UKERC

UKERC RESEARCH LANDSCAPE: BIOENERGY

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1. Overview

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Characterisation of the field

Bioenergy has an important role to play in meeting the UK aspirations in renewable energy supply for 2010 and 2020. Energy from biomass is complicated since several feedstocks (e.g. dedicated bioenergy crops such as willow, or food crops such as rape, sugar beet and wheat) may be utilised in different conversion processes (combustion, fermentation, gasification) resulting in several energy outputs including ***heat, power*** and ***liquid transport fuels*** (called here biofuels). It is important that this mixed portfolio of bioenergy supply is maintained at this time, ensuring the development of competitive and secure bioenergy and a firm research base for future large-scale deployments. Currently, including biogas from waste, bioenergy contributes more than 80 % of all UK Renewable Energy (BERR, 2007)[1] with several large-scale commercial deployments already in progress including bioethanol production and the use of biomass in co-firing and dedicated combustion.

Deployment is being encouraged by a large number of Government incentives including Renewable Obligation Certificates (ROCs) for co-firing, energy crop planting grants and capital programme incentives and these may extended further. Research to develop high yielding feedstocks and improvement of inefficient conversion processes and environmental sustainability is also developing, enabling us to identify clear short-term research priorities for the UK.

There are powerful, long-term environmental, political and economic drivers for the further development of the UK (and international) bioenergy sector. Bioenergy development in the UK has been impeded in the past largely by the persistent low cost of crude oil and associated policy and development barriers. The economic situation has undoubtedly changed and at $70 per barrel, many bioenergy operations begin to approach a commercial reality[2]. We have entered a period of sustained high fossil oil prices, with a seemingly long-term upward trend and in the future a move towards a more 'bio-based' economy where bio-based products (including bioenergy) are seen to have a higher value. Much advanced research will be necessary to make this move to biofuels, bio- polymers and bio-oils as well as other products, over the next two decades[3], within the appropriate framework of environmental and economic sustainability.

Current emphasis on the use of food crops (first generation bioenergy crops) to generate bioethanol and biodiesel has highlighted the potential environmental costs and poor energy balance of these approaches[13, 14] and these must be addressed through a move towards second generation perennial lignocellulosic and other more efficient systems and a reconsideration of biomass use for heat and power compared to liquid biofuels.

Despite strong multilateral interests in bioenergy R&D within the UK, split broadly between the Government departments and the Research Councils (where EPSRC leads the energy portfolio), there are international investments across the full spectrum of research, and combined UK R&D activities must be considered to be lagging behind international leaders in this field. There is clear strategic vision in Europe through the EU[4] and the United States[5,

[19], which is being matched by considerable resource investments, not least at the biology end of the R&D spectrum, for example from the BP Energy Bioscience Institute now up and running in the USA[18].

Land use will be a limiting factor for bioenergy in the UK. The Biomass Task Force[11] in a recent review concluded that a reasonable assumption for the UK would be up to 1 million hectares of UK land dedicated to specialist bioenergy crops by 2020, although in response, the UK Biomass Strategy believes 350,000 ha is more likely[14], whilst a recent Europe wide study has suggested that the UK should move towards the use on 1.6 m hectares by 2030[1], but a requirement of 740,000 hectares is estimated as necessary to fulfil 50 % of the RTFO current targets For liquid transportation fuel. These land-use scenarios should be viewed with caution – they do not consider the large step-changes that may occur in biosciences and second generation crops over the coming decades. Although it is difficult to predict the prevailing socio-economics conditions we would point to three clearly identifiable drivers, each of which will increase the attraction of bioenergy deployment in the future.

Most importantly, atmospheric CO_2 concentrations will continue to rise well into this Century and the pressure for low-carbon energy solutions will grow as an aid to fulfil UK and EU targets of 60 % on CO2 emissions reduction. Alongside this there will be increasing global impact of climate change.

Secondly, declining fossil fuel reserves and concern over energy security and long-term high fossil fuel prices will drive R&D in renewable substitutes for petrochemical.

Finally, land use competition will grow, making dual- or multi-use crops increasingly appealing. For example, a single crop may be grown for grain, which is harvested for food and then the remaining biomass is combusted for heat or fermented to bio-ethanol.

The research agenda must reflect this and currently is not well placed to develop integrated interdisciplinary research solutions. In this context the development of bio-refineries – based on the model of petrochemical refineries – where raw product (plantfeedstock) enters and more than one refined product is generated (including heat and power), is a logical ambition for biorenewable petrochemical substitution[2]. Even with this approach the UK will still require imports to fulfil even the current commitment to the Biofuels Directive (RTFO) for 5% by volume of liquid transportation fuels derived from biological sources by 2010, where progress towards these targets was reported recently by the EU[16].

A further factor that is likely to increase the economic favourability of bioenergy is the decentralisation of power generation through microgeneration (small combined heat and power units serving individual homes, businesses or communities). This will help to alleviate the need to transport biomass from point of production to large regional power stations. Microgeneration is currently a small contributor to the UK energy economy, but with careful development could become a very major one by 2030. No clear strategy currently exists in the UK to capture bioenergy from biomass 'waste' including municipal solid waste (MSW) and agricultural waste and this should be an important future priority and has been recently addressed in the UK Biomass Strategy[8, 14].

Research Challenges

Considerable recent effort in the EU[4] and USA[5] has addressed the question of future research challenges within Bioenergy, with the publication of the Department of Energy Roadmap for biofuels[5], recent roadmaps for lignocellulosic-to-bioethanol[6] and the EU Biomass Action Plan[9] and Biofuels in the European Union Vision for 2030[10]. In general, it seems likely that over a timescale of 10-20 years and beyond, there will be a move from an 'oil-based' to a 'bio-based' economy where natural resources, particularly those from green plants, can be used more effectively. Many of these bio-processing routes are inefficient and still remain costly, both in necessary energy inputs and for environmental impacts, including greenhouse gas mitigation potential and other negative effects. Bioenergy from biomass can be considered a 'low quality high volume' bioresource, whilst bio-polymers, oils and other products may be considered as 'high quality low volume'. The future long-term research challenge will be to optimise the biorefinery to ensure both types of output are possible, as appropriate.

In the longer-term, artificial photosynthetic systems, hydrogen from biomass and the use of microbial and other biological systems should be considered as having future potential. A report of UK R and D priorities for current funding agencies in the UK was made in April 2007[15], although this was focussed mostly on short-to-medium term applied research requirements.

Short term Research Challenge (5 years)

- Quantify environmental impacts of bioenergy production systems using whole life cycle analysis tools
- Developing and assessing supply chains based on biorefining (bringing together biochemical and thermochemical processes)
- Improve the efficiency of bioethanol production at pre-processing, hydrolysis and fermentation steps, using biological research
- Improve deployment of CHP in the UK linked to microgeneration
- Identify optimum land-use strategies for the UK biomass resource and likely future use of arable, set-aside and marginal land in a changing climate with consequent impacts on ecosystem services
- Develop and deliver new cultivars from past and current research and breeding of dedicated energy crops.
- Develop a UK strategy to capture energy from waste
- Improve public engagement in bioenergy decision making and understand public perceptions on use of GM technologies for bioenergy
- Assess the impact of bioenergy imports, including life-cycle analysis for both co-firing in power production and as raw and finished material for liquid transportation fuels and commitments to RTFO.

Medium term Research Challenge (10 years)

- Improve total yield and develop new genotypes of a range of bioenergy crops, including oil seed crops, woody lignocellulose and grasses
- Improve understanding and manipulation of carbon partitioning in green plants
- Identify new and novel crops and microbes; identify new or improved products and new bacteria/yeasts from genomic research
- Develop technologies for second generation biofuels, including woody and grass lignocellulose as feedstock and aviation fuels
- Understand advanced conversion routes including gasification of lignocellulosic resources

Long-term Research Challenge (20 years)

- Develop systems for large-scale production of second generation biofuels, advanced conversion and deployment of biorefining complexes
- Develop novel artificial photosynthesis systems and other synthetic biology approaches for capturing solar energy

- Continue to improve feedstock quantity and quality, conversion efficiencies and environmental sustainability in a changing climate.

References

[1] BERR UK Energy Statistics 2007

[2] The Path Forward for Biofuels and Biomaterials -- Ragauskas et al. 311 (5760): 484 -- Science

[3] EPOBIO- Bioproducts from non-food crops

[4] An EU strategy for Biofuels

[5] Genomes to Life: Systems Biology For Energy and Environment

[6] Breaking the biological barriers to cellulosic ethanol. A joint research agenda. A research roadmap resulting from the biomass to biofuels workshop, Dec 2005, published by DOE, June 2006.

[8] Waste strategy for England 2007

[9] EU Biomass Action plan

[10] Report: Biofuels in the European Union - A Vision for 2030 and Beyond on the ManagEnergy Website

[11] Biomass Task Force, October 2005, Report to UK Government

[12] Farrell AE, Plevin RJ, Turner BT, Jones AD, O'Hare M, Kammen DM. 2006. 311, 506-508, Science,

[13] Rowe, R, Street NR and Taylor (2007). 'Identifying potential environmental impacts of large-scale deployment of dedicated bioenergy crops in the UK' Renewable and Sustainable Energy Reviews (in press)

[14] UK Biomass Strategy, 2007

[15] Bioenergy Funders Forum Research priorities – 2007.

[16] EU Biofuels Progress Report, 2007

[17] How much bioenergy can Europe produce without harming the environment? - English - EEA

[18] EBI BP Energy Bioscience Institute

[19] DOE, USA Bioenergy Centres, 2007

2. Capabilities assessment

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Independent analysis suggests that the UK has research strength in basic bioscience and also in engineering, but these skills to date have not been fully applied to the bioenergy industry. They could provide valuable future capability to develop new engineering control systems linked to bioprocessing, but this still represents an unknown market for the UK. High level computing and systems biology will also be necessary for the industry to develop from a strong research base. The global biomass and bioenergy market is expanding rapidly and UK expertise could be deployed to benefit from these developments.

Table 2.1 Capability Assessment

UK Capability	Area	Market potential
High	Basic bioscience	Global Potential
	Research in plant genomics, breeding and agronomy	Global Potential
	Engineering solutions for future technologies	Global Potential
	Environmental impact and life cycle analysis of new energy systems.	Global Potential
Medium	Demonstration and deployment of existing technologies	Global potential
	Development of co-firing technologies and clean coal solutions	Global potential
Low	Developing the 'whole-chain' for utilisation of biomass from diverse sources.	UK – relevant
	Improved technologies for utilisation of energy from waste.	Global Potential
	Development of the biorefinery concept for R and D and second generation biofuels.	Global Potential

3. Basic and applied strategic research

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Here we summarise the organisations funding basic and strategic applied research (Table 3.1) and follow this with a summary of the main UK research providers – mostly university groups and research institutes (Table 3.2).

