ESRC Genomics Forum Workshop Report

BIOENERGY AND THE BIOECONOMY

National Institute of Agricultural Botany, Cambridge

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Report prepared by Emma Frow (ESRC Genomics Forum) and Maija Hirvonen (Innogen)

Contents

The contents of this report reflect discussion that took place during the meeting, and may not represent the views of all the meeting participants, nor the views of the ESRC Genomics Forum.

About the workshop — Executive Summary

The ESRC Genomics Policy and Research Forum workshop on 'Bioenergy and the Bioeconomy' set out to discuss the socioeconomic, scientific and policy context of bioenergy development, and to map out different stakeholder perspectives and activities in light of this context — with the aim of identifying possible opportunities, synergies, tensions and pressing needs. The workshop format consisted of six presentations by invited speakers (day 1), and discussion group sessions to address specific questions relating to bioenergy development (day 2). The focus was on the UK bioenergy scenario, within the context of EU and global (particularly the US and developing world) settings.

A small but highly interdisciplinary group of participants attended the workshop. Despite the diversity of opinions and expertise, an encouraging level of consensus was reached on several issues. A recurring theme throughout the workshop was the need to take action and stimulate 'learning by doing' around bioenergy — specifically, to develop a pilot project in the UK that allows for comprehensive and holistic investigation of scientific, technical, social, economic and environmental aspects of second-generation bioenergy. From a 'bottom-up' perspective, there is considerable entrepreneurial momentum and research interest in bioenergy. Participants identified several important research questions, and highlighted a need to engage with the full range of stakeholders implicated in the bioenergy debate, especially public audiences.

The challenge will be for 'top-down' regulatory, funding and policy frameworks to keep up with the pace of developments in bioenergy, especially given rapidly changing relationships and convergence among traditionally distinct policy and socioeconomic issues (e.g. agriculture and energy). Several tensions in current innovation strategies and policy frameworks were identified in the meeting — for example, relating to different bioenergy options, trade, certification, and production scale — and many participants were concerned with how to mobilize both public and private investment to develop bioenergy as a 'public good'.

Participants also highlighted the potential for the UK to act as a global leader in helping to develop and establish environmentally sustainable and socioeconomically viable bioenergy solutions. Strengthening research capacity and developing partnerships were seen as key to this.

Presentation summaries

The workshop began with a welcome from Wayne Powell (National Institute for Agricultural Botany), and an outline of the workshop agenda by Emma Frow (ESRC Genomics Forum). After introductions by workshop participants, a series of short presentations and discussion sessions took place.

Presentation 1: Geopolitics of bioenergy

Stephan Slingerland from the Clingendael International Energy Programme in the Netherlands outlined the current global context for bioenergy, identifying a number of geopolitical and economic factors influencing bioenergy development. Energy issues are occupying an increasingly prominent position on political agendas worldwide, and bioenergy is emerging as a response to rising energy demands, fossil fuel import dependencies, and growing concern over climate change. Bioenergy also represents a new market opportunity for agriculture in developing countries: sub-Saharan Africa, southeast Asia and Latin America are said to have vast areas of so-called 'un-used' land that could be brought under energy crop cultivation. What is the likelihood that bioenergy will fulfill its potential? Although unlikely to contribute to reducing energy demand, biofuels could lessen dependence on fossil fuel imports through domestic production or importation of feedstocks or biofuels from non-fossil-fuel-exporting regions. The overall energy balance of different bioenergy options varies considerably, although transport biofuels are indisputably receiving the bulk of the attention.

Stephan suggested that although there is considerable potential for developing countries to benefit from any future bioenergy market, a number of very important uncertainties remain — including possible deforestation, degradation of lands and 'food versus fuel' trade-offs. Genomics may have a role in improving the productivity of current food crops, improving crop performance on sub-optimal lands, and developing second-generation biofuels. However, here too many uncertainties remain — including the role of public opinion towards genomics.

Presentation 2: UK energy innovation — the role for biomass?

