

BiogasHeat: Development of sustainable heat markets for biogas plants in Europe

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BIOGASHEAT

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Executive summary

Biogas production increasingly contributes to meeting energy demands in the European market. It opens new opportunities for farmers, industry and the environment as well as offering sustainable solutions to a variety of challenges we face today in the agricultural, transport and energy sectors. Energy efficiency targets are one of the major priorities and challenges on the European energy policy agenda. The EU set a goal to reach 20% reduction in Europe's primary energy consumption by 2020, meaning that also the biogas sector is faced with a challenge of reaching higher energy efficiency levels in biogas plants.

Even though in many European countries production and use of biogas is increasingly recognised as a sustainable option to meet 2020 targets, the main focus remains on the optimisation of the electricity production. Most biogas plants produce electricity in CHP biogas plants, providing an opportunity to implement different heat utilisation concepts next to a biogas plant. However, the utilisation of heat from CHP is often not taken into account and is wasted. One of the main reasons for wasting heat from CHP plants is the lacking recognition of renewable heat as valuable source of energy by consumers and energy policy makers in most EU Member States. This leads to slow market development of renewable heating and cooling technologies, including heat recovery from CHP biogas plants.

The BiogasHeat project promotes the efficient utilisation of heat from biogas plants at the European and national level. The project carries out activities in 8 European countries - Austria, Croatia, Czech Republic, Denmark, Germany, Italy, Latvia and Romania - and creates a platform for knowledge exchange and transfer regarding sustainable use of heat from biogas plants.

This report provides a concise result oriented summary of activities, results, conclusions, lessons learnt and recommendations derived from BiogasHeat project. The BiogasHeat project is supported by the European Commission funded through the *Intelligent Energy Europe Programme*. The project activities were implemented from April 2012 to April 2015.

Chapter 1 of the report provides an introduction to project setting – background, objectives, target countries and target groups. The Chapter 2 describes the methodology and approach for implementation of project activities. Chapter 3 describes activities and the most important outcomes of the BiogasHeat project. Chapter 4 provides conclusions, lessons learnt and recommendations for policy makers and biogas plant operators.

1. Introduction

Background

In many European countries the production and use of biogas is increasingly recognised as suitable and sustainable energy option in a renewable energy mix. Considerable developments were achieved e.g. in Germany, Austria, Czech Republic, and Denmark for the installation of agricultural biogas plants. Most plants produce electricity in CHP plants. However, in many cases the heat from the CHP plant is not used, but wasted. This inefficiency in energy use is a bottleneck in current biogas production, causing macroeconomic and microeconomic losses and challenges in an overall increasing land use competition.

The BiogasHeat project addresses the problem of how to efficiently using the heat from biogas plants at the European, national and project level. Thereby a set of different policy, best practice, field tests and project implementation measures have been developed and used.

The BiogasHeat project targets sustainable development of the heat market for existing and new biogas plants. It specifically addresses appropriate solutions, business models, strategies and promising services on sustainable biogas heat use. The project aims at bringing together key actors, initiating and encouraging the development of sustainable biogas heat use, therefore enlarging the biogas business scope.

Project objectives

The BiogasHeat project has four specific objectives:

- **To enable the economic and sustainable utilisation of heat** from existing and future biogas plants, which currently is wasted.
- **To increase capability in biogas heat utilisation** in target countries through specific measures, including analysis of technical options, feasibility studies, entrepreneurial strategy development of business cases and field testing to address key barriers.
- **To increase capacity in biogas heat utilisation** in target countries and Europe through capacity building actions, skills enhancement, creating references with good practice and field tests, demonstrating in which direction good practice in heat utilisation from biogas plants and support for respective market development can go.
- **To raise awareness, transfer and disseminate experience and knowledge** about sustainable use of biogas heat.

The BiogasHeat project generally addresses the objective of 20% greenhouse gas reduction and raise of renewable share to 20% by 2020. In particular it responds to the ambitious RES targets for the individual Member States supporting the development of biogas heat markets and biogas-CHP, which exemplarily combine energy efficiency, raise of RES share and, thus, enabling to reach or even exceed the CO₂ reduction targets.

In the medium-term to long-term (to 2020) BiogasHeat has one main strategic objective: 'to ensure that biogas for energy production is used in the most energy efficient way'. It should become basic knowledge for the players in the chain of decisions as well as for the public that heat generation associated to biogas plants must be used, which responds to energy efficiency, climate protection, clean environment and technical reliability all in one. Therefore the three main strategic objectives of the BiogaHeat project are:

- **To increase the share of RES-heat** using biogas heat, which otherwise will be wasted.
- **To raise awareness, transfer and disseminate experience and knowledge** about sustainable use of biogas heat in all Europe.
- **To increase common knowledge on sustainable use of heat from biogas plants** as obligatory choice to consider in relevant decisions.

Target countries

The target countries of the BiogasHeat project were Austria, Croatia, Czech Republic, Denmark, Germany, Italy, Latvia and Romania (see Figure 1).



Figure 1: BiogasHeat project target countries

Furthermore, the results of the project have been disseminated to other countries of the European Union through international capacity building events (workshops and conferences) and organisation of tailored coaching events.

Project target groups

Four main target groups addressed by BiogasHeat are:

- Existing biogas plant operators
- Future biogas plant planners and operators
- Heat consumers
- Policy makers

Existing biogas plant operators were an important target group of the BiogasHeat project since many of them do not use heat from biogas CHP plants in an efficient way. They were directly involved in the project by participating in several activities. Some existing biogas plant operators were selected as business case examples to increase the heat use of their plants. In the case of biogas plant operators who use the heat already, this experience has been promoted as good practice examples to other biogas plant operators.

Future biogas plant planners and operators were among the main target group of the BiogasHeat project since they still have the opportunity to plan their plants with a sound heat

concept. They have benefited from the BiogasHeat activities by increasing the economies of their future plants. They have been addressed by large capacity building campaigns of BiogasHeat. They were furthermore directly involved in the BiogasHeat project by providing input for the development of promising strategies and business models as well as for the development of business cases for biogas heat use.

Heat customers (district heating companies, factories, hospitals, schools, office buildings, etc. in both public and private ownership) have been directly addressed to promote heat sale opportunities. They were invited to national workshops to communicate their needs. They provided important inputs for development of promising strategies and business models. These target groups were reached both with direct contacts and via relevant associations.

Policy makers (including politicians, lobbyists and ministries) were targeted by the BiogasHeat project. Policy makers have the duty to enable a framework addressing the main bottlenecks in national strategies and legislation towards the most sustainable use of biogas. This is achieved mainly by the implementation of suitable legislation and support mechanisms. National and regional policy makers of the target countries have been informed in the BiogasHeat project about all possible solutions for heat utilisation from biogas plants. The project has provided them arguments, benefits and recommendations for the most sustainable use of biogas. Policy makers have been be directly addressed in BiogasHeat activities through round table discussions, national workshops and dissemination materials.

2. Applied approach and methodology

The BiogasHeat project started with a detailed framework and market analysis on the use of biogas heat and with a collection of good practice biogas heat use examples.

It further built on these analyses, developing promising business models and entrepreneurial strategies for the use and recovery of biogas heat.

These models and strategies were field tested in cooperation with relevant key actors – with farmers, biogas operators, municipalities and district heating companies.

The results achieved in the target countries were further promoted with specific actions aimed at capacity building and with other dissemination activities.

The applied methodological approach is provided in the Figure 2.

