



**MEETING THE ENERGY
CHALLENGE CONFERENCE
Full Report**

Scarman House, University of Warwick

2 – 4 February 2004

Report Compiled by Robert Heathman

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Background

Academics, Industrialists and Government representatives from a variety of disciplines both from the UK and the US attended the Research Councils UK (RCUK) conference ‘Meeting the Energy Challenge’ at the University of Warwick in early February. The event focussed on harnessing ideas and skills from relevant disciplines including the underpinning sciences, and developing creative solutions with a particular emphasis on encouraging information exchange between academia and industrialists under the Memorandum of Understanding linking the work of the US Department of Energy (DOE) and the Department of Trade and Industry (DTI). In March 2003, three Research Councils (the Engineering and Physical Sciences Research Council (EPSRC) along with the Economic and Social Research Council (ESRC), and the Natural Environment Research Council (NERC)) launched a £28 million initiative on energy, ‘Towards a Sustainable Energy Economy (TSEC)’. This initiative will address many key issues including the feasibility of the hydrogen economy, renewable energy resources, and carbon emissions. February's conference was held in the light of this new programme to discuss and identify long term R&D issues to meet the challenges of energy research, contribute to the agenda for the proposed UK National Energy Research Network, explore opportunities for international collaboration, and expand the research community active in energy research.

The objectives of the conference were to:

- Discuss and identify long term R&D issues to meet the challenges of energy research across all basic disciplines considering the recommendations highlighted by the UK Chief Scientific Advisor’s Energy Research Review Group (http://www.ost.gov.uk/policy/issues/csa_errg/) and the DOE report

from the Basic Energy Sciences Advisory Committee

(http://www.sc.doe.gov/bes/BESAC/Basic_Research_Needs_To_Assure_A_Secure_Energy_Future_FEB2003.pdf);

- Contribute to the agenda for the proposed UK National Energy Research Network;
- Explore opportunities for UK/US collaboration;
- Expand the research community active in energy research.

Event Overview

An introduction and welcome to the conference was given by Dr Peter Hedges, EPSRC Programme Manager for Infrastructure and Environment. This was followed by presentations by Professor Michael Grubb (The Carbon Trust), Professor John Schellnhuber (Tyndall Centre) and Dr Chris Mottershead (BP). All presentations from the conference have been previously available for downloading from the EPSRC's website. Copies can now be obtained from robert.heathman@epsrc.ac.uk.

In order to maximise output and enable all participants to be actively involved, the conference was organised as an "Open Space" event. Open Space Technology is a method for conducting meetings based on principles and values that enable innovation, problem solving, creativity, teamwork and rapid change. In Open Space, participants self-organise based on what is important to them, and as a result, are committed to implementing the changes they envisage. In Open Space meetings and events, participants create and manage their own agenda of parallel working sessions around a central theme or question of strategic importance. The first session, 'Setting the Agenda' asked delegates: 'What are the most important issues and opportunities in meeting the energy challenge that concern you?' Delegates recorded their answers onto cards and these were placed under one of four themes based on the topics presented by the speakers: Climate Change, Fuel Poverty, Energy Security and Supply and 'other'. Similar topics were clustered, given an overarching theme and assigned a 'champion' who would lead the discussion session; these formed the basis for the breakout sessions on day two. Delegates were given a timetable of all available sessions which can be seen in Annex 1 – 'Issues and Opportunities'. Delegates were encouraged to attend as many as they wished employing the 'Open Space' rule that they 'could vote with their feet' and provide input to as many sessions as they wanted.

During the breakout sessions the groups were asked to complete a pro-forma detailing the research challenges and the related actions that would make progress towards addressing these together with an associated contact. (Annex 2 – ‘Breakout Pro-Forma’).

Presentations were given on the final day by Professor Jim Skea (Policy Studies Institute), Mr Duncan McLaren (Friends of the Earth) and Dr Andrew Garrad (Garrad Hassan) summing up the conference events. These were followed by the action generation session where a vote was taken by the entire attendance on the actions identified from the breakout sessions. The resulting actions were then placed under various group/organisation categories considered to be responsible for seeing that the actions are taken forward. The list of prioritised actions and those bodies responsible can be seen in Annex 3 – ‘Actions’.

The Research Councils have already made progress on many of the actions identified throughout the course of the conference, a selection are summarised below:

- Research into skills/R&D/capabilities needed to keep the nuclear option open – the TSEC Keeping the Nuclear Option Open initiative is dealing with aspects of these actions and the initiative will feed into nuclear aspects of the UK Energy Research Centre programme.
- Research into new CO₂ disposal methods – this is included as a priority in the current TSEC call 2 on carbon management, will also feed into the UKERC programme.
- Resolve impasse between biomass production and take up by users/conversion groups – TSEC call 2 on renewables includes this area, SUPERGEN biomass and bio-fuels consortium in addition to UKERC for research and/or networking activities.
- Invest in a review to develop domestic level engagement – The TSEC Managing New Uncertainties initiative is looking at this development and this will also feed into the UKERC programme.
- Economic and technical evaluation of clean energy vectors – Future SUPERGEN and TSEC activities could include hydrogen production research.

Actions identified for other bodies will be highlighted through communications which will be distributed to the relevant contacts and available to all on the EPSRC website as soon as they are available.

Finally a talk was given by Dr John Stringer of the Electric Power Research Institute, EPRI to give the US view on UK energy research and how to align our efforts to meet the global energy challenges.

Annex 4 – ‘Questionnaire Analysis’ shows a summary of the exit questionnaire, the majority of delegates were happy with the event as a whole and many found the ‘Open Space’ approach explored the entire range of energy issues, the responses, however, mainly focussed on defining the next steps and implementing the identified actions.

The conference successfully achieved its original objectives, particularly in identifying the most important research challenges that require addressing if we are to tackle the issue of climate change, the most severe problem we face today.



**Annexes to
'Meeting the Energy Challenge
Conference'**

**(Scarman House, University of Warwick
2 – 4 February 2004)**

ANNEX 1

Setting the Agenda

**What Are The Issues And Opportunities In
Meeting The Energy Challenge That Concern
You?**

Limits to Technology - Lounge, 9-10 (Duncan McLaran)

- Remote condition monitoring and fault tolerance for deep sea energy exploitation
- Test Tank - Some wave power devices are vulnerable to currents. Some tidal stream devices are vulnerable to waves. Research on both needs a combined wave/current tank with independent repeatable control of both
- Technology and ways to achieve sub ppm levels for S and N in gas/oil
- How do different generating sources interact in terms of their environmental requirements and impacts?
- Long-term storage of nuclear waste makes nuclear unsustainable
- Limits to Energy - Apart from climate, what limits are there to the use of particular energy technologies?

Improving Academic/Industrial Links - CS Rm 5, 13.30-14.30 (Jim Halliday)

- Encourage more effectiveness interaction between industry and university
- Balance conflicting pressures of Government, Industry, Academic and recognise different roles
- Academic-policy interface
- Meeting the challenge of converting technical academic innovation into commercial reality
- How best to get private investment into early-stage technologies that provide 'public good'

Hydrogen Storage - Rm 2, 13.30-14.30 - 14.30-15.30 (J Kilner)

- Load Management - Load management of non-critical electrical equipment could be done by **local** measurement of voltage and frequency and a comparison with a randomly generated number cost ~ £15/kw. Load factor 25%? Helps security, negative generation = storage
- Need for **significant** demonstration projects in H₂ production storage and use
- Need for much larger R&D effort on storage technologies
- Storage - Intermittent renewable need the technology to convert electricity and hydrogen plus CO₂ to make methanol which can be used as a liquid fuel
- How to resolve the H₂ storage problem (safety issues)
- Hydrogen storage
- Hydrogen economy (storage)
- Zero/reduced emissions H₂ economy

CO₂ Abatement and Sequestration - Case Study Room 3, 13.30-15.30 (N Otter)

- Use of timber in buildings as carbon storage
- CO₂ storage verification and monitoring
- Carbon Abatement Strategy for Fossil Fuels - transition to sustainable energy

- CO₂ capture and storage - UK and/or international
- Zero emission
- Is research able to deliver a short term fix to CO₂ levels without reducing the effort to solve climate change in the long term?
- Is indefinite “storage” of carbon any more credible than that of nuclear waste?
- Low carbon emission fossil fuel energy production eg burn it in the ground!
- Geological sequestration - risks: leakage; inhibits search for new energy systems (makes fossil use easier to continue)

Environmental Justice - CS Rm 6, 13.30-15.30 (D McLaren)

- The distribution of the costs, impacts and benefits of the future energy system; how to make it **fair**
- Environmental justice

Training - CS Rm 5, 15.30-16.30 (J Irvine)

- Training of skilled workforce. Lack of technicians, engineers etc etc
- Do we have enough trained people to implement the required new technologies/approaches?

Economic Barriers - Lounge, 13.30-14.30 (Doug Everard)

- Energy utilities have multinational operations. Need to encourage investment in UK research base which may be distant from markets and other international expertise
- There are **two** valleys of death - in addition to ‘demonstration’, we need access to funding for proof-of-concept to move projects along the tech transfer chain
- How can governments’ best encourage technologies into markets? And without ‘picking winners’
- There is significant under-funding in UK energy R&D, even with recent measures taken into account. How/what can we do to redress this?
- How do we direct resource to key technologies to achieve critical-mass in centres of excellence and thus compete internationally?
- Improve early stage cash for the development end of R&D

Energy Systems Modelling - Rm 5, 9-10 (Chris Bronsdon)

- Sustainable exploitation of the marine environment (renewables and transport)
- A flexible mechanism that doesn’t select a winner(s), but delivers the technical/environmental target
- How do you relate broad policy and model output to local scale and individual decisions?
- Organising multidisciplinary E3 - technology research (for 60% target)

- The model of a European energy economy
- Complex adaptive systems [understanding/modelling, distributed and diverse energy systems]
- Include behavioural change into energy systems assessment
- Local micro-interruptible loads for load control in diversified networks
- Modelling of energy systems (predictive)

New Technologies for Fuel Poverty - Rm 6, 9-10 (John Stringer)

- Technology transfer of renewables to third world
- How do you provide clean cheap energy to the non-Organisation for Economic Co-operation and Development (OECD) countries?
- Lets all go and work in China?
- Technology Transfer and Dissemination - How can we deliver low/zero carbon technology to the poor? What trade/IPR reforms are needed?

Viability of Hydrogen - Rm 5, 11-12 (John Irvine)

- Way to a hydrogen society through fossil fuels via CO₂ capture and storage
- Is the hydrogen economy (macro-scale) really viable? Alternative vectors must be considered
- Is the hydrogen economy the fashion of the moment or is it a desired end point?

Energy Security and Diversity (Social Context) - CSR4, 13.30-14.30 (C Mitchell)

- New methodologies for assessing fuel security/diversity
- Energy autonomous robots (distribution of useful “units”) conflate energy generation (eg PV, MFC) with **very** efficient usage
- Security: should most UK energy sources be locally secure?
- Extent to which sustainable energy and security are complimentary
- Diversification of transport fuel mix
- Role of energy regulation in determining def of security/ability of SE and security to be complimentary
- Small communities to take responsibility for their energy system, demand, carbon emissions, waste, and therefore security
- Can energy security be achieved whilst still protecting the environment?

Consumers - Rm 1, 13.30-14.20 (D Fisk)

- “Inform and empower the energy consumer”
- ‘Consumerism’ and fuel use
- Public understanding of the costs of energy use

Network Infrastructure - Rm 2, 10-11 and 11-12 (G Burt)

- Electricity transport networks
Local vs. remote generation storage - vr load
- Networks for distribution - What investment is needed for diverse supply? How much generation should be embedded?
- Infrastructure - how do we get it in place in time?
- Development and management of high concentrations of small generation sources - local infrastructure
- Stability of large scale interconnected networks
- How to overcome intermittency of renewable technologies?
- Continuity of renewable supply eg windpower variability
- Network infrastructure that supports diverse, intermittent sources
- Solutions to RES intermittency required

Conventional - Rm 4, 10-11 (Brian Smart)

- Improvements in the FTS (gas to liquid) → new technologies
- Higher efficiency fossil fuel generation technology
- How to make coal-fired generation competitive with gas fired
- Improve efficiency of gas turbine based generation technologies
- The king is dead, long live the king?
 - Natural gas to liquid conversion
 -

Social Factors/Public Perception - Lounge 10-12 (J Skea)

- Socio-technical systems [understanding the tech/soc interaction]
- Promotion, particularly renewables
- Influencing public opinion
- Finding measures/policy measures to encourage local communities to accept local generation projects
- Social acceptability and public perception
- Is there a role for carbon credits?
- Change taxation from income to energy use
- Personal carbon quotas to get us to lower emission levels more equitably than taxation/carbon taxes would
- Human behaviour
- Importance of individuals/consumers

- How to enthruse people to change their behaviour
- Lifestyles, behaviour, values
- Dispense (by education) “consumer is king” mindset
- Enable individual “eco” decisions. PC vs mainframe thinking
- Low carbon **economy** vs low carbon **society**? What perspectives go beyond price/technical fixes?

