Technology Collaboration Programme
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Task 37

Energy from Biogas

Triennium 2016-2018

IEA Bioenergy

IEA Bioenergy: ExCo: 2019: 08E

Task 37
Energy from Biogas

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Website: http://task37.ieabioenergy.com/about-task-37.html

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Introduction

The specific objectives of the new Task as set out in the Triennium Proposal of January 2016 were:

1. To carry out expert technical work on sustainable digestion of substrates, associated reactor configurations and utilisation of produced biogas

- *Biogas production from wastes, residues and by-products:* Assessment of optimised processes for mono-digestion of food waste. This includes analysis of operating systems in a number of countries using a range of different technologies. Assess long-term performance and define optimum digestion systems. Assess novel residue streams including from beverage industry, liquid biofuel production systems, biorefineries, paper industry and fish processing.

- *Biogas outside Europe and biogas without subsidies:* Examine international applications of biogas facilities in regions such as Australia, Asia and Latin America. Assess the potential for low cost technologies and the potential for economically feasible subsidy-free digestion systems.

- *Biogas in grids:* Describe biogas upgrading systems, gas grid injection processes, and methods of greening of the gas grid. Highlight use of biomethane in energy/fuel supply of the future.

2. To provide expert technical support to assess the externalities of biogas systems:

- *Socio-economic aspects of biogas utilisation*: Assess the real cost of biogas systems, including the benefits such as amelioration of impacts of agriculture and disadvantages such as methane leakage. Assess the environmental impact of biogas systems. Assess the role of alternative feedstocks with consideration of competition with other uses of biomass.

3. To provide guidance and advice on best practice to policy makers:

- *Guide for recommended laboratory assessment.* Outline methods, which result in standardised repeatable results for laboratory assessment. Include a database of results from Biomethane Potential Assays (BMPs) carried out using good laboratory techniques.

- *Best practice for use of digestate as biofertiliser and biomethane as substitute for natural gas*: Provide data on quality assurance of digestate and examine gas quality issues.

- *Health and safety*: Highlight all health and safety aspects of biogas systems.

4. 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 performance, 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.

Background

The main 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 thousands of biogas plants in OECD countries, operation in the vast majority of 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, particularly at small farm-scale, in order to reduce both investment and operating costs and to increase income.

The approach of Task 37 involves the review and exchange of information and promotion of best practices for all steps of the process chain for anaerobic digestion (AD) of biomass residues and energy crops for the production of biogas as a clean renewable fuel for use either directly in combined heat and power generation or after up-grading to biomethane where it replaces natural gas. In addition, there is growing interest in the use of biogas and biomethane to help stabilise power grids that are increasingly fed from variable sources of generation like wind and solar.

The Task also addresses utilisation of the residues of the AD process, the digestate, and the quality management methods for conversion to high quality organic fertiliser. The scope of the work covers biogas production at small and large farm-scale, in wastewater treatment plants and treatment of the biodegradable fraction of municipal waste (biowaste), energy crops and algae.

Only recently has the environmental performance of biogas production and utilisation been assessed in detail. Recent studies have identified key sources of emissions of greenhouse gases at various stages of the biogas production chain. Task 37 has addressed emissions and is directing attention to environmental sustainability of biogas production and utilisation and is working towards defining best practices for emissions reduction.

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.

Task objectives and work carried out

The Task had four objectives for the triennium as outlined below:

1. TO CARRY OUT EXPERT TECHNICAL WORK ON SUSTAINABLE DIGESTION OF SUBSTRATES, ASSOCIATED REACTOR CONFIGURATIONS AND UTILISATION OF PRODUCED BIOGAS

The questions posed in this objective are what feedstocks can be used to make sustainable biogas, why are these feedstocks digested and how should the system be optimised. In this objective we included three technical reports:

Food Waste Digestion

Banks, C.J., Heaven, S., Zhang, Y., Baier, U. (2018). Food waste digestion: Anaerobic Digestion of Food Waste for a Circular Economy. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 12 ISBN: 978-1-910154-58-8 (eBook electronic edition), 978-1-910154-57-1 (printed paper edition)

Full report and two-page summary published December 2018.

Estimates suggest the total food waste lost globally each year is around 1.3 billion tonnes. Food waste is seen as a difficult substrate for mono-digestion. The report highlights economic drivers and sustainability of collection systems, characterisation and composition of feedstocks, handling and pre-treatment, historical issues in mono-digestion and the energy potential of food waste. The report highlights that mono-digestion of food waste is energetically favourable and possible at commercial scale despite the high ammonia concentration through selective trace element addition to promote a more resilient microbial community. The report is populated with case studies from 11 countries.