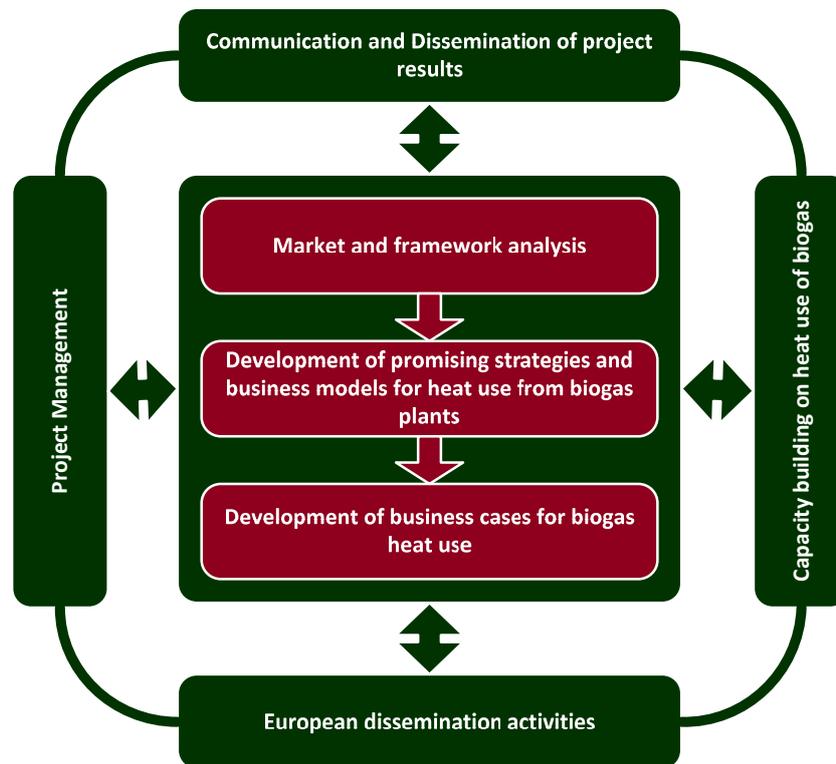


Figure 2: Methodological approach of the BiogasHeat project

Project Management included the overall management of the project, coordination of project activities and tasks, and communication with Advisory Committee of the BiogasHeat project.

Market and framework analysis provided general overview on biogas markets and the use of heat from biogas in the target countries. Detailed description of good practice examples on heat use from biogas plants has been developed. These results were further used as input for development of strategies and business models for the biogas heat use. A handbook on “Sustainable Heat use from Biogas Plants” has been developed and gives technical basis and solutions to the problem of heat utilisation from biogas plants. Furthermore, the objective of the first step of the project was to describe advantages and disadvantages of different heat use concepts and finally to integrate energy efficiency measures of biogas, being the use of heat instead of wasting it, into national and European policies.

Development of promising strategies and business models for heat use from biogas plants represented the “bridge” between the market and framework analysis and the

development of business cases. In this step the entrepreneurial strategies and business models for biogas heat utilisation from existing biogas plants and new/future biogas plants have been developed. These strategies were mainly developed by experts from the consortium with cooperation with key actors and Advisory Committee members supporting the project. The target groups of these outcomes were both – biogas planners and operators and potential customers, like for example district heating companies. The strategic concepts and business models have been further used by key actors participating in the field tests in the next step of the BiogasHeat project. 80 pre-feasibility studies have been developed for the use of heat in biogas plants (existing plants and biogas plant projects) and have been further used for decision-making by target groups and key actors interested in getting engaged and requiring solutions for heat delivery from the biogas plants.

Development of business cases for biogas heat use. Promising strategies for heat utilisation from biogas plants and pre-feasibility studies alone may not be sufficient to trigger relevant investment in biogas heat projects, in particular in short medium terms. Therefore the next step of the project concentrated on the development of business cases. Identified business cases were further developed and brought in practice. Specific business cases have been developed and field tests have been conducted in each participating country (1-2 projects per target country). The concepts and strategies produced were used and transferred to key actors for sustainable use of biogas heat in the market. Support has been provided to key actors by experts from the consortium and Advisory Committee of the BiogasHeat project.

Capacity building on heat use of biogas has been implemented to build capacity among existing and future biogas plant operators in order to increase the share of heat use in biogas projects. Good practice and lessons learnt during the development of business cases for biogas heat utilisation have been summarized and transferred to biogas plant operators, policy makers and other key actors within the project target countries and to Member States outside the project consortium. This has been achieved by European transfer Conference, where the results of pre-feasibility studies, business models and field test results were presented. Stakeholders have been gathered through Euroheat & Power's network, project partner's networks and key actors' networks, also addressing the European networks and umbrella organisations. Number of relevant key actors from European countries had the opportunity to receive "coaching" by the project partners and their local experts. At target country level trainings for existing biogas plant operators and future biogas plant operators have been organised. National policy makers have been addressed for developing sustainable policy framework that is appropriate to stimulate and enforce heat use from biogas plants. Direct contact with policy makers was assured with roundtable discussions organised in every target country.

Communication and Dissemination activities supported the tasks of the all steps of the project through systematic public campaigning providing a corporate design and the content management system for the website, newsletters, press releases and project related presentation materials, and presentations at workshops or conferences. These activities ensured the visibility of the project and disseminated the outcomes to stakeholders and to the general public. The final international conference in Brussels has been organised and final results of the project have been presented.

In general, an important strength of the methodological approach of the BiogasHeat project is the interaction between two different groups of biogas plants operators – biogas plants (good practice examples) with successfully developed useful heat demands and biogas plants (existing, under renovation and/or expansion or to be planned) where it is necessary to develop or access the heat market. These two kinds of biogas companies have been addressed by national experts with different types of strategies.

3. Results and findings and impacts achieved

BiogasHeat project publications and reports can be downloaded from the project web-site:

<http://www.biogasheat.org/documents/>

Main results and findings from market and framework analysis

Assessment on the use of biogas heat in the project target countries

The assessment on the use of biogas heat showed that the market developments in different countries are heavily influenced by legal and political framework conditions. In addition, the historical development of the sector as well as other factors such as the general economic welfare of the countries, administrative procedures and access to financing led to uneven developments of the biogas sector in Europe. One of the most important factors that considerably contribute to a fast development and market growth is the application of feed-in tariffs for the sale of electricity generated by biogas production. A major bottleneck, however, is the often lacking consideration of efficiency measures in the feed-in tariff system. Some countries have already noticed this bottleneck and adjusted the feed-in tariff system by including obligatory measures to use the produced heat from CHP units of biogas plants.

In general, the actual status of heat utilization from biogas plants is not satisfactory. Although some heat is used for own purposes and internal processes, the commercial use of heat from biogas plants is rare even though an enormous potential exists. Furthermore, in many countries it is difficult to describe the current situation, as reliable data on the heat use in biogas plants are lacking.

In Denmark, district heating systems as well as CHP production have been highly supported by the government. Due to favourable conditions, almost 80% of Denmark's district heating is produced in combined heat and power plants that generate both heat and electricity simultaneously. Biogas is utilized mainly for decentralized co-generation plants in which biogas replaces natural gas, being the heat used in district heating systems. It is remarkable that all centralized biogas plants in Denmark are connected to district heating systems and sell the heat.

In contrast, the biogas development in Germany was mainly focusing on the maximization of the electricity production supported by good feed-in tariffs. Thereby, only some plants have established sound heat use concepts. With the introduction of several legislative amendments, this situation slowly changes, especially for new plants, as a 60% heat use obligation was introduced. Also Austria and Czech Republic have introduced measures to increase the heat use of biogas markets. The future development in the sector will show if these measures are successful.

Furthermore, in some countries the heat use of biogas plants has not yet been considered in legislation. The current focus in these countries is on the development of legal framework conditions for the emerging biogas markets to establish a critical number of biogas plants. Legislation on efficient heat use may be introduced at a later stage. It is very important to take into account lessons learnt from other countries and consider the integration of heating concepts at the early stage of biogas market development.

Further and detailed information can be found in the BiogasHeat project report "Biogas Markets and Heat Use in Europe".

Good practice examples of heat use from biogas plants

Within BiogasHeat project 20 good practice examples of heat use from biogas plants in several European countries have been identified and described. Examples include heat supply to district heating systems, local heating systems and public buildings by different

organisational concepts (e.g. gas pipe to a satellite CHP plant at the heat consumer site, installation of heat pipes), use of heat with ORC systems, providing heat to industrial processes, heating of greenhouses, aquacultures, using heat for drying and cooling. An overview of described good practice examples is provided in Table 1.

