

Sustainable biogas production in organic farming

Project results and impact



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Dear readers,

Sustainable bioenergy will play a crucial role in achieving our 2020 renewable energy targets. It currently provides more than two thirds of the renewable energy in the EU, and by 2020 is expected to account for more than half, according to the Member States' National Renewable Action Plans. This will cover about 11% of the total EU energy consumption.

Although it is now well established in some European countries, the production and consumption of bioenergy faces a number of non-technological barriers that are impeding its large-scale entry into the markets of most EU Member States.

Established by the European Commission, and running from 2003 to 2013, the Intelligent Energy Europe programme (IEE) supported initiatives that addressed these non-technological barriers. Its activities were intended to create favourable market conditions and prepare the ground for investments; it provided information to stakeholders and fostered their commitment, while working to shape policy development and implementation, and to build capacities and skills. As of 2014, such projects are now being financed through the Horizon 2020 programme.

The IEE project SUSTAINGAS promoted biogas production on organic farms. Earlier EU projects generally did not address organic farmers as a specific target group, despite the fact they can obtain additional benefits from biogas production, compared to conventional farmers.

SUSTAINGAS worked to identify and analyse the specific characteristics of organic biogas. It assessed the barriers to its market uptake, and evaluated its economic viability and sustainability. It also promoted best practice examples and issued a handbook on sustainable biogas production. The latter is designed specifically for use with organic farmers in workshops, online trainings and webinars.

This report provides an overview of SUSTAINGAS' activities in its target countries, and of the impacts achieved. It also provides useful information about biogas production in organic farms and how to replicate the project's activities throughout the EU.

Enjoy your read!

Emilio Font de Mora

Project Officer

European Commission

Executive Agency for Small and Medium-sized Enterprises (EASME)

Introduction

In 2011, some 9.5 million hectares of land were devoted to organic farming in the European Union (EU-28), with an average annual growth rate of 7.3% over the last six years. Organic agriculture provides significant potential for sustainable biogas production, a potential that remains largely untapped.

Many organic farmers seem reluctant to invest in biogas production. The barriers to its uptake include economic, ecological considerations as well as problems of acceptance. Organic farming can be defined as a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs that have adverse effects. On organic farms, the operation of biogas plants must be part of a holistic approach where the plant itself is not the main focus, but rather the whole farm.

The choice of substrate to be fed into the plant is crucial to its sustainability. Agricultural waste and catch crops, both produced on the farm, represent high-potential and low-cost options. They have a positive effect on the environment and enjoy a high level of acceptance, as there is no conflict between food/feed and fuel. Meanwhile, using biogas slurry on the fields increases the quality and yields of crops. For organic farms to combine on-farm cycle management with a biogas plant is an ideal strategy, as it provides fertiliser and improves soil quality while bringing tangible economic advantages.

For the successful implementation of biogas production in organic agriculture, it is very important to create knowledge, and transfer it to farmers, advisors and decision makers. Raising awareness, disseminating facts and the provision of training are all key factors in any future-oriented energy policy.

SUSTAINGAS has developed a tool for assessing the economic feasibility of running biogas plants on organic farms. It has also published sustainability guidelines and a handbook, and carried out market analyses. It has collected best practice examples and introduced relevant training activities. Furthermore, the project has developed a series of recommendations which it has shared with political and commercial decision makers in the different countries.

Executive Summary

The SUSTAINGAS project was set up in response to the lack of standards or information for the production of biogas on organic farms. The project supports sustainable organic biogas by assessing aspects of its production, and by analysing the relevant markets and barriers to its uptake, as well as its economic viability and sustainability. It identifies examples of best practice and has produced handbooks, workshops, online training and webinars to spread information about organic biogas.

SUSTAINGAS has developed a definition of sustainable biogas production in organic farming that can serve as a reference point for organic producers and their associations as they define their own standards or guidelines. A market analysis was carried out to provide an overview of opportunities for market development, and to identify weak points and potential barriers. The study drawn on 696 survey responses from organic farmers in six countries.

