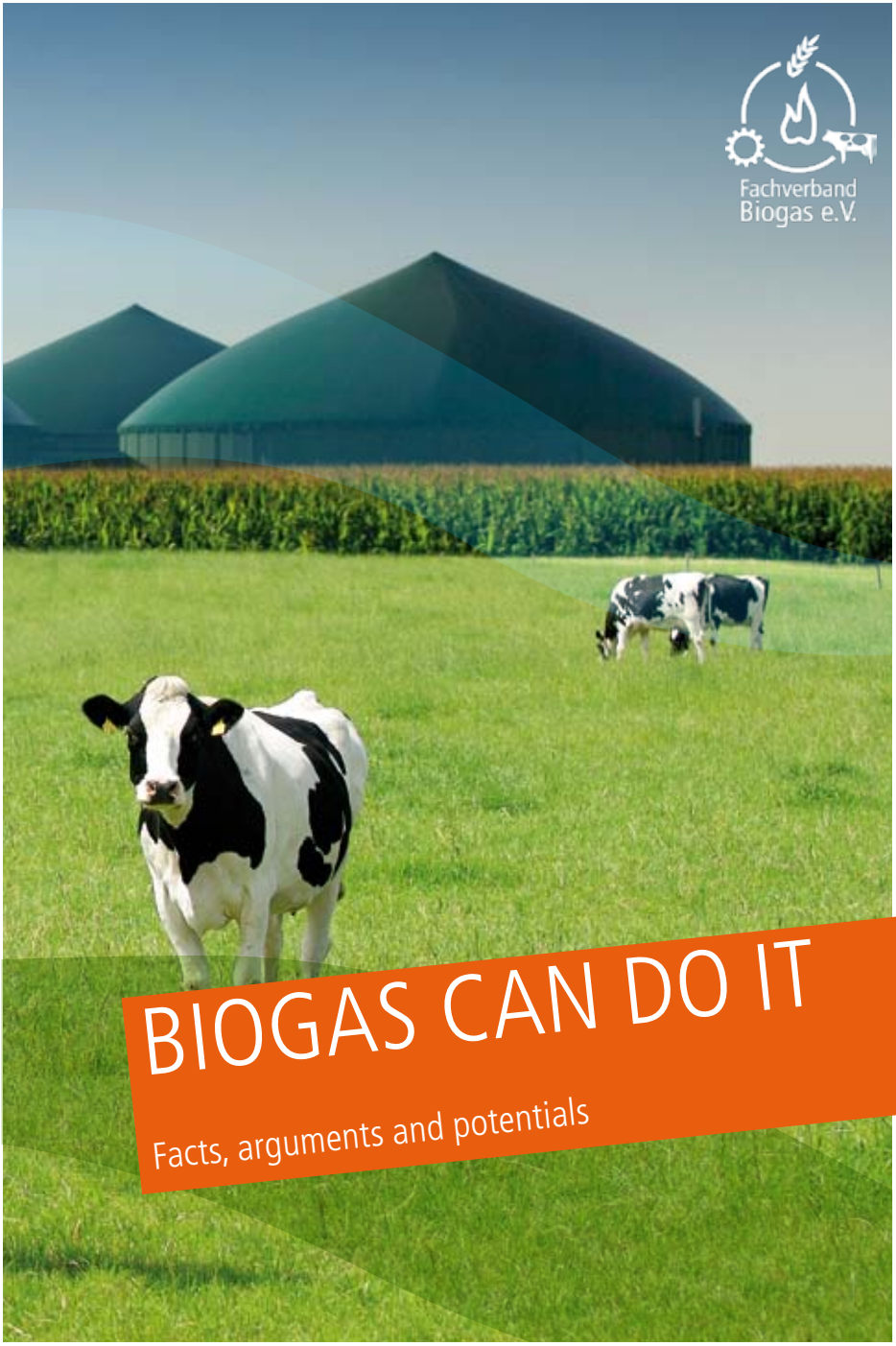

BIOGAS CAN DO IT

Facts, arguments and potentials

IMPRINT

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Closing date: December 2011

TABLE OF CONTENTS

Text colour:
Grey text explains background, black text contains basic information for biogas use.

BIOGAS IN FIGURES

Biogas helps make electricity supply safe
In 2011, about 18 billion kilowatt-hours (kWh) of electricity are generated from biogas. This is equal to a little less than 18 per cent of the electricity obtained from renewable sources and about 3.5 per cent of the total electricity consumption in Germany. On average, more than five million homes are supplied with electricity from biogas in 2011.

Biogas supplies us with heat
When biogas is converted into electricity in a cogeneration unit, heat is produced – some 18 billion kWh in 2011. This provides CO_2-neutral heating to over 530,000 homes today.

Biogas – for our mobility
When upgraded to biomethane, biogas is a motor fuel like natural gas. Biomethane can be used as fuel in natural gas-powered vehicles without technical modifications. At the beginning of 2011, more than 90,000 natural gas-powered vehicles had been registered in Germany. Nearly 200 of about 900 local natural gas filling stations sell fuel containing between five and 100 per cent bio-methane.

Biogas as a substitute for natural gas
Treated biogas can be fed into the natural gas grid without problems. This has two advantages: On the one hand, the place at which the gas is produced need not be the place where it is used and, on the other hand, the gas grid provides a giant storage and transport medium. By the end of 2011, about 60 plants will feed approximately 260 million cubic metres of bitomethane into the German natural gas grid.

Biogas is good for the climate
The substitution of electricity and heat from fossil fuels by biogas helps save about twelve million tonnes of harmful carbon dioxide in 2011. If biogas is produced from liquid manure, climate damaging emissions of methane from the storage and spreading of the manure are also avoided.

Digestion products replace industrial mineral fertilizer
When substrate is digested in a biogas plant, the mineral nutrients are not degraded and can be returned to the fields as valuable fertilizer. This closes nutrient cycles in regional ecosystems. Replacing one kilogram of mineral nitrogen fertilizer saves over six kilograms of CO_2 which would be released by the production of the mineral fertilizer.

Biogas is an all-rounder:
Biogas can be converted into electricity and heat or it can be used as fuel. Another use is as an equivalent to natural gas.

Construction of a biogas plant

Biogas is regional SME-based

Two thirds of sales in the industry are made to customers in the region and generate higher local added value. Industry sales through new construction, repairs, operations and supply of substrate amount to almost six billion euros in 2011.

Biogas saves jobs

In 2011, more than 40,000 people were employed in plant construction, service and operations, the maintenance of biogas plants and the cultivation of energy crops. Most of these jobs are regional and in agriculture. The farmer who operates a biogas plant can rely on it as a safe, long-term source of income. The remuneration for biogas fixed for 20 years in the Renewable Energies Act (EEG) compensates fluctuations of produce prices from conventional farming.

German biogas companies are global leaders

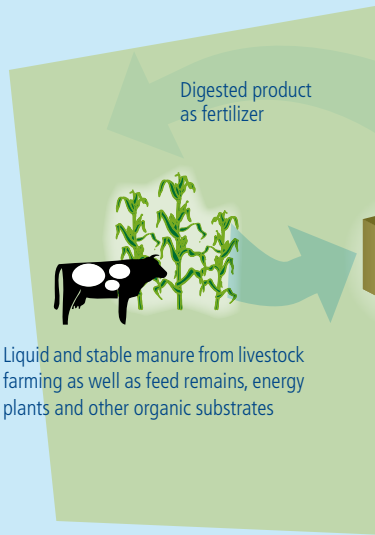
Biogas "made in Germany" is in high demand. As world market leader in this forward-looking technology, German firms are active in many countries around the globe. In 2011, they generate about 10 per cent of their turnover (500 million euros) abroad.

