March 2009 Energy Research Partnership report

Assessing UK Energy Technologies

ERP
Energy Research Partnership

Energy Research Partnership report

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Executive summary

The Energy Research Partnership's report on 'UK Energy Innovation' identified 12 key technology sectors which were expected to transform the UK's energy landscape, making dramatic reductions in greenhouse gas emissions whilst maintaining secure access to competitive sources of energy. That report set out the support available in each sector along the full innovation chain. In 'Assessing UK Energy Technologies' we present a study of the status and development needs of 150 specific technologies, to aid public and private sector decision makers in the targeting of energy RDD&D support.

The assessment has followed a rigorous process, with detailed input from experts in each field, and a workshop to peer-review the results. A range of barriers and enablers to bringing each technology to commercial deployment has been considered, producing an intricate and information-rich matrix. This technologies matrix shows the complexity of the energy innovation landscape and will be kept under review to provide an up-to-date resource for business, funders and policy makers.

Clearly, no single intervention will accelerate progress across the board; a portfolio of technologies and associated mechanisms will be required to enable the UK to meet carbon emissions targets, improve security of supply and reduce fuel poverty in a competitive market. We show that the UK can make key international contributions in several technology areas. ERP will be sign-posting opportunities for further collaboration on energy RDD&D in Europe (especially under the Strategic Energy Technologies Plan), and in the light of the International Energy Agency's technology roadmaps.

This will not be the only analysis that can be used to help set priorities for funding (in the private or public sectors) or other support mechanisms. However, the comprehensiveness, level of detail and rigour of the process should make it a valuable input into the decision-making of funders and policy-makers.

Contents

1. Introduction

In the report, 'UK Energy Innovation', the Energy Research Partnership recognised that innovation in the energy sector is complex and non-linear, with a series of feedbacks permeating the so-called innovation chain of research, development, demonstration and deployment (RDD&D). The report recognised that government support mechanisms (financial, fiscal and regulatory) should be tailored as appropriate to agreed priority technologies (the full set of recommendations is at Annex A).

ERP has undertaken an exercise to assess 150 energy technologies according to a set of criteria which reflect energy policy aims. It has benefited from expert contributions addressing each technology, and a workshop to review the final output. Alongside assessments by other bodies, such as the technology roadmaps from the UK Energy Research Centre and the Carbon Trust's Low Carbon Technology Assessment, this provides funders and policy makers with an account of the state of energy technologies, the barriers and enablers they face, and where support could be targeted to move them to commercial deployment. Basic research in the UK is the domain of the Research Councils, where researchers are best-placed to determine detailed priorities and the main criteria should be one of excellence. However, in recent years a number of bodies have been created to focus on the later stages of innovation, including the Technology Strategy Board and Energy Technologies Institute. Private sector funding will also be concentrated in the DD&D segments. On top of this, Government has an important role to play in technological innovation either through funding (in this case the Environmental Transformation Fund) or the various policy levers.

This report focuses on the process that was followed to arrive at the technologies assessment matrix, which is being made available on ERP's website. Some examples of the information that can be extracted from the matrix are given in section 3; further analysis of the data should help guide all players in energy innovation as to the state of technologies, and what barriers they face in progressing to commercial deployment. Ongoing work by ERP will keep the information up to date, and make it more accessible to potential users.

The Energy Research Partnership thanks all those who have been involved in this work, for their time and expertise. In particular, members of the Review Group, respondents to our questionnaire, and those who attended the Peer Review workshop in October 2007.

2. The process

The assessment process followed several stages: establishment of a review group, drawing-up of a technologies list, expert input via a questionnaire, and a peer review workshop.

Review group

A Review Group was established to oversee the process and provide technical input. Members were: Tony Amor (ITI Energy), Andy Boston (E.ON UK), Mike Colechin (E.ON UK), Mike Farley (Doosan Babcock Energy Ltd), Kathryn Newell (BERR), Jim Skea (UKERC), David Vincent (Carbon Trust), Alison Wall (EPSRC), Matthew White (DfT).