University based bioenergy research covers basic bioscience, crop science, bioenergy policy, engineering solutions and both wet and dry biomass conversion and processing as well as socio-economic and environmental considerations for large-scale bioenergy deployment. An increased expertise in environmental impact is also apparent with emphasis on water resources and the GHG mitigation potential of different bioenergy chains and life cycle analysis (LCA), where they may be considerable overlap between several current projects and where UKERC is attempting to provide synthesis.

The dedicated UK bioenergy research community is small compared to the USA and other EU members and in general, in the past, bioenergy research was funded largely from DEFRA and DTI and focussed on crop science, feedstock supply, and technological innovations for combustion and conversion and whole-chain developments with some consideration of the environmental impacts of deployment. In contrast to many other nations, the UK has not previously developed a firm single-focus strategy for bioenergy - identifying preferred feedstocks, land-use options, conversion pathways and end products, but rather has used directed strategic science to provide consistent support for Government Policy for maximised GHG mitigation and has thus focussed on heat and power bioenergy, rather than liquid transportation fuels research. As a consequence, the liquid biofuels research area was until recently quite diffuse but in the long-term, this may be seen as advantageous, providing a flexible base from which to develop appropriate solutions. But for now, few university departments have large groups working together to address this interdisciplinary problem, however this is changing with major new funding initiatives being used to develop critical mass.

The Crop Improvement Networks funded by DEFRA are internationally competitive with involvement of BBSRC Institutes in partnership with universities including Southampton. Similarly research at Aston University on Pyrolysis and more recently in leading the SUPERGEN Biomass and Bioenery partnership and several other European activities is also central to UK expertise. The RELU projects on bioenergy and sustainability (coordinated by Rothamsted Research) and anaerobic digestion (coordinated by Southampton) and the TSEC-BIOSYS project (coordinated by Imperial College), add to UK critical mass. SUPERGEN II on Bioenergy and recent calls from BBSRC in Bioenergy (April 2007) and EPSRC on improving the efficiency of solar energy conversion (August 2007), add momentum in this area. The BBSRC call alone is valued at £20 million over 10 years providing a reasonable injection of funds for feedstock research. Glamorgan has a long-term interest and capability in biohydrogen production and in general the UK has extensive expertise in plant science but this has not been applied to bioenergy problems. Research on greenhouse gas mitigation potential at Aberdeen University forms part of several international projects. CEH has extensive experience of likely water use by bioenergy crops. Many groups may be working on

bioenergy topics but if these are not core to their activity it may be difficult to identify all expertise and so care should be taken when interpreting the information below.

Table 3.1: Research Funding

Programme	Funding Agency	Description	Committed Funds	Period	Representative Annual Spend
NERC Towards A Sustainable Energy Economy	NERC/ EPSRC	**A whole-systems approach to analysing bioenergy demand and supply: mobilising the long-term potential of bioenergy. A multidisciplinary consortium to address gaps in the whole system.** The project uses a whole systems approach bringing together a an interdisciplinary group to analyse the policy, environmental and crop science (feedstock) issues determining the supply and demand for bioenergy in the UK and identifying optimal chains for future development.	£2.2M	2005-2009	£500,000
RELU - Rural Economy and Land Use, Research Councils UK	BBSRC/ESRC/NERC	**Social, Economic and Environmental implications of increasing rural land use under energy crops.** This project integrates social, economic, hydrological and biodiversity studies in an interdisciplinary approach to develop a scientific framework for Sustainability Appraisal (SA) of the medium and long term conversion of land to energy crops. The project will provide scientific tools for updating Best Practice Guides and Environmental Impact Assessments, Strategic Environmental Assessments or SAs involving projects, policies or programmes where increased planting of energy crops is proposed or anticipated. **Integrated systems for farm diversification into energy production by anaerobic digestion: implications for rural development, land use & environment.** This project examines the potential for development of anaerobic digestion (AD) on farms, and the contribution that this could make to rural development and diversification of agricultural practice by	£859,000	2006-2008 2007-2010	£285,000

Programme	Funding Agency	Description	Committed Funds	Period	Representative Annual Spend
		enhanced land use planning for bioenergy production. The research is set in the context of a rapidly developing European agenda aimed at both strengthening the rural economy and protecting the environment. Coordinated by University of Southampton.			
Supergen	EPSRC	**The SUPERGEN Biomass, Biofuels and Energy Crops Consortium**. The project will carry out research into renewable energy generation from biomass - any plant material which can be used as a fuel, such as wood, agricultural waste and vegetable oils. The conversion processes will be studied for production of bio-fuels that can be used to generate renewable energy more efficiently using thermochemical routes for conversion. The results will be used to create computer models for designing and maximising the efficiency of the thermal processes, and to identify the ideal specifications of biomass fuels for different processes. The performance, cost, and socio-economic benefits of the full range of bio-energy systems will be considered. **SUPERGEN II for Biomass.** The project continues the bioenergy consortium focussing on all aspects of the thermal processing of biomass with three additional partners in comparison with SUPERGEN I	£2.9M £6.4 M	2003-2007 2007-2010	£75,000 £1.1 M
Supergen	EPSRC	**The UK Sustainable Hydrogen Energy Consortium** The project will target many of the forefront fundamental, multidisciplinary research challenges in the production, storage, distribution and utilization of hydrogen. In addition, the project will study the feasibility and acceptability of sustainable hydrogen as an energy carrier through a range of socio-economic projects, ranging from the public awareness and acceptability of hydrogen, impact analyses and regulatory	£3.5 M	2003-2007	£900,000

Programme	Funding Agency	Description	Committed Funds	Period	Representative Annual Spend
		issues.			
Energy crops – genetic improvement	DEFRA	Underpinning and strategic research to deliver improved grass and tree crops for bioenergy, with high yield and pest and disease resistance. Two networks have been initiated. The first BEGIN aims to produce improved willow genotypes with high yield and improved pest and disease resistance. The second is for the improvement of the grass Miscanthus.	£3.5 M	2003-2008	£800,000
Bioenergy	DEFRA	Support for research on bioenergy	On-going	On-going	£200,000
Capacity building in Bioenergy	BBSRC	A research initiative called in 2007 to fund a Bioenergy research centre, projects grants and networks for feedstock research to improve the efficiency of bioenergy crops.	£20 M	2007-2017	£2 M
Chemical and biological solar energy	EPSRC	A research initiative on solar energy conversion	£3 M	2007-2010	£1 M
UKERC	EPSRC/NERC/ESRC	A project for networking and development of the research atlas and roadmap for UK Bioenergy Research. Contribution to TSEC. Analysis and synthesis of on-going research.	£290,000	2005-2009	£45,000
Responsive Mode	BBSRC	The Plants and Microbial committee of BBSRC research topic 'Fossil carbon substitution: biomass to biosynthesis	Limited to date	2005-	Limited to date
Responsive Mode	EPSRC	Energy	variable	2002-current	variable
SUE Waste Consortium Programme	EPSRC	A cluster on waste, water and land management	£1.6M	2004-2008	£400,000
TOTAL					

Table 3.2: Key Research Providers

Name	Description	Sub-topics covered	No of staff	Field
School of Biological Sciences - University of Aberdeen	School of Biological Sciences is actively engaged in research on the GHG mitigation potential of bioenergy crop systems	• GHG mitigation and carbon balance of bioenergy crop systems. • Member of TSEC-BIOSYS. Environmental sustainability.	2 Faculty	Biology
Aberdeen University, Institute of Energy Technologies	Long-term interest in SRC forestry	• SRC forestry – practical application	1 Faculty	Biology/forestry
Forest Research, Forestry Commission, Edinburgh and Alice Holt, Surrey	Research on modelling yield in SRC bioenergy trees, biofuel as a source of renewable energy and GHG balance of bioenergy cropping systems.	•SRC Yield Models in development • Woodfuel as a resource • Member of TSEC-BIOSYS •Climate change programme to predict the effects of future climates on woodfuel resource in the UK. Environmental sustainability. • Policy development and advice to central	4 Principal Investigators	Forestry

Name	Description	Sub-topics covered	No of staff	Field
		Government. • Member of SUPERGEN BIOMASS II		
Leeds University, Energy and Resources Research Institute	Expertise in the improved efficiency of biomass combustion and characterisation of emissions.	• Pyrolysis products and their characterisation. • Gasification of biomass • Emissions	2 Faculty	Environmental Engineering
Sheffield University, Waste Incineration Centre	SUWIC is one of the leading international research centres for the thermal treatment of wastes. The centre has a worldwide reputation for innovative investigations into combustion, gasification and pyrolysis of biomass/waste and the associated electrical power generation systems.	•Member of SUE – Waste management •Member of the SUPERGEN Bioenergy consortium •Dioxin Research NEtowrk for emissions. Environmental Sustainability. •Expertise in Energy from waste streams and use of both MSW and SS.	13 Faculty	Chemical and Process Engineering
Lancaster University, CEH, NERC	CEH – UK-leading on the Sustainable economies research programme with central UK funding to NERC. Director of UKERC, with overall	•Director or UKERC. •Core funding for Sustainable economies.	3 Principal Investigators	Environmental Science

Name	Description	Sub-topics covered	No of staff	Field
	responsibility for the horizontal theme 'Environmental Sustainability			
CEH, Wallingford, NERC	Hydrological expertise to assess the current and future impacts of large-scale bioenergy cropping systems on water resources.	• Member of TSEC-BIOSYS. • Expert in environmental assessment. Expert in land-use.	1 Principal Researcher 5 Researchers	Environmental/Ecological Science
Aston University, Chemical Engineering and Applied Chemistry Aston University Bioenergy Group	Professor Bridgwater established the Bio-Energy Research Group in 1986, since when it has grown to 14 members with an aggregated research income of over £6m. The current focus of the research is on fast pyrolysis of biomass and solid wastes for production of liquid bio-fuels and chemicals. There is also work on advanced gasification and bio-energy system analysis, design and evaluation including, economic assessment.	• Expert in fast pyrolysis, - at R and D level. • Coordinator of the SUPERGEN I and II Biomass consortium, including development of the British Biomass and Bioenergy Forum. • Member of two European networks for Bioenergy • Leader of IEA Task 34	6 Faculty	Chemical Engineering and Applied Chemistry
Glamorgan University, Sustainable Environment Research Centre	Two research units - the Wastewater Treatment Research Unit and the Hydrogen Research Unit. The aims are: To produce high quality scientific research in the field of sustainable environment in particularly acting as an umbrella body for the Wastewater Treatment Research Unit and the newly approved Hydrogen Research Unit. To advance knowledge and	• Expertise in dark fermentation reactions for hydrogen production • Member of TSEC-BIOSYS consortium • Member of SUPERGEN Fuel cells consortium • Member of the SUPERGEN Sustainable hydrogen economy consortium	7 Faculty	Bio-engineering

