

## **Research Councils UK Energy Programme: End-use Energy Demand**

**Workshop Report Date:** 23 March 2011

**Venue:** Montague on the Gardens, London, WC1B 5BJ

### **Summary and Main Conclusions**

This was a one day workshop to help plan the Research Councils UK Energy Programme's research agenda in end-use energy demand (EUED). The main purpose of the workshop was to examine the research gaps, possible synergies and needs and provide advice on what research is required and what might be the best mechanisms to support the research.

There were 50 attendees from a broad range of organisations most attendees were from academic institutions but there were representatives from industry, charitable organisations and government departments

The workshop included keynote speeches and presentations on the current research portfolio and the recent international review which were intended to promote discussions in two breakout sessions. The breakout sessions were aimed at helping to answer the questions:

- What research do we need in EUED?
- How should the Energy Programme spend its budget for EUED?

To help answer the first question the attendees were split into six themes: Buildings, Transport, Industry, Digital Economy/ICT, Whole Systems and Social Sciences.

Importance vs Capability diagrams for each of the themes are recorded on separate pages in this report.

Important research areas that were seen as growing in importance and requiring increased capability are:

- Social behaviour at the individual, group and macro (economic) level and the need for technological research to take this into account.
- The need for a 'whole systems' approach because of complex interaction between sectors and the use of transitional pathway analysis to help define the role of research at each phase of transition to a low carbon economy
- The use of ICT in increasing operability, control and visibility which was also a theme that appeared across the groups as increasing in importance and needing capability increases.
- The storage, transmission and upgrading of heat and developments in basic materials science and chemistry to support the technological improvements needed.

For the second question attendees were divided into six groups with a broad mix of expertise. A summary of the outputs from these groups is given below.

There was strong support at the workshop for a coordinated programme of research in End-use Energy Demand.

The favoured mechanism to support research in the programme was the formation of interdisciplinary research hubs. Important features of the hubs should be:

- A mechanism to include researchers outside the hubs who had niche expertise
- Encouragement of new research approaches.
- The research hubs needed to be truly interdisciplinary and include social sciences (behavioural, economic and policy research) as well as engineering and physical sciences.

The programme required a central guiding objective focused on outcomes of research, such as ‘tons of Green House Gas reduced’ rather than on sectoral and discipline issues. Societal and sustainability objectives such as intra-generational justice and respect for nature and biodiversity should not be forgotten.

A high level networking facility was required to facilitate public engagement, interaction with users and promote any synergies between research projects.

A strong message from the meeting was that funders, government departments and academics working in the energy area should be seen to set an example in reducing energy use. For example, in the case of workshops such as this, better planning of venues and geographical location, possible use of regional workshops and electronic engagement should be considered.

## **1.0 Introduction**

The UK is committed to reducing greenhouse gas emissions in the UK by at least 80% by 2050, relative to 1990 levels. The Research Councils UK Energy Programme aims to help position the UK to meet these, and other energy and environmental targets and policy goals, through world-class research and training. In order to meet these targets the UK will, in addition to decarbonising the energy supply, have to significantly reduce its energy consumption.

The Energy Programme has made substantial investments in research into energy efficiency/demand reduction. The current portfolio splits into three areas: buildings, industry, and transport.

The splitting of the portfolio into these categories has been useful in the past as it has enabled the appropriate research communities to concentrate on the most promising research avenues to reduce energy consumption. It has not however encouraged the identification of common approaches and issues across and at the boundaries of the disciplines. Buildings and transport research has been predominantly socio-technical in nature with little research on policy while the industrial research has been mostly technical with little research on societal aspects.

In order to begin to guide the future investment in energy demand research supported through the Energy Programme a small expert group was convened to give advice on a suitable methodology.

The first recommendation of the group was to get a better definition of what was meant by Energy Demand Reduction. It was agreed that the topic was better described by the title:

### **'End-use Energy Demand'**

This embraces energy efficiency measures, reduction in demand for energy, and reduction in demand for energy services / mobility - all of which will contribute to reducing carbon emissions from energy use. It includes research extending from the built environment to industrial processes and products, from materials to design and from markets and regulation to organisational and individual behaviour.

The group also suggested that the research challenges might lie at the boundaries of the traditional divisions and pointed out that it is people who use energy and that three-quarters of UK emissions come from household consumption, including direct emissions (associated with energy used in the home and for personal travel) and indirect emissions (embedded emissions used to produce, transport and disposal of goods). This might suggest a different way of looking at research into end-use energy demand. There are other views on how best to understand the complex real world problem of end-use energy demand and a large number of studies and reviews have been published in the last few years.

The main purpose of this workshop was to examine the research gaps, possible synergies and needs and provide advice on what research is required and what might be the best mechanisms to support the research.

The objectives of the workshop were:

- To define the shape of the future portfolio to ensure that it contributed appropriately towards the objectives of the Energy programme.
- To define the means by which the desired portfolio might be achieved.
- To allow networking and research community building to take place.

## **2.0 Workshop Process**

### **2.1 Pre Workshop**

A call for Expressions of Interest (EOIs) to attend the workshop was issued in January 2011 with the intention of inviting about 50 people to the workshop from a range of institutions with a broad discipline base in order to get as wide a view as possible. Institutions were asked to liaise internally and submit only one EOI to try and limit the numbers applying, despite this 130 EOIs were received which were sifted by a panel with representatives from EPSRC and ESRC to give 50 attendees. A list of the attendees is given in Appendix 1.

### **2.2 Workshop**

The workshop agenda is given in Appendix 2. The main activities were:

#### **Keynote presentations:**

*Professor Geoff Hammond (Bath):* 'The role of end-use energy demand reduction in transition pathways to a UK low carbon future'

*Professor Kevin Anderson (Manchester):* 'Quantifying the challenge: what role for energy demand in a low-carbon transition'

Presentations on the recent RCUK International Review of UK Energy Research and on the current EUED portfolio.

