Challenges in Materials R&D in solving Environment and Energy problems

UK Energy Technologies Institute response

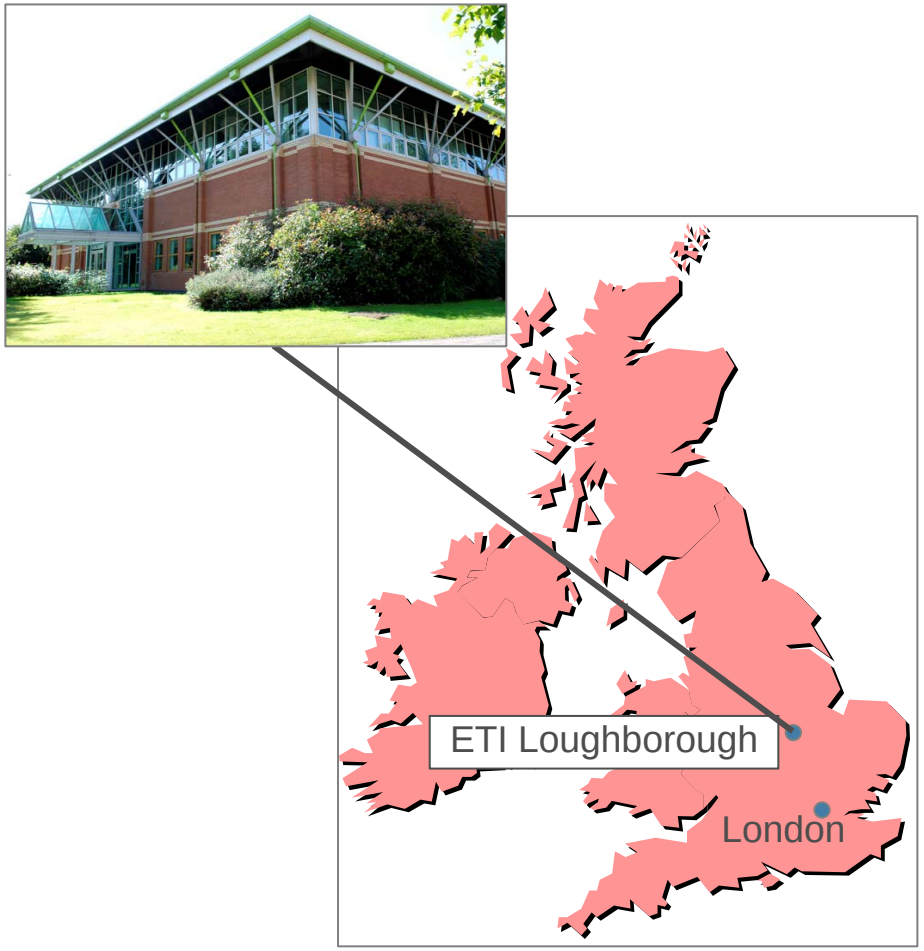
May 29th 2008

David Clarke – Chief Executive ETI

www.energytechnologies.co.uk

Energy Technologies Institute

- 50:50 public private partnership
  - up to £110m p.a.
  - up to 11 core industry partners each committing up to £5m p.a.
  - UK Government commitment - £550m over 10 years
- Energy research, technology development and validation
- HQ at Loughborough Technology Park, UK



Energy Technologies Institute (ETI)
- overview

- ETI invests in technology and service development projects in areas that address Climate Change, Energy Security and Energy Poverty
  - *Focused portfolio of large scale projects – each typically £5m - £25m*
  - *Each project aims to accelerate development, demonstration and then commercial deployment of low carbon technologies and services*
  - *'Supply-side' and 'Demand-side' will be addressed*
  - *Projects delivered through multi-partner consortia – national and international*
  - *Outputs to be made available as widely as possible following delivery in line with partner needs and agreed ETI outcomes*

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Energy Technologies Institute - members

- £50m investment by each member secures access to £1.1bn R+D programme over 10 years
- Opportunity for up to 11 industry members

Department for **Innovation, Universities** & **Skills**

EPSRC

Department for Transport

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Outcome Focused

- ETI's programmes over the next 10 years will support …..