Name	Description	Sub-topics covered	No of staff	Field
	provide trained scientists and engineers to meet the needs of industry. To enhance the standing of the University of Glamorgan both nationally and internationally	• Expert in biohydrogen production including anaerobic and aerobic digestion.		
Institute of Grassland and Environmental Research, BBSRC, Institute, Wales.	Focus is on breeding and improvement of exotic grasses as bioenergy crops, with associated projects on willow and poplar as bioenergy trees in Wales. Emphasis on the whole-chain and integration with end users. Underpinning research on quality traits in grasses. Also undertakes underpinning research on cell walls and developing high throuput technologies for cell wall phenotyping	• Coordinator of DEFRA crop improvement network for *Miscanthus* improvement. • Coordinator of 'poplar for Wales' project. • Member of the SUPREGEN Biomass consortium	3 Principal Researchers	Biology
University of Southampton, School of Biological Sciences	Emphasis on underpinning research on bioenergy trees, particularly using genomics and latest biotechnological tools. Work on biodiversity and spatial supply of biomass. Expert on bioenergy tree response to future climates including water and CO_2. UKERC Research partner for research and networking on bioenergy,	• Member of the TSEC-BIOSYS consortium. • Joint contractor in the DEFRA Crop improvement network for SRC. • Coordinator of EU project 'POPYOMICS' • Department of Energy research on poplar tree genomics for carbon sequestration. • Responsible in TSEC-	1 Faculty	Biology and Biotechnology

Name	Description	Sub-topics covered	No of staff	Field
	including Environmental Sustainability.	BIOSYS for developing the bioenergy resources in the UK		
University of Southampton, School of Civil Engineering	Expertise in anaerobic digestion of wet biomass for energy	• Leader of the EPSRC SUE Consortium on energy from waste • Leader of CROPNET, a Sixth Framework Programme Consortium for crop solutions to anaerobic digestion of wet biomass • Extensive expertise in waste to energy technologies • Coordinator of RELU Biogas	3 Faculty	Civil and Chemical Engineering
Silsoe campus of Cranfield University, Institute of water and Environment	Expertise on understanding the hydrological implications of bioenergy cropping systems. Use of bioenergy trees on landfill and other strategic applied research.	• Modelling expertise	1 Faculty	Environmental Engineering
Rothamsted Research, BBSRC Institute	UK focus for SRC willow research on breeding and improvement and also on underpinning research on pest and disease resistance. Crop science expertise including in grasses and holder of National willow collection and several long-term trials of bioenergy crop species.	• Member of TSEC-BIOSYS. • Coordinator of DEFRA Crop Improvement Network on SRC. • Coordinator of RELU project on bioenergy crops. • Member of the SUPERGEN Biomass consortium.	4 Faculty	Biology

Name	Description	Sub-topics covered	No of staff	Field
Bioenergy Research Group, ICCEPT, Imperial College, University of London	Research focus on techno-economic, environmental and policy issues related to biomass energy systems applied to the heat, electricity and transport sectors. The group is composed of an inter-disciplinary team of experienced researchers. Work is carried out for a range of government research councils, government and international organisations, non-government organisations and industry.	• Expertise in policy analysis and authors of several authoritative documents contributing to policy. • Coordinator of TSEC-BIOSYS. • Expertise in all aspects of liquid bioethanol production in the UK and EU. • International trade in bioenergy	3 Faculty	Environmental Technology Environmental Policy
The Porter Alliance	The Porter Alliance is an interdisciplinary group coordinated from Imperial College and including four major Research Institute partners and three individual investigators covering all aspects of bioenergy research. ICCEPT Partners ar Rothamsted, IGER, John Innes, Southampton, York and Cambridge	• Feedstock research – improving feedstock quality and yield. • Microbiology – improved processing and novel microbiology • Fundamental plant science • Chemical engineering and systems analysis • Environmental sustainability and developing a sustainability analysis tool	Over 100 researchers and many PIs are captured by The Porter Alliance. New RAs and PhDs will begin research on October 2007	Biology Chemical Engineering
University of Surrey, Centre for Environmental Strategy,	Research is clustered around two themes: Environmental Systems Analysis and Environmental Policy and Risk Management	• ecological economics and ethics • environmental management and policy-making	10 Faculty	Environmental Science

Name	Description	Sub-topics covered	No of staff	Field
		• environmental systems analysis • sustainable energy • development of educational software		
Cardiff University, Institute of sustainability, energy and environmental management	This centre carries out research on a wide range of problems relating to energy, electricity generation, solid, liquid and gaseous pollutants. A key area of its research portfolio is in the field of sustainable and integrated waste management, particularly that of Municipal Solid Waste. The centre seeks to stimulate and support industry through technology transfer, research, advice and technical support.	• Renewable energy • Large scale combustion modelling using CFD and experimental validation • Investigation and characterisation of fine particulate emissions • Biological processing of solid wastes	7 Faculty	Environmental Engineering
John Innes Centre	JIC is an independent, international centre of excellence in plant science and microbiology. The scientific research at the Centre makes use of a wide range of disciplines in the biological and chemical sciences, including cell biology, biochemistry, chemistry, genetics, molecular biology, computational and mathematical biology.	• Fundamental plant science • Cereal genetics and genomics • Development of *Brachypodium* as a model bioenergy crop	Up to three PI scientists	Biology Crop Science

4. Applied research (inc RDA support)

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This section gives details of the Applied Research Funders (Table 4.1) and those engaged in providing Applied Research (Table 4.2). Applied research on bioenergy in the UK is largely funded by DTI, DEFRA, The Carbon Trust with some input from other agencies including Forestry Commission

The DTI as part of the New and Renewables Energy Programme supported bioenergy research in the past through grants to business and research organisations with 50 % matched funding projects. This focussed on equipment and feedstocks to ensure increased yield and efficiency in bioenergy production. Recently this scheme has been followed by the Technology Programme where the emphasis will be on low carbon technologies, particularly the biorefinery concept. In recent years The Carbon Trust has increased the funding to bioenergy projects through a mixture of smaller research grants and large directed initiatives, particularly the 'Biomass Heat Accelerator' programme to overcome barriers associated with bioenergy chains in the UK and to improve efficiency and is planning to fund a large Bioenergy project in the near future (2007). Applied bioenergy research is undertaken in the UK by a mixture of Government-funded departments and research organisations, particularly Forestry Commission, Forest Research, Rothamsted and IGER, with some additional input from a selected number of universities including partners in the Tyndall Centre. This is complemented by some industrial partners who through necessity in an emerging industry have committed resources to research. Several small companies are focussed on feedstock supply and management, such as TV Energy in the south of England. Engineering companies such as Talbott's and other involved in large scale deployment are listed in section five, below.

Table 4.1: Research Funding

Programme	Funding Agency	Description	Committed Funds	Period	Typical Annual Spend
New and Renewables Energy Programme	DTI	Past research on fuel supply systems for energy crops, and agricultural and forestry residues, including - Target of doubling energy crop yields (based on SRC willow) from current yields of 8 oven dry tonnes (ODT) per hectare. - Equipment development for reduced costs and increased efficiency. Energy crop production work supported by DTI is coming to a conclusion. Future projects to be funded on a responsive basis through the Technology Programme, and taking account of the Innovations Review, but energy crops unlikely to be a priority. The New and Renewable Energy R&D Programme is now being delivered through the Collaborative R&D Business Support Product. Open competitions for funding under this product happen twice a year.		-2006	
DTI Technology Programme	DTI	A new DTI Technology Innovation Programme was announced in April 2006.Technology priority areas include emerging Energy Technologies (**Low Carbon Energy Technologies, including development of the biorefinery concept**); Sustainable Production & Consumption (Energy Efficiency Technologies); Bioscience & Healthcare (Exploitation of Plant and Microbial Bioscience for Industry, Safety Biomarkers for Pharmaceutical Development); Advanced Materials (Materials for Extended First Use and Re-use); Information & Communication Technology (Data,	£80 M in total	2006-	Unknown

Programme	Funding Agency	Description	Committed Funds	Period	Typical Annual Spend
		Scientific and Medical Visualisation for innovative products and services).			
Applied Research, Carbon Trust	The Carbon Trust	The Carbon Trust is an independent company funded by Government. Their role is to help the UK move to a low carbon economy by helping business and the public sector reduce carbon emissions now and capture the commercial opportunities of low carbon technologies. It supports the development of low carbon technologies through R&D grants, with several of these placed within the Bioenergy sector in recent years. Other activities of the trust with specific relevance to Bioenergy are given below.	£672,000	2003-2007	£150,000
Carbon Vision	The Carbon Trust	The overall aim of this Carbon Trust project is to develop a pragmatic life cycle methodology that will allow a systematic estimation of carbon inventories in different industrial sectors that supports the incorporation of the carbon intensity of the full supply chain. This will involve both environmental and economic aspects of carbon footprints and embodied carbon, enabling estimation of "carbon added" and "valued added" at each stage in the supply chain.	£1.05M	2005-2008	£330,000
Biomass Heat Accelerator	The Carbon Trust	The broad aim of BHAP is to help make the UK biomass heat market self-sustaining by reducing costs and addressing supply chain risks. The project aims to work with existing and new sites to develop benchmarks from robust case studies, identify and demonstrate cost reductions, and raise awareness amongst end users and other stakeholders.	£5.0 M	2006-2011	£1.0M
Tyndall Centre	NERC/EPSRC/ESRC	Trans -disciplinary research related to climate change, with some limited desk-studies on low carbon economy related to bioenergy.	~£200,000	2001-2006	£40,000
SEERAD	Scottish	Currently reviewing priorities in the area, and reviewing	NA	2006-	NA

Programme	Funding Agency	Description	Committed Funds	Period	Typical Annual Spend
	Executive	ways forward for biofuel development in Scotland. SEERAD has indirect investments through 'GREEN grain', co-funded with Defra and HGCA (genetic reduction of nitrogen emissions and growing costs of wheat production whilst enhancing the value of wheat grain for the bioethanol industry amongst others).			
Environment Agency	Environment Agency	Funds small-scale hydroelectric and biomass energy. Developing BEAT, a computer-based predictive tool for potential environmental impacts and mitigation responses to aid decision-making on biomass developments from an environmental perspective, especially for environmental impact assessment (EIA) scoping.	~£50,000	2004-ongoing	£10,000
DEFRA Science	Environment Agency	DEFRA has now provided significant funding to develop BEAT as the definitive comprehensive LCA tool	£206,000	2006-2007	£206,000
DEFRA Science	DEFRA	Assessing biomass miscanthus and SRC willow and poplar varieties: the way forward	£40,000	2006	£40,000
DEFRA/Forest Research	Forestry Commission /DEFRA	Co-funding, with DTI/Defra/DARD, the project 'Yield Models for Energy Coppice Poplar and Willow- Phase IV.' Other activity is highly applied, near market, e.g.: - extraction, drying and chipping of woodfuel from plantations- ash recycling - medium to large-scale recovery, baling, handling of residue from logging.	~£2M	1999-2006	£385,000
Biomass Energy Centre	DEFRA	Established in May 2006, the 'Biomass Energy Centre' as an expert centre for advice to growers, technologists and developers in bioenergy.	~£25,000	2006-	£25,000