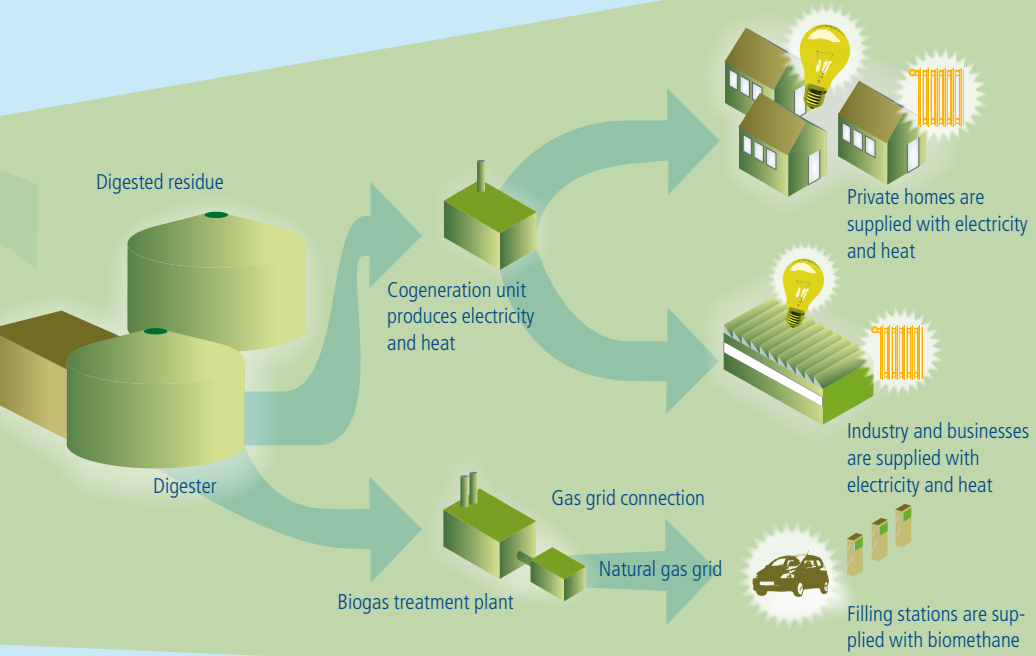
WHAT IS BIOGAS?

THE GENESIS OF BIOGAS:

Biogas is produced in biogas plants by the biological degradation of biomass – primarily agricultural substrate such as liquid or stable manure or energy crops (maize, rye, sugar beet, etc.). In addition to these inputs, biogas can also be produced from organic waste from rural districts, towns and villages, such as cut grass, waste food and by-products of the food industry.

Fermentation by bacteria in air-tight tanks, so-called digesters, produces biogas in a process comprising several stages. The bacteria are similar to those in the digestive tract of the cow.



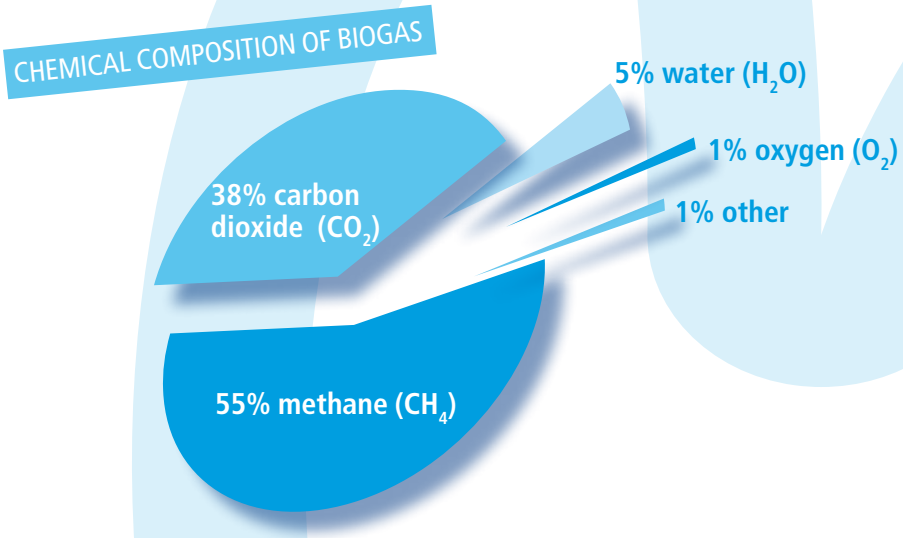

Digested residue
Digester
Cogeneration unit
produces electricity
and heat
Private homes are
supplied with electricity
and heat
Industry and businesses
are supplied with
electricity and heat
Gas grid connection
Natural gas grid
Biogas treatment plant
Filling stations are sup-
plied with biomethane

WHAT IS BIOGAS?

COMPONENTS OF BIOGAS

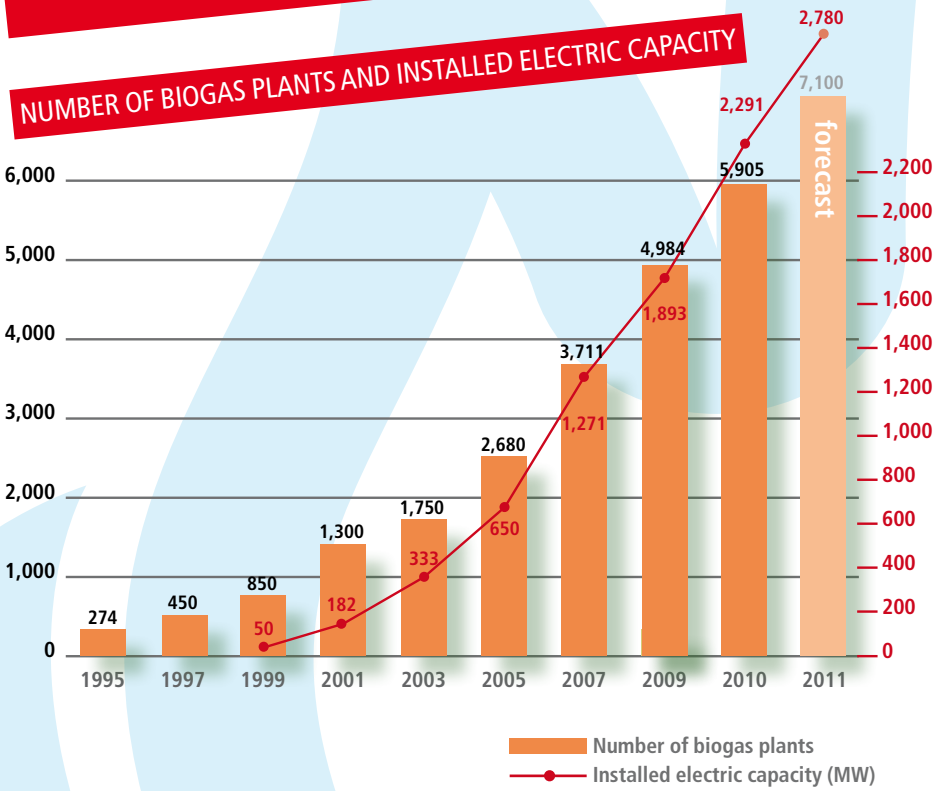
Like fossil natural gas, the essential component of biogas, which is responsible for the energy it contains, is methane (CH_4), a flammable gas. Depending on the substrate on which a biogas plant feeds the methane content of the biogas fluctuates between 50 and 65 per cent. The second most important component of biogas is carbon dioxide (CO_2), which accounts for 35 to 50 per cent.