Mike Colechin from E.ON UK considered the potential role of biomass within the context of UK energy innovation. UK Government energy policy has the concurrent aims of reducing CO_2 emissions (by 60% by 2050), ensuring security of energy supply, and eliminating fuel poverty, all within the context of a competitive market. Mike provided an overview of UK energy requirements (in terms of transport, heat and electricity), CO_2 emissions by sector (public, business, transport and residential), and current electricity sources and supply issues. What is the potential contribution of biomass under these circumstances? The UK Renewables Obligation (RO), which places a legal obligation on all licensed UK electricity suppliers to meet a defined percentage of retail sales from renewable sources, was identified as a current driver for energy crop development through biomass co-firing. The *complexity* and *uncertainty* surrounding future bioenergy options have led E.ON UK to undertake 'PESTLE' analyses (addressing policy, economic, social, technological, legal and environmental issues) for matrices of different bioenergy feedstock, technology, supply chain and policy options.

In his presentation, Mike also highlighted the work being done by the Energy Research Partnership (ERP), chaired by Sir David King, to model the energy innovation process (from R&D through to pre-commercial demonstration-scale projects and deployment). A particular concern of the ERP is in how to get new ideas and technologies to the marketplace with timeliness and at the

appropriate scale. Some analysis of current funding schemes across the energy innovation process has already been carried out, and was shared with the participants.

Presentation 3: Genomics and bioenergy

In her presentation on genomics and bioenergy, Gail Taylor from the University of Southampton suggested that biomass resources have enormous potential to contribute to future energy demands, but are currently under-used. However, a 'step-change' will be needed for bioenergy to become economically and environmentally sustainable. Crops currently used for bioenergy production have been bred for food (not fuel) production. Trees and grasses are becoming an increasing focus for so-called *second-generation* bioenergy crops, but efficient processing of these lignocellulose-rich plants will require the development of new plant cultivars, enzymes and processing systems. Although bioenergy trees have the potential to yield 30–40 oven-dried tonnes of biomass per hectare per annum (ODT ha^{-1} y^{-1}), actual commercial yields in the UK are more like 10 ODT ha^{-1} y^{-1}. A number of feedstock traits can be improved, and Gail stressed the need to *optimize*, not to *maximize* crop yield. Optimized yields would be sensitive to environmental conditions, and ideally require low fertilizer and water inputs.

Gail suggested several ways in which biotechnology and genomics might be harnessed to promote the necessary step-change in bioenergy development. These include transgenic (GM) technologies, systems biology approaches (combining genomic, transcriptomic, proteomic and metabolomic data), linking genomics and quantitative genetics, marker-assisted breeding, and other non-GM biotechnological methods. Although the UK/EU perception of GM technologies is poor, at a global level GM is likely to be widely deployed for bioenergy development.

Presentation 4: Biomass power — 'our world of experience'

Steve Critchley of Stewart Thermal Ltd gave a personal perspective as development director of a UK-based company specializing in biomass and waste energy conversion technology. Stewart Thermal Ltd was founded 4 years ago, and has been involved in a number of small-scale projects worldwide. The company aims to provide holistic advice and support relating to biomass conversion, including in-depth technical and logistical advice, feasibility assessments, combustion plant design and tuning, and planning and environmental support services.

Steve highlighted some of the many difficulties faced in setting up bioenergy processing plants in the UK, and stressed the need as an SME to be flexible and pro-active in sourcing projects. The UK bioenergy market is only just beginning to take off, and much of Stewart Thermal's revenue has come from outside the UK, with projects in countries including Hungary, Australia, China and Spain. Planning procedures and regulations were highlighted as a particularly cumbersome issue (not just in the UK). The cost of feedstock supply for biomass conversion was singled out as a factor influencing the economic viability of bioenergy projects — small-scale projects are often viable only if the client has an existing, local source of feedstock or receives payment, for example gate fees for agricultural waste. SMEs benefit greatly from membership in bodies such as the Renewable Energy Association, but would like to see increased funding for R&D in the UK, and greater recognition and support for combined heat and power benefits of biomass conversion.

Presentation 5: Biodiversity and bioenergy — where are the current dynamics taking us?

