Energy Materials Research in Europe

John Oakey

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- Research Approach in the EU
- UK and EU Initiatives
- Materials Research Priorities

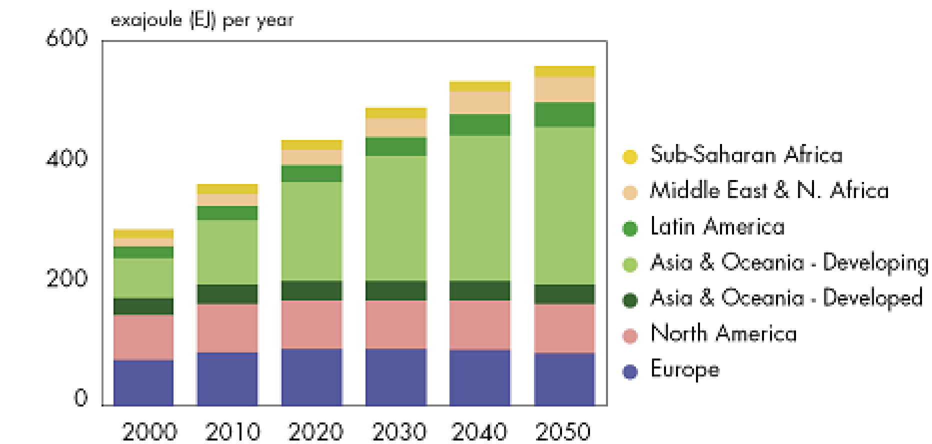
CO_2 emissions reduction

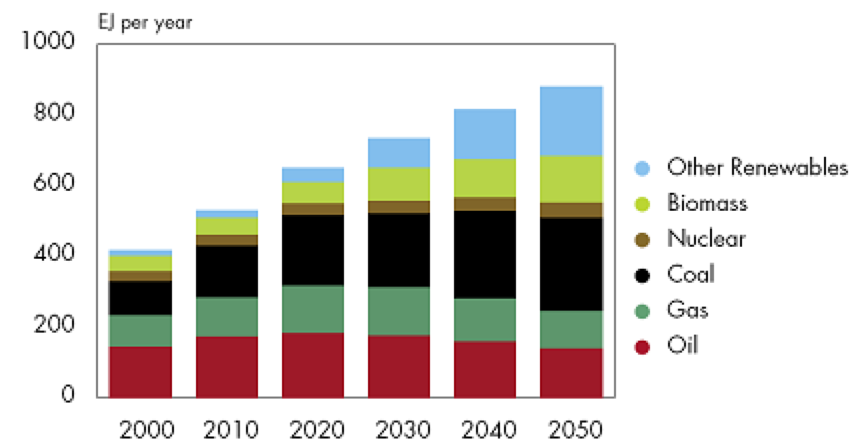
Technology options

CO_2 reduction

- Reducing energy consumption
- Switching to other fuels
    - natural gas in place of coal
    - renewable sources
    - nuclear power
- Sequestering CO_2
    - enhance natural sinks for CO_2
    - Capture and storage of CO_2

Rising Energy Consumption





source: IEA

The EU Approach

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Research/development/demonstration priorities are set through a <u>bottom up</u> route

- Industry/RTO/Academic Groups formed
- Funding bodies develop competitive calls
- Industry/RTO/Academic Groups form consortia to bid for funding
- Bids reviewed by independent panels – peer review
- Contracts placed to carry out the research within legal/commercial constraints
- IPR owned by the research providers

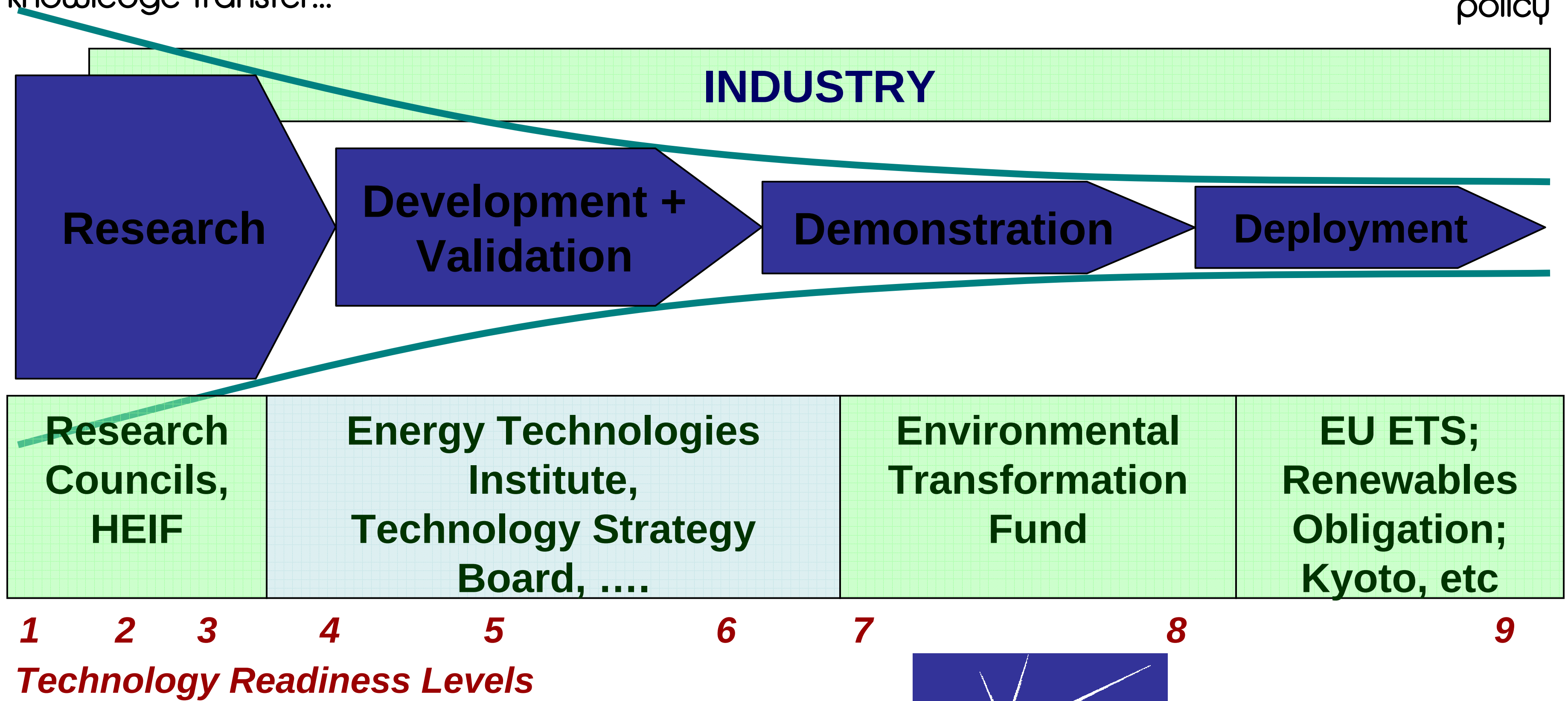
Funding can vary from 25% up to 100% depending on the nature of the research

