014	-	Further cooperation with Cluster and the arrangement of following infodays on biogas in FAB industries, further dissemination of the handbook and FABbiogas calculator, dissemination of advisory services

Table 8: Communication / Dissemination by CB4 ANIA

Task 3: Information flyer and digital newsletters	Task 4: Articles for national and international newspapers / journals	Task 5: Presentations at national and international events	Others	Planned Communication and Dissemination activities
Received 500 flyers, distributed approximately 200, in ANIA meeting room and ANIA flyer stand in Paris (France), principally for food company representatives at "sustainable development" meetings and random companies passing by, at the CFIA conference in Rennes (France), and at the Salon de l'Agriculture in Paris (France).	Published article on ANIA website and in the ANIA newsletter Le Flash de l'ANIA. Article in the press for the professional journal "Process Alimentaire".	Presentation at the CFIA conference in Rennes (food industry equipment suppliers international salon), presentation at national Food For Life technology platform meeting	-	article in other professional journals, further dissemination of the flyer, handbook and FABbiogas calculator

Table 9: Communication / Dissemination by CB5 Cluster

Task 3: Information flyer and digital newsletters	Task 3: Information flyer and digital newsletters	Task 4: Articles for national and international newspapers/journals	Task 5: Presentations at national and international events	Others	Planned Communication and Dissemination activities
Received 500 flyers; distributed approx. 100 at Kern, LfL (Bayerische Landesanstalt für Landwirtschaft), network meeting biogas of Umweltcluster Bayern, Conference „Kooperationsforum funktionelle Inhaltsstoffe für Lebensmittel"	Digital newsletter 04/2013, 01/02/2014, 01/03/2014, 01/03/2015, 01/04/2015; press release: 01/04/2013, 30.09.2014, 01/10/2014, 01/07/2015,	Published article on Cluster website, newspaper article 05/2013, 04/2013 Nordbay. Kurier, 04/2013 Frankenpost, 04/2013 Wiesentbote, 07/2014 SuB, 08/2014, 10/2015 DMZUtmeets, 10/2014 Fleisch net, 10/2014 BLW, 02/2015 Int. Article, 08/2015 Sol-Journ.	Oral presentation at the renewable energy work group meeting of the LfL in Freising 11/2013, Oral presentation at the biogas network meeting of the UmweltCluster Bayern in Augsburg 01/2014, Oral presentation at the internal business meeting in Kulmbach 01/2014, Oral presentation at the biogas workshop Umwelttechnologie meets Ernährung in Pfaffenhofen 06/2014, Oral and poster presentation at the Abwasser and Biogas Energietage 2015 in Wuppertal 09/2015	-	Further Dissemination activities of fact sheets of best practice examples and project results; Further cooperation with atres and the arrangement of following infodays on biogas in FAB industries

Table 10: Communication / Dissemination by CB6 FEDER

Task 4:	**Articles for national and international newspapers/journals**	**Task 5: Presentations at national and international events**	**Other Communication and Dissemination activities**	**Planned Communication and Dissemination activities**
Published short articles via Federation official Newsletter "Informalimentare" (issues May , August 2013, July 2014, February, April, June 2015)	http://www.federalimentare.it/Informalimentare/informalimentare_4_2013.pdf http://www.federalimentare.it/Informalimentare/informAlimentare_7_2013.pdf http://www.federalimentare.it/Informalimentare/informalimentare_3_2015.pdf http://www.federalimentare.it/Informalimentare/informalimentare_2_2015.pdf http://www.federalimentare.it/Informalimentare/informalimentare_1_2015.pdf http://www.federalimentare.it/Informalimentare/informalimentare_4_2014.pdf	Slide presentations during following meetings: Daniele Rossi, Ecomondo Fair, Rimini, 8/11/2013; Paolo Patruno, GIURI Innovation, Bruxelles, 19/11/2013; Daniele Rossi, Workshop "Behaviour of businesses related to waste generation, handling and use of materials obtained from by-products" Athens 12/5/2014; Maurizio Notarfonso, "Business opportunity for ASSICA association" Parma, 21/11/2014; Maurizio Notarfonso "FoodWard meeting" Rome, 16/4/2015	Display of project logo in CIBUS Fari Parma (May 2014)	further dissemination of the handbook and FABbiogas calculator

Table 11: Communication / Dissemination by CB7 PKCR

Task 3: Information flyer and digital newsletters	Task 4: Articles for national and international newspapers / journals	Task 5: Presentations at national and international events	Other Communication and Dissemination activities	Planned Communication and Dissemination activities
Distribution of flyers during meetings of PK ČR´s Body and Czech Technology Platform for Foodstuffs (see Annex I.).	Project awareness at PK ČR´s official website.	Oral presentation on actual project existence followed by its progress during meetings of PK ČR´s Body and Czech Technology Platform for Foodstuffs (see Annex I.).	-	Article on actual project´s existence and its progress in national Foodstuffs journals (i. e. PK ČR´s journal "Svět potravin"/"World of Foodstuffs" etc.); dissemination of fact sheets on best practice examples (WP 2) during future meetings of PK ČR´s Body and Czech Technology Platform for Foodstuffs.

Table 12: Communication / Dissemination by CB8 ECOPLUS

Task 3: Information flyer and digital newsletters	Task 3: Information flyer and digital newsletters	Task 4: Articles for national and international newspapers / journals	Task 5: Presentations at national and international events	Other Communication and Dissemination activities	Planned Communication and Dissemination activities
Published articles in the newsletter of the food cluster of lower Austria.	Information flyers distributed on the first national seminar "Biogas13" and company visits.	Published articles on ecoplus website, food cluster of lower Austria- and Netzwerk Land website	Oral presentation of FABbiogas at the Austrian International Seminar in December 2013	Published article in the brochure "Eco-Innovation driven by clusters"	further dissemination of advisory services, further dissemination of the handbook and FABbiogas calculator

Table 13: Communication / Dissemination by CB9 TUL

Task 3: Information flyer and digital newsletters	Task 3: Information flyer and digital newsletters	Task 4: Articles for national newspapers / journals	Task 4: Articles for international newspapers / journals	Task 5: Presentations at national and international events	Others	Planned Communication and Dissemination activities
Flyers distributed (approx.. 150) at: TUL, Research and Innovation Center “ProAkademia”, National Conference on Process Engineering, among food and beverage producers, biogas plant operators who participated in questionnaires for WP2 (Task 1, 2 and 3).	Two press articles in national newspapers on FaBbiogas project	Publications in Journals: *Biogas in Europe: Food and Beverage (FAB) Waste Potential for Biogas Production*, Energy and Fuels, Volume 29, Issue 7, 16 July 2015, 4011-4021, DOI: 10.1021/ef502812s. *The potential for methane production from waste of food and drink industry (in Polish) Chemical Engineering and Equipment* (Inżynieria i Aparatura Chemiczna), 4, 2015, 194-195. PL ISSN 0368-0827.	National Conferences: 3rd International Congress of Bio-economy, Lodz, Poland, 19th September 2014: lecture "The production of biogas from organic waste in the European food and drink industry". XII Conference "For the City and the Environment – Problems of waste management" held in Warsaw, Poland, on 24th November 2014: there poster "The production of biogas in Poland from waste from food and drink industry" and report in the Conference Proceedings "The production of biogas in Poland from waste from food and drink industry". XII Conference "Progress of bioreactor engineering" September 1nd-4th, 2015 in Uniejow, Poland: poster "The potential for methane production from waste from the food and drink industry", abstract and full text published in Chemical Engineering and Equipment.	International Conferences: 41st International Conference on Chemical Engineering, May 26-30th, 2014 in Tatranske Matliare, Slovakia: poster "The present state and potential of biogas market in Poland based on waste from the food and beverage industry (FAB waste" abstract and full text published in Conference Proceedings. The project results were presented (as paper and poster) during the conference "BioScience2014: International Conference on Anaerobic Digestion", which took place on 26-30th October, 2014 in Vienna, Austria. two lecturesat the International Conference of the 7th European Meeting on Chemical Industry and Environment, EMChIE 2015 in 10-12 June 2015 in Tarragona, Spain	-	Article on FaBbiogas results (WP2, TUL results)

