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Bioeconomy BW

Biogas and sustainability

The German Renewable Energy Sources Act (EEG) has led to a considerable increase in the use of biogas in Germany. However, increasing biogas production must make ecological sense and not generate conflict with the sustainability objectives of environmental conservation schemes. There must therefore be a careful consideration of the overall conditions. An analysis of the ecological impact of the generation and use of biogas in Germany taking into account legal and economic aspects was coordinated by ifeu - Institute for Energy and Environmental Research in Heidelberg and recommendations were given to policy makers.

Biogas plant.
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The latest version of the Renewable Energy Feed-in Act (also known as the Renewable Energy Sources Act, EEG), which came into force on 1st January 2012, sets the following goals: the percentage of renewable energies will represent at least 35% of total gross electricity consumption

and 18% of total energy consumption by 2020. After that date, a continuous increase is prescribed, reaching 80% of total gross electricity consumption by 2050.

The purpose of the EEG, which was adopted in 2000 by the Red-Green coalition, is to facilitate the sustainable development of energy supply, protect the climate and the environment and conserve fossil resources. Many experts from Germany and abroad agree that the EEG was instrumental in "turning Germany into the only country in the world that has managed in a relatively short time to substantially increase the proportion of renewable energies in total energy consumption," said Dr. Claudia Kemfert, Professor of Energy Economy and Sustainability at the Hertie School of Governance.

Expansion of biogas facilities and maize fields

The number of biogas plants in Germany has increased exponentially over the last few years. At present, Germany is home to around 7,100 biogas plants. Around 1,900 new facilities were established in 2009 and 2010. The 7,100 biogas plants have an electrical power capacity of over 2,700 MW, which corresponds to the electrical power capacity of two big nuclear power stations (according to information from the German Biogas Association). Each individual biogas plant in Germany only has an average electrical power capacity of around 380 kW. Due to the feed-in tariffs and other incentives as set out in the EEG, there is a growing tendency towards the construction of small or medium-sized biogas plants. There are huge regional differences: big plants dominate in the northwestern Lower Saxony and eastern Germany, whereas Baden-Württemberg has a large number of mainly small biogas plants. If you drive from Ulm to Ravensburg (eds. note: cities in the south of Germany approx. 86 km apart) you'll pass numerous farms with on-site biogas plants in close vicinity to one another.

Another thing that becomes blatantly obvious is the enormous areas set aside for maize cultivation. Maize cultivation accounts for around one fifth, or more in some areas, of all agricultural land in Germany. Instead of growing grain varieties for human and animal consumption, many farmers have started growing silage maize for utilization in biogas plants. In 2010, the cultivation of silage maize in the Ulm/Ravensburg region increased by 15%.

The reason for this expansion is that silage maize (also known as "energy maize") delivers the highest yield of input material for the production of biogas. One ton of wet maize silage generates around 200 m^3 of biogas, which corresponds to around 105 m^3 of methane. This is six to seven times more methane than can be generated from liquid cattle or pig manure. The expansion of silage maize production for exclusive use in biogas plants is mainly due to the crops' relatively high energy density as well as the technology bonus for dry fermentation, a remuneration scheme established by the German government in a previous version of the EEG aimed at encouraging the production of energy from renewables (known in German as "nachwachsende Rohstoffe", NawoRo).

Silage maize harvest.