The project has devised strategies to improve the economic situation of biogas plants on organic farms, and has developed a calculator – available in seven languages – with which to assess the economic relationships between biogas plants and organic farms. The sustainability of organic biogas plants has been evaluated, in terms of the land use, biodiversity and socioeconomic aspects. In a life-cycle assessment, SUSTAINGAS demonstrated potential reductions in CO₂ emissions, which depend on the size of a plant and the materials fed into it. Building on these results, the project drew up recommendations on the sustainable production of biogas, which in turn led to the development of potential sustainability standards for biogas on organic farms.

25 best practice examples were selected from across Europe. These have been published in a booklet showing their beneficial impacts in eight countries. The first Bulgarian biogas plant to use organic residues is now under construction. Through their work on the SUSTAINGAS project, our partners have convinced many farmers to start looking at ways of using their waste sustainably. Based on research and contacts with farmers, we have published a handbook that provides information about organic biogas and acts as a guide to its production. This handbook is available in English, German, French, Bulgarian, Polish, Danish and Spanish.

The project's dissemination activities have proved effective at spreading information to a wider public, as well as to specific target groups. Regional workshops in all the partner countries have reached a total of 329 people, while 564 registered to take part in live webinars, and an online learning module has so far attracted more than 330 international participants. The handbook has been accessed by nearly 3,000 people to date, and it continues to be ordered and downloaded. SUSTAINGAS has also interviewed more than 70 political and commercial stakeholders, many of whom have committed themselves to promoting sustainable biogas production in organic farming.

Market analysis

Addressing the demand for sustainable biogas production in organic farming

SUSTAINGAS has made available a market analysis of sustainable organic biogas production, which includes an overview of opportunities, weak points and potential barriers for market development. The analysis evaluates the responses to more than 700 questionnaires submitted by organic farmers in six countries.

The potential for biogas production in organic farming is increasing rapidly, although its actual development still lags behind. In 2011, some 9.5 million hectares of land were used for organic farming in the European Union (EU-28), with an average annual growth rate of 7.3% recorded over the last six years. But even in Germany, the most advanced market for biogas production in organic farming, only 0.74% of organic farms currently operate a biogas plant. The total installed electricity generating capacity of biogas plants on organic farms in the European Union is still below 50 MW.

Many organic farmers seem reluctant to invest in biogas production, as the number to have installed the necessary equipment remains proportionally lower than in conventional farming. Consequently, the organic sector is not doing enough to exploit its full potential for renewable energy production. It is still necessary to establish conducive conditions for sustainable biogas production in organic farming. The market analysis identifies suitable entry points from the farmer's perspective. It includes a product definition, a comparative literature study and a survey of organic farmers with and without biogas production.

Significant results

The following product description was developed in consultation with 41 organic farmers already involved in biogas production.

Sustainable organic biogas is biogas produced using substrates that mainly originate from organic agriculture, organic food production and/or nature conservation activities. These substrates are predominantly catch crops, residues from animal husbandry or crop production, material from conservation areas and/or uncontaminated biological residues. The significance of energy crops as substrates is limited, since organic biogas is intended to have a positive impact on food production by avoiding competition for land use. Material from conventional agriculture is restricted.

The resulting digestate is used as an organic fertiliser in the organic farms' own nutrient cycle. Organic biogas production is therefore designed to improve soil fertility in organic farming systems. Essential to the sustainability of the process are its safety and efficiency, resulting in low emissions, particularly of methane. Positive impacts are expected in terms of water conservation and biodiversity.

Many states' regulations do not consider organic biogas to be a new product, but treat it in the same way as biogas from conventional farms. The regulations issued by organic associations tend to set stricter rules regarding the proportion of non-organic materials permissible in digestate that is used as fertiliser on organic farms. At the same time, however, they also allow for a transitional period, enabling farmers to adapt to the rules.

