TASK 37

Energy from Biogas

Final Proposal for Task Prolongation for the new triennium 2016-2018

ExCo76
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Summary of proposal items: Objective, work scope, work programme, deliverables, management qualifications	

Objectives

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 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.

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); emissions; and market development and trade of biomethane.

In 2016-2018 Task 37 will continue to examine substrates, process optimisation and sustainability. Prominence will be given to wastes as substrate, in particular food wastes. Investigation of the role of biogas in smart energy grids will be continued through investigation of greening the gas grid. The practice and the potential for biogas in developing countries and in countries outside Europe will be assessed. AD systems that can minimise or remove requirements for financial subsidy will be investigated. Environmental performance of biogas production and utilisation will be included in a study, which will include externalities of biogas systems. Advice will be given on best practice.

Work programme

Key topics for the new triennium are the economic and environmental sustainability of the biogas value chain. The work programme will be organised to address various aspects of the biogas process, with a main focus on anaerobic digestion processes applied to wastes, innovative upgrading of biogas to biomethane (through for example Power to Gas concepts), use of the produced biogas or biomethane in a way that can offer the best economic return and may facilitate larger portions of intermittent renewable electricity in a smart energy grid. International applications of anaerobic digestion will be investigated with particular attention to countries outside Europe and developing countries and to cost effective applications, which do not require financial subsidy. The work programme will be designed to provide expert input to policy debates in the areas of renewable energy, waste management and environmental sustainability.

Deliverables

The deliverables will include direct technical input to developing energy, waste and environmental sustainability discussions in the member countries. Dissemination of information to industry, standardisation bodies and licensing authorities, through dedicated technical reports, seminars and workshops and to the public through the Task 37 website.

Management The Task will be led by Prof Jerry D Murphy (University College Cork, Cork, Ireland). Jerry has been a Task member since 2010. Jerry will be supported by the Task members who will lead specific activities within the work programme.

Annual budget (US$): Total US$196,000 less 10% for Strategic Fund, net US$176,400
Annual budget per participant (US$): 14,000 - assuming 14 participants

1. RATIONALE AND OBJECTIVES

Rationale
The work of the Task will address technological aspects of anaerobic digestion (AD). Based on the technical knowledge and expertise of its members, the Task will provide support to policy makers, in the Member Countries during the implementation period, on expansion of renewable energy in an environmentally sustainable and cost effective manner.

Based on many favourable reports over a number of years AD is a favoured treatment process for organic residues and wastes, particularly for feedstocks with high water content. AD has been adopted by a range of sectors to tackle ground water pollution in agriculture, treatment of municipal sewage and treatment of the organic fraction of municipal solid waste. AD is used in a range of industrial processes to recover energy from residues while substantially reducing the overall impact of a primary process on the environment. AD is also a useful process for dedicated energy production from both purpose-grown crops as well as residues. Biogas when upgraded may be used for renewable heat and/or renewable gaseous transport biofuel in the form of biomethane. Indeed, AD may be a route in the future to third generation biofuel through digestion of micro-algae and macro-algae (seaweed). Biomethane injection to the natural gas grid allows distribution from the biogas production site to the consumer. Power to gas systems (where excess electricity is converted to gas) coupled with AD systems may eliminate the CO_2 content of the biogas, whilst facilitating greening of the gas grid. Both Power to Gas systems and demand driven biogas concepts facilitate higher portions of intermittent renewable electricity in smart energy grids. The AD process has the added benefit of preserving nutrients found in the feedstock and allowing these nutrients to be recycled back to the soil, thereby reducing the amount of fossil-derived fertilisers needed for subsequent crop production. AD provides additional income and jobs in distributed installations, often in rural communities. It may provide a cost efficient route to sanitation in underdeveloped areas, whilst simultaneously providing fuel for cooking and electricity generation.