Table 1: Good practice heat use examples described in BiogasHeat project

Good practice example	Location
District heating for residential houses	Margarethen am Moos, Austria
District heating	Wallsee-Sindelburg, Austria
Heating supply to a SPA centre	Trebon, Czech Republic
Heating of buildings by satellite CHPs	Prestice, Czech Republic
ORC plant	Valovice, Czech Republic
District heating for residential purposes	Odense, Denmark
District heating for residential purposes	Lemvig, Denmark
Heat supply to public buildings	Peckelsheim, Germany
Use of heat in aquaculture	Affinghausen, Germany
Air cooling for pig stalls	Thuringia, Germany
Satellite CHP	Eickenrode, Germany
Heating hospital rooms	Nauen, Germany
Heating for a cannery	Niederdorla, Germany
Heat for public buildings from a satellite CHP	Steinfurt, Germany
Local heat for a village	Lenthe, Germany
Digestate drying in Azienda Agricola Andretta farm	Marcon, Italy
District Heating	Este, Italy
Sludge drying	Padua, Italy
Heating of greenhouses	Rumbula, Latvia
Heat supply to a residential area	Poderwijk, Netherlands

Good practice example descriptions can be found in the BiogasHeat report “Good Practice Examples of Biogas Heat Use”.

Handbook on “Sustainable Heat use from Biogas Plants”

During the BiogasHeat project a Handbook on “Sustainable Heat use from Biogas Plants” has been developed. At the end of the project the 2nd edition of the handbook has been published including additional information and experiences from implementation of pre-feasibility studies and field tests of biogas heat use solutions for biogas plants in project target countries. Both editions of the handbook are available in English and in 7 other languages (see Figure 3).

During the project lifetime 3 100 printed handbooks have been distributed and more they have been more than 14 500 times downloaded from the project web-site.

The Handbook provides an overview of different options for heat use of biogas CHP units. The handbook addresses current and future biogas plant operators as well as other interested stakeholders such as policy makers, investors and students working in the field of biogas. It provides general information on the characteristics of heat produced in biogas plants and focuses on general technical solutions for the efficient use of heat. The overview of general technical solutions addressed in the Handbook is provided in Figure 4.