6.6 Videos of best practices

GROßFURTNER GMBH – ONE OF THE BIGGEST SLAUGHTERHOUSES IN AUSTRIA

https://www.youtube.com/watch?v=1LQFgrcfivo&feature=youtu.be

The company Großfurtner exists since 1972. It is one of Austria's biggest slaughter houses for pig and cattle. Our raw material is delivered from the surroundings within 50 km. This is very important for us because we emphasize meat quality. As our advertisement slogan says, we are "dedicated to good quality". Since 2003 we operate our own biogas plant in St. Martin. The most important reasons were the necessity to provide our own energy and heat from waste materials in a long-term sustainable process, to save costs for waste disposal and to reduce transportation. In 2006 we received the Energy Award in the category air pollution control for our efforts. -

ARA PUSTERTAL AG – WASTE WATER TREATMENT PLANTS IN SOUTHERN TYROL, ITALY

https://www.youtube.com/watch?v= 7X57zQotbk&feature=youtu.be

The ARA Pustertal AG is a company representing 28 municipals of the area Pustertal in Southern Tyrol, Italy. In five waste water treatment plants, we purify the whole waste water of the area Pustertal. Additionally, we built plants to dry and burn sewage sludge. Half of the total sewage sludge in Southern Tyrol is treated in our plants.

Spreewald Konserven Golßen

https://www.youtube.com/watch?v=bHK4J0uPH8s&feature=youtu.be

The company Spreewald Konserven Golßen is a medium-sized family company with 170 fix employees and 200 to 250 seasonal workers. They conserve around 60 000 tons of raw material like apples, cucumbers, red cabbage and similar in tins. During the production processes of the company Spreewald Konserven Golßen, organically highly contaminated waste water is produced. This waste water is processed in a waste water treatment plant where biogas is also produced. The biogas is burned in a CHP unit and the heat is used in the production process.

CERNA HORA BREWERY, CZECH REPUBLIC

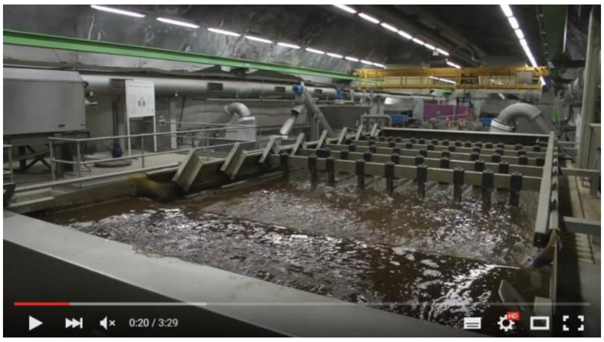
https://www.youtube.com/watch?v=_LS9lKcNwu4&feature=youtu.be

The brewery Černé Hora belongs to the Lobkowicz Brewery Group. The Lobkowicz Breweries produce in total about 900 000 hl/a of beer. We have small and middle sized breweries in the group, so we produce really classical and traditional high quality Czech beers.

The motivation for the implementation of biogas technology was mainly the ecological and (environmental) reasons. This makes us to one of the most efficient breweries in Czech Republic.

CEO Rudolf has been the driving force for the construction of the biogas plant

Spreewald Konserven Golßen treat their organically highly contaminated waste water in their own waste water treatment and biogas plant



ARA Pustertal GmbH treats waste water of the Southern Tyrolian region Pustertal and also waste from food companies

The brewery Cerna Hora has its own treatment plant

Figure 31: Videos of best practice examples of FABbiogas plants are available online

7 Summary

The primary aim of AD in industrial applications depicts a single substrate treatment for supplying a renewable energy source by producing biogas. Furthermore the motivation focuses on reducing treatment or disposal costs for by-products and waste water.

The implementation of the environmental friendly technique depends widely on a political framework, creating and providing an economical attractive incentive for running AD plants. Besides, on-site infrastructure and cost structure are amongst others most limiting factors for economically feasible AD installations.

During the last years' legislative restrictions concerning waste treatment and environmental protection were aggravated. Among others, companies of the food industry were forced to think their waste-management over, including wastewater management. It became not only unpopular to produce organically high loaded wastewater but also very expensive.

Anaerobic digestion (AD) is state of the art in a wide range of applications. Agricultural biogas plants as well as anaerobic waste water treatment plants and anaerobic treatment plants for biological wastes are becoming increasingly widespread.

AD of industrial by-products combines two effects: the effective and hygienic procedure for treating organic residues and waste water and also biogas is produced which represents a renewable energy source. Biogas fired in steam vessels or combined heat and power units, or even in combination of absorption chillers, helps to substitute fossil fuel sources.

The successful awareness raising events and the high amount of detailed advisory services show the interest of food and beverage industries to invest into biogas technology. The advisory service is continuing even beyond the project duration. Every partner will keep on promoting the tools of FABbiogas project:

- link to handbook: http://www.fabbiogas.eu/en/download/
- manual and tool on website of every partner's website: http://www.fabbiogas.eu/en/project-results/biogas-calculator/
- link to the contact points at the FABbiogas website: http://www.fabbiogas.eu/en/advisory-services/

8 Contacts and Consortium

- http://www.fabbiogas.eu/en/home/
- http://www.fabbiogas.eu/en/advisory-services/
- http://www.fabbiogas.eu/en/contact/

Partners & Contacts

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Alimentare
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EBA – European Biogas Association
Arthur Wellinger
BELGIUM

Potravinářská komora ČR
Miroslav Koberna
CZECH REPUBLIC

ATRES Group
Gunther Pesta
GERMANY

Ecoplus. Niederösterreichs
Wirtschaftsagentur GmbH
Silke Steiner
AUSTRIA

Association Nationale des Industries Alimentaires
Françoise Gorga
FRANCE

Politechnika Łódzka
Liliana Krzystek
POLAND

Kompetenzzentrum für Ernährung (KErn)
Cluster Ernährung
Sabine Helm
GERMANY

www.fabbiogas.eu

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10 Attachment - Fact sheets of best practice examples

The fact sheets are available online http://www.fabbiogas.eu/en/download/

The list of fact sheets can be found in Table 14 and the fact sheets are attached to this document.

Table 14: List of FABbiogas plants considered as best practice examples

	COUNTRY / LOCATION	COMPANY	TYPE OF WASTE
01	AUSTRIA / St. Martin	Großfurtner	Slaughterhouse waste
02	AUSTRIA / Zirl	Abwasserverband Zirl und Umgebung	Faulty batches, expired bread, grease separation material and coffee grounds
03	AUSTRIA / Wels	Berglandmilch eGen	Whey, diary residues, wastewater
04	AUSTRIA / Hollabrunn	Frisch & Frost Nahrungsmittel GesmbH	peel mash, potato and potatoes residues, potato product slurry
05	GERMANY / Dannenberg	Kraft und Stoff Dannenberg GmbH & Co. KG	Spice, fruit juice, pomace wastes and energy crops
06	GERMANY / Radeberg	Bio-Verwertungsgesellschaft	Sewage sludges, liquid biological waste (e.g. industrial fat) and solid biological waste.
07	GERMANY / Friweika	Friweika eG	potato residues
08	ITALY / Ospedaletto	Inalca SpA	Slaughterhouse waste
09	ITALY / Minerbio	Coprob	Sugar beets
10	POLAND / Boleszyn	Biogal Sp. z o.o	Manure, corn silage, as well as distillery stillage and whey
11	POLAND / Skrzatusz	Zeneris	Distillery, rotten fruit and vegetables
12	POLAND / Konopnica	Bioenergy Project Sp. z o.o.	Distillery stillage, apple pomace
13	CZECH REP. / Krásná Hora	Zd Krásná Hora a.s.	Bovine dung, corn and grass silage
14	CZECH REP. / Telč	SELMA a.s.	Pig slurry, dairy sludge, corn silage
15	CZECH REP. / Dobrovice	TEREOS TTd	Distillery
16	FRANCE / St. Laurent de Cognac	REVICO	Cognac distillery residue
17	FRANCE / Calais	CVO Sevadec	Food oils, green clippings
18	FRANCE / Passel-Noyon	Ferti-RNJ	Sludge, greases, scraps

St. Martin, Upper Austria

Biogas Plant Grossfurtner

This biogas plant in the village of St. Martin is directly integrated into the largest abattoir of Austria. The company Großfurtner slaughters 550,000 pigs and 50,000 cattle per year. It is the first biogas plant worldwide which exclusively uses slaughterhouse waste as substrate for biogas production. All in all 10,000 tons of blood, rumen content, colon content and grease separation material is used to produce 3.6 Mio. kWh electricity and 3.6 Mio. kWh heat per year.