- Fundamental research at universities through EU and national research bodies – 100%
- Industry and industry:university national R&D projects – 50% (EU state-aid rules)
- Industry and industry:university EU R&D projects – a mix of the above
- Industry demonstration projects – 25%

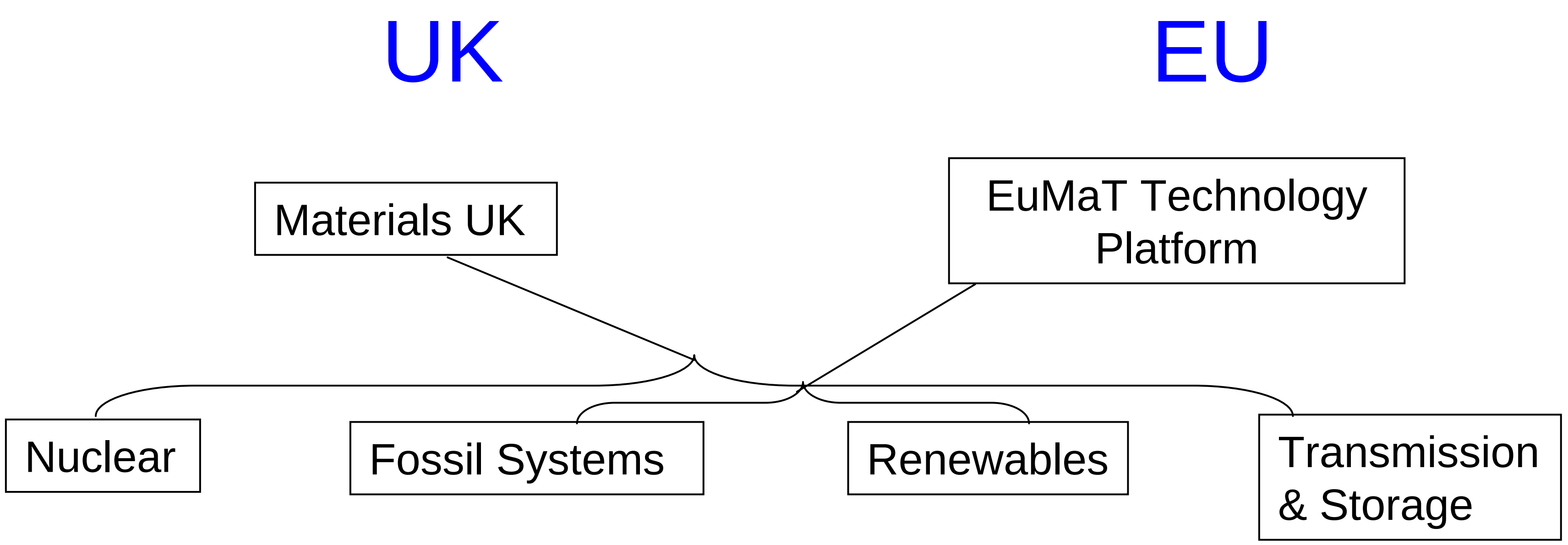
UK Funding Options for UK Energy R, D, D & D

Technology push & knowledge transfer…

… market pull & public policy



UK/EU Energy Materials Groups



Developing the MatUK Strategic Research Agenda for Energy Materials

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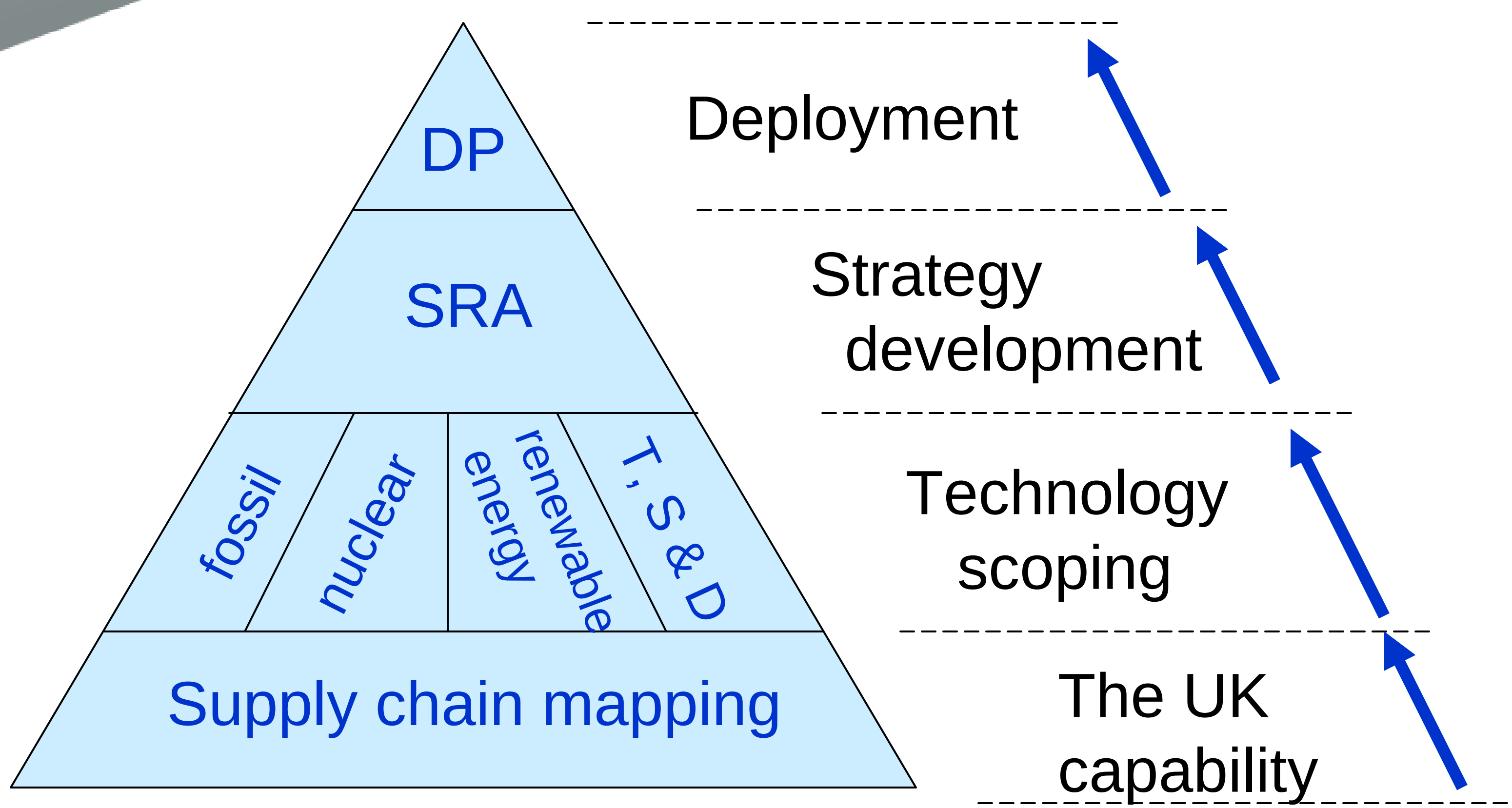

