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The UK Energy Innovation System: A Review and a Commentary

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BIEE, Oxford
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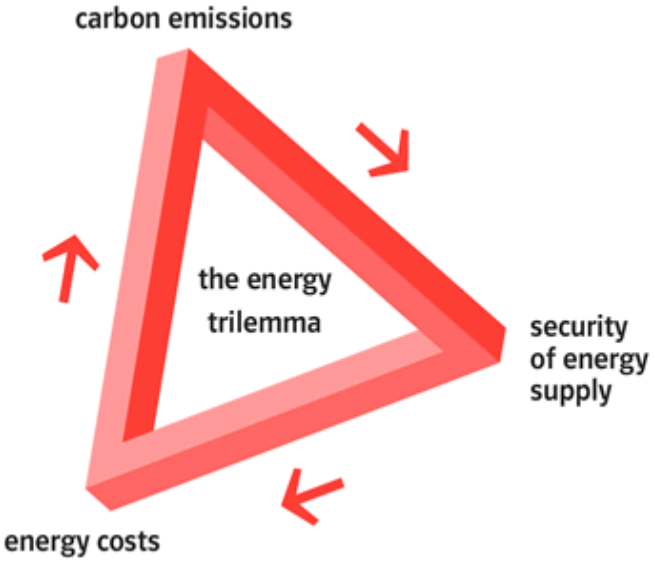
Background

- Concurrent pressures facing energy systems: decarbonisation, security of supply / energy independence and cost reduction
- cumulative costs of meeting policy targets are halved in some advanced technology scenarios
- …detailed assumptions and outcomes of such scenarios can be questioned …
- … but technology innovation has a broad appeal



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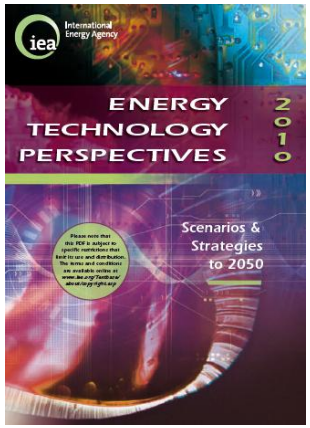
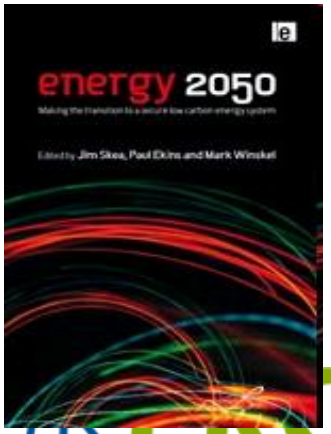
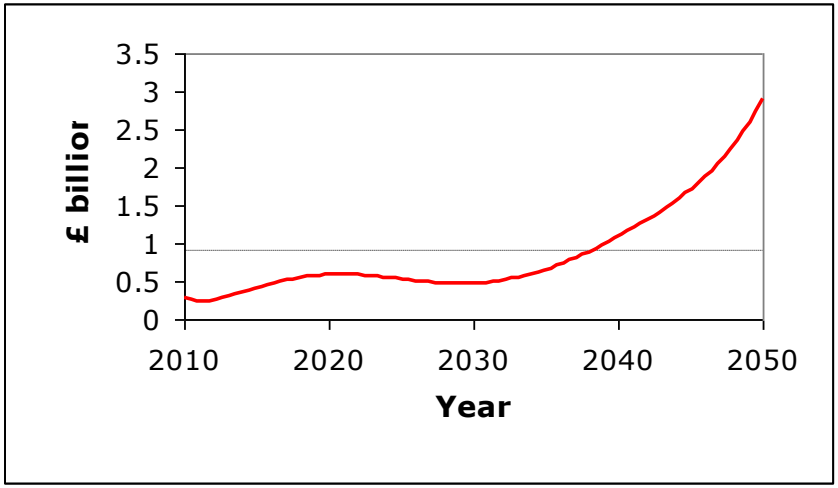




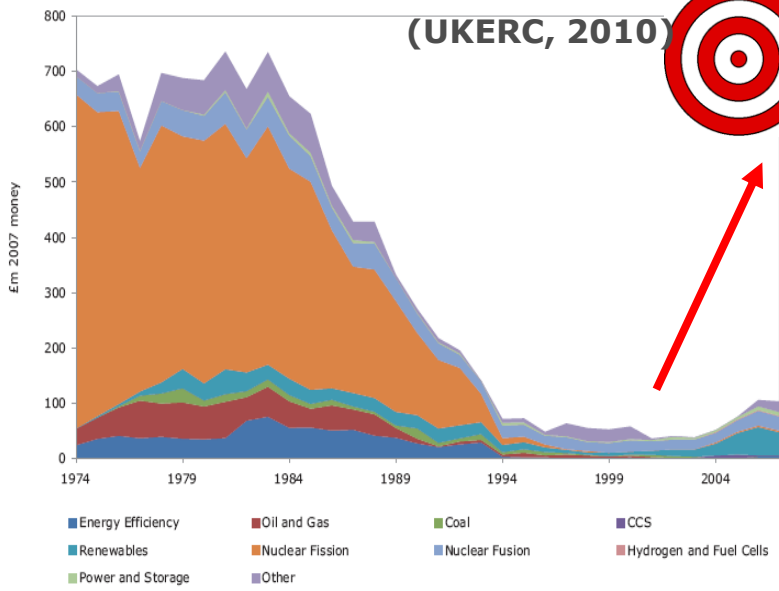
UKERC Accelerated Technology Development Scenario

- Much greater RD&D effort is justified across a range of low carbon supply technologies, equivalent to efforts after the 1970s energy crisis.
- Need to consider
  - allocation of spending across the technology portfolio
  - Long term R&D, shorter term demonstration
  - Public / private mix
  - UK contribution and focus in the wider international effort



UK Welfare Cost 'Savings' associated with low carbon technology acceleration

(UKERC, 2010)



Review Aims

Descriptive

- map the changing UK energy innovation system, in terms of its overall spending patterns, strategic goals and changing organisational make-up
- position UK developments in international context

Reflective

- consider 'research policy' – 'policy research' links… if any
- burgeoning number of reviews of current innovation efforts and 'best practice' prescriptions
- with advocates of niche-led, regime-led and breakthrough approaches…