The aim of the project was the improvement of the economic and ecological performance of this abattoir. Two cost intensive areas in the company are the energy costs (natural gas, electricity) and the disposal costs for the slaughterhouse waste. By using the slaughterhouse waste as substrate for biogas production Großfurtner can reduce the disposal costs and can cover approximately 33% of their electricity demand and 75% of their heat demand with renewable energies.

Technology at a glance

- Biogas production: 5,000 m^3/day
- Methane content: 67% – 69%
- Installed power: 525 kWel, 525 kWth
- Digesters: 1x600 m3, 2 x1,000 m3
- Substrate/year: 2,000 m^3 blood, 1,000 t rumen content, 3,000 t colon content, 4,000 t grease separation material
- Input waste/substrate: 170 – 230 t/week
- Pre-treatment: continuous pasteurisation
- Operating hours: 8,400 h/ year

Information on financing

Year of realisation: 2003
Investment costs: € 1.8 million (first stage in 2003)
Feed-in tariff electricity: 11 cent/kWh
Tariff for heat sale: covering for own heat demand
Disposal costs: 5 – 50 €/ton slaughterhouse waste

Special features of the project

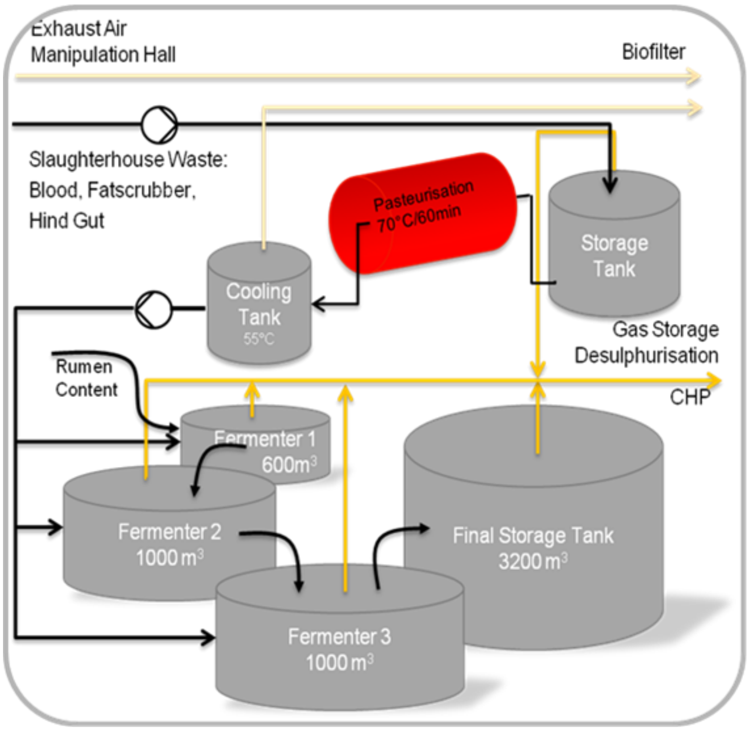
Slaughterhouse residues are interesting substrates for producing biogas because disposal costs of most fractions are high. So lots of companies are interested to implement biogas technology to reduce disposal costs and energy costs.

However, these fractions (like blood) have high nitrogen content and nitrogen (ammonia) can lead to microbiological inhibition and insufficient biogas production. So slaughterhouse residues are generally used as co-substrate to limit ammonia content to max. 5 g/l in the digester content. The biogas plant Großfurtner was the first biogas plant using 100% slaughterhouse residues with ammonia content of more than 7 g/l and high degradation rates. Within several research projects a number of parameters were changed and the whole process optimized to work satisfactory at high nitrogen concentrations.

Co-funded by the Intelligent Energy Europe Programme of the European Union

BEST-PRACTICE

BIOGAS PLANT ST. MARTIN, UPPER AUSTRIA



Process design biogas plant Großfurtner

More information

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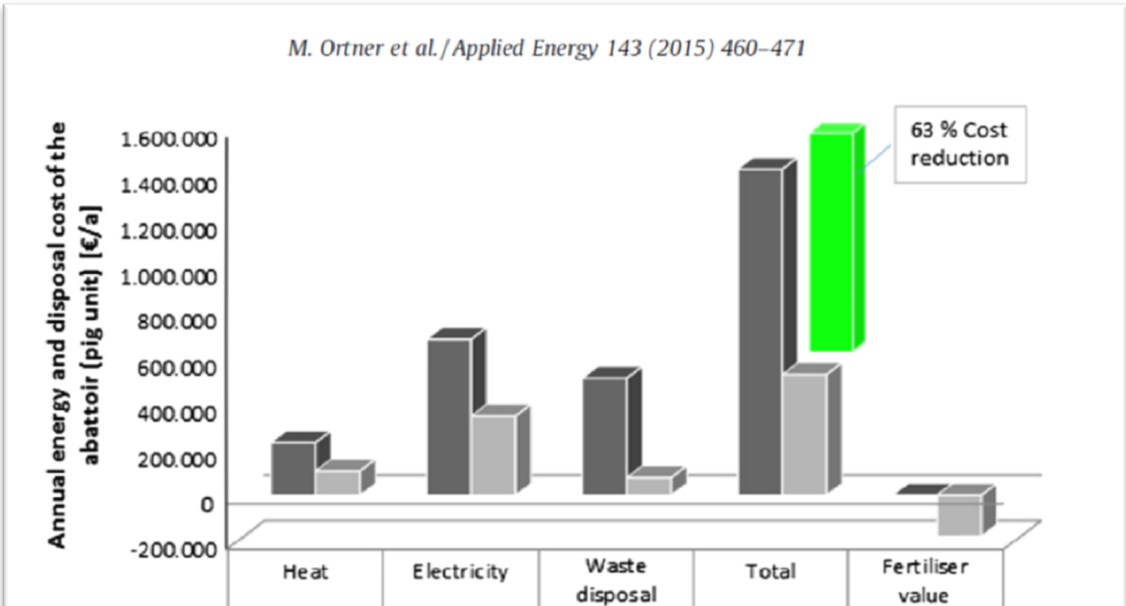

	Heat	Electricity	Waste disposal	Total	Fertiliser value
before [€/a]	230.000	682.500	513.000	1.425.500	0
after [€/a]	105800,0	346.500	76.950	529.250	-179000,0

Cost reduction after implementing the biogas plant into the slaughterhouse

Co-funded by the Intelligent Energy Europe Programme of the European Union

BEST-PRACTICE

BIOGAS ZIRL, TYROL

Zirl, Tyrol

Wastewater treatment plant

The wastewater treatment plant in Zirl is designed for 61,500 population equivalent and has an anaerobic digester with 1,350 m^3. In Austria on average wastewater treatment plants can cover 43% of their energy demand by anaerobic digestion of sewage sludge.

By using organic waste as co-substrate the plant in Zirl reached to cover the whole electricity demand. They use co-substrates like faulty batches, expired bread, grease separation material and coffee grounds from Nespresso-taps. From a Truck-Load with 23 tons of Nespresso-taps biogas with an energy equivalent of 23.500 liters of fuel oil can be produced. All in all approximately 3,000 tons/year of organic waste is used as substrate additionally to the arising sewage sludge. The waste like Nespresso-taps is pre-treated by a private waste management company using a hammer mill.

The wastewater association in Zirl is cooperating with different partners from industry and science to further optimize the use of digester volume of wastewater treatment plants.