#### **Breakout Sessions:**

Two breakout sessions were held to contribute to answering the questions:

- What research do we need in EUED?
- How should the Energy Programme spend its budget for EUED?

The morning breakouts were intended to help answer the first question. The attendees were assigned to specific themes and a Research Council Facilitator assigned to each group, the themes with the RC facilitators were

Buildings (Chris White)

Transport (Nick Cook)

Industry (Dave Holtum)

Economics/Policy/Legislation/People (Owen Dowsett and Paul Rouse)

Digital Economy (DE)/ICT (Hannah Foreman)

Whole Systems (Jacqui Williams)

The process in the Breakouts was as follows:

*What research do we need in EUED?*

Identifying research components required.

Plotting the research components onto Relative Importance V Relative Capability diagrams both for how this was perceived at present and for the future desired position. The axes were defined as follows:

Relative Importance (Y axis): Alignment to government strategy, Impact, Research gap, market etc.

Relative Capability (X axis): International standing of research, size of existing groups, and number of research grants, training ability etc.

The Importance V Capability diagrams were then scrutinised by representatives from other groups and appropriate adjustments made.

*How should the Energy Programme spend its budget for EUED?*

The attendees were allocated to 6 groups with as broad a mix of disciplines as possible and asked to address the question:

How would you commit £ 40 million over the next 4 years in end-use energy demand?

To do this the desired features of the overall activity were identified and then the type of mechanism with some idea of the proportion of funding to be assigned to each activity area derived.

The outputs from the breakout sessions are given in the next two sections.

### **3.0 Breakout Sessions Outputs Research Themes.**

Importance V Capability diagrams for each of the groups are recorded on separate pages in the following section. The following is a brief summary of the main conclusions.

Overall the research theme that was most frequently mentioned was social behaviour and this was most often seen as the theme that would increase in importance in the future and required the greatest increase in capability.

The use of ICT in increasing operability, control, visibility was also a theme that appeared across the groups as increasing in importance and needing capability increases.

In buildings policy delivery, operability and improving existing stock were major themes. Underlying this, improvements in technology, management and understanding of social behaviour were seen as being areas to emphasise. It was thought that the capability existed to use the existing evidence base to inform the other themes but that this would become more important in the future.

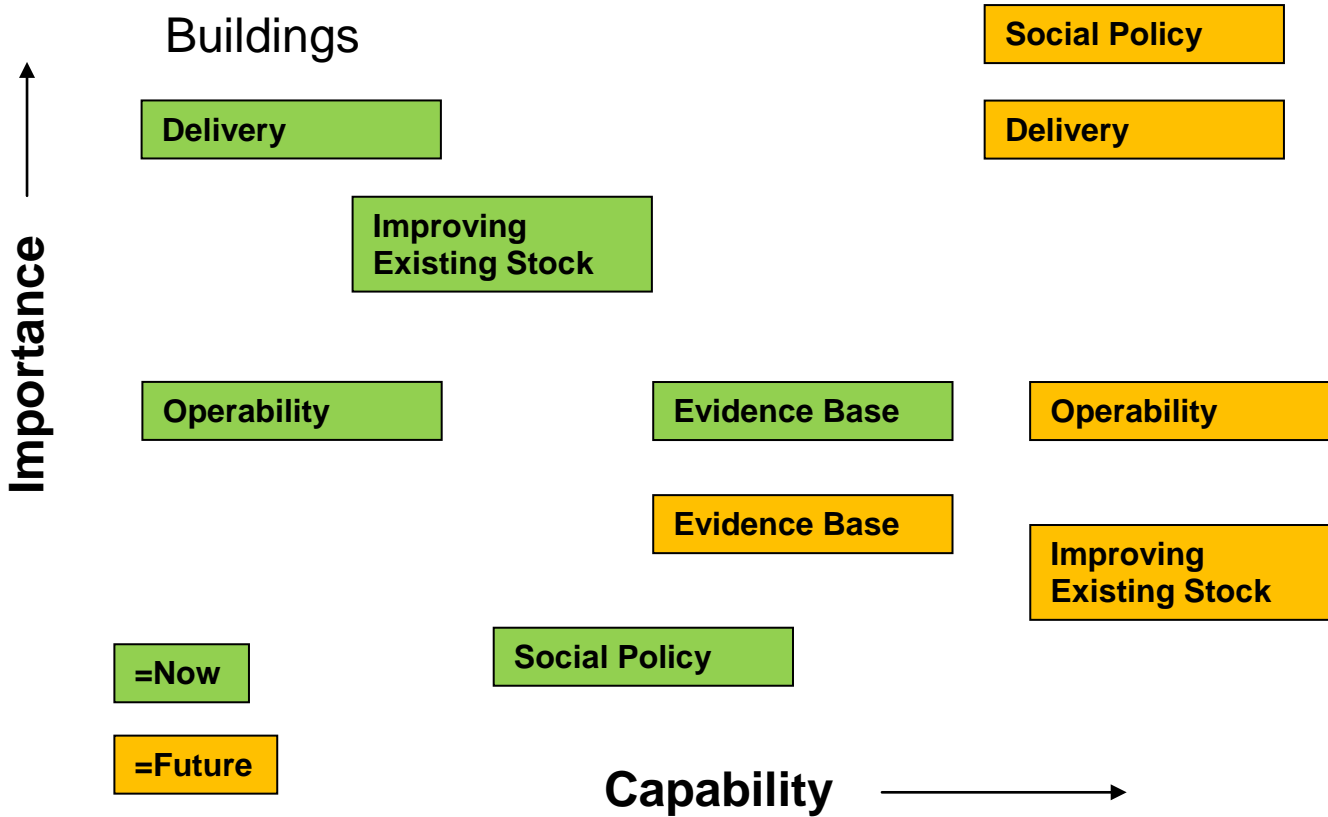
In the DE/ICT group local and global policy was seen as being of the highest importance, both now and in the future, but this was also an area that required a large increase in capability and understanding. The use of ICT in smart meters and smart grids was seen as important but broadly speaking capability already existed to ensure that there was sufficient relevant research in these themes. In general it was thought that IC technology was at an appropriate capability but that the application of this to other areas and its interaction with social science themes required an increase in capability.