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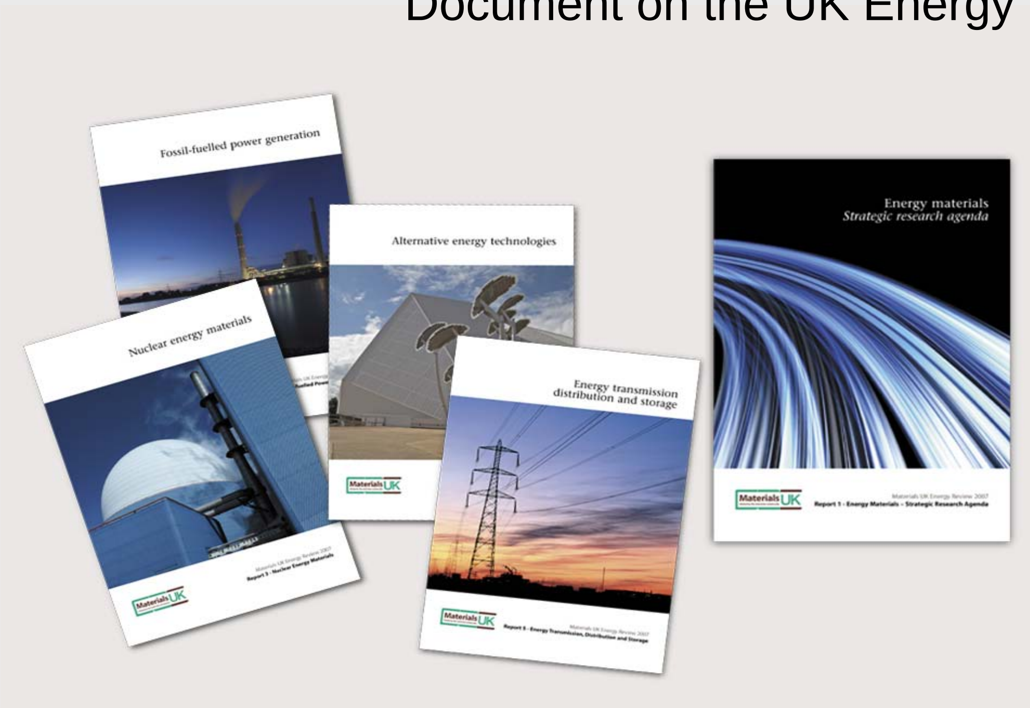
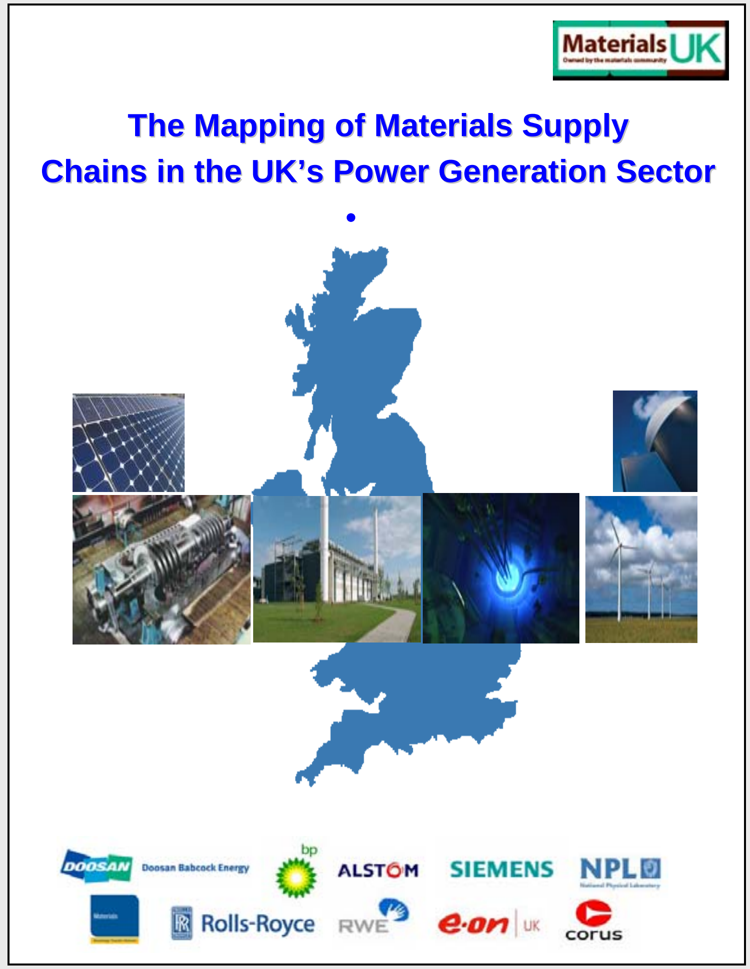
MatUK Energy Materials Outputs

4 key technology scoping reports and the SRA and a Consultation Document on the UK Energy Materials supply chain





EuMaT

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European Technology Platform for Advanced Engineering Materials and Technologies

Overall objective

……the promotion of the leading global position and global competitiveness of the EU technology in the area of Advanced Engineering Materials, as well as promotion of the consolidated and unified R&D and innovation European policy in this area…

….to assure optimum involvement of Industry and other important Stakeholders in establishing European R&D priorities.