Technology at a glance

- Biogas production: 700,000 m^3/year
- Installed power: 175 kWel
- Digester: 1x1,350 m3
- Substrates: expired food, faulty batches, grease separation material, coffee grounds,..
- Input waste/substrate: 3,000 tons/year (68% sewage sludge, 32% organic waste)
- Operating hours: 8,000 h/ year

Information on financing

- Year of realisation: 2005 – start digester
- Feed-in tariff electricity: no green power plant; only covering of own electricity demand
- High disposal costs for dewatered sludge: biogas production could be doubled – increase of dewatered sludge only 10%-15%

Special features of the project

The biogas plant in the village of Zirl is a good practice example because already existing infrastructure is used to produce biogas out of alternative substrates (e.g. Nespesso-taps) efficiently. Wastewater treatment plants are often the most expensive expenditure items of communities.

The existing digester of the wastewater treatment plant is perfectly used by adding additional organic residues as co-substrates to produce biogas. So the energy demand of the plant can be covered and so civil taxes are saved.

Moreover, the recycling of coffee taps by separating the aluminium from the coffee ground is a promising technology to use receive a new, previously unused substrate for biogas production.

Co-funded by the Intelligent Energy Europe Programme of the European Union

BEST-PRACTICE

BIOGAS ZIRL, TYROL

Hammer mill and storage tanks (picture Abwasserverband Zirl)

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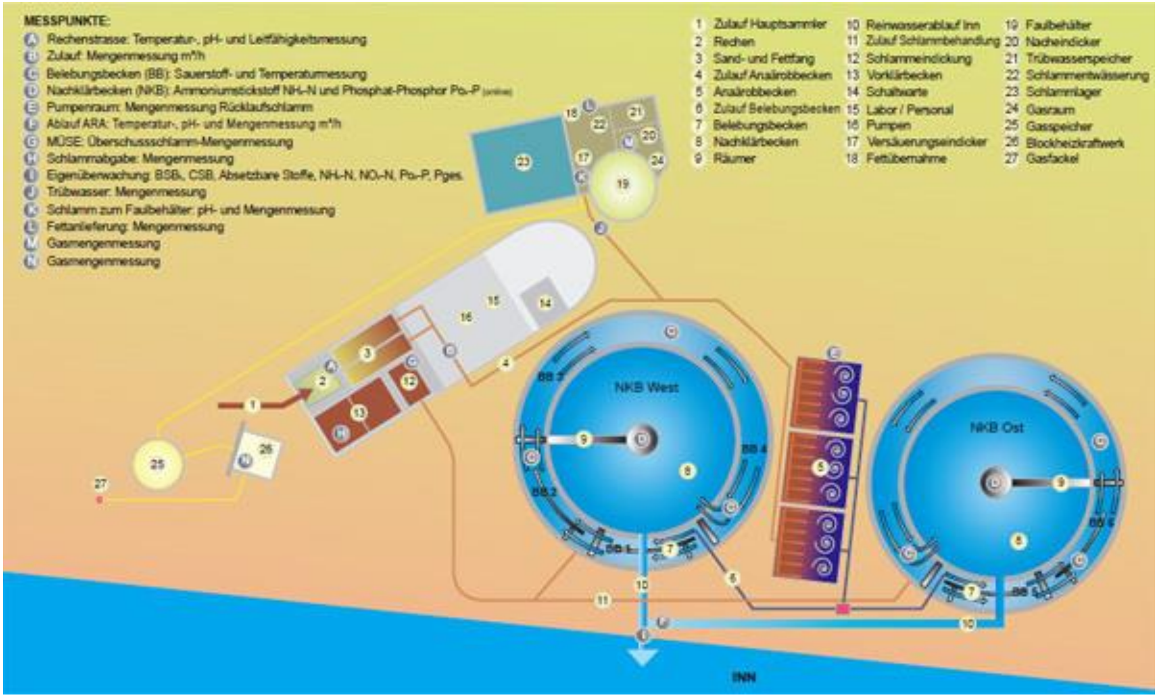

Process design of wastewater treatment plant Zirl (picture Abwasserverband Zirl)

Co-funded by the Intelligent Energy Europe Programme of the European Union

Wels, Upper Austria

Biogas Plant at Dairy in Wels

This dairy is part of the company "Berglandmilch" which is the biggest dairy company in Austria with 10 production sites and a market share of 37 % (1.010.000 t milk/year). A by-product from cheese production is whey which can be used in the food- and feed industry. However, in dairies large amounts of whey are produced and so biogas production/energy production can be a useful alternative.

Approximately 5,500 m^3 of biogas are produced every day out of 180 t whey and 180 t of wastewater. The produced electricity is fed into the grid and the waste heat of the CHP is used for hot water production for the dairy. With the produced electricity (approx. 3,000 MWh/year) 1,500 households can be supplied with green electricity – this corresponds to approx. 2,000 tons of CO_2 savings. The digestate can be used as high quality fertilizer or disposed via the public wastewater treatment plant. A challenge during realisation phase was the limited space available in the urban area and the concerns from neighbours regarding odour emissions.

Technology at a glance

- Biogas production: 5,500 m^3/day
- Modified fluidized bed reactor: 1,200 m^3
- Gas storage: 500 m^3
- Substrate: 180 t/day whey, 180 t/day wastewater
- Installed power: 500 kW_{el}, 550 kW_{th}
- Energy production: 7,900 kWh_{el}/day; 9,900 kWh_{th}/day

Information on financing

- Year of realisation: 2006
- Investment costs: € 2.0 million
- Operating costs: € 400,000/year
- Tariff for electricity sale: approx. 14 cent/kWh
- Tariff for heat sale: covering for own heat demand

Special features of the project

This was the first biogas plant only using whey and wastewater as substrate to produce biogas and there were no experiences from other projects. There were protests from local residents because they feared intensive odour emissions. So this biogas plant was originally only approved for one year of trial operation. Moreover there were fears because of possible risk of explosion.
However, also after one year the biogas plant was working satisfactory and without problems.
Compared to a conventional agricultural biogas plants the biogas plant at the dairy in Wels has low retention times and the special fluidized bed reactor guarantees that the bacteria biomass stays in the digester and is not washed out.

Co-funded by the Intelligent Energy Europe Programme of the European Union

BEST-PRACTICE

BIOGAS PLANT WELS, UPPER AUSTRIA

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Co-funded by the Intelligent Energy Europe Programme of the European Union

Hollabrunn, Lower Austria

Biogas Plant Frisch & Frost

The company Frisch & Frost is the largest potato processor in Austria with a capacity of 100,000 tons of potatoes/year and a turnover of 74 million euro/year. Approximately 15% of all harvested potatoes in Austria are processed at Frisch & Frost.

In 2007 the biogas plant was enlarged and now 100% of the organic waste stream of can be used as substrate to produce green electricity and heat. Every day 62 tons of peel mash, potatoes residues and product slurry are used to produce 2,740 m^3 biogas/day. The whole heat is used in the production process and the electricity is fed into the grid. So approx. 15% of the natural gas demand (of 4 Mio. m^3 whole annual demand) can be covered and the green electricity production corresponds to 33% of whole electricity consumption. Moreover, with the separation of organic waste and the use as biogas substrate the residual waste could be reduced by 70%. The occurring digestate is a valuable fertilizer which is used at the fields to close the nutrient cycle.

Technology at a glance

- Biogas production: 2,740 m^3/day
- Installed power: 285 kWel, 315 kWth
- Hydraulic digesters: 1 x 1,100 m^3
- Input waste/substrate: 62 t/day; peel mash, potato and potatoes residues, potato product slurry
- Operating hours: 8,400 h/ year
- Reduction of 15% natural gas; approx. 33% of electricity demand covered

Information on financing

Year of realisation: biogas production started 20 years ago, expansions in 2003 and 2007

Investment costs in 2007: € 1.3 million

Tariff for electricity sale: approx. 14 cent/kWh

Tariff for heat sale: covering for own heat demand

Special features of the project

An important aim of the company Frisch & Frost is to produce and offer ecological sustainable products for their customers. The farmers who supply the potatoes limit their use of artificial fertilizer and spray agents to a minimum. The potatoes are then processed in the factory with the use of renewable energies, the wastewater is purified in their own wastewater treatment plant and the digestate of the biogas plant is used as valuable fertilizer at the farmers' fields. Customers like McDonald´s appreciate high quality products which are produced sustainable.