Table 4.2: Key Research Providers & Developers

Name	Description	Sub-topics covered	No of staff	Sector
Greenergy International Ltd	Leading supplier of low carbon fuels, particularly biodiesel. R and D into low carbon fuels and analysis of market opportunities. Work with growers to provide contract for rape and SRC for bioenergy sector.	• Biodiesel supply • Fiscal incentives for biofuels • Carbon certification	30 with a turn-over of £250 M	Chemical Engineering Agriculture
North Energy Associates	North Energy has been pioneering the use of agricultural and forestry-derived woodfuel for heating systems in the UK. We see woodfuel production as a way to strengthen the rural economy by creating and safeguarding jobs. Forestry wastes, slabwood from sawmills and specially grown energy crops are a potential source of income, as is industrially derived clean wood waste.	• Woodfuel supply chain • Heating systems • Non-technical problems • Integrated renewable energy systems	10	Advice and consultancy Project management
Future Energy Solutions	Future Energy Solutions, as part of AEA Technology, is Europe's leading sustainable energy consultancy, helping public and private sector organisations across the world find answers to the growing challenges of sustainable energy, climate change and related environmental issues.	• Biomass co-firing expertise • Technology assessments • Low carbon management • Feasibility studies	15	Advice and consultancy Project management
Forest Research, Forestry Commission	Provide Yield models of SRC poplar and willow. Management of the new 'Biomass energy Centre'. Research on boilers and technologies for	• Forestry		Applied research Engineering

Name	Description	Sub-topics covered	No of staff	Sector
	combustion			Advice and consultancy
Rothamsted Research and IGER as BBSRC Institutes (see links above)	Undertake a large portfolio of applied research on crop agronomy and demonstration	• agriculture	4	Applied research Advice and consultancy
National non-food crops centre	The Centre disseminates scientific and technical information on non-food crop issues as widely as possible in order to increase knowledge and understanding, to initiate and facilitate technology uptake and to meet the government's and society's wider objectives for sustainable development.	• Dissemination of information • Bioenergy • Non-food products from plants	10	Advice and consultancy Information dissemination
TV Energy	To promote and facilitate practical sustainable energy solutions and provide education for communities, businesses, organisations and individuals within the Thames Valley and beyond." TV Energy operates in Berkshire, Buckinghamshire, Oxfordshire, Surrey and northern Hampshire.	• Best practice for SRC deployment • Project management • Biomass supply	11 across the whole company, 4 dedicated to bioenergy	Advice and consultancy Agriculture Applied research
National Farmers' Union - Bioenergy	Representing farmers and growers in England and Scotland. 2006 – appointment of bioenergy tsar to head policy and information in this area.	• Policy analysis and dissemination • Best practice • Agricultural and landscape implications for bioenergy deployment	3	Agriculture Policy

Name	Description	Sub-topics covered	No of staff	Sector
		• Grower and farmer representation		

5. Development and Demonstration Funding
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DTI supplies the largest source of development and demonstration funding. A new 'Technology Programme' was announced in April 2006 (see 4 above) and this should provide considerable funds for developments in bioenergy, subject to restrictions imposed by the responsive mode of funding. . The 'New Opportunities' lottery fund has also funded several bioenergy projects within the Renewable Energy theme, within environment. Few demonstration projects in bioenergy are currently funded although those that are, tend to be from EU and pan-European programmes. Some DTI projects are listed here. Several commercial large-scale bioenergy projects are currently in development for deployment and these have been summarised here. This is a fast-moving area and new projects are likely to be forthcoming over the next few months and these tables should be interpreted with this in mind. They cover a range of end uses including liquid biodiesel and bioethanol as well as large scale biomass combustion facilities for heat and power.One of the largest uses of biomass currently in the UK is in the co-firing market where biomass is co-combusted with coal at power stations such as Drax and Didcot, providing ROCs to the company. It is estimated that approximately 1 million tonnes of dry biomass is utilised in this way each year currently and this amount is set to increase. Up to half of co-fired biomass imported.

Table 5.1 Development and Demonstration Funding

Name	Funding Agency	Description	Number of projects	Committed Funds	Period	Representative Annual Spend
Capital Grants Scheme	DTI	The DTI's Capital Grants Scheme funds demonstration projects that help reduce the costs and risks involved in such developments, Biomass: approximately £66 million has been provided to help encourage the efficient use of biomass, particularly energy crops, for energy production by stimulating the early deployment of biomass-fuelled heat and electricity-generation projects. Of this, the New Opportunities Fund provided approximately £33 million for energy crops power generation and around £3 million for small-scale biomass/combined heat and power projects	5 projects announced in April 2006	£66 M of which £18.74 M committed to bioenergy projects in 2006	2006-	~£4M
Energy Crops Scheme	DEFRA	Energy Crops Scheme (ECS) provides establishment grants for SRC & miscanthus, and aid to help SRC growers set up producer groups. It closed in June 2006 but it is	Large number of grants between 2002-2006	Programme £29M	2002-2006	

Name	Funding Agency	Description	Number of projects	Committed Funds	Period	Representative Annual Spend
		anticipated as part of the new rural development plan, the scheme will be extended.				
Low Carbon Buildings Programme	DTI	Funding available as a replacement to the DTI Blue Skies fund for household, communities or business projects for microgeneration technologies including biomass	Initiated April 2006	NA	2006-	NA
Renewable Energy Deployment	New Opportunities Lottery Fund	Project support in renewable energy deployment projects	7	£21 M	2003-2005	~£7M

Table 5.2: Major Demonstration Projects

Name	Description	Sub-topic	Total Project Cost	Public Sector Funder	Public Sector Funding	Period
British Sugar	55,00 tonnes per annuum (70 million litres of bioethanol) plant being constructed in Wissington, Norfolk.	• Bioethanol production at commercial scale			£20 M capital cost of plant	Construction initiated in January 2006
Greenergy International Ltd	Biodiesel plant at Immingham on the east coast of England. The plant will initially process 100,000 tonnes/114 million litres of biodiesel per year and is expected to begin by the end of 2006. Preliminary planning and design work for a second phase to double our biodiesel production capacity at Immingham to 200,000 tonnes/228 million litres per year.	• Biodiesel production at commercial scale			unknown	Construction completed by end of 2006
Energy Power Resources	38 MW straw burning power plant in Ely, Cambridgeshire. Largest straw burning power station in the world generating over 270GWh from 200,000 tonnes of biomass each year.	• Straw burning bioenergy plant			£60 M	Commissioned in 2000
ESD Biomass	Co-firing project for Didcot with 30,000 tonnes per year of dedicated bioenergy crops required for co-firing	• Co-firing with biomass • Bioenergy projects including technical			unknown	Deliveries of biomass to Didcot estimated for 2009

Name	Description	Sub-topic	Total Project Cost	Public Sector Funder	Public Sector Funding	Period
		deployment				
Seb Corp at Wilton 10	30 MW biomass burning boiler, Wilton 10, that will operate following construction in 2007, when 300,000 tonnes of biomass per year will be required, supplied from four sources ALL from within the UK – energy trees (55,000 tonnes by 2011), sawmill waste (80,000), small roundwood (80,000) and recycled wood (80,000)	• Biomass combustion			£60 M project, with £10M supplied from DEFRA Bioenergy Capital Grant Scheme	Construction completed by mid 2007
Alternative fuels | Drax	Co-firing at Drax with dedicated bioenergy crops and imported biomass, with a requirement for 20 tonnes per hour aiming at 9 % of fuel supply.	• Biomass co-firing			unknown	Developing co-firing from 2005
Green Spirit Fuels	Wessex Grain company to develop wheat grain as a source of bioethanol in the UK. Plant in development in Somerset for 141 million litres bioethanol (100,000 tonnes) by 2007.	• Bioethanol production			£50 M	Construction completed in 2007
Lockerbie woodfuel burning power station	44MW plant requiring 220,000 tonnes biomass wood burning power station in development at Lockerbie, Scotland, with 45,000 tonnes from dedicated SRC trees.	• Woody biomass combustion			£90 M	Construction completed by Dec 2007
BiCal Miscanthus	Deployment of Miscanthus as a commercial bioenergy crop in the	• Miscanthus			unknown	On-going

Name	Description	Sub-topic	Total Project Cost	Public Sector Funder	Public Sector Funding	Period
as a bioenergy crop	UK	feedstock supply				
Renewable Fuels Ltd	Leading supplier of energy crops, particularly willow, to the UK, interfacing with energy producers and primary fuel producers to provide logistics and specification fuel for renewable energy production	• Research and demonstration on SRC willow			unknown	On-going
Talbotts	Small to medium scale deployment of bioenergy boilers for domestic and commercial use. Demonstration project at Harper Adam Agricultural College CHP. Eccleshall Biomass Project will be a 2 MW plant supplied by Miscanthus.	• Biomass combustion technology • Microturbine generation			Several case studies DTI funded project.	On-going 2005- 2007 for Eccleshall plant
CRL Coppice Resources Limited	Company dedicated to development of SRC, dealing with all aspects of feedstock supply and management for bioenergy deployment.	• Agriculture • SRC specialists • Commercial deployment of bioenergy and interaction with several research projects			unknown	On-going
Port Talbot bioenergy plant	13.8 MW bioenergy plant to be supplied by woody biomass.	• Biomass combustion for power			£33M	Construction completed in 2008

Name	Description	Sub-topic	Total Project Cost	Public Sector Funder	Public Sector Funding	Period
		• CHP				
Charlton Energy Ltd	CHP for 7 MW heat and & MW power plant in Somerset, supplied by SRC and woody biomass in a pyrolysis plant.	• Pyrolysis plant – first commercial plant in the UK			£2M	Construction completed in 2007
Bronzeoak	Bronzeoak in Castle Cary, Somerset to build a 7MWe and 1.5MWth CHP plant to fuel a wood products facility with electricity and heat as well as supplying heat for curing feedstock	• Biomass combustion • CHP			£3.8M	Complete in 2007
Roves Farm	Roves Energy in Sevenhampton, Wiltshire - to build a 2.5Mwe and 5MWth combined heat and power plant (CHP) fuelled by up to 5000 hectares of locally grown energy crops	• Biomass combustion • CHP			£0.96M	Complete in 2007
Peninsula Power	23 MW combustion plant supplied by energy crops grown in Devon.	• Biomass combustion			£11.5	Complete in 2007
Waste-to-energy plants	DTI figures suggest that 24 watse-to energy plants were operational in 2005	• Waste-to-energy			unknown	On-going
BP and Associated British Food	420 M litres of bioethanol at Saltend, Hull, providing potentially the largest bioethanol plant in Europe.	• Bioethanol from low-grade wheat feedstocks			£200 M partnership	2009 commission

6. Research Facilities and Other Assets

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Many facilities exists at laboratory-level across the UK, for example, plant biology and microbiology facilities, CFD testing, pyrolysis, combustion, fermentation and other test facilities. Those are not listed here. Below is given a summary of UK-national resources that should have the highest priority for funding and maintenance since without them, UK research may in future be hindered and because these resources are utilised by many members of the research community.