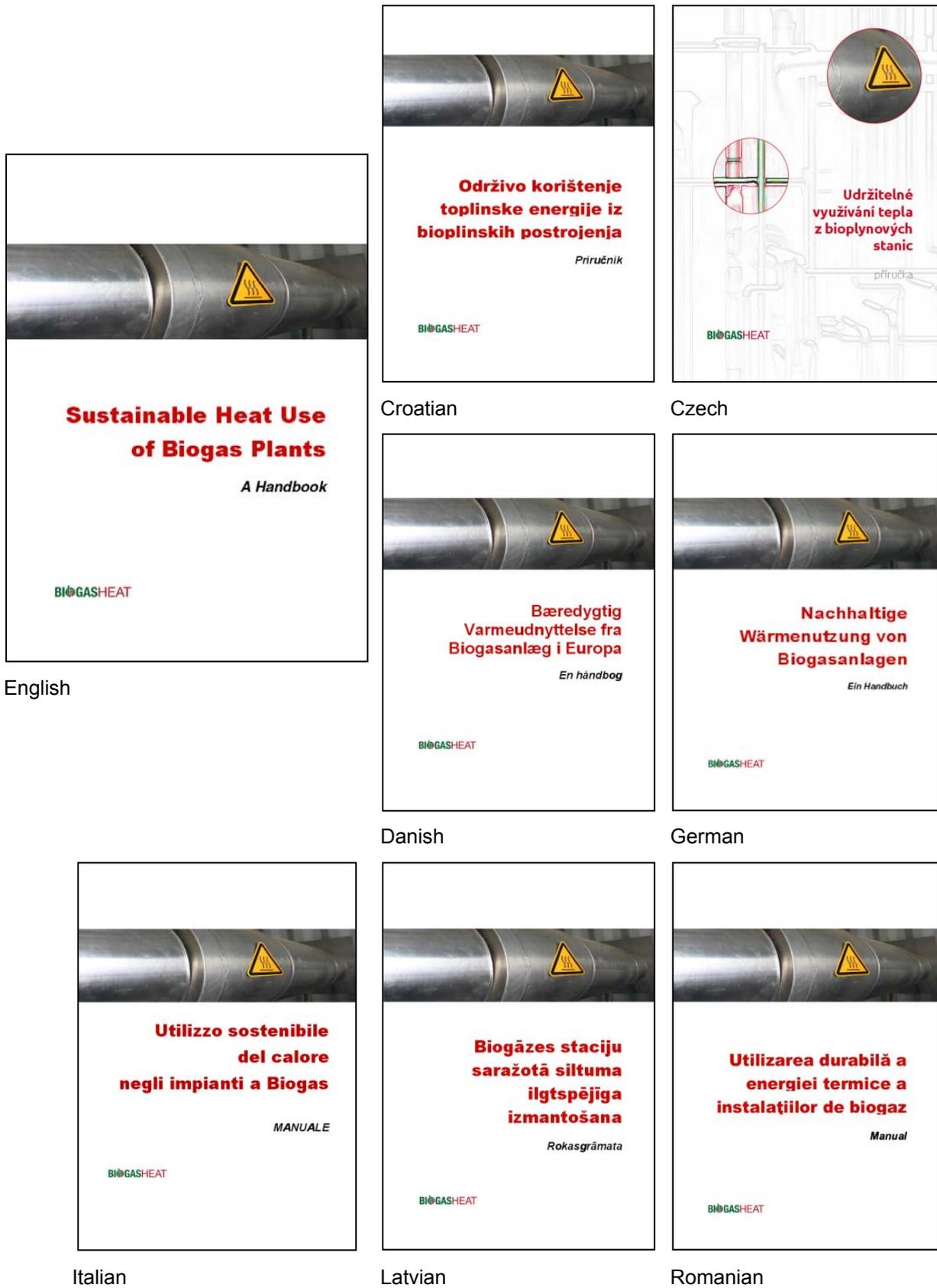


Figure 3: BiogasHeat handbooks

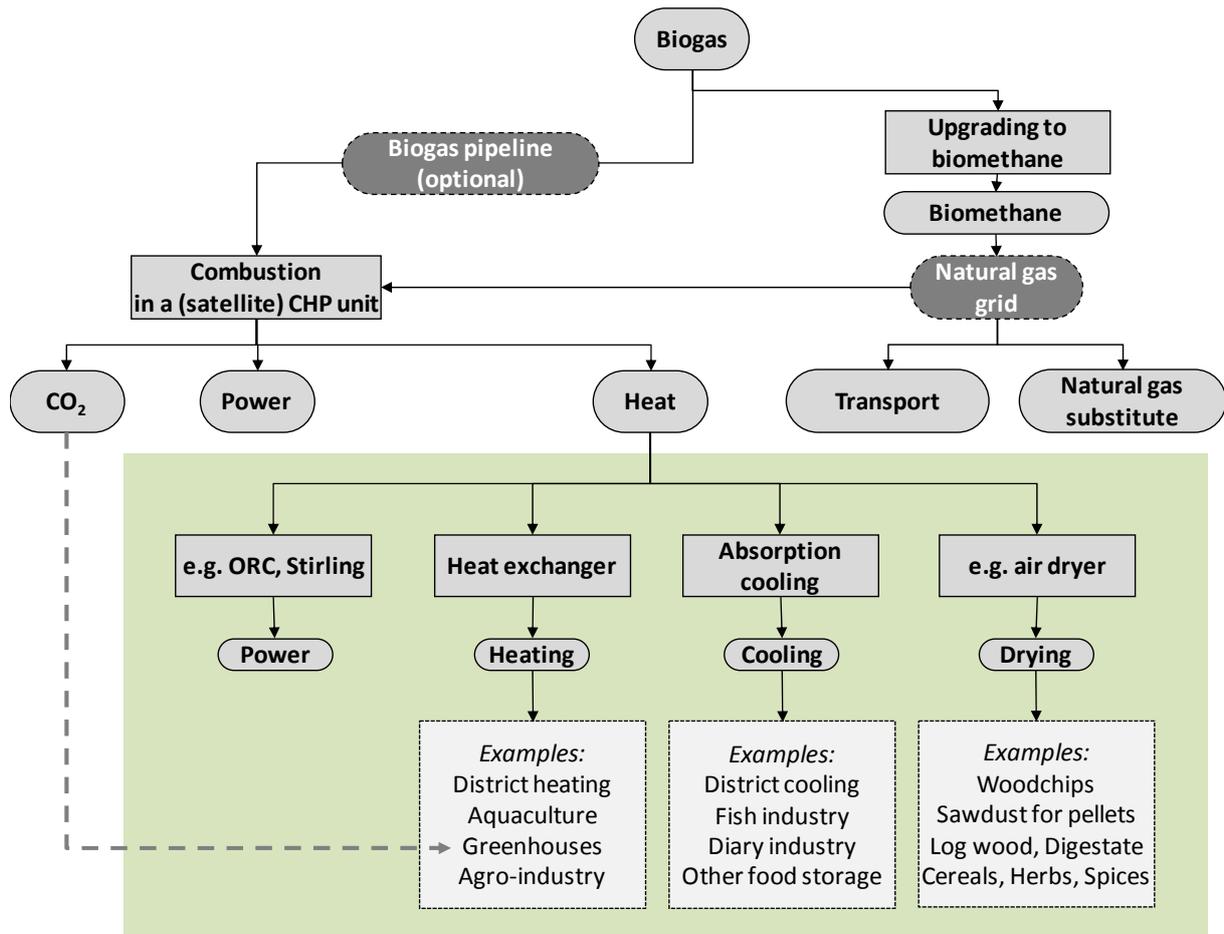


Figure 4: General technical solutions for using heat of biogas plants described in the Handbook

The handbook is available for downloading at the BiogasHeat project web-site.

National and European policy enforcement for heat use from biogas

For each BiogasHeat project country a report on national policy enforcement for heat use from biogas has been prepared and revisions of the reports have been made at the end of the project as an outcome of roundtable discussions with national policy makers.

A huge potential for heat utilization from biogas CHP plants exist in 8 target countries of the BiogasHeat project (Austria, Croatia, Czech Republic, Denmark, Germany, Italy, Latvia and Romania). Even though the situation of heat utilization from biogas CHP plants is different in each country, there are some common bottlenecks existing in all target countries.

In general, heating market still lacks legislative improvements in most of the countries. For example, heat utilization concepts have to be considered only in new biogas plants, whereas older biogas plants are not obliged to utilize their heat. Also older biogas plants have a potential for optimization and could consider heat utilization concepts. Therefore the focus should also be given to combined heat and power production in existing biogas plants. Political push for the heat market is still missing in most of the countries. For example, stronger incentives for the development of new heating networks are still missing.

Lack of knowledge in different useful energy forms that biogas could provide among decision-, policy-, strategy- and legal framework-makers is a bottleneck as well. Therefore heat utilization is often not taken into account. In addition, only Germany had a 'positive list'

for heat utilization from biogas CHP plants that was defined in the Renewable Energy Law. Definition of a 'positive list' for heat utilization could help to clearly define which concepts should be supported and promoted.

Lack of incentives for utilisation of renewable heat in general, including biogas, also hinder broader implementation of heat utilization concepts from biogas plants. Implementation of heat utilization concepts requires additional investments from biogas plant operators and is related to additional risks if heat consumers are suddenly lost.

One of the barriers for heat utilization from biogas CHP plants is the location of the biogas plant. Many plants are located in areas where there are no potential heat consumers. Incentives are still missing to increase biogas injection into the grid. New biogas plants should take into account heat utilization concepts to avoid wasting of heat in the future.

At the end of the project, the situation across the target countries has not improved much. In many countries, operators face the same problems as in the beginning of BiogasHeat. In some countries the situation even deteriorated. The new German law aims at the full integration of RES in the energy market which leads to lower requirements but also less support, the support in the Czech Republic was cut heavily. Nevertheless, there are positive developments. The situation in Croatia has slightly improved due to the country joining the EU and receiving support for agricultural activities. Also, in Austria extensions of support schemes are under discussion. Generally, it can be said that although the regulations have not changed that much, the discussion of solutions and the general level of awareness have improved notably.

At European level a strategy paper on European policy enforcement for heat use from biogas has been prepared and presented in relevant DGs of the European Commission. Policy recommendations from the strategy paper are provided in Chapter 4 of this report.

More information can be found in the BiogasHeat reports "National policy enforcement for heat use from biogas", "Reviewed report on National policy enforcement" and "European Strategy Paper on Heat Use from Biogas Plants" available on the project website.

Main results and findings from development of promising strategies and business models

Expert interviews and European workshop

During the BiogasHeat project 19 experts in 9 European countries representing associations, financiers, consultants, policy makers, plant operators and researchers have been interviewed. The aim of the interviews was to prepare the empirical basis for the development of promising strategies for the utilisation of heat from biogas plants. Further inputs to the strategy development were collected during European workshop organised in Vienna, Austria on 12 June 2013 (see Figure 5) and during the consultations with BiogasHeat Advisory Committee members.

Report on the European workshop is available on BiogasHeat website.



Figure 5: Participants of the European workshop

Report on promising strategies for the utilisation of heat from biogas plants

Report provides strategies and promising business models for heat use from biogas plants. Considerations described in the report should fit to all existing and planned biogas plants to a large extent. However, the focus was given to biogas facilities with agricultural feedstock.

As a general rule it can be said that there is no general solution that is appropriate for all plants. Viable options for heat utilisation vary among Europe depending on factors like climatic conditions and development of district heating grids. Especially existing plants, very often in remote locations, need an individual heat use solution. For plants which will be planned in future more general conclusions can be drawn if some decision variables, parameters and constraints are considered. The report provides inputs for both existing biogas plants and plants in the very early planning phase.

The basis of this report has been set by expert interviews, comments from BiogasHeat advisory committee members and it included feedback from the European workshop, where experts from several European countries discussed the strategic dimension of heat use in biogas plants.

The report describes general strategies and business models, future trends and challenges for the European biogas heat market, defines framework and criteria to assess promising business models and gives examples of them along with variables, parameters and constraints.

The report "Promising Strategies for the Utilisation of Heat from Biogas Plants" can be downloaded from BiogasHeat project website.

Pre-feasibility studies of heat use solutions for biogas plants

All together 80 pre-feasibility studies of heat use solutions for existing biogas plants and biogas plant projects (plants in the planning stage) in 8 countries has been prepared. BiogasHeat project partners have worked together with cooperation partners – biogas plant operators, heat users, municipalities and made the feasibility checks (pre-feasibility study) on promising heat use options for particular biogas plants. In addition the assistance to cooperation partners has been provided by collecting and answering their questions regarding efficient use of heat from biogas plants. These questions and answers have been summarized in the FAQ section of the BiogasHeat website and in Questions and Answers brochure developed by the end of the project. In total more than 270 target group stakeholders have been supported during implementation of feasibility checks.

Due to confidentiality issues not all pre-feasibility study reports are available for public. The published feasibility checks and English summary can be found on BiogasHeat website in the publications section under "Documentation on initial feasibility studies".

Main results and findings from development of business cases

Documentation of business cases

In a context of BiogasHeat project the business case describes the adoption of a specific strategy and business model for heat delivery from a biogas plant. It contains the cooperation partner's (developer/ investor/ owner/ operator of the plant) specific background for adopting and marketing the service, its expected business benefits, the options considered, the expected costs, expected chances and risks.

Business cases are based on the initial feasibility studies and on the developed strategies for heat utilisation from biogas plants.

For the identification and development of business cases, there should be considered both framework (e.g. national legislation) and also local specific conditions.

As the most important factor for definition of given business case is the long-term sustainability of which precondition is the economic effectiveness – for the cooperation partner and the other parties engaged in the given case.

In addition, business cases shall be (ideally) designed in such a way, that they could function as models for a potentially larger range of cases and provide high chance of replicability.