Carbon Tax or Credit - Lounge, 10-12 (J Skea)

- How could China, India, USA ... be induced to drink the cocktail promoted by C Mottershead?
- Joined-up action - community charge benefits, tax credits, energy utilities

Energy Crops - Lecture Theatre, 13.30-14.30 (A Bridgewater)

- Agriculture
- Development of crops for improved efficiency under climate stress
- Bio energy crops - multiple benefits for environment and land use
- What is the potential for harnessing plant light-harvesting complexes within photovoltaic devices?

Resources for R&D (J Irvine)

- How to generate large scale industrial investment in low-C products
- Small components of wave and tidal-stream plant should be tested in large parallel batches on test-raft before being chosen for generating plant (reliability of wave and tidal)
- Sufficient funding for research to make a significant impact in developing renewal energy technologies (eg PV)
- Britain has a higher level of renewables support than any other country, but the lowest take-up rate
- UK R&D effort still far too small (it fell 10 fold in the ‘90s)

Role/Future of Nuclear Fission/Fusion - Lecture Theatres, 15.30-17.30 (D Baldwin)

- Fission and fusion require large capital investment. Is this unlikely to come from business?
- What characteristics would nuclear power be required to have to become an acceptable alternative?
- Will nuclear be allowed a second chance in the UK?
- Role of nuclear power in a mixed energy economy)
- Will alternatives be available in time to replace the UK’s ageing fission power stations?
- Does nuclear power have a future in the UK beyond 20 years? Is this consistent with other countries?

- How will materials developments impact on energy systems - particularly new systems such as fusion?
- What after 2050? Controlled fusion?
- Developing “fast ignition” as a fusion energy source
- Energy mix projections were shared today that illustrated the mix out to 2100, however none of these accounted for the introduction of fusion
- Should there be a (world) crash fusion programme?
- Developing new drivers (Z pinches, diode pumped solid state lasers) for inertial fusion energy)

International Collaboration - Case Study Rm 4, 15.30-16.30 (T Ali)

- Where do we get expertise from? International collaboration/swapping, industry/academia links need reinforcing
- Facilitate and improve international co-operation eg renewables
- We need a single submission/decision mechanism with our overseas partners if international collaboration is to work. How is this to happen?
- Use of non-OECD countries to grow new markets, that can later move into discounted economics of the OECD
- Role of US/UK MOU in carrying forward work of seminar
- International R&D collaboration
- Should we try to find out if fusion is viable with an international push on a multi approach programme?
- International collaboration on energy R&D UK/USA, EC, Other
- International, interdisciplinary, programmes

Science Enablers - Case Study Rom 2, 11-12 (Linda Horton)

- How to maintain/develop underpinning basic research that feeds into developments in energy technologies?
- Role of science in the creation of a wholly new suite of energy technologies
- Role of science in the improvement of the existing suite of energy technologies - Radically new ideas (or out-of-the-box old ideas) that could be enabled by advances in science (revolutionary)
- What can advanced science tools (light, neutrons, computing) bring to these issues?
- Materials research will underpin all energy developments. Can the UK train sufficient personnel?
- Problems: erosion of PV technology base in research technology is not high profile in RAE
- In which areas of “bioenergy” research should BBSRC invest its limited public funds?

Fuel Cells - Lounge, 16.30 (J Kilner)

- High efficiency conversion of real fuels in fuel cells for early CO₂ reduction
- Developing fuel cell technologies
- Zero emission technology for fossil fuel PG

Governance - CS Rm 3, 15.30-17.30 (C Mitchell)

- Regulatory “incentives” - transitioning from today
- Managing migration
- Governance
- Social norms and the role of governance
- Institutional change
- More evidence on policies/measure that promote successful innovation - can we ‘pick winners’
- Innovation policy related to evidence
- Top down vs bottom up strategies for achieving technical change
- How to develop a balanced energy mix with comparative assessment of all technologies?
- Cross-cutting issue: need for a robust and transparent process for policy development and implementation that will allow government to deliver what is required!
- Power and citizenship: who actually makes decisions and with what impacts for social acceptability?
- Europe - where and how to make energy - environment-tech decisions
- How to influence government to enforce high energy efficiency regulations for housing and business
- Strong, mandatory minimum standards for products, EU wide including houses, appliances

Global Climate Change - Case Study Rom 2, 15.30-16.30 (John Stringer)

- Translating rate of change of natural systems to rate of change needed to deliver targets?
- What do you believe accounts for the increased saliency of global warming concerns in the EU countries vs the US
- Coping with (inevitable) climate change
- What opportunities exist to engage us on climate change through collaborative R&D?
- Shouldn't we be addressing **global** climate change, rather than just UK? Engagement of Chinas of this world
- Risks of higher global temperatures
- John Latham of the University of Colorado has shown that 300gm/km hour of 1 μ salt crystals our oceans will increase cloud albedo enough to allow double CO₂. Spray turbines can lift it.

Research needs atmospheric ‘test-tube’ in the form of a super-insulated vertical wind-tunnel with temperature, pressure, water, light and chemical control.

Also needs work on ‘yachts with Damieus rotors to squirt sea water (Ideas/Solar Reflection)

Integrated Evaluation Perspectives - CS Rm 1, 15.30-16.30 (A. Bridgewater)

- Understanding what is meant by 'step change' - most things happen incrementally
- Encourage polygeneration (multiple products including some non-energy)
- Consistent comparative evaluation of alternative renewables
- How do you factor in environmental and social benefits of different energy technologies into energy price?
- Life cycle cost comparisons to assess different systemic options on a common footing
- How does 'energy' relate to other 'sectors'? (e.g. agriculture, nature conservation, water)
- How can we make comparable valuations of environmental potential and impacts for different technologies?
- Identifying measures/technologies that benefit climate/security/cost at the same time
- Environmental economics and full environmental case accounting
- How to get realistic and unbiased estimates of various energy options - avoid industrial biases, or those of 'enthusiasts'
- Integrate renewables with conventional energy
- Sustainable development assessment methods - is there a multidisciplinary standard (eg global foot printing)

Managing Intermittency - Rm 1, 14.30-15.30 (P Crossley)

- Electricity system control and trading - technology and policy issues
- Electricity transmission control and stability
- Fuel cell CHP
- Networks with 100 generators; 1,000 generators; 10,000 generators; 100,000 generators; 1,000,000 generators
- Networks with renewable and storage and demand management and local generation ie active management of networks

P V Issues - Rm 5, 11-12 and 15.30-16.30 (Robin Nicholas)

- What are the constraints on development of solar cells (PV) for energy generation?
- Solar PV: moving householders from consumers to producers of power: what challenges?
- Can we produce new/flexible thin film PV technology 'paint' a PV cell onto a surface
- How do we develop much lower cost, higher efficiency photovoltaic devices?

Energy Markets - Rm 5, 10-11 (Chris Bronsdon)

- Detecting industrial niches in a global industry
- Market mechanisms to create the optimum energy mix?
- What market pull mechanisms would help translate research into commercial viability?
- Will the role of direct cost be less important in determining future energy strategies?
- Financial markets - how to invest and deploy new plant in deregulated markets?
- How to create significant markets for low-C energy products
- Demand side power management (social/economics/tech)
- Attitudes/principles to markets and regulation

Hydrogen Economy - Case Study Room 1, 9.00-11.00 (K Kendall)

Biofuels - Hydrogen Economy (K Kendall)

- Few blues; no policy; who is putting it together; BP, Air Products, BOC; no-one here has done it; nice to have Denmark, Western Europe; micro and macro; several different hydrogen economics - which one?
- H₂ economy - what, how, when
- Hydrogen economy - potential from development
- Energy required to generate hydrogen
- Photosynthetic H₂ production
- H₂ from biomass
- Biological hydrogen generation - from biomass? - whole cell? - enzymological?
- What is the real potential for H₂ production from microbes to be commercially exploited?
- Defining a clear timeline for conversion to a hydrogen economy - including technical, environmental, social considerations
- Technologies for H₂ storage and distribution
- Small-scale reformers
- How will materials problems for hydrogen storage and hydrogen generation be solved?
- Hydrogen infrastructure
- Hydrogen delivering large scale implementation (eg refuelling stations from Brown and Green Hydrogen)
- Zero/reduced emissions, H₂ economy
- Hydrogen economy - large scale zero emission production

Policy - CS Rm 3, 9-11 (J Köhler)

- Meaningful interaction between engineers working on basic R&D and social scientists working on technology diffusion
- Energy efficiency: how to turn theory and ideals into reality
- How can the 'market' in energy R&D become more effective and efficient?
- How do you get people to adapt energy efficiency measures?

- Improve acceptability of energy and power processes for permits and approvals
- Need for an integrated energy policy - power generation transportation etc to establish focus for future research issues
- Sequencing and Displacement - what sequence of actions for mitigation and adaptation will maximise system efficiency? How do we ensure all appropriate actions are used?
- How to develop convincing visions of a low-C society
- How to demonstrate to government policy makers that: policy to move society towards a low-C society is politically feasible
- Educate people on the importance of climate change - so they pull the politicians and decision makers

Energy Storage - Rm 2, 9-10 (Chris French)

- Nano-materials energy storage, membranes, etc. Renewables
- Energy storage
- Energy storage for DC
- Is magnetic energy storage viable?
- Storage of energy is paramount
- Cost-effective energy storage for transport and energy distribution
- Novel ideas for storing energy from intermittent sources?

Energy Efficiency - Rm 6, 10-11 (Rafe Bertram)

- Vehicle engines have very poor mean to peak power rating. A continuously-variable transmission with energy-storage and regenerative braking could reduce urban fuel consumption by about 40%. This is being studied as a spin-off from wave energy research
- Efficiency and Consumption - how do we ensure increased efficiency only leads to increased consumption where it is necessary to overcome fuel poverty?
- Will future technology developments allow a drastic reduction in energy consumption or will the inexorable increase continue?
- How to make domestic-scale combined heat and power competitive with centralised generation
- Greater efficiency of energy production
- Improved, new material for energy generation, use efficiency
- High efficiency end-use of electricity -50% chp
- Reduced energy industrial processes
- Emerging technologies for use within energy efficient buildings
- Energy-efficiency in consumer goods at 'top of the range'

ANNEX 2
to 'Meeting the Energy Challenge' Conference
Forms from Discussion Groups

Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)

ROOM: 2

SESSION TIME: 15:30

Title: climate change

Summary Paragraph (approx 100-200 words):

There is evidence that sudden events associated with climate change may be about to occur: such as turning off of the north atlantic drift. This would have serious effects on the climate of Europe. More evidence might help mobilise public opinion.

Despite popular conception in the rest of the world, there is concern in the US about climate change. Politically, the US would prefer to collaborate with the UK on research in this area. Modelling and data gathering are prime areas for collaboration.

We need to seek alternative crops that will cope with different climates (hotter, colder, drier). Flood defences. Dealing with water shortages. Engineering methods of mitigating climate change need to be examined eg. Injection of salt crystals into the atmosphere to feed clouds.

Convenor: Chris Elston

3 Key Actions:

1) UK/US collaboration of data gathering and modelling, especially north atlantic drift.

Contact: Tyndall Centre and the Hadley Centre

2) Crop research and development to allow population to remain living where they are.

Contact:

3) Engineering solution to be pursued eg. Lathami? salt crystals

Contact: Stephen Salter

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)**

ROOM: 3

SESSION TIME: 13:30-15:00

Title: CO2 Capture and storage

Summary Paragraph (approx 100-200 words):

It was agreed the fossil fuels would be used for decades to come and one of the key issues would be to as to how they could be used cleanly. In this respect CCS was recognised as a critical technology to be applied (along side RES and others in a portfolio approach) if the 60% reduction targets are to be met by 2050.

To this end it would be highly beneficial if any future work undertaken would be positioned in a carbon-management strategy included fossil fuels.

This should involve (for example) efficiency improvements right out to 0 emission (including CCS) and the link to hydrogen. Critical to the deployment of the technology are the economics, the value of CO2 (especially WRT the emission trading schemes where verification/measurement will be essential), cost reduction of capture, legal implications, environmental, public perceptions of health and safety. These are in addition to specific technology/research associated with integrity of storage (the north sea being the most appropriate to the UK), cost effective long term monitoring techniques and the impact of potential leverage on the biosphere and humans.

International collaboration is regarded as essential (making better use of the UK-US MOU) and the participation in such activities as the carbon sequestration knowledge forum. Policy and availability of information was identified as a particularly important issue.

Convenor: Nick Otter

3 Key Actions:

1) Establish CCS as a strategic theme in the energy research programmes linking to the proposed DTI carbon abatement technologies programme for fossil fuels.

Contact: DTI (Bronwen Northmore/Brian Harris) EPSRC AND (TBA)

2) Instigate a proactive approach to ensure greater sharing and pooling of information, possibly leading to joint projects (eg under US/UK MOU, EU, CSKF)

Contact: EPSRC (Peter Hedges) US DOE (Barry Gale) DTI (David Irving)

3) Development of cost effective monitoring and measurement techniques for

verification of CO2 storage.