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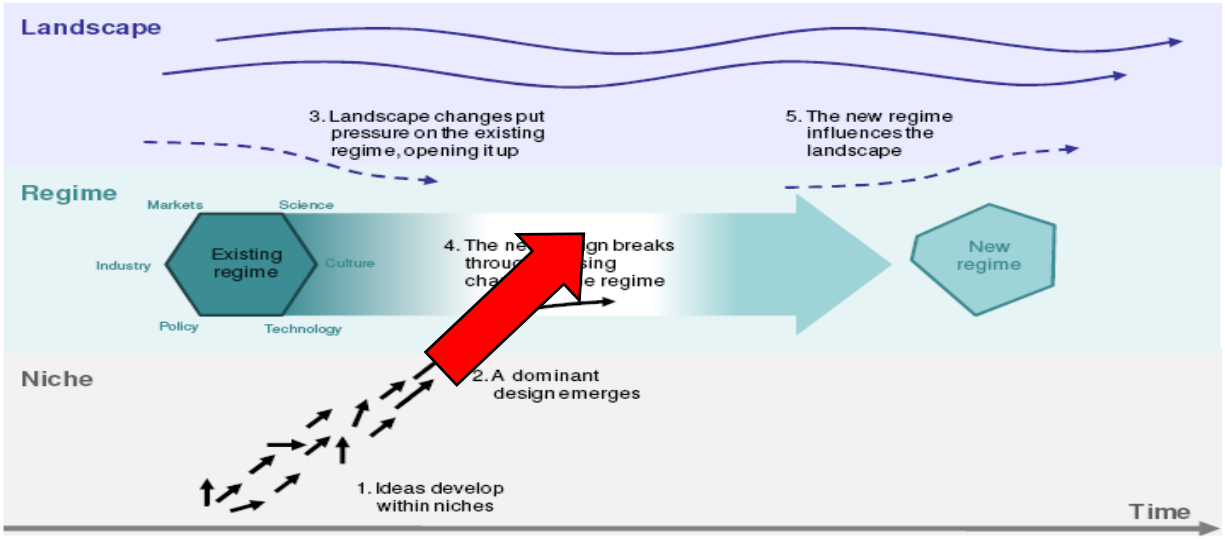
Alternative prescriptions: niche-led (Mowery, Nelson and Martin, 2010)

- need for a decentralised, diverse, with long periods of niche-based learning
- the emergent nature of energy system change meant that it is *'difficult if not impossible to plan or predict the structure of the overall R&D effort in any detail'*
- shared by a significant part of the innovation studies research community –the 'sustainable transitions' community



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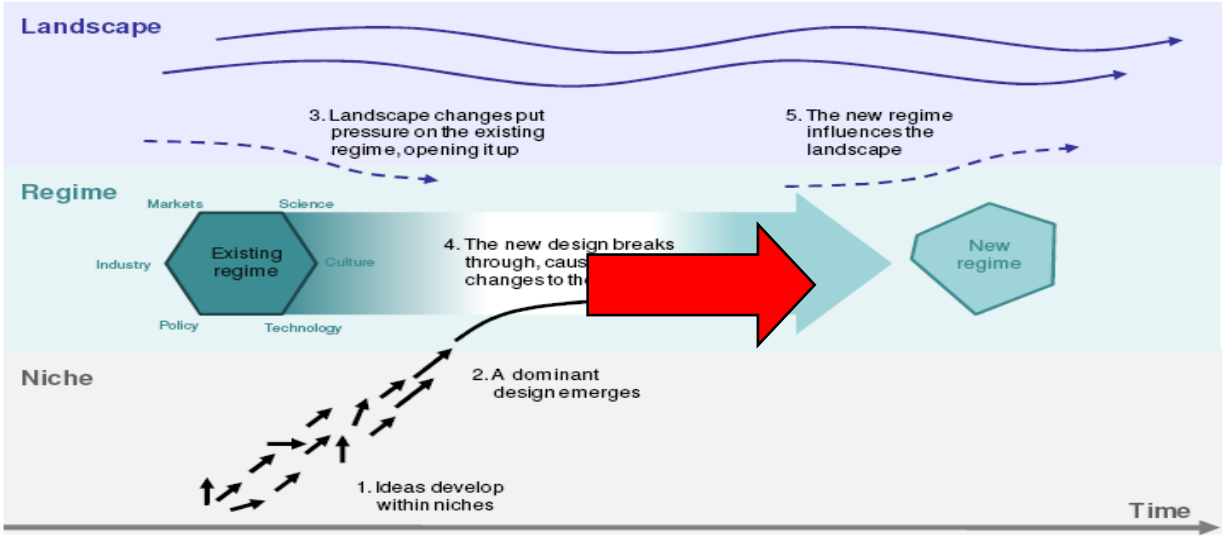
Alternative prescriptions: continuity-led

continuity approaches are likely to offer most effective responses to accelerated innovation imperatives (Unruh, 2002)

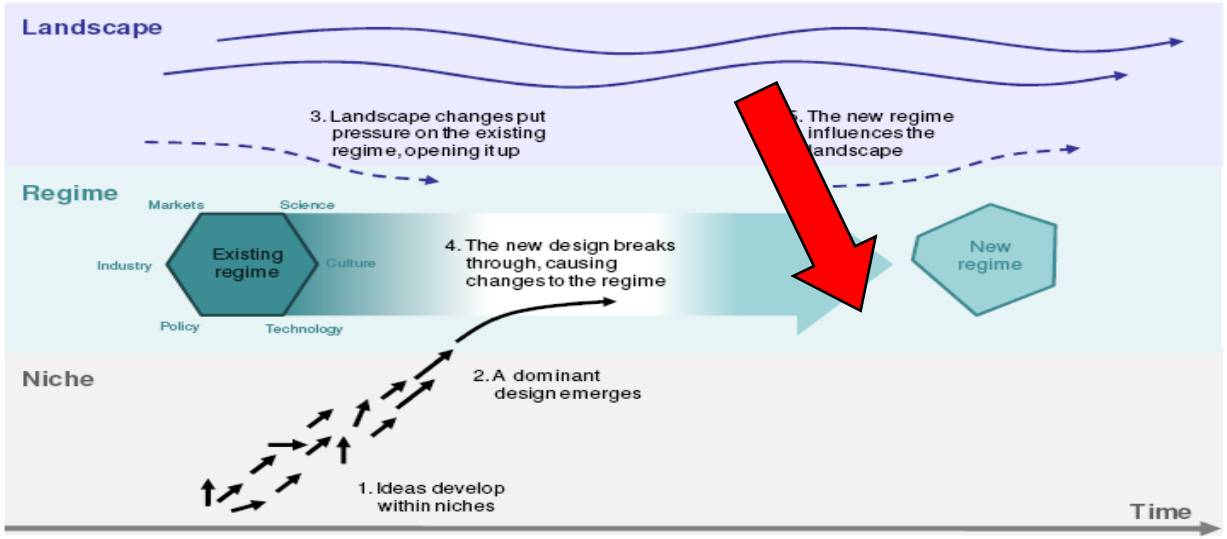
real … opportunity lies in improving [known] technologies … [we] cannot afford to place … hopes on … a radical technological transformation (Lester and Hart, 2012)

- Newell (2011) highlighted success of incrementally-oriented programmes in US federal energy RD&D (resource extraction and processing, industrial process efficiencies)
- .. efforts at breakthrough innovations, such as on synthetic fuels, had much less impact.