INTEGRATED BIOGAS SYSTEMS: Local applications of anaerobic digestion towards integrated sustainable solutions

McCabe, K., Schmidt,T. (2018). INTEGRATED BIOGAS SYSTEMS: Local applications of anaerobic digestion towards integrated sustainable solutions. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 5 ISBN: 978-1-910154-40-3 (eBook electronic edition), 978-1-910154-39-7 (printed paper edition)

Full report and two-page summary published May 2018.

The biogas industry is well placed to achieve nine of the United Nations (UN) sustainable development goals (SDGs) pertaining to food and energy security, well-being, gender equality, sustainable water management and sanitation, resilient regions and cities, sustainable industrialisation and combating the effects of climate change. To meet these nine SDGs it is imperative that the biogas sector is both economically and environmentally sustainable. Digestion of substrates (such as municipal solid waste, sewage sludge, manures and slurries and agro-industrial waste streams) improve water quality, reduce pollution and fugitive greenhouse gas emissions, produce biofertilisers, generate jobs, decentralise energy generation, improve livelihoods. Nine case stories from 7 countries (Australia, Brazil, Ghana, Nepal, New Zealand, Rwanda and India) are used to illustrate local applications of anaerobic digestion towards integrated sustainable solutions. Examples include reducing capital investment through use of covered anaerobic ponds treating pig waste. Another example highlights digestion of sewage from a prison in Rwanda to reduce pollution of water courses, provide gas for cooking and heating, reduce firewood use and provide biofertiliser for crops.

Green Gas: Facilitating a future green gas grid trough the production of renewable gas

Wall, D., Dumont,M., Murphy, J.D. (2018). Green Gas: Facilitating a future green gas grid through the production of renewable gas. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 2

ISBN: 978-1-910154-38-0 (eBook electronic edition), 978-1-910154-37-3 (printed paper edition)

Full report and two-page summary published February 2018.

Gas is an important energy vector used for home heating, production of dispatchable electricity in combined cycle gas turbines (CCGT) and transport in natural gas vehicles (NGVs). It is also essential for industries such as breweries, distilleries and creameries. To meet commitments to decarbonisation, renewable gas must be used in lieu of natural gas.

This report highlights the sources of renewable gas including anaerobic digestion, gasification, algal biogas and power to gas systems (figure 1). The work identifies how these systems should be integrated to optimise outputs. For example curtailed electricity may be converted to hydrogen via electrolysis ($2H_2O = 2H_2 + O_2$) to upgrade biogas to biomethane ($4H_2 + CO_2 = CH_4 + 2H_2O$) while the oxygen from electrolysis may be sent to the gasifier to improve the energy value of the producer gas (by removing nitrogen found in air from syn-gas). Capture of CO_2 from biogas is discussed in terms of cultivation of micro-algae and in terms of reaction with hydrogen to produce renewable methane. The report highlights the Green Gas Commitment whereby 6 European Gas Grids have an ambition of substituting 100% of natural gas with green renewable gas by 2050. These commitments are exemplified by country. For example, in the case story GREENING THE GAS GRID IN DENMARK, February 2019 Denmark, which at present has approximately 10% renewable gas, intends decarbonising the gas grid with 72PJ of renewable gas by 2035. Addition of Power to Gas systems could see a resource of 100 PJ, which would be in advance of gas demand.