In a survey of 696 organic farmers, mostly without biogas plants, in six European countries, about six per cent of respondents made a clear declaration, or regard it as highly probable, that they will operate a plant within the next 10 years. On organic farms, biogas is predominantly used for generating heat and electricity. An attractive alternative usage would be as fuel for vehicles, though this is not as yet implemented on any organic farms. Many farmers expressed an interest in attaining self-sufficiency in their energy supply. Another significant potential use of biogas is for drying purposes in the further processing of organic and other products. A particularly important impact is also the increased yields resulting from the on-farm use of processed materials as fertiliser, which helps maintain soil quality at the same time.

Factors that discourage the wider production of biogas on organic farms include the farmers' fears of stressed situations, competition with food or feed production, and possible financial constraints. The competition with food or feed production can be avoided by making a sustainable choice of materials, while training and knowledge transfer (especially the sharing of best practices) can help reduce the level of uncertainty.

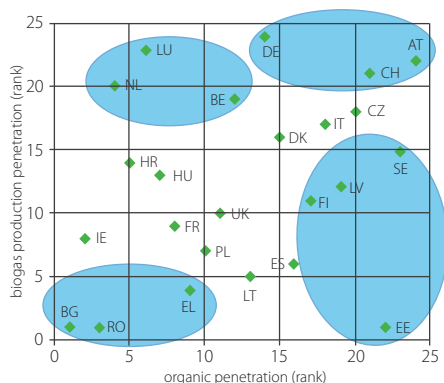
In some countries (e.g. Bulgaria, Poland and Spain) there is a need to overcome information shortfalls resulting from the relatively low penetration of biogas production and organic agriculture.

Technologically and economically sound small biogas plants still have to be developed for use on organic farms. Thus, there is an urgent need for examples of good practice based on small-scale solutions (30–40 kW) – in particular for evidence of economically viable biogas plants integrated successfully in farms' biomass cycles. Organic farming associations, biogas associations and local authorities should cooperate in their efforts to inform the customers. It is also important to achieve greater cohesion between the energy, agricultural and environmental policies of European countries. Legal frameworks (including feed-in tariffs) and state funding should be made more consistent to ensure greater clarity regarding the circumstances affecting organic farmers and their biogas production.

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Figure 1:
Penetration ranking of organic farming vis-à-vis agricultural biogas production
(per agricultural land, by country)

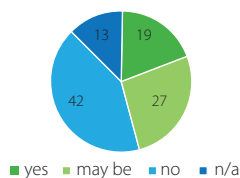


The rank of a value in a distribution is its numbered place in the list of ordered values (here in ascending order).

Source: © Studia Schlierbach

Figure 2:
Are you interested in operating a biogas plant? Answers: “yes”, “no” or “maybe”

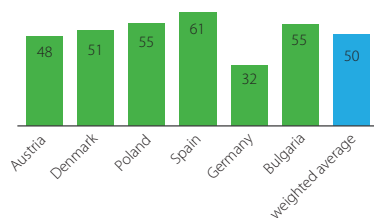
Are you interested in operating a biogas plant?



All numbers are percentages; survey of organic farmers, total n=696, SUSTAINGAS 2014

Figure 3:
Barriers to biogas plants on organic farms, index values per country

Level of hindrance factors - average index



Index values 0 = lowest, 100 = highest; survey of organic farmers, total n=696, SUSTAINGAS 2014

Strategy for economic performance

Many research activities highlight the positive impacts of biogas production on organic food production. This is confirmed by a series of interviews SUSTAINGAS has conducted with 40 organic farmers who also produce biogas. They all report higher crop yields, a better supply of nutrients and generally improved economic performance.

However, organic biogas production entails a number of economic and technological challenges. If biomass is purchased for the biogas plant, the operation becomes very vulnerable to fluctuating prices for that biomass. At the same time, many of the operators have experienced technical failures as their stirring and feeding equipment is sometimes inadequate to cope with the more solid and fibrous biomass used in organic biogas plants.

Among its published recommendations, the project has proposed new strategies involving collective supplies of biomass and the use of more robust technology. Another recommendation is to target higher farm incomes from the improved nutrient supply by using the digestate more efficiently, thereby reducing nutrient losses.