The technologies list

Work contributing to ERP's report 'UK Energy Innovation' had established an initial list of technologies that were some way along the innovation chain but not yet commercially proven. Using this, together with the UKERC Research Atlas, the ETI high level list and input from the Review Group, twelve 'sectors' were subdivided into 47 'technology areas', containing a total of 150 individual technologies or applications.

The level of granularity was chosen such that assessment of each technology/application could help funders and policy makers direct support across the energy landscape. Further sub-division within each technology would be possible, but not appropriate for this exercise.

The initial technologies list was sent out to experts in each sector, and it remained under review as the project developed. The final list is given in Annex B; an abbreviated list showing the sector and technology areas is shown in Table 1.

[1] 'UK Energy Innovation' (May 2007), available from www.energyresearchpartnership.org.uk.

Table 1

Top two levels of ERP technologies list

SECTOR	TECHNOLOGY AREA
CARBON ABATEMENT TECHNOLOGIES	CO2 Capture
	Higher efficiency conversion processes
	CO2 transport and storage
	Products from fossil fuels
WIND	Onshore
	Offshore
	Transmission
MARINE	Wave
	Currents
	Others/Novel
MICROGENERATION	Wind
	Heat pumps
	CHP
	Fuel cells
	Small hydro
	Connection & monitoring
BIOENERGY	Feedstocks
	Electricity
	Heat
	Biofuels and chemicals
SOLAR	Photovoltaic
	Solar Thermal, domestic and industrial
NUCLEAR FISSION	Existing (Generation II) Plant
	Near Term (Generation III Plant)
	Long Term (Generation IV Plant)
NUCLEAR FUSION	Existing R&D Facilities
	Future Facilities
	Demonstration / Commercial Plant
NUCLEAR DECOMMISSIONING & WASTE MANAGEMENT	Waste Management
	Decommissioning
	Disposal
NETWORKS	Electricity
	Gas
	Hydrogen
	Other energy vectors
TRANSPORT	Vehicles - all surface Transport modes
	Fuels
	Transport system
	Roads
	Rail
	Water
	Aviation
DEMAND SIDE	Building design and controls Existing
	Building design and controls New and Emerging
	Industrial processes Existing
	Industrial processes New and Emerging

Questionnaire

A Questionnaire (at Annex C) was sent to experts from academia and industry, covering each of the sectors, asking them to:

- Clarify the key technologies/applications that are relevant to each sector.
- Establish the current position of each of these on the energy innovation chain in the UK and internationally.
- Where the primary activity on a particular solution is taking place outside of the UK, establish at what point we should commence work in the UK.
- Identify the support needed,(eg science, technology, fiscal, regulatory, social etc), to move each technology/solution to the "end" of the innovation chain.
- Define critical points for each technology/solution which determine whether they progress further down the chain.

Responses were received in the first half of 2007. Detailed information captured from the returned questionnaires will be made available online.

Applying the criteria

A set of criteria designed to aid in the prioritisation of technologies/applications was drawn up by the Review Group (Table 2, with full description at Annex D). With the ETI as a key user of the project outputs, the criteria were also presented to the ETI Technical Committee.

Table 2

The criteria

ESSENTIAL CRITERIA	BARRIERS & ENABLERS	OTHER CONSIDERATION
a. Impact – GHG reduction	a. Environmental impact (other than GHG)	a. Strength of UK R&D relative to international capabilities
b. Impact – Security of supply	b. Wider economic impact	b. Prominence in international energy policies
c. Impact – Fuel poverty	c. Societal – planning/policy/public acceptability	c. Availability of appropriate materials technologies
d. Impact – competitive markets	d. Scientific or technical risk	d. Availability of C&I and monitoring
e. Size of a mature market	e. Regulatory or fiscal incentives	
f. Fit with Government technology strategy	f. Timescale to commercial deployment	
	g. Costs to commercial deployment	
	h. Market willingness to invest	
	i. Ultimate export potential	
	j. Link with EU priorities	
	k. Availability of appropriate international standards	

Applying the criteria continued

The application of the criteria was carried out by the Review Group using information in the responses to the Questionnaire together with details from ERP's previous work. The criteria were applied using a 'traffic light' system, defined in Appendix E.