Tony Weighell from the Joint Nature Conservation Committee charted some of the social, technical and political drivers associated with bioenergy, and considered how they might affect biodiversity. Tony's discussion focused on biofuels, and was set against the backdrop of JNCC's Global Impacts Programme, which advises government regarding the effects of UK activities and policies on global biodiversity. The starting point for his discussion was an EU perspective. The EU is not expected to produce sufficient quantities of biofuel to meet its fuel substitution targets. The availability of first-generation domestic biofuel is likely to level off within the next ten years, and is expected to meet approximately half of the demand. The remainder will be made up by imported feedstock and biofuels and/or second-generation domestic crops. International studies suggest that sub-Saharan Africa has the greatest potential for the production of bioenergy feedstock for export, with South America also likely to be a major global source. The development of domestic second-generation bioenergy technology may reduce the necessary level of feedstock import and/or reduce domestic cultivation of first-generation crops — exactly when this technology will become available, and which way it will contribute is at present unclear.

Sub-Saharan African countries, like much of the developing world, are faced with the decision of opting for particular bioenergy production routes. The two prevailing routes — the so-called 'community' and 'big business' approaches — are thought to have different implications for biodiversity and the distribution of benefits, and are often juxtaposed against one other. The EU can exert considerable influence on the shape that developing country bioenergy markets take. Overall, the three scenarios — first-generation domestic biofuels, second-generation domestic biofuels, and imported biofuel and feedstock — are expected to have unique positive and negative impacts on biodiversity, making overarching statements unjustified.

Presentation 6: Methods for appraising the sustainability of biofuel options

Adrian Ely and Markku Lehtonen from SPRU–Science and Technology Policy Research at the University of Sussex contrasted two ends of a spectrum of approaches for evaluating the sustainability of biofuel options: aggregative and non-aggregative. A common aggregative approach is life-cycle analysis (LCA), which assesses the environmental impacts of a product or service over its entire life span. LCAs to date have concentrated on greenhouse gas (GHG) emission profiles and the energy balance of various biofuel scenarios in the EU and the US. Such analyses have not tended to incorporate wider environmental effects (such as biodiversity, acidification, eutrophication and health impacts), social impacts (e.g. employment, workers' health, and possible trade-offs between food and fuel) or second-generation biofuels into their models. Moreover, analyses on tropical crops are, save few exceptions such as Brazilian bioethanol, either absent or very incomplete. Results of LCAs vary widely because of the different assumptions informing these analyses (e.g. what impacts are considered? What is defined as a full 'life cycle'? How much importance is given to context?). LCAs embody some of the typical shortcomings of aggregative approaches.

Does the solution lie in carrying out more studies of the same nature, or adopting alternative approaches? The latter include more participatory, deliberative and qualitative techniques such as citizens' juries, focus groups, deliberative polls, and multi-criteria mapping (MCM). Multi-criteria analyses allow for the inclusion of a multiplicity of perspectives, and the inherent uncertainty of emerging innovation, in the evaluation of socio-technical *pathways* as opposed to *end-points*. (This is in contrast to aggregative methods, which tend to necessitate generalizations or simplifications, and focus on static end-points.) Consequently, their application in appraising biofuel scenarios seems warranted.

Key issues and discussion points

There was reasonable consensus among participants at the meeting for 'learning by doing', and developing a pilot-scale bioenergy project in the UK to investigate in parallel some of the key scientific, technical, social, economic, environmental and infrastructure issues relating to second-generation bioenergy. However, clarity and transparency would be required with respect to the reasons for setting up the project, and regarding the criteria for government support.

The broader question of what contribution bioenergy could and should make to the future energy mix still needs careful consideration — but cannot easily be answered at this point owing to the complexity and uncertainty surrounding so many aspects of bioenergy development and deployment. Participants advocated developing a broad and consistent *strategy* for bioenergy development, with some *clear short-, medium- and long-term priorities* and goals set out. However, they cautioned against specifying strict targets and particular means of achieving these goals, as there are several routes by which the same end(s) might be achieved.

Key points raised during the workshop discussions are summarized below and grouped into five main themes. Note, however, that there is considerable overlap among themes.

a. Framing the debate and setting the boundaries of the system

- Workshop participants noted that much of the current debate around bioenergy is often framed in terms of dichotomies or stark choices, such as:
    - the role of bioenergy in the overall energy portfolio (e.g. transport biofuels vs. CHP)
    - the feasibility of technologies (e.g. first- vs. second-generation)
    - possible scales of production (e.g. small- vs. large-scale)
    - the energy balance and best end-use of particular energy crops

