

Final report

1.1 Project details

Project title	IEA Bioenergy Task 37- Energy from Biogas
Project identification (program abbrev. and file)	64013-0506
Name of the programme which has funded the project	EUDP
Project managing company/institution (name and address)	BIOSANTECH Lerhøjs Allé 14; 6715 Esbjerg N; Denmark
Project partners	
CVR (central business register)	33685041
Date for submission	

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1.2 Short description of project objective and results

Short description (English)

IEA Bioenergy Task 37 is an international partnership whose purpose is international co-operation, dissemination of knowledge and of research results about biogas-based energy production. The aim is to communicate and advance the knowledge of biogas systems and their application via circular economy processes, to decarbonisation and environmental improvement. The activity is carried out as a joint project for the participating countries: Australia, Austria, Brazil, Denmark, EC (Petten), Finland, France, Germany, Ireland, Korea, Netherlands, Norway, Sweden, Switzerland and the UK. The project results are disseminated through the Task 37 website <http://task37.ieabioenergy.com>, through supporting activities and through the task members' national networks and webpages. The Danish participation in IEA Bioenergy Task 37 offers a strong international network and expertise, built up on behalf of the Danish biogas sector and biogas industry.

Kort beskrivelse (Dansk)

IEA Bioenergy Task 37 er et internationalt partnerskab hvis formål er internationalt samarbejde, formidling af viden og forskningsresultater inden for biogasbaseret energiproduktion. Det overordnede mål er at formidle og fremme viden om produktion og anvendelse af biogas via cirkulære økonomiprocesser, til erstatning af fossile brændstoffer og miljøforbedring. Aktiviteten udføres som et fælles projekt for alle medlemslandene: Australien, Brasilien, Danmark, EC (JRC Petten), Finland, Frankrig, Tyskland, Irland, Korea, Holland, Norge, Sverige, Schweiz, Storbritannien og Østrig. Projektresultaterne formidles gennem Task 37 hjemmeside <http://task37.ieabioenergy.com>, diverse støtteaktiviteter samt gennem medlemmernes nationale netværker og websider. Danske deltagelse i IEA Bioenergy Task 37 er med til at sikre en stærkt international netværk- og ekspertise, opbygget på vegne af den danske biogas sektor- og biogasindustri.

1.3 Executive summary

Executive summary (English)

IEA Bioenergy Task 37 is part of the International Energy Agency - IEA (www.iea.org), which is a permanent international partnership whose purpose is international cooperation, dissemination of knowledge and research results in the area of biogas-based energy production.

The main objective of the Task 37 work is to address the challenges related to the economic and environmental sustainability of biogas production and utilisation and to disseminate the results for the benefit of the Task 37 member-countries and of the biogas development in general. The growing biogas sector in OECD countries faces sustainability challenges and requires subsidies to be able to compete with the fossil energy industry. There is a clear need to optimise many of the process steps in the biogas production chain in order to reduce both investment and operating costs and to increase overall sustainability. The focus on process optimisation, started in 2010-2012, was intensified in the triennium 2013-2015. By the end of 2016, more than 11,000 biogas installations operated in the Task 37 Member Countries.

IEA Bioenergy Task 37 plays a significant role in the definition and promotion of best available biogas technologies that are in use on farms, in organic waste treatment facilities and on wastewater treatment sites. However, while there is substantial further po-

tential for expansion of the AD sector, based on availability of potential feedstocks, challenges remain to maximise the potential benefits in terms of energy yield and to reduce both investment and operating costs. There is a well-understood need to reduce the reliance of biogas plants on subsidies such as investment grants, feed-in tariffs and green certificates. Other major objectives of the activity refer to providing technical biogas expertise to member countries, plant operators and policies and decision makers, and to exchange and disseminate the newest knowledge and research results among the member and non-member countries.

The activity is carried out as a joint project of the participating countries: Australia, Austria, Brazil, Denmark, EC (Petten), Finland, France, Germany, Ireland, Korea, Netherlands, Norway, Sweden, Switzerland and the UK. The Danish participation in the IEA Bioenergy Task 37 offers a strong international network and expertise built up on behalf of the Danish biogas sector and biogas industry.