In addition to these criteria, the position of the technology/ application on the innovation chain (in terms of the level of activity) was described, defined by four categories: research; development; demonstration; deployment.

A 'technologies matrix' was drawn up to hold the information gathered and allow some qualitative and quantitative analysis. To give quantifiable information, 'scores' for each entry were entered on the matrix, based on 'green' scoring 3, 'amber' scoring 2 and 'red' scoring 1. In a few cases where cells are blank; then, either there was insufficient information to apply the criteria or the criteria were not appropriate in this particular case.

Peer review

An expert workshop was organised by EPSRC and held on 10 October 2007 with the objective of reviewing the technologies matrix and the evaluation that had been carried out for each technology area. The participants in the workshop are given in Annex F.

There was general agreement on the assessment of most of the criteria for the individual technologies. In a few areas where individual experts could not agree, the review group made the final decision.

3. The energy technolgies matrix

By its nature, the assessment could only consider the information available at a point in time and the analysis below is based on this snapshot. The technologies matrix will be made available online, initially in the form as agreed following the peer review workshop. A review process will seek to keep the matrix up to date, so that it can be a useful ongoing resource.

Of the 150 technologies considered, two-thirds (99) had at least two assessments of 'significant positive' impact in the essential criteria. Notably, technologies under distributed generation, heat from bioenergy, rail transport, and nuclear waste management and decommissioning did not reach this level. This is not to say that these components of the energy system themselves cannot make a contribution to meeting energy policy aims, rather that the new technologies associated with them may not make a significant impact.

Barriers and enablers

Of those technologies that scored highly against the essential criteria, the barriers and enablers that they were found to face were varied. However, some technology areas clearly face more challenges to further development than others. In particular, barrage systems, Gen IV nuclear fission, nuclear fusion and hydrogen networks scored poorly. There is no surprise in this group, and the size of the barriers should be set against the strategic importance of what the technologies may deliver.

Other technology areas were judged to have few barriers – higher efficiency conversion processes for carbon abatement technologies, onshore wind, co-firing of biomass for electricity generation, Gen II fission, hybrid vehicles and aviation. Apart from aviation and some specific onshore wind technologies, these were seen to be at an advanced stage along the innovation chain. As such, it may be appropriate to develop them further through legislative/regulatory incentives and market pull mechanisms. Aviation and new blade and generator designs for onshore wind technologies were found to have lower risks to eventual deployment, and at an earlier stage of development with potential for export and some UK expertise.

Aviation technologies and Gen II fission were also highly rated for the strength of UK R&D, as are biofuels and much of the marine sector. Despite the importance and potential of onshore wind, it was an area identified as lacking capability in the UK.

In other sectors and technology areas, all of which will be needed to contribute to energy policy aims, some of the most obvious issues impeding commercial deployment were:

- Barriers faced by CO_2 capture technologies in the development/demonstration phases are environmental, regulatory and cost.
- CO_2 transport and storage technologies face significantly negative societal impacts with additional regulatory or fiscal barriers.
- High cost to commercial deployment of marine technologies.
- Lack of appropriate international standards for distributed generation, a sector in which UK is also lacking significant R&D capability.
- Low market willingness to invest in bioenergy technologies.
- The relatively long times to market of solar PV.
- Most demand side technologies face lack of investment, with regulatory or fiscal barriers a barrier to industrial process technologies, and time to commercial deployment a barrier to new and emerging building design and controls

International engagement

Overcoming the challenges of energy technologies will require a coordinated global effort. Engagement through initiatives, such as the EU's Strategic Energy Technologies (SET) Plan and the roadmaps developed by the International Energy Agency, could accelerate eventual deployment.

In many technology areas the UK's strengths in research and innovation coincide with international priorities for action, with the greatest overlap between these and meeting the UK's energy policy aims found in:

- Carbon capture, transportation and storage
- Wave and tidal current energy
- Bioenergy
- Solar PV
- Electricity networks
- Surface transport (other than hybrids and electric vehicles) and fuels
- Demand side technologies

Nuclear waste management (for Gen II fission) and disposal is also an area where the UK has capability in an internationally important area, though its contribution to the specific energy policy aims was seen to be limited.