Table 6.1: Research Facilities

Name	Description	Type of Asset	Turnover	No of staff
Research Trials	Several long-term experimental trials of miscanthus, willow and poplar and some other potential bioenergy crops exist in the UK. No central register or ability to fund these trials is currently available but a recent DEFRA project is addressing this question using NIAB as a contractor. Since they provide unique insight into long-term ecological adaptation, this should be seen as an urgent priority for future funding.		NA	10 from four research providers
Breeding Programmes and germplasm collections	Genetic improvement of feedstock requires a continual supply of new germplasm in which to identify genetic variation. Currently, collections in willow, poplar, miscanthus, oil seed and wheat are available in the UK.		NA	6
Genomic and other resources	Some plant genomic resources exists that are relevant to bioenergy crops including spotted microarrays for gene expression, proteomic and metabolomic databases.		NA	6 from several sources
Woodfuel and Yield Modelling tools	Forest Research have developed an extensive dataset of yield from two rotations of SRC poplar and willow . By 2006 these will become available as GIS and tools part of output from TSEC.		NA	3

7. Networks and co-ordination activity:
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Numerous networks in bioenergy extant to the UK have developed in recent years and future effort should be focussed to ensure clear purpose for UK networks, avoiding unnecessary overlap and providing better integration.

The various public funders of bioenergy R&D work together through the Bioenergy Funders' Forum to co-ordinate their research investments. The Forum was initiated by MAFF in 1999 and has been led by MAFF/Defra since. It conducted an analysis of requirements in 2001, and this has formed the foundation of co-ordination since, particularly in relation to burden sharing between Defra, DTI and the Forestry Commission. This exercise has been repeated and published on the web in 2007. As such the BFF provides a very useful network for funders. UK Bioenergy networks to integrate findings have been limited and this could be considered a weakness, particularly given new consortium-based projects in Bioenergy within RELU, SUPERGEN and TSEC. SUPREGEN was the first consortium project to kick-off and as such has lead the way in developing a Bioenergy Forum British Bioenergy News which in future will be co-edited by TSEC and UKERC researchers. Within the BEGIN Genetics Improvement Programme, there is a stakeholder group that meets once each year, providing a forum for discussion between growers and researchers and in 2007, UKERC hosted the first Bioenergy UK Network meeting, which will hopefully be an annual event with wide participation. UK participation within European networks has been present but with only a very limited number of groups appearing in several networks. Current EU networks are shown below. EPOBIO represents an exciting new approach for an EU network with partnership with the USA. The focus of EPOBIO is on harnessing the economic potential of green plants for non-food crops. UK contributed to several sessions at the May 2006 EPOBIO workshop and this network is lead by the UK. The Renewable Energy Association (REA) acts as a network for industrial interests and organises an annual Bioenergy meeting for the industry.

Table 7.1: Bioenergy networks in the UK and EU

Network	Established	Description	Membership	Activities
Bioenergy Funders Forum	1998	A cross- department group of funders from the UK. Produced a research priority document in 2000 and are currently working alongside UKERC to produce an updated version in 2006	DEFRA (leading), DTI, NERC, BBSRC, Environment Agency, English Nature, EPSRC	• Meetings and report on funding priorities. • Identification of cross-cutting areas
Bioenergy NoE	2005	EU Network of Excellence for Integrating activities to achieve new synergies in research to build a Virtual Bioenergy R&D Centre that will spearhead the development of a competitive bioenergy market in Europe.	Eight EU partners	• Collaborative projects and synergies identified in bioenergy • Networking including meetings and joint activities • Virtual Centre for Bioenergy in the EU
Thermal Net	2005	ThermalNet consists of three technologies: pyrolysis (Pyne), gasification (GasNet) and combustion (CombNet) and is funded through Altener in the Intelligent Energy for Europe Programme operated by DG TREN.	Many EU members	• Develop collaborative projects • Act as an information point for three technologies
EPO-BIO	2005	EPOBIO brings together world-class scientific and industrial expertise to identify areas for further investment in plant science research in order to realise the economic potential of plant-derived raw materials with long-term benefits to society	12 European and 2 USA partners	• Three flagship areas identified as cell walls (biomass and bioethanol), plant oils (biodiesel) and plant polymers • Desk studies and

Network	Established	Description	Membership	Activities
				workshops and input to FP7
ERA-Net	2006	A network of national government agencies and ministries responsible for coordinating and funding national research efforts into bioenergy. The goal of this network is to strengthen national bioenergy research programmes through enhancing cooperation and coordination between national agencies. Through collaboration, the individual national programmes will produce higher quality results, while through coordination, they will seek to complement each other, avoiding duplication.	DTI for UK plus The Netherlands, Sweden, Finland, Austria, Germany	• Coordination and collaboration between national programmes in member states • Issue of draft call in biomass for combustion
EUBIONETII	2005	The EUBIONET II - European bioenergy network will analyse current and future biomass fuel market trends and biomass fuel prices. It will also collect feedback on the suitability of CEN 335 solid biofuel standard for trading of biofuels. Estimation on techno-economic potential of the biomass will be given until 2010 based on the existing studies and experts opinions.	16 European partners with Jiri Klemes Manchester University for the UK	• Emissions trading • Policy framework to develop bioenergy in Europe • Special condiseration of wood fuel supply chains
NETBIOCOF	2005	A Network dedicated to improved understanding of biomass co-firing practices and principles through networking and cooperation. The UK is not a partner in this network.		• Promote cooperation between European researchers working on co-firing. • Promote uptake of innovative technologies that increase the amount of co-firing
MICROCHEAP	2004	This co-ordination action intends to bring together industrial	EU-wide network	• Improve

Network	Established	Description	Membership	Activities
		specialists and research experts to focus entirely on renewable micro-CHP technology. It will co-ordinate and steer research in this field and highlight the most promising technologies with the highest potential for market penetration in existing and future market conditions	with one UK member	coordination of research in micro CHP • Develop state of the art review of micro CHP • Provide database of on-going research in micro CHP
Renewable Energy Association	2001	The Renewable Energy Association was established in 2001 to represent British renewable energy producers and promote the use of sustainable energy in the UK. The REA's main objective is to secure the best legislative and regulatory framework for expanding renewable energy production in the UK. The biomass trade association – British Biogen was incorporated into REA after its inception.	In excess of 100 members, mostly from industry	• Resource group to consider primary biomass • Resource group to consider Renewable transport fuels • Resource group for bioenergy
Scottish Renewables Bioenergy Network	2006	A network of individuals and organisations established by Scottish Renewables to coordinate activities and share information.	200 members for the whole renewables sector	• Advice and consultancy • Project development • Project register

8. UK participation in EU Framework Programmes (main programmes) – CORDIS

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UK participation in the EU Fourth, Fifth and Six Framework Programmes has been extensive with projects funded from Energy, Environment, Agriculture work programmes and encompassing coordinated actions, standard research projects, networks of excellence and human exchanges. Dry biomass rather than wet biomass has been the focus most projects in the past but recently there has been an increased interest in biomass for liquid biofuels within Framework Six. Within Framework seven, there is considerable emphasis on the biorefinery concept and on developing research to support liquid biofuels, particularly through biological conversion routes.

The BIOMAT-NET provides an extensive database of all FP V, VI, and VII bioenergy projects

Table 8.1 Participation in EU Framework Programmes

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
Bioenergy NoE	EU Network of Excellence for Integrating activities to achieve new synergies in research to build a Virtual Bioenergy R&D Centre that will spearhead the development of a competitive bioenergy market in Europe. The NoE comprises approximately 150 researchers and over 40 doctoral students from all eight partner	FP6	DG research	Aston University	Vtt, Finland 7 Partners	€8.05m	€8.05m	2004 - 2009	€1.61m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	institutions. Activities include collaborative projects and synergies identified in bioenergy, networking including meetings and joint activities								
Thermal Net	ThermalNet consists of three technologies: pyrolysis (Pyne), gasification (GasNet) and combustion (CombNet). Activities include developing collaborative projects and acting as an information point for three technologies.		Intelligent Energy – Europe Programme	Aston University	Pyne: Aston University Combnet: Procede Group Bv Gasnet: Technical University Of Vienna	Through Altener in the Intelligent Energy-Europe Programme operated by DG TREN.	€	New call in 2006	
EPOBIO	POBIO brings together world-class scientific and industrial expertise to identify areas for further investment in plant science research in order to	FP6	Specific Support Action	Centre For Novel Agricultural Products (Cnap) York, Uk Cpl Scientific Publishing Services Ltd (Cpl) Newbury, Uk	University Of York 11 Partners	€1.48m	€1.40m	2005 - 2007	€0.64m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	realise the economic potential of plant-derived raw materials with long-term benefits to society. Three flagship areas were identified: cell walls (biomass and bioethanol), plant oils (biodiesel) and plant polymers. Activities include desk studies and workshops and input to FP7. 12 European and 2 USA partners.			British Sugar Plc (Bs) Peterborough, Uk					
ERA-Net	A network of national government agencies and ministries responsible for coordinating and funding national research efforts into bioenergy. The goal of this network is to strengthen national bioenergy research programmes through enhancing cooperation and	FP6		Dti		Maximum €3m for an ERA-NET		2002 - 2006	

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	coordination between national agencies. Through collaboration, the individual national programmes will produce higher quality results, while through coordination they will seek to complement each other, avoiding duplication. Activities include issuing of draft call in biomass for combustion.								
EUBIONETII	The EUBIONET II - European bioenergy network will analyse current and future biomass fuel market trends and biomass fuel prices. It will also collect feedback on the suitability of CEN 335 solid biofuel standard for trading of biofuels. Estimation on techno-economic potential of the		Intelligent Energy - Europe	16 European Partners With Jiri Klemes Manchester University For The UK	Vtt, Finland	Supported by the European Commission under the Baltic Sea Region INTERREG III B Neighbourhood Programme		2005 - 2006	