Task 37 is managed with input from all member/member countries and the final Programme of Work, including budget, is discussed and agreed by all members. The individual Topics are led by the most appropriate and most expert person in the field within the Task. Progress of the work and peer review is carried out both in meetings and via correspondence, and usually involves expert groups within the member countries. Any amendment to the POW is made according to the needs of the member countries and in consultation with the ExCo. The Task Leader directs and manages the work programme. National Team Leaders are responsible for coordinating the national participation in the Task and for coordinating specific topics in the work programme.

The project results are disseminated through the project website www.iea-biogas.net, in the form of, inter alia, publications and technical reports as well as through regular task meetings, conferences, research workshops and study trips, newsletters and the members national networks.

Executive summary (Danish)

IEA Bioenergy Task 37 er en del af Det Internationale Energiagentur - IEA (www.iea.org), som er et permanent internationalt netværk, hvis formål er at fremme internationalt samarbejde, formidling af viden og forskningsresultater inden for biogas baseret energi-produktion.

Hovedformålet for Task 37 er at imødegå de udfordringer der er i forbindelse med den økonomiske og miljømæssige bæredygtighed af biogas produktion og anvendelse samt at formidle projekresultaterne, til gavn for Task 37 medlemslande og for udbygning af den globale biogas sektor. Den voksende biogas produktion, især i OECD-landene, står overfor bæredygtighedsudfordringer, som kræver at der ydes tilskud til at biogas, såvel som andre vedvarende energier, skal kunne konkurrere med fossil energiindustriektoren. Der er dermed et klart behov for at optimere mange processer i biogasproduktionskæden, for at reducere både investerings- og driftsomkostninger og for at øge den miljømæssige bæredygtighed. Fokus på procesoptimering, begyndte allerede som en del af work programme 2010-2012, og blev intensiveret i perioden 2013-2015. Ved udgangen af 2016, flere end 11.000 biogasanlæg var i drift i Task 37 medlemslandene.

IEA Bioenergy Task 37 spiller en væsentlig rolle i udvikling og promovning af de bedste biogasteknologier til behandling af landbrugsbiomasse, organisk affald og spildevand. Der er betydeligt potentiale for udvidelse af AD sektoren, baseret på tilgængelighed af råmaterialer, men der er også udfordringer vedr. maksimering af energi udbyttet samt reduktion af investerings- og driftsomkostninger. Der er nødvendigt at mindske biogasanlæggenes afhængighed af offentligt tilskud, (investeringstilskud, feed-in tariffer og grønne certifikater). Andre centrale mål for Task 37 vedrører teknisk bistand og biogas ekspertise til medlemslandene, til driftslederne på biogasanlæggene, og ikke mindst til politikker og beslutningstagere. Desuden, udveksling og formidling af nyeste biogasviden -og forskningsresultater til medlemslande såvel som til tredjelande er vigtige mål.

Task 37 aktiviteten udføres som et fælles projekt for medlemslandene, som er: Australien, Brasilien, Danmark, EC (JRC Petten), Finland, Frankrig, Tyskland, Irland, Korea, Holland, Norge, Sverige, Schweiz, Storbritannien og Østrig. Dansk deltagelse i IEA Bioenergy Task 37 er med til at udbygge et stærkt internationalt netværk og ekspertise, på vegne af og til gavn for den danske biogas sektor -og biogas industri.

Task 37 styres med input fra alle medlemmer/ medlemslande, og det endelige work programme, herunder budget, diskuteres og aftales af alle medlemmer. De enkelte emner ledes af den mest erfarende og mest kvalificerede task medlem på området. Arbejdets fremskridt og peer review gennemføres via møder -og korrespondance, og det involverer normalt ekspertgrupper fra medlemslandene. Enhver ændring af work programme er lavet i overensstemmelse med medlemslandenes behov og i samråd med ExCo. Task Lederen styrer og administrerer arbejdsprogrammet. National Team Leaders er ansvarlige for at koordinere den nationale deltagelse i opgaven, samt koordinere specifikke emner (topics) i arbejdsprogrammet.