EuMaT

European Technology Platform for Advanced Engineering Materials and Technologies

EuMaT

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An Effective vision of the Industrial needs

Innovative use of existing materials based on good understanding of applications, material requirements and materials degradations mechanisms

Modification of existing materials to fit better for applications (new grades for existing materials systems, possibly new manufacturing processes)

Development of entirely new materials or materials groups (nanomaterials, active/intelligent materials, composites, hybrid and multimaterial structures etc.)

Breakthrough

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Testing and characterization…

Use, exploitation, maintenance …

Inspection, maintenance, repair…

Component / system manufacturing…

Hazards, risks, impacts…

Advanced Design and modeling …

Recycling, decommissioning…

Life-cycle simulation and optimization

EuMaT

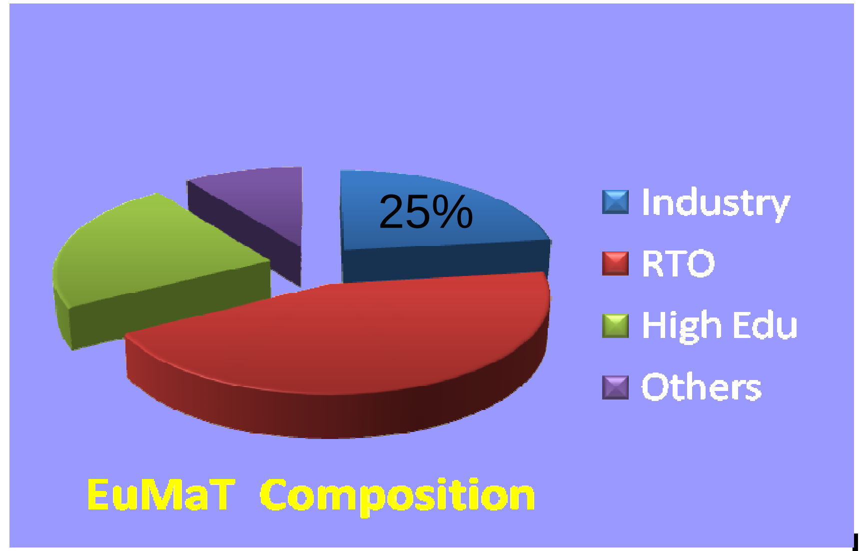
European Technology Platform for Advanced Engineering Materials and Technologies

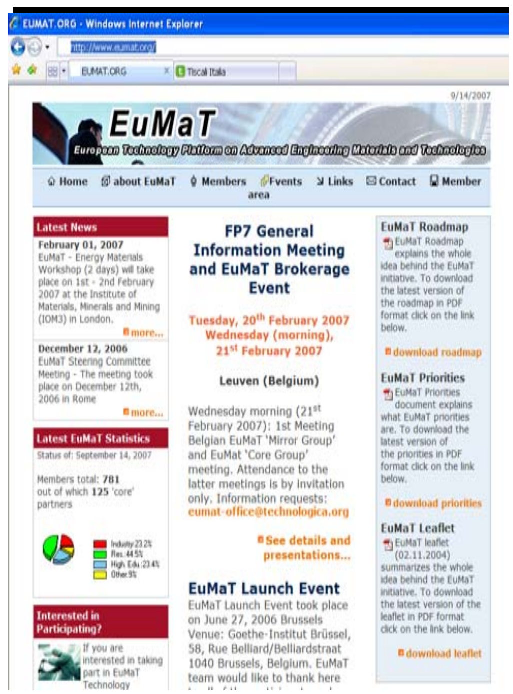
SUPPORTING:

- *All "steps" in the life-cycle of Advanced Engineering Materials*
- *All related "horizontal aspects" like education, standardization, social responsibility, databases, IT, www, publication, information dissemination…*

Development and Production of Advanced Engineering Materials, multimaterials, nano-, MF- , TBC, gradient, virtual, …

EuMaT Outputs





www.eumat.org

Impact to date

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European Commission funding for projects on *Novel materials for energy applications*

Joint Call between two areas of the European Commission's Framework Programme 7 (FP7) - Energy and Nanosciences, nanotechnologies, materials & new production technologies (NMP)

Key aspects of FP7

- **Research and demonstration programme**
- **Collaborative (min. of 3 different member states or associated countries in proposal consortium)**
- **Cost sharing:**
  - **Research - 50% (75% for SMEs, public bodies, universities)**
  - **Demonstration – 50%**
- **Innovative**
- **European impact**

Call for Proposals

- **Call to be published on 30th November '07**
- **Stage 1 deadline likely to be in February '08**
- **Budget 25M€**
- **2 stage submission process:**
  - **Evaluation Stage 1 proposals: February/March 2008**
  - **Evaluation stage 2 proposals: May/June 2008**

The Call is currently only in draft format however early indications are that the priority fields of application for energy technology are likely to be energy conversion and storage, photon capture and CO_2 capture and storage.

To receive more information please contact energie@enviros.com (UK National Contact Point for Energy in FP7).

Technology Strategy Board

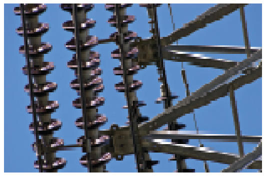
Materials for Energy
Autumn 2007 Competition for Funding

The Technology Strategy Board and the Engineering and Physical Sciences Research Council have allocated an indicative amount of £12M to fund highly innovative collaborative research proposals in Materials for Energy. Funding is available for industry-led collaborative projects across a range of Technology Readiness Levels, from basic research to applied research and development in materials technologies that will enable the UK to rapidly meet the urgent and difficult challenges posed within the global Energy Sector.