Contact: APGTF (Nick Otter in the first instance)

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ____)**

ROOM: 1

SESSION TIME: 13:30

Title: Consumers
Summary Paragraph (approx 100-200 words): Incentive structures need to be provided to public bodies so that they can adopt commercial sector type approaches to promoting low-carbon life styles. One driver for change could be supply/power cuts through failures in energy security policy which could induce completely new consumer choices of products. Many other consumer issues have been exhaustedly discussed else where (energy efficiency/socio-technical modelling). Convenor: David Fisk
3 Key Actions: 1) Public bodies adopting commercial sector approaches to promote changes in patterns of consumption. Contact: David Shipworth 2) Study consumer reactions in other countries where there has been major disruption. Contact: see Diversity/security/ESRC 3) Contact:

Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)

ROOM: 4

SESSION TIME: 10:00-11:00

Title: Conventional

Summary Paragraph (approx 100-200 words):

Coal and gas measured against the UK plc energy challenges of
Security and Surety of Supply
Environmental Impact
Global Economics

Conventional at the very least will have to migration of supply to renewables and CCGT.
Even possible to combine coal and gas IGCC (Integrated gasification combined cycle).

Coal best for security and surety of supply but new mining methods required. In situ
gasification with CO₂ sequestration offers hope. But blue sky work on bugs/chemical
methods of extraction required. Really blue sky – in situ conversion of coal to energy in
chemicals leaving CO₂ behind. (some parallels with oil industry).

Economics of the deregulated industry dictate that short time to pay back on any
investment now required.

Environmental – improve efficiency – Burners and supercritical – export potential and
carbon trading eg to China or lignite in India.

Niche-ish UK technology in danger of being lost.

Conditioning/capture from the gas co₂ in particular offers big opportunity if could be
improved.

CO₂ storage by injection still to be taken to demo stage.

CO₂ and H₂O and bugs to CH₄ in u/g reservoir possible, but requiring acceleration.

Big message – Large plant regs to be introduced in 2007 – death knell for coal plant – so
small window.

Convenor: Brian Smart

3 Key Actions:

1) Public policy – coal must have future – key export?

Contact: DTI

2) New extraction methods

Contact: Brian Smart/Steve Larter

3) Minimizing environmental impact including efficiency – CCGT target

Contact: Tariq Ali

Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)

ROOM: Lounge
SESSION TIME: 13:30

Title: Economic Barriers

Summary Paragraph (approx 100-200 words):

The discussion focussed on the fundamental disconnect between the costs and timeframes for technology innovation and the current market (and support) mechanisms. Issues raised included:- what technologies should the UK be backing (global potential v niche advantage)

:- how can public funds best reduce investor risk.

:- entrepreneurial spirit v big company balance sheet.

:- critical mass required to be a global player

:- balancing environmental, wealth creation and security of supply agendas.

:- current disconnect between government view of attractive market c.f. financiers view.

Convenor: Doug Everard

3 Key Actions:

1) Develop research in how to attract (major £1bn over 10 years) private sector investment into technology development to boost public funds.

Contact:

2) Develop research in how to design the energy market top reduce investor risk for capacity build taking account of timeframe, environmental agenda, wealth creation, security and supply.

Contact:

3) Develop research in how best to quantify and give credit for non cost measures eg. Security of supply, environment.

Contact:

Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)

ROOM: Lecture theatre
SESSION TIME: 1330 -1530

Title: Energy crops

Summary Paragraph (approx 100-200 words):

How can the objectives of quality and quantity be achieved? Quality must be defined. There are existing perennial and annual crops, and novel crops to be developed. Most crops are grown as food, and how can these practices be modified or developed for energy crops? There are 17M ha agricultural land in the UK, of which 1M ha can be considered for energy crops by 2010.

The scale effect of large scale production of biomass crops is not well understood. Previous work should be reviewed and re-assessed including logistics, socio-economics, environment etc.

A long term biomass crop market is needed to restore confidence after Arbre. A guaranteed market is desirable eg a national "CAP" to encourage production.

Co-firing is an important short to medium term opportunity, quality requirements need to be established through dialogue between producers and power generators.

How do farmers decide what to grow? To what extent can C. be sequestered in roots and what are the benefits. How can N and H₂O inputs be minimized? Yield is not the only criterion. Optimisation not maximisation of crops is important.

Centres of activity in energy crops and plant science need to work better together.

Willow and poplar genome sequencing should be developed internationally.

An analysis of options for UK production of bio-energy products vs imported raw materials of final products should be carried out technically economically and by LCA.

Convenor: Tony Bridgwater

3 Key Actions:

1) Review and re-assess effects and impacts of large scale biomass production.

Contact: Gail Taylor

2) Develop a guaranteed market for energy crops to encourage farmers and to provide a resource base.

Contact: DEFRA

3) Bring power generators and growers together so both understand the requirements and limitations of the other – particularly for co-firing

Contact: Tony Bridgwater

4) How do farmers decide what to grow? What systems should be built? Match crops grown locally?

Contact: DEFRA

5) Optimisation not maximisation of crops is important – N inputs H₂O inputs. To what extent can C be sequestered in roots? What is benefit? Use biotechnology to optimise systems.

Contact: BBSRC

6) Integrate energy crop centres and plant science research centres for information exchange and R&D.

Contact: BBSRC? SUPERGEN BIO-ENERGY?

7) Develop willow and poplar genome sequencing. Play internationally particularly.

Contact: BBSRC

8) Establish biomass crop quality characteristics.

Contact: Tony Bridgwater- SUPERGEN B AND B

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)**

ROOM: 6

SESSION TIME: 10:00-11:00

Title: Energy Efficiency

Summary Paragraph (approx 100-200 words):

Efficiency vs Conservation

- Focus on conservation – more likely to bring co2 emissions down. “Minimum standards” – Permission to manufacturing

Domestic vs commercial – Can energy efficiency be mandated?

How can energy efficiency be made more fashionable.

Can there be a generalised labelling procedure – use date on goods when they were to standard.

Energy Efficient Advances

More vision needed (why can't we talk like fusion people?) How to develop it, How to disseminate information, How to market it.

Personal carbon allowance.

Convenor: Rafe Bertram

3 Key Actions:

1) Understand what can encourage people to buy energy efficient goods (marketing)

Contact: ESRC Gary Grubb via Garry Staunton

2) Label everything

Contact: Brenda Boardman

3) Research personal carbon allowance.

Contact: Garry Staunton

4) Research visionary energy conservation.

Contact: Brenda Boardman

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ____)**

**ROOM: Tiered Lecture Theatre
SESSION TIME: 0915-1215**

Title: Energy from biological systems.

Summary Paragraph (approx 100-200 words):

The group recognised a degree of fragmentation of research and researchers in the energy of biosciences. There was agreement for the need to improve integration and promote interface with industry. We thought the Supergen network was a good conduit for this aim. With respect to producing and using biomass to help meet the Government's renewable energy targets, we noted the present impasse between potential growers and potential users. There are too many non-technical barriers. Encouragement of biomass as a renewable energy source could be helped by incentivising the heat market, by building demonstration units (eg 2 Megawatt +) and (most importantly) clarification of existing policies – or even consider re-nationalisation.

In order to better distinguish R&D into biomass as fuel itself and R&D on systems or processes (eg. To sequester CO₂, to abstract electrons or abstract useful products) we agreed that a glossary of terms should be compiled for use by bioscience/ energy communities and research councils.

Convenor: John Greenman

3 Key Actions:

1) Recommendation for integration of the bio-energy community using Supergen network.

Contact: Tony Bridgewater

2) Break the impasse between supply of biomass crops and their take-up by end users.

Contact:

3) Glossary of terms

Contact: Tony Bridgewater

Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)

ROOM: Case Study Room 5

SESSION TIME: 10:15

Title: Energy Markets

Summary Paragraph (approx 100-200 words):

A transition in the energy supply system is need/ indicated by the White Paper, but the present electricity market with its focus on cost seems unlikely to deliver it.

There is also a stark contrast between the highly taxed transport fuels market and the electricity market – both contribute to CO2 emissions.

The position of a primary electricity market with “bolt-on” features such subsidies for introducing new sources should be considered. The possibility of a new market which directly incorporates social, environmental and security aims should be investigated, not least because the 60% CO2 reduction target may otherwise lead to an increasing system of “bolt-ons”.

Interventions may include CO2 escalators (increasing Carbon tax), diversity tax etc. Although resistant to prescribing the future energy mix, even in broad categories, there are clear implications for the achievement of CO2 reduction targets, both for generation and energy efficiency. Energy supply companies may play a role in delivery. Ways of addressing the short-term view of financial markets need to be considered in order to deliver the longer term energy goals

Convenor: Chris Bronsdon

3 Key Actions:

1) Research into ‘New Market Ideal’ to deliver 60% reduction target i.e. not ‘cost only’ basis

- consider intervention in primary market.
- CO tax/ ‘bolt-on’ incentives
- Role for a non-energy (but technology) champion.
- Consider: time constraints; transition timing (are we too late?)
- capital markets/ risk

Contact: UKERC

2)

Contact:

3)

Contact:

Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)

ROOM: 4

SESSION TIME: 13:30 – 14:30

Title: Energy Security and Diversity

Summary Paragraph (approx 100-200 words):

Security seen as 1) physical/macro – can we obtain enough gas/oil etc 2) will the infrastructure (domestic and international) be secure enough to transport it 3) do markets provide enough incentives for new generation, back-up for intermittency etc to ensure security and for maximum link to sustainability and security (ie renewables/energy efficiency) 4) are the energy networks systems going to be reliable when you want them to be plus links to gas and electricity security 5) whose responsibility should security be?

See key actions for summary of concerns.

Convenor: Catherine Mitchell

3 Key Actions:

1) Is it acceptable that increasing percentage in gas (for electricity and industry etc) use, given move to net imports and research into geo-politics of energy, particularly oil and gas.

Contact: Government

2) Is current regulatory system providing appropriate incentives for secure, sustainable energy system; do these incentives provide sufficient inducement to max complimentarily to sustainability and security, including all levels eg local and demand; need understanding of costs and values (monetary and non-monetary) of security of different diverse technological futures and combinations of different institutional involvement.

Contact: C.Mitchell

3) Research into framework for quantification/value of diversity/security.

Contact: C.Mitchell

Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ____)

ROOM: 2

SESSION TIME: 9:15 – 10:15

<p>Title: Energy Storage</p>
<p>Summary Paragraph (approx 100-200 words):</p> <p>Targets/Issues/Drivers</p> <p>Dash to renewables with 30/40% load factor Need ability to match load supply</p> <p>Timescales</p> <ul style="list-style-type: none">1) Hrs/day2) mins/hours3) secs/mins <p>Issues of length and capacity and response frequency.</p> <p>Trickle supply model (eg water with energy storage)</p> <p>Convenor: Chris French</p>
<p>3 Key Actions: International Conference/workshops will lead to focus</p> <ul style="list-style-type: none">1) E2E (electron to electron) Energy Conversion/storage <p>Contact:</p> <ul style="list-style-type: none">2) Consumer direct control of power <p>Contact:</p> <ul style="list-style-type: none">3) Chemical for high capacity <p>Contact:</p> <p>Load management</p>

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)**

ROOM: 5

SESSION TIME: 9.15

Title:

Energy systems modelling (ESM)

Summary Paragraph (approx 100-200 words):

If the UK is to meet the 60% CO2 reduction target then ESM will become more important in the future. There is a real opportunity for the UK to develop new thinking on the scope and inter linkage of ESM that will:

**1. Account for : fundamental technological change
: real issues – geo-political constraints, capital flows Incentive structures, resources, security of international markets.
Temporal feedback on capacity building and delivery.**

2. Address : Real data vs assumptions, lack of empirically based understanding of UK demand, feedback between groups – continuous improvement ethos.

The interface between techno-socio-economic disciplines must be enabled in order to translate outcomes to policy makers.

Work needs to focus on priorities that have the greatest uncertainty/impact.

Convenor: Chris Bronsdon

3 Key Actions:

1) Feedback between Tech community/Advance and S.E models discussion fora.