This list should be used as a guide for targeting engagement activities. Future work by ERP will signpost opportunities for UK involvement.

4. Further work

This report will be disseminated to relevant bodies to inform their decision-making processes. Specific sectors and technology areas will be described in greater detail according to the users.

A challenge of an exercise such as this, covering a wide range of emerging technologies, is to ensure information stays relevant. However, it is clear that a comprehensive analysis of energy technologies in the UK can be of benefit to the public and private sectors. Therefore, we propose to maintain the technologies matrix, with a web interface to allow users and experts to provide up-to-date information, and periodic peer reviews to preserve its authoritative value.

ANNEX A

Recommendations from ‘UK energy innovation’, May 2007

1. Tailored and strategic Government intervention is essential to ensure seamless support for UK Energy RDD&D.

2. Careful co-ordination will be required to realise the full potential of recent improvements to the energy innovation chain:- The public-private Energy Technologies Institute will bring focus, momentum and scale to innovation and will be further enhanced by the announcement of the Environmental Transformation Fund and the Research Councils’ long term commitment to better exploitation of research

3. Appropriate Government support for early stage demonstration is essential. In most cases, international collaboration would allow such projects to proceed with maximum benefit.

4. The UK energy innovation chain is characterised by a diversity of schemes and scheme providers. It is timely to consider whether this diversity is appropriate and whether it is adding value.

5. The design and introduction of new government support mechanisms (financial, fiscal and regulatory) should be part of a strategy for accelerating energy innovation. These mechanisms should be coherent, consistent and significant - tailored as appropriate to agreed priority technologies.

6. The development of a strategic vision by the principal stakeholders has been very useful in some technology areas and should be extended to cover all priority technologies.

7. The Government should engage with industry and relevant bodies regarding the review of EU State Aid rules to ensure that large scale demonstration projects can be supported adequately.

8. It is timely for the Energy Research Partnership to take an overview of the level and type of innovation support needed over the next 10 years to improve the impact of funding for energy RDD&D in the UK.

ANNEX B

List of technologies

SECTOR	TECHNOLOGY AREA	TECHNOLOGY/APPLICATION
CARBON ABATEMENT TECHNOLOGIES	CO2 Capture	Pulverised coal + Scrubbing
		Pulverised coal + Oxy-fuel
		IGCC + precombustion capture
		Advanced GT cycles - hydrogen
		Advanced GT cycles - oxyfuel
		Industrial processes
		Novel cycles
	Higher efficiency conversion processes	Pulverised coal ASC/USC
		Fluidised bed combustion
		Gas turbines
	CO2 transport and storage	Off-shore
		On-shore
		Transmission
		Monitoring, leakage & remediation
	Products from fossil fuels	Hydrogen production
		Coal to products (liquids & chemicals)
		Gas to products (liquids & chemicals)
WIND	Onshore	Life extension of existing fleet
		New blade design
		New generator design
	Offshore	Resistance to marine environment
		New blade design
		New generator design
		Access and egress
		Floating platforms
		Fixed platforms
	Transmission	Convertor development
		Offshore energy parks
MARINE	Wave	Offshore
		Shoreline
	Currents	Tidal current
		Barrage systems
		Lagoons
		Ocean currents
DISTRIBUTED GENERATION	Wind	Domestic
		Commercial/industrial
	Heat pumps	Domestic
		Geothermal
	CHP	Biomass
		Organic Rankine cycle
		Internal combustion
		Microturbines (<50kW)
		Stirling engines
		Fuel cells
	Small hydro	
BIOENERGY	Feedstocks	Energy crops
		Forestry and agricultural residues
		Industrial residues
		Other wastes
	Electricity	Dedicated
		Cofiring
		Chp
	Heat	Domestic
		Commercial/industrial
	Biofuels and chemicals	Biorefineries
		Gasification
		Pyrolysis
		Molecular engineering