The focus will be on the development of materials technologies for:

- Energy generation
- Energy transmission and distribution
- Energy storage
- Energy conservation

It is also anticipated that materials developments in these areas will have spillover energy-related benefits for other industrial sectors; e.g. transport, including aerospace.



Background

Energy supply and the control of CO_2 emissions represent major environmental and sustainability challenges for the UK. Materials technologies can play an important role in meeting these challenges, within a worldwide context.

Energy demand in the UK is set to grow as the economy expands, with 30-35GW of new electricity generation capacity needed over the next two decades and around two thirds of this required by 2020[1]. This must also be seen in the context of a security of supply, the UK will require a balanced future energy portfolio, potentially including a mix of fossil, nuclear and renewable energy sources. Energy generation in each of these areas, together with storage and power transmission, will continue to need advancement in the development and application of materials technologies.

Materials will also have an important part to play in the more efficient use of energy. For example, in the built environment sector, to meet the 2050 targets for carbon emissions, the thermal performance of the existing housing stock must be dramatically

Fossil Fuelled Power Generation.

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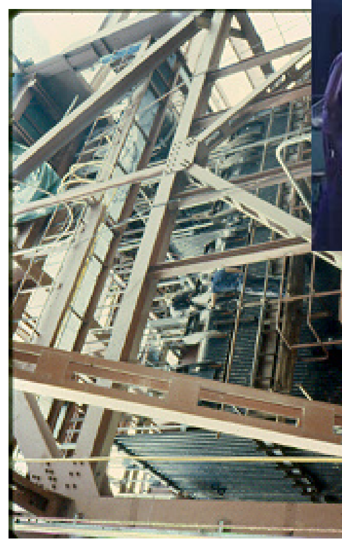
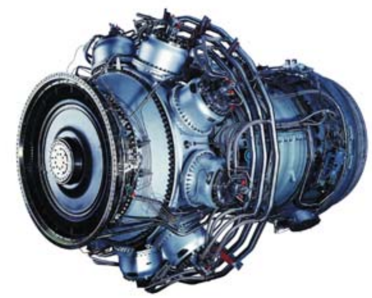
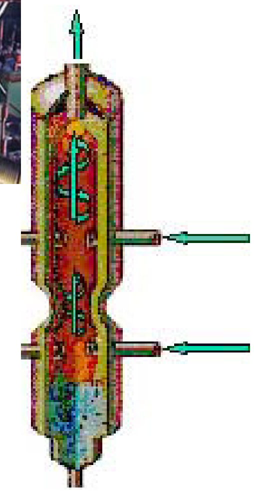
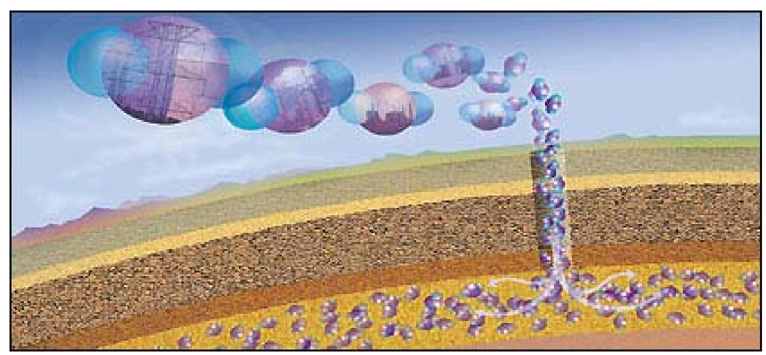
Scope

- Boilers.
- Steam Turbines.
- Gas Turbines.
- Gasifiers.
- CO_2 Capture.



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Key Materials Challenges – 5 Years.

- Production and characterisation of prototype components manufactured using identified materials and processes.
- Repair and improvement solutions for existing plant and materials.
- Advanced manufacturing development for existing materials and processes aimed at cost reduction, increased performance and integrity.

Refurbishment and Repair of a Steam Turbine – © Sulzer Metco

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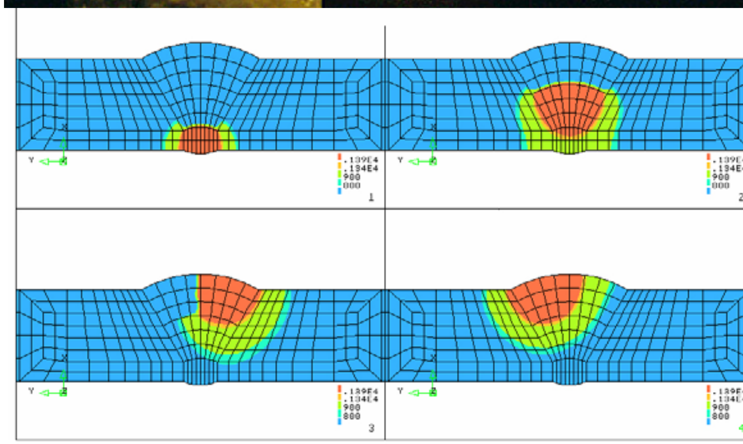
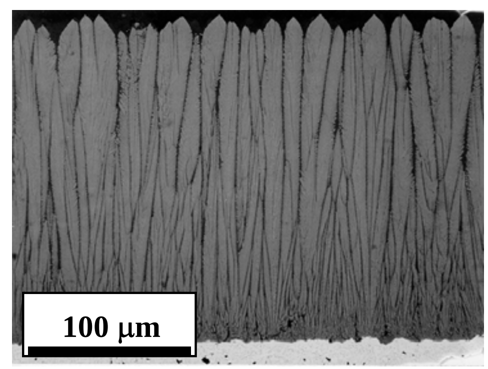
Key Materials Challenges – 10 Years

- Development of new material systems (substrate and coatings) based on existing knowledge including behaviour in realistic environments.
- Development and application of process modelling to new materials to speed up introduction and help define new system solutions.
- Adopting a total system approach to critical part design and life prediction with multi-material components with joints and coatings.





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Key Materials Challenges – 20 Years

For example - gas turbine materials targets for 2020.