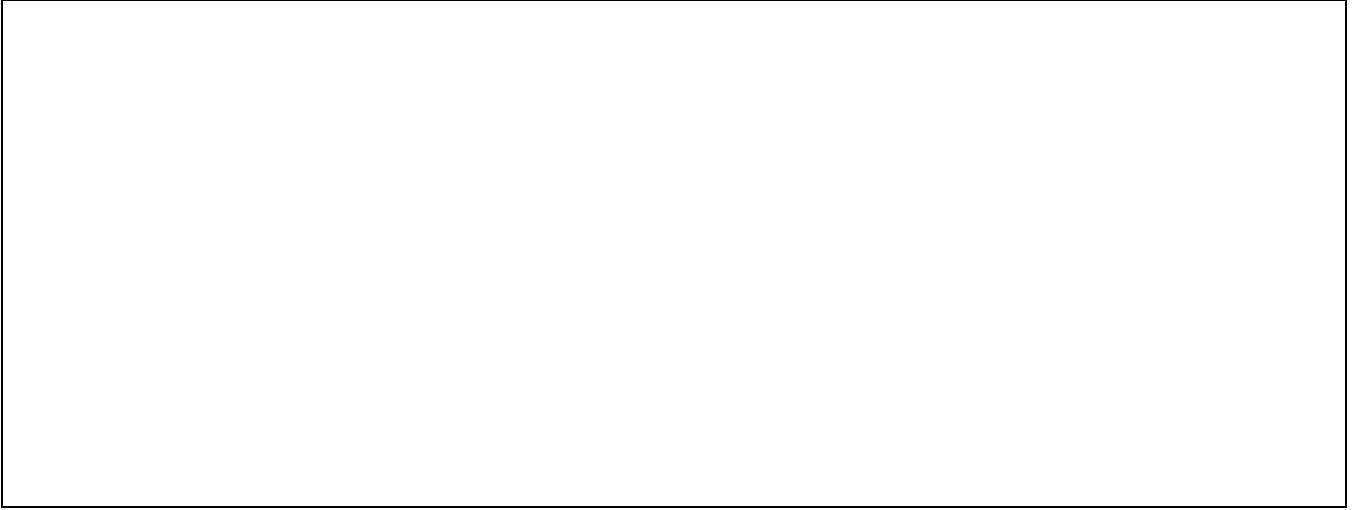
Contact: NERN ‘DS’

**2) How to improve ‘quality’ – bring in new techniques (eg behavioural)
How to handle uncertainty**

Contact: David Fisk

3) Thinking beyond UK boundaries / TSB/political/Int’l/capital/Markets/PE Incentives. Big opportunities for modelling of fundamental tech/change – Int’l collaboration.

Contact: Linda Horton



**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)**

ROOM: 6

SESSION TIME: 1330-1430

Title: Environmental Justice

Summary Paragraph (approx 100-200 words):

Justice and distributional issues are an important dimension of the energy system. Climate is an extreme example because impacts are remote in time and space from the beneficiaries.

Under one model, there is a research agenda into the mechanisms for accountability and justice (legal/political) that will change behaviour of corporations and their interactions with consumers.

Under the second model, there is a research agenda into the consumer education role of corporations to incorporate justice concerns - how can you add to the product a dimension of justice (eg labelling).

Within intergovernmental negotiations on climate, “contraction, convergence and compensation” models advocate a basis for environmental justice.

Incorporation of externalities in consumer prices for energy, whilst desirable in ecological terms, would exacerbate injustice for the ‘fuel poor’.

Convenor: Duncan McLaren

3 Key Actions:

1) Establishing a research agenda into legal and other mechanisms to make the beneficiaries (of energy use) accountable to the victims (eg corporate accountability)

Contact: Duncan McLaren

2) Establishing a research agenda into educational and market tools to incorporate justice concerns into purchasing decisions.

Contact: Chris Mottershead

3) Research into the necessary regime of property rights to underpin a global regime of ‘contraction and convergence’.

Contact: Chris Mottershead

Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)

ROOM:

SESSION TIME:

Title: Fission/Fusion
Summary Paragraph (approx 100-200 words): <p>In any assessment of global energy needed for the future, particularly when environment and climate needs are folded into the mix, it appears that energy drawn from the nuclear must be considered a serious option –advanced fission in the nearer term and fusion in the longer term. For fission this requires working with other parties to address and resolve the issues standing today in the way of its acceptance – safety, proliferation, nuclear waste and cost/financing In recent years major advances have been made in all areas but now can and should be done. In fusion this requires first confirming that fusion energy is scientifically/technical possibly through the generation of 500 mw of fusion power in ITER, and then proving that it can be economically competitive.</p> <p>Convenor: Dave Baldwin</p>
3 Key Actions: 1) Explore collaboration activities and training opportunities with US and Europe in advanced fission development eg the GenIV programme. Contact: 2) Work with the US and Europe to develop in detail a planning timeline for fusion energy development, arriving at a prototype reactor operating in 25 years. Contact: 3) Work with the US and Europe to develop the advanced materials required for both of these technologies. Contact:

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)**

**ROOM: Lounge
SESSION TIME: 1630 - 1730**

Title: Fuel Cells
Summary Paragraph (approx 100-200 words): Early introduction of fuel flexible FCs using conventional fuels is needed to achieve emissions gains from high efficiency. Issues which currently prevent large scale penetration of FCs are cost and durability. The cost issue is application dependant and is centred on materials and fabrication processes, although a system approach is probably needed. The UK research base is excellent and innovative with good relationships between basic science and engineering however there is a critical lack of training manpower. Relative issues are the need for life cycle analysis for all designs and type of FC and the use of FCs in related technologies, eg reversible fuel cells for energy storage. Convenor: John Kilner
3 Key Actions: 1) FC cost reduction programme Contact: 2) Ensure supply of trained manpower Contact: 3) Global funding is v large not matched in UK Contact:

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)**

ROOM: 3

SESSION TIME: 15:30 – 17:30

Title: Governance

Summary Paragraph (approx 100-200 words):

Governance is relationship to government and those affected including upwards to international/ EU issues. Downwards to admin\regions/local.

Governance to government and creation of policies

- should be evidence based, transparent
- need to understand how it occurs, how interests are involved/ expanded
- need to understand distributional effects
- need responsibilities for delivery of policies

Government and Institutions

- Need clarification between organisations and delivering power
- Clarification of responsibilities for delivering outcomes

Governance 2 way activity – if occurs well then ownership occurs/roles respected, trust of less importance if accountability is clear.

Convenor: C.Mitchell

3 Key Actions:

1) Research to understand how the governance relationship between government and actors is arrived at (eg Ofgem's duties) guidance etc from a politics – socio-economic new point.

Contact:

2) Research into what the messages are that need to be got across to public and how that can best be done – may be government may be other. If its government then its important that processes by which governance occur is appropriate and accountable, roles should be clear and respected.

Contact:

3) Research into how policies are arrived at and implemented. Research into how policies can be evidence based and followed this. Understanding of distributional effects of policies should be part of this and confronted. Important that those

who/which are affected (including future generations)can appeal/address policy outcomes if feel unfairly treated/impacted.

Meeting the Energy Challenge

PRO-FORMA for Discussion Group (No: ___)

ROOM: 1

SESSION TIME: 0915

Title: Hydrogen economy

Summary Paragraph (approx 100-200 words):

Gap analysis – Group quite varied but several gaps were evident – No policy people, no H industry people BP, BOC etc – No Germans or Dane, who are ahead – who is putting it all together? Several different H economies, micro, macro, island need more biomass.

Ideas Injection – Why do we need this H, what is it, how do we do it and when is it achieved? Answer – benefits – a bunch of hydrogen activities, limited UK activity at present, some in Scotland, Arguable 2050? Hydrogen from renewables is key issue.

Prioritisation – Step change needed in H storage, lots of incremental work but where are the breakthroughs? How do we encourage and fund these studies – radical R&D – life cycle analysis – not clear where balance of benefits and snags is. We want full picture of H. Biomass to hydrogen looks very interesting, questions arise about scale-up and intensity. Infrastructure very important – can we put 10% H into present gas pipes? – can we generate enough h hydrogen economically? – does it leak, problems of transport – high cost. Hydrogen as a vector – solves intermittency, store off peak electricity eg nuclear – Zero emission – very controversial – what does it mean, need full picture – need to buy carbon – can hydrogen compete with natural gas?

Definition of H economy – Problem of definition because 1) it does not exist 2) Confusion between generation and transmission (can hydrogen beat electrical power lines) 3) Several different kinds of hydrogen economy – Scottish island, Johnson Mathy building is H economy, transport seemed biggest sectors.

BENEFITS 1) zero emission at point of use 2) high efficiency –H and fuel cell 3) transport is a convincing market 4) Intermittent energy supplies (wind or wave) could use hydrogen 5) Peak topping could use hydrogen 6) Public perception is that hydrogen will solve problems.

Problem areas

1) Production – more efficiency needed – bio hydrogen is excellent idea but does it work? – hydrogen from PV, nuclear, electrolysis, reforming and cracking.

2) Storage is main area of importance – lightweight for transport – chemical eg hydrides, pressure or cryo (costly 30% energy use liquefaction) porous carbon can store hydrogen – need more results (Only 20 people in the UK studying this and we need at least 100.

3) Transmission depends on infrastructure – did it with town gas – cost is major element – known technology – leakage is a problem – safety issues.

4) Utilisation – need cheaper fuel cells – need better catalysts and materials

- 5) Light house projects – need demonstration like hydrogen bus in London fuel cell light house in Teeside– need UK funds for more examples.
- 6) Regulation – Ofgem regime has no mechanism for funding R&D – easily produce a mechanism for funds eg climate change levy, scandal that climate change levy 95% diverted into national insurance eg capital asset depletion Security of supply levy– ESRC need to examine market
- 7) Public acceptance – some student courses in sustainability – need more mass media – safety – get rid of Hindenberg – need positive demonstrations

Convenor: Kevin Kendall

3 Key Actions:

- 1) Fundamental R&D can still make a contribution, eg hydrogen storage, regulatory incentives –3 hydrogen storage units – Liverpool, Bham
Several regulatory units – Imperial

Contact:

- 2) Raise public awareness of ‘zero emissions’ need more exhibitions, demos, lighthouse projects – mass media – Grove conference, Elsevier, NEC Mar 31st

Contact:

- 3) Proving clean H₂ generation and efficiency – funding projects regionally?
Scotland is ahead, Iceland, California, Vancouver

Contact:

- 4) Hydrogen spine – Teeside 100,000 te H₂ – Bham-London – Infrastructure invest.

Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)

ROOM: 2

SESSION TIME: 1330 –153-

Title: Hydrogen storage
Summary Paragraph (approx 100-200 words): The discussion started with a review of H ₂ storage technologies noting that storage is critical for the H ₂ economy and in particular the transport sector. Technologies are compressed gas, liquefaction, solid storage (micro-porous, metals, hydrides, and nano-materials) and chemical (alanes eg NaAlH ₄ , FeO, TMB). For large scale storage salt caverns are used. Discussion moved on to what is needed to achieve storage targets eg DOE targets. It is clear that the UK has a small number of people working in this area (20 people). It was felt this is sub-critical to make a significant impact. R&D needed in 2 areas, incremental to develop existing technologies and blue sky basic research. It was agreed that a step change was needed to approach targets and this would come from basic research. The UK National energy centre should take active role in managing research into hydrogen storage and interact with existing networks such as SUPERGEN. It was suggested that development of several application fields eg transport and embedded generation was a way to ensure development in a more gradual manner, however to achieve a step change will require a more oblique innovative approach eg bio-inspiration or considering chemical carriers eg methanol, trimethol benzene etc.
Convenor: John Kilner
3 Key Actions: 1) Ensure widened participation of basic science research base in H ₂ storage. Contact: 2) Manage limited resources - target specific groups Contact: 3) Contact:

Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)

ROOM: 5

SESSION TIME: 13:30 –14:30

Title: Improving academic/industrial links

Summary Paragraph (approx 100-200 words):

The varying needs of industry (involvement of projects to solve immediate problems- watching brief on issues with 10-20 year impact); and academia (publications for RAE and promotion) were discussed.

Industry would appreciate a single point of contact (per energy sector) to highlight/discuss novel innovations and to strengthen flow of information from university sector (action 1).

The relationship between percentage of funding and time to impact was noted (industry willing to fund 50% of ideas with immediate application but 0% for 10 year timescale projects).

Big multi-university projects were complex and would benefit from full-time professional project management by technically qualified person (action 2).

PhD= over qualified for industry, but graduates of decreasing quality – increased need for Msc level training (action 3).

Time to write RC proposals, get decision, recruit staff means that time from initial idea to starting work is often long.

Convenor: Jim Halliday

3 Key Actions:

1) Active technical management of portfolio of projects needed – provide sector contact for industry to talk to.

Contact: Research Councils with NERN/UKERC

2) Professional managers (with technical training) required to manage large multi-university projects.

Contact: Research Councils

3) Masters courses needed to upgrade quality of graduates (and make more relevant to industry).

Contact: Research Councils/Universities

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)**

ROOM: 1

SESSION TIME: 1530

Title: Integrated evaluation perspectives
Summary Paragraph (approx 100-200 words): How can evaluations of different systems be compared – global foot-printing one method that has been used. There are concerns about its general suitability. A general methodology would be very difficult to devise that will be sufficiently robust, widely acceptable and gave meaningful answers. Establishing a list of criteria might be feasible. Extensive discussion resulted in the one action below. Convenor: Tony Bridgwater
3 Key Actions: 1) Investigate the potential for refining a framework for consistent and comparative evaluation. Contact: Establish a truly interdisciplinary group – Jane Powell – David Shipworth 2) Contact: 3) Contact:

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)**

ROOM:

SESSION TIME:

Title:

International Collaboration

Summary Paragraph (approx 100-200 words):

Discussions began with a summary of the UK perspective and background for the US/UK MOU for energy research. UK participants were generally unaware of this document and of its ramifications for research. There is a disconnect between DTI (owners of the MOU), the research councils, and the academic research community. Relative to possible research interactions under the MOU it was clear that UK lacks a concise prioritization of research needs and a mechanism for seeing these through. Additional possible responsibilities for the UK Energy Research Center relative to these needs were identified. Research in the UK that is funded by the US, additional areas of emphasis (e.g., clean coal), and planned workshops (Hydrogen, Neutron scattering, etc.) were discussed. Interactions with other countries, particularly the EU, were discussed in the context of the MOU with the U.S. It was recognized that the UK needs a coordinated effort to identify research priorities as input to the EU Framework VII.