  Participants called for moderation in the debate, noting that bioenergy options are highly contingent in nature and present distinct advantages and disadvantages in particular settings.
- The UK cites climate change mitigation as the main driver of its national bioenergy development strategy, whereas a number of other countries refer to ensuring energy security as the main motivation for such efforts. Although this may be another example of a false dichotomy, prioritizing different drivers does seem to have consequences for bioenergy development and policy — what are the wider implications of framing the debate in these terms?
- Participants identified value in clarifying the differences between 'first-generation' and 'second-generation' biofuels. These are variously defined in terms of crop variety, processing technologies and agricultural practices, and developing some consensus within the group about what is meant by first- and second-generation was seen as a useful exercise.
- Past experience regarding the emergence of new technologies has revealed the stifling effects of framing debates in negative terms. Workshop participants highlighted the importance of maintaining a positive outlook on bioenergy, but without overlooking the numerous problems and questions involved.
- Discussion and debate regarding bioenergy development and supply should take place with the wider 'energy hierarchy' in mind, including the overarching goals of reducing energy demand and increasing energy efficiency.

- Bioenergy scenarios are frequently evaluated using aggregative and predictive life-cycle analyses (LCAs). Non-aggregative methods are better able to incorporate diverse standpoints and the uncertainty surrounding new innovation, thereby providing a means to framing the bioenergy debate in a more holistic manner.

b. Innovation priorities and obstacles in the UK

- Getting new ideas to market with timeliness and at the appropriate scale requires R&D support across the entire innovation process. There was some debate about whether enough funding exists for basic bioenergy research, but general consensus that funds and subsidies for pilot- and pre-commercial-scale projects should be increased. Economies of scale may make new technologies more economically viable once they reach the marketplace.
- There seemed to be consensus among participants that a shift from first- to second-generation biofuels was necessary in the medium- to long-term, for reasons of carbon emission profiles, food–fuel balance, and landscape and biodiversity protection. Are first-generation technologies a bridge or an obstacle to the development of second-generation bioenergy? Participants expressed concern regarding the corn-based bioethanol strategy adopted by the US, questioning its effects on the environment as well as global food supplies and prices.
- Participants also emphasized the importance of maintaining diverse innovation trajectories at this early stage, and avoiding 'lock-in' to particular bioenergy paths. A diversity of models may in fact help us to find 'optimal' solutions faster. How can this long-term goal be balanced against the desire for short-term targets and a coherent interdisciplinary research strategy?
- Social science has a particular but largely unrecognized contribution to make in identifying appropriate governance frameworks and conditions for supporting bioenergy innovation.
- Some participants predicted that second-generation bioenergy production in the UK will never be more than a niche market — the required production volumes and available land will not make large-scale private/commercial investment in the UK worthwhile. If this is the case, how can private capital be mobilized to develop this 'public good' technology?
- Bioenergy as a 'public good' was identified as an issue worthy of further consideration. What do we mean by a public good? Does the international dimension of bioenergy as a (global) public good change the UK's focus/direction for bioenergy research? And how do we secure investment (both public and private) for bioenergy research, development and deployment?
- Translational medicine was identified as an example of how profit-making and commercial enterprise can be balanced with promoting 'public good'. The impetus for setting up translational medicine initiatives stemmed from the problem that new drugs were not being developed fast enough for the health service. New collaborations between research councils, universities and pharmaceutical companies (among others) were established to help overcome the lack of incentive in getting new drugs to market when the markets do not present obvious profit-margins. Could a similar translational mechanism work for bioenergy?
- Some participants voiced concern about the current push to secure intellectual property (IP) rights in bioenergy-related research, for example relating to new plant cultivars, feedstock-processing enzymes and processing reactions/technologies. Much of this IP stands to be obtained by the US. This would leave the UK with less to offer to international partnerships.