The AD treatment of agricultural residues helps to reduce greenhouse gas emissions of both methane (CH_4) and nitrous oxide (N_2O). It also promotes better hygiene in relation to safe treatment of animal by-products and provides better recycling of nutrients back to the soil. Life cycle studies show that biogas from residues saves considerably more greenhouse gas emissions than first generation liquid biofuels for transport, bioethanol and biodiesel. A greater energy yield per hectare is achievable with biomethane than with first generation liquid biofuels. The treatment of green wastes or biowastes, likewise, enables the production of renewable energy, saving CO_2 emissions, while providing an effective alternative to landfilling of waste that leads to higher CH_4 emissions. However, more recent studies have highlighted potential high methane emissions from various steps in the biogas value chain. The sources of these emissions need to be identified, quantified and eventually reduced to an acceptable level.

By the end of the 2013-2015 triennium there would be more than 11,000 biogas installations in the Member Countries of Task 37. IEA has played 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 potential 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.

AD has an important role to play in the future of sustainable agriculture, rural development, waste management and renewable energy/biofuel production. 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.

Objectives
The specific objectives of the new Task are summarised as follows:

- 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.
  - *Reactor configurations and operating parameters*: Assess high solids digestion systems, high rate digestion systems, multi-phase systems and psychrophilic digestion.
  - *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.
  - *Smart Grid applications:* Assess the provision of electricity at times of peak demand with production of biomethane (aligned with biological power to gas systems) for use as a transport fuel or source of renewable heat at times of low demand for electricity.

- 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.

- 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.

- 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.

2. WORK SCOPE

The Task will divide the specific objectives into the following Topics:

A. Substrates and reactor configurations
- Biogas production from residues;
- Integration of biogas into advanced biofuel systems and biorefineries;
- Reactor configuration and operating parameters.

B. International approaches for local sustainable anaerobic digestion
- AD outside Europe;
- AD without subsidies.

C. Grid injection, smart grid, greening of the gas grid and local grids
- Biogas upgrading;
- Greening of the gas grid;
- Innovative AD technologies.

D. Externalities
- Socio-economic aspects of biogas and utilisation;
- Alternative feedstocks.

E. Best Practice Guidelines
- Guide for recommended laboratory tests;
- Best practice guideline for digestate as biofertiliser;
- Best practice guideline for biomethane as substitute for natural gas;
- Health and safety aspects.

F. Outreach, dissemination and support activities
- Workshops and seminars;
- Success stories;
- Website and Newsletter.

Topics A to E will provide input to papers and reports to be published and to support policy makers. Collaboration with other Tasks will be included where possible. Potential for collaboration will be explored with: Task 33 (Thermal Gasification of Biomass) and Task 40 (Sustainable International Bioenergy Trade - Securing Supply and Demand) in the area of greening the gas grid; Task 38 (Climate Change Effects of Biomass and Bioenergy Systems) on Externalities in particular on the environmental impact of biogas systems; Task 39 (Liquid Biofuels) in the area of integrating biogas into advanced biofuel systems; and Task 42 (Biorefining) in the area of integration of biogas into biorefineries.

Task Management
Task 37 is managed with input from all Member/Member Countries and the final Programme of Work (POW), including budget, is discussed and agreed by all members. The individual topics will be 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 between regular meetings 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.

3. 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 2016-2018 Task period are summarised:

A. Substrates and reactor configurations

- *Wastes and residues*;
  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 integration into advanced biofuels including biorefineries;*
  Evaluate the role of biogas, when integrated into advanced biofuel production systems, including for biorefineries.
- *Reactor configurations and operating parameters*:
  Assess high solids digestion systems, high rate digestion systems, multi-phase systems. Assess for operation at differing temperature settings (psychrophilic, mesophilic and thermophilic).

B. International approaches for local sustainable anaerobic digestion

- *AD outside Europe.*
  Examine international applications of AD in countries outside Europe and in developing countries.
- *AD without financial support (such as without feed-in tariffs);*
  Examine cost effective applications for biogas facilities. Assess the potential for economically feasible subsidy free digestion systems. Undertake risk-based assessment of such systems.