Convenor: Tariq Ali, Linda Horton

3 Key Actions:

1) Immediate need to raise the profile/awareness of US MOU (workshops, websites, publication) across the UK scientific community.

Contact:

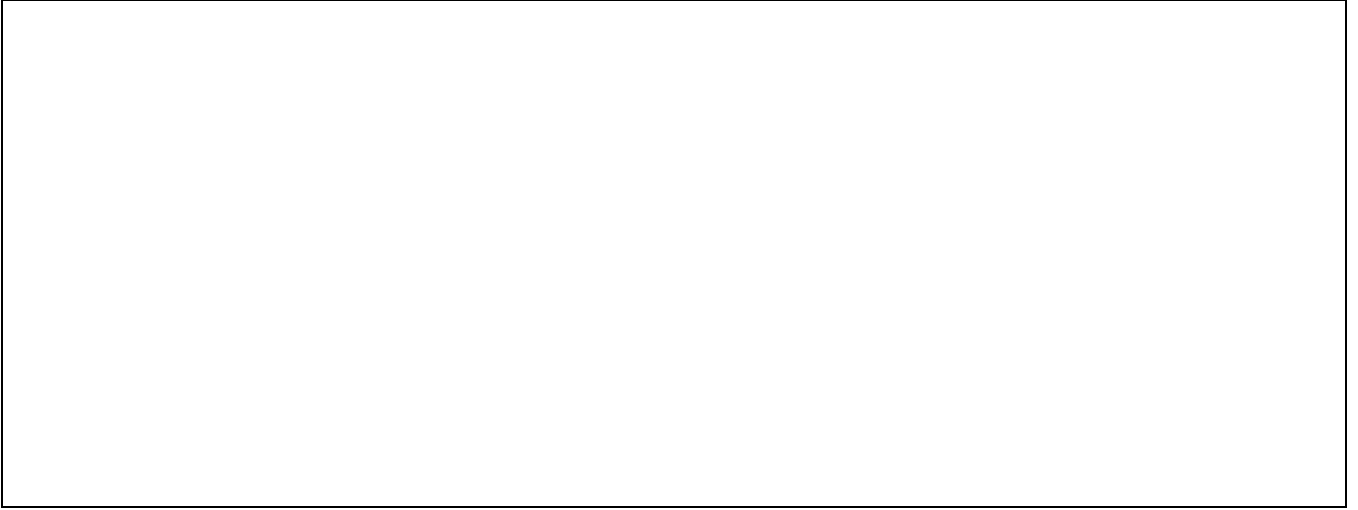
2) UK needs to develop a cross Council/Department process for MOU related research in the funding process

Contact:

3) Identify the UK ERC as a focal point for joint international research and establishment of UK energy Research priorities with an aggressive time table.

Contact:

4) Need single, responsible, high level coordinating group for energy in the UK. Suggested that this should be a cabinet level responsibility, e.g., Department of Energy



**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)**

**ROOM: Lounge
SESSION TIME: 09:15**

Title: LIMITS TO TECHNOLOGY

Summary Paragraph (approx 100-200 words):

Climate/carbon constraints are driving development and adoption of different energy technologies – but we do not know what environmental limits exist to their use or where such limits lie. A precautionary approach suggests we should be concerned about potential limits such as hydrological impacts of biomass crops, impacts of materials supply (eg Cadmium) for PVS, sea- bed and coastal ecological impacts of tidal power, impacts of nuclear waste (amongst others).

Systems interactions are critical. We need to improve scientific understanding of how dynamic limits operate, and interact within natural systems, recognising that there may be a sequence of rate-limiting steps for any given technology and that some technologies are very location specific.

For some technologies – eg marine – knowledge of impacts (and thus of potential limits) is especially limited.

There are consequences for economic and social research agendas.

Convenor: Duncan McLaren

3 Key Actions:

1) Identify relevant systems and technologies experts to assemble a research directory and devise a research agenda (esp NERC?)

Contact: David Howard

2) Set a research agenda for assessing impacts and identifying limits – possibly starting with a cross-disciplinary workshop on system interactions.

Contact: David Howard/Duncan McLaren

3) Establish contacts with relevant economic and social scientists (via ESRC) to ensure that scientific research on limits informs/stimulates economic research on demand management and social research on energy distribution.

Contact: Duncan McLaren/Jim Skea

Meeting the Energy Challenge

PRO-FORMA for Discussion Group (No: ___)

ROOM: 4

SESSION TIME: 11.15am

Title:

LOW-CARBON ECONOMY

Summary Paragraph (approx 100-200 words):

The vision of a low-carbon economy for the UK by 2050 (CO₂ emissions at 60% of 2000 levels) requires more quantification and more detailed assessment of its implications for energy supply and demand. The low-carbon outcome without further policy intervention (e.g. from IT revolution leading to more energy saving) was judged to be unlikely on the scale required, partly because new goods and services will emerge (e.g. plasma TVs, low-cost air travel) that will increase energy use.

A portfolio of policies across sectors will be needed to affect both supply and demand, adopting a portfolio of instruments. Most current policies were seen as not well focussed and not well integrated.

The projections of a low-carbon economy should also consider the effects of major social changes in prospect, such as the ageing population.

Convenor: Terry Barker (not present on Day 3)

3 Key Actions:

1) Further research on use of market mechanisms versus regulation in achieving effective and efficient low-carbon energy use, especially in consumer durables.

Contact: Cathy Mitchell

2) Research into what causes shifts in social perception (such as those seen regarding drink and driving, and smoking) and how may these occur in the climate change area.

Contact: David Shipworth

3) Business school research into a low-carbon business model that makes sense in the absence of a high price of carbon.

Contact: ?

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)**

ROOM: 1

SESSION TIME: 1430

Title: Managing Intermittency

Summary Paragraph (approx 100-200 words):

Most renewable generation is intermittent, but some types are more predictable than others. In the near future wind-generation will be the dominant source of renewable generation in the UK and will be based on large off shore sites. The meeting discussed whether intermittency is really a problem particularly if the sites are distributed around the UK coast-line. Generally it was felt that within mainland GB bulk wind generation plus local CHP and load management and PV could provide a secure and predictable supply up to perhaps 20% of peak demand. The amount of conventional bulk generator (coal and nuclear) will reduce in the next 10 years. This will be replaced by bulk gas, bulk wind generation and local energy sources and demand reduction. The distant future may involve active micro-grids that balance local load and generation plus a back-up energy transport network. This will be achieved by changes in the regulatory structure, greater understanding and availability of diversified renewable energy sources and public acceptance of CHP local storage and active load management. Further work on the balance between local and bulk generation is also required.

Convenor: P.A.Crossley

3 Key Actions:

1) Investigation into the effect on electrical energy supply of different combinations of bulk and local wind, local CHP, storage, load management, tidal, PV and bio-mass

Contact:

2) Studies into the regulatory issues required to ensure adequate investment into the electrical energy system

Contact:

3) Greater understanding required about the balance between local and bulk conventional and renewable generation.

Contact:

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)**

ROOM: 2

SESSION TIME: 10.15-12.15

<p>Title: Network infrastructure</p>
<p>Summary Paragraph (approx 100-200 words):</p> <p>Current performance and historic investment, risk aversion, trading-incentives-regulatory review..... Insufficient innovation to meet challenge.</p> <p>Concern for 5-10 year R&D horizon. Who informing key business decisions? Disjoint short term to long term.</p> <p>Technical solutions required at bulk transmission and local levels for security and quality – plant, protection and control, communications. Radical options to be considered. Commercial sector and housing new-build offer opportunities for implementation. Also important: migration to new infrastructures?</p> <p>Convenor: Graeme Burt</p>
<p>3 Key Actions:</p> <p>1) Requirement for technical coordination (not just administration) of diverse R&D initiatives – DTI/FES, SUPERGEN, DTI Centre, OFGEM, industry. Should be role for ERC (+ENA).</p> <p>Contact: C French</p> <p>2) Research alternative risk/reward business models for network businesses enabling scenario playing inc stakeholders and new players.</p> <p>Contact: ESRC and OFGEM role</p> <p>3) Address technical issues of new network architectures, multiple energy transportation networks and their integration, local network design and operation.</p> <p>Contact: G Burt</p>

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ____)**

ROOM: 6

SESSION TIME: 09:15 – 10:20

Title: New Technologies for Fuel Poverty

Summary Paragraph (approx 100-200 words):

Discussion of world markets/sectors. Largest group with very low energy availability is rural/survival farming.

Second largest group is developing nations (eg China, India). Major thrust is to expand this sector – limited by funding mechanisms. These technologies are largely evolutionary improvements.

Introduction of PV most successful in rural sector.

Convenor: John Stringer

3 Key Actions:

1) Research into modification of export credit systems to support dissemination of clean technologies.

Contact: Duncan McLaren

2)

Contact:

3)

Contact:

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ____)**

ROOM: 3

SESSION TIME: 9.15-11.15

Title: Policy for a low C society

Summary Paragraph (approx 100-200 words):

The problem: Both UK public and government believe that climate change is a problem, but don't take individual responsibility for changing behaviour. Need to set effective targets, even if difficult but as well show and convince people how they can achieve the targets.

Policies – price signals, making low C alternatives cheap and easy.

Put more weight on CO2 savings vs narrow economic criteria.

Education of people, information about CO2 implications when purchases made.

Convenor: J Kohler

3 Key Actions:

1) Increase energy research funding for low-C to 1-5% of energy research market value; by x100 to x1000; identify activities where the UK can be a global leader

Contact:

2) Identify and address subsidies on energy use.

4) Conduct research into a low C integrated transport system

Contact:

3) Generate better public engagement and understanding

Contact:

Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ____)

ROOM: 6

SESSION TIME: 1530

Title: PV Issues
Summary Paragraph (approx 100-200 words): Technical Issues : Cost, Lifetime, performance – absolute and cost biased Diverse and distributed knowledge base exists Need some concentration in topics- relate to SUPERGEN and prioritise Technology is uncertain Convenor: Robin Nicholas
3 Key Actions: 1) Invite prioritisation to supplement broad spread Contact: PV Net SUPERGEN 2) Enhance international collaboration Contact: 3) Contact:

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)**

ROOM:

SESSION TIME:

Title: Resources for R&D
Summary Paragraph (approx 100-200 words): A step change in funding is required if the UK is to take advantage of its strong technological base in energy technology. This should be carefully focussed upon areas where maximum return can be achieved for UK plc This strong technological base has arisen from underpinning basic research. The UK must maintain and strengthen its basic research funding. Convenor: John Irvine
3 Key Actions: 1) Present case to OST for increased RC funding to combat global warming. Contact: 2) Contact: 3) Contact:

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)**

Title: Science Enablers

Summary Paragraph (approx 100-200 words):

Efforts to explore the science enablers led to a discussion of the limitations of the current institutional mechanisms within the U.K. Participants from the US and UK were working from different perspectives. UK currently lacks an effective strategic alignment of research along energy priorities; more basically, has limited articulation of energy priorities, directions and pathways; and lacks a politically empowered organizational entity that could move such a combined, progressive agenda forward. In the absence of these, it was difficult for the group to engage fully on the task at hand, and it was generally felt that to do so would require the resolution of these fundamental issues. Limited discussion of science enablers included materials and nano-science research, fusion and a few others. It was noted that materials research for energy was not receiving the level of attention that it is in the U.S. (in spite of this being a high priority area in the King review) and that the U.S. views this as a critical science enabler of future energy technologies and options. It was also noted that the U.S. was building five nano-science centers with open access for the international community, providing potential high leverage for modest U.K. investments if the U.K were interested. It was also mentioned that materials problems are, perhaps, one of the greatest technological challenges for development of the fusion option. Wave/tidal, fusion, next generation PV, carbon sequestration, and to a lesser extent, wind were areas of general R&D strategic interest and recognizable U.K. strength.

Convenor: Linda Horton, Bob Vallario

3 Key Actions:

- 1) Create a compelling vision of UK scientific research needs for Energy
- Inventory, identify priorities

Contact:

- 2) Create/Improve UK structure for implementing the vision for energy research, programs, and policies
Energy agency? Authority? (a new body, push for new funding, inclusion of non-directed basic research)

Contact:

- 3) Extend the Scientific Advisory Committee (formed for the UK Energy Research Center) to become a standing committee to advise the UK Research Councils broadly on energy research.

Contact:

Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ___)

ROOM: Lounge

SESSION TIME: 10:00 – 12:00

Title: Social Factors/Public Perceptions

Summary Paragraph (approx 100-200 words):

This session addressed two broad topics: individual behaviour and its consequences; and people's perceptions/responses to energy supply options such as renewables. As a general observation, participants emphasised the need for the early engagement of the social sciences in interdisciplinary research, avoiding a "bolt-on" approach to social science within projects.