ANNEX B

List of technologies continued

SECTOR	TECHNOLOGY AREA	TECHNOLOGY/APPLICATION
SOLAR	Photovoltaic	Crystalline silicon
		Thin films
		New materials (other than Si)
		Incorporation into bldgs & system integ'n
		Manufacturing
	Solar Thermal, domestic and industrial	Concentrated solar
		Hydrogen production
		Domestic Hot water
NUCLEAR FISSION	Existing (Generation II) Plant	Magnox
		AGR
		LWR
	Near Term (Generation III Plant)	Advanced LWR
	Long Term (Generation IV Plant)	High Temperature Reactor
		Fast Reactor
		Heat Application
		Integral LWR
NUCLEAR FUSION	Existing R&D Facilities	JET
		MAST – Spherical Tokamak
	Future Facilities	ITER / IFMIF
	Demonstration / Commercial Plant	DEMO
NUCLEAR DECOMMISSIONING & WASTE MANAGEMENT	Waste Management	Encapsulation
		Interim Storage
	Decommissioning	Site Remediation
	Disposal	Deep Geol Disposal-ILW & HLW
		Near-surface for LLW
NETWORKS	Electricity	Decentralised generation
		Intermittent generation
		Active Dist Network management
		Electricity bulk storage
		Life extension
		Environmental impact
		Elect transmission undergrounding
		Demand user participation
		Efficiency improvement-networks
		Life extension
		Efficiency improvement
	Gas	Environmental impact
		Gas quality
		LNG production and transport
		Gas bulk storage
	Hydrogen	Storage
		Centralised
		Distributed
	Heat	Domestic/commercial heat pumps
		Geothermal
		Heat

ANNEX B

List of technologies continued

SECTOR	TECHNOLOGY AREA	TECHNOLOGY/APPLICATION
TRANSPORT	Vehicles - all surface Transport modes	Advanced ICEs and drivetrains
		Fuel cells
		Hybrids
		Electric drive, batteries and storage
		Hydrogen
		Vehicle design, electronics & control
	Fuels	Conventional
		Biofuels
		New fuels
	Transport system	Design including freight logistics
		Passenger logistics
	Roads	Infrastructure
		Telematics
	Rail	Electric
		Diesel
		Advanced propulsion systems
		Infrastructure
		Road/rail integration
	Water	Propulsion systems
		Inland
		Ocean
	Aviation	Aerodynamics
		Advanced propulsion systems
		Novel designs
		Unmanned aerial vehicles
		Operations and logistics
DEMAND SIDE	Building design and controls Existing	Design optimisation
		Building fabric
		Heating, cooling and lighting
		Domestic appliances
		Control and energy management
	Building design and controls New and Emerging	Design optimisation
		Building fabric
		Heating, cooling and lighting
		Domestic appliances
		Control and energy management
	Industrial processes Existing	Process intensification
		Process control
		Combustion technologies
		High efficiency process plant
	Industrial processes New and Emerging	Process intensification
		Process control
		Combustion technologies
		High efficiency process plant

ANNEX C

ERP questionnaire

1. List the technologies/solutions that you believe are relevant to the sector being considered – starting from the Technologies List provided.

2. Identify the "materiality" of each of these technologies to achieving the objectives of government Energy Policy (CO^2 reductions, security of supplies and affordability in a competitive market scenario) both in the UK and also in a global context.

3. Where are the UK's strengths with regard to this list and more generally in the particular sector being considered and what are the strengths of the other key countries?

4. What is the expected total global market size for the technology and
   a) what proportion of this market is in the UK?
   b) what proportion of this market is the UK likely to supply?

5. In this sector, what do we uniquely do in the UK that adds value to any international activity?

6. What advantage would we seek to extract from further international collaboration?

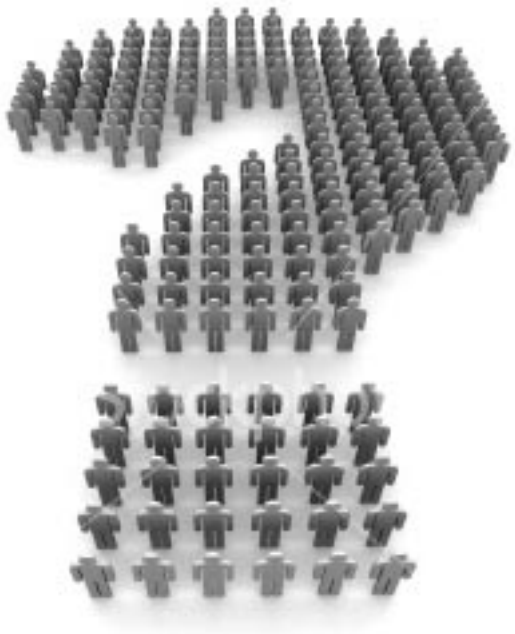
7. For each technology/solution identify its current position on the energy innovation chain either in the UK or internationally.