- ➢ Density <7g cm-3.
- ➢ T capability >2100K.
- ➢ Oxidation resistance 1450K.
- ➢ Creep +100K over current.
- ➢ Ductility equivalent to TiAl.
- ➢ Recyclable

- Material ????
- Manufacturing process??
- Etc.

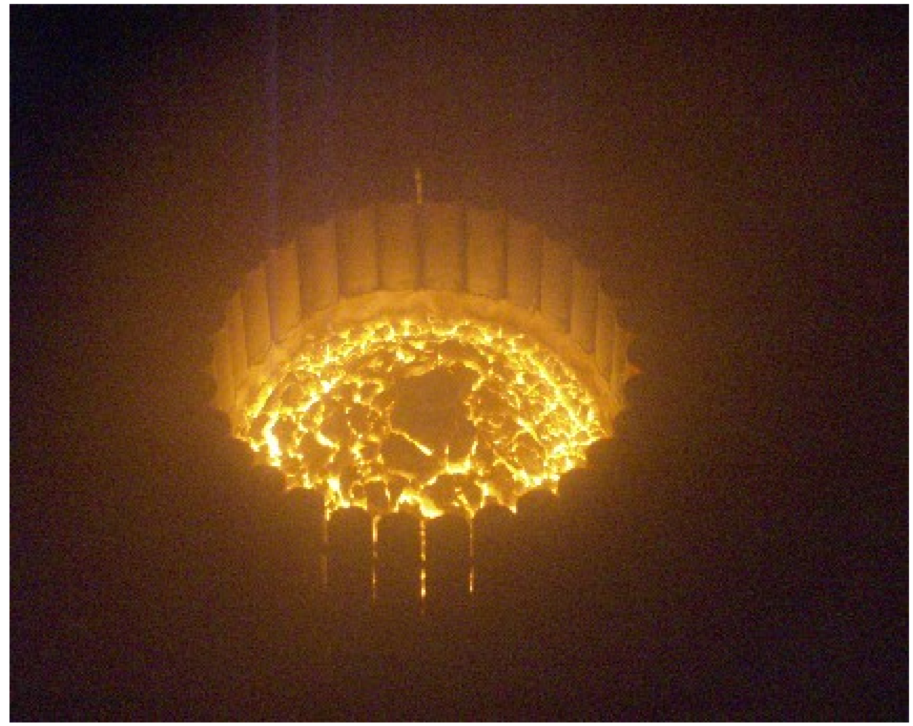

Image © Berlin TU

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Biomass

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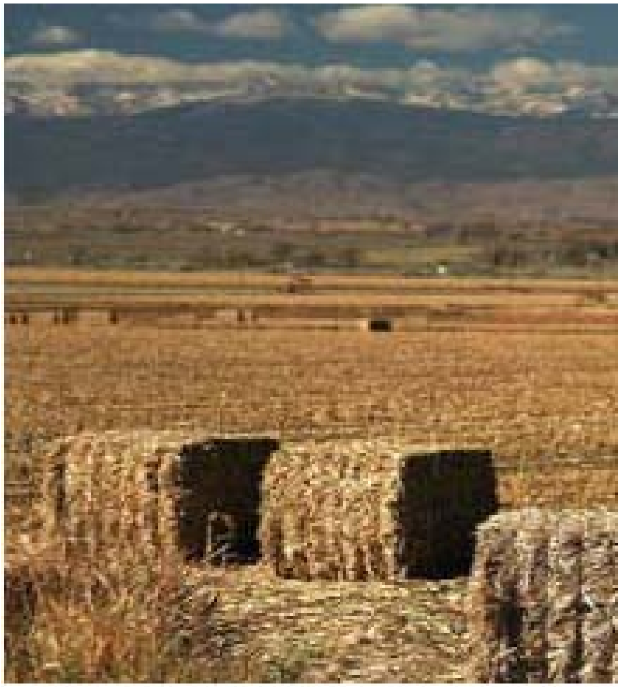
- Improved alloys and coatings for heat exchange and gas turbine/gas engines
- Life prediction modelling for heat exchangers to optimise maintenance and repair
- Monitoring of corrosion and contaminants in order to provide early warning of problems
- Improved repair/refurbishment procedures



- Agricultural/domestic waste
  – wood chips, sawdust, bark, straw, rice husks, bagasse, coconut fibre, sewage sludge, etc.
- Energy crops
  – willow, miscanthus, eucalyptus, etc.

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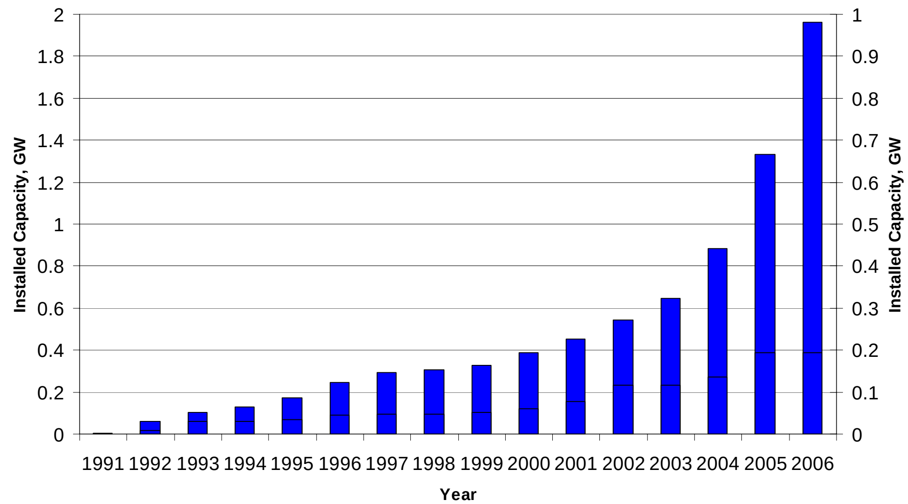
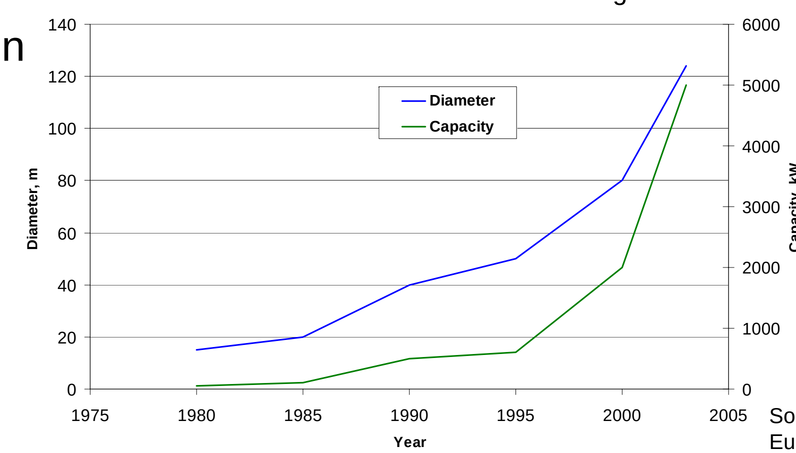
Wind Turbines