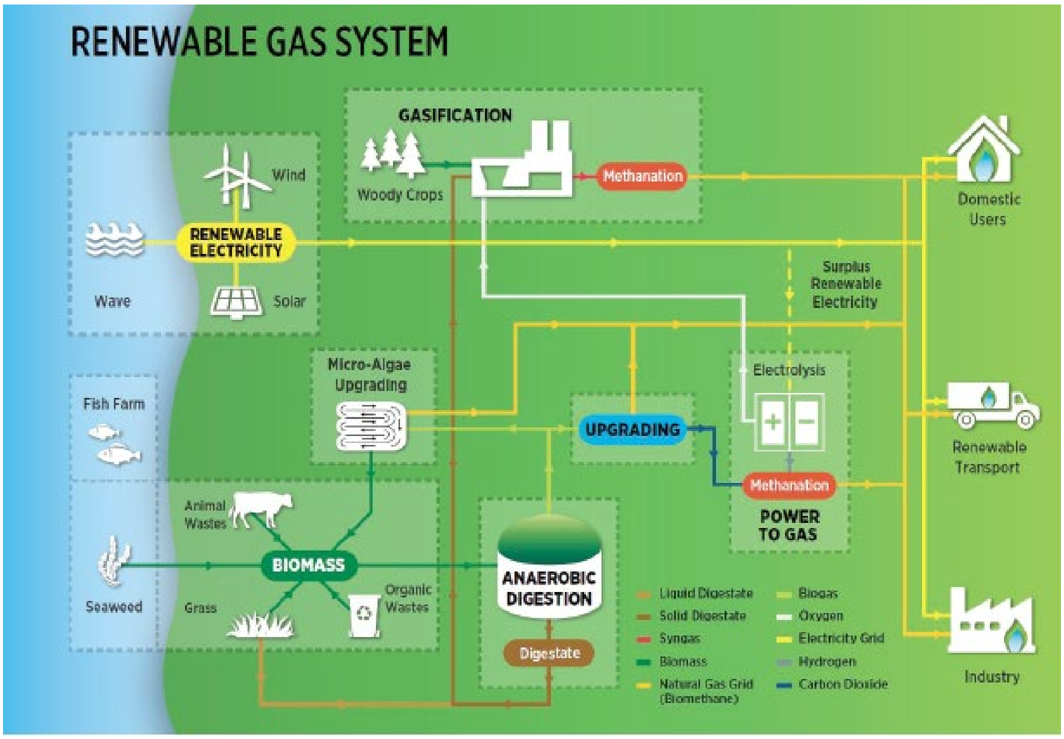

Figure 1 Example of a future integrated cascading green gas system

2. TO PROVIDE EXPERT TECHNICAL SUPPORT TO ASSESS THE EXTERNALITIES OF BIOGAS SYSTEMS:

Methane Emissions from Biogas plants

Liebetrau, J., Reinelt, T., Agostini, A., Linke, B. (2017). Methane emissions from biogas plants Methods for measurement, results and effect on greenhouse gas balance of electricity produced. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2017:12 ISBN: 978-1-910154-35-9 (printed paper edition) ISBN: 978- 1-910154-36-6 (eBook electronic edition)

Full report and two-page summary published December 2017.

Methane is a potent greenhouse gas with a global warming potential much higher than carbon dioxide. Fugitive methane emissions from a renewable energy production system are not conducive to the ambition of reducing Greenhouse Gas (GHG) emissions. It is essential to ensure minimum fugitive emissions at the biogas facility. If we cannot measure, we cannot manage. This leads to new challenges regarding emission monitoring, quantification and reduction. The methods used and the interpretation and evaluation of the results obtained is not as yet standardised. This report addresses methods used for evaluation, presents selected results of measurements, proposes mitigation measures and puts methane emissions in a context of a standard greenhouse gas balance in order to evaluate the impact of these emissions on the sustainability of the biogas system. A significant output was the graphical representation of the impact of fugitive methane emissions on sustainability (as measured in g CO_{2eq}/MJ). For example there is potential for negative emissions for biomethane systems. This is based on the credit for digestion of manure, which in the JRC methodology represents 17.5% of the produced methane. This credit is based on the removal of fugitive emissions from open slurry tanks. For example if we can limit fugitive losses to 2% in co-digestion of maize (40%) and slurry (60%) the GHG emissions approximate to zero. With 70% Maize we can still have GHG emissions less than 30% of the fossil fuel comparator (FFC).

3. TO PROVIDE GUIDANCE AND ADVICE ON BEST PRACTICE TO POLICY MAKERS:

Governance of environmental sustainability of manure-based centralised biogas production in Denmark

Al Seadi, T., Stupak, I., Smith, C. T. (2018). Governance of environmental sustainability of manure-based centralised biogas production in Denmark. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 7 ISBN: 978-1-910154-41-0 (printed paper edition) ISBN: 978-1-910154-42-7 (ebook electronic edition)

Full report and two-page summary published July 2018.