Individual behaviour

Concern about social equity underpinned much of the discussion in this area. There is much existing work in the social sciences and there is a need to draw this together and learn from it, avoiding duplication of effort. Although there is currently caution about the use of standards to drive energy efficiency, on the whole consumers will accept standards which reflect social norms. There is a need for better understanding of the tension between the use of standards and innovation which may bring longer-term environmental benefits. Conversely, rapid innovation in consumer electronics in the absence of energy standards is leading to rising household energy demand. The importance of the supply side (manufacturers, building trade etc) as well as the actions of individual consumers was emphasised. Market signals are not enough by themselves – habit and routine are key to consumer behaviour and understanding how patterns are formed (and can be broken) is critical. For some participants, market signals which incentivised individual behaviour were essential in order to focus people's minds. There was articulate advocacy in favour of personal carbon credits to cap GHG emissions. These would, in addition, help funnel economic resources towards those on lower incomes. This was balanced by scepticism from several participants and an exploratory, workshop-based approach was recommended.

Perceptions of energy technologies

Much of this discussion related to wind energy, but it was recognised that the area of application was wider. The key challenge was seen to be reconciling top-down national targets (e.g. for renewable energy) with bottom-up, local concerns. Research which investigated decision-making frameworks for doing this was seen to be high-priority. Learning from existing UK initiatives in the field of waste management and radwaste, as well as wider international experience, would help.

There was also a need to research and evaluate the experience of different communities in taking up or re-acting to different kinds of energy projects (e.g. community-based renewables v. commercial development) to understand determinants of buy-in and the value of education. A suggestion to carry out studies on "matched pairs" of communities was seen by some to be impracticable because of the number of uncontrolled variables but at least a systematic approach to evaluation is required.

Convenor: Jim Skea

6! Key Actions:

1) A synthesis of the substantial body of existing social science research regarding individual behaviour aimed at communicating insights to non-social science audiences

Contact: David Shipworth

2) Research on systems of innovation which accounts for the full network of actors, particularly issues relating to the psychology of suppliers (e.g. the building trade).

Contact: RCUK/ESRC

3) Research/evaluation of new initiatives in the provision of energy services

Contact: RCUK/ESRC

4. More systematic evaluation of policy measures and instruments (e.g. the “buyers pack” for house purchasing to help with policy learning

Contact: RCUK with DTI, DEFRA etc.

5. Research on the framework for decision-making where the implementation of top-down national energy/environmental goals (e.g. renewables) needs to respond to bottom-up, local concerns. Drawing lessons from waste/radwaste experience

Contact: RCUK/DTI

6. Workshop on carbon credits v. taxation for incentivising individual behaviour.

Contact: Brenda Boardman

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ____)**

ROOM: 5

SESSION TIME: 1530

Title: Training
Summary Paragraph (approx 100-200 words): Due to the disruptive nature of the new energy technologies there is a critical skills shortage. This is amplified by the shortage of science and engineering graduates. In short term for industrial development there is an urgent need for graduate level researchers. In long term for implementation we need trained technicians (scientifically literate). Convenor: J Irvine
3 Key Actions: 1) More PhD students in relevant areas. Contact: 2) New vocational training schemes to generate a cohort of technicians. Contact: 3) Contact:

**Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ____)**

ROOM: 5

SESSION TIME: 11:00 – 12:00

Title: Viability of Hydrogen

Summary Paragraph (approx 100-200 words):

Hydrogen offers some important routes to CO₂ emissions improvements and the development of a hydrogen economy should be progressed with vigour. There are, however, thermodynamic considerations such as low storage density that mean that the success of the hydrogen economy in its full glory is far from guaranteed.

The main driver for alternative energy carriers such as hydrogen is transport as this equates with 40% of UK energy usage and no direct means of utilising renewable sources is available for transport. Hydrogen only offers 1% of the volumetric energy storage density of liquid fuels such as gasoline. Alternative vectors that may be produced in CO₂ – neutral or renewable means must be fully evaluated in terms of efficiency, cost, full cycle CO₂ analysis. These are liquids or liquefiable gases such as NH₃, synfuel, bio-ethanol, methanol, bio-diesel. If better performance than hydrogen can be demonstrated a new energy economy could be created.

Convenor: John Irvine

3 Key Actions:

1) Evaluation of alternative energy vectors as an alternative to hydrogen

Contact: John Irvine

2)

Contact:

3)

Contact:

Meeting the Energy Challenge
PRO-FORMA for Discussion Group (No: ____)

ROOM: 5

SESSION TIME: 14:30

Title: water resources

Summary Paragraph (approx 100-200 words):

Some regions of the UK already regularly experience water shortages. Predicted climate change is likely to lead to increased water shortages. There is a need to improve water supply for human and agricultural/ horticultural consumption.

Population needs to be better informed of the needs to conserve water.

Desalination plants operate successfully in desert regions and could be used in the UK, but renewable energy sources would need to be used to drive them to be cost effective.

Problems of effective water use in the agricultural and horticultural industries could be addressed by developing crops with improved water use efficiencies. This would require new techniques for effective, simultaneous screening of water loss and carbon gain by crops.

Convenor: Neil Baker

3 Key Actions:

1) Development of programmes to educate the public of the need for water conservation.

Contact:

2) Investigate the possibilities for the use of renewable energy sources to power desalination plants.

Contact: Stephen Salter

3) Encourage development of programmes for improving water use efficiency crops.

Contact: Neil Baker

ANNEX 3
to 'Meeting the Energy Challenge' Conference
Actions and Responsibilities

Ref	Actions	Votes
Actions for UK Government		
1	Work to establish recognized, single responsible high level coordinating Gp for energy in the UK. (Cabinet level responsibility).	21
2	Government policy to keep the nuclear option open – research into what skills/R&D/ capabilities needed.	10
3	Clear Steer from Government on future of coal – given current critical state of generating and other infrastructure including new emerging CO ₂ disposal.	7
4	Raise the profile/awareness of the UK-US MOU across the scientific community.	7
5	Relate energy research funding to energy industry turnover (1-5%) i.e. very large increase.	5
6	'State of the art review' – Energy storage. Electric – chemical Electric – Mechanical Hydrogen Link materials, bio-tech and nano-tech The way forward towards energy storage for R&D.	4
7	Resolve impasse between biomass production and take up by users/conversion groups. Encourage both.	4
8	Explore collaborative activities and training opportunities with US and Europe in advanced fission development, e.g. the GEN IV programme.	3
9	Enable funding for studies into regulatory issues required to ensure adequate investment into electrical energy systems. Regulator (OFGEM) electrical utilities engineering/social sciences economics. Funding – Government DTI.	2
10	Energy Crops – Re-assess and re-evaluate prior research on energy crops to identify research gaps - DEFRA (publish findings widely).	2
11	Demonstration of 'Clean' hydrogen from renewable sources e.g. lighthouse projects.	2
12	Identify, address and rationalise all subsidies and taxes on energy use.	1
13	Energy efficiency. How can UK lead the EU on energy labelling (of products etc) rather than follow?	1
14	Establishment of an annual monitoring process of energy security issues which is independent of government (to include monitoring in the broadest sense from short to long term issues, development of framework for value of diversity, appropriate energy reg, clear responsibilities, analysis of imports/exports and potential future energy mixes.	1
15	Vocational training in new technologies (e.g. technicians).	
16	Establish a research agenda into legal and other mechanisms to make the beneficiaries (of energy use) accountable to the victims (e.g. corporate accountability).	
17	Energy crops – Guarantee market for biomass crops to encourage development.	
18	Energy crops – Advise, encourage and help farmers decide what to grow.	
19	Need for a 'joined up' strategy between government department (e.g. DEFRA and DTI) regarding the issues, barrier and benefits to renewable technology.	
	Ministerial ownership required to force through interdepartmental issues.	
	Public procurement policies need to include environmentally benign technologies to drive innovation and close 'economy of scale' gap.	
20	Enhance/publicize improve UK structure for implementing the vision for energy research programmes/policy.	
21	More systematic evaluation of policy measures/instruments to facilitate policy learning – Action DTI/DEFRA.	

22	Financing R&D – Require OFGEM to take a longer view of cost, and via a small capacity development charge, to support R&D and demonstration projects in the technologies discussed at this meeting (DTI).	
23	CO ₂ capture and storage (CCS) Establish CCS as major strategic theme for energy research linking with DTI proposed carbon abatement technologies programme – DTI with EPSRC.	
24	Encourage (fund) collaboration between economic and social scientists and environmental scientists to link demand management to energy distribution. – Limits to technology.	
25	‘Engage the consumer’ – Programme required to:- Develop low-cost/high-volume renewables for domestic users. As 1 but including energy storage. Link to energy Link to social/economic impact. Action – Invest in a review to develop domestic level engagement.	
26	CO ₂ capture and storage (CCS) – Develop cost effective monitoring and measurement techniques for verification of CO ₂ storage – DTI/Industry.	
27	Development of a programme to educate public of need for water conservation.	
28	Develop a clear process for facilitating links and research funding under the UK-US MOU. DTI	
<i>Actions on Government – Emerging Issues</i>		
29	Consumer education (on c.c)	
30	Accessibility of network data. Give us consistency.	
<i>Actions for the Research Community</i>		
31	Create a compelling vision of UK scientific research needs for energy (shared responsibility with government).	19
32	Synthesise existing social research on human behaviour and communicate insights to non-social scientists – Action – Community.	7
33	Energy efficiency – Convene a workshop on personal carbon quotas. What are they? How could they be used? Benefits in comparison with taxes.	7
34	Economic and technical evaluation of alternative clean energy vectors to hydrogen. E.g. bio-ethanol ammonia.	6
35	Energy from Biological systems. – Research activity on biological systems for bio-energy should be integrated. Using SUPERGEN, UKERC, Provide a forum for exchange of ideas.	6
36	Research into what causes shifts in social perceptions (e.g. drink-driving, smoking) and how may these occur in the climate change area.	4
37	Energy systems modelling – Need for short-term models that look at impact of electricity market on ability of system to deliver security. Recognise that UK system is strongly influenced by geo-political institutional, capital markets and incentives etc – not currently modelled.	3
38	Energy crops – Integrate energy crop research to fundamental plant science research more closely – BBSRC/Community.	1
39	Create a network to showcase visionary energy conservation.	1
40	Fuel Poverty (3 rd world) Research into modifying export credit system to support dissemination of clean technology.	1
41	Raise public awareness of complexity of ‘Hydrogen economy’.	1
42	Scoping study on how public and/or private bodies can be structure to create commercial incentives to change consumer behaviour.	
43	Study of how consumers have responded to energy disruptions around the world and lessons to be learnt for changing behaviour.	

44	Decide if we need an atmospheric 'test tube' with accurate control of temperature, pressure, humidity, droplet size, light, chemicals, dust smoke etc. The original use was to investigate salt crystals for increased cloud albedo.	
45	Workshop on carbon credits/taxes for incentivising individual behaviour.	
46	Increase research into feasible low-C integrated transport systems.	
47	Decide if we need a combined Current/wave tank which could also model hills and wind flows over them.	
48	Investigate the possibilities for use of renewable energy to power desalination plants.	
49	Raise the profile of potential 'mitigation' measures for climate change – such as cloud seeding techniques using salt crystals.	
50	Business school research into a low carbon business model that makes sense in the absence of a high price of carbon.	
51	Masters course needed to upgrade quality of graduates (and make more relevant to industry) – Universities to set up and ask RC to fund places.	
52	Further research on use of market mechanism vs regulation in achieving effective and efficient low carbon energy use, especially in consumer durables.	
Actions on the Research Councils		
53	Diversify basic science research for H ₂ storage – Critical for H ₂ economy. Need a critical mass of research.	8
54	Commit the UKERC as a focal point for joint international research (especially for UK-US MOU). To establish research priorities with an aggressive timetable.	7
55	Water/Crop (energy) – Use latest biotechnologies (not GM) to improve carbon sequestration and water-use efficiency – nitrogen-use efficiency in bio-energy crops. Optimise rather than maximise biological outputs. – Research funding, BBSRC, NERC, DEFRA. – Promote research into more climate-tolerant crops.	5
56	PV Technology – Produce a continuously updated assessment of current state of UK research in international context. Produce UK strategy for future research program combining broad science based innovation with in-depth research in 2/3 areas. Action on UKERC.	4
57	RCs/UKERC – Develop and undertake research theme in 'new market ideal in year 1'.	4
58	Integrated Evaluation – Investigate potential for defining a framework for consistent and comparative evaluation. – Workshop, study group.	3
59	Active technical management of portfolio of projects is needed – provide sector contact for industry to talk to. Action – RC to appoint/pay for professional contacts (UKERC/NERN linkage).	3
60	Energy Crops – Invest in collaboration with USA, Canada on genome sequence of poplar and willow. Develop science resource – BBSRC, NERC.	3
61	Develop a clear process for facilitating links and research funding under the UK- US MOU.	2
62	RCs/NERN – Establish 'techno-econ-socio' forum to facilitate cross-discipline working and model development.	2
63	Fund/organise cross-disciplinary workshops to set the research agenda for impact assessment and identifying limits for different energy technologies. Limits to technology.	2
64	Delivery of 'new market ideal' based on research.	2
65	Network Infrastructure – Technical coordination of diverse R&D initiatives. Special concern for 5-10 year horizon and key business decisions. Role for ERC.	1
66	Research decision-making frameworks for implementing national goals/interaction with bottom-up/local concerns. – Action ESRC.	1
67	Support fundamental R&D e.g. for H ₂ storage and regulatory incentives.	1
68	Ensure supply of trained manpower for fuel cell development.	
69	Transport and UKERC – Requires coordination and agenda guidance – may be a national centre linked to transport or part of UKERC.	