Following the pre-feasibility studies 12 business cases have been further developed and documented. The overview of documented business cases is provided in Table 2.

Table 2: Overview of the documented business cases

Country	Business case	Amount of heat to be utilized [MWh/a]	Status of the implementation
Austria	Drying of wood-chips	Up to ~300	Under preparation
Croatia	ORC installation	n/a	To be assessed in the field test
Czech Republic	Heat supply to external customers	Up to ~1 500	Under preparation
Czech Republic	Heat supply to external customers	Up to ~4 700	To be assessed in the field test
Denmark	Decreasing heat demand of fermenters (for additional heat supply to external customers)	n/a	To be assessed in the field test
Germany	Heat supply to external customers	Up to ~1 100	Realized
Italy	ORC installation	Up to ~ 6 800	To be assessed in the field test
Italy	Drying of wood-chips (for pellets production)	~800	To be assessed in the field test
Italy	Heat supply to external customers	n/a	To be assessed in the field test
Latvia	Heat supply to external customers	Up to ~9 400	To be assessed in the field test
Latvia	Drying of wood-chips	Up to ~9 500	Realized
Romania	Heat supply to external customers	n/a	To be assessed in the field test

For further information the report “Summary documentation on business cases” is available at BiogasHeat website.

Field testing of real project implementation

In BiogasHeat project 11 field tests with implementation of heat use solutions for real biogas plants have been implemented. In each project target country partners have been working together with biogas plant owners and operators, providing technical consultations, additional studies and assisting in negotiations with potential heat consumers.

Regular on-site meetings and discussions have been organised. Together more than 65 meetings and on-site visits took place in project countries during the field test implementation process.

At the end of the project three projects were implemented (in Austria, Germany and Latvia) and remaining 8 projects were still under preparation and assessment stage.

It can be concluded that most promising and with largest potential for useful heat utilization seems to be heat supply to external consumers. However these solutions are also most complicated in the implementation, as they require not only the agreement of the two major parties (biogas plant and the district heating company) but also involve numerous other private and public subjects (land owners at the route of the connecting hot water or gas line and municipal, regional and national authorities).

Solutions with local heat use like drying technology (woodchips, digestate) or additional electricity production (ORC unit) have a closer round of decision makers but their payback is not short enough for a clear decision and the investors often wait for potential subsidies.

The reasons why not all field tests resulted in a successful implementation can be summarized as follows:

For projects in preparation:

- Implementation requires substantial organizational work to meet all legal and environmental requirements. Typical example is the obligation to organize a public tender for the services required, which takes additional efforts and time.
- Institutions founded by public entities (regional and local governments) cannot make decisions on their own management level and have to get the plans approved on the level of their founders.

For projects under assessment:

- Heat supply from a biogas plant is a long term project and accepting this solution requires often a decision on the sustainability of existing technical system and their modernization, so that the further operation of the system could be confirmed in a given time period.
- Alternative solutions of heat supply have to be analysed in parallel (such as heat generation from biomass or from fossil fuelled CHP plant), which might be supported by public schemes, which reduces the competitiveness of heat from biogas.

Full report "Overall documentation of field tests, and their interim and final evaluation" is available on BiogasHeat website.

BiogasHeat help-desk

During the field test activities, assistance to field test partners was provided through BiogasHeat help-desk. Communication activities of the Help desk took place on 3 levels:

Practically all questions were received on the **national level** in the participating countries. Most of these questions were also directly answered by project partners who are familiar with specific conditions in the national legislation and have experiences with the business environment in the country.

Some questions were also discussed on the **project level** between the partners, such as exchanging information about the different national regulations, promising technical solutions and good practice examples successfully implemented in respective countries.

Several specific, mainly technical questions were also consulted with the **Advisory Committee** and/or with external experts.

Another opportunity to address BiogasHeat helpdesk has been made available for external people by placing the help-desk in the **Facebook**. There are about 160 members of the BiogasHeat Facebook page. Moreover the consultations were also given through **LinkedIn**.

The overall organisation of help-desk activities is provided in Figure 6.

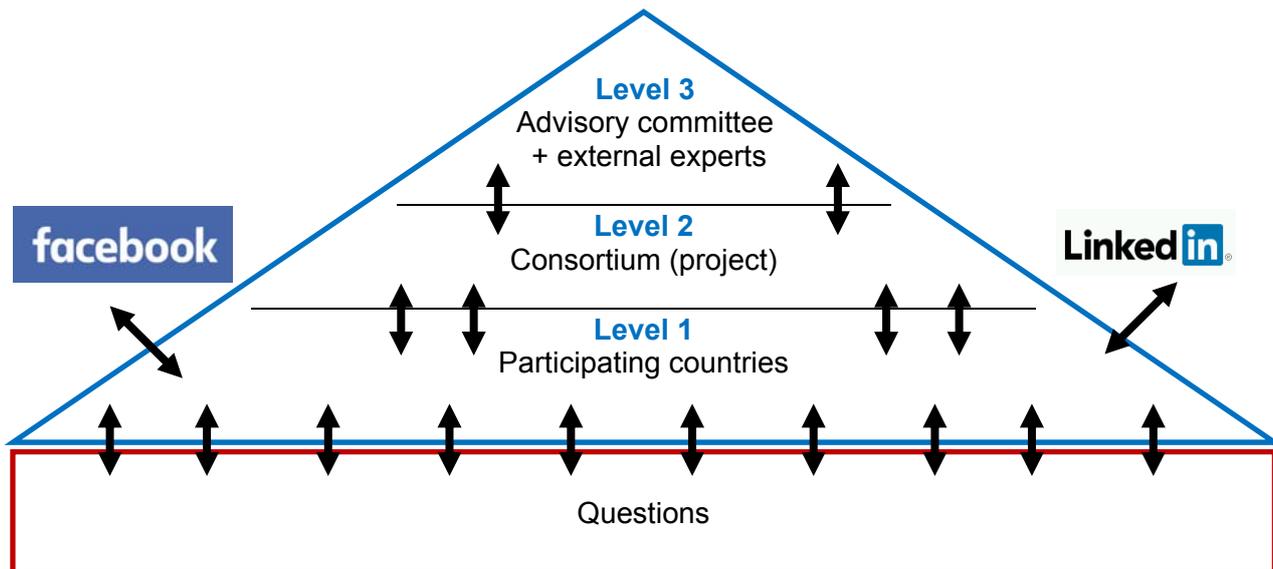


Figure 6: Organisation of help-desk activities in BiogasHeat project

The role of the help desk and its performance in the project might be summarised as follows:

- The problem of efficient heat use from biogas plants at the first look might seem to be easy to handle because several general solutions (also provided and summarized in BiogasHeat handbook) exist.
- On the other hand, the questions arise only when real project implementation is started. So, BiogasHeat helpdesk was somewhere in-between these two steps. Answers to general questions were provided during feasibility checks and summarized in the Questions and Answers brochure, while answers to specific questions during heat use project implementation in field tests were addressed confidentially on individual level among project partners and the field test cooperation partner.

Main results and findings from capacity building activities

Capacity building activities in BiogasHeat project were organised on two levels – on national level and on the European level.

Roundtable discussions for policy makers

On national level roundtable discussions and workshops with policy makers have been organised in each project country. In total 124 policy makers participated in capacity building events organized by BiogasHeat project (see Figure 7). The outcomes of the discussions have been included in the reviewed national policy enforcement report.

More information about roundtables for policy makers can be found in country specific reports “Report on roundtable discussions on policy recommendation with policy makers and authorities” on BiogasHeat website.

Trainings for biogas plant operators

Trainings for biogas plant operators in project countries have been provided. Trainings addressed technical solutions for heat use from biogas plants. Good practice examples and results from pre-feasibility studies, business cases and field tests were presented. In total 276 biogas plant operators and other relevant stakeholders were trained during national capacity building events. Photos from training events are provided in Figure 8.

Reports from biogas plant operator training events “Reports on training for biogas operators” can be found on the BiogasHeat website.