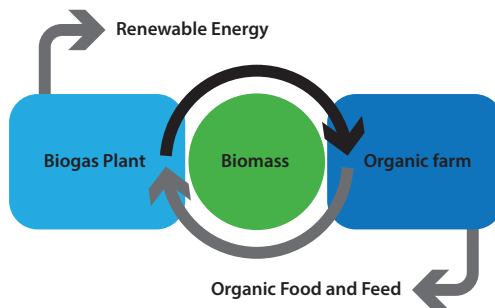
The ECO PLAN BIOGAS tool

The project has developed the first ever tool for farmers and biogas planners that illustrates clearly and simply the economic benefits of dynamic interactions between organic farms and their respective biogas plants. ECO PLAN BIOGAS is an Excel-based tool, and is available in seven languages from the project website.

It is used to calculate a farm's economic performance before and after investment in a biogas plant. The economic value of the plant is calculated in a simple manner using a limited set of parameters.

So far, the tool has demonstrated that:

- farms with little access to manure can gain a particular benefit from using digestate from the biogas plant
- biomass should not be transported too far as the benefits are then undermined by transportation costs
- quite a large volume of biomass must be collected to make a biogas plant feasible; running a collective biogas plant for a group of farms is therefore a good idea
- feed-in tariffs below a certain level make biogas uninteresting for farmers.



Sustainable biogas production

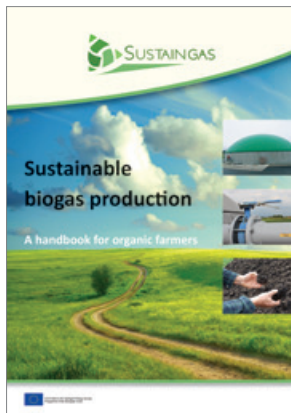
A handbook for organic farmers

Drawing on research as well as discussions with farmers, SUSTAINGAS has produced a handbook summarising the work of the project team. With this publication we want to provide organic farmers with a guide to organic biogas production.

As a lot of biogas literature already exists, the handbook focuses on the special issues relevant to organic farming. It describes the general principles of biogas production and points out the differences between organic and conventional systems. It also explains the environmental benefits and the advantages to farmers of organically produced biogas, and it provides a number of best practice examples illustrating the successful integration of biogas into organic farming systems.

An extensive chapter entitled “Getting started” looks at the details of practical implementation and highlights things that must be considered when realising a biogas project. A section with further information rounds off the manual.

Besides organic farmers, the handbook has also attracted a great deal of interest among politicians and representatives of the biogas sector, as it explains the differences that occur in organic farming, and how biogas production can be more sustainable. In our partner countries, we have reached at least 2,800 recipients with the handbook. It has also been read by interested people in other European countries and further afield (e.g. Turkey).



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Sustainable biogas production - A handbook for organic farmers, is available in English, German, French, Bulgarian, Polish, Danish and Spanish. You can download it at the following addresses:

- The project website: www.sustaingas.eu/handbook.html
- The FiBL Shop: www.fibl.org/de/shop

The benefits of sustainable biogas

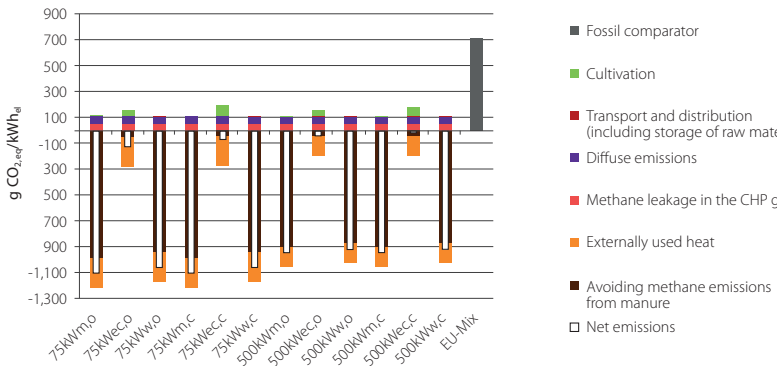
Biogas plants on organic farms can provide several environmental benefits. The SUSTAINGAS project has conducted life-cycle assessments to evaluate the greenhouse gas performance of 12 specific models of biogas plants. Our calculation shows that large savings can be achieved in CO₂ emissions due to the substitution of biogas for fossil fuels. One reason for this is the avoidance of methane emissions through the treatment of the manure; another is that burning biogas to generate energy produces fewer greenhouse gas emissions than burning fossil fuels.