The carbon dioxide (CO_2) is climate neutral because the energy plants have drawn it from the atmosphere for their growth. Other components of biogas are water (H_2O), oxygen (O_2) and traces of sulphur (S_2) and hydrogen sulphide (H_2S). If the biogas is upgraded to biomethane with about 98 per cent methane in a biogas treatment plant, that biomethane has the properties of natural gas.



WHAT CAN BIOGAS DO?

NUMBER OF BIOGAS PLANTS AND INSTALLED ELECTRIC CAPACITY



ELECTRICITY AND HEAT

In Germany, most biogas is converted into electricity and heat in a simultaneous process in cogeneration units at present. In 2011, about 7,000 German biogas plants supply electricity to more than five million homes, which equals about 18 billion kilowatt-hours (kWh). The heat produced when electricity is generated is either used locally for heating stables and homes or for drying wood or it is distributed to nearby homes through local heat distribution systems.

More electricity can be produced from heat by innovative systems such as Organic-Rankine-Cycle (ORC) plants.

Where the distance between the heat consumer and the biogas source is large, biogas can also be transported to the cogeneration unit in so-called micropipelines. These "satellite cogeneration units" are an efficient and future-oriented option.

WHAT CAN BIOGAS DO?

The heat can be used in different ways, for example:

- Heating of:
  - homes
  - schools
  - industrial buildings
  - swimming pools
  - greenhouses
- Industrial processes (steam, drying, cooling)
- Fertilizer production
- Electricity generation

BIOMETHANE AS A SUBSTITUTE FOR NATURAL GAS

Swimming pools are regular users of biogas heat

Instead of being converted into electricity directly, the carbon dioxide in biogas can be eliminated, the gas purified and the product – biomethane – fed directly into the public gas grid.

From there, most of the biomethane is converted into electricity and heat in cogeneration units on the basis of the Renewable Energies Act (EEG). The biomethane is withdrawn from the gas grid where the heat can be put to use best.

The German government has set the target of feeding six billion cubic metres of biomethane into the gas grid every year by 2020.This is almost seven per cent of today's consumption of natural gas in Germany. The target for 2030 is ten billion cubic metres.

In the past, the feeding of biomethane and the

biomethane market remained very sluggish. The main reason for this must be seen in connection with the lacking safety of investments in biogas feeding projects. What we need is a tool stimulating the offer of, and demand for, biomethane and providing the safety investors expect for their capital expenditure. In an eight month-process, the biogas industry, with the assistance of one of the leading solicitor's offices for energy law and together with a large number of market actors, has developed a concept for such a stimulating tool.

By making purchase obligatory and fixing an efficient remuneration with a market component, the Renewable Gas Feeding and Storage Act (EEGasG) would provide investors with the safety they need for their investments in biogas feeding projects. This would revive the market and act as a reciprocal booster of supply and demand in an interactive process. Without the EEGasG the targets of biogas feeding set by the German government would not be achieved by far. At present, about 60 biogas feeding projects are in operation; another 20 are in the pipeline or under construction. Biomethane accounts for less than one per cent of the natural gas consumption, at present.

GAS GRID AS LONG-TERM STORE FOR RENEWABLE ENERGY

The concept of the EEgasG outlined above not only includes biomethane, it also covers hydrogen and methane from wind electricity electrolysis and the downstream methanisation of "wind hydrogen". Feeding this renewable gas in the public gas grid can store energy for a long period of time (one year). Because the storage capacity of the gas grid is gigantic, seasonal fluctuations of wind electricity production can be compensated.

The EEGasG would, for the first time, make use of the second energy network available – the gas grid – as transport system and a gigantic, directly available long-term storage for renewable energy. The combination of the electricity grid and the gas grid will help overcome the challenges the move to alternative energies makes on storage and transmission capacity.

WHAT CAN BIOGAS DO?

100 per cent biomethane at the natural gas filling station at Munich Airport

MOTOR FUEL

The treated biogas also provides a highly efficient and climate-friendly fuel for natural gas- or biogas-powered cars. The fuel can be filled at the available natural gas filling stations – drivers fill a "virtual" mixture of biomethane and natural gas. Or they get pure biogas at a filling station that is directly linked to a biogas plant.

The first biogas filling station in Germany started operation in Jameln, Lower Saxony, in 2006. Today, about 20 filling stations sell 100 per cent biomethane, another about 175 stations add between five and 50 per cent biomethane to the natural gas. A car can drive up to 70,000 kilometres with the biogas obtained from one hectare of maize.

This makes biogas the most efficient biogenic motor fuel with an almost neutral carbon footprint. Unlike petrol and diesel powered vehicles, biomethane reduces pollutant emissions (hydrocarbons, carbon monoxide, nitrogen oxides, etc.) by about 80 per cent and saves money due to lower operating and fuel costs than fossil fuels.

Raw biogas is produced in the digester

Photo by: FHgitarre (flickr.com)

PROCESSING OF FRACTIONS

After eliminating methane (CH_4) and carbon dioxide (CO_2) from the raw gas, both gas fractions can be processed further. Methane, for example, can be converted to methanol, hydrogen or other hydrocarbons by chemical synthesis. CO_2 provides a valuable plant fertilizer, raw material for the production of dry ice or the basis for the methanisation of hydrogen from wind or photovoltaic electricity.

BIOGAS AS A PILLAR OF THE NEW ENERGY AGE

Energy (biomethane, electricity and heat) can continuously be produced from biogas. Because biogas can be stored, electricity generation can systematically be increased when consumption is high or it can be reduced at times of low demand. The production of electricity and heat from biogas is capable of complementing the base as well as the peak load.

As an essential part of the renewable energies, biogas is a major control variable for electricity from renewable sources. Biogas can compensate fluctuations of electricity generation from wind and solar systems and therefore makes a major contribution to the full supply of energy from renewable sources. As such, biogas dramatically reduces the dependence on fossil energy.

AGRICULTURE, NATURE AND CLIMATE PROTECTION

Photo by: pixelio zunami

BIOGAS AS AN ALTERNATIVE SOURCE OF INCOME FOR FARMERS

The production of biogas is gaining importance not only as an additional source of income for farmers but also as their principal source of earning. The compensation rates fixed for 20 years in the Renewable Energies Act (EEG) provide agricultural enterprises with the required income.

The regular earnings from the sale of electricity are an interesting option of compensating low producer prices (e.g., for milk or cereals) by the sale of biogas. Concepts that make use of local liquid manure in the biogas plant receive higher benefits under the EEG.

BENEFIT FOR AGRICULTURE

Energy plants take pressure off the traditional food markets. Overproduction in the EU member states had caused a continuous drop of the prices for farm produce since the mid-1980s. As the biogas industry developed, a new outlet was created which had positive repercussions on agriculture as a whole.