- Reducing greenhouse gas emissions
  - *UK targets - 15% renewable energy by 2020 and 60% CO_2 reduction by 2050*
  - *'Supply-side' generation and 'demand-side' efficiency and operational improvements*
- Accelerating development and deployment of affordable low carbon technology and service solutions
- Increasing security of energy supply in conjunction with greenhouse gas mitigation
- Increasing the level and capacity of the global low carbon skills pool

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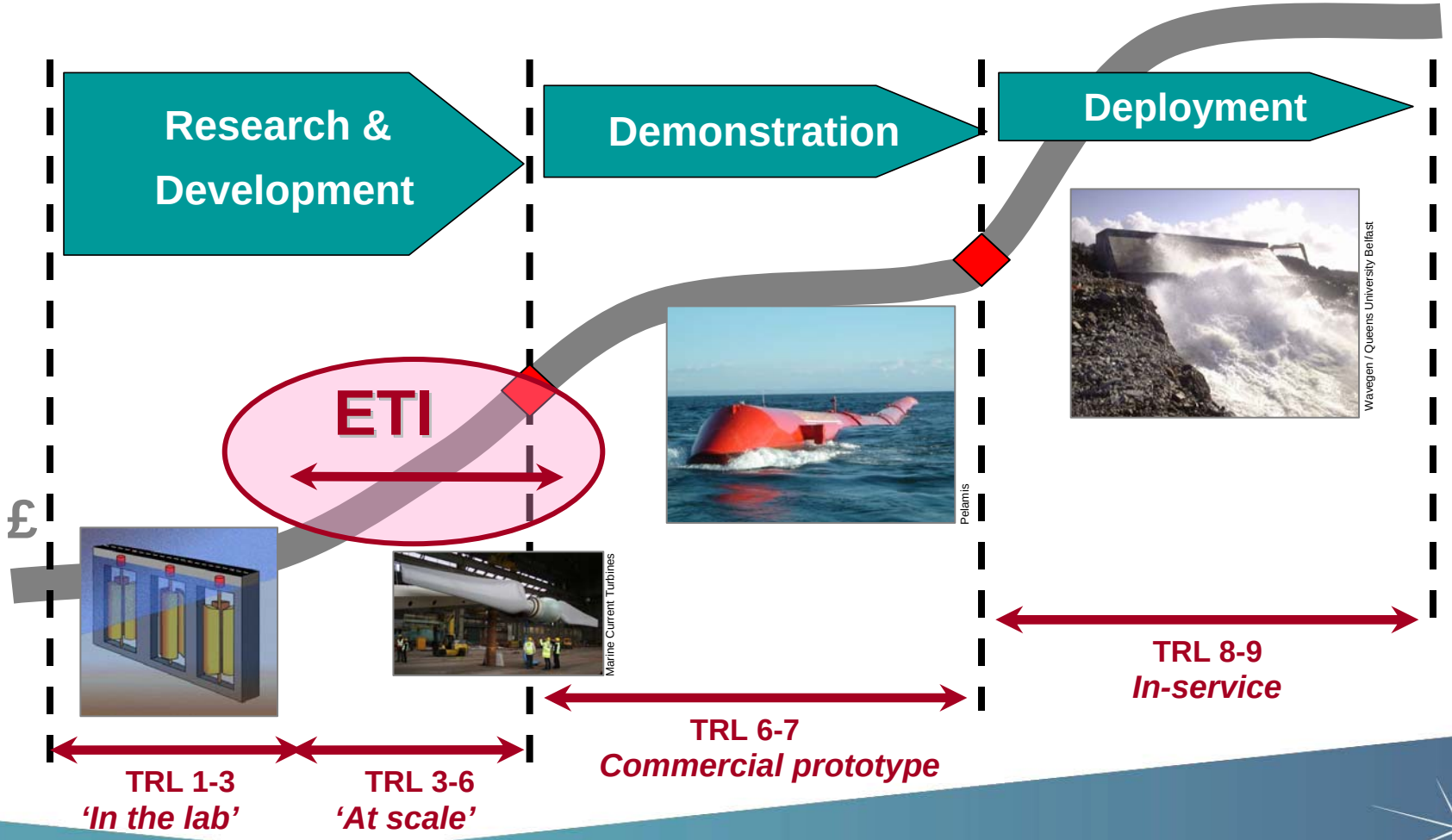
ETI is central in the Energy Innovation Chain …..

Technology push & knowledge transfer...

… market pull & public policy



TRL = Technology Readiness Level, Images are for illustration of TRL definitions and are ETI assumed TRL status of a range of marine devices at early 2008

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A typical ETI project will provide…..