In Denmark, at the moment, biogas is seen to have two new important functions: supporting intermittent renewable electricity (from wind and solar energy); and playing a central role in the circular bioeconomy. The most significant sustainability concern associated with biogas has been undesirable indirect land use changes and competition with fodder and food production. This led to restrictions on the use of energy crops as feedstock, and a political decision to phase out their use in Danish biogas production. Biogas sustainability is first of all about following best practice to ensure safety and sustainability improvements, throughout the closed loop supply chain. This involves the use of good practice in: crop production; handling and management of the feedstock; appropriate digestion to avoid sanitary problems of the digestate; reduction of fugitive emissions and leakages from the plant; and safe and sound application of the digestate as a biofertiliser in the field. A mix of laws, statutory orders, voluntary monitoring systems and good practice guidelines govern these issues. Examples of enabling policy include:

- A target of using 50% of all manure for biogas production by 2020.
- Use of dedicated energy crops as co-substrate for manure is limited to 12% in co-digestion by mass by 2020; exceptions to this are applied to perennial ryegrass and clovers from land that have not been tilled for 5 years.

The Role of Anaerobic Digestion and Biogas in the Circular Economy

Fagerström, A., Al Seadi, T., Rasi, S., Briseid, T, (2018). The role of Anaerobic Digestion and Biogas in the Circular Economy. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 8

ISBN: 978-1-910154-45-8 (printed paper edition) ISBN: 978-1-910154-46-5 (eBook electronic edition)

Full report and two-page summary published August 2018.

This technical report has been written to highlight the diversity of benefits from anaerobic digestion and biogas systems. Biogas from anaerobic digestion is not merely a concept of production of renewable energy; it cannot be compared to a wind turbine or a photovoltaic array. Nor can anaerobic digestion be bracketed as just a means of waste treatment or as a tool to reduce greenhouse gases in agriculture and in energy. It cannot be pigeonholed as a means of producing biofertiliser through mineralisation of the nutrients in slurry to optimise availability, or as a means of protecting water quality in streams and aquifers. It is all these and more. The process is illustrated with case stories from 4 countries (Denmark, Finland, Norway and Sweden).

For example, The Magic Factory in Norway recycles food waste and manure into biogas, green CO_2 and valuable biofertiliser for the production of new food. The produced biogas is upgraded and fed into a gas grid and is primarily used as vehicle fuel replacing about 5 million litres of diesel. The local county Vestfold (2157 km2 and about 250 000 inhabitants) has reached the government’s goal of 30% of all manure digested to produce biogas before 2020, by 2016. Green CO_2 and biofertiliser are used inside industrially adapted greenhouses for food production.

Value of batch tests for biogas potential analysis

Weinrich, S., Schäfer, F., Bochmann, G., Liebetrau, J., (2018). Value of batch tests for biogas potential analysis; method comparison and challenges of substrate and efficiency evaluation of biogas plants. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 10

ISBN: 978-1-910154-49-6 (eBook electronic edition), 978-1-910154-48-9 (printed paper edition)

Full report and two-page summary published October 2018.

The batch test is an established test system for the determination of the biogas potential of organic materials. Inter-laboratory tests and investigations analysing the impact of inoculum have revealed a significant variability in the results of the test. Other methods for the determination of the biogas potential based on chemical analysis show a significantly lower variability in the results, but limited correlation with batch tests. Which test result is more accurate and freer of bias remains unknown since there is no absolute value or method to be compared with.

Revisions of the available protocols and identification and elimination of causes for the variability is needed. If the variability of the batch test can be reduced, the development of biochemical analysis combined with regression analysis might become more precise and result in a higher accuracy. A further series of inter-laboratory tests (including continuous processes and chemical analysis such as nutrient assessment) and the publication of these results are necessary for further improvement of applied test procedures and more precise results.

Country Reports and Databases

The Task published an updated Country Report Summary for 2017 in September 2018. It may be found at: http://task37.ieabioenergy.com/country-reports.html. The 71-page document summarises information on the biogas sector in 15 Task member countries, including energy recovery data, biogas utilisation data, details of support schemes and key research projects. Three individual country report presentations (Switzerland, Sweden and Brazil) were also uploaded. In September 2018 the Task produced the 2017 upgrading plant list. This included details of approximately 600 upgrading facilities; 532 of these are in Task member countries with details of a further 68 outside Task member countries.