Alternative prescriptions: breakthrough-led (Perrow, 2010)

- centralised top-down approach for large-scale generation technologies such as carbon capture and storage.
- to enable rapid international diffusion by licensing
- Historically, central planning (and incumbent support) have been key elements in e.g. Brazilian sugarcane fuel and French nuclear power programmes



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UK Energy Innovation System: three recent phases

1. Early Efforts (2000–2004)
2. Momentum Building (2005–08)
3. Acceleration and Critical Review (2008–12)

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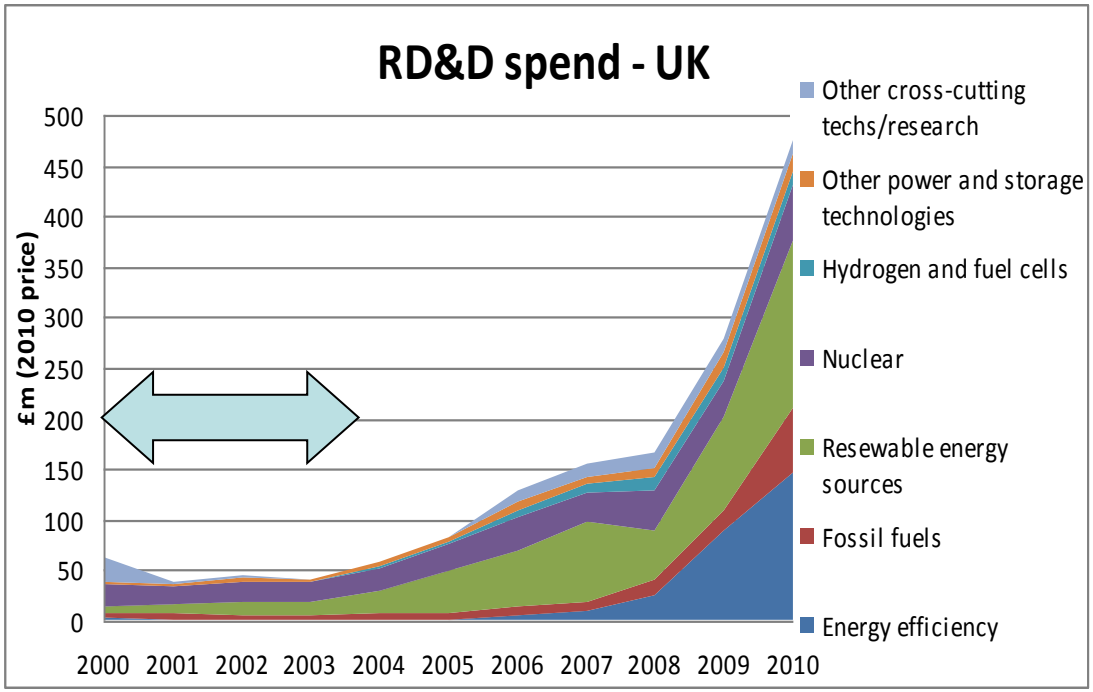
Early Efforts (2000–2004)

- collapse in energy RD&D funding after privatisaion
- global trends, but experienced particularly strongly in the UK
- closure of most of the UK's national research infrastructure.
- By 2000, only small number of isolated university research groups
- climate change driver emerges, but in a benign context: cheap, secure and (relatively) sustainable energy,



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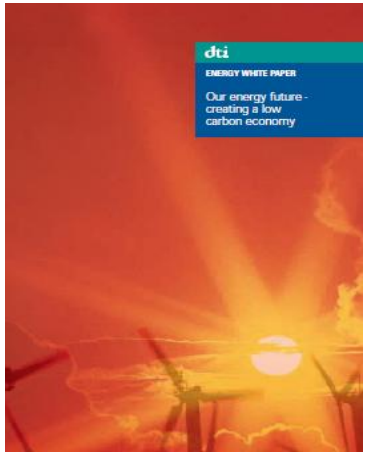
Early Efforts (2000-2004)

- modest / non-binding ambitions for decarbonisation and renewables deployment
- Energy RD&D spend increasing, but gradually, from very low base
- new UK organisations and networks were grafted-on to a system still oriented to short-run market efficiency and technology neutrality
- ERRG calls for greater co-ordination and focus on selected technologies
- emphasis on R&D - so fusion and hydrogen prioritised by ERRG, but not windpower
- a *niche* approach to energy innovation



CARBON TRUST

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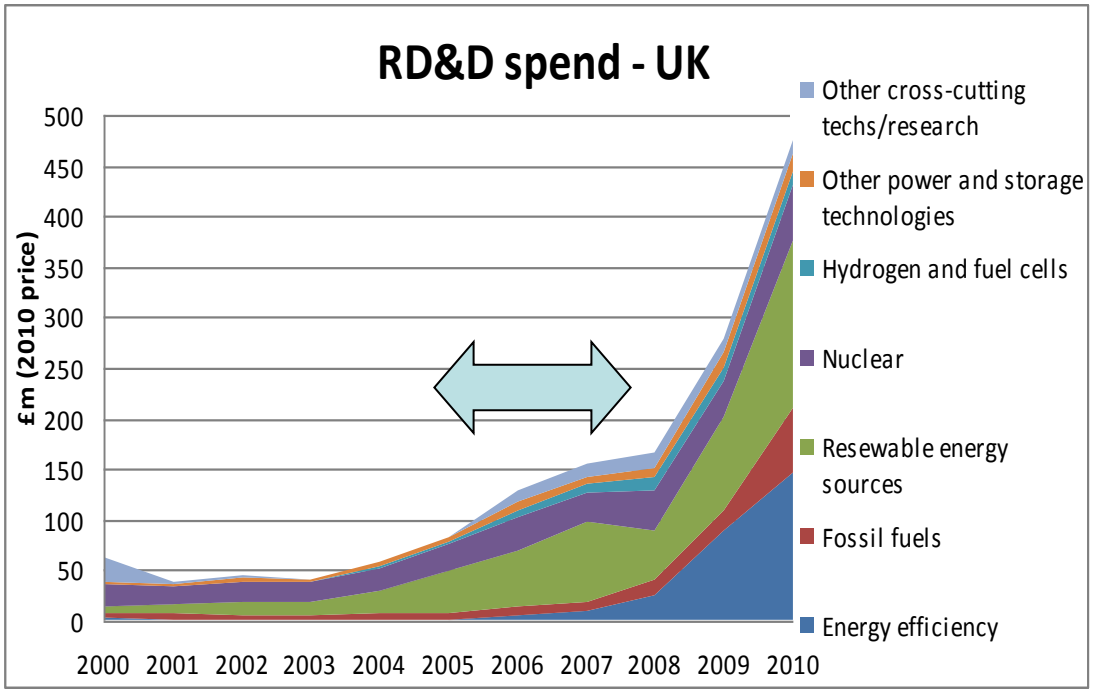
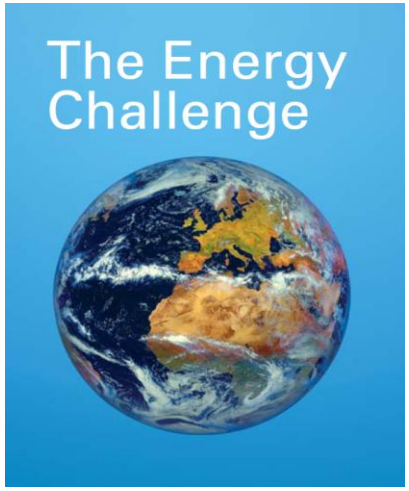
Momentum Building (2005–08)

