CROPGEN - Renewable Energy from Crops and Agro-wastes

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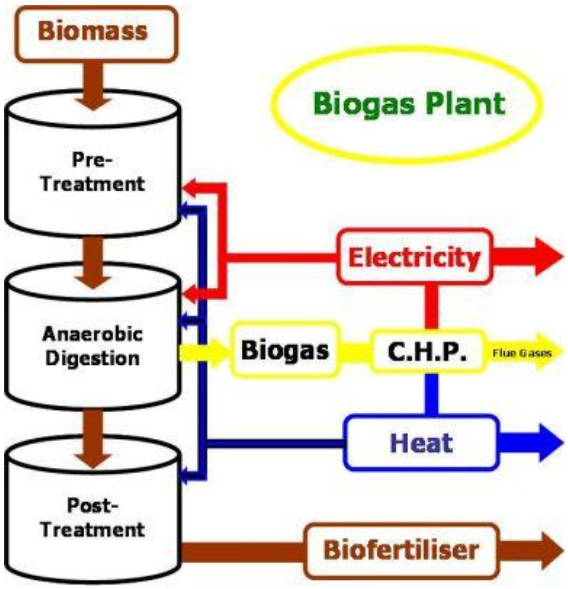
Start year	2004	
Finish year	2007	
Funding body	EU FP6 Sustainable Energy Systems	
Related website	http://www.cropgen.soton.ac.uk	

Objectives

The overall objective is to produce from biomass a sustainable fuel source that can be integrated into the existing energy infrastructure in the medium term, and in the longer term will also provide a safe and economic means of supplying the needs of a developing hydrogen fuel economy. The project is based on the use of anaerobic digestion (AD) as a means of producing methane from biomass, including energy crops and agricultural residues. The technology of biochemical methane generation is well established: the breakthrough to a cost-effective and competitive energy supply will come from engineering and technical improvements to increase conversion efficiencies, and from reductions in the cost of biomass by the introduction of integrated systems making use of novel and multi-use crops and agro-wastes. The research will determine how the technology can best be applied to provide a versatile, low-cost, carbon-neutral biofuel in an environmentally sound and sustainable agricultural framework.



• Biomass to energy schematic

Key issues

Annual growth plant tissue with its high water content is inherently unsuitable for combustion or other thermal treatments: the ideal route for such materials is through biochemical conversion. The concept of an energy-only farm, where annual crops are grown solely for biomethanisation, is still speculative and depends on two key factors: the development of digesters with higher conversion efficiencies than current conventional reactors; and the optimisation of other costs and benefits. These problems could be solved in the medium term. The concept of energy self-sufficient farming units can be realised in the short term by introduction of integrated systems making effective use of bio-residues in energy production. This, coupled with selection of crop species with multipurpose use as soil improvers and fodder crops, could yield a positive energy balance allowing export of energy off the farm.

• Grass as a renewable energy crop in Finland

• A Greenfinch research digester

Technical approach

The work will identify crops and agro-wastes best fitted to energy production in an integrated farming environment, consider energy losses in production and processing, and use these to set net energy production targets. The role of storage and pre-treatments will be considered. Co-digestion

will be evaluated for improving energy yields. Some agricultural residues will be investigated as potential high-yield substrates. Innovative bioreactor designs and operating modes will be tested. A database of bio-kinetics for use in design and operation will be established. True life-cycle costs for biogas production will be determined in large-scale trials for verification of laboratory data and predictive models. The work will consider the need for continuity of energy supply in a farm environment. Issues of sustainability, environmental impact and socio-economic factors will also be addressed.

Expected achievements / impact

The results will add to EU databases on bio-energy crops; give engineers the necessary tools to develop the technology; and provide the farming community with evidence of profitable energy production without subsidy and within the EU's target cost for renewable energy. The work will contribute to security and diversification of energy supply, reduction in greenhouse gas emissions, soil amelioration and reduced water pollution. It will also create opportunities for increased employment in agriculture and reinforced competitiveness in technology export.

Collaborators

School of Civil Engineering & the Environment, University of Southampton, UK (Soton)
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Department of Environmental Science, University of Jyväskylä, Finland (JyU)
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Department of Environmental Sciences, University of Venice, Italy (UNIVE-DSA)
Scientific and Technological Department, University of Verona, Italy (UNIVR-DST)
Industrial Process & Environment Department, Instituto de la Grasa, Spain (CSIC)
Organic Power Ltd, UK (OPL)
Metener Ltd, Finland (Metener)
Greenfinch Ltd

Selected Publications

Banks C. J., Salter A. M., Chesshire M. (2007). Potential of anaerobic digestion for mitigation of green house gas emissions and production of renewable energy from agriculture: barriers and incentives to widespread adoption in Europe. Water Science and Technology, 55(10), 165-171

Banks C. J., Zotova E. A, Heaven S., (2010) "Biphasic production of hydrogen and methane from waste lactose in cyclic-batch reactors" Journal of Cleaner Production 18(1) S95-S104

Banks, C. J. and Salter, A. M. (2007) EU Cropgen: biogas from energy crops and agrowastes. In, *Bioenergy 2007: 3rd International Bioenergy Conference and Exhibition, Jyväskylä, FI, 03 - 06 Sep 2007*

Cysneiros D, Banks C. J., Heaven S., (2008) Anaerobic digestion of maize in coupled leach-bed and anaerobic filter reactors Water Science and Technology 58(7) 1505-1511

Cysneiros D., Banks C. J., Heaven S., Karatzas K.A.G. (2012) The role of phase separation and feed cycle length in leach beds coupled to methanogenic reactors for digestion of a solid substrate (Part 1): Optimisation of reactors' performance reactors for digestion of a solid substrate (Part 1):

optimisation of reactors' performance. Bioresource Technology 103(1) 56-63
Cysneiros D., Banks C. J., Heaven S., Karatzas K.A.G. (2012) The effect of pH control and 'hydraulic flush' on hydrolysis and Volatile Fatty Acids (VFA) production and profile in anaerobic leach bed reactors digesting a high solids content substrate, Bioresource Technology, 123, 263-271.
Heaven S., Salter A. M., Banks C. J., (2011) Integration of on-farm biodiesel production with anaerobic digestion to maximise energy yield and greenhouse gas savings from process and farm residues Bioresource Technology 102(17) 7784-7793
Raposo, F., Banks, C.J. Siegert, I. Heaven S. and R. Borja. (2006) Influence of inoculum to substrate ratio on the biochemical methane potential of maize in batch tests. *Process Biochemistry*, 41, 1444-1450.
Salter A. M., Delafield M., Heaven S., Gunton Z. (2007). Anaerobic Digestion of Verge cuttings for transport fuel: closing the energy cycle. Proceedings of ICE Waste and Resource Management.