Project no. **SES6-CT-2004-502824**

Project acronym: **CROPGEN**

Project title: **Renewable energy from crops and agrowastes**

Instrument: Specific Targeted Research Project

Thematic Priority: SUSTDEV: Sustainable Energy Systems

D2: Project presentation

Due date of deliverable: Month 3
Actual submission date: Month 5

Start date of project: 01/03/2004 Duration: 39 months

Organisation name of lead contractor for this deliverable

University of Southampton (Soton)

Revision [1]

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Project Presentation

Contract number: SES6-CT-2004-502824
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Strategic objective

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 economical means of supplying the needs of a developing hydrogen fuel economy. The concept 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.

Project logo:

Participants

School of Civil Engineering & the Environment, University of Southampton, UK (Soton)
Centre for Under-utilised Crops, University of Southampton, UK (Soton-CUC)
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Industrial Process & Environment Department, Instituto de la Grasa, Spain (CSIC)
Greenfinch Ltd, UK (Greenfinch) • Organic Power Ltd, UK (OPL)
Metener Ltd, Finland (Metener)

Total cost: 2509838 € **Commission funding:** 2099731 €

Project main goals

- To identify novel process designs that will help overcome known problems of digester stability when dealing with high cellulose content bio-energy feedstocks.
- To develop methods for retention of feedstock solids and to advance the design of robust technology allowing phase separation and uncoupling in AD.
- To quantify the energy usage and potential savings in the use of different mixing systems and reactor configurations.
- To look at processing control strategies using decision support systems, neural networks and fuzzy logic to maximise biogas production
- To compare methods for characterisation of plant materials for their bio-energy potential.
- To describe the batch growth kinetics of methanogenic activity and to relate them to the primary composition of plant material.
- To determine rates of degradation and ultimate methane yield of selected plant materials.
- To determine accurate energy balances for selected crop species by calorimetric methods.
- To predict biogas energy production per hectare of arable land under different conditions.
- To classify and rank crop species that can be grown for bio-energy production.
- To select optimum storage practices and to evaluate the potential of pre-treatments for maximising bio-energy production from crops.
- To assess advantages and limitations of co-digestion of energy crops with animal slurries.
- To assess characteristics of digested residue and potential benefit in the agro-ecosystem.
- To quantify benefits from energy crops with a dual or multiple function, eg. increasing soil fertility by nitrogen fixation, producing high protein seed products for animal feed or providing a nutrient-balanced soil conditioner from energy-depleted resides.
- To maximise net overall energy surpluses from digestion and to assess the potential for optimising energy provision in an integrated livestock/arable farm environment.
- To evaluate possible market, educational and legislative barriers to crop-based bio-energy use both nationally and EU wide and analyse methods to overcome the barriers.

Specific targets

Parameter	**Target**
Digester volatile solids loading rates for pilot-scale plant per unit of reactor capacity	10 kg VS m^{-3}
Digester volatile solids loading rates in innovative lab-scale two-phase systems, per unit of reactor capacity	20 kg VS m^{-3}
Biochemical methane potential of crops identified in research as suitable for energy production	0.35 m^3 kg^{-1}
Net crop energy yield after inputs into cultivation and harvesting	48%
Life cycle cost for conversion of biomass energy into methane	35 MJ/€
Full life cycle cost of energy production in the form of electricity	0.05 € kWh^{-1}
Full life cycle cost of energy production in the form of biofuel	0.036 € kWh^{-1}

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.

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.

Coordinator contact details

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