- End of benign times in wider energy economy / policy tone
- Global expansion of the fossil fuel economy, stalling of UK decarbonisation trend
- New UK supply security concern …UK gas import dependency, volatile international oil and gas markets
- Still favourable macroeconomic context, and growing momentum in UK energy innovation system





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Momentum Building (2005-08)

- Larger-scale interventions, stronger role for private sector in spending and strategy
- greater emphasis on demonstration phase, and development of big technologies (nuclear, CCS, offshore wind)
- Trend to more technology-specific support - RO banding
- Growing number of organisations, each prioritising according to their remits

ERP
Energy Research Partnership

energy technologies institute

Technology Strategy Board
Driving Innovation

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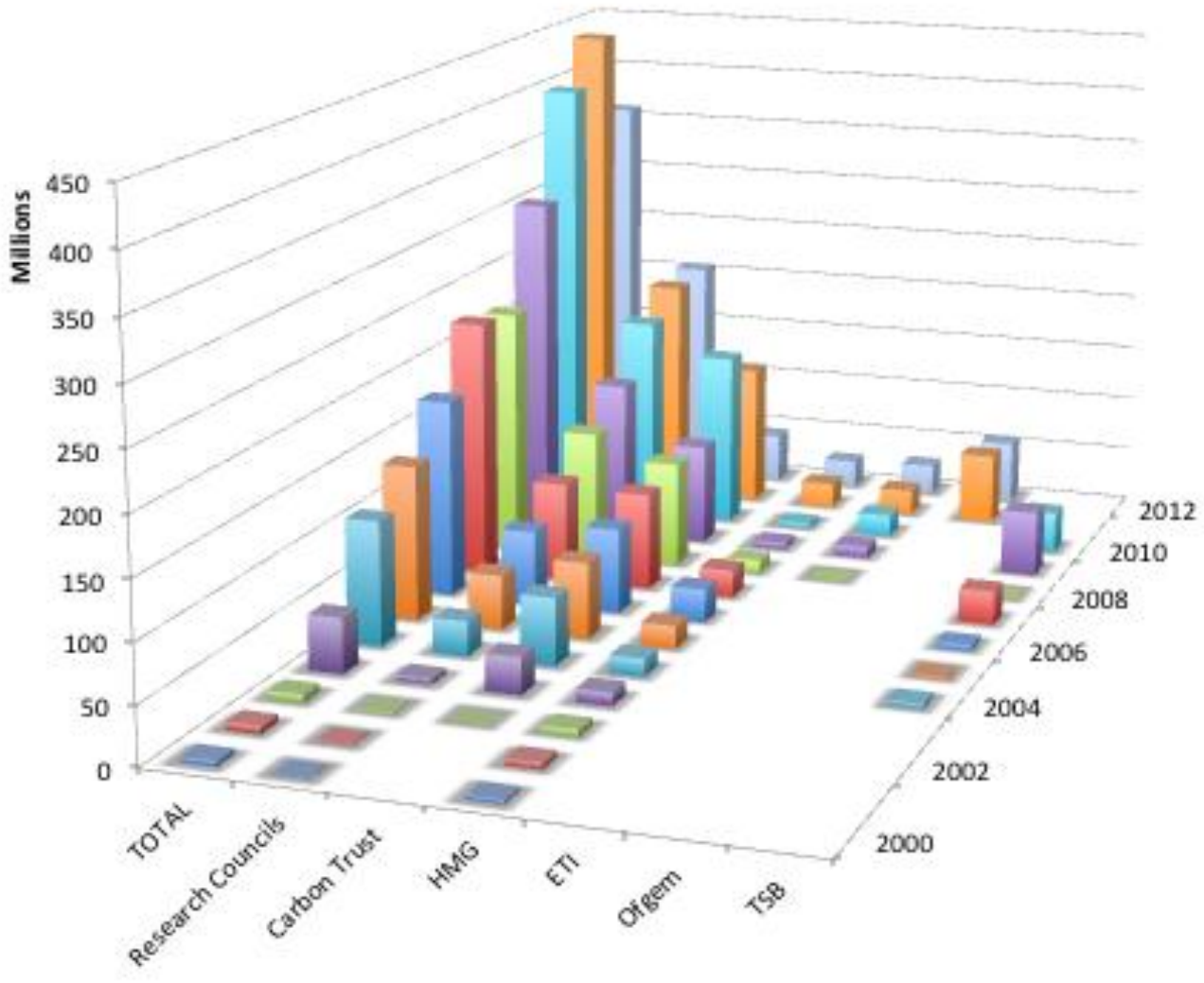
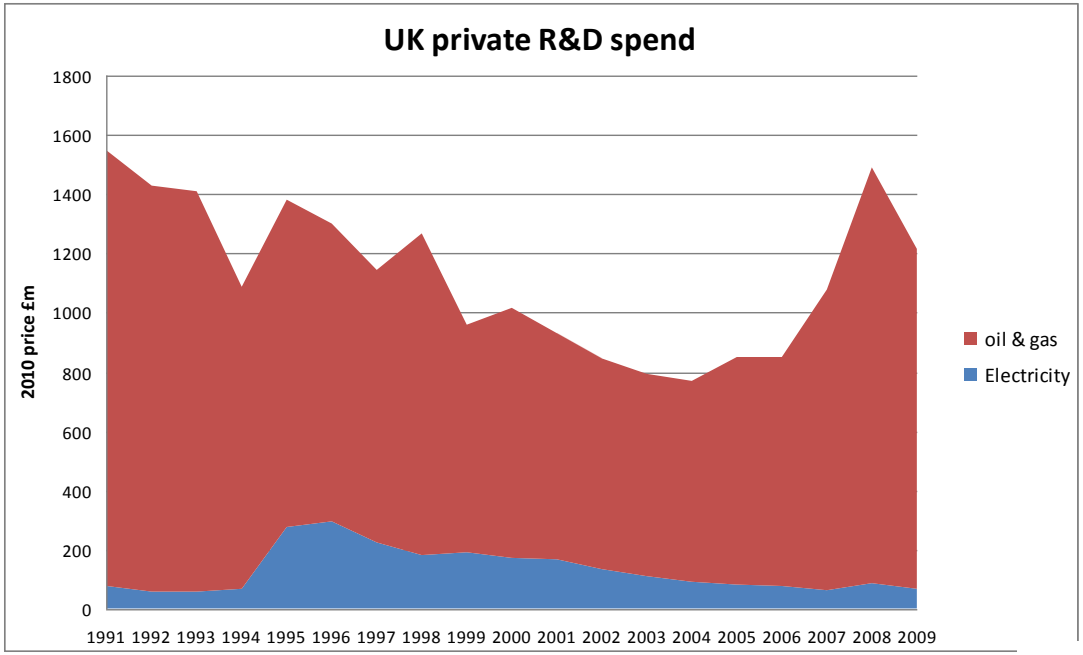
Growing Public Sector Spending, across more bodies