- The UK plant variety rights (PVR) scheme developed in the 1960s was seen as an outdated and inappropriate regulatory system for stimulating investment in light of current science and the types of plant products/cultivars being developed. Some participants were concerned with how to maximize the *value* of new discoveries, and suggested some kind of patenting system might be an appropriate solution.
- Boosting and further developing UK *capacity* in bioenergy-relevant research was also seen as important, particularly in the context of establishing international partnerships. The UK has strong capacity and skills in some bioenergy-relevant research disciplines, but is weak in other areas (see section c). Bioenergy (and the bioeconomy more generally) might offer an opportunity to reinvigorate and reorient certain research communities, particularly plant sciences and engineering.
- The tensions between *small-scale* and *large-scale* bioenergy generation and innovation were identified several times during the meeting. There is no doubt that energy security and climate change are large-scale (global) problems, and that any meaningful contribution made by bioenergy will have to contribute at this level. However, the role for large-scale, commercially driven bioenergy generation is at present unclear. Environmentally and socioeconomically, the most viable and sustainable bioenergy solutions are likely to be on a smaller, local scale — but the current regulatory environment is not conducive to development of small bioenergy businesses. What types of policy environments and regulatory frameworks can promote bioenergy innovation and development at both small and large scales?
- It was acknowledged that the UK Renewables Obligation (RO) has not worked to foster innovation in bioenergy. However, the main area of intervention for the RO is at the far end of the innovation spectrum (commercial deployment), and indeed it has succeeded in increasing the level of biomass co-firing for electricity generation.
- Participants agreed that transport biofuels have dominated the bioenergy debate thus far, at the possible expense of other bioenergy options (particularly combined heat and power, CHP). The question of how bioenergy in general, and biofuels in particular, should be positioned and developed with respect to other potential sustainable technologies, such as hydrogen (fuel cell) technology, also emerged.

c. Research and public engagement

- Workshop participants highlighted the interdisciplinarity of bioenergy, which calls for the integration of various strands of natural sciences (including genomics, chemistry, physics, engineering, agricultural and environmental sciences) and social sciences (including economics and political science). Participants acknowledged the need for interdisciplinary collaboration and sharing of information — which is increasingly being initiated by researchers themselves — but also stressed that basic research could be threatened with the growing push for large-scale collaborations on applied research projects (especially for small research communities).
- There was reasonable enthusiasm for establishing a pilot second-generation bioenergy project in the UK, to 'learn by doing' research on the scientific, technical, social, economic, environmental and infrastructure issues relating to second-generation bioenergy. This should contribute towards the goals of securing IP and developing UK-based skills and capacity, as well as helping to build a solid, holistic model — obviously context-specific to a certain extent, but with some general conclusions and findings that could be applied to building better subsequent models.

- Participants believed that the research capacity for such a project is available and that motivation to carry out the work is high. How much would it cost to run such a project (estimates of £250 million were made), and where might the investment come from? Arguably, any such project would have to tie in with high-level Government energy and bioenergy strategy. Some participants highlighted the need to plan such a project carefully (e.g. involving international partners and support), and to ensure transparency with regards to the criteria for government support.
- Bioenergy was seen to offer an opportunity to reinvigorate some research communities, as well as to boost capacity, research and skills in other areas. The UK has a strong track record in agronomy and basic plant science, expertise in engineering and chemical engineering (which is currently under some threat of being lost), and a strong base in social science analysis. Increased capacity in soil and marine microbiology for bioenergy is needed (particularly for the purposes of identifying new enzymes and processing mechanisms, and for securing IP).
- Some concern was voiced about the availability of public funding for developing second-generation processing technologies — for example, engineers are worried that the research councils will not fund plant design (not novel enough research), and in practice government agencies have not tended to fund this type of research.
- The promotion and reward system within academia does not focus on delivering public goods (but emphasizes, for example, publications). Does this stifle innovation and research in bioenergy, and if so, can anything be done about this?
- The issue of public engagement arose repeatedly throughout the workshop. Previous polls have shown low awareness of (and often strong opposition to) biomass as an energy option. Questions of who should be engaging with the public, and how information about energy options should be communicated and disseminated, triggered some discussion. Involving public stakeholders from the outset on issues of bioenergy (especially with regards to lifestyle, landscape and environment) was acknowledged as important, and engagement with school-aged children was seen as crucial, given the long-term nature of the energy problem. Framing engagement within the context of the 'energy hierarchy' was also identified as important.
- Participants identified a need to gauge UK/EU public opinion regarding genetic modification (GM) for bioenergy feedstocks, and to lead discussion and debate on this issue. Would GM for bioenergy be considered acceptable — especially if it results in high-yielding, low-input crops that do not enter the food chain?

d. Environment, trade and regulation

- The potential biodiversity, landscape and land-use effects of bioenergy received considerable attention. The complexity inherent to bioenergy development was again highlighted by the distinct biodiversity effects anticipated from first-, second- and third-generation technologies.
- Broad environmental, landscape and socioeconomic effects of bioenergy options risk being overshadowed by exclusive focus on GHG emissions and net energy balance as indicators of environmental benefit/harm. There was some call for a more integrated and holistic approach to modelling and monitoring, but measuring and quantifying these wider effects is difficult.
- The notion of 'un-used' lands, which a number of developed and developing countries are setting aside for dedicated energy crop cultivation, was worrying to some participants, who

noted that such lands may, among other things, contribute to maintaining local biodiversity, and serve as a source of livelihood for landless communities in developing countries.