In the Industry group heat and its storage, transmission and upgrading was emphasised as the most important issue, but, developments in underlying technologies such as materials and sciences such as chemistry were required. The economics of any interventions and the interaction of industrial with domestic and other sectors were also thought important.

In the social science group social behaviours and the interactions with practices and habits were seen as the most important research area. Effective policy and carbon inequality were also considered as important themes.

In transport the role of ICT was seen as being of primary importance both now and in the future and this, together with whole systems interaction and research into leisure were seen as needing the most increase in research capability.

For whole systems effects climate change was seen as the theme that would grow most in importance and also the area that required most increase in capability. It was thought particularly important to try and identify unintended consequences and their effect on infrastructure. Security and demand side management were also important themes requiring capability increase.



**Delivery:** Economics and viability of low energy solutions,  
 Procurement of low carbon buildings (re-engineering)  
 Service expectations of customers  
 Management of procurement, buildings, property and improvement  
 Risk management  
 Business models for property facility management

**Operability:** Usability of interface controls  
 Physical and behavioural interventions  
 Rebound effect

**Social Policy**

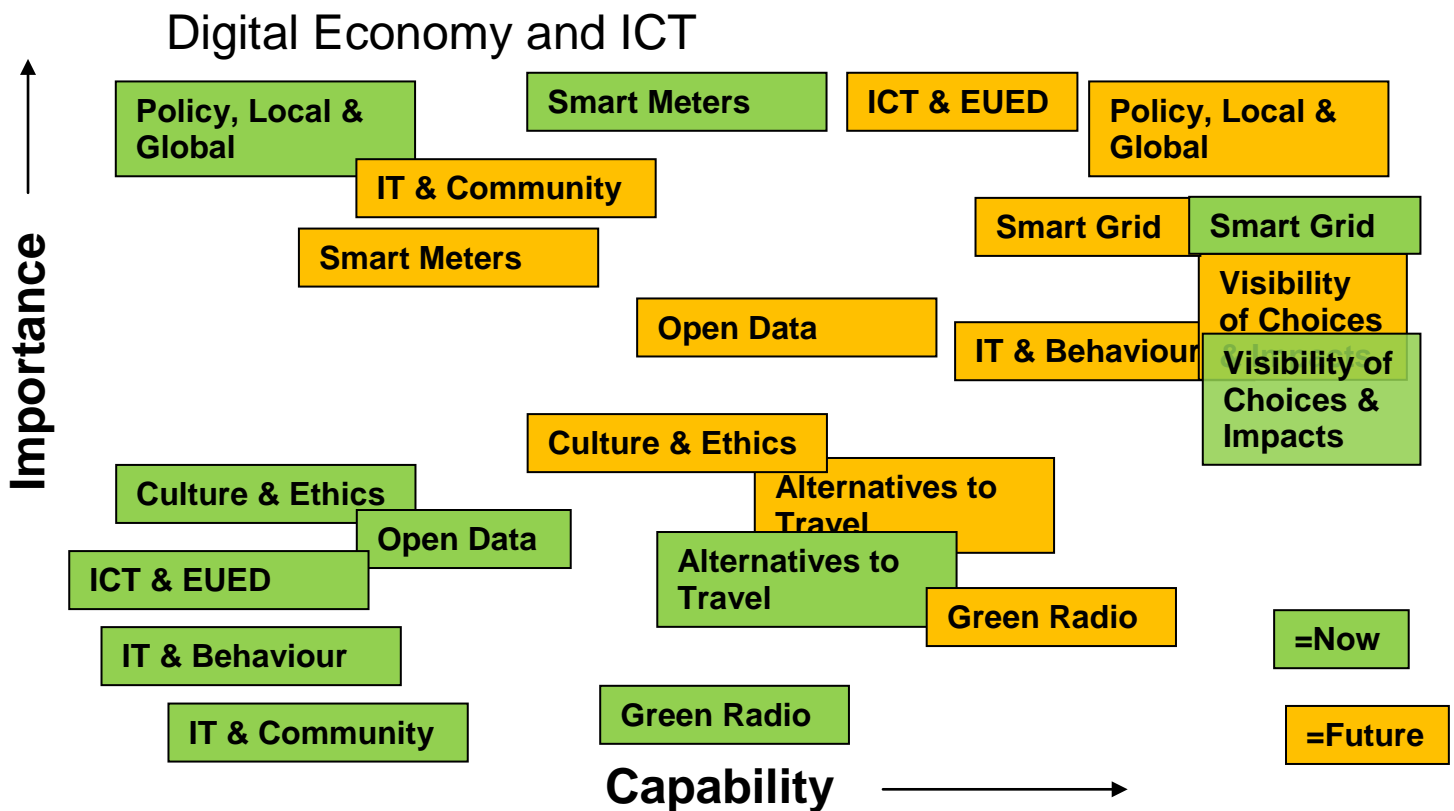
**And Practice:** Governance and delivery models  
 Systematic understanding of built environment  
 Ethnographic research to understand life style values  
 Incentives  
 Contextual frameworks and legislation  
 Increased industrial involvement

**Improving Existing**

**Stock:** Building industry capacity to implement refurbishment  
 Retrofitting technologies, processes and practices  
 Innovations for retrofit

**Evidence Base:**

Spatial mapping  
 Actual performance of buildings  
 Energy usage benchmarking  
 Demand reduction in a changing climate  
 Overheating  
 Databases and data manipulation



**Policy, Local & Global:** Models of whole system to explore dynamics, multi-scale agent based models, demand response levelling, self driving cars, heat pumps, more efficient algorithms.