8. What would need to be done to move each of the identified technologies/solutions to the end of the innovation chain (i.e. to the point where they are considered "commercially proven" and economies of scale have been achieved) and what are the risk areas that may prevent this?

9. What would be the key milestones in this process and what timescales could these realistically be achieved in?

10. What needs to be achieved during each phase in development to enable the technology/solution being considered to move past these milestones?

11. What contribution could the ETI and/or the ETF make to any of the above issues?



ANNEX D

Explanation of selection criteria

This Annex gives a further explanation of how the selection criteria are defined and how they have been applied – it should be read in conjunction with Annex E.

Essential criteria

2a. Impact – GHG reduction (UK) – this relates directly to the first of the four goals of the Energy White Paper (2): "to put ourselves on a path to cut the UK's carbon dioxide emissions -----". The scoring reflects the potential contribution to this goal.

2b. Impact – Security of supply (UK) – this relates directly to the second of the four goals of the Energy White Paper: "to maintain the reliability of energy supplies". The scoring reflects the potential contribution to this goal.

2c. Impact – Fuel poverty (UK) - this relates directly to the fourth of the four goals of the Energy White Paper: "to ensure that every home is adequately and affordably heated". The scoring reflects the potential contribution to this goal.

2d. Impact – Competitive markets (UK) - this relates directly to the third of the four goals of the Energy White Paper: "to promote competitive markets in the UK and beyond, helping to raise the rate of sustainable growth and to improve our productivity". The scoring reflects the potential contribution to this goal with particular reference to providing low cost solutions or increased competition.

3. Size of a mature UK and global market – this relates to the potential market size. To score 'large', the size must be at least in the Gigawatts scale (ie £billions) or equivalent, where applicable; 'small' equates to MWs, or £millions, range.

4. Fit with Government technology strategy – for those sectors where a Government strategy exists, this gives a measure of the fit with that strategy.

Barriers and enablers

5. Environmental impact (other than GHG) – in some cases there is an additional impact on the environment, other than from GHG, which can be positive or negative

6. Wider economic impact (other than GHG) – some technologies/applications may have a wider economic impact than that associated with the energy sector and GHG, for example there may be additional markets.

7. Societal – planning/policy/public acceptability – in some case UK society can encourage or be against a particular technology/ application; this is usually expressed through planning procedures, policy or public acceptability.

8. Scientific or technical risk – this refers to the scientific or technical risk involved in getting to the commercial deployment stage

9. Regulatory or fiscal incentives – in some cases there are regulatory or fiscal incentives in place to encourage early commercial deployment; alternatively there may be regulatory or fiscal barriers that prevent or obstruct commercial deployment

10. Timescale to commercial deployment – this refers to the timescales relative to the current position, with the categories as defined in Appendix 3, for the start of large scale commercial deployment – defined as when sufficient deployment occurs to make significant contribution to UK energy needs (same definition as used by ERP Work Stream 1).

11. Costs to commercial deployment (to GW scale) - relative costs to reach commercial deployment on a scale that has significant impact in the UK (eg to GW market size or equivalent). 'Large' approximates to £hundreds of millions; 'small' approximates to £millions.

12. Market willingness to invest – a measure of how willing the market-place is to invest in the development through to commercial deployment

ANNEX D

Explanation of selection criteria continued

13. Ultimate export potential – the expected size of the export market assuming it reaches commercial deployment. 'Large' equates to a market size in the GWs, or £billions, range; 'small' equates to MWs, or £millions, range.