… but limited private sector response



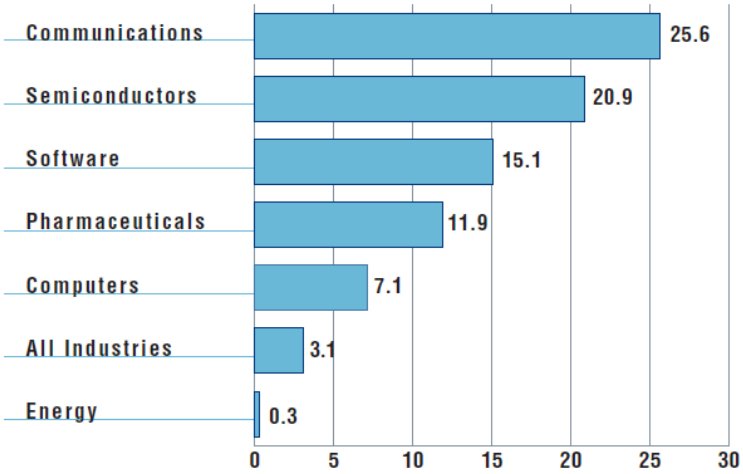
Annual UK R&D spend in 2009

- £64m on electricity
- £20m on alternative energy
- £1.15bn on oil and gas

(Source: BIS R&D Scoreboard)

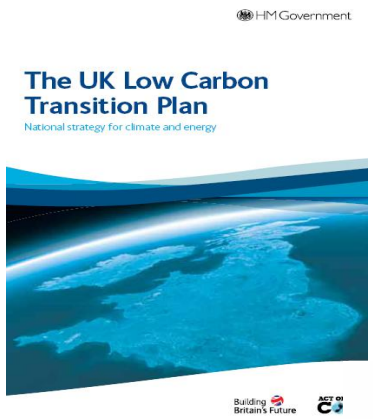
US Industry R&D Spend,
% of domestic sales

(Source: US Breakthrough Institute / NSF)



Acceleration and Critical Review (2008–12)

- Policy targets of real corporate and political impact
  - CC Act, Rens Directive
- From *long term scenarios* to short-term *plans and roadmaps*
  - Planning reforms for 'swifter delivery'
  - Expanded domestic supply chains
- Huge infrastructure investments envisaged
  - £110bn in generation and transmission by 2020
  - Replacement of ¾ of UK generation system by 2025



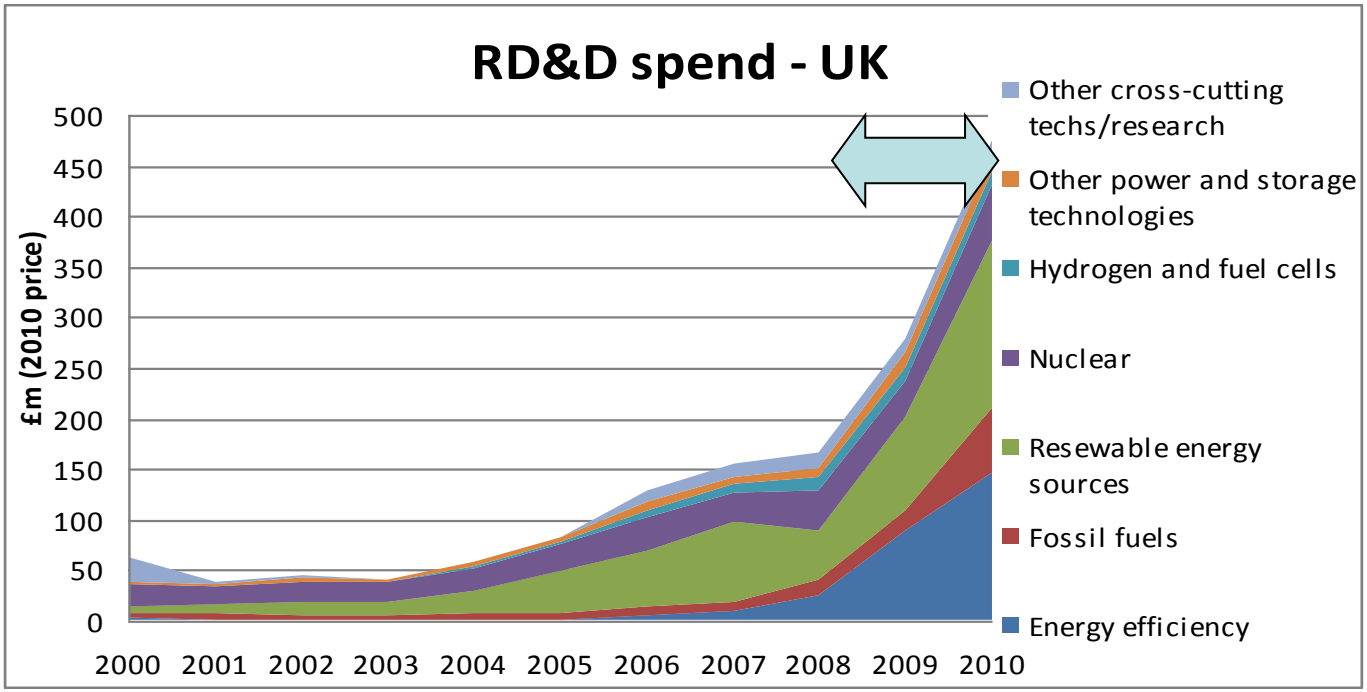
HM TREASURY Infrastructure UK

National Infrastructure Plan 2011

2008–12: Acceleration …

- Rapidly growing energy RD&D spend across public sector
- incumbent-oriented energy innovation programmes … aimed at driving down the costs of large-scale technologies

  in the 2020s we will run a technology race, with the least cost technologies gaining the largest market share. Before then, our aim is to help a range of technologies bring down their costs so they are ready to compete