- Development of materials / designs / processing techniques e.g. sandwich constructions, joints, FRP pre-forming, etc.
- Development of test and modelling methods for materials characterisation for harsh environments
- Development and application of NDI techniques for accurate / rapid defect detection
- Development of standards and certification procedures
- Development of test and modelling methods for lifecycle analysis/fatigue performance of constituent materials, sub-components and major structures i.e. blades
- Structural health monitoring techniques



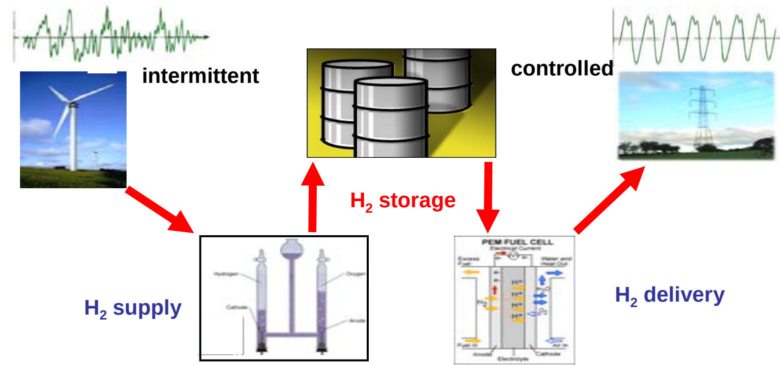
Source of Data: British Wind Energy

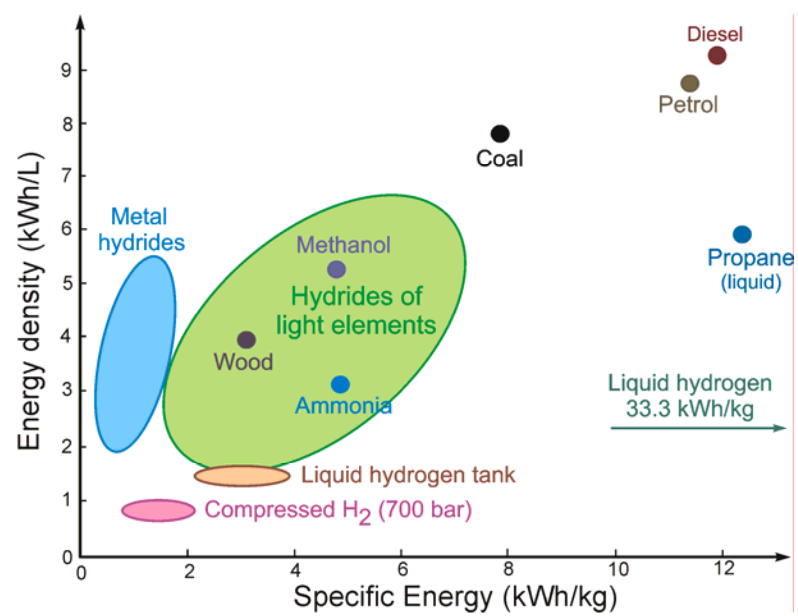


Source of Data: European Wind Energy Association

Hydrogen

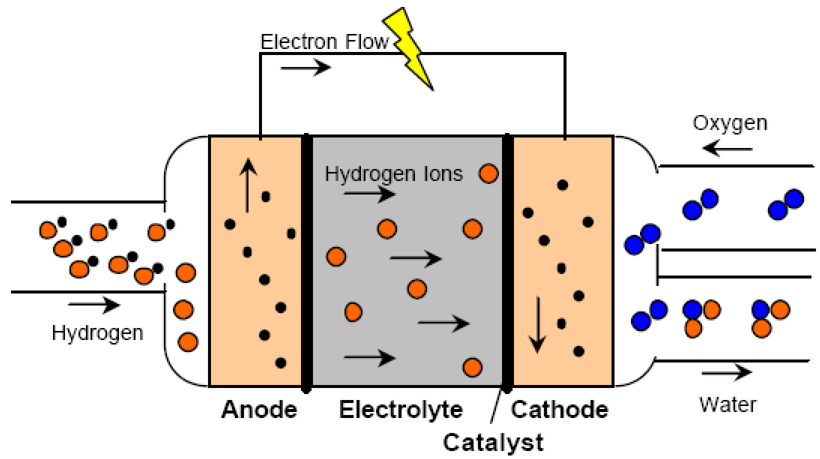
- New materials – particularly for H_2 storage and H_2 sensors
- Catalysts for reduced cost H_2 production
- Membranes and separation media to reduce the cost of meeting the hydrogen purity requirements of fuel cells, and other applications.
- Advanced instrumentation and characterisation techniques.
- Modelling of the interaction of H_2 with materials, embrittlement, and electron transfer processes in solids to enhance photocatalysts and photoelectrochemical processes



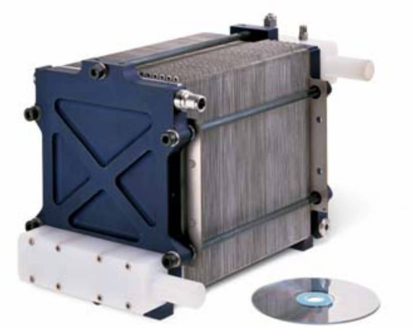


Fuel Cells

- Scale-up - efficient processes providing low cost products
- Understanding of failure mechanisms and durability issues
- Fabrication techniques and manufacturing consistency
- Inspection techniques to ensure the supply of high quality components
- New and improved existing materials - increased conductivity for cell and stack components
- Environmentally stable materials



PEM Fuel Cell powered bus



PEM Stack

Solar PV

- **Low cost materials**
  - quartz to Si and advanced crystal & Si ribbon growth
  - plastic optics for concentrators
  - thermal conductors
- **Improved design**
  - rear contact cells for mass production & high efficiency cell structures - crystalline Si
  - cell concepts for flexible substrates for thin film PV
  - improved concentrators for wide angles
- **Improved, sustainable materials**
  - module materials for crystalline Si (e.g. polymers) for improved stability and life
  - alternative transparent conducting oxides
  - improved deposition technologies - thin film PV
  - low band-gap semiconducting polymers & sensitiser dyes for excitonic PV
  - anti-reflective coatings for thermal
- **Durability and life modelling of materials**
- **Improved fabrication**
  - large area modules and high volumes
  - testing and QC procedures

Eden Centre, Cornwall

Sharp module factory, Wrexham
Manufacturing 220 MW per year for the European market.