14. Link with EU energy policy priorities – a measure of how well aligned it is with the priorities in EU energy policy and EU RDD&D strategy

15. Availability of appropriate international standards – a measure of whether appropriate international standards are in place to enable commercial deployment

Other considerations

16. Strength of UK R&D relative to international capabilities – considers all UK R&D organisations. 'Key international contribution' means there would be a significant international impact if it stopped.

17. Prominence in international energy policies – a measure of its significance in energy policies and RDD&D strategies in other countries around the world.

18. Availability of appropriate materials technologies – a measure of whether or not materials R&D is needed to enable commercial deployment

19. Availability of C&I and monitoring – a measure of whether control and instrumentation or monitoring R&D is needed to enable commercial deployment

ANNEX E

Definition of criteria

KEY TO CRITERIA RAG INDICATOR

WEIGHT DEFINITIONS:-

High = Essential and key criteria for choosing technologies
Med = Enablers or barriers, some of which may be overcome during development process
Low = Other considerations

NO.	CRITERIA	ABBREVIATION	WEIGHT	GREEN
1	Potential for ETI to add value	ETI val.	High	High
2a	Impact - GHG reduction (UK)	GHG	High	Significant positive
2b	Impact - Security of Supply (UK)	SoS	High	Significant positive
2c	Impact - Fuel Poverty (UK)	Fpov.	High	Significant positive
2d	Impact - Competitive Markets (UK)	Mkts	High	Significant positive
3	Size of a mature global market	Mksize	High	Large (GW.eqv scale)
4	Fit with government technology strategy	Strat	High	Strategy recommends
5	Environmental impact (other than GHG)	Env.	Medium	Significant positive
6	Wider economic impact (ie broader than GHG)	Econ.	Medium	Significant positive
7	Societal -planning/ policy/ public acceptability	Soc.	Medium	Significant positive
8	Scientific or technical risk	TecRsk	Medium	Low Risk
9	Regulatory or fiscal incentives	Reg.	Medium	Clear incentives
10	Timescale to commercial deployment	Time	Medium	0-10y
11	Costs to commercial deployment (to GW scale)	Cost	Medium	Low cost
12	Market willingness to invest	Invest	Medium	High
13	Ultimate export potential	Export	Medium	Large (GW.eqv scale)
14	Link with EU energy policy priorities	EUlink	Medium	Well aligned
15	Availability of appropriate international standards	Stdrds	Medium	Already exist
16	Strength of UK R&D relative to international capabilities	Strgth	Low	Key International contib'n
17	Prominence in international energy policies	Intl.	Low	Key in no. of countries
18	Availability of appropriate materials technologies	Matls	Low	Already exist
19	Availability of C&I and monitoring	C&I	Low	Already exist

ANNEX F

Workshop attendees

AMBER	RED
Medium	Low
Limited impact	Significant negative
Limited impact	Significant negative
Limited impact	Significant negative
Limited impact	Significant negative
Medium	Small (~ few MW.eqv)
Strategy neutral	Strategy discourages
Limited impact	Significant negative
Limited impact	Significant negative
Limited impact	Significant negative
Medium	High risk
None present	Reg/ fis bar'ers in place
10-20y	20+y
Medium	High cost
Medium	Low
Medium	Small (~ few MW.eqv)
Some correlation	No alignment
Some definitions	Not covered
Recognised capability	No significant capability
Limited visibility	Does not feature
Some development required	Requires significant development
Some development required	Requires significant development

NAME	SURNAME
Raj	Aggarwal
Andrew	Boston
Nigel	Brandon
Michael	Colechin
Harry	Eccles
Mike	Farley
Richard	Green
Tim	Green
Geoff	Hammond
Stuart	Hazeldene
Nick	Jenkins
David	Klug
Bill	Leithead
Gordon	McKerron
David	Infield
Gavin	McPherson
Peter	Reason
Sebastien	Ruez
David	Rutherford
Jim	Skea
Garry	Staunton
Peter	Storey
Jim	Swithenbank
Henry	Jeffrey
Matthew	White
Mark	Winskel
Tony	Oliver
Filomena	LePorta
Katherine	Newell
Iftikhar	Kran
Nick	Riley
Assen	Gasharov
Henry	Jeffrey
Robert	Lowe
Alison	Wall
Vania	Croce
Johanne	Bunce

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