- Landscape and land-use considerations led to further discussion regarding the natural resource implications of bioenergy. Will land set aside for dedicated energy crop cultivation lead to potential 'food versus fuel' trade-offs? How will water availability for agricultural use be affected? Might second- and possible third-generation crops mitigate pressure on natural resources?
- Some new thinking on environmental regulation is required, and is starting to happen. We may not necessarily see an increase in regulation, but perhaps a move towards a more risk-based approach to regulation.
- Global trade in bioenergy — and specifically biofuels — was considered inevitable, and is expected to become a central issue in the bioenergy debate. Some discussion centered on current regulatory frameworks and certification schemes, and their impact on future trade. A number of countries (including the UK) are currently working on bioenergy feedstock certification schemes. The classification of bioenergy feedstocks as agricultural or energy commodities, as well as the origins and production processes of fuel and (semi)processed feedstocks, will influence certification procedures and ultimately trade opportunities as well as barriers. Some participants felt that bilateral certification schemes will become more common than multilateral agreements.
- Industrial standards have a great effect on which technologies and players enter the market. Such standards can be socially exclusive, for example, expensive certification schemes can prevent small-scale feedstock producers from finding markets for their products. The nature of industrial standards for bioenergy will almost certainly affect the balance between small-scale and large-scale bioenergy generation.

e. The role of the UK in the global context

- (Bio)energy is a global issue. The UK is small in terms of its bioenergy production potential and total bioenergy consumption, and will probably be at the mercy of decision-making elsewhere (for example, at global, EU or US levels).
- However, participants felt strongly that the UK can make a big contribution to bioenergy globally, and particularly in the developing world, by taking a lead in helping to develop and establish environmentally sustainable and socioeconomically viable bioenergy solutions. *Partnerships* will be key to this. Research capacity/expertise and IP were seen as valuable contributions to bring to partnerships (not simply capital/financial investment). Involving agencies such as DFID (Department for International Development) and the FCO (Foreign and Commonweath Office) in the development of the UK bioenergy strategy was seen by participants as very important.

Outputs and next steps

Findings from this meeting will be communicated directly to representatives from the UK Energy Research Centre (UKERC), Defra, the DTI and the OECD.

Written outputs from the meeting will include this report, as well as a series of two-page briefings or perspectives contributed by workshop participants. Topics for these perspectives were identified at the meeting, and contributions are currently being solicited. The series of perspectives will be collated as a single publication for widespread dissemination to a wide range of stakeholders and interested parties — including representatives from industry, government, NGOs and the academic community — and will be posted on the Genomics Forum website (www.genomicsforum.ac.uk).

Workshop participants have suggested convening a second meeting on Bioenergy and the Bioeconomy in 12–18 months' time. The Genomics Forum would certainly be prepared to do this, provided that there is still interest from participants in a year's time.

Appendix 1: Workshop Participants

Name	Affiliation
Mike Colechin	E.ON UK
Steve Critchley	Stewart Thermal Ltd
Adrian Ely	SPRU, University of Sussex
Emma Frow	Genomics Forum
Howard Griffiths	University of Cambridge
Debbie Harding	BBSRC
Maija Hirvonen	Innogen, University of Edinburgh
David Ingram	Genomics Forum
David Klug	Imperial
Markku Lehtonen	SPRU, University of Sussex
John Moverley	Royal Agricultural Society of England
Wayne Powell	National Institute of Agricultural Botany
Rupen Raithatha	National Farmers' Union
Stephan Slingerland	Clingendael International Energy Programme, Netherlands
Janet Sprent	Independent
Deryck Steer	Joint Nature Conservation Committee (JNCC)
Steve Sturdy	Genomics Forum
Joyce Tait	Innogen, University of Edinburgh
Gail Taylor	University of Southampton
Tony Weighell	Joint Nature Conservation Committee (JNCC)
Jeremy Woods	Imperial
Julian Wright	Environment Agency
Steve Yearley	Genomics Forum

Participant profiles are available upon request; please email Emma Frow (emma.frow@ed.ac.uk).