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	biomass will be given until 2010 based on the existing studies and experts opinions. Sub-topics covered include: emissions trading and policy framework to develop bioenergy in Europe with special consideration of wood fuel supply chains								
MON-CHP: Optimised Biomass Chp Plant for Monaghan Integrating Condensing Economiser Technology	Build a 28 MW optimised biomass fired CHP plant in Monaghan, Ireland. Demonstrate a bubbling fluidised bed boiler with high plant availability of 92% and innovative integrated condensing economiser technology. Demonstrate the production of energy from spent mushroom compost (a world first).	FP5: Optimisation of CHP systems	No contract type	Emvertec Limited, Integrated Energy Systems Limited, Mccarron Poultry Limited	South Western Services Co-Operative Society Ltd. 5 Partners	€46.39m	€2.98m	2001-05-01 to 2006-02-28 58 months	€0.62m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
BIODIEPRO: Demonstration of the Production of Biodiesel from Tallow and Recovered vegetable Oil	The project will demonstrate an environmentally sensitive solution for the safe disposal of animal by-products, increase the knowledge of biodiesel production and investigate the potential in the fuel supply sector. It will be necessary undertake first life cycle analysis of biodiesel produced from RVO and tallow.	FP5: Cost effective components for biomass and waste	No contract type	Argent Group Europe Limited	Argent Group Europe Limited 4 Partners	€17.44m	€3.15m	2003-01-01 to 2005-12-31 36 months	€1.05m
CO-PRODUCTION BIOFUELS: Integrated biomass utilisation for production of biofuels target action h and j	The goal of the proposal is to develop a novel cost energy effective production system for co-production of bio ethanol and electricity.	FP5: Economic and Efficient Energy for a Competitive Europe	Cost sharing contracts	Tmo Biotec Limited	Elsam A/S 6 Partners	€13.59m	€6.45m	2002-12-01 to 2006-03-31 40 months	€1.93m
BGGE: 13 MW CHP Plant Based on Biomass Gasifier with	The partners will demonstrate and optimise a novel CHP plant based on biomass gasification	FP5: Biomass (including waste) conversion	No contract type	Energy Power Resources Ltd.	FLS Miljoe A/S 5 Partners	€6.00m	€2.10m	2001-06-01 to 2004-05-31	€0.70m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
Gas Engines	on a full scale (13 MW thermal input). In this plant two biogas fuelled engines produce electricity (4 MWe) from gasified biomass. While the district heat (8 MWth) is produced in various heat exchangers.	systems						36 months	
BIONORM: Pre-normative work on sampling and testing of solid biofuels for the development of quality management (BIONORM)	The aim of the BioNorm project is to work out a quality assurance system for solid bio fuels to help to develop the bio fuel market. This will be based on extensive work on sampling (i.e. investigations of the sampling errors and the sample reduction errors) and the testing of physical-mechanical fuel characteristics (i.e. moisture content & bulk density, ash melting	FP5: Economic and Efficient Energy for a Competitive Europe, Cost effective components for biomass and waste	Cost sharing contracts	Forestry Constracting Association Ltd., Signalsfromnoise.Com Ltd, Green Land Reclamation Limited	Universitaet Stuttgart 37 Partners	€5.67m	€3.43m	2002-01-01 to 2004-12-31 36 months	€1.14m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	behaviour, particle size distribution & particle dimensions, durability and raw density of pellets & briquettes) and chemical fuel characteristics (i.e. sulphur & chlorine content, major & minor elements). The results of this work will contribute to the work of CEN TC 335 "Solid Biofuels".								
TYREPYRO: Tyre Pyrolysis Process for Cement Manufacturing and Tyre-to-energy Plants	The aim of this project is to demonstrate a patented tyre pyrolysis process with energy and by-product recovery, first in a cement plant and subsequently in a full scale 17 MWe tyre-to-energy power plant. Scrap tyre is undesirable for landfill, but has very high calorific	FP5: Biomass (including waste) conversion systems	No contract type	Energy Power Resources Ltd., Bpi Projects Ltd.	FLS Miljoe A/S 4 Partners	€5.29m	€1.85m	2002-02-01 to 2005-05-31 40 months	€0.56m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	value, and is due to the high natural rubber content a renewable energy source.								
FORENERGY: Forest Energy - A Solution for the Future Power Needs	The main objectives of the project are to: conduct high level research on the development of the renewable and clean bio-energy technology; develop the complete energy chain from the forest to the consumer; develop an energy system producing renewable energy to the market price (fuel price <8Mwh); develop an CO2 emission neutral energy system; keep other emissions at a lower level than the regulation require.	FP5: Biomass (including waste) conversion systems	No contract type	Shotton Paper Co Plc	Timberjack Oy 7 Partners	€4.92m	€1.72m	2001-05-01 to 2004-04-30 36 months	€0.57m
BIOFEAT: Biodiesel fuel processor for a	The BIOFEAT project will develop, design, build and test a	FP5: Cleaner Energy	Cost sharing contracts	Johnson Matthey Plc (Trading As Synetix)	Politecnico Di Torino 7 Partners	€4.75m	€2.60m	2003-01-01 to 2006-06-	€0.74m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
fuel cell auxiliary power unit for a vehicle	biodiesel fuel processor for a vehicle auxiliary power unit (APU) utilising a PEMFC or SOFC. An APU enables electrical power, which is used for control, lights, air conditioning etc., to be generated independently from the traction power train.	Systems, including Renewable Energies						30 42 months	
HIAL: HIAL-biofuels for chp plants - reduced emissions and cost reduction in the combustion of high alkali biofuels	The scientific objective of this proposal is to understand the influence of fuel composition and combustion conditions on the release of alkali metals, S and Cl to the gas phase considering different combustion systems. The technical objective of this proposal is to apply the understanding of the	FP5: Cleaner Energy Systems, including Renewable Energies, Biomass (including waste) conversion systems	Cost sharing contracts	City University	Forschungszentrum Juelich Gmbh 7 Partners	€2.87m	€1.81m	2001-12-01 to 2004-11-30 36 months	€0.60m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	alkali chemistry to develop primary measures for grate firing to achieve SO2 emissions below 200 mg/Nm3 without the need for installation of flue gas desulphurisation unit (FGD).								
BIO-STIRLING: Small-Scale Chp Plant Based on a Hermetic Four-Cylinder Stirling Engine for Bi	An efficient utilisation of biomass for energy with a minimum of environmental impact can be obtained, when biomass is used for small-scale combined heat & power (CHP) production in villages close to biomass production sites as well as in the wood processing industries. The main objective of this proposal is to develop a small-scale biomass fired CHP plant based on	FP5: Biomass (including waste) conversion systems	No contract type	University Of Bradford	Technical University Of Denmark 6 Partners	€2.50m	€1.10m	2000-07-01 to 2003-06-30 36 months	€0.37m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	a 70-100 kWel hermetic Stirling engine & to erect a pilot plant where comprehensive test runs will be performed with solid biomass fuels. This new development will be based on the experiences already obtained with a 30 kWel Stirling engine that has been in operation for more than 700 hours. The further technological development is essential in order to extend the area of application & cover the large market potential of biomass CHP plants. The aim of the project is to develop a technology with high overall & electric (>20%) efficiency & low operating & maintenance requirements to								