4. TO PROVIDE TECHNICAL SUPPORT TO POLICY MAKERS AND TO THE PUBLIC:

Thirteen case studies were published and are available at http://task37.ieabioenergy.com/casestories. html: These may be grouped into sub-topics as below:

Small-scale facilities:

1. Den Eelder Farm: Small farm scale mono-digestion of dairy slurry, March 2017

2. Organic Biogas improves Nutrient Supply, Kroghsminde Bioenergy I/S, Denmark February 2019

Large-scale agricultural facilities:

3. Sønderjysk Biogas Bevtoft: Hi-tech Danish biogas installation a key player in rural development, March 2018

4. Icknield Farm Biogas: An Integrated Farm Enterprise, August 2018

5. Profitable on-farm biogas in the Australian pork sector, February 2018

6. Mono-Digestion of Chicken Litter: Tully Biogas Plant, Ballymena, Northern Ireland, January 2019

Upgrading biogas and decarbonisation of gas use:

7. Green Gas Hub: Provision of biogas by farmers by pipe to a Green Gas Hub with a centralised upgrading process, April 2017

8. Greening the Gas Grid in Denmark, February 2019

9. Upgrading Landfill Gas to Biomethane: using the WAGABOX process, November 2018

10. Biomethane Demonstration: Innovation in urban waste treatment and in biomethane vehicle fuel production in Brazil, November 2017

11. Gösser Brewery: The role of biogas in greening the brewing industry, December 2018

12. Distributed Generation using Biogas in a Microgrid: in the Western Region of Parana, Brazil, February 2019

Power to gas facility

13. Biological Methanation Demonstration Plant in Allendorf, Germany: An upgrading facility for biogas, October 2018.

Success story

Problem Statement:

Can we continue to use gas as an energy vector in a world where significant decarbonisation is required.

Synthesis of output:

Green gas in the present is dominated by upgraded biomethane with 532 facilities in Task member countries [1]. Biomethane has many sources including landfill gas [2], slurries and grasses. The methods and logistics of upgrading are varied. Biogas from a number of small facilities may be pumped to a central processing facility for upgrading to compressed or liquified biomethane [3]. Alternatively, slurries may be pumped to a large centralised anaerobic digester where the biogas is upgraded to biomethane and inserted into the gas grid where via green gas certificates it may be sold elsewhere on the grid as a transport fuel [4]. To increase the resource other sources of green gas are required. The Task has explored gasification of woody crops, digestion of algae (for advanced gaseous transport fuel) and electro-fuels [5]. Electro-fuels utilise electricity to make gas [6]. For example, at present Denmark has 10% green gas in the grid (and a similar amount in CHP) [7]. The Danes believe that by 2035 they can match gas demand (72PJ) and even surpass it using power to gas technologies (100 PJ). In Brazil they have explored use of 400 ha of grass cuttings in a campus to supply transport fuel to 60 vehicles [8]. In Austria a brewery has decarbonised with the aid of biogas production from residues [9].

Relevant publications, technical reports, case stories and databases:

1. Upgrading plant list 2017 (http://task37.ieabioenergy.com/plant-list.html)

2. Upgrading Landfill Gas to Biomethane: using the WAGABOX process, November 2018

3. Green Gas Hub: Provision of biogas by farmers by pipe to a Green Gas Hub with a centralised upgrading process, April 2017

4. Sønderjysk Biogas Bevtoft: Hi-tech Danish biogas installation a key player in rural development, March 2018

5. Wall, D., Dumont, M., Murphy, J.D. (2018). Green Gas: Facilitating a future green gas grid through the production of renewable gas. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 2

6. Biological Methanation Demonstration Plant in Allendorf, Germany: An upgrading facility for biogas, October 2018

7. Greening the Gas Grid in Denmark, February 2019

8. Biomethane Demonstration: Innovation in urban waste treatment and in biomethane vehicle fuel production in Brazil, November 2017

9. Gösser Brewery: The role of biogas in greening the brewing industry, December 2018

Symposium and Workshop

http://task37.ieabioenergy.com/workshops.html.

- ***"The role of anaerobic digestion and biogas in the Circular Economy", Cork, Ireland, 6 September 2018***; an attendance of 135 with a Q&A session on Green Gas Grid led by Brian Ó Gallachóir, Chair of IEA ETSAP. An afternoon workshop on technical aspects of greening the gas grid.

- **"Grid Injection of biomethane and innovations in the biomethane market" Vlijmen, The Netherlands, 6th April 2017**. An industry workshop on the extent of the resource and market for green gas.

Benefits to Industry:

The Cork workshop (figure 2) included a discussion on the technicalities of injection of renewable gas to the transmission grid, the distribution grid, rates of compression, quantities of storage, the limitations of the summer trough, the need to match the composition of natural gas in the grid in terms of energy value and Wobbe index, and the detailed specification of the biomethane to be injected.