Appendix 2: Workshop Programme

Thursday 22 March

9:30 – 10:00 **Arrival and registration**

10:00 – 10:30 Welcome and introductions
Wayne Powell, *National Institute of Agricultural Botany*
Emma Frow, *ESRC Genomics Forum*

Session 1: Setting the context for bioenergy development (Chair: Wayne Powell)

10:30 – 11:15	The geopolitics of (bio)energy Stephan Slingerland, *Clingendael International Energy Programme, Netherlands*
11:15 – 11:45	**Tea / coffee**
11:45 – 12:30	UK energy innovation — the role for biomass? Mike Colechin, *E.ON UK, Power Technology*
12:30 – 13:15	Genomics for bioenergy Gail Taylor, *University of Southampton*
13:15 – 14:00	**Lunch**

Session 2: Exploring perspectives and options for bioenergy (Chair: Steve Yearley)

14:00 – 14:45	Biomass power — 'our world of experience' Steve Critchley, *Stewart Thermal Ltd*
14:45 – 15:30	Biodiversity and bioenergy: where are the current dynamics taking us? Tony Weighell, *Joint Nature Conservation Committee*
15:30 – 16:00	**Tea / coffee**
16:00 – 16:45	Methods for appraising the sustainability of biofuel options Adrian Ely & Markku Lehtonen, *SPRU — Science and Technology Policy Research, University of Sussex*
16:45 – 17:30	General discussion
19.15 – 19.45	**Drinks**
19.45 – 22.00	**Dinner**

Friday 23 March

Session 3: Mapping the trajectory of bioenergy development (Chair: Steve Yearley)

9:15 – 9:30	Structure and goals for discussion groups
9:30 – 11:30	Discussion groups Group 1 chair: David Ingram, *ESRC Genomics Forum* Group 2 chair: Deryck Steer, *Joint Nature Conservation Committee*
11:30 – 11:45	**Tea / coffee** **(Also available throughout the preceding discussion session)**
11:45 – 12:00	Reports from discussion groups
12:00 – 13:15	Discussion and next steps • Looking forward, recommendations • Issue briefings: possible topics, participant contributions
13:15 – 14:00	**Lunch + depart**

Appendix 3: Discussion Questions (day 2)

9.30 – 11.30, Friday 23 March

The purpose of this session is to focus on some of the questions highlighted in the bioenergy working paper (http://www.genomicsforum.ac.uk/documents/pdf/BioenergyPaper0307.pdf), drawing on participant expertise and building on Thursday's presentations and discussion.

The two discussion groups will be asked to base their discussion on different sets of questions — one will be more research-focused, and the other primarily concerned with mapping changing dynamics and stakeholder relationships. The same, overarching set of general questions applies to both groups. The listed questions are intended to stimulate discussion, and need not be discussed in order nor in their entirety.

General discussion questions (Groups 1 & 2)

What are some of the main drivers, tensions and trade-offs with regards to bioenergy development? How might we begin to integrate different agendas and perspectives to develop a consistent approach to bioenergy?

Can you identify specific examples of overlaps, gaps, synergy or conflict in current stakeholder activities, policies, and policy interpretations with regards to bioenergy? How might we begin to address these?

Can the dynamics within the bioenergy sector be viewed as an indication of what might occur in other emerging sectors of the bioeconomy?

How might governance frameworks best promote the development of a bioenergy industry, and an environmentally sustainable bio-based economy more generally?

Group 1: Research issues for bioenergy

How is the current investment in bioenergy R&D allocated? What is the balance among bioenergy options, basic/applied research, public/private research, and infrastructure development for bioenergy?

Does this allocation appropriately reflect current research needs along the chain from seed to energy consumer? Should the emphasis with regards to funding for bioenergy be on research and development, or deployment of existing technologies? Is the current balance consistent with short- and long-term bioenergy policy targets?

What new research strategies and partnerships are being developed in relation to bioenergy R&D? Are they proving successful?