**Smart Meters & Smart Grid contributing to the Smart Green Home:**

Controlling appliances, low cost internet enabled sensing (new and retrofit), Broadband in rural areas, integration across sectors.

**Visibility of Choices & Impacts:** New visualisation technologies, Visibility in the home in supermarkets in the street embedded into everyday life, personal carbon footprints.

**Culture & Ethics:** Quality of life, People's attitudes and emotions, Privacy, Slow Technology, Culture of openness re embodied carbon, big society, changing modernist individualist paradigm.

**Open Data:** Secure open datasets for modelling, visualisation and analysis of EUED.

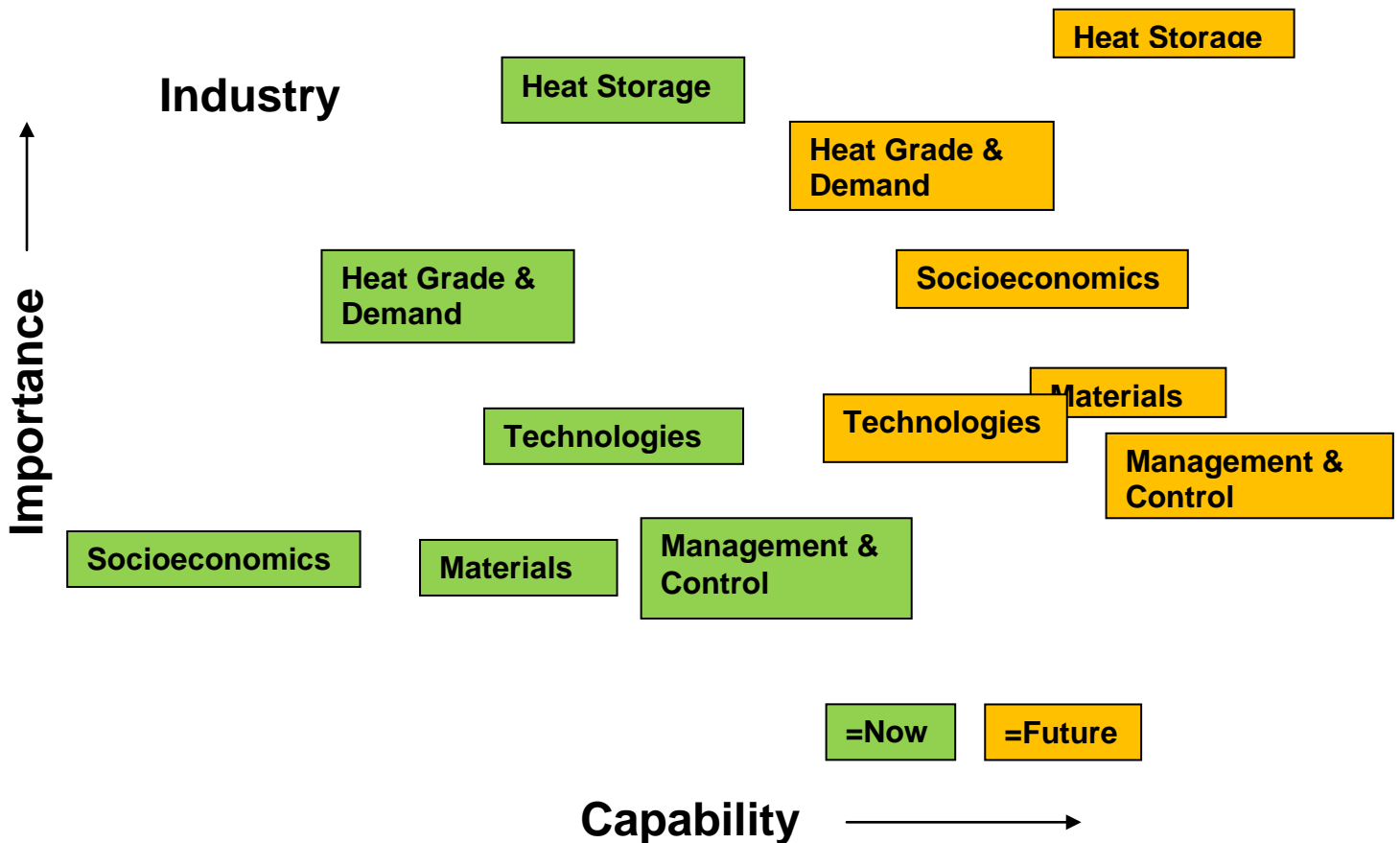
**ICT & EUED:** New applications: Food & waste, Packaging, Smart Clothing, Gamification

**IT & Behaviour:** New approaches to IT mediated behaviour change: Study of Energy consumption in the home, ICT Energy Demand Inflation, Expert Systems, Social Media, Target professions

**IT & Community:** IT enabled community sharing of services such as car pooling, laundry, heating

**Green Radio:** Environmentally friendly and energy efficient next generation communication systems.

**Alternatives to Travel:** Academic conferences, business, commuting.



**Heat Storage:** Long time shift of heat storage, Thermochemical Storage, Steam accumulators.

**Heat Grade & Demand:** National heat grid across domestic users and industry, Spikes in demand, Low grade heat for district heating, trigeneration