Biogas offers a number of outstanding interactions especially with regard to the methods of livestock farming. Pig and poultry farmers, in particular, need considerable amounts of heat. Heat from the generation of electricity in biogas plants is an excellent source for heating stables and pens. This not only applies to farms with biogas plants but, in particular, also to livestock farms near the site of the biogas plant to which heat can be supplied from the biogas plant, e.g., through a heat or gas micropipeline.

Since the EEG 2009, the use of natural manure (liquid manure, stable manure) has received particular support. This stimulus encourages the close cooperation between biogas plant owners and stock farmers. At the same time, the harmful emissions of methane from open manure tanks are avoided, by and large, when the manure is converted into energy in the biogas plant. At present, about 15 to 20 per cent of the manure produced in Germany is fermented in biogas plants.

BIOGAS IN LINE WITH AGRICULTURE

Many family farms lack the necessary capacity of operating a biogas plant as an additional source of income: dairy farmers have no labour to spare, beef farmers lack the substrate areas and processors usually find that capital is a limiting factor.

For these and other similar reasons the joint operation of a biogas plant is an interesting option. The stock farmers have the advantage that the manure is turned into high-grade fertilizer and– with high animal populations and accordingly large amounts of manure – can use the biogas plant as a "stock exchange" for manure which is used by arable farmers.

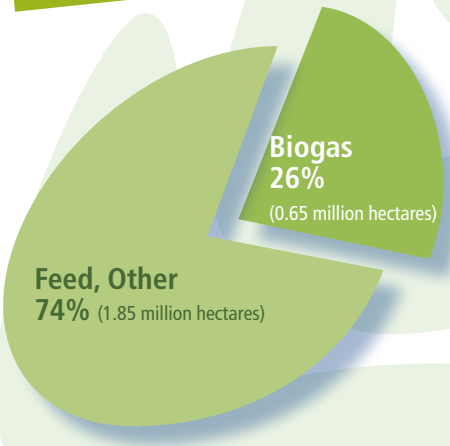
AGRICULTURE, NATURE AND CLIMATE PROTECTION

ENERGY CROPS

Biogas plants can digest a wide variety of energy crops. In addition to conventional biogas substrates such as maize silage, cereal whole plant silage or grass silage, more and more alternative crops are grown increasingly. Examples include beetroot and millets, but also entirely new varieties such as the cup plant, Szarvasi grass or wild plants, whose cultivation and use are under trial at present. Frequently, energy crops are grown as the only main crop. In some regions, two crops can be grown in succession: For example, maize or millet can follow the harvest of green rye late in spring and are harvested in autumn. Professional management of the crop rotation which maintains the fertility of the soil is critical to high biomass yields over a long time.

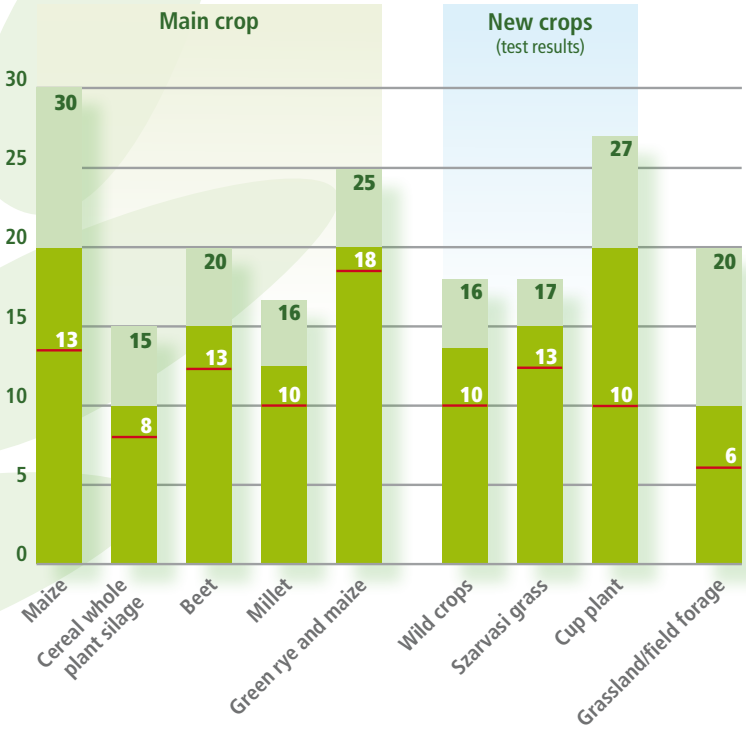
Catch crops and undersown crops that cover the soil in winter and thereby reduce erosion can be one building block. A positive side effect is that the growth can also be utilized as feedstock in a biogas plant. In any case, energy crops are grown on the basis of good farming practice and in accordance with European requirements (cross compliance).

MAIZE CULTIVATION IN GERMANY IN 2011



Sources: Statistisches Bundesamt, FNR e.V. 2011; Vetter et al. 2009

BIOMASS YIELD IN TONNES OF DRY MATERIAL PER HECTARE



Source: Fachverband Biogas e.V. – own data
After Conrad 2010; Conrad 2011; FNR 2010;
Geißendörfer 2011; Karpenstein-Machan 2005; LWG

Good growing conditions
Average growing conditions
Poor growing conditions

AGRICULTURE, NATURE AND CLIMATE PROTECTION

PLATE, FEEDER AND TANK

On a global scale, there is a giant untapped potential of areas that can be used for the production of biomass for food or energy. In addition to that, the yield potential of much farmland is greatly underused. Despite that, arable fields will remain a scarce resource due to the climate change, the growing world population and changed consumer habits. So it is important to make production as efficient as possible. The plate, the feeder and the tank must be filled. New energy crops and new cultivation systems make decisive contributions in this quest.

The difficult nutritional situation in many developing countries is not a consequence of the cultivation of energy crops. Hunger has many sources: Lacking investment in the improvement of agriculture, price speculation, no access to the market and export. Besides, the agricultural overproduction in the 1980s and 1990s forced the poor countries to import food.

The cultivation of food in their own countries became unprofitable and, as a consequence of this, wide areas lie fallow. The most important task, therefore, is to re-establish the farming structures and solve the problems of food distribution. Besides, as a rule, biomass from which biogas is produced is grown in Germany and not imported from abroad.

To an ever larger degree, biogas production from residual material and waste is also practiced in developing countries as an interesting option of the local supply of energy. In this way, an important contribution can be made to the economic development of these countries and to climate protection.

Irrespective of that, Germany still has reserves for expanding the cultivation of energy crops. At present, such crops are grown on about two million hectares of land. Given a continuous rise of yields, by 2020 between 2.7 and 3.9 million hectares could be available for energy crops without curtailing food production.

CLOSED-LOOP SYSTEMS

The fermentation of manure and biomass in biogas plants converts the nutrients in the substrates into forms that plants can use more efficiently. Besides, digested substrate is a lot less odorous than undigested manure. People in areas with intensive livestock farming know best what that means.

Biogas plants are the last link in many closed-loop systems. The digested product leaving the biogas plant can replace costly industry-made fertilizer, when returned to the field. This closes the local natural nutrient cycle.

In addition, biogas plants are ideal digesters of organic residue and biological waste (e.g., cut grass, kitchen refuse, waste food) for conversion into energy. Here again, the fermentation product is a valuable fertilizer for the soil. Biogas links nutrient cycles with energy production.

The right size of the biogas plant for its site is a decisive criterion. The size of the plant should fit the agricultural and natural structures.