Transmission and Storage - Scope

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Materials R&D issues related to the following:-

- The Transmission and Distribution of energy
  - Electricity
  - Gas
  - Oil, including networking issues.

- Storage issues associated with
  - Electricity
  - Gas
  - Oil
  - CO_2
  - Hydrogen *(covered elsewhere)*

- Issues associated with transportation of fuels

- Specific issues associated with renewable & distributed power

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Transmission and Storage Medium & Long Term Priorities (5-20 years)

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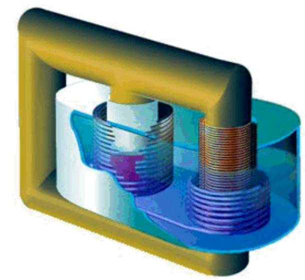
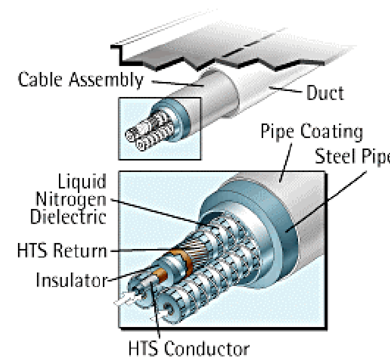
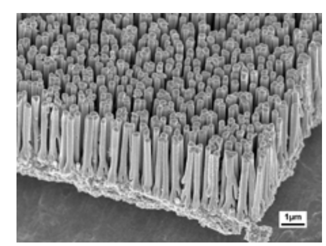


Priority themes should include

- Materials Developments on
    - Packaging technologies,
    - High temperature supporting components (e.g. capacitors),
    - Thermal management.
- Development of High temperature superconducting (HTS) materials application technologies for
    - Cabling,
    - Fault current limiters,
    - Superconducting magnetic electrical storage (SMES).
- Materials and process development for high strength pipelines,
- Full understanding of fracture properties to allow development of modified design codes for pipelines operating in low temperature regions.





Electrical Energy Storage

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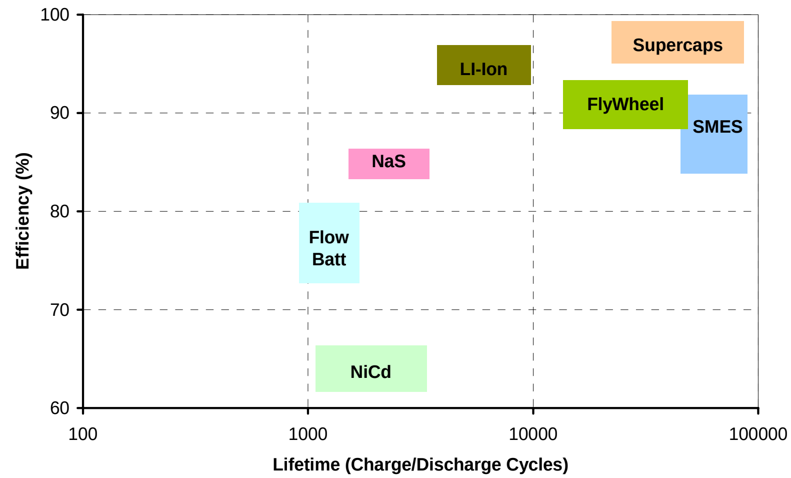
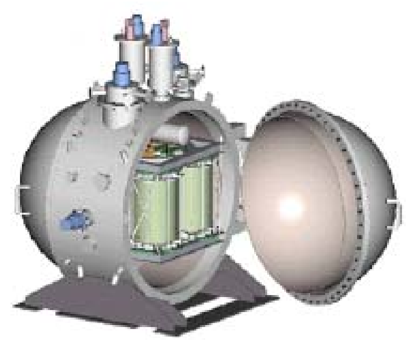
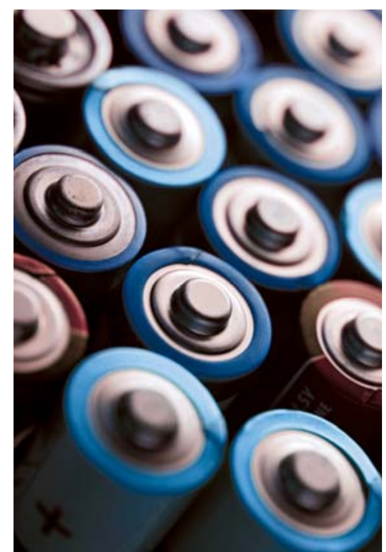
- Superior secondary lithium cells using chemistries that do not rely on strategically sensitive cobalt additions.
- Super-capacitors for fluctuating energy storage [e.g. wind turbines] and for hybrid drive regenerative braking systems.
- Flow batteries / fuel cells together with Redox Flow Storage Technologies with emphasis on scale, efficiency and environmentally acceptable operation
- Superconductor-based Magnetic Energy Storage systems (SMES). *Of all electrical storage options SMES provide high storage and release capabilities over a wide range of energy levels.*







Energy Materials – Key Areas

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3 key common themes where UK/EU materials R&D should focus:-

- Reducing time to market and life cycle costs (e.g. solar, fuel cells, marine)
- Higher performance in harsher environments (e.g. carbon capture, co-firing, nuclear)
- Improved life management and reliability (e.g. offshore wind, nuclear)

Thank You

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Energy Technology Centre

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