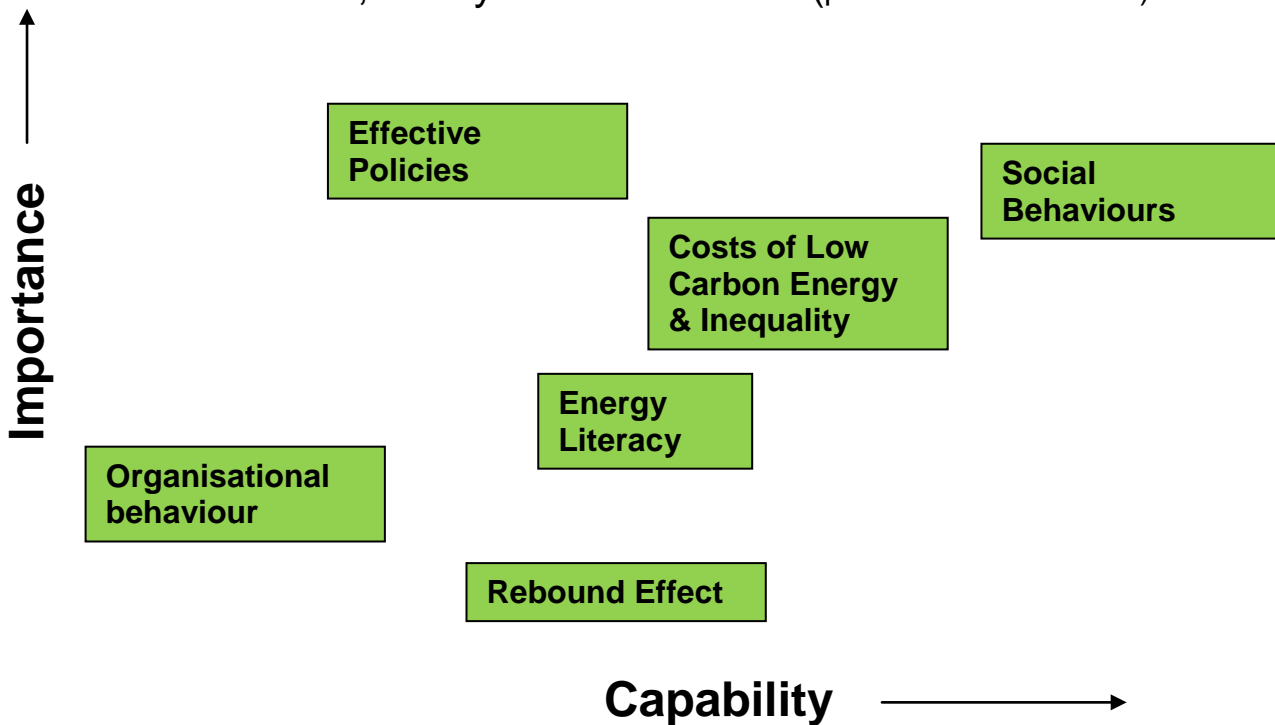
**Technologies:** There are a series of technologies such as upgrading of heat, waste work heat, thermal energy storage, thermal energy transport that are interlinked and which use underlying science such as thermodynamics, materials and chemistry. Additional considerations are: Process Intensification, Integration of power generation, storage and CCS, variable speed drives and improvements to combustion.

**Socioeconomics:** Economic and social barriers to take up of new technology, Cultural Issues, Clustering of industries with mixed energy demand, Legislation.

**Materials:** Efficiency improvements and lightweighting will lead to most of the embodied carbon being in Steel and Cement, Dematerialisation, Material with lower embodied energy e.g. Polycarbonate instead of glass, Material for heat storage.

**Management & Control:** Visualisation of energy, Local smart grids, intelligent heat management.

## Behaviour, Policy and Economics (present & future same)



**Effective Policies:** Devolved policy at all scales, Effective monitoring and evaluation of data, indirect energy use reflected in consistent policy.

**Costs of Low Carbon Energy & Inequality:** Changing demographics, fuel poverty (a larger issue as price increases), Exclusion of some from demand management policies, health implications of fuel poverty, Equity implications of new mechanisms and policy (e.g. green deal), Interaction with other aspects e.g. food and transport.