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	achieve production costs.								
GASASH: Improvement of the economics of biomass/waste gasification by higher carbon conversion and advanced ash management - target action H	The project will focus on optimisation and improvement of biomass/waste derived fuel gasification process and utilisation of gasification ashes in order to improve the overall feasibility of biomass/waste derived fuel based energy production.	FP5: Cleaner Energy Systems, including Renewable Energies	Cost sharing contracts	Emc Environment Engineering Ltd.	Technical Research Centre Of Finland 8 Partners	€2.40m	€1.20m	2002-11-01 to 2005-10-31 36 months	€0.40m
BIFIC: Biomass/waste fbc with inorganics control (BIFIC)	The primary technical objective of the project is to establish the feasibility to use a broad range of biomass and waste materials and possible mixtures as fuel in FBC installations (fuel flexibility), minimising at the same time strain on the environment through optimised	FP5: Cleaner Energy Systems, including Renewable Energies	Cost sharing contracts	Cinar Ltd, Wykes Engineering Company Limited, Cre Group Ltd	Tps Termiska Processer Ab 7 Partners	€2.28m	€1.14m	2001-02-01 to 2004-01-31 36 months	€0.38m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	operating conditions.								
BIOWARE: Clean energy recovery from biomass waste and residues (BIOWASTE)	The project centers on reduction of the main pollutants and PM emissions from bio-waste combustion by a cost effective one-step combined dry gas cleaning and particle removal system based on ceramic filter candles. The main innovation of the system is the introduction of a selective catalytic process in the candle medium to reduce NOx.	FP5: Cleaner Energy Systems, including Renewable Energies, Biomass (including waste) conversion systems	Cost sharing contracts	Conversion And Resource Evaluation Ltd.	Centro De Investigaciones Energeticas, Mediambientales Y Tecnologicas 7 Partners	€1.96m	€1.31m	2001-11-01 to 2005-07-31 45 months	€0.35m
MBF: Mixed Bio-Fuel 38Mwe Power Plant Project	FLS miljoe and EPR are planning to develop design, build own and demonstrate the operation of an innovative 38 MWe 'Mixed Bio-Fuel' power plant in the UK. The objective of	FP5: Biomass (including waste) conversion systems	No contract type	Energy Power Resources Ltd.	FLS Miljoe A/S 2 Partners	Not given	€1.50m	2000-01-01 to 2004-06-30 54 months	€0.33m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	the eligible part of the project is to demonstrate 3 innovative features. The first innovation is the supply and handling systems for Miscanthus, the short rotational crop, which will be used as a biofuel for the first time in UK. The second innovation is an upgraded biomass firing system to burn the combination of Miscanthus, poultry litter, sludge and natural gas.								
BIOSOD: Development of an autonomous Biomass-Solar Thermally Driven Distillation System	Not given	FP5: Biomass (including waste) conversion systems	No contract type	Thermomax (Gb) Ltd.	Austro Control Keg 7 Partners	€1.71m	€0.85m	2003-01-01 to 2004-12-31 24 months	€0.43m
BIOGAS BY BIOAUGMENT: Optimised	The project aims to demonstrate the use of bio-augmentation	FP5: Biomass (including	No contract type	Rivacross Biotechnology Limited	Centro Para A Conservaçao De Energia	€1.60m	€0.50m	2000-01-01 to 2002-12-	€0.17m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
Biogas Production and Resource Recovery through Bio-Augmentation in a Joint Plant Treating Poultry and Pig Waste	to improve energy and resource recovery in a joint biogas plant for co-digestion of the 8.000 tonnes of poultry litter and 44.000 tonnes of pig slurry generated annually in those farms.	waste) conversion systems			3 Partners			31 36 months	
Era bioenergy strategy - short term measures to develop the european research area for bioenergy rtd (target actions : b, h, j)	To reach the goals set by the "White Paper" and the "Kyoto Protocol " bio energy RTD will have to be enhanced significantly. The introduction of the European Research Area (ERA) will support this. An Accompanying Measure on actions necessary for the implementation of ERA in the field of bio energy RTD should be carried out with the objectives: to develop strategies	FP5: Cleaner Energy Systems, including Renewable Energies, Biomass (including waste) conversion systems	Preparatory, accompanying and support measures	South Western Services Co-Operative Ltd. Dti	Joanneum Research Forschungsgesellschaft Mbh 17 Partners	€1.42m	€1.08m	2002-01-01 to 2003-10-31 22 months	€0.59m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	for measures to promote coordination between EU and the member states in the area of bio energy RTD policies and programmes; and to identify opportunities for short-term actions leading to the ERA for bio energy RTD. The project consists of these tasks: A "Country survey": Survey of national and EU RTD policies and programmes and B "Bio energy policies and programmes mapping".								
INTCON: Intelligent process control system for biomass fuelled industrial power plants (INTCON)	In this proposed project a combination of neural network and fuzzy logic methods will be used to develop a control system which will have properties such	FP5: Economic and Efficient Energy for a Competitive Europe, Cost effective components	Cost sharing contracts	Cinar Ltd	Tps Termiska Processer Ab 4 Partners	€1.36m	€0.74m	2001-12-01 to 2004-11-30 36 months	€0.25m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	that based on the load demand, the combustion process at all time will be optimised both for minimum emissions, good burn outland good control of the slogging and fouling properties. The system is modular with a number of functions, which either can be used autonomous or linked.	for biomass and waste							
TBR: Waste To Recovered Fuel	It is intended to facilitate a cost-effective system for integrated resource and waste management which will reduce costs for both the waste management and power generation industries, and the end consumer. The objective is to bring together relevant stakeholders within a discussion Forum	FP5: Biomass (including waste) conversion systems	No contract type	Green Land Reclamation Limited, Slough Heat & Power Limited	Borealis Polymers Oy 15 Partners	€1.28m	€0.20m	2000-01-26 to 2003-01-25 36 months	€0.067m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	that will adopt an informed technical and economic position on waste recovery in general, and on the production and use of solid Recovered Fuels in particular. Debate in the Forum will be informed through the compilation of a database of existing plant performance and emissions data, collected from operational projects across the EU.								
THERMONET: Network Cluster on Thermal Biomass Conversion Implementation	This project will establish a cluster of two Networks on thermal processing of biomass for fuels and electricity. One network will address gasification and the other pyrolysis. Each network will have its own work programme, but both will have a	FP5: Cost effective components for biomass and waste	No contract type	Aston University	Aston University 2 Partners	€1.17m	€0.80m	2001-06-01 to 2004-05-31 36 months	€0.27m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	common focus of addressing commercialisation issues and providing support for more rapid and more effective implementation of all the technologies in the market place.								
SFH: Sludge for heat	Not given	FP5: Biomass (including waste) conversion systems	No contract type	Energy Technology Promotion Ltd.	Energy Technology Promotion Ltd. 5 Partners	€1.14m	€0.62m	2003-01-01 to 2005-12-31 36 months	€0.21m
DIPROWASTE: Enhanced Production of Methane from Anaerobic Digestion with Pre-Processed Solid Waste for Renewable Energy	To tackle the worldwide problem of depletion of natural, non-renewable fuel sources, the production of biogas from the digestion of organic waste is being developed as a renewable energy source. The principle objective of the Diprowaste project is to investigate	FP5: Cost efficient photovoltaic	No contract type	C-Tech Innovation Ltd, Sundorne Products *Llanidoes) Ltd, Bioplex Ltd.	Ingenieurbüro Dobelmann & Kroke Gmbh 6 Partners	€1.09m	€0.54m	2003-01-01 to 2004-12-31 24 months	€0.27m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	maximising the volume, proportion and rate of methane production from anaerobic digestion of organic waste, containing varying amounts of straw, by using various pre-treatments of the material.								
ASMICAF: Development of an innovative acidic shape-selective mineral catalyst added pelletised fuel from organic wastes	The objective of this project is the development of an innovative acidic shape-selective mineral catalyst added palletised fuel from organic wastes and to develop a prototype process for binding harmful materials in the production of briquettes from waste products by adding inorganic compounds such as CaO, MgO, MgCO3, silicates or Al2O3 and some acidic	FP5: Cleaner Energy Systems, including Renewable Energies	Cooperative research contracts	Pyromex PLC	Teccon Innovation Gmbh 7 Partners	€1.06m	€0.53m	2003-01-01 to 2004-12-31 24 months	€0.27m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	mineral catalyst. The product will be a dry pellet with comparable combustion and gasification qualities to coal, so that it can be burned directly without any necessary adaptation of an incineration or boiler system and without the need of further waste gas treatment.								
FERMATEC: Development of a biotechnical high yield process for ethanol production based on a continuous fermentation reactor	The FERMATEC project will provide a modular fermentation unit for continuous ethanol production. Compared with traditional units, it will decrease ethanol production costs to a minimum of 20% and increase bio-ethanol production yield to approximately 25 g EtOH/l.h.	FP5: Cleaner Energy Systems, including Renewable Energies	Cooperative research contracts	Manchester Metropolitan University, Agrol Ltd.	Tecnia - Processos E Equipamentos Industriais E Ambientais Lda 10 Partners	€0.96m	€0.48m	2003-01-01 to 2005-08-31 32 months	€0.18m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	The main achievements of FERMATEC project will have an impact on environmental, social and economic fields: • applying biotechnology to the production of renewable fuels will directly improve the quality of the environment • enhancing sustainable development by using waste products and valorisation of sub products • increasing ethanol production plants and updating the								

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	large number of European distilleries that still use traditional fermentation processes.								
BIOCOGEN: Biomass Cogeneration Network	The proposed thematic network intends to: provide technical and economic data and deal with the key issues in the implementation of biomass CHP in Europe	FP5: Cleaner Energy Systems, including Renewable Energies, Biomass (including waste) conversion systems	Preparatory, accompanying and support measures	Tv Energy Ltd	Centre For Renewable Energy Sources 8 Partners	€0.84m	€0.39m	2001-12-01 to 2003-11-30 24 months	€0.19m
WTE-ISLE: Waste Management in Island Communities: Strategy to Integrate Waste to Energy Policies	The project aims at facilitating their penetration by: providing islands with sustainable, indigenous & renewable energy supply options based on waste management practices, in line with guidelines set by EC Waste	FP5: Biomass (including waste) conversion systems	No contract type	Isle Of Wight Council, Shetlands Islands Council	Exergia, Energy, Management, And Information Technology Consultants S.A. 14 Partners	€0.83m	€0.50m	2002-02-01 to 2003-07-31 18 months	€0.33m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	Directives; disseminating proven methods of using solid waste as an energy supply source; integrating clean and renewable energy produced from waste into the energy supply system of islands; dealing with the waste problem of islands.								
EU CHINA BIOTECH: Accompanying Measure to Assist Technology Transfer of EU Biomass / Biomass Waste Utilisation Technologies to China	The primary objective of the proposed Accompanying Measure is to quantify the potential for transferring EU technologies to China for the increased utilisation of biomass and biomass-derived waste materials. This would directly aid the competitiveness of European industry in	FP5: Cleaner fuels by substitution and treatment	No contract type	Aston University, Emc Environment Engineering Limited	Emc Environment Engineering Limited 10 Partners	€0.73m	€0.73m	2002-02-01 to 2003-07-31 18 months	€0.48m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	the Chinese market, and help to stabilise levels of trans-national greenhouse gases.								
BIOMITRE: Biomass-based Climate Change Mitigation Through Renewable Energy	The aims of BIOMITRE are to assist propagation of biomass energy technologies throughout the European Union as a cost-effective means of providing commercial renewable energy supplies, which mitigate global climate change through greenhouse gas emissions savings.	FP5: Biomass (including waste) conversion systems	No contract type	Sheffield Hallam University, The Forestry Commission	Sheffield Hallam University 6 Partners	€0.60m	€0.45m	2003-04-17 to 2004-10-16 18 months	€0.30m
BIO-SME-TC: Promotion of Eu Biomass Technology in Agro-industry of High-potential Third Countries	Objective of the proposal is the promotion of EU Agro-Industry residues combustion technologies, developed by European SME, in third countries with high potential in	FP5: Cost effective components for biomass and waste	No contract type	Green Land Reclamation Limited, British Biogen Ltd.	Exergia, Energy, Management, And Information Technology Consultants S.A. 5 Partners	€0.57m	€0.51m	2001-08-01 to 2003-03-31 20 months	€0.31m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	particular China, Turkey and Uzbekistan. Specifically, the scope of the proposal is the promotion of combustion technologies developed by small and medium European manufactures for the exploitation of process waste from cotton and rice and residues from wheat cultivation.								
BIOTOX: An Assessment of Bio-Oil Toxicity for Safe Handling and Transportation - Target Action H	Not given	FP5: Cost effective components for biomass and waste	No contract type	Aston University	Centre De Coopération Internationale En Recherche Agronomique Pour Le Développement 3 Partners	€0.52m	€0.44m	2003-01-01 to 2005-06-30 30 months	€0.18m
MOND: Accompanying measure on critical technology selection and	This accompanying measure proposes as 2 year techno-economic study leading to the main aim of a Conference	FP5: Cleaner Energy Systems, including Renewable	Preparatory, accompanying and support measures	BLC Leather Technology Center Ltd.	BLC Leather Technology Center Ltd. 4 Partners	€0.44m	€0.22m	2002-12-01 to 2004-11-30 24	€0.11m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
conference for renewable energy recovery from biomass generated within the european leather sector	as a dissemination platfonn for the facilitation and implementation, of renewable energy technology selection for subsequent EU based exploitation within the EU leather sector. This project is essential to overcome technical and non-technical barriers, culminating in a selection process forest practice and workshop / conference and interactive web site establishment for dissemination.	Energies						months	
TAR MEASUREMENT STAN: Standardisation of a guideline for the measurement of tars in biomass producer gases	In a previous EU project, a Guideline for tar measurement ("the Guideline") was developed. Although several institutes have now used this Guideline, it does not have the status of an	FP5: Cleaner Energy Systems, including Renewable Energies	Preparatory, accompanying and support measures	Emc Environment Engineering Ltd.	Energy Research Centre Of The Netherlands 9 Partners	€0.38m	€0.35m	2002-12-01 to 2005-11-30 36 months	€0.12m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
(tar measurement standard)	international standard yet. The objective of this project is to remove this obstacle by standardising the Guideline. The result will be a CEN Standard. As acceptance and use by others is considered to be essential, dissemination and internalisation of the Standard forms part of this project								
TAR PROTOCOL: Development of standard method for the measurement of organic contaminants 'tars' in biomass producer gases	The objective of the project is to remove this obstacle by developing a standard measurement method (Protocol) which is accepted and used by parties working on biomass gasification and has entered the standardisation procedure at CEN. This work continues	FP5: Economic and Efficient Energy for a Competitve Europe	Coordination of research actions	Cre Group Ltd	Energy Research Centre Of The Netherlands 15 Partners	€0.33m	€0.26m	2000-04-01 to 2002-07-31 28 months	€0.11m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	an initiative started by IEA, EU and US-DoE to develop such a Protocol and will be based on the two draft Protocols which resulted from this initiative.								
INTEGRATE: Integration of Biomass and Waste for Energy into Local Authority Energy Systems	Objectives: To examine EU experience on the public acceptability of schemes for energy from waste and biomass residues, including comparisons of successful and unsuccessful schemes; To transfer this experience to regions where there are extensive problems with acceptance of incineration of energy from waste and biomass residues, through a workshop for appropriate local	FP5: Integration of new and renewable energy sources into energy systems	No contract type	Improvement And Development Agency, AEA Technology Plc	Aea Technology Plc 5 Partners	€0.19m	€0.15m	2000-07-01 to 2001-09-30 15 months	€0.12m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	authority personnel; To organise a study tour of successful systems; To make recommendations on public consultation to improve acceptability of energy from waste and biomass residues; To identify local authorities interested in such schemes and willing to be monitored through public consultation.								
Development of an innovative acidic shape-selective mineral catalyst added pelletised fuel from organic wastes	The objective of this project is the development of an innovative acidic shape-selective mineral catalyst added palletised fuel from organic wastes and to develop a prototype process for binding harmful materials in the production of briquettes from	FP5: Cleaner Energy Systems, including renewables Energies	Exploratory awards	Pyromex PLC	Teccon Innovation Gmbh 2 Partners	€0.03m	€0.023m	2001-10-11 to 2002-04-10 6 months	€0.023m