Figure 2 Task 37 Meeting in Cork September 2018

The symposium in the Netherlands examined the future uses of green gas. The easiest market was seen as heating for domiciles. Deep retrofit and heat exchangers for heating was seen as desirable but more expensive than green gas. It is postulated that while the gas-grid was modern it would be used for domestic heating but as the gas grid aged it may not be replaced. Overall gas consumption would decrease but it would all be green by 2050. There was a perspective that industrial demand was paramount.

Conclusions and recommendations

CURRENT STATE-OF-THE-ART AND FUTURE POTENTIAL

The main objective of the Task 37 work programme was 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 the vast majority of 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. This enhancement is now also required to effect significant decarbonisation and meet stringent sustainability criteria.

In 2013 – 2015 Task 37 produced reports on: substrates (sewage sludge, algae); pre-treatments including source separation of MSW; process optimisation (role of biogas in smart energy grids, process monitoring and nutrient recovery); and market development and trade of biomethane. In 2016-2018 Task 37 reported on: substrates (food waste); optimisation of the sustainability of the produced biogas through measurement and minimisation of methane slippage at biogas facilities; system optimisation (greening of the gas grid; the role of biogas in circular economies; integrated sustainable solutions). Best practice in the lab was assessed through interrogation of the biomethane potential assay. In 2019 – 2021 Task 37 proposes work on three broad themes: the role of biogas in energy systems; sustainability of biogas systems and methods to ensure good practice; and integration of biogas into processes.

To mitigate climate change, it is essential to develop integrated and sustainable decarbonised renewable energy systems. Heat and transport together, account for about 80% of final energy consumption. Significant progress has been made in renewable electricity, but decarbonisation of transport fuel is not advanced. Gaseous renewable energy carriers, such as renewable 'green gas' can have a considerable impact in future energy systems and play a key role in decarbonising heat and transport. Green gas at present is dominated by biomethane, which can be generated from the anaerobic digestion of organic biomass and residues produced in agriculture, food production and waste processing. In 2015, there were 459 biogas-upgrading plants in operation producing 1,230 M Nm3 of biomethane. The market for biomethane is still growing. Sweden, the UK, Switzerland, France and the Netherlands have all increased their biomethane production significantly in the last five years. In the short term, the development of green gas projects, including the injection of biomethane into 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.

Recent EU policy measures facilitate the development of such pathways with progressively increasing obligations on decarbonisation. The share in renewable and low-carbon transport fuels (excluding first generation biofuels and including electrification) is required to increase from 1.5% in 2021 to 6.8% in 2030, with advanced biofuels to make up at least 3.6% by that time. Biomethane can provide this advanced biofuel for intercity buses and heavy commercial vehicles.

The on-going requirement to decarbonise will lead to integration of anaerobic digestion systems in other processes, be they agricultural, agri-food, waste management and or beverage industry.

Anaerobic digestion would also be seen as an integrated element in the biorefineries of the future.

Challenges

There are many challenges to anaerobic digestion related to the economic and environmental sustainability of biogas production and utilisation. Task 37 must meet this challenge and provide expert evidence in areas where biogas systems offer innovative solutions. It is proposed to address in the new triennium: the use of biomethane in heavy commercial vehicles; the flexibility of biogas systems and the potential to facilitate intermittent renewable electricity; the integration of biogas into other industries, including farming, beverage and biorefinery processes. Evidence and advice are needed to ensure best practice and compliance with stringent sustainability criteria, whilst ensuring minimum cost of energy. An overarching challenge is the communication of the evidence to highlight the benefits of the biogas industry.

REALISING THE IEA BIOENERGY STRATEGIC PLAN

All deliverables play a role in realising the objectives of the IEA Bioenergy Strategic Plan 2015-2020.

WORK PROGRAMME

The work programme was compiled in discussion with the prospective Task participants and where possible, IEA Bioenergy members using:

- Information collated on the specific interests and on-going programmes in the IEA Bioenergy Member Countries through Task Members.
- The status of trends in substrate availability, gas utilisation and biofertiliser utilisation.
- Discussion and adoption of the Work Programme with the Task 37 members after their feedback from the national ExCo members.

The major Topics to be dealt with during the 2019-2021 Task period are summarized below:

A. Energy Systems

Biomethane as a transport fuel

This project has an overarching ambition of raising awareness of the contribution of biogas systems to advanced biofuel production. The report will examine national policy backgrounds including: bans and/or phasing out of diesel and petrol; air quality; electrification of cars; decarbonisation; and areas where biomethane may have a competitive advantage in particular in intercity buses and heavy commercial vehicles.