70	Establish research theme, workshops to establish governance structures which are transparent, trusted and accountable.	
71	Research on 'systems of innovation' which accounts for all players, including suppliers. – Action ESRC.	
72	Raise the profile/awareness of the UK-US MOU across the science (RCs) community.	
73	CO ₂ capture and storage (CCS) Instigate proactive approach to ensure greater sharing/pooling of information. Possibly leading to joint projects e.g. UK/US MOU – EC, EPSRC, DTI, US DOE.	
74	Studies into greater understanding of technical/social issues of local vs bulk and renewable vs conv vs storage or mixtures. 10-20 years timescale. Lead Research councils/government.	
75	Establishing a research agenda into educational and market tools to incorporate justice concerns into purchasing decisions.	
76	New initiative to promote 'electron-2-electron' energy storage – improve efficiency and cost – Bring pure science and engineering community to meet common goal – EPSRC action.	
77	Develop technical structure to quantify and give credit for non-cash elements e.g. security of supply.	
78	Professional managers (with technical training) required to manage large multi-university projects. Actions – RCs to change procedures and culture to fund such professional managers and 'encourage' universities to appoint such managers.	
79	Develop a research directory (NERN?) linking environmental issues, energy technologies and individuals/groups. Limits to technology.	
80	Present case to OST for increased RC funding to combat global warming.	
81	Develop fair comparative manner for assessing all generation tech' as part of mixed energy economy.	
82	RCs UKERC Research Group – Establish a research theme/call which looks at how governments decide policies/establish institutions/include and confront interests.	
83	Extend scie.Adv.Comm (formed for UKERC) to become a standing comm. To advise Research Councils (plus other funders) broadly on energy research.)	
84	Postgraduate training in new technologies.	
Actions for Industry		
85	Fuel cell cost reduction programme.	4
86	Research into how to make marketing give priority to energy efficiency and climate impacts.	2
Actions for Partnership Working		
87	Work with the US and Europe to develop the advanced materials required both for fusion and advanced fission (Culham, Universities, and US).	15
88	Work with the US and Europe to develop in detail a planning time-line for fusion energy development, arriving at a prototype reactor operating in 25 years.	8
89	Research and Government – Develop active method and links to bring £1bn of private money into technology development within 2 years.	6
90	For fossil fuels :- Invent, develop better methods for neutralising or capturing SO ₂ , NO _x , CO ₂ . Make CO ₂ disposal work. (RCs, academe, industry).	5
91	Energy crops – Integrate interests of biomass produces and industrial users to provide sound basis for development.	4
92	Network Infrastructure – Research and deliver innovation in network architectures and network management for bulk power transportation (including potential 'European grid') and for local power distribution. Partnership: Industry, Universities, Government (UK&EU).	4
93	Energy crops – Biomass crop production must be optimised not maximised. – Linked to research council initiative/point).	3
94	Network Infrastructure – Research alternative risk/reward models for network	3

	business in relation especially to new generation and network infrastructure – ESRC & OFGEM.	
95	For fossil fuels :- Invent, develop new extraction methods using e.g. well technology from oil industry. Nb. Produce chemicals as well as energy (RCs, Academe, Industry).	2
96	Explore collaborative activities and training opportunities with US and Europe in advanced fission development e.g the Gen IV programme (UK Gov. Industry, Research Councils Academia.)	2
97	Energy Crops – Define biomass crop quality characteristics.	1
98	Programme/Calls on the investigation into the effect on electrical energy supply of different combinations of bulk and local wind, CMP, storage, load management, tidal etc and distribution/transmission industries. Interest: Universities, Electrical Utilities, renewable gens, Research Councils – Simulation studies.	1
99	Evaluate new initiatives in provision of energy services. – Action ESRC/DTI/OFGEM.	
100	Big opportunities for modelling of fundamental tech. change through International collaboration.	
101	Research into the necessary regime of property rights to underpin a global regime of 'contraction and convergence'.	
102	Joint working to bring new techniques into energy systems modelling that will improve 'quality'/uncertainty. E.g. behavioural models into economic analysis of electricity markets and new technology introduction.	
103	UK/US collaboration on climate change data gathering and modelling – especially changes to north Atlantic drift (aim to engage public opinion worldwide with real examples of climate change.	
104	Biomass and bio-energy glossary of terms (S-Gen B&B).	
Actions for Partnership Working – Emerging issues		
105	Biomass scientists – producers – users.	

Responsibilities for Actions

Ref	Category	Action for the Research Councils	Reference to Others	TSEC	UKERC	EPSRC	NERC	ESRC	BBSRC	DTI	DEFRA	OFGEM	DFID	OST	HLEG	Carbon Trust	Cogent Plus	UKWIR	Tyndal Centre	DfT
1	Government	None	Refer to High Level Energy Group for response	No	No	No	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No
2	Government	Feed into the developing TSEC and EPSRC KNOO programme	DTI for response	Yes	No	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No
3	Government	Feed into the TSEC, EPSRC and NERC developing programme on Carbon Sequestration and to UKERC for the research and/or networking programme	DTI for response	Yes	Yes	Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No
4	Government	Research Councils and UKERC to publicise the opportunities available through the MoU	DTI for action	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No
5	Government	Research Councils have submitted a bid for extension and expansion of TSEC in SR2004	OST for information	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No
6	Government	Feed into the developing SUPERGEN Consortium and to UKERC for the research and/or networking programme	DTI for response	No	Yes	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No
7	Government	Feed into the developing TSEC, EPSRC & BBSRC biomass/biofuels activities and refer to the SUPERGEN Consortium and UKERC for their research and/or networking activities	DTI/DEFRA for response	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No
8	Government	Explore further under the US/UK MoU and feed into EPSRC input to the developing UK and EURATOM fusion programme priorities. EPSRC has submitted a bid to SR2004 for expansion of UK fusion R&D	DTI & OST for information	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	No	No	No
9	Government	Feed into the programme of SUPERGEN Future Networks and to inform the development of SUPERGEN infrastructure Consortium. Also feed into developing TSEC and UKERC programme and/or networking.	DTI & OFGEM for information/response	Yes	No	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No
10	Government	See 7	See 7	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No
11	Government	Feed into SUPERGEN & TSEC future activities. Identified as a possible area for further funding under Carbon Vision	DTI for response	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
12	Government	Input to ESRC and TSEC developing	DTI & DEFRA for	Yes	No	No	No	Yes	No	Yes	Yes	No	No	No	No	No	No	No	No	No

		programme	response																	
13	Government	Input to ESRC, TSEC and Carbon Vision developing programme	DTI & DEFRA for response	Yes	No	Yes	No	Yes	No	Yes	Yes	No	No	No	No	No	No	No	No	No
14	Government	Input to ESRC, EPSRC and TSEC developing programme and to UKERC programme and/or networking	DTI & OFGEM for information/response	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	No	No	No	No	No	No	No	No
15	Government	Included as a priority areas for EPSRC Collaborative Training Accounts. Input to the TSEC developing programme.	DTI & Cogent Plus for response	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
16	Government	Input to ESRC and TSEC developing programme and to UKERC research and/or networking activities	DTI & DEFRA for information & response	Yes	Yes	No	No	Yes	No	Yes	Yes	No	No	No	No	No	No	No	No	No
17	Government	Input to BBSRC, EPSRC and TSEC developing programme	DTI & DEFRA for response	Yes	No	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No
18	Government	See 17	See 17	Yes	No	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No
19	Government	Input to TSEC developing programme and to UKERC research and/or networking activities	DTI for response	Yes	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No
20	Government	UKERC to consider for action	Refer to High Level Energy Group for response	No	Yes	No	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No
21	Government	Input to TSEC developing programme and to UKERC research and/or networking activities	DTI & DEFRA for response	Yes	Yes	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No
22	Government	Input to SUPERGEN and TSEC developing programme and to UKERC research and/or networking activities	DTI & OFGEM for information/response	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No
23	Government	Input to NERC, EPSRC and TSEC developing programme and to UKERC research and/or networking activities	DTI for response	Yes	Yes	Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No
24	Government	Input to NERC, ESRC and TSEC developing programme and to UKERC research and/or networking activities	DTI for information	Yes	Yes	No	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No
25	Government	Input to ESRC, EPSRC and TSEC developing programme and to UKERC programme and/or networking	DTI & DEFRA for response	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No	No	No	No	No	No	No	No	No
26	Government	See 23	See 23	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No
27	Government	Input to ESRC developing programme. Research Councils (NERC leading) have submitted a spending review bid on Water Management to SR2004	DEFRA & UKWIR for response & OST for information	No	No	Yes	Yes	No	No	No	No	No	No	Yes	No	No	No	Yes	No	No
28	Government	Feed into Research Councils research activities	DTI for response	No	No	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No

29	Government	Feed into Research Council's public engagement activities and refer to Tyndal Centre	DEFRA for response	No	No	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No
30	Government	Refer to SUPERGEN Future Networks Consortium and UKERC for research and/or networking activities	DTI, OFGEM and industry for response	No	Yes	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No
31	Research Community	UKERC to consider for action	Refer to High Level Energy Group for information	No	Yes	No	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No
32	Research Community	UKERC to consider for action. Feed into developing TSEC and UKERC research and/or networking activities		Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
33	Research Community	UKERC to consider for action	DEFRA for information	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No
34	Research Community	Identified as a possible area for funding under Carbon Vision.	DTI for information	No	No	Yes	No	No	No	Yes	No	No	No	No	No	Yes	No	No	No	No
35	Research Community	Included as a priority area (biological fuel cells) in SUPERGEN. Feed into EPSRC, BBSRC and TSEC developing programme and to UKERC for research and/or networking activities	DTI for information	Yes	Yes	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No
36	Research Community	Refer to Tyndal Centre for research and/or networking activities	DEFRA for information	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	Yes	No
37	Research Community	Feed into EPSRC and TSEC developing programme. Refer to SUPERGEN Future Networks Consortium and UKERC for research and/or networking activities	DTI and OFGEM for information	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No
38	Research Community	Feed into BBSRC and TSEC developing programme	DEFRA for information	Yes	No	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No
39	Research Community	UKERC to consider for action	Carbon Trust for information or action	No	Yes	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No
40	Research Community	Feed into ESRC and TSEC developing programme	DFID for response	Yes	No	No	No	Yes	No	No	No	No	Yes	No	No	No	No	No	No	No
41	Research Community	Refer to UKERC and SUPERGEN Hydrogen Consortium to consider for action	DTI for information	No	Yes	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No
42	Research Community	Feed into ESRC developing programme		No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
43	Research Community	Feed into ESRC and TSEC developing programme		Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
44	Research Community	Feed into NERC developing programme		No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
46	Research Community	Refer to TSEC and UKERC for action	DTI and DEFRA for information	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

47	Research Community	Feed in NERC and EPSRC developing programme		No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
48	Research Community	Feed into EPSRC developing programme		No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
49	Research Community	Feed in NERC and EPSRC developing programme		No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
50	Research Community	Feed into ESRC and TSEC developing programme and refer to UKERC for research and/or networking activities		Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
51	Research Community	Included as a priority in EPSRC CTA Programme		No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
52	Research Community	Feed into ESRC and TSEC developing programme and refer to UKERC for research and/or networking activities		Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
53	Research Councils	Feed into EPSRC and TSEC developing programme.		Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
54	Research Councils	Refer to UKERC for action		No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
55	Research Councils	Feed into BBSRC, NERC, TSEC and RELU developing programme	DEFRA for information and action	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No
56	Research Councils	Refer to UKERC and SUPERGEN PV Consortia for action	DTI for information	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
57	Research Councils	Feed into ESRC and TSEC developing programme. Refer to UKERC for action		Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
58	Research Councils	Refer to UKERC for research and/or networking activities		No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
59	Research Councils	Refer to UKERC for action		No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
60	Research Councils	See 55	See 55	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No
61	Research Councils	Research Councils for action	DTI for action	No	No	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No
62	Research Councils	Feed into TSEC developing programme. Refer to UKERC for action		Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
63	Research Councils	Feed into TSEC developing programme. Refer to UKERC for action		Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
64	Research Councils	Feed into TSEC developing programme. Refer to UKERC for research and/or networking activities		Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
65	Research Councils	See 9	See 9	Yes	No	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No