Is the development of a bioenergy industry dependent on scientific advances and new technologies? What research questions should be prioritized?

How might potential developments in science and technology affect the balance among possible bioenergy production chains? Should this be accounted for in policy incentives for bioenergy development?

What research is being done, and what needs to be done, regarding the effects of bioenergy development on other socioeconomic, environmental and policy issues? (for example, biodiversity, the rural economy, etc.)

Group 2: Changing dynamics and stakeholder relationships for bioenergy

Which of the emerging bioenergy sectors and supply chains have dominated the development of the field? How would you position the emerging sectors in terms of relative potential?

What kinds of stakeholder partnerships are being developed in relation to bioenergy? Are they proving successful at stimulating the development of a sustainable bioenergy sector?

What other collaborative mechanisms are evolving with regards to bioenergy development? Are all stakeholders in the bioenergy debate being represented in these various strategies?

What are some of the main challenges and obstacles in setting up reliable supply chains for bioenergy? What could be done to address this?

What are some of the key tensions and trade-offs emerging between different sectors and stakeholders? What lies at the root of these tensions? (for example, conflicting policy frameworks, differing organizational structures, development timescales, etc)

How can trade-offs among energy supply, climate, soil, water, food/feed requirements, landscape, biodiversity, social acceptance, and the rural economy be balanced in relation to bioenergy development?

What research is being done, and what needs to be done, regarding the effects of bioenergy development on wider socioeconomic, environmental and policy issues?

Appendix 4: Summary of workshop aims

BIOENERGY AND THE BIOECONOMY

22–23 March 2007

The 'bio-based' economy, or **bioeconomy**, can be broadly defined as an economy for which the raw materials and basic building blocks for energy, industry and growth are derived from biological, renewable resources. Continuing improvements in our ability to harness biological processes for practical applications will almost certainly provide new options for sectors including health, industry, environment, agriculture, energy and security, and should also make a valuable contribution to the wider policy goal of sustainable development.

Achieving the desired shift towards an environmentally sustainable, bio-based economy is predicted to require the convergence of a number of research domains, technologies, infrastructures, and government practices[1]. This workshop will use **bioenergy** as a case study to investigate the nature and possible effects of such convergence.

The bioenergy landscape

Biomass is receiving increased interest as a source of 'carbon-neutral' renewable energy, as many countries strive to simultaneously reduce their dependence on foreign oil reserves, cut greenhouse gas emissions, and stimulate their rural economies. However, the landscape for bioenergy R&D is complicated and finely balanced, set against a backdrop of existing regulatory frameworks and policy targets for climate change, conservation, land use and CAP reform, transport, and energy supply and security.

Despite strong political goodwill towards bioenergy development, a robust economic case for bioenergy has not been systematically made, and it is increasingly apparent that there are a number of complex social and environmental implications to consider. There is growing demand to integrate these various facets of the bioenergy debate, both to help guide policy decisions and to suggest the most appropriate way for bioenergy R&D to move forward.

This interdisciplinary workshop will begin to address these issues by mapping and exploring some of the changing relationships between stakeholders, the infrastructure and research needs, and the new value chains emerging in relation to bioenergy development in the UK and abroad. Discussion will focus on key issues for bioenergy research as well as the wider policy context for bioenergy:

- How is the current investment in bioenergy R&D allocated? Does this allocation appropriately reflect current research needs along the chain from seed to energy consumer?
- What kinds of new partnerships and research strategies are being developed in relation to bioenergy? Are they proving successful?
- What is the role for bioenergy among other possible energy options? Does this role stand to change in response to developments in science and technology? Is the development of a viable bioenergy sector dependent on new technologies such as genomics?
- How should trade-offs among energy supply, climate, soil, water, food/feed requirements, landscape, biodiversity, social acceptance, and the rural economy be balanced in relation to bioenergy development?
- What governance frameworks would best promote the development of a bioenergy industry, and an environmentally sustainable bio-based economy more generally?
- Can the dynamics within the bioenergy sector be viewed as an indication of what might occur in other emerging sectors of the bioeconomy?

For further information about this workshop or the plant genomics work programme, please contact Emma Frow (emma.frow@ed.ac.uk).

[1] OECD. *The Bioeconomy to 2030: designing a policy agenda.* OECD International Futures Programme Scoping Paper, 2006.