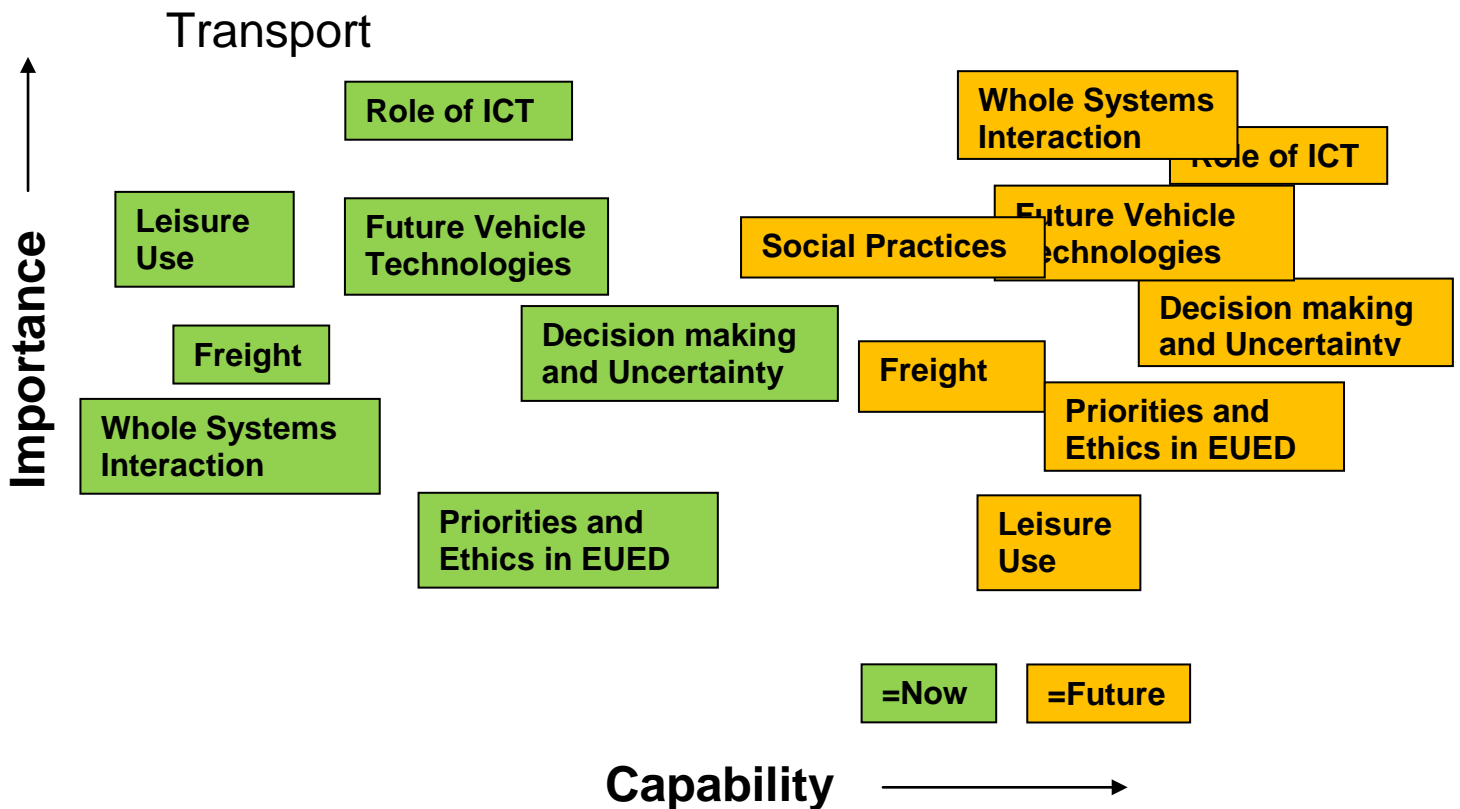
**Rebound Effect:** Improvements in energy behaviour and lifestyle changes may have unintended consequences, often of a counter arching nature.

**Energy Literacy:** Making energy visible and understandable and the effect of doing this, Education about the impact of practices – these needs to be more than a deficit model as visibility on its own is not sufficient, Climate change scepticism, Embodied energy.

**Social Behaviours:** In general different scales and contexts of energy behaviour, interactions, practices and habits. People use services, not energy, in a habitual manner. Some examples are:

- Adoption of new practices such as cycling, walking and line drying
- Interaction with, tolerance of, and opposition to some policies.
- Evolution of public attitudes and identification of milestones in these.
- Commons problems

**Organisational Behaviour:** How people behave in relation to energy use within organisational settings, how organisational entities make decisions and conduct activities in relation to energy. Important factors are SMEs, fashion, non residential buildings, food distribution networks and consumer actions.



**Future Vehicle Technologies:** Electric vehicles, Hydrogen, Supply implications.

**Decision making and Uncertainty:** Long term oil price, differing timescales for change, energy security, consistency of energy policy.

**Freight:** Light goods vehicles, Alternative fuels.

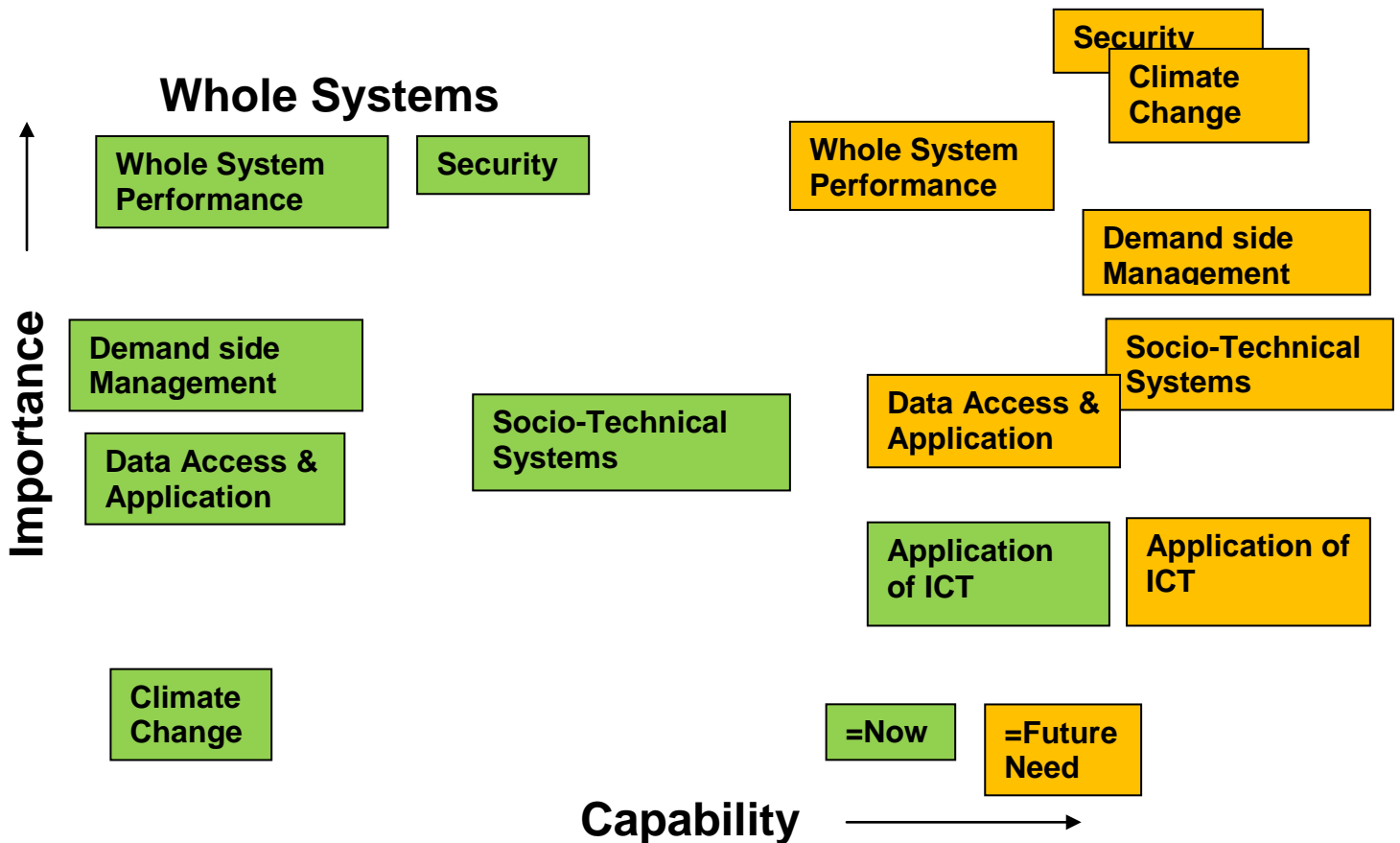
**Whole Systems Interaction:** Rebound effects, Interactions with buildings, New business models (through life costing, value in use V exchange), Alignment of incentives.