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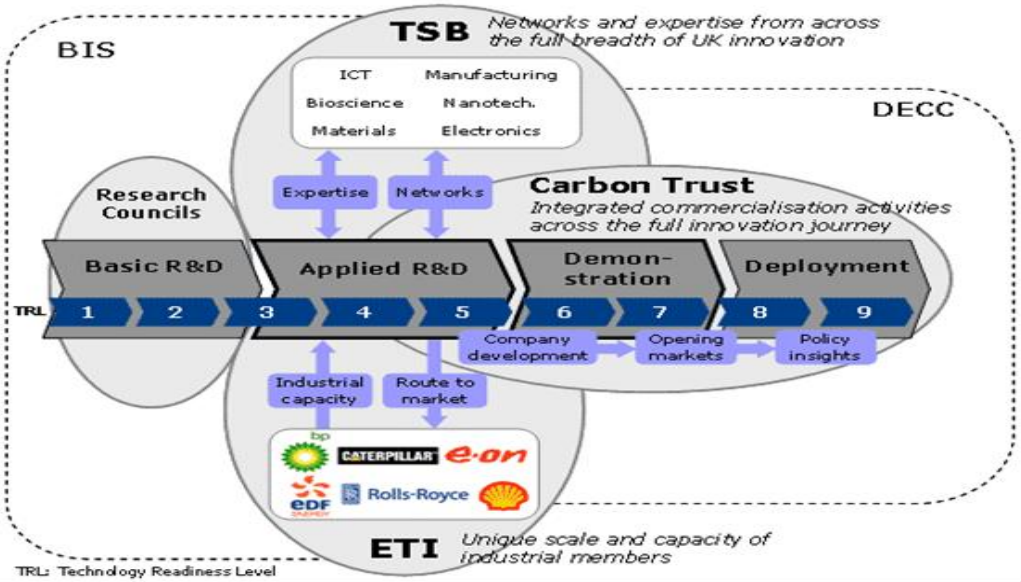
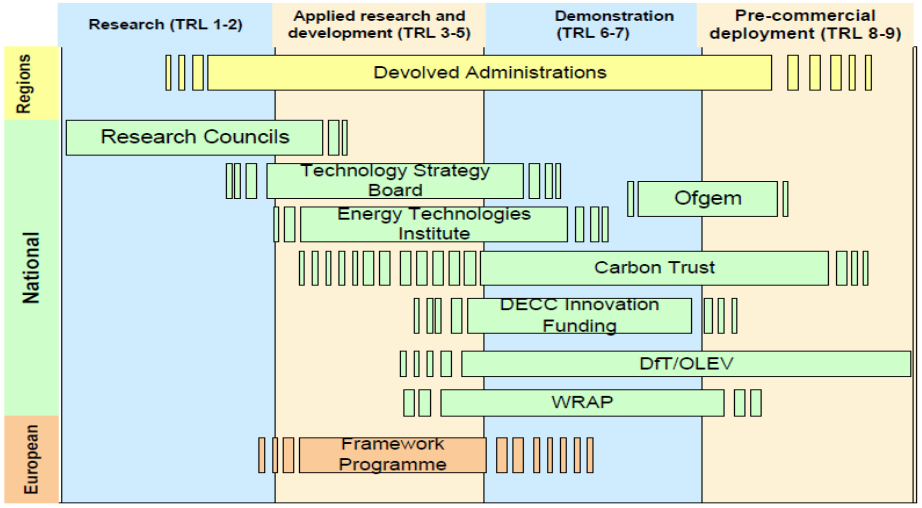
… and critical review





UK public sector support has mostly been short term … coordination has historically been limited … the overall value for money cannot be demonstrated. (NAO, 2010)

Areas where the UK has leading-edge capability account for only 20% of the total energy RD&D budget (IEA, 2011)

See also Carbon Trust, 2009; PAC, 2010, CCC, 2010

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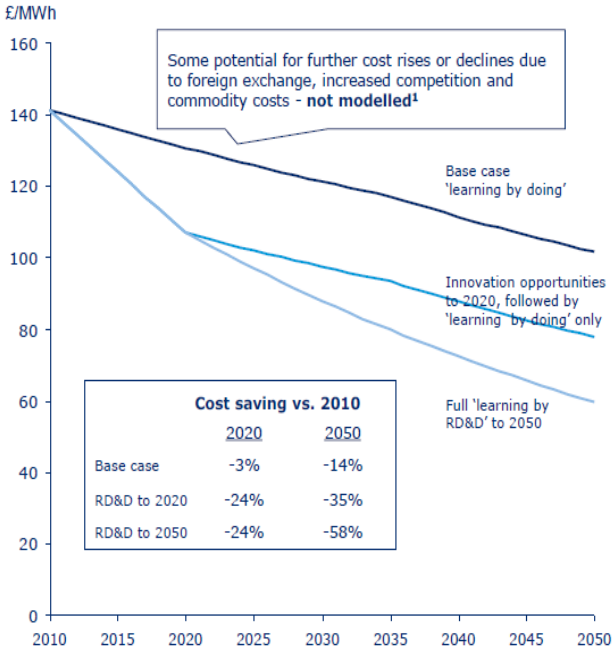
… and Response (DECC, 2011)

- Relaunched Low Carbon Innovation Group (now re-named LCICG, (with an extra 'C' for Coordination).
- a *technology prospectus* setting out "a clear strategy for UK low carbon innovation
- a *toolbox* of common metrics to appraise and evaluate innovation programmes.
- *Technology Innovation Needs Assessments* (TINAs) with a uniform process to be drawn on by all departments and organisations
- assesses the value to the UK from innovation, the green growth opportunity, case for public sector intervention, and innovation priorities

Low Carbon Innovation Delivery Review

Summary Report

Chart 3 Potential impact of innovation on levelised costs of an example offshore wind site