C. Grid injection, smart grid, greening of the gas grid and local grids

- *Biogas upgrading;*
  Detail the state of the art in biogas upgrading. Assess impact of technology and of scale on cost per m^3 of upgraded biomethane. Detail innovative systems such as upgrading with hydrogen produced from power to gas systems.
- *Greening of the Gas Grid;*
  Detail relevance of injection of biomethane to the natural gas grid for downstream use as renewable heat or renewable transport fuel. Assess potential level of substitution of natural gas with green gas (biomethane) in IEA Task 37 countries. This work could be carried out in collaboration with Task 33 (Thermal Gasification of Biomass) and Task 40 (Sustainable International Bioenergy Trade - Securing Supply and Demand). Examine role of biomethane in energy/fuel supply of the future and its ability to facilitate larger quantities of intermittent variable renewable electricity in the electricity grid system. Evaluate the role of local gas grids in sustainable energy systems.
- *Innovative AD technologies;*
  Assess innovative AD systems, including for demand driven biogas and Power to Gas Systems.

D. Externalities

- *Socio-economic aspects of biogas and utilisation:*
  Assess the real cost of biogas systems, including for the benefits such as amelioration of impacts of agriculture and disadvantages such as methane leakage. Assess the environmental impact of biogas systems.

- *Alternative feedstocks:*
  Assess the role of alternative feedstocks with consideration of competition with other uses of biomass.

E. Best Practice Guidelines

- *Guide for recommended laboratory assessment.*
  Outline methods, which result in standardised repeatable results for laboratory assessment. This will include a database of results from Biomethane Potential Assays (BMPs) carried out using good laboratory techniques.
- *Best practice guideline for biomethane as substitute for natural gas:*
  Examine gas quality issues including for example potential for microbes in biomethane.

F. Outreach, dissemination and support activities

- *Workshops and Seminars:* Workshops and meetings with operators, industry and local/national decision makers will be organised alongside the Task meetings. Past Workshops organised by the Task proved very effective in generating fruitful discussions between technical experts, industry and policy makers.
- *Success Stories:* These will be defined from the above Topics and will focus on 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.
- *Website and Newsletter:* The website is the centralised library of publically available Task 37 literature and plant list (only upgrading list to be updated; where possible links to national and association biogas plant lists to be provided) to be regularly updated. The Task will continue to gather contributions from its members and contacts and publish the newsletter on a regular basis.

4. DELIVERABLES

Information Exchange between the Member Countries

- *D1. Task meetings (nominally Q2 and Q4 each year):* To allow full technical exchange between members, reporting and planning. Site visits will be made during each meeting for the purpose of data collection and dissemination, as appropriate. Inter-Task collaboration meetings will be held when appropriate.
- *D2. Meeting Minutes (nominally Q2 and Q4 each year):* The discussions and the conclusions of each meeting will be documented in extended minutes.
- *D3. Technical workshops (nominally either Q2 or Q4 each year):* In collaboration with national organisations workshops will be held at least once each year.
- *D4. Country reports (nominally either Q2 or Q4 each year):* At least once each year the country updates presented by the members will be published on the web site.
- *D5. Web Site (continuous basis):* The web site (www.iea-biogas.net) will be regularly updated with news, publications and Task reports.
- *D6. Newsletter (nominally Q2 and Q4 each year):*

Technical Reports

- *D7.* **Food waste digestion systems and application to other residues** *(from Topic A) (Q2, 2018):* 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. Examine role of high solids digestion; high rate digestion; multi-phase systems; psychrophilic, mesophilic and thermophilic digestion. Assess biomethane potential of novel residue streams including from beverage industry, liquid biofuel production systems, biorefineries, paper industry and fish processing.
- *D8.* **International approaches to sustainable anaerobic digestion** *(from Topic B) (Q4, 2017):* Focus on AD outside Europe and without financial support; Examine cost effective and simple design options; Undertake risk-based assessment of such systems.