**Leisure:** Patterns of use in recreation

**Priorities and Ethics in EUED:** Patterns of use in recreation and business, ICT and satellites, Prioritising appropriate supply to different groups.

**Social Practices:** Influence of media, land use, Education choices, Working practices, Model of car ownership, Institutional level analysis, Globalisation.

**Role of ICT:** Optimisation of travel, Smart traffic control and intelligent transport systems, Driving behaviours, Basic needs (such as food provision)



**Security of Power Energy and Services:** Big grid V Micro grid and implications for resilience, Measurement of energy

**Whole System Performance:** Trade implications of the energy sector consumption V emissions production, Sustainability appraisal (the 3 pillars), Inclusion of aviation and shipping, Waste heat from industry and power stations, bridging the gap between component performance and system performance.

**Demand side Management:** System balancing –wider than energy, Heat storage and heat pumps, Future demand prediction, Gas, Power V Energy.

**Socio-Technical Systems:** Full fuel cycle and life cycle approaches, Driving demand change (for transport), Bottom up analysis of the whole system without economics, Apply the 80/20 rule to tailor mitigation policies – different policies for different groups.

**Data Access & Application:** Legal practices.

**Climate Change:** Effect on new build design, unintended consequences of a low carbon system, Step change rather than an incremental change needed.

**Application of ICT:** Bridging the gap between supply and demand, Improved real time monitoring, optimisation and control, Integration of data systems.

## 4.0 Future Portfolio

### 4.1 Desired Programme Features

1. Genuinely Interdisciplinary research is essential but this needs to be underpinned by strong single discipline research. The means of encouraging this type of research should be understood and should take into account relationships between researchers and the different languages used by different research communities.
2. Interdisciplinary research groups take a great deal of time and effort to become established and where these exist they should be maintained and strengthened. There should be mechanisms in place that guard against entrenchment and stagnation and allow refreshing and inclusion of new researchers into existing groups.
3. Some support for radical and speculative research was required.
4. Research capacity should be built using individual studentships, which were seen as a source of individual innovative thinking, as well as DTCs. targeted to specific research needs.
5. Policy makers, industry, NGOs and charities should be involved in the commissioning, operating and knowledge transfer phases of a project. This would help ensure that the impact of the research was generated and demonstrated throughout the project. A high level impact team that examined all outputs from EUED should be considered.
6. Public engagement needed to be embedded in projects and in some cases a mechanism for commissioning bottom up research involving the Public and communicating the results of that research directly to the General Public was needed.
7. There needed to be a central guiding theme/objective for a EUED programme a possible metric for this was 'Tonnes of Carbon Dioxide saved'. Though other economic and societal aspects needed considering.
8. A critical review of current research should be undertaken to evaluate its current and potential future impact and hard decisions taken on stopping underperforming areas and reallocating sponsorship.
9. Stage gating and review of projects should be a part of any programme.
10. A high level networking function that brought together theme leaders, funders and users would help ensure synergies were exploited and data and techniques were shared to help projects to be completed efficiently and deliver better outcomes.

## 4.2 Possible Shape of the EUED Programme:

The majority of the groups thought that most of the sponsorship should be directed to the formation of a limited number of large 'Research Hubs' or centres. Possible models for these were:

Digital Economy Research Hubs  
Supergen consortia  
UKERC

The individual hubs needed to be networked together to help facilitate public engagement, interaction with users and promote any synergies between research projects. There also needed to be a mechanism in place to engage other researchers outside of the core consortium and to interact with appropriate Doctoral training Centres.

Features of the hub/centres would be:

- Focus on outcomes rather than sectors
- Leverage of funding in Universities and from Industry and other funding bodies.
- Focus on providing advice on what is needed next
- Strong branding with substantial gearing
- Some flexible funding to pursue novel research leads.
- Funding to engage other groups and potentially international researchers
- Mechanisms to support training and mid and early career researchers
- Engagement of stakeholders, international groups, policy makers and other researchers through the network
- An academic 'Champion' to promote interdisciplinary research
- Funding to support calls for research projects that work at the boundaries of sectors (Buildings, Industry and transport) and disciplines.

It was suggested that the mechanism to form the hubs should involve sponsorship of a number of 'Research Clusters' which would define the research required and the resource needed. The clusters would have flexible funding to commission studies and carry out short term research. It was not envisaged that they would operate for more than 1 year. These clusters would lead (through a stage gate) to the hubs/centres.