Projektets resultater formidles primært via i IEA Bioenergy Task 37 hjemmeside: www.iea-biogas.net , i form af publikationer og tekniske rapporter samt gennem regelmæssige møder, workshops, studieture og lignende begivenheder, periodiske nyhedsbreve samt igennem medlemmernes nationale netværker.

1.4 Project objectives

IEA Bioenergy Task 37 is an international partnership belonging to the International Energy Agency - IEA (www.iea.org), whose central purpose is international cooperation, dissemination of knowledge and of research results in the area of biogas- based energy production. Based on this, the overall objective of the Task 37 is to communicate and advance the knowledge of anaerobic digestion systems and their application. The Task 37 work aims to provide expert advice on the optimal role of biogas in future energy systems, to inform policy makers and developers of sustainability of biogas systems and the methods to ensure application of good practices. Furthermore, it provides expert advice on the integration of anaerobic digestion into processes, and overall technical biogas support and -information to policy makers and to the public.

Based on the above, the objective of the Task 37 work programme is to address the challenges related to the economic and environmental sustainability of biogas production and utilisation. While there are many biogas plants in OECD countries, operation, in most cases, can only be sustained with the help of subsidies to be able to compete with the fossil energy industrial sector. There is a clear need to enhance many of the process steps in the biogas production chain in order to reduce both investment and operating costs. Task 37 started the process optimisation work in the 2010-2012 work programme and intensified this focus in the subsequent period.

Until recently the environmental performance of biogas production and utilisation was not assessed in a detail manner and studies have started to highlight concerns about emissions of greenhouse gases at various stages of the biogas production chain. Task 37 started to address emissions in the 2010-2012 work programme and will focus special attention on environmental sustainability of biogas production and utilisation and establish best practices for emissions reduction.

In combination, process optimisation studies in Task 37 attempted to significantly improve both economic and environmental performance of the biogas value chain, where the end-product is heat, or electricity, or biomethane for pipeline injection and use as a vehicle fuel and includes recycling/utilisation of the digestate as fertiliser.

The specific objectives of the Task 37 work programme are summarised as follows:

To carry out expert technical work on improved economic performance of the biogas/biomethane value chain and efficient product utilisation:

- Biomethane as a transport fuel:

Assessment of biomethane uses in all forms of transportation, from small to large engines, road, rail and water, including engine performance, emissions and safety aspects. The use of biomethane in heavy duty engines will be linked to the new work of Task 41 and IEA-AMF.

- Biogas Up-grading:

Collection and assessment of the costs and performance of large and small scale up-grading technologies.

- AD Process optimisation:

- a) Assessment of techniques for process control, including dry fermentation.
- b) Evaluation of methods for improving process kinetics

- AD of other feedstocks:

- a) overview of sewage sludge/waste water treatment
- b) assessment of the value of algae alone and as co-digestant.
- c) evaluation of source separation of biodegradable wastes and biodegradable fractions of MSW (in collaboration with Task 36).

- Digestate up-grading and biofertiliser:

Study of nutrient recovery, for example for regions with intense animal rearing; focus on nutrient capture and pelletisation for export.

To provide expert technical support to evaluate methane emissions from biogas plants and biogas/biomethane utilisation:

- Life Cycle Studies:

To establish guidelines for LCA studies of the biogas value chain and provide verified input data in order to provide a sound starting point for LCA (in collaboration with Task 38).

- Emissions management in AD plants:

Description and assessment of emissions measurement techniques, best operating practices for measurement, ranges of emissions, emissions inventory and emissions reduction techniques and strategies.

To provide technical support to policy makers and to the public through:

- Providing a verified source of information on biogas production and utilisation to decision makers from both industry and governments.
- Assisting both member and non-member countries in adopting appropriate energy crop, agricultural residue and waste management practices to improve environmental standards, reduce emissions, provide an additional source of renewable energy and increase the number of jobs, particularly in rural areas.
- Providing verified data for determining greenhouse gas emissions used in sustainability assessment schemes.
- Providing guidance to standards organisations in the development of appropriate standards supporting commercial exploitation of biogas/biomethane in the energy and fuels markets.
- Stimulating interaction between RD&D programmes, industry and decision makers.
- Informing the general public via the Task website.