Co-funded by the Intelligent Energy Europe Programme of the European Union

BEST-PRACTICE

BIOGAS PLANT HOLLABRUNN, LOWER AUSTRIA

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Co-funded by the Intelligent Energy Europe Programme of the European Union

Radeberg in Saxony, Germany

Co-fermentation Plant

The co-fermentation plant in Radeberg demonstrates that the combined purification of sludge, domestic and industrial organic waste in an anaerobic sludge plant leads to synergy effects. As part of the extension of the sewage treatment plant, a complete sludge treatment was integrated additional to an aerobic biological purification. Since 1999 two anaerobic waste fermenters process in addition to 41 000 tons of sewage sludge another 15 000 tons of organic waste per year in the plant.

Co-fermentation plant Radeberg (source: Strabag 2013)

The plant has separate pathways to process the different waste fractions sewage sludges, liquid biological waste (e.g. industrial fat) and solid biological waste. Therefore the plant is highly flexible to the frequently changing availability of biological waste and allows adjustment to the current energy demand. Two fermenters with a capacity of 2 300 m^3 each, can be operated separately by different input flows. The pre-treatment facilities of the organic waste include wet processing with a mill, a magnetic separator, a pulper and a drum screen. The mechanical cleaned waste then goes into a hydrolysis container. Before moving to the fermenters, hygienic conditions are created at 70°C for one hour.

The plant produces around 40 m^3 Biogas per ton of input, which supplies two gas engines with an installed electrical power of 380 kW. The generated electricity covers more than the total demand of the plant, thus surplus electricity is fed into the public grid. The produced heat is used for the total heat demand of the waste treatment plant, the service building and a nearby school.

The combination of the joint digestion of sewage sludge and biological waste provides in addition to its high technological flexibility further advantages. The purified sewage waste water can be used as cooling (BHKW) and process water. When processing sewage sludge and biowaste together, the dewatered digestate is used as a secondary fuel in an extern co-generation plant. If biowaste is porcessed separately the digestate can also be used as fertilizer.

With higher fat input, the biogas production was doubled and the methane content of the produced biogas rose to 65 %.

Technology at a glance

- Installed electr. power of CHP: 2 x 380 kW
- Installed therm. power of CHP: 2 x 550 kW
- Installed therm. power of heating boiler: 335 kW
- Biogas production: 40 m3/t input (mixture)
- Gas storage: 780 m3, double membrane
- Gas fare: 800°C

Co-funded by the Intelligent Energy Europe Programme of the European Union

BIOGAS PLANT IN RADEBERG, GERMANY

Gas fare (source: Strabag 2013)

- Digester: 2 x 2 300 m^3, wet fermentation
- Retention time: 20 days
- Organic loading rate: 2,5 kg /(m^3 * day)
- Amount & type of waste used:
    - Domestic biowaste: 5.000 t/a
    - Industrial biowaste: 6.000 t/a
    - food waste: 4.000 t/a
    - sewage sludge: 41.000 t/a
- Dewatered digestate (28 % DM): 11.440 t/a

Pulper and drum screen (source: Strabag 2013)

Information on financing

The investment costs for the co-fermentation plant were drastically reduced compared to the building of two separate plants, a sewage and a biogas plant. Simultaneously the economic efficiency of the waste treatment site Radeberg was improved significantly. By using existing infrastructure of the sewage plant and supplying the plant with self-generated electricity and heat the running costs were reduced. Substantially higher gas yields improved the profitability additionally. Finally, the approval procedure could be simplified, due to the already existing license according to the Water Act.

Crucial Factors

The co-fermentation plant in Radeberg represents an innovative system for a sewage plant including organic waste fermentation. It demonstrates the important synergy effects of a combined purification of sludge and organic waste.

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Co-funded by the Intelligent Energy Europe Programme of the European Union

BEST-PRACTICE

BIOGAS PLANT & BIO-METHANE FILLING STATION DANNENBERG

Dannenberg, Lower-Saxony

Biogas Plant & Bio-methane

Filling Station

An innovative concept of combined biogas plant and bio-methane filling station is located in Dannenberg. The operator and investor Horst Seide who is President of the German Biogas Association has invested into a future market. The station sells upgraded biogas from a spice producer’s waste, a fruit juice producer’s pomace and from energy crops since 2011.

Biogas plant and bio-methane filling station, Dannenberg

As a result car drivers benefit from markedly reduced fuel prices since. The biofuel costs only 69 Cents compared to a liter of petrol.

Furthermore, CO_2 emissions of biogas are 90 % lower than those of petrol. Surplus bio-methane is fed into the natural gas grid. A combined heat and power station produces additional heat and electricity which covers the internal energy requirements of the plant. Remaining electricity is fed into the public electricity grid. Extra heat and thermal discharge of the upgrading plant is transferred to a food producer through a district heating system.

Technology at a glance

- Inst. power CHP: 690 $kW_{el.}$, 700 $kW_{therm.}$
- Biogas production: 750 Nm^3 / h
- Bio-methane production: 200 Nm3 / h
- Digester: 1 x 2 000 m^3, wet fermentation
- Process temperature: 39 °C
- Biogas upgrading method: AminSelect
- Substrate input / a: 20 000 t maize, 15 000 t parsley stalks and fruit pulp

Information on financing

- Year of realization biogas plant: 2007
- Year of realization upgrading plant: 2011
- Investment cost: 5 Mio. Euro
- Sales price bio-methane: 1,099 Euro / kg
- Feed-in tariff electricity: ca. 18 cent / kWh
- Sales price digestate: 1,5 Euro / t

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Co-funded by the Intelligent Energy Europe Programme of the European Union

Weidensdorf, Saxony

Biogas Plant of Friweika eG

The potato processing company Frieweika eG handles around 140 000 tons of potatoes per year resulting in a daily production of 80 m^3 organic residues. To economically utilize these residues within the company, Friweika eG decided to build their own biogas plant in 1997.

Biogas Plant of Friweika eG (Foto: Friweika eG)

Three CHP plants with an installed electrical power of 210 kW generated electricity, which was fed in to the public grid. The waste heat was used for water heating. In 2002 the biogas plant was expanded to a fermenter volume of 3 600 m^3 and an installed electrical power of 500 kW. Since 2008 biogas is only used to generate heat for potato processing. This improved the efficiency of the biogas plant and simplified the process of energy conversion which made it less sensitive to failure.

Friweika eG not only uses its organic production residues to generate biogas, but also treats its wastewater in an own anaerobic wastewater treatment plant since 2003 and hence gains additional biogas. In 2012 the wastewater treatment plant was expanded. The biogas of both plants is used to generate heat for the production process. Altogether the use of biogas contributes 30% to the total heat demand, of which 90% is produced from organic residues. Friweika eG thus saves one million liter of fuel oil per year. The digestate is given to nearby farmers as natural fertilizer.

Technology at a glance

- Substrate: 29 200 t/a potato residues with a dry matter content of 12%
- Heating boiler: 2 000 $kW_{therm.}$
- Fermenter: LARAN® loop reactor 3 600 m^3
- Biogas production: 2 Mio. m^3/a

Information on financing

- Fuel oil savings: 1 Mio. l/a
- Transport costs for digestate: 2 Euro/m^3

Cruzial Factors

The plant of Friweika eG displays an industrial biogas plant using food waste resulting from potato processing. It successfully combines the anaerobic digestion of solids and waste water treatment.