There was also a view that some of the sponsorship should be directed to a small 'responsive mode' programme that would operate alongside the centres. The purpose of this was to try and promote adventurous longer term research.

One group thought that all of the available research mechanisms (Fellowships, a few centres, sandpits, grand challenges etc.) should be deployed as needed and as appropriate

## Appendix 1: Workshop Attendees

<b>Dr Jillian Anable</b>	<b>University of Aberdeen</b>
<b>Professor Kevin Anderson</b>	<b>University of Manchester</b>
<b>Dr Colin Axon</b>	<b>Brunel University</b>
<b>Professor Phil Banfill</b>	<b>Heriot-Watt University</b>
<b>Dr Sandra Bell</b>	<b>Durham University</b>
<b>Dr Karen Bickerstaff</b>	<b>Kings College London</b>
<b>Professor Mark Blythe</b>	<b>Northumbria University</b>
<b>Dr Bill Bordass</b>	<b>Useable Buildings Trust</b>
<b>Mark Bornhoft</b>	<b>Carbon Limiting Technologies Ltd</b>
<b>Dr Alice Bows</b>	<b>University of Manchester</b>
<b>Dr Trevor Bradbury</b>	<b>Transport Research Laboratory</b>
<b>Teresa Bray</b>	<b>Changeworks</b>
<b>Dr Sally Caird</b>	<b>Open University</b>
<b>Mr Nick Cook</b>	<b>EPSRC</b>
<b>Professor Robert Critoph</b>	<b>University of Warwick</b>
<b>Dr Janet Dickinson</b>	<b>Bournemouth University</b>
<b>Professor Yulong Ding</b>	<b>University of Leeds</b>
<b>Dr Sylvie Douzou</b>	<b>EDF</b>
<b>Dr Owen Dowsett</b>	<b>ESRC</b>
<b>Dr Nick Eyre</b>	<b>University of Oxford</b>
<b>Dr Hannah Foreman</b>	<b>EPSRC</b>
<b>Dr Adrian Friday</b>	<b>Lancaster University</b>
<b>Dr Nigel Goddard</b>	<b>University of Edinburgh</b>
<b>Professor Richard Green</b>	<b>University of Birmingham</b>
<b>Dr Rajat Gupta</b>	<b>Oxford Brookes University</b>
<b>Dr Richard Guy</b>	<b>Carbon Trust</b>
<b>Dr Victoria Haines</b>	<b>Loughborough University</b>
<b>Professor Geoffrey Hammond</b>	<b>University of Bath</b>
<b>Heather Haydock</b>	<b>AEA Technology</b>
<b>Dr David Holtum</b>	<b>EPSRC</b>
<b>Bradley Hook</b>	<b>United Sustainable Energy Agency</b>
<b>Professor David Infield</b>	<b>University of Strathclyde</b>
<b>Dr Mark Jackson</b>	<b>University of Bristol</b>
<b>Craig Kennedy</b>	<b>Historic Scotland</b>
<b>Professor Shaun Lawson</b>	<b>University of Lincoln</b>
<b>Professor Kai Luo</b>	<b>University of Southampton</b>
<b>Dr Rebecca Mancy</b>	<b>University of Glasgow</b>
<b>Dr Greg Marsden</b>	<b>University of Leeds</b>
<b>Dr Nafees Meah</b>	<b>DECC</b>
<b>Dr Andrew Melchior</b>	<b>Technology Strategy Board</b>
<b>Dr Arumugam Nallanathan</b>	<b>King's College London</b>
<b>Dr John Nonweiler</b>	<b>Sharpe Laboratories of Europe Ltd</b>
<b>Professor Tadj Oreszczyn</b>	<b>University College London</b>
<b>Dolly Parkinson</b>	<b>EPSRC</b>
<b>Dr Glenn Parry</b>	<b>University of the West of England</b>

**Dr Chris Preist  
Dr Ruth Rettie  
Professor Clive Roberts  
Professor Tony Roskilly  
Dr Paul Rouse  
Professor R Mark Rylatt  
Dr Tim Ryley  
Professor Mark Savill  
Professor Mark Sexton  
Wendy Shillam  
Professor Graham Smith  
Dr Steve Sorrell  
Professor Koen Steemers  
Dr Will Swan  
Professor Jim Swithenbank  
Professor Savvas Tassou  
Professor Chris Tweed  
Dr Loraine Whitmarsh  
Dr Jacqui Williams**

**University of Bristol  
Kingston University  
University of Birmingham  
Newcastle University  
ESRC  
De Montfort University  
Loughborough University  
Cranfield University  
University of Reading  
Whitehall Bordon Eco-town  
University of Southampton  
Sussex University  
University of Cambridge  
University of Salford  
University of Sheffield  
Brunel University  
Cardiff University  
Cardiff University  
EPSRC**

## Appendix 2: Agenda

### **Research Councils UK Energy Programme: End-use Energy Demand Workshop - Developing the Research Plan**

#### **Agenda:**

**0900 -1000 Registration**

**10.00 Welcome**

**10.15 Keynote presentation: *Professor Geoff Hammond (Bath): Transition Pathways to a low Carbon Economy and Energy Demand.***

**10.45 International review of energy. *Jacqui Williams (RCUK Energy Programme)***

**11.00 Current research portfolio and analysis. *Dave Holtum (RCUK Energy Programme)***

**11.15-11.30 Tea/Coffee**

**11.30 Breakout Sessions: Research Themes**

**13.00 Networking opportunities /Lunch**

**14.00 Keynote presentation: *Professor Kevin Anderson (Manchester). Systems Approach to EUED***

**14 .30 RCUK Energy Programme Priorities: *Dave Holtum (RCUK Energy Programme)***

**14.45 Breakout Sessions (Tea/Coffee Available): Research Programme**

**16.00 Wrap-up**