Based on the stated objectives, the work programme was compiled in discussion with the prospective Task members and where possible, IEA Bioenergy members using:

- Information collation on the specific interests and on-going programmes in the IEA member countries through Task Members
- The status of trends in substrate availability, gas utilization and biofertiliser utilization
- Discussion and adoption of the Work Programme with the Task 37 members after their feed-back from the national ExCo members

The specific objectives highlighted before, were dispatched on the following work topics:

1. Feedstocks and the AD Process

- AD process optimisation
- AD of source separated MSW
- AD of sewage sludge
- Biogas from algae

2. AD products utilisation

- Biogas up-grading
- Biomethane use as a transport fuel
- Digestate up-grading

3. Sustainability

- Methane emissions
- Biogas LCA

1.5 Project results and dissemination of results

The above topics provided input to following papers and technical reports, aiming to offer technical support to policy makers. The technical reports are available for free download as pdf files on the task webpage <http://task37.ieabioenergy.com/technical-brochures.html>

***Exploring the viability of small-scale anaerobic digesters in livestock farming,
Published 2015***

***Sustainable biogas production in municipal wastewater treatment plants,
November 2015***

***A perspective on algal biogas,
September 2015***

***Nutrient Recovery by Biogas Digestate Processing,
August 2015***

***A perspective on the potential role of biogas in smart energy grids,
December 2014***

***Biomethane - Status and Factors Affecting Market Development and Trade,
September 2014***

Pretreatment of feedstock for enhanced biogas production, February 2014

Apart from the above research topics, the activity includes the so-called horizontal topics, consisting of outreach, dissemination and support activities, such as Information exchange between Member Countries, Workshops and seminars, Website updates and Newsletters publication, Collaboration with other IEA Bioenergy Tasks, aiming exchange of biogas knowledge, broad biogas information and education, providing support to formulation of standards etc.

Information Exchange between the Member Countries

Task meetings: Two task meetings per year were held, to allow for full technical exchange, reporting and planning.

Site visits: Were organised during each task meeting, for the purpose of data collection and dissemination, as appropriate.

Country reports: Country Report presentations continue to be published on the Task website (<http://www.ieabiogas.net/country-reports.html>). The summary of the Country Reports was published in January 2015 and January 2016. The reports are available for free download from: <http://task37.ieabioenergy.com/country-reports.html>

Minutes: The discussions and the conclusions of each meeting are documented in extended minutes.

Workshops and Seminars

Workshops and meetings with operators, industry and local/national decision makers were organised alongside the Task meetings. The Workshops organised by the Task proved very effective in generating fruitful exchange of knowledge and information, through contacts and discussions between technical experts, industry and policy makers. In collaboration with national organisations, a research workshop is always organised as part of each one of the regular task meeting programmes.

Workshop organized by IEA Bioenergy, in collaboration with GSE, FAO and IRENA in Rome, 17 May 2016: Mobilizing sustainable bioenergy supply chains-opportunities for agriculture.

IEA Bioenergy EUSEW Workshop: Brussels, 14 June 2016: Bioenergy in balancing the grid and providing storage options, cancelled

Webinar With Australia Bioenergy 28 April 2016. Available at:
<http://www.bioenergyaustralia.org/pages/resources.htm>

Webinar With IEA Bioenergy 2 June 2016. Available at:
<http://www.ieabioenergy.com/iea-publications/webinars/>

IEA Task 37 Session at Bioenergy Australia Conference 2016
Location: Brisbane, Australia, Date: November 15th 2016

IBBA Workshop 2016
Location: Esbjerg, Denmark; Date: August 25th 2016
www.ibbaworkshop.eu

Energy from Biogas Workshop (UK)
Location: George Hotel, Wallingford, UK; Date: April 14th 2016

IEA Bioenergy 2015 Conference - Biogas Session
Location: Berlin, Germany; Date: October 28th 2015
<https://ieabioenergy2015.org/>

IBBA Workshop 2015
Location: Malmö, Sweden; Date: September 10th 2015
www.ibbaworkshop.eu