AGRICULTURE, NATURE AND CLIMATE PROTECTION

ACTIVE CLIMATE PROTECTION

The amount of carbon dioxide released during the utilization of biogas as energy is equal to the amount of CO_2 which the plants have taken up from the atmosphere for their growth. As a result, more than eleven million tonnes of harmful CO_2 emissions were avoided in 2010.

The following components contributed to this result:

- Replacement of fossil fuels
- Substitution of mineral fertilizer in the nutrient cycle of farms with a biogas plant
- Lower methane emission (23-times more harmful to the climate than CO_2) from the storage of animal droppings by feeding them to biogas plants
- Avoidance of harmful climate gases by feeding municipal waste in biogas plants

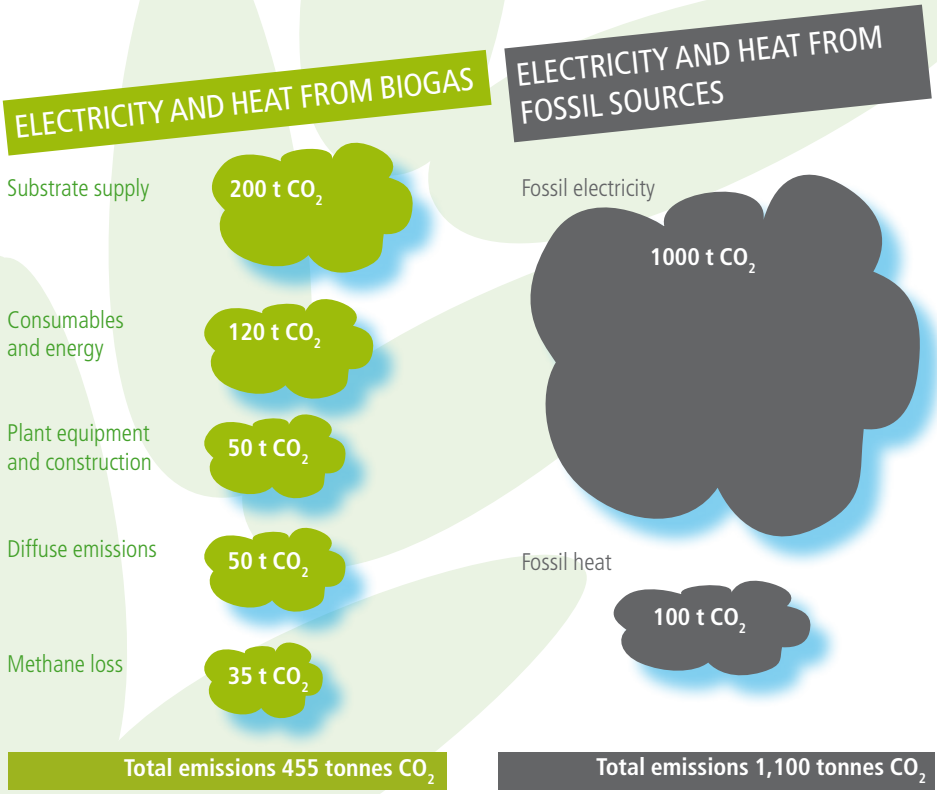
The 190-kW biogas plant illustrated on page 21 generates about 1.5 million kilowatt-hours of electricity and 350,000 kilowatt-hours of heat every year. This is enough to supply about 430 homes with electricity and 30 homes with heating energy. The biogas plant consumes short of 7,000 tonnes of substrate (of that 2,500 tonnes cattle manure).

The greenhouse gas emissions released by the supply of the substrate (cultivation, fertilization, transportation) amount totally to 200 tonnes in total. There are other emissions from the construction and operation of the plant. The total emission is 455 tonnes of CO_2.

If the same amount of electricity and heat was provided from fossil fuels, the total emissions would amount to 1,100 tonnes of CO_2. Thus, the net savings from the use of biogas are 650 tonnes a year. Even higher saving potentials can be generated if manure or residues and waste are digested. The balance can be improved even more if more heat can be utilized, in which case savings of almost 100 per cent are realistic.

In addition to the climate balance, the energy balance of a biogas plant is clearly positive, as a rule: Up to five times more energy is generated than consumed.

GREENHOUSE GAS EMISSIONS OF A 190-KW BIOGAS PLANT COMPARED WITH A FOSSIL POWER PLANT OF THE SAME SIZE



COLOUR TO THE FIELD

FARBE INS FELD

BIOGAS PROTECTS THE ENVIRONMENT

Biogas is beneficial for the environment. Not only because the resources of this planet are finite and must be saved but also because active climate protection is practiced. The selection of different energy crops can add variety to crop rotations for an attractive landscape and preserve it as a food source and retreat for many animal species.

Winter catch crops and wild plant mixtures, in particular, ensure that alternative habitats are available for wild animals in the cold season. Besides, wild plants or strips sown to flowering varieties provide ample sources of food for bees and other insects from early to late in the year.

On this background, the Fachverband Biogas started the project „Colour to the Field" (FiF) in 2010 to encourage the cultivation of flowering species and wild plants. In addition to the ecologically valuable effects for flora and fauna and the avoidance of soil erosion, such measures improve the visual impression of energy crop fields and the communication between passers-by and plant owners. By the way, hunters are sure that wild boars are attracted by strips of flowering plants so they have a good hunting lane.

Idealistic support comes from:

Ministerium für Umwelt, Gesundheit und Verbraucherschutz
Land Brandenburg
BUND Freunde der Erde
DMK
natur+mensch

Seed suppliers:

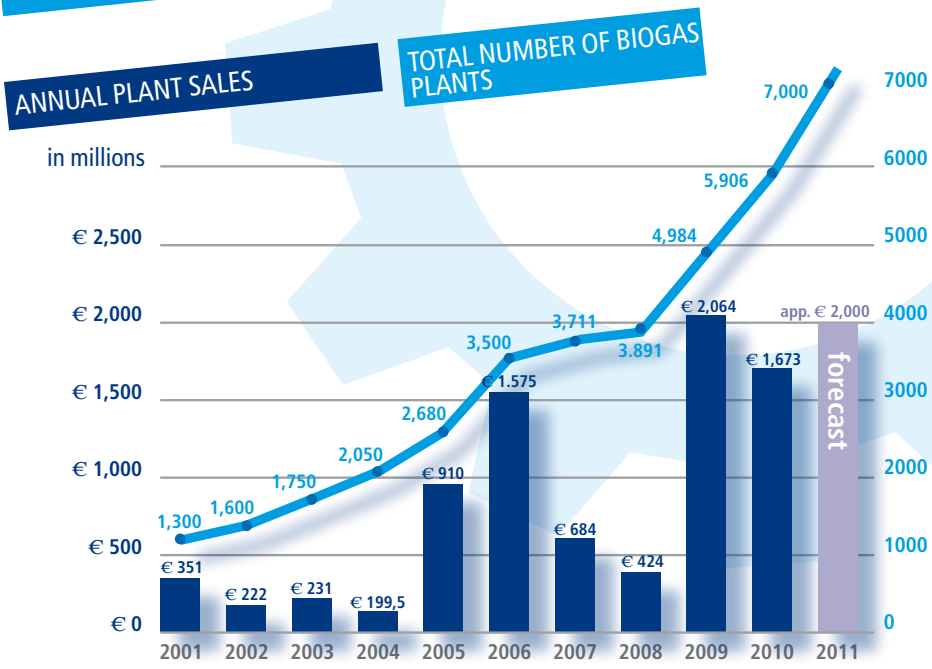
camena SAMEN
SaatenZeller
BSV Saaten
DSV
Rieger-Hofmann GmbH

With the assistance of numerous supporters the project was advanced and its awareness among people raised further this year. Five seed suppliers offer special terms and conditions for members of the Fachverband Biogas and thereby encourage the cultivation of such plants on larger areas.