Technical requirements for integration of biogas systems into the energy system

The energy demand of the end user or grid operator does not necessarily fit to the energy output of a biogas facility. In particular the increasing share of renewables in the electricity grid and seasonal heat demand represents challenges for the biogas plant operation. The report will define the flexibility from the perspective of the biogas facility and describe technical aspects of a demand-oriented operation.

B. Sustainability and Environment

Green gas certification & sustainability criteria

This report will outline the sustainability of a range of green gas systems, the sustainability criteria that renewable gas systems will be subject to and examine certification systems that provide evidence of such sustainability criteria.

Good Management Practice of the anaerobic digestion facility

This report will detail good practice about anaerobic digestion systems. It will offer advice on optimal technologies, minimisation of slippage of methane and of smells and will offer good practice on all aspects of practices associated with biogas facilities.

C. Integration of anaerobic digestion into processes

Integration of anaerobic digestion into agricultural sector

This project will assess circular economy processes to evaluate integration of biogas and anaerobic digestion systems into the farming system. It will deal with production of food, feed and bioenergy. It will include biogas done right principles producing energy without impact on food production whilst decarbonising the farming system.

Increasing the range of feedstocks for anaerobic digestion

This project will examine the potential to greatly expand the utilisation of anaerobic digestion processes through use of feedstocks that have been considered recalcitrant.

Integration of anaerobic digestion into biorefineries

This inter-Task project will assess the optimal role of anaerobic digestion in biorefinery systems.

Attachments

- Deliverables (Task meetings, conference papers, seminar proceedings, technical notes, newsletters, Industry Days, scientific publications, books, etc.), including website address and dissemination of results. *Included*

- Co-ordination with other Tasks with IEA Bioenergy. *Included*

- Co-ordination with other bodies outside of IEA Bioenergy, e.g. other Implementing Agreements; and other organisations – FAO. *Included*

DELIVERABLES AND PUBLICATIONS

IEA Bioenergy Task 37 Technical Reports

website: http://task37.ieabioenergy.com/technical-brochures.html

1. Food Waste Digestion

Banks, C.J., Heaven, S., Zhang, Y., Baier, U. (2018). Food waste digestion: Anaerobic Digestion of Food Waste for a Circular Economy. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 12

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2. Value of batch tests for biogas potential analysis

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Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 10

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3. The Role of Anaerobic Digestion and Biogas in the Circular Economy

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4. Governance of environmental sustainability of manure-based centralised biogas production in Denmark

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Full report and two-page summary published July 2018.

5. Integrated Biogas Systems: Local applications of anaerobic digestion towards integrated sustainable solutions

McCabe, K., Schmidt,T. (2018). Integrated Biogas Systems: Local applications of anaerobic digestion towards integrated sustainable solutions. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 5

ISBN: 978-1-910154-40-3 (eBook electronic edition), 978-1-910154-39-7 (printed paper edition)

Full report and two-page summary published May 2018.

6. Green Gas: Facilitating a future green gas grid through the production of renewable gas

Wall, D., Dumont,M., Murphy, J.D. (2018). Green Gas: Facilitating a future green gas grid trough the production of renewable gas. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 2

ISBN: 978-1-910154-38-0 (eBook electronic edition), 978-1-910154-37-3 (printed paper edition)

Full report and two-page summary published February 2018.

7. Methane Emissions from Biogas plants

Liebetrau, J., Reinelt, T., Agostini, A., Linke, B. (2017). Methane emissions from biogas plants. Methods for measurement, results and effect on greenhouse gas balance of electricity produced. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2017:12 ISBN: 978-1-910154-35-9 (printed paper edition) ISBN: 978-1-910154-36-6 (eBook electronic edition)

Full report and two-page summary published December 2017.

CASE STORIES

http://task37.ieabioenergy.com/case-stories.html:

1. **Greening the Gas Grid in Denm**ark**,** February 2019

2. **Organic Biogas improves Nutrient Supply**, Kroghsminde Bioenergy I/S, Denmark February 2019

3. **Distributed Generation using Biogas in a Microgrid**: in the Western Region of Parana, Brazil, February 2019

4. **Mono-Digestion of Chicken Litter**: Tully Biogas Plant, Ballymena, Northern Ireland, January 2019

5. **Gösser Brewery**: The role of biogas in greening the brewing industry, December 2018

6. **Upgrading Landfill Gas to Biomethane**: using the WAGABOX process, November 2018

7. **Biological Methanation Demonstration Plant in Allendorf, Germany**: An upgrading facility for biogas, October 2018