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	waste products by adding inorganic compounds such as CaO, MgO, MgCO3, silicates or Al2O3 and some acidic mineral catalyst.								
Small-scale total energy systems powered by biomass and wastes	Application is made for assistance in preparing a Step 2 proposal aimed at developing small-scale 'total' energy generation systems for European markets by 2005. The target development will exploit advances in gas conditioning, filtration and electro-chemistry to generate 'high-grade' energy, in the form of medium CV gas and electricity, from renewable carbohydrate feedstock (energy crops and agricultural wastes)	FP5: Cleaner Energy Systems, including Renewable Energies	Exploratory awards	Progressive Energy Technology Ltd.	Progressive Energy Technology Ltd. 2 Partners	€0.03m	€0.022m	2000-07-06 to 2001-07-05 12 months	€0.022

Name	Objectives	Action line	Type of action	Uk Participant	Co-Ordinator And Partners	Total Funding	EU Funding	Duration	Annual Spend
	and from selected domestic and commercial wastes.								
A biomass gasification combined heat and power [chp] sheme for the production of up to 100 kwe and 250 kwth	Biomass Eng. Ltd.'s objective is to demonstrate economically viable small-scale biomass gasification CHP system. Current small-scale systems are expensive and gas clean up is expensive, due to high levels of tars and particulates.	FP5: Economic and Efficient Energy for a Competitive Europe	Exploratory awards	Biomass Engineering Ltd.	Biomass Engineering Ltd. 2 Partners	€0.03m	€0.023m	2001-07-19 to 2002-04-18 9 months	€0.023m
Efficient production of secondary fuels from paper recycling rejects and low colorific sludges through integrated rushing-dewatering-pelletizing	The project aims at developing an innovative mechanical sludge treatment system with integrated crushing - dewatering - palletising based on a special screw extruder. The dewatering reaches 85 % of dry contents and > 90 % by simple steam release of pellets.	FP5: Economic and Efficient Energy for a Competitive Europe	Exploratory awards	H And S Environmental	Gesellschaft Fuer Forschung, Entwicklung, Herstellung Und Betriebkompletter Anlagen Zur Verwertung Umweltbelastender Productie Mbh 2 Partners	€0.03m	€0.023m	2000-05-15 to 2001-05-14 12 months	€0.023m

9. International Initiatives (including IEA operating agreements and UK contacts)

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IEA acts as a focus for international collaboration in the complex area of bioenergy and consequently, 10 IEA tasks are in place for bioenergy, within the IEA Bioenergy implementing agreement. The UK has a good representation from several organisations including universities, private companies and DTI. The IEA networks provide a mechanism for the exchange of expert information and advice and have been of value to the UK in developing improved technical expertise in short rotation crops for bioenergy. The UK has current active participation in most of the IEA tasks. In addition to IEA, the International Poplar Genome Consortium has acted as a focus for developing genomic resources in poplar, including the full genome sequence and its relevance to both poplar and willow as bioenergy crops. The UK is part of the leadership of PYNE, the Biomass pyrolysis network. A new international network has been proposed by FAO, May 2006, (http://www.fao.org/sd/dim_en2/en2_060501_en.htm)and the Global Bioenergy Partnership was launched in 2007.

Table 9.1 International Actions

Name	Type	Description	UK Contact Point
IEA Task 29. Socio-economic drivers for implementing bioenergy	An international collaboration within the IEA Implementing Agreement on Bioenergy.	Task 29 is an ongoing initiative from 1 January 2000 with the aim to: i) to determine the economic contribution (financial, local industry creation, infrastructure developments, etc.) resulting from the deployment of bioenergy systems ii) to determine the social impact (employment, education, health, etc.) resulting from the deployment of bioenergy systems iii) to encourage the exchange of information and Task results between participants and also with countries in transition (Objective 5 of the Strategic Plan). The participating countries in the 2003-2005 period were Austria, Canada, Croatia, Ireland, Japan, Norway, Sweden and United Kingdom.	Keith Richards, TV Energy
IEA Task 30 Short rotation crops for bioenergy systems	An international collaboration within the IEA implementing agreement on bioenergy	The objective of the Task is to acquire, synthesise and transfer theoretical and practical knowledge of sustainable short rotation biomass production systems and thereby to enhance market development and large-scale implementation in collaboration with the various sectors involved.	Keith Richards TV Energy
IEA Task 32 Biomass production for energy from sustainable forestry	An international collaboration within the IEA Implementing Agreement on Bioenergy.	Biomass Combustion and Co-firing works on further expansion of the use of biomass combustion for heat and power generation, with special emphasis on small and medium scale CHP plants and co-firing biomass with coal in traditional coal-fired boilers. This is done by generating and disseminating information on technical and on non-technical barriers and anticipated solutions. Task 32 is a continuation of Task 19.	William Livingstone, Mitsui Babcock Energy Limited
IEA Task 33 Thermal gasification of biomass	An international collaboration within the IEA Implementing Agreement on	The objectives of this Task 33 are to review and exchange information on biomass gasification (BMG) research, development, demonstration, and commercialization, seek involvement with bioenergy industries and to promote cooperation among the participating countries to	Nick Barker, Future Energy Solutions

Name	Type	Description	UK Contact Point
	Bioenergy.	eliminate technological impediments to advance the state-of-the-art of thermal gasification of biomass. The ultimate objective is to promote commercialization of efficient, economical, and environmentally preferable BMG processes, for the production of electricity, heat, and steam, for the production of synthesis gas for subsequent conversion to chemicals, fertilizers, hydrogen and transportation fuels, and also for co-production of these products.	
IEA Task 34 Pyrolysis of biomass	An international collaboration within the IEA Implementing Agreement on Bioenergy.	PyNe - The Biomass Pyrolysis Network - a global network of active researchers and developers of fast pyrolysis, has been established to discuss and exchange information on scientific and technological developments on pyrolysis and related technologies for the production of liquid fuels, electricity and chemicals.	Tony Bridgwater, Aston University
IEA Bioenergy Task 36 - Energy Recovery from Municipal Solid Waste	An international collaboration within the IEA Implementing Agreement on Bioenergy.	The Task objectives include the maintenance of a network of participating countries as a forum for information exchange and dissemination. The participating countries in this Task are Australia, Canada, the EC, France, Finland, Japan, Sweden, Norway and the United Kingdom.	Gary Shanahan, DTI
IEA Task 37 Energy from biogas and landfill	An international collaboration within the IEA Implementing Agreement on Bioenergy.	The overall objectives of Task 37 are to review and exchange information on biogas production, upgrading and utilisation in research, development, full-scale application and legal frameworks.	Christopher Maltin, Organic Power Ltd
IEA Task 38 Greenhouse gas balance of bioenergy and biomass	An international collaboration within the IEA Implementing Agreement on Bioenergy.	Task 38 analyses and integrates information on bioenergy, land use, and greenhouse-gas (GHG) mitigation; thereby covering all components that constitute a biomass or bioenergy system, i.e. from biomass production to bioenergy conversion and end use. The ultimate goal is to aid policy and industry decision makers in selecting mitigation strategies that optimise GHG benefits while being practical and cost effective.	No UK representation
IEA Task 39	An international	Task 39 "Liquid Biofuels from Biomass" is currently composed of 13	Gary Shanahan, DTI

Name	Type	Description	UK Contact Point
Liquid biofuels from biomass	collaboration within the IEA Implementing Agreement on Bioenergy.	countries The Task brings together leading researchers and industry pioneers in our bid to successfully introduce biofuels for transportation into the commercial marketplace. Activities include the technical challenges of biofuel production, as well as the policy and regulatory issues that must be addressed in commercialization. The goal is to provide our members with comprehensive information that will assist them with the development and deployment of biofuels for transportation fuel use.	Tony Sidwell, British sugar
International Poplar Genome Consortium	An international consortium to develop poplar as the model tree for bioenergy, timber, paper and pulp.	Poplar is the first tree for which the complete DNA sequence is now known. As such it provides biologists with a unique resource, which funded by the USA Department of Energy, is central to the research push to develop second generation biofuels from woody lignocellulosic materials. This network of scientists exists to promote poplar at all levels including developing a science plan.	Gail Taylor, University of Southampton
Global Bioenergy Partnership	An international partnership lead by FAO	GBEP brings together public, private and civil society stakeholders in a joint commitment to promote bioenergy for sustainable development. The Partnership builds its activities upon three strategic pillars: Energy Security - Food Security - Sustainable Development	Both DTI and DEFRA are partners in this network.
LAMNET	Latin American Network on Bioenergy	The project Latin America Thematic Network on Bioenergy (LAMNET) is funded by the European Commission in the framework of the specific research and technological development programme 'Confirming the International Role of Community Research'. The main objective of LAMNET is to establish a trans-national forum for the promotion of sustainable use of biomass in Latin America and other emerging countries.	EU membership

Name	Type	Description	UK Contact Point
BMT-CES: Biofuel Micro-Trigeneration with Cryogenic Energy Storage (EPSRC funded UK-China Energy Awards)	collaborative projects	The Research Councils' Energy Programme wishes to develop collaborative projects in the fields of energy technologies, hydrogen and fuel cells as a key component of its strategy to foster closer scientific, technological and engineering links with China.	Prof Y Ding, N J Hewitt, A P Riskilly University of Leeds, Ulster, Newcastle
Impact of DMF on Engine Performance and Emissions as a New Generation of Sustainable Biofuel (EPSRC funded UK-China Energy Awards)	collaborative projects	The Research Councils' Energy Programme wishes to develop collaborative projects in the fields of energy technologies, hydrogen and fuel cells as a key component of its strategy to foster closer scientific, technological and engineering links with China.	Dr HM Xu, University of Birmingham