Figure 4 below illustrates all the factors influencing emissions from biogas plants in organic farms and conventional farms. Positive values show emissions, while negative values represent emissions reduction.

The white column shows the result for each model of biogas plant. The grey column on the right indicates the average CO_{2,eq} emissions for electricity production in the European Union. The substitution of heat produced with fossil energy allows further savings.

All the biogas plants that were assessed have a huge potential for emission savings compared to the fossil comparator (which in Europe is 713 CO_{2,eq}/kWhel). CO₂ emissions from biogas plants usually range from 0 to minus 1,000 CO_{2,eq} /kWhel, assuming that the heat generated is also used to replace heating with fossil fuels.

Figure 4:
GHG emissions of each plant model, divided into processes according to the SUSTAINGAS methodology. Normalised to electricity output. Negative number = GHG savings; positive numbers = GHG emissions



The diagram in Figure 4 reveals the most important tendencies:

- The most significant impact in terms of CO_2 ,eq reduction comes from the treatment of manure. Its effect is much greater than all the other factors. All biogas plants that treat large amounts of manure also produce energy. By using this as a substitute for fossil fuels, in addition to the reduction in methane emissions from stored manure, they can therefore reduce CO_2 emissions enormously. The detailed explanation of this is that, on cattle farms with no biogas plants, methane emissions occur when the manure is stored. In a biogas plant the manure is degraded and the output of the plant produces only low methane emissions. Methane has a greenhouse effect 23 times greater than CO_2 . Thus in all biogas plant models that involve high manure inputs, negative emissions occur. These plants reduce GHG emissions (up to 1 kg CO_2 ,eq /kWhel) and produce energy.
- There is considerable potential to save additional emissions by using the co-generated heat as a substitute for heating derived from fossil fuels. The more heat that is used externally, the lower the CO_2 emissions will be.
- Emissions caused by the process (labelled here as “diffuse emissions”) are important. The less biogas that is lost (in the process or through leakage), the higher the emissions reduction (see below for further information).
- One difference between biogas plants in organic farms and those in conventional farms is the quantity of energy crops used. The cultivation of conventional energy crops always correlates with higher CO_2 emissions, due to the use of mineral fertiliser and pesticides, and to the indirect land use change (ILUC) effect (which was not calculated in the project). Although in our models of organic and conventional biogas plants the difference remains small (because the same percentage of input material was calculated), in practice the difference is much bigger. This is because organic farms use much more clover, grass and residues as their input material, whereas conventional biogas plants typically use greater quantities of energy crops.
- Transport is of minor importance.



The largest dairy farm in Spain operates one of only 32 agricultural biogas plants in the country with slurry from 2500 cows. The digestate is dried and sold as fertiliser for organic agriculture. Photo: STUDIA

Additional advantages of biogas plants on organic farms:

- The farm is less dependent on fossil fuels; it may produce more electricity and heat than it needs and can even sell energy to other users. The heat produced offers numerous opportunities for heat recovery, such as wood drying or stable heating. Biogas can also be used as a fuel substitute, but this incurs additional expenses (adaptation of tractors to run on biogas, or conversion of biogas to natural gas quality (called biomethane) by installing upgrading technology).
- Emissions to the air and water are avoided. In farms without livestock and with no biogas plant, cover crops (e.g. clover and grass) are usually mulched into the ground. As they rot in the winter months, nitrous oxide is emitted into the air and nitrates seep into the ground. These emissions are reduced with a biogas plant because the material is harvested and not mulched.
- With a biogas plant it is possible to expand the crop rotation. Catch crops, which are normally unused and costly, gain a value as feedstock for the biogas plant, making them more attractive to grow. The flexible use of the digestate as a fertiliser also raises more cropping possibilities. An enlarged crop rotation usually has a positive impact on biodiversity.
- Using the digestate after biogas production can greatly increase crop yields on the farm. All the nutrients from the input material are retained during the production process. By storing the digestate in winter and spreading it on the fields when the crops need it most (in spring), and by dosing these nutrients precisely, the crops can be fertilised optimally. Moreover, removing catch crops (like clover) serves to activate the bacteria that fix nitrogen in the ground.
- Organic biogas plants typically have a more positive impact on the environment than conventional biogas plants because:
 - they consume fewer energy crops
 - they use up more manure and residues
 - cultivation is not tied to the use of pesticides and synthetic fertiliser.



Digestate provides a versatile fertiliser. The digestate on the photo is the dry material after separation. Photo: F. Gerlach, FiBL

Best practice examples

The nine project partners took to the road and visited numerous biogas facilities across the European Union, in order to interview their owners and get to know their farms. Seven different countries are represented in the SUSTAINGAS consortium, but our search for best practice examples in the field of organic biogas extended to more than twelve countries.

Having completed the fieldwork, we have now selected 25 examples. We wanted to showcase the best examples of working organic biogas facilities, while at the same time representing the different countries, weather patterns and states of technical development in Europe.

As expected, our main source of data was Germany, but we are sure that, in our best practice examples booklet, you will find examples that fit your needs. This digital publication is available as a PDF file.

To make it easier to compare the different facilities, it presents each example in the same way: with a descriptive text, detailed photographs and a technical sheet.

You should appreciate the comments made by our partner farmers, especially in explaining how they started out, and describing their ideas for future development.

Why is this interesting to you?

Although we used strict criteria in selecting the examples, this is the part of the SUSTAINGAS project that is most relevant to a wider audience. It is here that you can find practical explanations of organic biogas from experienced practitioners – explanations which take into account the different technologies available, the differing states of national economies and agricultural development, and the differing levels of open-mindedness on the part of neighbours and the authorities.



A biogas plant supplied by a general contractor in operation at the Krumbeker Hof organic farm, managed by Gerhard Moser. Photos: F. Gerlach, FiBL



Hubert Miller has been an organic arable farmer in Schmiechen, Germany, since the 1980s. For the last six years he has run a 350 kW biogas plant with an extra high fermenter and vertical stirring. He uses a substrate mix containing up to 98% cover grass from about 40 organic farms. Photo: F. Gerlach, MEP

No two organic biogas projects are alike. Nevertheless, all the farmers questioned stressed the importance of social and professional networks for resolving problems during the initial and development phases of their projects. This means your colleagues could be your best advisors!

This booklet can be read in many different ways. It can provide you with a general idea of the organic biogas sector in the EU; it can introduce you to other people involved and examples to visit; or you can draw on the experiences compiled in the technical sheets to help you prepare your own biogas project.

You decide! We hope you enjoy our booklet!



Bulgaria now appears on the Biogas map of Europe!

The first biogas plants in Bulgaria to use organic residues are now under construction. Through its work on the SUSTAININGAS project, our Bulgarian partner FEA has convinced many farmers to start considering the sustainable utilisation of their waste. Europe's biggest grower of organic cucumbers is currently building a new-generation mid-sized biogas plant – the first such facility in Bulgaria. Photo:FEA

Knowledge dissemination

329

**participants
of workshops
carried out in six partner
countries**

564

**webinar participants
(351 + 213 webinar
participants 2013 –2014,
first and second rounds)**

310

**participants of
online module
(as of 20/11/2014,
upward trend)**

Training courses, workshops and dissemination activities are excellent ways of promoting topics and sharing information with the general public as well as with specific target groups. Various different forms of training exist, each defined by the special way in which it addresses and involves participants, and presents information. Through our training and dissemination activities, SUSTAINGAS addressed a large number of people – more than 1,200 in total – and sensitised them on the options for sustainable biogas production in organic farming. The largely positive feedback we have received would suggest that our activities to promote organic biogas were successful.