8. **Icknield Farm Biogas**: An Integrated Farm Enterprise, August 2018

9. **Sønderjysk Biogas Bevtoft**: Hi-tech Danish biogas installation a key player in rural development, March 2018

10. **Profitable on-farm biogas in the Australian pork sector**, February 2018

11. **Biomethane Demonstration**: Innovation in urban waste treatment and in biomethane vehicle fuel production in Brazil, November 2017

12. **Green Gas Hub**: Provision of biogas by farmers by pipe to a Green Gas Hub with a centralised upgrading process, April 2017

13. **Den Eelder Farm**: Small farm scale mono-digestion of dairy slurry, March 2017

TASK MEETINGS

Minutes meeting IEA Bioenergy Task 37 April 2016 UK

Minutes meeting IEA Bioenergy Task 37 Nov 2016 Australia

Minutes meeting IEA Bioenergy Task 37 April 2017 Netherlands

Minutes meeting IEA Bioenergy Task 37 September 2017 Denmark

Minutes meeting IEA Bioenergy Task 37 March 2018 Finland

Minutes meeting IEA Bioenergy Task 37 September 2018 Ireland

WORKSHOPS

http://task37.ieabioenergy.com/workshops.html.

"The role of anaerobic digestion and biogas in the Circular Economy." Cork, Ireland, 6 September 2018

"Circular Economy in the Food System" Workshop Jyvaskyla, Finland, 8 March 2018

"Biogas Externalities" Esbjerg, Denmark, 14th September 2017

"Grid Injection of biomethane" Vlijmen, The Netherlands, 6th Aprilh 2017

"Bioenergy Australia" Brisbane, 25th August 2016

"Energy from Biogas Workshop" Wallingford, 14 April 2016

COUNTRY REPORTS

http://task37.ieabioenergy.com/country-reports.html

IEA Bioenergy Task 37 Country Report Summaries 2017

IEA Bioenergy Task 37 Country Report Summaries 2016

DATABASES

http://task37.ieabioenergy.com/plant-list.html

Upgrading plant lists 2017,

Upgrading plant lists 2016,

Upgrading plant lists 2015.

NEWSLETTERS

Typically 10 per year

COLLABORATIONS WITH OTHER TASKS

Collaboration with Task 40 on Sustainable Bioenergy Chains

Governance of environmental sustainability of manure-based centralised biogas production in Denmark Al Seadi, T., Stupak, I., Smith, C. T. (2018). Governance of environmental sustainability of manure-based centralised biogas production in Denmark. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 7

ISBN: 978-1-910154-41-0 (printed paper edition) ISBN: 978-1-910154-42-7 (ebook electronic edition)

Full report and two-page summary published July 2018.

In Denmark, at the moment, biogas is seen to have two new important functions: supporting intermittent renewable electricity (from wind and solar energy); and playing a central role in the circular bioeconomy. The most significant sustainability concern associated with biogas has been undesirable indirect land use changes and competition with fodder and food production. This led to restrictions on the use of energy crops as feedstock, and a political decision to phase out their use in Danish biogas production. Biogas sustainability is first of all about following best practice to ensure safety and sustainability improvements, throughout the closed loop supply chain. This involves the use of good practice in: crop production; handling and management of the feedstock; appropriate digestion to avoid sanitary problems of the digestate; reduction of fugitive emissions and leakages from the plant; and safe and sound application of the digestate as a biofertiliser in the field. A mix of laws, statutory orders, voluntary monitoring systems and good practice guidelines govern these issues.

Co-ordination with other bodies outside of IEA Bioenergy, e.g. other Implementing Agreements; and other organisations – FAO.

Task 37 worked with and co-funded the 2017 Biogas and Biomethane Report in Mercosur Mercosul Ad Hoc Group on Biofuels, see: http://task37.ieabioenergy.com/countryreports.html;

Brazil represents IEA Bioenergy Task 37 on the Global Bioenergy Partnership (GBEP) hosted at FAO headquarters in Rome;

Collaborations with Bioenergy Australia and ENEA Consulting

http://task37.ieabioenergy.com/country-reports.html

Biogas Opportunities in Australia, January 2019

Brian Ó Gallachóir, Chair of IEA ETSAP invited to Task 37 Symposium in Cork, September 2018 to chair sessions and discussion on biogas policy

IEA Bioenergy

Further Information

IEA Bioenergy Website
www.ieabioenergy.com

Contact us:
www.ieabioenergy.com/contact-us/