66	Research Councils	Feed into ESRC and TSEC developing programme.		Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
67	Research Councils	Feed into EPSRC, NERC, ESRC, BBSRC and TSEC developing programmes. Research Councils have submitted a bid for extension and expansion of TSEC in SR2004	OST for information	Yes	No	Yes	Yes	Yes	Yes	No	No	No	No	Yes	No	No	No	No	No	No
68	Research Councils	Included as a priority areas for EPSRC Collaborative Training Accounts. Input to the SUPERGEN Fuel Cells and Biological Fuel Cells developing activities		No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
69	Research Councils	Feed into EPSRC and TSEC developing programme and to UKERC for research and/or networking activities	Refer to DTI and DfT for information	Yes	Yes	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No
70	Research Councils	Feed into TSEC developing programme. Refer to UKERC for action		Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes
71	Research Councils	Feed into ESRC, EPSRC and TSEC developing programme. Refer to UKERC for action		Yes	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
72	Research Councils	Research Councils for action	DTI for action	No	No	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No
73	Research Councils	Feed into the developing thinking in TSEC on Carbon Sequestration and to UKERC for the research and/or networking programme	DTI for information and action	Yes	Yes	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No
74	Research Councils	Feed into EPSRC and TSEC developing programme. Refer to SUPERGEN Future Networks and Distributed Technology Consortia and UKERC for research and/or networking activities	DTI & OFGEM for information/response	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No
75	Research Councils	Feed into ESRC and TSEC developing programme and to UKERC for research and/or networking activities		Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
76	Research Councils	Feed into EPSRC developing programme and to SUPERGEN Energy Storage Consortium for action		No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
77	Research Councils	Feed into EPSRC and TSEC developing programme and to UKERC for research and/or networking activities	DTI & OFGEM for information/response	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No
78	Research Councils	Research Councils to action		No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No
79	Research Councils	Refer to UKERC for action		No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

80	Research Councils	Research Councils have submitted a bid for extension and expansion of TSEC in SR2004	OST for information	No	No	Yes	Yes	Yes	Yes	No	No	No	No	Yes	No	No	No	No	No	No
81	Research Councils	Feed into EPSRC and TSEC developing programme and to UKERC for research and/or networking activities	DTI & OFGEM for information/response	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No
82	Research Councils	Feed into ESRC and TSEC developing programme and to UKERC for research and/or networking activities		Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
83	Research Councils	Research Councils to consider for action		No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No
84	Research Councils	Included as a priority areas for EPSRC Collaborative Training Accounts.		No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
85	Industry	Input to SUPERGEN Fuel Cells and Biological Fuel Cells Consortia	Industry for information and action	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
86	Industry	Feed into ESRC and TSEC developing programme and to UKERC for research and/or networking activities	Industry for information and action	Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
87	Partnership Working	See 8	See 8	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	No	No	No
88	Partnership Working	See 8	See 8	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	No	No	No
89	Partnership Working	Research Councils to consider	DTI for response	No	No	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No
90	Partnership Working	Feed into the developing thinking in TSEC on Carbon Sequestration and to UKERC for the research and/or networking programme	DTI for information and action	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
91	Partnership Working	See 7	See 7	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No
92	Partnership Working	Feed into the programme of SUPERGEN Future Networks and to inform the development of SUPERGEN infrastructure Consortium. Also feed into developing TSEC and UKERC research and/or networking activities.	DTI & OFGEM for information/response	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No
93	Partnership Working	See 7	See 7	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No
94	Partnership Working	Feed into the ESRC and SUPERGEN Future Networks / Infrastructure Consortium. Also feed into developing TSEC and UKERC research and/or networking activities.	DTI & OFGEM for information/response	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	No	No	No	No	No	No	No	No

95	Partnership Working	Feed in NERC and EPSRC developing programme	DTI for information	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
96	Partnership Working	Feed into the developing EPSRC KNOO and TSEC Programme	DTI for information and response	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
97	Partnership Working	See 7	See 7	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No
98	Partnership Working	Feed into the SUPERGEN Future Networks / Distributed Technology & Infrastructure Consortia. Also feed into developing TSEC and UKERC research and/or networking activities.	DTI, OFGEM and industry for response	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No
99	Partnership Working	Feed into the ESRC and SUPERGEN Future Networks / Infrastructure Consortium. Also feed into developing TSEC and UKERC research and/or networking activities.	DTI & OFGEM for information/response	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No
100	Partnership Working	Refer to UKERC for consideration		No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
101	Partnership Working	Feed into ESRC and TSEC developing programme and to UKERC for research and/or networking activities		Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
102	Partnership Working	Feed into the ESRC and SUPERGEN Future Networks / Infrastructure Consortium. Also feed into developing TSEC and UKERC research and/or networking activities.	DTI & OFGEM for information/response	Yes	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
103	Partnership Working	Feed into NERC and Tyndal Centre developing programme		No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
104	Partnership Working	See 7	See 7	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No
105	Partnership Working	See 7	See 7	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No

ANNEX 4
to 'Meeting the Energy Challenge' Conference
Exit Questionnaire

EXIT QUESTIONNAIRE

39 questionnaires were returned.

1. How satisfied were you with the following?

	Very Satisfied	Satisfied	Dissatisfied	Very Dissatisfied
Pre-event organisation	34%	63%	3%	
Organisation at the event	55%	45%		
“Open space” approach	34%	63%	3%	
Venue	89%	11%		

Comments:

- An excellent meeting.
- Excellent idea, was sceptical but..... it worked!
- Very interesting and stimulating meeting, certainly worthwhile.

Delegates

- Under-representation of microbiologists viz micro-algae and diatoms research.
- Not sure how representative delegate invitation lists were – some technical areas had minimal representation.
- Valuable for bringing a broad mix of people (who would otherwise not have met) together.x3
- It would perhaps be better to ensure a complete mix of delegates with higher industry and UK government input.
- Not clear how the original invitation list was developed.

Pre-event.

- Would have liked a delegate list beforehand.
- It was not clear to me what I needed to prepare before coming to the event eg viewgraphs.
- Some more details on the open space concept would have been helpful, particularly to prepare for “Setting the Agenda” session.
- More background information pre-event x2

Open space

- Open space empowered discussion and made exchange of ideas/opportunities better.
- The open space approach worked well.x3
- I would agree with 1.5 hour slots.x3
- It would have been useful to constrain discussion and specifically say actions (on named bodies) were to be generated.
- The open space was an interesting approach but may have been too structured in issues. It certainly encouraged contribution and effort. Output important.
- Useful opportunity to cover multidisciplinary issues. However wanted a little more context over the reasons for the conference and what happens afterwards.

- Convenors need 30 minutes to write up results.
- Explanations of requirements (cards, procedures etc) not very clear.
- Outcomes are critical, if poor we have wasted a lot of time, track record of such events is poor.
- Surprisingly there were less “out of the box” ideas than I was expecting. In hindsight some important areas were missed.
- Some open-space activities resulted in “vested interest” taking control.
- Interesting approach but in some cases I felt that the groups lacked relevant expertise and/or factual information upon which to base their judgements.
- Perhaps more careful scheduling of parallel sessions.

2. How satisfied were you with the various sessions?

	Very Satisfied	Satisfied	Dissatisfied	Very dissatisfied
Setting the agenda	24%	76%		
Break out groups	36%	59%	5%	
Action generation	16%	70%	14%	

Comments:

- As a non-energy expert I felt that I needed more information on technical aspects of the problems before I could really contribute in evaluation of technical barriers and options.
- Community/background not taken account of so dependent on individual distribution of delegates.
- The approach obliged delegates to participate actively and forced them to think about the process and the issues.

Setting the agenda session

- Useful in bringing out the key topics for break out groups
- Good range of talks.
- Little too disorganised and rather too long.x2
- People were reluctant to volunteer to be convenors but would have obeyed a direct order.

Break out groups

- I would have liked to have participated in more break-out groups. As it was each subject group paddled their own cause with insufficient awareness of the overall picture and critical comments from those in other fields.
- Absence of perhaps the UK leaders in several areas resulting in break-out group discussions that seemed uninformed in several sessions I attended.
- Missing key contributors due to clashes of timing.
- Worked well but the self selection process may have stopped really creative ideas from emerging.

- Important to brief convenors to get actions agreed during meeting – mechanism to ensure group agreed with summary and actions – some seemed to be written entirely by one person.
- More time needed in some cases.
- Would have been better to be for 1.5 hours ie 4 total as 6 got a bit mind blowing.x2
- Could have been longer and having neutral facilitators may have helped stop some chairs driving the session on their personal agendas.
- Need better chairing – too much broad chat and not enough focus on actions/recommendations.

Action generation session

- Less useful unless clustering of similar areas was possible.
- The weakest session.
- Too many potential actions.
- Many participants had left so suffered x2 also voting very skewed.
- Clear outcomes should be quickly available.x2
- More time was needed from prioritisation (which could only have been done properly on the basis of a written text and adequate time – eg off-line after the meeting?).
- Important not to lose the lower priority actions. A complex field needs complex situations.

3. The event had the following objectives:

- Discuss and identify long term R&D issues to meet the challenges of energy research across all basic disciplines considering the recommendations highlighted by the UK Chief Scientific Advisor’s Energy Research Review Group and the DOE report from the Basic Sciences Advisory Committee.
- Contribute to the agenda for the proposed UK national Energy Research Network.
- Explore opportunities for UK/US collaboration.
- Expand the research community active in energy research (longer term objective).

How well do you think these objectives were achieved?

Fully	Mostly	Partially	Not at all
3%	60%	38%	

Comments

- The exploration aspect was best.
- DoE report was unknown to majority of participants, so great opportunity was lost for joint agenda setting.
- US links needed communicating more before the meeting.
- Useful information provided in advance by US colleagues. Need equivalent for UK.
- Insufficient information on the UKERN proposal and agenda.

- The meeting certainly flagged up the need for an effective UKERC and would have expanded academic interest in energy. As to identifying new R&D areas it is less clear it did that.
 - Minimal discussion of Chief Scientists Groups rec and only late mention of US agenda; therefore little opportunity to define UK/US collaboration.
 - The 4 objectives did not map well onto the group topics actually adopted.
 - The discussions were largely focused on item 1.x2
 - Discussions were not particularly targeted towards meeting the objectives – maybe open space is not the right way to meet those objectives.x2
 - Not clear how the 3rd part was met.
 - The discussions were a little too general for my taste, but the objectives were of this nature.
 - There was a marked bias against fission, and very little discussion on European collaboration. A French perspective would have been interesting – especially if their nuclear plant has to cope with others’ wind intermittency.
 - Worrying aspect is “ageing” of many parts of the UK “Energy Technology” across many sectors.
 - Pleased that all energy technologies covered and the common themes and issues in all areas.
 - The extent of sectoral balance was not clear – some disciplines were well represented and some not, potentially leading to unbalanced result x3
 - I am doubtful that anything will be achieved because the EPSRC is using the outputs, not the scientists, engineers and social scientists in marked contrast to the US approach as described by John Stringer, where the inter-disciplinary research team, not government bureaucrats, ran the effort. I am pessimistic.
 - Not enough time to do this cf the US method.
 - Not convinced all issues identified.
 - Most conclusions arrived at before fully discussed.
 - Needs follow-on x2
 - How will the outcome be used to explore UK/US collaborations?
4. Please also give any other comments you have about the conference and/or energy research challenges not covered elsewhere.

Attendees

- The format suffered considerably from a high-proportion of part-time participants.
- Lacking industry/government/regulator active input.
- Junior/mid-career research staff could have had a bigger role. Senior staff may be set in their ways and “game plan” key actions. X2
- Good to have the Americans. Perhaps the Japanese should be invited in future as there are several EPSRC-Japan links in energy.
- Needs more industry people. BP was excellent.

Comments on event

- Congratulations on attempting an ambitious project.
- Very interesting and thought provoking.
- Keeping it within 2 full days would have been easier.
- We did not know the US were participating and/or about the MOU. Was it a good idea to combine the 2 objectives?

- I liked the open space approach – allowed open discussion.
- More questions in lectures – open discussion.
- Generally very good speakers, but those on the last day had too little impact – move them earlier.
- The lecture by Andrew Garrad was particularly informative as well as entertaining.
- More woman speakers.
- Possibly too many people at times – jostling.
- The meeting showed that there are a huge number of myths and misconceptions by different communities relative to others.
- Overall it was worthwhile; I learnt a lot about the concerns of other disciplines.

Outputs

- The background information said that we would receive a written record of the discussions and recommendations.. before the conference closes. Perhaps this was a bit ambitious!
- Do not believe this has bottomed out the key issues and to do so need further discussions with key participants.
- The proof of pudding will be in results, how many actions are delivered.
- Important to set the context of the conference – what happens next.
- Action plan is essential to know how to take things forward – will this group/conference be required to meet again?
- Now that group knows itself, reconvene it and build on their new awareness.
- Engagement of stakeholders?
- Coordination of actions in key areas.
- Major problem will be the follow-on. I would suggest that you identify champions for the areas discussed to try and pull things together.
- Inadequate funding the real issue x2
- The idea that the UK could produce “light house projects” eg the hydrogen spine from Teesside to London was excellent. Great motivator.
- The approach used by the US to specify research topics/agenda had much to commend it – perhaps a similar method should be used in the UK.
- I look forward to reading the report and participating in future energy research.

UK Energy Research Centre (UKERC)

- Let’s make sure UKERC has a clear and functional structure that can deliver a national research strategy in energy – we clearly need one.
- Need this event to happen regularly under the auspices of UKERC.x2