- Collaborative development and demonstration of system level capabilities
  - Technologies and / or services
- Development of supply chain capabilities and demonstration of potential new capacity
- Demonstrable de-risking of the system and supply-chain at commercially relevant scale to potential investors or operators
- Identification of critical areas requiring ‘next generation’ science and technology support through university and research institute based activity
- New IP and skills in low carbon energy
  - Benefiting project partners, ETI members, the wider industrial base and society

Hammerfest strom / Rolls-Royce

Oxford University

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Benefits to Project Consortia

- Scale of funding
  - *typical projects expected to be £5-25m*
- Potential for ETI to fund 100% of project costs
- Access to capabilities of ETI Members
  - *Skills, Technology, Services, Market access*


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Making ETI work - Technology Programmes

- First programme calls 17th December 2007
  - *Offshore Wind, jointly with the Carbon Trust*
  - *Marine – wave and tidal*
- 100+ Expressions of Interests received for each programme
- Project proposals in development
- Distributed Energy programme launched 16th April 2008
  - *Focused on CHP and Alternative Fuels*

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Energy Technologies Institute's pilot programme in marine energy: wave and tidal stream

We invite organisations to join us to develop a small number of major new development and demonstration projects in marine energy. We expect projects to be funded at a level of £5 million to £10 million.

Marine energy could supply up to 2GW of UK electricity demand by 2020 and significantly more than this by 2050. However, progress towards commercial devices has been slower than predicted. ETI funding is well placed to accelerate the development and small scale demonstration phases by the commercial and end-user focus brought by ETI's industrial membership.

The UK is leading internationally in the development of marine energy but further development investment is needed to move the technology forward. We aim to bring together UK and international expertise to support and to accelerate the realisation of marine energy as a major contributor to energy provision.

Our outcome goals are to:

- increase deployment to 2GW by 2020 and towards 30GW by 2050
- reduce electricity costs to be competitive with established renewables by 2020 and with conventional generation 2050.
- increase unit availability (not including weather risks) to 90% by 2020 and 99% by 2050.

If you would like to be involved as a potential project participant, please send an expression of interest to us by 19 February 2008.

If you would like to be involved as an ETI Programme Associate, please contact us for a discussion.

Energy Technologies Institute

The Energy Technologies Institute (ETI) has been established to spearhead the UK response to the energy challenges of reducing green house gas emissions and energy security of supply, by developing a focused portfolio of commercially viable, sustainable energy technologies.

A public/private partnership, the ETI is backed by companies including BP, Caterpillar, EDF Energy, E.ON, Rolls-Royce and Shell. Its target is to secure up to 11 private sector investors, each contributing £5 million per year for 10 years, with the UK Government matching these investments to create a potential £1 billion investment fund for new energy technologies. The public sector funders are the Engineering and Physical Sciences Research Council (EPSRC) and the Technology Strategy Board (TSB) with additional funding from the Department for Transport.

Technological excellence and innovation are central to achieving our energy goals and the ETI represents the most important development in UK energy research and innovation for decades. ETI brings together

For further information visit www.energytechnologies.co.uk

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Making ETI work – some potential programme areas

- Wind (primarily offshore)
- Marine
- Distributed energy
- Energy Networks – grids and management
- Efficiency in Domestic and Commercial Buildings
- Transport (inc non-hydrocarbon fuels and small-scale energy conversion systems)
- Carbon capture, handling and sequestration (CCS)
- Waste Heat Recovery and Conversion
- Storage Technologies - Small scale & Large scale
- PV Solar
- Industrial Processes (Process effectiveness and Demand Reduction)
- Large Scale Energy Conversion (inc efficiency improvement on fossil fuel systems)
- Bioenergy - Liquid Fuels, Bioenergy - Heat and Electricity
- Fuel Cells
- Advanced Conversion technologies
- And ……?

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Materials UK Energy Review 2007

- National review across key application areas
  - Fossil Fuel
  - Nuclear
  - Alternative energy systems
  - Transmission, Distribution and Storage
- Identified 3 focus areas for materials R+D
  - Reducing time to market and life cycle costs (solar, fuel cells, marine)
  - Higher performance in harsher environments (Carbon capture, co-firing, nuclear)
  - Improved life management and reliability (offshore wind, nuclear)

Materials UK Energy review 2007

- Identified 5 common underpinning technologies
  - Design/materials integration
  - Modelling (materials and process)
  - Life time prediction methodologies
  - Condition monitoring, sensors, NDE
  - Repair, joining

Materials UK Energy review – Priorities and Timing

Now

Ongoing incremental R&D

- support existing fossil / nuclear life extension & grid infrastructure / networks