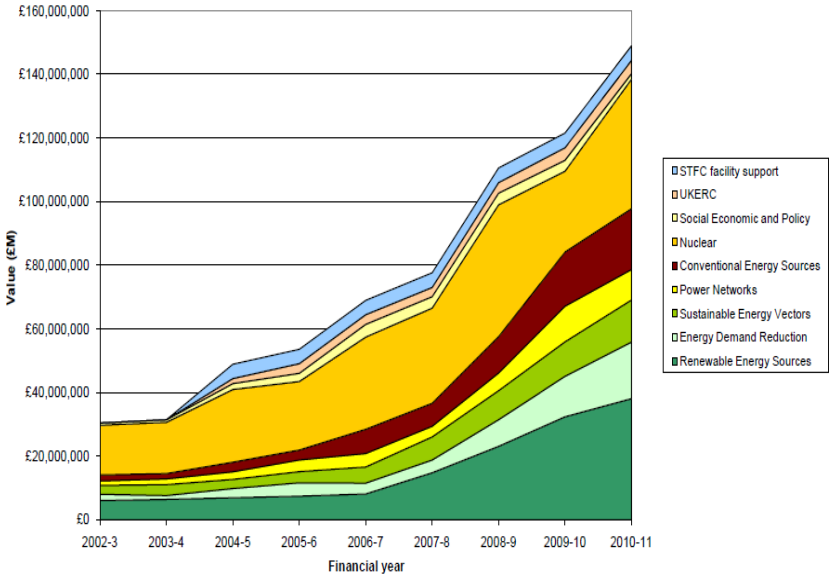
art 9 Summary of current/recent UK public sector activity/investment

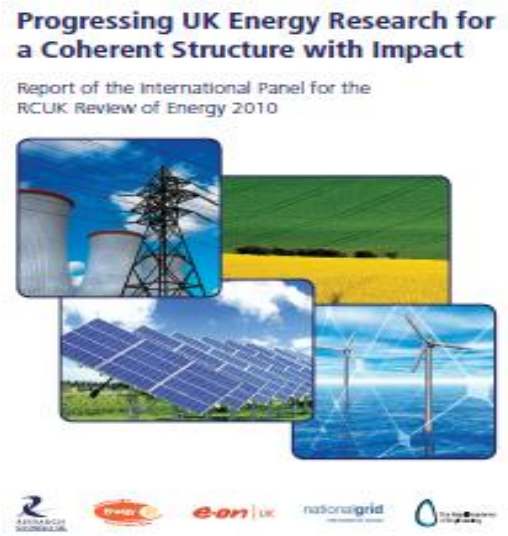
ket pull (demand side)	**Technology push** (supply side)	**Enablers**
evy Exemption Certificates ECs) – As a renewable energy ource offshore wind energy ualifies for LECs evenue support through **Banded enewables Obligation** - 2009 to 017, offshore wind currently igible for 2 ROCs/MWh*. CfD FiT xpected 2017 onwards arbon price, via the **EU Energy rading Scheme (ETS)**	– **Offshore Renewable Energy Catapult** – from summer 2012; up to £10m per annum over five years (£50m) from the Technology Strategy Board. To be set up by a consortium of the Carbon Trust, Narec and Ocean Energy Innovation, headquartered in Glasgow with an operational centre in the North East of England (Northumberland) – **Supergen 2** – 2010 to 2014; £5.8m; Research Council led funding to undertake research to achieve an integrated, cost-effective, reliable & available Offshore Wind Power Station – **Carbon Trust Offshore Wind Accelerator**– 2008 to 2014; c£30m fund to accelerate cost reduction and increase reliability and yield in a consortium with eight major developers – **ETI Offshore Wind Programme**; funding for the design and demonstration of novel offshore systems and improvement of existing technologies – **ETF Third Demonstration Call** – 2010-2011; up to £8m; capital grant funding for component / technology development There have also been a number of programmes funded by RDAs including ONE, NWDA, EMDA and SEEDA	Testing sites: – **Narec** – National Renewable Energy Centre; Narec operates the only full-scale and independent blade testing facility in the UK (sin 2005). A second 100m+ blade test facility, a 15MW drive train test facility, and an offshore wind test site are under development (to be operational in 2012/13) – **AREG** – Aberdeen Renewable Energy Group i developing the European Offshore Wind Deployment Centre – an offshore wind test faci off the coast of Aberdeen – in a joint venture wi Vattenfall, using an EC grant of up to €40m Permitting regime: – **Crown Estate** – has leased sites with the aim o installing 25GW by 2020 Non-technology bottlenecks: – RenewableUK and Scottish Enterprise are working on, amongst others, health and safety issues and skills shortages – DECC ports & infrastructure funding Centres for doctoral training (EPSRC)

RCEP Review, and response

- ‘lack of a long-term coherent programme across the different funding bodies, competition between the funding bodies, a lack of transparency .. and poorly executed or non-existent mechanisms
  (RCEP Review, 2010)

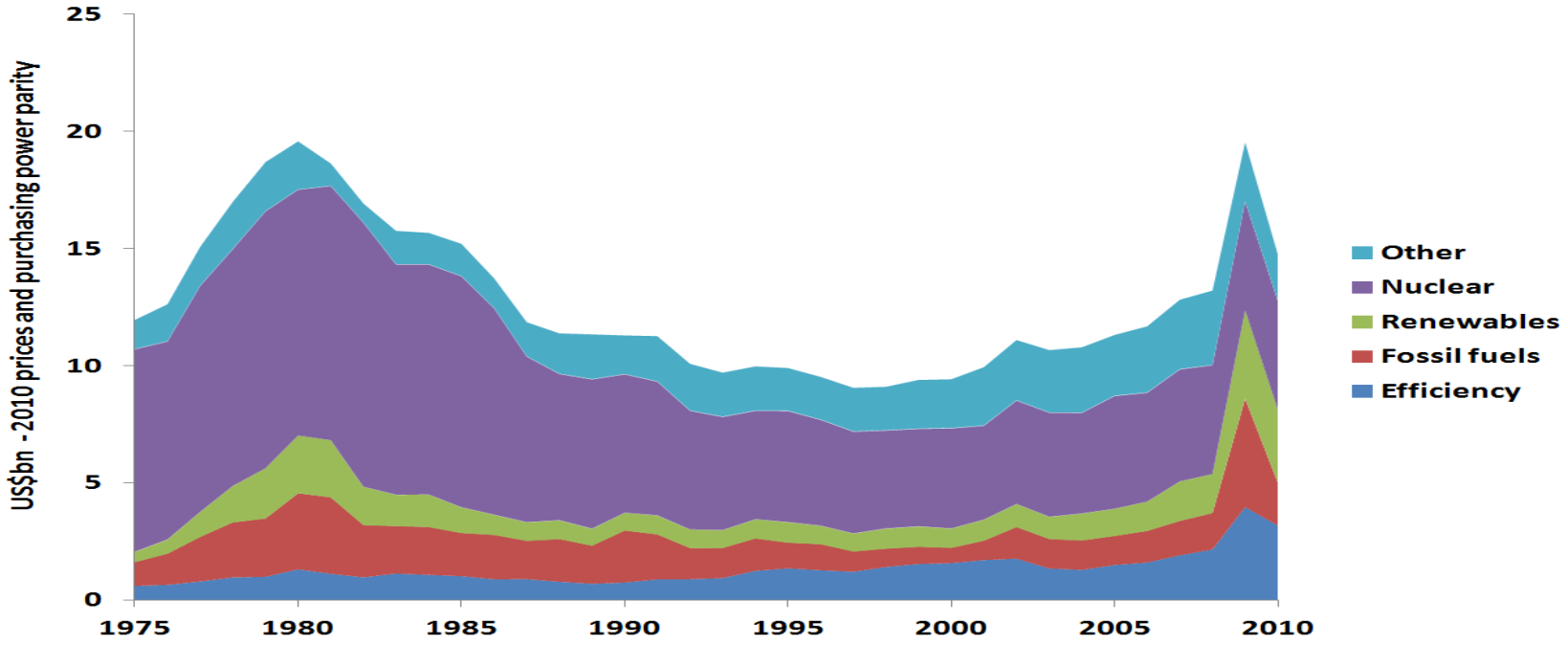
- Led to EPSRC strategic review, with decision to grow, maintain or reduce funding for key energy research areas.
- RCEP Strategy Fellow to develop an overall assessment of the energy programme
- …and to conduct research on UK energy innovation in international context