IEA Session at Green Gas Research Outlook Sweden 2015
Location: Örnköldsvik, Sweden; Date: March 23-25th 2015
www.greengasresearch.se

meeting with Inter Baltic Biogas Arena (IBBA)
Location: Kiel, Germany; Date: September 4th 2014
<http://www.ibbaworkshop.eu/kiel-2014/>

Brazil joint meeting with CIBiogas
Location: Foz do Iguaçu, Brazil; Date: April 4th 2014

For more details about the workshop topics and the presentations, please see
<http://task37.ieabioenergy.com/workshops.html>

Case Stories and Success Stories

The published case stories are newer, innovative projects, while success stories describe projects that have proved successful in commercial operation and that can be used as “visible proof” for visits by prospective new project planners and users. During the project triennium, the case stories listed below were published, and are available for free download, on the webpage of the task: <http://task37.ieabioenergy.com/case-stories.html>

Solrød Biogas – Towards a circular economy, December 2015
[Case Story Denmark \(197.8 KiB\)](#)

Ringkøbing-Skjern, Denmark – Decentralised Biogas Network Model, May 2015
[Case Story Denmark \(351.4 KiB\)](#)
REVAQ Certified Wastewater Treatment Plants in Sweden for Improved Quality of Recycled Digestate Nutrients, April 2015
[Case Story Sweden \(279.4 KiB\)](#)

Non-grid Biomethane Transportation in Sweden and the Development of the Liquefied Biogas Market, September 2014
[Case Story Sweden \(398.9 KiB\)](#)

Maabjerg Biogas Plant: Operation of a very large scale biogas plant in Denmark, June 2014
[Case Story Denmark \(2.5 MiB\)](#)

Fredericia biogas upgrading: the first full scale upgrading plant in Denmark opens the way for use of biogas for biomethane fuel production, May 2014
[Case Story Denmark \(256.4 KiB\)](#)

Biowaste and sewage sludge recovery: separate digestion, common gas upgrading and heat supply, Switzerland, April 2014
[Case Story Switzerland \(2.3 MiB\)](#)

List of biogas upgrading plants in Task 37- Member Countries

The list is updated each year, and is available for free download from:
<http://task37.ieabioenergy.com/plant-list.html>

Website updates

The project results are currently disseminated through the project website <http://task37.ieabioenergy.com>, which is the centralised library where the publications of the Task 37 are available for free download. These are the technical biogas reports, the case stories, the country reports, the periodic newsletters and information about the research seminars etc.

The website continues to be up-dated as appropriate. A new search tool for national biogas published reports was launched in 2015.

Newsletters

The Task 37 gathers contributions from its members and contacts and publishes the newsletter on a regular basis. 30 Newsletters were published in the period 2014-2016, and are currently available at <http://task37.ieabioenergy.com/archive.html>

Outreach and collaboration

Collaboration with other IEA Bioenergy Tasks is a high priority for the activities of the Task. In 2016, Task 37 started an inter-task collaboration, involving with Task 40 (Sustainable International Bioenergy Trade - Securing Supply and Demand) on a report entitled "Sustainable Bioenergy Chains". The Inter Task Project synthesis report "Mobilizing Sustainable Bioenergy Supply Chains" and a Danish Case concerning governance of biogas sustainability are in preparation, and will be published in 2017. The Task 37 work in the inter-task project is coordinated by the Danish National team Leader, Teodorita Al Seadi.

National dissemination of results

At national levels, further dissemination is done through the task members' national networks and their webpages. National mirror groups were formed in many Member Countries. These groups continue their activities in support of Task 37 and in support of their own national objectives regarding biogas and biomethane. National mirror groups play an important role in formulating topics for inclusion in Task 37's work programme and in the dissemination of output. Dissemination of results takes also place through the regular task meetings and supporting activities such as conference participation, research workshops and study trips.

1.6 Utilization of project results

The project does not have a research objective of its own, although the aim is that the partnership acts as an international platform for sharing and dissemination of the newest biogas knowledge and research results.

Through the work of the Task, communication between RD&D programmes, relevant industrial sectors and governmental bodies is encouraged and stimulated. Continuous education is addressed through dissemination of the Task's publications in workshops, conferences and via the website. Information and data collected by the Task is used increasingly for providing support to all levels of policy making and the drafting of standards in Member Countries.