<5 years

Near term-applied R&D to assist rapid, cost effective deployment

- clean fossil, offshore wind, marine, networks

5-10 years

Medium term applied R&D

- remove barriers to large scale deployment-costs & reliability for fuel cells, solar pv

>10 years

Longer term-fundamental R&D

- hydrogen, superconductors

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Critical issues for ETI confirmed through current programmes *- all link to UK 2007 Materials review priorities*

- Roadmapping and technology strategies
  - *Industry understanding*
  - *Global capabilities and links*
- Manufacturing supply-chains
  - *Enabling volume production*
- System integration capabilities
  - *Engineering, manufacturing, installation, operation and support*
  - *Validation of modelling techniques in all these areas*
- Underpinning skills supply and development
  - *Long-term capability with critical mass for effective delivery*

Priority areas will benefit from global collaborations

- Opportunities to establish complementary programmes
  - Financial effectiveness and leverage
  - Rapid delivery
- Sharing of capabilities
  - Skills
  - Facilities
  - Supply-chains
  - Experience and ‘lessons learnt’
- Creating new supply routes
- Creating new market access routes

- **Accelerating the pace of energy R+D**
- **Catalysing deployment of low carbon solutions**

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Through …….

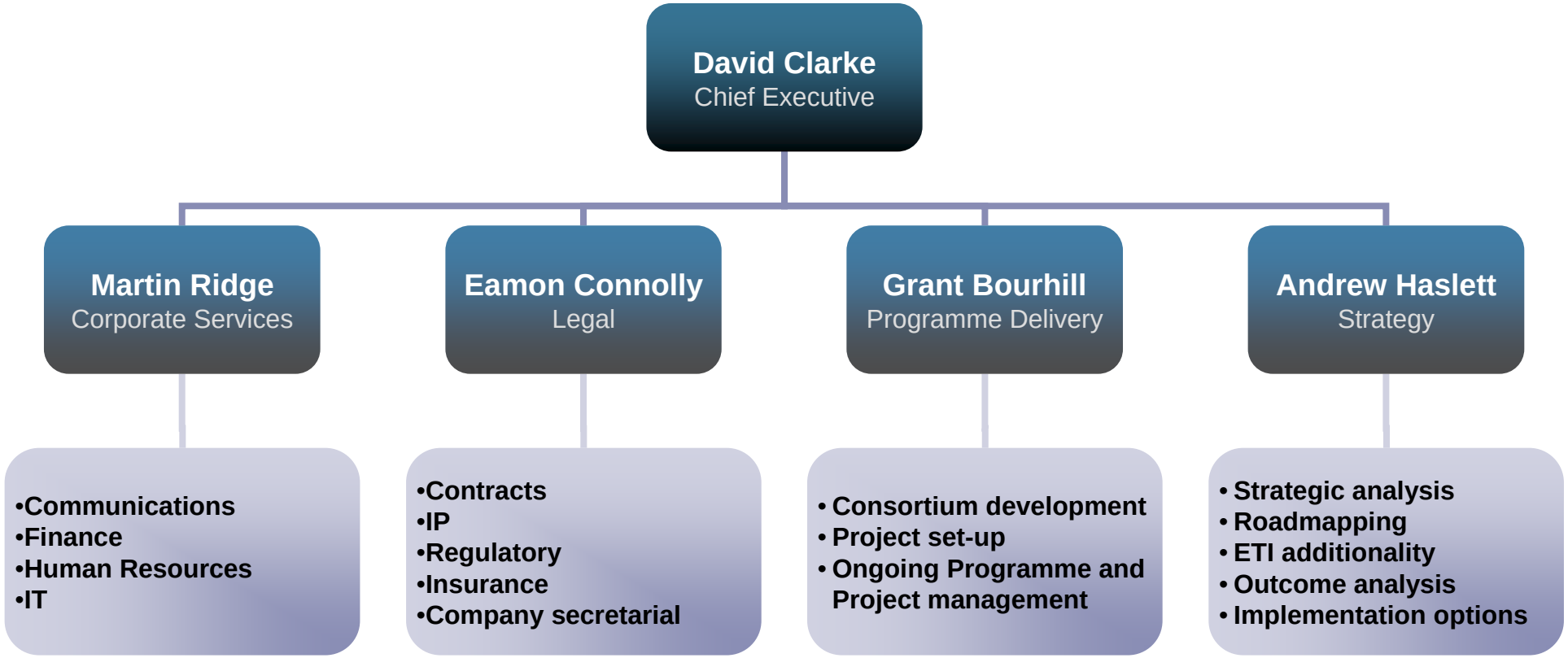
- ***Collaboration and system demonstration***
- ***Focus and effective decision making***
- ***Effective pull-through from the technology base***
- ***Growth in engineering and technology skills and capacity across industry and academia***
- ***An increased "appetite" for risk at all levels***