Figure 7: Photos from roundtable discussions in Austria and Latvia



Figure 8: Photos from biogas plant operator trainings in Germany, Czech Republic and Romania

Coaching events in other European countries

In order to spread the knowledge and experience of BiogasHeat project to broader audience and to increase the impact of the project, coaching sessions with countries outside the project consortium have been organised. In order to be able to target specific needs of coaching partners, the coaching was split in two parts. During a first event the coaches visited the target areas and met with the trainees (i.e. 2-3 stakeholders) to present the project as such, give general insights in the results and to learn about the specific needs of the different trained stakeholders, followed by a first evaluation of possible opportunities.

In the second round, one of the stakeholders was invited to the country of the coach or a best practice facility located elsewhere, to learn about suitable examples and to discuss suitable solutions for this specific case. Every partner in the BiogasHeat consortium took responsibility for one target area and conducted the coaching independently. Together 9 coaching events were organised.

To ensure that the selection of coaching partners (i.e. trainees) would be fair and transparent and at the same time serve the purpose of the project, the consortium defined eligibility criteria:

- Location: The interested entity had to be based in a country eligible for IEE – funding but not in one of the project countries.
- Type of entity: The interested stakeholder had to be a current/future plant operator or planner, or a large heat consumer including District Heating entities, a farmer, biomass company and similar.
- Interest in coaching: The interested entity had to express and explain its interest in heat utilisation from biogas.
- Project realisation: The interested stakeholder had to declare his/her willingness and the existence of capabilities to realise heat utilisation projects.

Additionally, the consortium defined two evaluation criteria:

- Number and diversity: According to the contract, the coaching events targeted 2-3 stakeholders in a region. The consortium decided to give priority to regions with more and more diverse interested entities than others.
- Cooperation: In line with the project contract, the consortium looked for cooperation between private and public actors.

Those criteria and all relevant information were combined in a call for expressions of interest which was circulated multiple times by email to project partners' contact lists and displayed online on the project website as well as on other websites. The promotion started in early 2014 but was officially launched with the International Kick-off Transfer Workshop on 12 May 2014 in Brussels. In the workshop 70 relevant stakeholders were directly addressed.

The call was also circulated to the members of cooperating associations/stakeholders such as AEBIOM, COPACOGECA, COGEN, EBA, EHP and others as well as to their contacts. In parallel the coaching opportunities were promoted at own and third party events across Europe.

After the first rounds of promotion, the return was very low. The consortium increased its efforts and decided to contact national multipliers directly by phone additionally to the email campaigns via European umbrella organisations. On top of that, stakeholders identified via European projects and at events were approached personally. When this approach did not provide a reasonable number of returned expressions of interest the consortium stepped up personal efforts in order to identify possible trainees via personal networks.

At the end of the project, the consortium had received expressions of interest from eligible stakeholders in 10 target areas of which the expressions from one area were received too close to the end of the project to result in a coaching.

The trainees in the 9 regions that were selected for coaching measures were distributed amongst the consortium members on the basis of geographical distribution (Belgium: Netherlands), comparable national conditions (Denmark: Belgium), first contact (Latvia: Estonia, Italy: Cyprus, Czech Republic: Slovakia, Croatia: Slovenia), expertise (Austria: France) and availability (Germany: Greece, Romania: Ireland).

Photos from the coaching events are provided in Figure 9



Figure 9: Photos from the coaching events in Latvia-Estonia, Germany-Greece and Croatia-Slovenia

More information can be found in the report “Proceedings of the coaching events” at the BiogasHeat website.

Report summarizing overall conclusions, recommendations and good practices

In October 2014 a report summarizing overall conclusions, recommendations and good practices has been prepared. This report was summarizing outcomes and results from market and framework condition analysis, implementation of pre-feasibility studies and from implementation of business cases. The report has been used for the preparation of capacity building events and can be accessed on BiogasHeat website. The main lessons learnt are partially transferred to the Chapter 4 of this report.

Questions and Answers brochure

In the Questions and Answers (Q&A) brochure relevant questions and answers are summarized. The brochure gives answers to general questions regarding heat use from

biogas plants, to operational questions and to policy related questions. “Questions and Answers brochure” can be downloaded from the BiogasHeat website.

Main results and findings from dissemination activities

Communication and dissemination material

For BiogasHeat project activities a set of dissemination materials has been prepared.

In September 2012 the BiogasHeat website (see Figure 10) was launched under the domain www.biogasheat.org. During the entire duration of the project the website has been visited more than 9 000 times and ratio between new visitors and returning visitors has been 60%:40%. They made 51 577 page views with 5.68 pages per session and average page duration of 03:42 minutes. Visitors came from 115 countries.

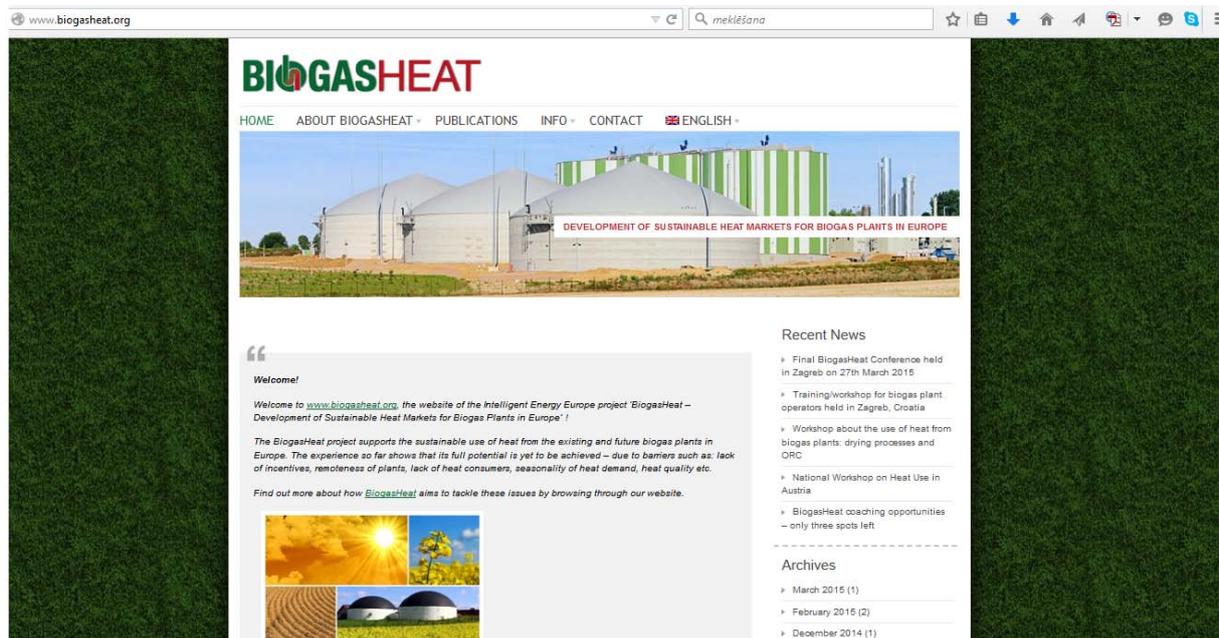


Figure 10: View on the BiogasHeat project web-site (www.biogasheat.org)

The following dissemination materials were elaborated:

- Project brief (in English and all target country languages)
- Project logo
- 5 BiogasHeat Newsletters (in English and all target country languages)
- Project posters (in English and in all target country languages)
- Articles and press releases in national and international media

All dissemination materials are available for download at BiogasHeat website.

National workshops

In project target countries two rounds of national workshops have been organized. The overview of organized workshops including number of participants and representation of target groups is provided in Table 3. In total during national workshops 786 stakeholders were informed about sustainable heat use from biogas plants.

Reports from the national workshops can be downloaded from the BiogasHeat project website.