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BEST-PRACTICE

MEAT PROCESSING INDUSTRY (SLAUGHTERHOUSE AND TRASFORMATION)

FAB biogas

Lodi, Lombardy (North of Italy)

Meat processing industry, Inalca

The Ospedaletto Lodigiano plant was inaugurated in 1999 and is the largest plant for the production of beef and industrial meat-based processed products in Europe. With a total surface area of 400,000 m2 (60,000 of which are covered) and a slaughtering capacity of approximately 6,000 head per week, the Inalca Spa plant in Ospedaletto has production lines featuring state of the art technology, guaranteeing excellent quality standards which respond to the rigorous hygienic-sanitary regulations of the European Union. All stages of the production process are carried out within the plant in a completely integrated manner. In addition to the first processing stage typical of the slaughtering industry (beef sides, quarters, fresh and frozen cuts), the plant also manufactures products with a high service content. The great variety of processing methods gives added value to the meat and guarantees a complete production cycle. With a production capacity of 10,000 tons of fresh hamburgers and 5,000 tons of portioned and fresh ready products per year, the new plant's extremely high degree of process automation makes it a global reference model for modernity and degree of innovation.

The biogas plant for the production of energy from renewable sources in the plant was opened in 2010. The biogas plant required an investment of 4.5 million euros and enables self production system approximately of 6.0 GWh per year entirely from renewable sources: company's goal is to get inside a self-production at the end of 2015 can cover more than 60% of energy needs through industrial cogeneration and the use of renewable sources.

Technology at a glance

- Sources: waste water treatment sludges, stomach contents, blood and fat wastes
- Amount of waste: 57.100 ton/y
- Load capacity plant: 2.607 MW
- Combined anaerobic and aerobic plant: JENBACHER JGS 320 (ECOMAX 10 BIO)
- Biogas production: 5.300 MWhe

Information on financing

- Year of realization: 2010
- Indicative cost of the plant: 4,5 mln €
- Operating hours: 8.400 h/Y
- Process temperature: 35° C

More Information

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Co-funded by the Intelligent Energy Europe Programme of the European Union

Minerbio, Emilia-Romagna (Centre Italy)

Beet sugar production, COPROB

Coprob associates more than 5,700 farms in Emilia-Romagna and Veneto, with two factories operating in Minerbio (BO) and Pontelongo (PD), is a national leader in the sugar-beet production. A production quota of 284,000 tons of sugar provides a turnover of 342 million euro (2012 data). Through the brand Italy Sugars, which markets the only sugar certified 100% Italian, the Group Coprob holds a national market share of 23% sugar. The Group Coprob initiated a diversification in the production of energy starting from renewable sources available.

Opened in 2012 the biogas plant is powered by more than 21,000 tons of pulp obtained from beets processed by the sugar factory Coprob Pontelongo (Pd) and thereby allow the recovery of by-products from sugar-beet, thus promoting the continuous production of beet itself and achieves a total biogas energy production up to 1 Mwe. The overall system is composed by three plants: Pontelongo, Minerbio, and Finale Emilia. Altogether, the three plants, which required a total investment of 18 million euro and are already all working, absorb over 63,000 tons of sugar beet pulp a year. The environmental benefits are numerous, because the destination of the pulp to the three biogas, instead of the traditional production of pellets, allows Coprob reduction of over 4.5 million cubic meters, the annual consumption of natural gas by avoiding the emission of nearly 9 million tons of CO2, as well as to help reduce the greenhouse effect.

Technology at a glance

- Sources: pressed pulps and sugar beet
- Total production: 25.000 t/y
- Load capacity plant: 75 kW/0,999 MW
- Co-generator model: GE Jenbacher JGS 320
- Biogas production: 8192 MW

Information on financing

- Year realisation: 2012/2013
- Investment cost: 6,5 mln €
- Operating hours: 8.200
- Temperature process: 38 - 42°

Further info

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Co-funded by the Intelligent Energy Europe Programme of the European Union

Province of Warmia and Mazury, Poland

Biogas Plant Boleszyn

Special feature of Project

Biogas plant in Boleszyn is an example of investment which benefited both the farmers and the local community. Currently burdensome slurry formed during the rearing of pigs is not a problem for local residents, and additionally inhabitants, school and the church in Boleszyn receive hot water, so that the cost of winter heating has significantly decreased. Electricity is sold and the heat produced in the biogas plant is also used by the local distillery. What is more, the owners built the pool, water in which will be heated by thermal energy produced from biogas. It is much cheaper than if it was produced from gas and coal. What's more, the owners signed a letter of intent with the local municipal governments in which they declare that they will lead the swimming classes for students from the schools.

Biogas plant owners decided to reach for external funds for the development of biogas plant for the installation for digestate management. The project was co-financed by the The Regional Operational Programme Warmia and Mazury. Thanks to a grant, the installation in Boleszynie was enriched by a third gas cogenerator of electric power of 800 kW, which is powered by biogas. Thus, the power of biogas plant was increased to 1.8 MW. The owners decided to go even further and once again reach for funds from the European Union to build a biomass heating plant and processing line for digestate.

Biogas plant description

Construction of biogas consumed approx. 22 million PLN, however more than 11.3 million PLN was funded from the Operational Programme Infrastructure and Environment.

The biogas plant in Boleszyn was built next to the pig farm. The substrates in this biogas plant are: manure, corn silage, as well as distillery stillage and whey. In the process four different co-substrates are stably fermented yielding high biogas production. All in all 43,900 tons of maize silage, slurry, distillery stillage and whey are used to produce 8.5 mln kWh of electricity and 9.2 mln kWh of heat per year. Firstly, the resulting gas - methane was burned in two cogeneration units - engines with an output of 500 kW, currently the biogas plant capacity was increased to 2 MW.

Initially, the residents of Boleszyn began to protest against this investment. That is why the investor invited to the village the scientists from the University and installation designers to speak about this technology. Some people opposed to the construction of biogas and the protests did not stop. Then investors invited all residents of Boleszyn for a coach trip to Germany to see some local agricultural biogas plants. They paid all costs, including the hotel. But not everyone wanted to take advantage of this offer. Moreover, even some of those who went to Germany, they still doubted. However, the attitude of the residents changed only when the biogas plant started operation. The residents found out that proximity of the installation do not have to be a nuisance, that biogas plant does not generate odours.

Co-funded by the Intelligent Energy Europe Programme of the European Union

BEST-PRACTICE

BIOGAS PLANT BOLESZYN

Boleszyn residents have recently been teased by the odor that came from standing on the edge of the village pig farm for a few hundred of pigs. Actually, from the slurry tanks in which it was stored (in Polish legislation for several months of the year it cannot be exported to the field). Also the odours came from the fields, on which it was spread. That all changed when the pig owners, built this biogas plant, in which all the manure from the farm is managed straight away and there is no need to store. The manure is transported to the biogas plant with the pipeline, which was built for this purpose. Thanks to biogas plant the piggery is much less annoying to neighbours than before.

What is more the owners of the biogas plant offered the residents to supply them hot water (for heating), heated by the energy produced in the biogas plant. The price was very attractive, so the costs of heating the house decreased twice.

So far, more than 20 homes in Boleszynie, church, rectory, and in cooperation with the municipal government- primary school was successfully connected to the pipeline.

Due to the fact that the owners built biogas plant, the piggery again began to be profitable. First of all, the buildings in which piglets and sows are holding must be heated. Previously, it cost thousands of PLN per year. Today, the entire house is heated by the biogas plant. Secondly, they do not have to export the manure to fields, which was also associated with considerable costs and was a pain for the villagers. Thirdly, they sell the digestate. And finally, manure makes more profit as a substrate for energy production than as a fertilizer. Currently, biogas plant in Boleszyn is one of the few in Poland, which do not generate losses. Mainly because they do not buy substrates

(Source:http://energiaodnawialna.kpodr.pl/index.php?option=com_content&view=article&id=115:biogazownia-po-ssiedzku&catid=39:biogaz-&Itemid=90)

for their installation which consumes 50 tons of corn silage and 30 tons of manure per day. They have their own silage and manure, and the rest of the substrates are waste from agro-food industry.

The owners decided to go even further and once again ask for funds from the European Union. This time, in order to build a biomass heating plant and the processing line for digestate. According to estimates heating plant will produce heat for 6, 5 thousand. hours per year and deliver it to 100 % Boleszyn residents and to newly built pool. In addition, the investment will contribute to the use of part of the heat generated by the biogas plant, which is now lost in the cooling process.

The main difficulties in the realization of biogas plant project were: obtaining the approval of inhabitants from Boleszyn. Another barrier was the wrong way of interpretation of the regulations not only during the process of issuing a building permit, but also obtaining licenses and permits for use and all decisions that are associated with it. Another stumbling block in the investment process was connection to the grid.