Background Information

www.energytechnologies.co.uk

Organisation and Governance

Making ETI work – Organisation



Making ETI work – Values

- Integrity
  - *Operating in a safe, open, ethical manner and being accountable for our activities*
- Innovation
  - *Demonstrating new and more efficient processes, technologies, operations and services*
- Ambition
  - *Delivering against demanding targets and timescales and learning from experience*
- Collaboration
  - *Creating skilled communities with common purpose and shared capabilities*
- Focus
  - *Concentrating on solutions that will make a real difference*

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A typical ETI project might be …..

A typical ETI project might be ……..

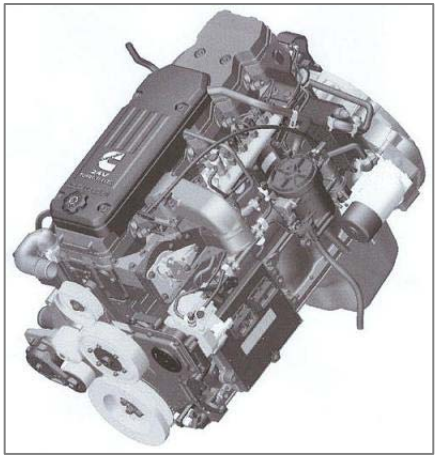
- Marine
  - Design, manufacture, test and decommissioning of a 500KW (full-scale) tidal current turbine at the EMEC test site off Orkney, Scotland
  - Goals – demonstrate reduced cost generation, improved system reliability and maintainability
  - Cost / Time - £12m over 2 years
  - Delivery risk – Medium
  - Partners – 2 ETI members, EMEC, 3 UK SMEs

Hammerfest strom / Rolls-Royce

Science Friday

A typical ETI project might be ……..

- Transport
  - Validation of combustion characteristics of an alternative diesel fuel using a range of bio-feedstocks
  - Goals – demonstrate ability to utilise fuel incorporating a range of sustainable feedstocks and develop database of necessary fuel characteristics and operating parameters
  - Cost / Time - £30m over 4 years
  - Delivery risk – Medium
  - Partners – 1 UK Corporate, 1 UK SME, 2 UK Universities, 1 European Corporate



Cummins

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A typical ETI project might be ……..

- Energy use in Buildings
  - Development of modular, low-cost Combined Heat and Power system and test technical and social science viability through incorporation into a new commercial building project
  - Goals – create viable design and manufacturing systems for compact, reliable and efficient heat delivery units that can be moved economically and effectively from site-to-site as building heat loads vary with building utilisation / purpose
  - Cost / Time £25m over 3 years
  - Delivery risk – Medium to High
  - Partners – 1 ETI member, 2 UK Universities, 1 North American University, 4 UK SMEs

Oxford University

Gussing / www.renet.at

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A typical ETI project might be ……..

- Demand-side management
  - Integration of active demand management systems with ‘smart metering’ and micro-generation renewable energy systems
  - Goals - demonstration at individual building level of management systems for generator and load controls whilst maintaining system stability and required quality levels
  - *Spin-off benefits in development of reliability database, maintenance procedures and interface requirements with main power grid*
  - Cost / Time - £20m over 2 years
  - Delivery risk - Medium to High
  - Partners - 3 ETI members, 1 US corporate, 1 Far East Corporate, 2 Universities

E.ON

Technology Readiness Levels (TRLs)

UK Innovation Chain for Low Carbon Energy systems

Technology Readiness Levels - Design and systems engineering
- ETI role is in TRLs 3-6

System validation

9) **Actual system proven** through successful mission operation

8) **Actual system completed and service qualified** through test and demonstration

7) **System prototype demonstration** in an operational environment

Final technology validation in *deployment* of a prototype product

Technology validation

ETI – Primary role

6) **System/subsystem model validation in a relevant environment**

5) **Component and/or partial system validation in a relevant environment**

Applied and strategic research

4) **Component and/or partial system validation in a laboratory environment**

3) Analytical and experimental critical function and/or characteristic proof-of-concept

Technology Validation– enabling technology pull-through)

2) Technology concept and/or application formulated

1) Basic principles observed and reported

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Executive team backgrounds

David Clarke, Chief Executive

- *David Clarke joined the ETI from his previous role of Head of Technology Strategy at Rolls-Royce plc. David has been involved in collaborative research and development of advanced technologies for over 20 years, leading a range of research groups including Rolls-Royce's Advanced Materials development activities and its corporate Strategic Research Centre. With the latter group he led Rolls-Royce's evaluation and development of new technology opportunities in fields as diverse as fuel cells, electrical propulsion technologies and advanced computational diagnostics.*

  With Rolls-Royce he was responsible for development and management of the Company's global research strategy. This included the company's multi-million pound University-based research programme at the Rolls-Royce University Technology Centres in the UK, North America, mainland Europe and Asia.