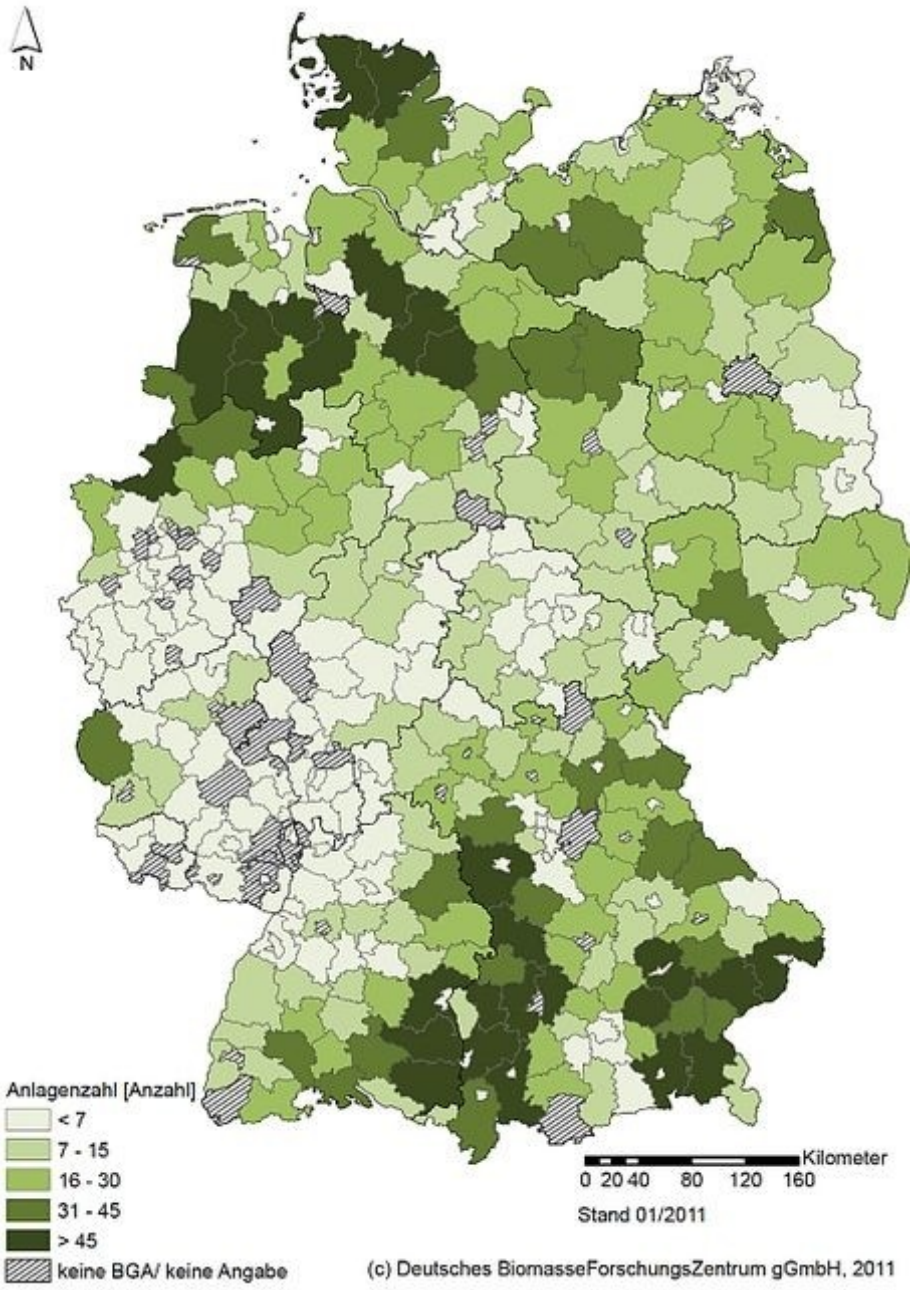
The problems and dangers associated with the massive cultivation of maize have been addressed on many occasions. These issues were extensively researched in 2008 in a cooperative project carried out on behalf of the German Federal Environment Ministry (BMU). The study "Optimization potentials for a sustainable expansion of the generation and use of biogas in Germany" was carried out by a biogas project team under the leadership of ifeu; the project also involved Öko-Institut (Institute for Applied Ecology) in Freiburg, Darmstadt and Berlin and the Deutsche BiomasseForschungsZentrum (DBFZ, formerly Institut für Energetik und Umwelt; Institute of Energetics and Environment) in Leipzig.

The aim of the EEG is to conserve fossil resources by promoting the further development of technologies for the generation of electricity from renewable energy sources in order to protect the climate and the environment, i.e. reducing the emission of climate gases such as CO_2 and methane. However, this goal can only be achieved if the general conditions are right, which particularly requires a reduction in the fertilization intensity of maize fields. The production of fertilizers requires a huge amount of energy and also has a negative effect on the CO_2 balance of energy crops (taking into account the use of harvesting machines and other methods of transport as well as the quantity of unintentional release of methane from the production of plants into the atmosphere). The ifeu study found that the emission of methane, in particular from small production plants, can be as high as 10% of the entire methane production. This counteracts climate conservation efforts as methane is a far stronger greenhouse gas than CO_2. On the other hand, biogas plants do quite well in terms of energy losses resulting from having to transport the gas long distances: the majority of biogas produced in Germany is directly burned by on-site combined heat and power plants for power generation. Such plants consist of a combustion engine (usually, special Otto motors that are able to directly use biogas with a methane concentration of 45%), which drives a generator for the production of electricity.