Co-funded by the Intelligent Energy Europe Programme of the European Union

BEST-PRACTICE

BIOGAS PLANT BOLESZYN

Technology at a glance

Biogas production:	4 230 000 m^3/year
Methane content:	53%
Installed power:	1050 kWel
	1156 kWth
Digesters:	3x4239 m^3
Substrate/year:	20 000 t maize silage
	13 000 t slurry
	7 300 t whey
	3 600 t distillery stillage
Input waste/substrate:	43 900 t/year

Information on financing

Year of realisation:	2012
Investment costs:	22 mln PLN
Feed-in tariff electricity:	0.38 PLN/kWh
Tariff for heat sale:	not available
Disposal costs:	not available

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Co-funded by the Intelligent Energy Europe Programme of the European Union

Wielkopolska province, Poland

Biogas Plant Skrzatusz

Special feature of Project

It is the first agro-industrial biogas plant in Poland. Installation in Skrzatusz is one of the very few biogas plants in Poland, which currently do not generate losses because as a raw material for biogas production uses only the waste, most of which gets for free.

The investor created its own design for the Polish market, because the others offered a ready project brought in a briefcase and not tailored to the needs of the real location. The owner of biogas plant in Skrzatusz applied another way to ensure its cost-effectiveness. He built the plant for drying wood. Thus the heat produced from biogas can be fully utilized. Another thing that distinguishes this biogas plant against the others is that this biogas plant has its own biotechnological laboratory which makes possible to test various raw materials and obtained data allows to calculate how much of the substrate can be added.

Biogas plant description

The desire to manage waste from a nearby distillery, rotten fruit and vegetables (the so-called plant-waste) from supermarkets resulted in the construction of the first agro-industrial biogas plant in Poland.

The biogas plant is located in the town of Skrzatusz, Szydłowo commune, Greater Poland Voivodeship in the vicinity of alcohol distillery. The immediate surroundings of the location is a field and fallow lands, the nearest human settlements are located at a distance of 250 m.

Installation in Skrzatusz annually processes about 24 000 tonnes of substrates. The resulting biogas allows to produce about 4 000 MWh of electricity per year.

The project was co-financed from EU funds under the Operational Programme Infrastructure and Environment. Support value was 5.2 million PLN.

Stillage intermediate tank in the distillery. From this tank the stock is pumped to the initial reservoir in the biogas plant.

Stillage premix tank with working volume approx. 370 m^3. The vertical mixer was installed to insure proper unification of the brew before feeding to the fermentation process.

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The reservoir of liquid organic waste. The heating system was installed providing the possibility of maintaining the proper temperature of the substrate prior to delivery to the fermentation process. Thanks to the heating system, it is possible to receive viscous waste, for example. glycerol, fat waste.

Collection building for waste requiring hygenisation. The building was installed to allow the device to receive and process the animal waste or, for example: overdue food.

Solid substrates container. Concrete bunker with installed moving floor and the system of screw conveyors automatically transporting solid substrates to the mixing tank. The bunker capacity is approx. 100 m^3.

Chemical filters for odors from the receptions station. Ventilation air is extruded outside the station by the main chemical filter. In addition, storage tank and hygieniser are equipped with air extraction from above the sludge. Extracted air flows through the lower odor filter.

Silo for grain or other flaked and dry substrate

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BIOGAS PLANT SKRZATUSZ

Mixing tank with a capacity of approx. 6 m^3 with a vertical mixer and tensomeric weight. Into this tank all substrates get and are dosed in accordance with a predetermined recipe. Weighing, dilution and mixing of substrates is automatic, even tens of cycles per day.

Digester 1. Concrete tank, equipped with a heating system and vertical double propeller mixer to prevent sedimentation and maintain uniform concentration of co-substrates in the workspace. Tank height 8 m, diameter 13 m, capacity approx. 982 m^3.

Fermentation tank 2. Open chamber, made of concrete, with a double, tight membrane covering. The tank is equipped with a heating system and lateral mixers to prevent sedimentation and maintenance of uniform co-substrates' concentration in the workspace. Tank height 8 m, diameter 22 m, capacity approx. 2813 m^3.

JENBACHER's gas engine type JMS 312 GS, with the electric power of 526 kW and thermal power of 300 kW. Electricity is directed into the grid, thermal energy jets used to cover own thermal needs of the biogas plant. The hot exhaust gases from the engine are directed to a steam boiler.

Steam boiler with heat capacity of 205 kW. The nominal steam production is 300 kg/h. Produced a steam goes to a neighboring distillery. The exhaust gases from the engine after passing through the steam boiler are directed to the chimney.

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Lagoon

(Source:http://www.google.pl/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCAQFjAA&url=http%3A%2F%2Fwww.reoseminars.pl%2Fseminaria%2Fcontent%2C51.4%2Cfile%2C220.html&ei=pflaVdfiA8SjsAGQy4H4Bw&usg=AFQjCNHCntVIRYOZQUl98K4UllTM3YHBaw&bvm=bv.89381419,d.bGg)

Technology at a glance

Biogas production:	2,058,600 m^3/year
Installed power:	526 kWel
	558 kWth
Digesters:	3795 m^3
Substrate/year:	15800 t distillery stillage
	2700 t carrot pomace
	5500 t potato pulp
	5500 t corn silage
	2100 t waste protein
Input waste/substrate:	33600 t/year

Information on financing

Year of realisation:	2011
Investment costs:	13 mln PLN
Feed-in tariff electricity:	0.38 PLN/kWh
Tariff for heat sale:	not available
Disposal costs:	not available

More information

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BEST-PRACTICE

BIOGAS PLANT KONOPNICA

Lodzkie province, Poland

Biogas Plant Konopnica

Biogas plant in Konopnica was built in 2011 and fully equipped within 6 months. Delivery of the substrates takes place in the "just-in-time" system. Substrates prior to feeding to the bioreactor are mixed and ground in two tanks with a capacity of 90 m^3. After the start-up of the biogas plant, the main substrates for biogas production were: corn silage, grain, grass and distillery stillage. Due to the high price of silage, in the biogas plant other substrates derived from the agri-food industry are used now, such as: apples, apple pomace, stale vegetables. The electricity produced is fed into the grid and used for the own needs. The heat produced in cogeneration is supplied to the district heating network in Rawa Mazowiecka. The whole biogas plant was built on the surface area of less than 1 ha.

Technology at a glance

Biogas production: 7 920 000 m^3/year
Methane content: 50%
Installed power: 1998 kWel, 2128 kWth
Digesters: 2x3300 m^3
Substrates/year: 20 000 t apples,
13 000 t distillery stillage, 7 300 t apple pomace,
Input waste/substrate: 40 000 t/year

Information on financing

Year of realisation: 2011
Investment costs: 27,6 mln PLN
Feed-in tariff electricity: not available
Tariff for heat sale: not available
Disposal costs: not available

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Krasna Hora, Central Bohemia

Biogas plant

The biogas plant in Krásná Hora nad Vltavou was put into operation in 2008. It processes annually 15 500 m^3 of bovine dung and further processes corn silage in the amount of 8 820 tons per year and grass silage in the amount of 8 750 tons per year, for a total of 33 070 tons of organic waste per year. Hourly production of biogas changes from 250 to 270 m^3/h that is produced in a two stage digester type circle in the circle. The produced gas is burned in a cogeneration unit type Jembacher, KH - JMS312 GS total output of 526 kWe.

The produced electricity is partly used in the company for its own consumption in the amount of around 10% and the rest is delivered to the public network. The heat produced is used for own business.