  He has also been a member of EPSRC Council and is a member of the North West Science Council.

  David graduated from the University of Surrey in 1984 with a BSc in Materials Technology, where he subsequently completed his PhD in Composite Materials in 1988. He is a Fellow of the Institute of Materials and a Chartered Engineer.

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Andrew Haslett, Director – Strategy

- *Andrew Haslett joined the Energy Technologies Institute from his previous role as Group Science & Technology Director (Measurement & Modelling) at ICI plc. Andrew has been involved in process and product technology development for 30 years, leading a range of research and engineering groups.*

  His experience covers a very wide range of technologies from large scale high hazard process plant engineering to developing electronic materials and also a broad range of industrial and consumer applications. He has experience of development, design and operation of large scale plant and also technology licensing and the sale of technology based services. At ICI he was recently responsible for the development of the Group Technology Strategy and for assisting businesses to measure and improve their application of technology to innovation.

  Andrew graduated from Cambridge University in 1977 with a BA in Chemical Engineering. He is a Fellow of the Royal Academy of Engineering, of the Institution of Chemical Engineers and the Royal Society for the encouragement of Arts,Manufactures & Commerce. He is a Chartered Engineer and a Chartered Scientist.

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Grant Bourhill, Director – Programme delivery

- *Grant Bourhill joined the Energy Technologies Institute in April 2008 from his previous role as Director of Business Development at Sharp Laboratories Europe. During his seven years at Sharp, Grant held roles including Director of R&T Programme Delivery for Optical Systems, as well as leading a team that established and maintained several global collaborative programmes. He successfully developed a number of technologies within his portfolio from concept through to successful overseas mass manufacture. Grant has also been involved significantly in IP management for both internal technology development as well as external company technology spin-in.*

  Prior to Sharp, Grant spent five years at QinetiQ in emerging technology management, including work on innovative composite damage sensors, which was recognised by the Rank Prize for Optoelectronics.

  Grant graduated from the University of Strathclyde with a BSc in Chemistry and subsequently completed his PhD in Nonlinear Optics at the same university. He has been a recipient of both a NASA Fellowship and a Von Humboldt Research Fellowship and has over 30 patents and more than 40 publications in peer-reviewed journals. He has enjoyed periods living and working in the USA, Japan and Germany.

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Eamon Connolly, Director – Legal

- *Eamon Connolly joined the Energy Technologies Institute in May 2008 as Director - Legal, having previously been Head of Intellectual Property at the Linde Group (formerly the BOC Group). During his five years at the Linde Group, Eamon was responsible for all intellectual property matters within the group, managing the development and acquisition of intellectual property rights through to the exploitation of the intellectual property rights of the group. He managed a team of intellectual property professionals in the UK, the US and Germany.*

  Prior to this, Eamon worked as a solicitor in the Intellectual Property Department of Herbert Smith, a leading City law firm.

  Eamon has a degree in Mechanical Engineering and Economics from the University of Birmingham.

Martin Ridge, Director – Corporate Services

- *Martin Ridge joined the Energy Technologies Institute as Director – Corporate Services in January 2008 on a two-year secondment from the UK Department for Innovation, Universities and Skills, where he was Deputy Head of the Research Councils Unit.*

  Martin's background is in scientific research and technology transfer in academia and industry in thin films, surface science and compound semiconductors. He has worked in Brussels for the Eureka Secretariat and has considerable experience of EU and UK collaborative research programmes in the areas of innovation and knowledge transfer. More recently he was involved in developing the UK Department for Trade and Industry's strategy and establishing the Energy Technologies Institute.

  Martin graduated from Loughborough University of Technology in 1984 with a BSc in Electronic Engineering and Physics and a PhD in thin films and surface science. He earned an MBA from London Business School in 1991 and is a Fellow of the Institute of Physics, a Member of the Institution of Engineering and Technology and a Chartered Engineer.

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