- *D9.* **Grid Injection and greening of the gas grid** *(from Topic C) (Q1, 2018):* Biogas in local gas grids; Biogas upgrading; Grid injection of biomethane; Greening of the gas grid; Utilisation of biomethane as a transport biofuel, as a source of green heat or in a downstream combined cycle gas turbine (CCGT); Innovative technologies (integration of green gas into smart energy grids).
- *D10.* **Externalities of biogas systems** *(from Topic D) (Q4, 2017):* Focus on socio-economic aspects of biogas and utilisation – what are the real costs of biogas; Sustainable (cost and environment) or alternative feedstocks with consideration of competition with other users of biomass; Environmental impacts.
- *D11.* **Best Practice Guidelines for Biogas Industry** *(from Topic E) (Q2, 2017):* Guide for recommended laboratory tests; Database for BMP test results; Gas quality issues including for issues relating to grid injection (microbes in biogas) (NL Case study translated and adapted to IEA)
- *D12. Success Stories (Q3, 2013, 2014 & 2015):* The subjects of at least 3 short Success Stories from commercial application of biogas/biomethane will be decided from the above Topics.

5. SCHEDULE AND MILESTONES

The schedule and the milestones of the different activities will be agreed at the first meeting of the 2016-2018 work programme. The responsibilities (Topic Leaders) will be assigned at the same time. Dates for completion of deliverables will be assigned in consultation with all Task members, ExCo and external customers, as appropriate.

6. ANNUAL BUDGET

The proposed annual budget is based on participation of 14 countries with an annual contribution per country of US$14,000. 10% of the budget will be reserved for projects on behalf of ExCo.

Category	**Annual Budget (US$1000)**	**% Of Budget**
Labour (editing brochures and technical output) and Benefits	59	30%
Workshops, Seminars and Meetings	12	6%
Travel and Subsistence	7.5	4%
Materials and Publications	12	6%
Website & Newsletter	6	3%
Topic Leaders (research and production of reports)	73.5	38%
Accounts administration	6.4	3%
Total	**176.4**	90%
Contribution to ExCo	19.6	10%
Annual Total	**196**	**100%**

The planned costs to Task 37 of collaborative activities account for approximately 10% of the Task budget over the 3-year work programme.

7. COUNTRY PARTICIPATION

Countries expected to participate are listed below:

- Australia
- Austria
- Brazil
- Denmark
- Finland
- France
- Germany
- Ireland
- Korea
- Netherlands
- Norway
- Sweden
- Switzerland
- UK

8. MANAGEMENT QUALIFICATIONS OF THE PROPOSED TASK LEADER

Prof Jerry D Murphy has been a member of Task 37 for 6 years and prior to this was a member of Task 39 for 3 years. Jerry is Professor of Bioenergy and Biofuels in the School of Engineering, University College Cork. He is the Interim Director of the 32M Euro SFI MaREI research centre and is Vice Director of the Environmental Research Institute (ERI). His own research team consists of 2 post-doctorates and 12 PhD students. He is an editor of the IEA commissioned book: "The Biogas Handbook: Science, Production and Applications". He is a co-author on three IEA technical brochures: "Biogas from Crop Digestion" (2011); "A perspective on the potential role of biogas in smart energy grids" (2014) and "A perspective on algae biogas" (2015). He has delivered keynote/invited lectures at a number of conferences including: The 3rd China International Bioenergy and Biomass Utilization Summit, Shanghai (2015); The World Renewable Energy Conference, London (2014); European Grassland Federation Conference, Iceland (2013); The World Renewable Energy Conference, Denver (2012); the International Energy Farming Congress in Papenburg, Germany (2011); the European Grassland Federation Conference, Kiel (2010); and the German Bioenergy Association, Berlin (2009). He has written 70+ peer review journal papers and according to Google Scholar this work has been cited ca. 3070 times in peer review press (H index 30). Jerry serves as a referee on numerous peer review journals and is on the Editorial Board of Renewable Energy.
Since 2007 he has secured ca. €3 million funding to study innovative biogas systems.

9. GANTT Chart of Task 37 for the 2016-2018 triennium

Deliverable	Subject	2016				2017				2018			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
D1 & D2	Task meetings and minutes												
D3	Technical workshops												
D4	Country Reports												
D5	Website updates												
D6	Newsletter												
D7	Report on food waste digestion systems and applications to other residues												
D8	Report on International approaches to sustainable Anaerobic Digestion												
D9	Report on Grid Injection and greening of the gas grid												
D10	Report on Externalities of Biogas Systems												
D11	Report on Best Practice Guidelines for Biogas Industry												
D12	Success stories												