Technology at a glance

- Biogas production: 250 - 270 m^3/h
- Installed power: 526 kW
- Digester type and volume (m^3): Two-stage fermentation: circle in the circle type
- Type of waste used: 15 500 tons/year of bovine dung, 8 820 tons/year of corn silage, 8 750 tons/year of grass silage
  Amount of waste/raw material used as substrate (t/year): 33 070 t organic wastes
- Operating hours: 8 500 hours per year

Information on financing

Year of realisation: 2008
Total investment costs: € 2,77 million
Feed-in tariff electricity: 15,25 cent/kWh

More information

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Co-funded by the Intelligent Energy Europe Programme of the European Union

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BIOGAS PLANT TELČ, VYSOČINA

Telč, Region Vysočina

Biogas Plant

The biogas plant in Telč was put into operation in 2014. It processes approximately 11 000 tons of animal by-products from agricultural production, 3 000 tons of energy crops and 3 000 tons of waste per year. Hourly production of biogas, which is produced in the digester with a capacity of 2 900 cubic meters, is 120-150 m3. The produced biogas is burned in a cogeneration unit with a total output of 250 kWe.

Generating electrical energy is consumed in the centre of fattening pigs and the surplus is supplied into the distribution system. Heat will be in 2014 in addition to heating the fermentation tanks supplied for the purpose of heating pre-fattening pigs. Own electricity energy consumption of the biogas plant is around 10%, depending on the produced output.

Technology at a glance

- Biogas production: 120 - 150 m^3/h
- Installed power: 250 kW
- Digester type and volume (m3): Single-stage fermentation: 1 x 2 900 m3 digester
- Type of waste used: 11 000 tons/year of pig slurry, 3 000 tons/year of corn silage, 3 000 tons/year dairy sludge
- Amount of waste/raw material used as substrate (t/year): 24 000 t organic wastes
- Operating hours: 8 500 hours per year

Information on financing

Year of realisation: 2013
Total investment costs: € 0,925 million
Feed-in tariff electricity: 13,14 cent/kWh

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Kamenice, Region Vysočina

Biogas Plant

The biogas plant in Kamenice was put into operation in 2010. It processes approximately 35 000 tons of animal by-products derived from primary agricultural production and 13 000 tons per year of energy crops. Hourly production of biogas, which is produced in two primary digesters with a capacity of 2 700 cubic meters and one secondary digester a volume of 3 400 cubic meters is 400 to 500 cubic meters. The produced biogas is burned in two cogeneration units with a total output of 990 kWel.

Produced electric power is supplied to the distribution system and heat in addition to heating the fermentation tanks delivered to the customer for the purpose of drying wood. Own electricity energy consumption of the biogas plant is around 8%, depending on the produced output

Technology at a glance

- Biogas production: 120 - 150 m^3/h
- Installed power: 250 kW
- Digester type and volume (m^3): Two-stage fermentation: 2x digester (1st stage) - 2700 m3 and 2700 m3 and 1x second digester (2nd stage) - 3400 m3
- Type of waste used: 30 000 tons/year of pig manure, 5 000 tons/year of bovine dung, 10 000 tons/year of corn silage, 5 000 tons/year of grass silage
  Amount of waste/raw material used as substrate (t/year): 50 000 t organic wastes
- Operating hours: 8 500 hours per year

Information on financing

Year of realisation: 2010
Total investment costs: € 3,704 million
Feed-in tariff electricity: 15,25 cent/kWh
Tariff for heat sale: 5,55 €/GJ

More information

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BEST-PRACTICE

BIOGAS PLANT ST. LAURENT DE COGNAC

St. Laurent de Cognac, France

Biogas Plant Description

The biogas plant in St. Laurent de Cognac was built in 1970 to valorise distillery waste from Cognac production. Approximately 300 000 t/a of vinasses are treated to produce 20 000 MWh worth of biogas. The vinasses are concentrated by mechanical vapour compression and tartric acid is precipitated with calcium carbonate. The vinasses are then sent to the 4 infinitely stirred - downflow recirculation –type digesters. Retention time is 3-4 weeks. The digestate (1200-1500 tonnes dry matter /a) is decantated, mixed with ground plant matter waste, and used as agricultural compost. H_2S is eliminated in a soda washing tower and the gas is dehydrated by condensation on an exchanger. A mobile tank containing activated carbon removes most pollutants. The gas is then compressed and valorised via 4 microturbines with an installed electrical power of 200 kW each. The electricity produced is sold and thermal energy is used for own purposes.

Technology at a glance

Biogas production: 20 000 MWh
(converted to 13 500 MWh/a thermal energy
3 300 MWH/a electric energy)
Installed power: up to 20 000 m^3/day
biogas production capacity
Digester type:
infinitely stirred with downflow recirculation
Digester volume (m^3): 17 500 m^3
Type of waste used: Cognac distillery residue
Amount of waste/raw material used as substrate:
300 000 t/a
Operating hours: Waste received Nov-Jun

Information on financing

Year of realisation: 1970
total investment costs: € 30 million
feed-in tariff electricity: not available
tariff for heat sale: € 400 000 turnover from sale of electricity

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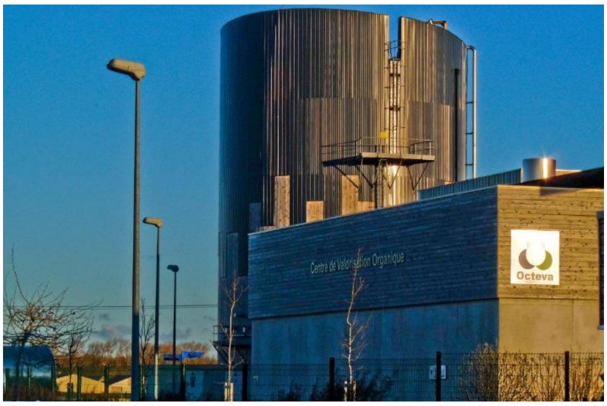
CVO Sevadec - Calais, France



Biogas Plant Description

The centralised biogas plant in Calais was built in 2005 to reduce the amount of household organic waste going to landfill. Fermentation takes place in one digester of a volume of 3100 m^3. The digester uses the VALORGA process, working in thermophile mode (55 °C) with 25-30% dry matter content (“dry digestion”). The outcoming digestate is dehydrated in two drying tunnels for 20h at 17 500 Nm3/h airflow. The biogas is collected in the upper part of the digester for drying and filtering. The biogas is then compressed in two compressors and a double-envelope tarpaulin allows for stocking the gas at 25 mbar. A booster allows for raising the pressure to 100 mbar. Surplus and substandard quality gas is torched. The gas mainly feeds two generators (installed electrical power of 940 kW and 500kW respectively) and the electricity produced is sold to the public grid.

Technology at a glance

Biogas production:	3 171 024 Nm^3/a
Installed power:	1 440 kW
Digester type:	dry digestion
Digester volume (m^3):	3100 m^3 (15m x 18m)

Type of waste used: food oils, green clippings, other residential waste

Amount of waste/raw material used as substrate:
26 994 t/a of which 1478 t/a food oils,
2323 t/a other residential waste,
22 194 t/a fermentable waste and green clippings

Information on financing

Year of realisation:	2005
total investment costs:	€ 21 million
feed-in tariff electricity:	not available
tariff for heat sale:	not available

More information

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Ferti-NRJ, Passel, France

Biogas Plant Description

The centralised biogas plant in Passel-Noyon has been operating since 2009. The plant processes 80% industrial waste such as sludge, greases, screening waste and production scraps, and 20% sewage sludge. It is authorised to process up to 38 000 t/a of waste. The waste is homogenised in a mixing tank before injection in the digester. Fermentation takes place in two digesters (3000 m3 each). The digestate is dried and valorised as compost (NFU 44-095). The gas feeds two generators (1.4 MW). The electrical energy produced (10 950 MWh / a) provides for the needs of 9000 inhabitants of a nearby town. The thermal energy produced (12 300 MWH / a) is entirely valorised on site to maintain digester temperature, buildings and offices and the drying of the digestate.

Information on financing

Year of realisation:	2009
total investment costs:	€ 8 million
feed-in tariff electricity:	not available
tariff for heat sale:	not available

Technology at a glance

Biogas production:
4 500 000 m3/a (118 m3 / ton of waste treated)
Installed power: 1.4 MW
Digester volume (m^3): 2 x 3000 m^3
Type of waste used:
industrial waste (sludge, greases, screening waste, production scraps), sewage sludge
Amount of waste/raw material used as substrate:
up to 38 000 t / a (80% food waste)
Operating hours: not available

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