To improve the up-take of sustainable biogas production in organic farming, we aimed to inform and involve as many people as possible. For the duration of the project the participants of our training events came from various backgrounds, including organic farmers, biogas plant operators, biogas plant providers, political and commercial stakeholders and organic farming and biogas associations. This mix of participants allowed the wide dissemination of organic biogas production methods, while at the same time supporting lively discussions and an exchange of experiences throughout the training events.

The webinars consisted of hour-long, online seminars in which it was possible to make presentations to the participants, regardless of their location. As such, the presentations were easy to access and free of charge. In the first phase of the project, from October 2013 to February 2014, eight webinars were conducted to enhance the participants' basic knowledge of organic biogas and to inform them about the activities of SUSTAINGAS. Each webinar was held in the language of the respective partner country. Some 351 people took part in the first round of webinars, which included presentations in Bulgarian (2), Danish, English (2), German (2, Austria and Germany), Polish and Spanish. The presentations informed the listeners about the markets for sustainable organic biogas production in their respective countries. They also provided an introduction outlining how biogas production works, as well as the potential substrates and technical processes involved, and presented country-specific best practice examples.

To impart a deeper insight into SUSTAINGAS and provide in-depth information on organic biogas production, two-day regional workshops were conducted in each of the partner countries.



Photo: RENAC



Photo: RENAC



Photo: Protecma

In these, participants could learn about the technical, economic and ecological background to the process, and could join in a discussion of its sustainability aspects. They also received guidance on specific steps in developing and implementing projects.

Alongside a presentation of their project results by the SUSTAINGAS partners, a number of organic farmers already running a biogas plant shared their knowledge and experiences with the audience. Furthermore, providers of biogas plant equipment spoke about the technical implementation of organic biogas plants. The workshops featured interesting discussions and lively interactions between the different participants. An evaluation of the workshops resulted in predominantly positive feedback from the altogether 329 participants, and the conclusion that the events were interesting for lecturers and participants alike.

The third training format is the SUSTAINGAS Online Module, which is still available in all the partner languages.

The content of this five-month, online course is based on the SUSTAINGAS Handbook, which is divided into five chapters. After studying each chapter, participants take a self-evaluation test to assess their learning progress. An online forum is available for them to exchange knowledge and experiences, and at the end of the Online Module, they sit a final test for an online certificate. The large number of around 310 people that have so far participated in the courses demonstrates the high level of interest in the topic and the will to learn more about organic biogas.¹

The Online Module opened with an introductory webinar for each country, providing information on the basics on biogas production in organic farming and describing the results of the project. It also explained how the platform functions and gave answers to questions on the organisation of the Module. In the end, 213 participants took part in these webinars.

¹ Status 20/11/2014: As people can register until the end of the online module, we are still receiving new registrations each day. Therefore, 310 is not the final number of participants.

Outreach

Since 2012, SUSTAINGAS has tried to reach as many people as possible with its message about the benefits, to farmers and to the climate, of producing sustainable biogas on organic farms. At the outset, the project partners defined a number of different target groups, including organic farmers, green energy suppliers, biogas engineers and researchers, European, national and regional policy-makers, etc.

Social media were used to promote activities and events. A Twitter account was specially created for the project as well as a LinkedIn account, and the results were also promoted through the Facebook accounts of IFOAM EU, Ecofys, Organic Denmark, Renac and Protecma.

Six newsletters were sent out over the course of the project, outlining progress made and any results as they became available.

IFOAM EU and its partners also presented the SUSTAINGAS project in national, European and international events (IFOAM World Congress, BioFach, the Green Week or the Roundtable that took place in the European Parliament). Participating in such events allowed us to raise awareness of the benefits of sustainable biogas production on organic farms, using presentations, workshops and discussions.



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