The energy policies in most parts of the world, including Denmark, are promoting production of energy from renewable sources and substitution of fossil fuels with renewable fuels/biofuels for the reasons of climate protection, security of energy supply and economic sustainability. The rise in oil prices and the shortening of gas delivery has clearly enhanced the interest in biogas.

The project is in line with the objectives of Green Growth (Grøn Vækst) plan and with the long-term Danish Energy Strategy, aiming to replace completely the fossil fuels from the energy supply by 2050 and to enhance the production of biogas from 4,1PJ today to 12PJ by 2020. This requires that up to 50% of the produced animal manure and slurry is treated in biogas plants, compared to 5-6% today. To achieve this objective, the necessary digester capacity must be established, the operational performance improved, new markets and technologies for gas and digestate utilization developed. The new role of the biogas sector will be to provide balance in a wind dominated energy sector, to contribute to security of energy supply, as well as to provide food safety and environmental protection. The international collaboration supports this move, through the joint international efforts of research sharing, networking, information and knowledge dissemination, at all levels.

The activities of the project are in line with the main EU energy policies, more specific the renewable energy objectives (Renewable Energy and implementation of the 2009 EU Renewable Energy Directive), agriculture (rural development) and the environment (climate change and the implementation of the 2008 EU Waste Framework Directive).

1.7 Project conclusion and perspective

State the conclusions made in the project. Try to put into perspective how the project results may influence future development.

During the present and the previous trienniums, the IEA Bioenergy Task 37 has played a significant role in the definition and promotion of sustainable biogas technologies, used for manure treatment in agricultural biogas plants, in organic waste treatment facilities and wastewater treatment sites.

The technical reports and the information and data published by Task 37 through its webpage <http://task37.ieabioenergy.com> are used as reference documentation by many national energy agencies, biogas developers, and research institutions around the world. Members of Task 37 continue to be called upon to provide data for European Union calculations of greenhouse gas savings as part of the implementation of the EU renewables directive. Some of the Task 37 National Team Leaders from European Countries have taken part in European (CEN) standardisation work concerning injection of biomethane into natural gas grids and the use of biomethane as a transport fuel. The input to standards has used information collected as part of the work programme of Task 37. Standards are expected to be published in 2017.

There are today more than 11,000 biogas installations in the Task 37 Member Countries. There is substantial further potential for expansion of the AD sectors in all member countries, based on feedstock availability, but there are challenges as well. These refer to maximizing the potential benefits in terms of energy yield and to reduce both investment and operating costs at the biogas plants.

The growing biogas sector in OECD countries faces sustainability challenges and requires subsidies to be able to compete with the fossil energy industry. There is a well-understood need to reduce the reliance of biogas plants on subsidies such as investment grants, feed-in tariffs and green certificates. There is a clear need to optimize many of the process steps in the biogas production chain, in order to reduce both investment and operating costs, and to increase overall sustainability. This enhancement is now also required to effect significant decarbonization and meet increasingly stringent sustainability criteria, which are essential in order to mitigate climate change. Significant progress has been made in renewable electricity but decarbonization of transport fuel is problematic.

Gaseous renewable energy carriers, such as renewable 'green gas' can have a considerable impact in future energy systems and play a key role in decarbonizing heat and transport. Green gas at present is dominated by biomethane, generated from the anaerobic digestion of digestible biomass and residues produced in agriculture, food production and waste processing.

The market for biomethane is still growing. In the short term, the development of green gas projects, including the injection of biomethane to gas networks will be the primary focus of this developing industry. Management of this process will require a green gas certificate scheme to ensure sustainability and to allow trade.

The on-going requirement to decarbonize will lead to integration of anaerobic digestion systems in other processes, be they agricultural, agro-food, waste management and or beverage industry. Anaerobic digestion is also seen as an integrated element in the biorefineries of the future.

IEA Bioenergy has an important role to play in the further sustainable development of AD technologies and provision of support to the relevant policy makers.

Annex

More details about all the activities and the publications, as mentioned in this report and in the table below, are to be found at the webpage of the IEA Bioenergy Task 37 Energy from biogas: <http://task37.ieabioenergy.com> .

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