Additional support for the project is available through the „Competition of Regions and Biogas Plant Owners". In this competition, the region in Germany in which plant owners grow flower crops on the largest area and the plant owner who creates the most beautiful flowering strip with the most species are chosen.

www.farbe-ins-feld.de

BIOGAS – DRIVER OF ECONOMIC GROWTH



BIOGAS – A SUCCESS STORY

The biogas industry has become one of the prime movers of economic growth in Germany. The number of biogas plants in operation will go up to about 7,000 by the end of 2011; they provide an aggregate electric output of approximately 2,700 megawatt (MW). Today, the German biogas industry is the undisputed world market leader in the distribution and development of biogas technology. The basis of this unique success story is an EEG-based innovative industry with small and medium size firms.

Jobs

In 2011 alone, the turnover of the biogas industry amounts to almost six billion euros; the total workforce in the industry is over 40,000. An army of specialists is needed from the initial idea to the finished plant and its professional operation. More than 700 SMEs provide service and maintenance activities, provide substrate (e.g., energy plant growers) or utilize the output (biogas, electricity, fermentation products). The operation of the 7,000 biogas plants in Germany secures approximately 10,000 jobs. This strengthens the local medium-size enterprises in the rural areas.

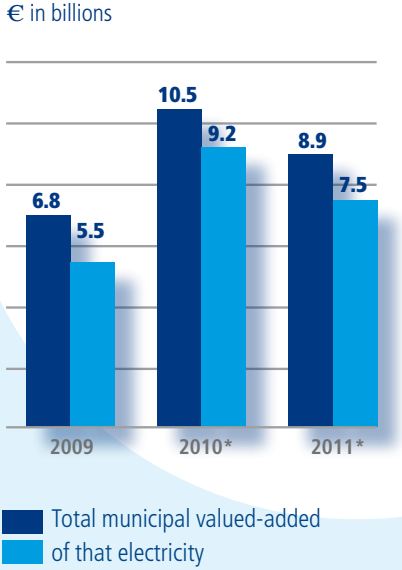
BIOGAS – A TOP EXPORT PRODUCT

The world market leadership of German biogas firms opens up most interesting opportunities for export and development. Many other countries have discovered the benefits of the biogas technology and, following the German example, establish attractive compensation schemes, e.g., Italy, the UK, France, Spain, Austria and Slovakia.

REGIONAL IMPACT

Biogas plants are locally based and make the stored energy of the sun available in the form of biomass from the region. The value added by the construction and operation of a biogas plant is not only enjoyed by the plant owner and the energy consumer but by the whole region. At times of low trade tax revenue, biogas plants provide stable and calculable income to the municipalities. The involvement of local trades and service firms in the planning, construction and operation of biogas plants binds capital that would otherwise go abroad to the exporters of fossil energy producers and therefore strengthens the rural economy. Regional enterprise means regional jobs, trade tax income and capital. On its website, the Agency for Renewable Energies has a calculator which can be used for defining the monetary earning effects of a region.

DEVELOPMENT OF MUNICIPAL VALUE-ADDED DUE TO RENEWABLE ENERGIES



* Calculated on the basis of the BEE development forecast; Source: IÖW; as of 10/10

BIOGAS – DRIVER OF ECONOMIC GROWTH

RELIABLE AND AFFORDABLE ENERGY

Energy from biogas is a reliable and an EEG-based calculable source of energy. Extreme price rises such as for crude oil or natural gas and the products made from them are excluded. The energy is based in the region and is not subject to supply fluctuations due to crisis areas or speculation. If you add all the benefits of local electricity feeding, e.g., no need of paying user charges, plus base load capability and saving of greenhouse gases, the compensation paid for biogas-based electricity is already nearing the average price per kilowatt electricity consumers in Germany are forced to pay today.

ENERGY FROM THE REGION FOR THE REGION

Local feeding makes it possible to encreasingly extend the production of electricity and is independent of centralized structures. The energy for a region is produced by site-adapted biogas plants in that region and as such strengthens the feeling of identity in rural areas.

BIOENERGY VILLAGES

Biogas villages are typical examples of the way the regional community concept can consistently be translated into practical results today. The inhabitants plan and manage their local energy supply from sun, wind and biomass and profit from this on all levels. More information at:
www.deenet.org or
www.kommunal-erneuerbar.de

SUPPLY HEAT TO NEIGHBOURS

Ideally, where a biogas plant turns the gas into electricity on site, all potential heat users are involved and share in the different positive effects of the project from an early point in time. Local heat pipelines, which can even be operated by the local population, can bring biogas plant owners and their neighbours closer together.

LANDSCAPE MANAGEMENT AND PRESERVATION OF RURAL STRUCTURES

Large areas have fallen into disuse due to the extreme volatility of the prices of farm produce. In some regions, grassland is difficult to lease and is often not utilized at all. Biogas plants are efficient and sustainable consumers of the grass grown on these areas and the landscape can be managed efficiently. Farmers can claim compensation of the cost of management activities under such joint schemes.

SALE OF GRASS AND SUMMER PRUNING

Every year, large amounts of energy-rich and digestible biomass are produced in gardens, parks, sports fields, etc. Profiting from the increased utilization of these sources of energy, hardly tapped in the past, is not only the party supplying the biomass, i.e., municipalities and home owners, but also the plant owners and the environment. In this case, biogas closes regional cycles.

FRAMEWORK CONDITIONS

NEW ENERGY POLICY IN GERMANY

After the disaster in Fukushima in March 2011, the German government decided not to continue on the route of permitting extensions of the operating lives of nuclear power plants it had adopted under its energy strategy in September 2010.

In June 2011, a package of new laws was adopted under which the energy system in Germany will be reoriented away from nuclear power and fossil fuels to renewable energies.

The roadmap provides for a gradual phasing out of all nuclear power plants until the year 2022. At the same time, the development of renewable energies (EE) will be speeded up. The target is to raise the share of renewable electricity in the gross electricity consumption to 35 per cent by 2020. The target for 2050 is 80 per cent electricity from renewable sources. Along with that, the German government's objective is to reduce greenhouse gas emissions by 40 per cent in 2020 in comparison with the base year 1990. Further intermediate targets are defined until the final reduction of 80 to 95 per cent is to be obtained by 2050.

THE RENEWABLE ENERGIES ACT (EEG)

The external costs of the generation of electricity from fossil fuels and uranium are not reflected in the present electricity prices. Likewise, the market prices in the heat and motor fuels markets do not reflect the expenditure that would be needed, for example, if the damage to the climate and the environment inflicted by the extraction and combustion of fossil fuel was to be repaired. As a consequence of this, electricity, motor fuel and heat from biogas are still more expensive than those from non-renewable sources.

It follows that if the share of biogas and other renewable energies in Germany is to increase, efficient transportation systems are needed. Globally the most successful and most (cost-) effective transportation system for the further development of renewable energies in the electricity sector is the Renewable Energies Act (EEG).