Table 3: Overview of the organized national workshops

Country	Event	Date	Place	No of partic.	Target groups
Austria	1 st National Workshop	04/12/2013	St. Pölten	80	Regional and local authorities, public bodies, project developers, research institutions and plant operators
	2 nd National Workshop	03-04/12/2014	Salzburg	85-90	Regional and local authorities, public bodies, project developers, research institutions...
Croatia	1 st National Workshop	15/03/2013	Zagreb	52	7% policy makers 24% agencies 53% biogas investors 16% others
	2 nd National Workshop	27/03/2015	Zagreb	57	Administrative bodies (20%), financing institutions (3%), project operators and developers (50%), consultants 25%, media (2%)
Czech Republic	1 st National Workshop	11/10/2013	Trebon	50	biogas plant operators
	2 nd National Workshop	03/03/2015	Prague	40	relevant state organizations staff, regional administration decision-makers, biogas plant planners
Denmark	1 st National Workshop	12/09/2013	Aarhus	22	educational organisations, municipalities, associations, companies
Germany	1 st National Workshop	06/03/2013	Lengdorf	66	80% biogas plant operators - farmers 15% companies - biogas plant developers and investors 5% others: legal experts, environmental experts, public authorities
	2 nd National Workshop	11/11/2014	Hannover	20	20% biogas plant operators - farmers 20% companies - biogas plant developers and investors 60% others: legal experts, environmental experts, public authorities
Italy	1 st National Workshop	15/11/2013	Vicenza	60	28% RES invest./operators 27% agriculture companies 25% consultants/ installers 11% public administration 2% Banks 7% others
Latvia	1 st National Workshop	20/11/2013	Riga	45	39% policy makers 37% biogas investors 24% others
	2 nd National Workshop	21/11/2014	Riga	72	38% biogas investors 17% academics 14% associations 14% consult. and industry 10% policy makers 7% others (banks, press)
Romania	1 st National Workshop	20/12/2013	Bucharest	23	30 % policy makers 60% biogas investors/ developers 10% others

Country	Event	Date	Place	No of partic.	Target groups
	2 nd National Workshop	25/03/2015	Bucharest	22	10 % policy makers 5% biogas investors/ developers 85% others(NGO, Universities, Research institutes, consultancy companies)

BiogasHeat final conference

On 7 October 2014 the final conference of BiogasHeat project has been organized. The final conference/workshop took place in Brussels during the Open Days – 12th European Week of Regions and Cities and was organised in cooperation with the final conference/workshop for the Rescue project (REnewable Smart Cooling for Urban Europe). The information about conference was published on several websites including Managenergy, EUAgenda, Knowledge4Innovation and others.

In total around 70 people attended the conference. Photos from the conference are provided in Figure 11. The report of the conference and list of registered participants is available on BiogasHeat website.



Figure 11: Photos of the BiogasHeat final conference in Brussels

Achieved impacts

The BiogasHeat during the project life time helped **10** biogas plant operators to realize the implementation of heat use of their plants. As a consequence, **25 000 MWh** per year are efficiently used and not wasted and contribute to the mitigation of climate change. In several countries these project implementations are best practice examples that serve as example and inspiration for other plant operators.

By the end of 2020 it is expected that due to BiogasHeat project at least **30** biogas heat use projects will be implemented and **207 000 MWh/year** of heat efficiently used.

One of the most important outcomes of the BiogasHeat project that will help biogas plant operators and other stakeholders in planning biogas heat use investments is the Handbook on sustainable heat use in biogas plant. The handbook during the project lifetime has been downloaded more than **14 000** times and more than **3 000** hard copies have been distributed.

BiogasHeat project supported **290** target group stakeholders in sustainable heat use planning from the biogas plants.

80 pre-feasibility studies has been carried out, **65** on-site visits and meetings organized, **12** business cases developed and **11** of them field tested. By the end of the project **3** of the field tests were actually implemented. The remaining ones are still in the analysis or in a construction stage.

Support to the target group stakeholders has been provided through the help-desk activities. **67** important questions/points have been professionally addressed.

124 policy makers were informed about sustainable heat use during national roundtable discussion events, **3** countries started introduction of heat use incentives in the national legislation. On the European level the policy strategy paper has been presented in **3** relevant DGs of the European Commission.

276 biogas plant operators have been trained regarding heat use solutions of the biogas plants during national training events.

786 stakeholders have been informed during the national workshops.

70 relevant stakeholders were directly addressed at the international coaching kick-off-transfer workshop. Coaching activities to 9 different European countries outside the project consortium have been implemented.

During the project lifetime **1 M€** of cumulative investments have been made by European stakeholders. It triggered **2 165 toe/year** of renewable energy production and gave **4 851 tCO₂e/year** of greenhouse gas emission savings.

By 2020 at least **21 M€** of cumulative investments are expected, triggering **17 842 toe/year** of renewable energy production and providing **39 988 tCO₂e/year** of greenhouse gas emission savings.

4. Conclusions and Recommendations

General conclusions

Biogas can significantly contribute to the renewable energy 2020 targets and beyond. Biogas can be converted to electricity and heat or upgraded to biomethane. In addition, digestate from biogas plants can be used as biofertilizer. However, the potential of biogas is not yet fully exploited in many Member States despite its high potential in terms of available agricultural resources.

In general, RES support in the Member States is focused on electricity production whereas efficient use of heat is hardly taken into account. According to the NREAPs, more than 1/5 of the EU's heating consumption in 2020 is expected to come from renewable sources. It is expected that the share of RES in heating and cooling will increase from 10.2% in 2005 to 21.3% in 2020. In 2020 biomass should represent 17.2% of heating and cooling consumption (EREC 2011). Sustainable heat use from biogas plants can significantly contribute to the share of RES in heating and cooling. However this requires a clear direction of Member States towards efficient use of primary energy from biogas. More focus on releasing the potential of RES, including biogas, in the heating and cooling sector is missing in the European and national policies.

From the biogas plant operators' point of view, heat utilisation is a complex business as heat is easy to produce but hard to sell. Heat is cheap but technical features of heat are sophisticated sometimes. Nevertheless, biogas plant operators have to increase the overall energy efficiency of their plants, which mainly can be done by utilising heat that, otherwise, would be wasted. Several examples in Europe show that it makes sense to spend time and other resources in developing heat use solutions, but an adequate strategy is necessary to develop a successful business case.

All heat use options depend on certain technical, social, economic and legal framework conditions that have to be fulfilled. As a general rule it can be said that there is no general solution that is appropriate for all plants. Viable options for heat utilisation vary among Europe depending on factors like climatic conditions and development of district heating grids. Especially existing plants, very often in remote locations, need an individual heat use solution.

General lessons learnt

Lessons learnt from the implementation of pre-feasibility studies

The decision of the location of the biogas plant and the CHP unit is the most important element for successful heat use (feedstock market and heat use market).

An unstable legislative framework is seen as the main barrier. Stable framework conditions are required which allow long-term planning and investments.

Incentives (e.g. grants, CHP-bonus, taxes) may boost the utilisation of heat.

A positive list of efficient heat use concepts (like in Germany) may provide a solid orientation to biogas plant operators.

Know-how about heat use varies significantly among plant operators.

Investments in heat use are sometimes seen as additional costs and not as potential source of further income.

The heat use business is a long-term business (for feedstock contracts and heat supply contracts).

The three most favoured biogas utilisation options in future are very likely to be:

- Upgrading of biogas to biomethane and subsequent injection into the natural gas grid
- Direct supply of raw biogas and combustion in a satellite CHP unit for heat supply
- Additional power production.

Lessons learnt from the development of business cases and field tests

Heat supply to external customers

A business offer to supply heat from a biogas plant to a nearby external customer must be first of all competitive. Thus, the price of heat originating from a biogas plant must be inevitably lower than current costs for the end customer compared to whichever system is operational (mostly only variable i.e. fuel).

Since heat for a biogas plant operator is very often a by-product (as biogas plant are very often designed as primary power production facilities), investments in the necessary infrastructure are the main cost-driver (that is either an interconnecting pipeline or biogas pipeline with a satellite CHP unit closer to the heat demand) that have to be compared to potential heat sales.