Biodiversity deserts

The use of maize as the primary source of energy is not at all consistent with the government's environment and nature conservation goals. Nowadays, only a few lobbyists still deny that there is conflict between modern industrial agriculture and biodiversity. The maintenance of biodiversity or the reduction of biodiversity loss is another major political objective in Germany and the EU as a whole, as the loss of biodiversity appears to impact ecosystems as much as climate stress, pollution and other forms of environmental impact do. Maize monocultures are real biodiversity deserts; the enormous cultivation areas destroy habitats for animals and plants, with the result that biodiversity is rapidly lost in agricultural regions.

This is supported by surveys that have been carried out in Germany on animal and plant species ("Die Roten Listen"; Eugen Ulmer publishing house, Stuttgart). Professor Dr. Josef H. Reichholf, a well-known German biologist, explains (in "Ende der Artenvielfalt", Fisher 2008, p. 145): "Most of the biodiversity loss in Central Europe over the last decades can be attributed to the twofold effect of agriculture: structural losses and overfertilization." A survey carried out in 2009 found that around half of the 254 bird species that regularly breed in Germany also breed in the metropolitan area of Stuttgart. In contrast, only 73 breeding bird species were observed in the administrative district of Biberach, which is an agricultural region. The district is around seven times larger than the Stuttgart metropolitan area and is relatively sparsely populated in contrast to other Baden-Württemberg regions (134 inhabitants/km^2; Stuttgart has around 2,800 inhabitants/km^2).



Distribution of biogas plants in the administrative districts of Germany.
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During the energy crisis of the 1990s, the German government started to specifically promote the construction of biogas plants on agricultural land. It was expected that the huge quantities of manure accumulating at factory farms would be used in an environmentally friendly way in biogas plants for the generation of energy. However, these expectations were not met due to the greater economic efficiency of energy crops such as silage maize. Many farmers chose to grow maize instead of using manure. The ifeu study therefore came up with the recommendation to replace the aforementioned technology bonus for dry fermentation with a liquid manure bonus. The 2009 version of the German EEG includes this recommendation along with a number of other improvements that are aimed at reducing methane emissions into the atmosphere, amongst other things. The manure bonus is only granted if the plant operator utilizes at least 30% farm manure in the total biomass (the bonus is paid for all electricity produced, not only for the 30%) and is nowadays claimed by many farmers with the result that the use of farm manure for the generation of energy has considerably increased. However, it must be pointed out that these are mainly dead-weight effects. In its 2011 experience report, the DBFZ pointed to the tendency of operators of biogas plants to use just 30% (or slightly over) of liquid manure and animal excrement because higher

quantities lead to an increase in electricity generation costs while the remuneration (via feed-in tariffs) per kilowatt-hour remains unchanged.

Bonus awards for the protection of the environment and climate

With the aforementioned financing schemes and subsidies along with some others – in addition to the basic remuneration for electricity generation, the so-called NawaRo (NawaRo = Germ.: nachwachsende Rohstoffe = Engl. renewable resources) bonus for electricity generated from renewables, the construction of combined heat and power plants and feed-in tariffs for supplying the electricity to the electricity grid – the German government is trying to achieve a difficult balance between developing a sustainable energy supply, effectively protecting the environment and nature and the interests of farmers. The bonus awards are claimed by more than 90% of existing biogas plant operators. Do such schemes and subsidies really help the country come closer to the other goals stipulated in the EEG? Critical analyses and surveys such as those carried out by ifeu, DBFZ and Öko-Institut will need to be carried out on a regular basis.

Models are used to investigate how the cultivation of energy plants for use in biogas plants changes the metabolism of soils, carbon cycles and water management and how these changes affect the climate gas balance. It has been shown that perennial plants (woody plants) and cultures of different plants that are able to grow without fertilization can help achieve the EEG's goals. Climate change is another issue that needs to be closely observed. The "Regional Climate Atlas of Germany" shows how climate change could affect the various regions in Germany during the next few decades up to 2100. The atlas predicts that many German regions will become particularly hot and dry.

With regard to the EEG's aim of preventing or reducing the negative effects on the environment as much as possible by promoting the use of biogas for the sustainable generation of energy, the use of green cuttings and agricultural and forestry waste is also essential. Researchers at the Helmholtz Centre for Environmental Research are working on improving the bacterial processes in biogas plants so as to enable a wide spectrum of residual plant matter to be used. It is important that this is not just applicable to high-tech plants such as Bioliq at the Karlsruhe Institute of Technology, but that it also enables small decentralized biogas on-site plants to use residual matter for the production of electricity and heat.

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