In the first half of 2011, electricity from renewable sources in Germany accounted for 20.8 per cent compared with six per cent in the year 2000. The EEG has been instrumental to a grandiose development also in the biogas sector. Until the Act became effective in 2000, the number of biogas plants in entire Germany amounted to a little over 1,000; their combined total output was 65 Megawatt (MW). At the end of 2011, about 7,000 plants with over 2,700 MW output generate approximately 18 billion kilowatt-hours of biogas electricity a year.

This amount can ensure a reliable supply of renewable electricity to about 13 per cent of the 40 million homes in Germany. Essential factors of this Act, which has meanwhile been adopted by 46 countries throughout the world, are the guarantee of the feeding bonus for 20 years, the obligation of the electric grid operator to give priority to the connection of renewable energy plants and the priority of the feeding of renewable energy over conventional energy. These general conditions give investors the reassurance that has been critical to this unique technology development in Germany.

UTILISATION OF HEAT AND MANURE UNDER THE EEG

The utilisation of the heat produced – together with electricity – during cogeneration has been stimulated by the EEG since the first revision in 2004: Until the EEG 2009, useful approaches were eligible to the so-called cogeneration bonus of two and three cents, respevtively for the simultaneous utilisation of electricity and heat. Since then, hardly any biogas plant has started operation without the claim to that bonus. In the EEG 2012, the cogeneration bonus has been replaced by the obligation of utilising 60 per cent of the heat.

The processing of liquid manure not only avoids greenhouse gas emitted by electricity and heat from fossil fuels, it also prevents the emission of methane from open manure stores. Therefore, the fermentation of liquid manure is particularly good for the climate and eligible for subsidy. The mistakes of the so-called "manure bonus" of the EEG 2009 have been set right in the EEG 2012.

FRAMEWORK CONDITIONS

Aggregation of bonuses will be forbidden from 2012. This should make the discussion of biogas more relaxed, most of all in areas with intensive livestock breeding.

The first biogas feeding plant started operating near Munich in 2006. It feeds biogas upgraded to biomethane directly in the natural gas grid. Since then, about 60 other plants have followed suit. Now (autumn 2011), a total of about 260 million standard cubic metres of biomethane are injected in the German natural gas grid – if the targets of the German government are met, this figure will go up to six billion cubic metres by 2020.

As set out on page eleven, the Fachverband Biogas is convinced that the implementation of the Renewable Gas Feeding and Storage Act (EEGasG) is an absolute necessity if the feeding targets are to be achieved.

With the establishment of a liquid biomethane market based on the EEGasG, biomethane would be available for direct conversion to electricity with local use of the heat and for cogeneration at any place, as a substitute for natural gas and as fuel for natural gas-powered vehicles.

RENEWABLE ENERGIES HEAT ACT

Under the Renewable Energies Heat Act (EEWärmeG) adopted in 2009, builders are obliged to include a certain amount of the heat for new buildings from renewable energies. Alternatively, the external envelope can be insulated more efficiently than prescribed by the Energy Saving Ordinance (EnEV). In the opinion of the Fachverband Biogas, these regulations remained ineffective, by and large, in the biogas sector. A new tool is needed for the efficient conversion to renewable energies of the energy sector which with 50 per cent end energy consumption is the largest single sector.

The Bundesverband Erneuerbare Energie (BEE) has developed the „Heat Bonus Model" that adds reliability and constancy to the volatile funds of the market stimulation program (MAP) for aids towards investments in renewable energy heat equipment by an off-budget approach. Developed suitably, the heat bonus concept could also be applied to line-bound concepts with biogas heat.

BIOFULES QUOTA ACT

Under the Biofuels Quota Act, biomethane in the motor fuels market can be recognised in the context of the quota obligations for renewable fuels. This possibility is gaining importance. However, because the market for natural gas-powered vehicles is (still) very small with 90,000 vehicles in Germany, not enough biomethane can be sold.

To effectively expand the biomethane/natural gas engine fuels market, the Fachverband Biogas demands an amendment of the tax levied on company cars in favour of gas-powered cars, an increase of the biomethane content in natural gas fuel to 50 per cent by 2015 and to 100 per cent by 2020, an increase in the number of gas filling stations by 50 a year until 2015 and the standardisation of the price display at filling stations, so that the lower price of natural gas/biomethane in comparison with petrol fuel is directly visible to consumers.

POTENTIAL AND OUTLOOK

BIOGAS POTENTIAL BY 2030

On the basis of KTBL data (2010) for the potentials in waste and residual material and on the assumption that energy crops for biogas production are grown on two million hectares, the Fachverband Biogas e.V. presumes a potential of well over 7,800 MW of installable electric capacity.

Assuming an internal electricity consumption of eight per cent and 8,000 full-load hours a year, a total of 57.6 terawatt-hours of electricity could be produced. This is equal to about eleven per cent of the present electricity consumption in Germany.

BIOGAS POTENTIAL UNTIL THE YEAR 2030

Products	Potential installable capacity (MW)
Energy crops	3,750
Natural manure (liquid and stable manure, etc.)	1,545
Farming by-products (beet leaves, straw, etc.)	1,503
Purely vegetable by-products (colza cake, etc.)	562
Biological waste	337
Animal by-products (blood, fat, etc.)	126
total	**7,823**

Source: Internal calculations;
Data base: KTBL 2010

Assumptions for the calculation:
Four million hectares of arable land are available on which energy crops can be grown, of that two million hectares for biogas; 8,000 full-load hours and eight per cent internal electricity consumption.

BIOGAS OUTLOOKS

Biogas is currently the only regenerative energy source available at low cost through the natural gas grid or stored under plastic covers in biogas plants. To manage the peaks and valleys of electricity production from wind and photovoltaics systems in the future energy system, a controllable renewable electricity generation option is needed. Biogas can play that part, at least to some extent, in the next few years. Therefore, biogas will be instrumental to the implementation of the fundamental reorientation in energy policies.

In addition to the need-based production of electricity, biogas will also become more important as fuel for natural gas-powered vehicles. In comparison with petrol fuel, biogas fuel reduces greenhouse gas emissions substantially. In this way, biogas helps car manufacturers reduce their fleet emission levels.

In addition to that, the role of natural gas as an input for industrial processes is bound to grow further. Many industrial applications need natural gas which must gradually be replaced by a renewable alternative.

FACTS VS. PREJUDICES

LEASE MARKETS AND PRICES

A biogas plant, if planned and run on realistic assumptions, cannot afford paying high lease rates for a longer term. The owner is bound to the remuneration for electricity feeding provided in the EEG Act for 20 years and in years of low biomass prices must make provision for lean years. If, despite that, lease rates of 800 euros are charged in some regions, the reasons are not alone found in the biogas: Rising prices for farm produce, notably market crops, and the area-related payment of premiums by the EU also affect lease rates.

In some regions, the situation is traditionally strained. Notably for regions with high cattle populations such as the Weser-Ems area where the number of pig fattening places has gone up in 2010. The Fachverband Biogas recommends that new biogas plants should be planned and built with local constraints in mind. The size of the plant should be chosen with a view to the substrate supply available locally. If additional energy crops are needed, substrate purchase should be preferred over leasing additional fields. Basically, the construction of plants by a community of owners generates a lot of positive synergy effects.