The level of total investment costs to interconnect a biogas plant with external heat customers increases with distance and heat transfer capacity. In the case of existing biogas plants, the local conditions typically determine the viability of such projects. Often financial incentives (i.e. an investment subsidy or operational subsidy in the form of e.g. CHP bonus) secure the feasibility in these cases.

The bigger the heat demand, the better the prospects for project viability. Hence, the most promising customers are large ones, such as municipalities, public entities, and industrial plants.

Any investment into establishing the pipelines for the transfer of biogas or heat to the external heat customers require long-term stability which must be secured by concluding long-term agreements on heat supplies. This might prove to be difficult.

Another aspect of these projects is that the longer the interconnecting infrastructure is, the more demanding project preparation usually is, too. The primary challenge is to find a suitable route via land of owners that do not misuse this opportunity to try to solicit unreasonable price for getting affirmative easement.

Last a very important factor for the development of the plans to a real business case is mutual trust and a close relationship between contractual partners, i.e. the heat supplier and consumers. Furthermore, intensive networking is recommendable. Being in regular communication helps and allows for the solving any unexpected problems which may slow down or threaten the preparation process. Partnerships that result in the sharing of understanding, innovative knowledge, skills, and other forms of support are invaluable to the successful development and realisation of the plan.

Drying processes

Utilisation of heat for drying is an activity typically performed by the operator of the plant or entities closely linked.

Drying wood chips to be used as fuel or drying of timber for construction wood

Dried chips have a better quality and price, however, trading biomass fuel has to be a developed business itself and drying can only enhance it – the availability of free heat is not sufficient for starting such a business. The installation of drying technology is also costly and payback of the respective investment based on higher revenues from wood sales could be long. An important aspect could be additional revenue if wood drying is eligible for a CHP bonus.

Drying of digestate

Dried digestate at a biogas plant using crops can be sold as substrate for gardens and pot flowers, but the chances of placing it on the market are rather low due to competition from other sources.

Drying digestate which is returned to the field does not make much sense, it just lowers the transportation volumes and costs, but causes some additional emissions (such as ammonia).

Drying digestate from waste water treatment plants can be justifiable. Savings thanks to the reduced transportation costs and especially reduced fees for land-filling can make this business case economically feasible.

Supplementary power generation by means of ORC module

An additional power generation unit utilising the waste heat from the standard motor-generator can increase the electric efficiency of the biogas plant by several percentage points. Whether or not this solution is economically feasible very much depends on the support schemes in place at the time of the commissioning of the unit. Installation of an ORC unit has a reasonable payback when the RE-electricity was supported by feed-in tariff. Another support mechanism might be a technological bonus or CHP bonus; however, for example Czech legislation does not recognise ORC as CHP electricity.

Reducing the self-consumption of heat at the biogas plant

Additional investment measures to lower the own heat consumption of the biogas plant have to be evaluated with respect to the cost of heat from competitive sources. This business case can be considered if heat demand is greater than the current net biogas plant capacity and the additional supply of heat from biogas plant will eliminate significant costs for fossil fuels and possibly also investment costs for peaking sources of heat in winter. While the heat supplied in off-peak times (transition periods and summer) can be regarded as free, heat demanded in winter peaks can have a high market price. The evaluation has to be based on an annual profile of the heat supply and its coverage by sources of different types (i.e. biogas plant as base load and other sources operated for peaking).

Recommendations

Recommendations to policy makers

Following the bottlenecks identified on the national level and the needs declared by the national stakeholders there is a number of recommendations for the European level:

On the use of biogas in general

- National 2020 targets for the development of the biogas sector have proven to be unambitious and unsustainable in various countries. It would be helpful if the European Commission would push for an *ambitious but realistic revision of the national targets*.
- Currently, there are no clear biogas targets for the time after 2020, but in order to foster the sustainable development it is crucial to define them. Therefore, the European Commission should include corresponding paragraphs in the relevant dossiers that urge the Member States to define *binding biogas targets for 2030 and 2050*.
- To ensure that these targets are reached Member States need to implement sustainable and predictable support measures. In the short-term the European Commission could urge the Member States to *create stable framework conditions*. In the long-term the definition of *future binding biogas targets could be linked to the development of a corresponding and binding support scheme*.

- Secured supply with adequate resources plays a major role in planning, building and running biogas plants. Whereas energy production must not interfere with food or feedstock production, *European policies should not discriminate against the utilization for energy production.*

On the use of heat from biogas:

- Generally, the use of waste heat from CHP must be promoted more. Therefore, the European Commission should adjust its strategies and *consider the whole potential of heat use for energy efficiency, energy security and phasing-in of RES.* Future binding biogas targets should include *realistic, but ambitious heat utilization targets.*
- Accordingly, a comprehensive assessment under the Energy Efficiency Directive 2012/27/EU should also consider the use of biogas as a strategic source for District Heating and Cooling and look into the use of heat from biogas. This should also include the development of a fair positive/negative *list for national heat use* from CHP plants which includes various possibilities such as DHC and on-site utilization.
- With view to the Member States it would be helpful if the European Commission pushes for harmonized efficiency targets for heat use from (biogas) CHP plants.
- Support schemes on heat use must be sustainable and predictable. Therefore, the *binding support schemes should include clear rules on support measures*, i.e. feed-in tariffs linked to efficiency, *and documentation needs*, i.e. utilization plans, but also safety measures for operators in case of changing demands.
- The European Commission is asked to push for *heat use plans for future CHP plants as well as for existing ones.*
- To support schemes for the development of biogas CHP plants it is also necessary to *support the development and construction of distribution networks.* Therefore, the European Commission should revise its energy network development plans and take the potential of heat distribution into account. Accordingly, the European Commission could urge Member States to revise their network strategies and consider heat distribution as sustainable alternative to other heating options.

Recommendations to biogas plant operators

Starting point: General goals

Before starting to develop a business case for heat use, biogas plant operators should ask themselves what the overall goal of the plant and the company is it is embedded in. Already at this stage, trends like the development of heat demand and framework conditions like competitors on the market should be considered.

Development of a strategy with solid pillars

Based on the general goals a robust strategy has to be developed that is built on solid pillars in form of clear action steps. However, even very well defined strategies will have to be adapted if some fundamental parameters change – but always with respect to general goals.

Development of business models

The development of business models for heat use (heat concept) needs a definition where the comparative advantage of the own facility is expected. The focus should be on the needs of customers and it has always kept in mind that in most cases under certain circumstances other market actors could satisfy customers' needs more favourable.

The following dimensions have to be analysed and considered in detail, when starting or developing a business with heat use from biogas plants:

Technical framework conditions, requirements and constraints

From a technical point of view there are several heat use options available. However, heat utilisation in own premises, stables and other facilities should have the highest priority. For customers in the vicinity of the plant the feasibility of all possible heat use options should be verified. As a next step also new heat consumers could be considered (drying, greenhouses, aquaculture) and it should also be analysed if biogas upgrading could be a realistic solution.

Economic framework conditions, requirements and constraints

Heat is easy to produce and hard to sell. Heat tariffs compete with well-established systems and therefore a careful economic analysis is necessary to come to a good result. This analysis should include a thorough risk analysis where major parameters of the business case should be variegated. This includes changes in the customer structure as well as changes in heat demand due to the refurbishment of buildings. Usually heat use contracts have quite a long time line and customers should therefore have the confidence that also the biogas plant will be able to deliver heat even after electricity feed-in tariffs are phased out.

Social framework conditions, requirements and constraints

Selling heat usually relies on well qualified and experienced staff and good customer relationships. However, biogas plant operators' position for negotiations is weak as several competing systems are on the market. In some cases also numerous third parties are involved in heat use projects, e.g. when constructing heat pipes that unavoidably cross properties of neighbours.

Political framework conditions, requirements and constraints

Political framework conditions are changing rapidly sometimes. As most biogas plants depend on public funding to a high degree, this development has to be considered when developing a business model. Concerning heat use, it is also necessary to know what legal conditions have to be fulfilled before a heat utilisation business can be started (approval procedures for technical equipment, land use restrictions in the case of installing pipes on foreign ground etc.). Have an exit scenario at hand in case of fundamentally changing political framework conditions.