THE ELECTRICITY PRICE

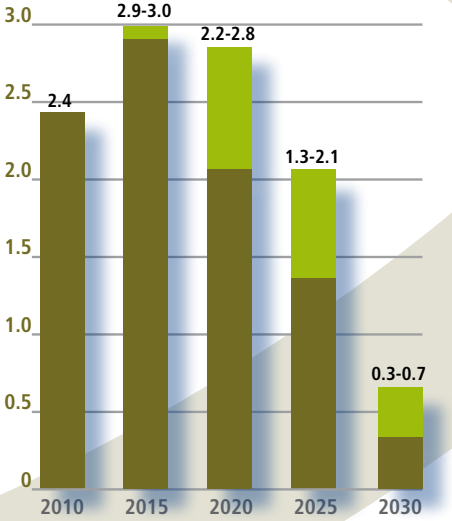
The compensation for electricity from renewable sources is charged to consumers as part of the general electricity price according to the EEC contribution procedure, which ensures that the charge is on an as-consumed basis. In 2011, the extra cost due to the EEG amount to 3.53 cents per kilowatt-hour. According to the study, the cost will drop to 0.3 – 0.7 cents by 2030. Despite the strong expansion of biogas and photovoltaics plants in 2011 the EEC contribution for 2012, according to data from the German Federal Network Agency, will only go up by 0.062 cents/kWh to 3.592 cents/kWh.

This does not even consider the avoided external cost: The substitution of fossil fuels by renewable sources avoided about 120 million tonnes of CO_2 in 2010. This is equal to savings of eight billion euros towards climate and environment damage.

Substrate supply

FORECAST OF THE DEVELOPMENT OF THE EEG COST SHARE

Cents per kilowatt-hour



Source: DLR/IWES/IfnE; date: 12/2010

The calculations are based on a revised development scenario for the renewable energies which, first and foremost, considers the strong growth of photovoltaics since 2009. The bandwidth of the cost share is the result of different assumptions as to the development of the wholesale prices of electricity

ODOUR AND NOISE

The processes in a digester substantially reduce the intensive odour we fear when liquid or stable manure is spread in the field. Odour emissions from biogas plants can only occur if the biomass is not stored properly before or after the process, the biological process gets off balance or poorly digested material is spread. Correct planning of the plant and its controlled operation are therefore getting more and more into the focus of planners and designers of biogas plants.

Like odour, noise emission is regulated sufficiently. Biogas plants must comply with the statutory limits. Experienced planners and the choice of the optimum site, the use of low-noise components (noise-insulated cogeneration rooms or drives) and suitable noise protection measures (earth walls, enclosures, location of buildings, etc.) help reduce noise emission.

FACTS VS. PREJUDICES

TRAFFIC VOLUME

Biogas plants require a certain amount of logistics to move the biomass to the plant and take the fermentation products from the plant back to the fields. This traffic volume is similar to what is normal in agriculture and will not be higher due to biogas plants: The fields would be managed also without biogas plants and manure is produced on any livestock farm. Depending on the available transport equipment, only a few trips are required and can be restricted to a few small time windows.

At the time the plant is planned, a logistics concept (approach route, by-passes, etc.) should be agreed. Owner and local residents can agree on maximum periods at the wheel during night time, lower driving speeds and other voluntary measures to reduce the traffic volume. This avoids potential traffic peaks and creates trust among the population. For practical tips, see "Fahrerknigge" (Driver Etiquette) of Biogasforum Bayern (www.biogas-forum-bayern.de)

PLATE **AND** TANK

At present, about 850,000 of a total of 17 million hectares of agricultural area are used for the cultivation of biogas crops in Germany. This is equal to a little less than five per cent of the area. Realistic studies say that potentially two million hectares can be used for biogas crops without putting food production at risk. In times of ruinous prices for farm produce and oversupply in the food market the utilisation of land for energy purposes helps stabilise prices in agriculture. Thus, the parallel use of area for the plate and the tank is not only unproblematic; it gives farmers the reassurance of long-term safe existence and realistic prices for their produce.

The fact that famines occur despite the availability of sufficient arable land has noting to do with biogas and the cultivation of energy crops. This is a problem of mass production in the globalised food industry. In many developing countries, agricultural structures and the possibility of self-sufficiency in food were systematically destroyed by the import of cheap food for decades.

In the so-called developed countries, on the other hand, the value of food seems to be constantly declining: Going by estimates, about half the food grown and produced in Germany, i.e., up to 20 million tonnes a year, end up as waste; most of that already on the way from the field to the shop.

PLANT SAFETY

Biogas plants are built and operated according to statutory requirements; they are maintained and repaired in regular intervals. A biogas plant can only start production after inspection by a competent expert or a central approval authority. The proper execution of the erection, installation and the site conditions must be certified to ensure that the plant is in good technical condition.

If these fundamental legal requirements are met, there is no risk of deflagration or explosion in a biogas plant. Because the process in the biogas plant is a closed-loop system, a potentially explosive atmosphere is almost certainly excluded under normal operating conditions.

To raise the safety of biogas plants even further, the Fachverband Biogas e.V. offers regular training courses for plant owners and operators, during which the correct behaviour during extraordinary events such as digester cleaning or repairs is explained.

CLIMATE BALANCE

Biogas plants have a uniquely positive climate balance. According to calculations by Fachverband Biogas e.V., one kilowatt-hour of electricity causes 290 g of CO_2. By comparison, generating the same amount of electricity from a fossil energy mix releases 720 g of CO_2.

Consequently, the biogas plant saves 430 g of CO_2 or 60 per cent of the climate gas for every kilowatt-hour generated. If waste and residues are digested, the result is even better. In addition, cattle manure in biogas plants avoids methane emissions otherwise unavoidable in conventional storage.

THE BASICS OF BIOGAS

GAS AND ELECTRICITY YIELDS:

1 cubic metre (m³) biogas =
50 to 75 per cent methane
30 to 50 per cent carbon dioxide + other gases
5.0 to 7.5 kWh total energy

1 m³ biogas =
1.5 to 3 kWh electricity

1 hectare silage maize =
7,800 to 10,000 m³ biogas =
16,000 to 18,000 kWh electricity =
electricity for 4.5 to 5 homes
10 to 20 m³ digestion volume

1 tonne (t) silage maize = 0.8 t fermentation product

1 head of cattle =
20 m³ liquid manure a year =
650 m³ biogas/year=
0.15 kW permanent electric output
(or conversely: Manure of 700 head of cattle is needed for 100 kW)

An average 190 $kW_{el.}$ biogas plant supplies 450 homes with electricity and about 30 homes with heat. This avoids, on average, 650 tonnes of CO_2 and 20,000 kilograms of mineral fertilizer.

INVESTMENT:

Depending on plant size:
4,000 to 7,000 euros per $kW_{el.}$

Investment for a 190-$kW_{el.}$ biogas plant, on average: 900,000 euros

SPECIFICATIONS:

Cogeneration unit efficiency
Electricity: 35 to 45 per cent
Heat: 35 to 60 per cent
Total: about 85 per cent

Average hours of operation of a biogas plant
7,500 to 8,500 hours a year

Electricity consumption of the biogas plant
5 to 10 per cent

Heat consumption of the biogas plant
20 to 35 per cent

Average plant size
390 $kW_{el.}$

Working time input in the operation of a biogas plant
3 to 7 man-hours per $kW_{el.}$ per year

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The Fachverband Biogas e.V. is the largest association representing the biogas interests in Europe. The Association staff in Freising, Berlin and the regional offices is supported by many unpaid activities in 23 regional groups. The target is the continued sustainable expansion of biogas use in Germany.