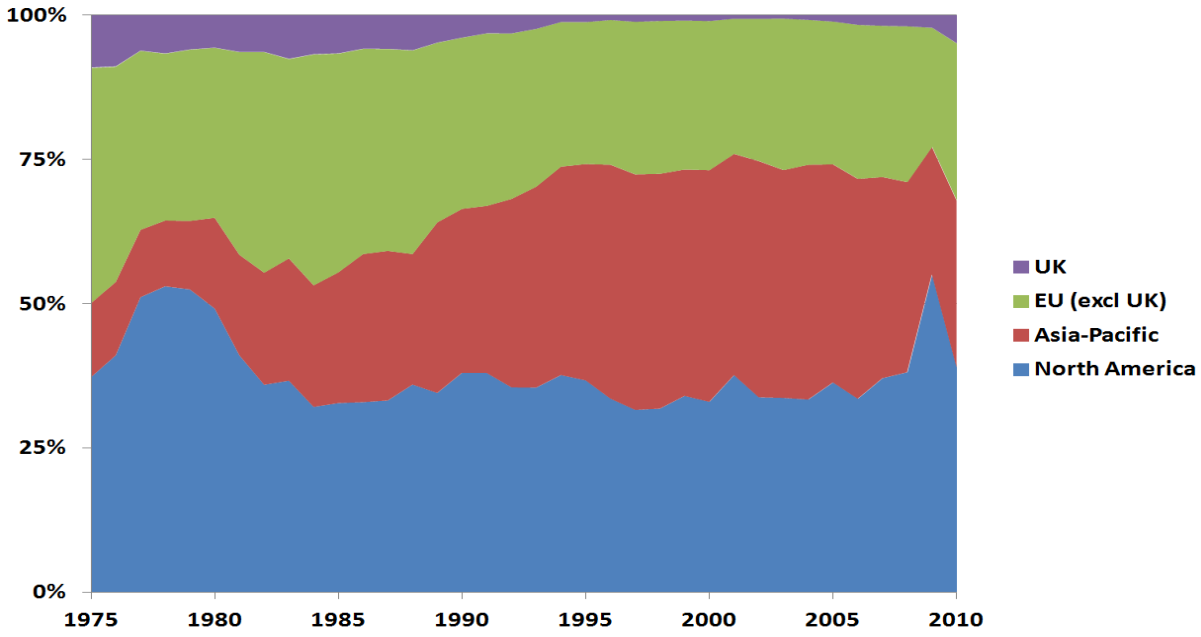
International Context: Global Trends

- Global expansion of energy R&D over the past decade
- 2009 spend in IEA-OECD equalled the previous peak in 1980
- fell back again in 2010, though still on a rising trend
- As in the UK, focus has changed significantly reduced nuclear, growing renewables and efficiency



International Context: Global Trends

- increasing importance of the Asia-Pacific region since the mid-1990s, with a fall in the European share
- North America share has been remarkably stable since the mid-80s (apart from 2009 spike)
- UK share fell to as low as 0.6% in the early 2000s
- UK's recent surge now brings it back up to around 5% of the IEA share; at the median level on a spend/GDP basis



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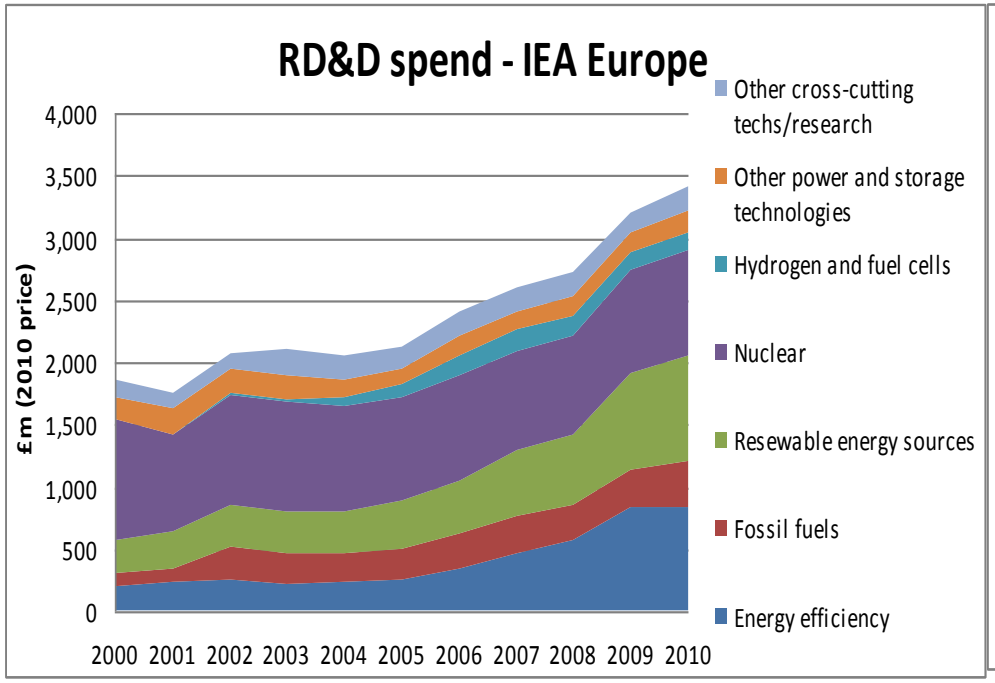
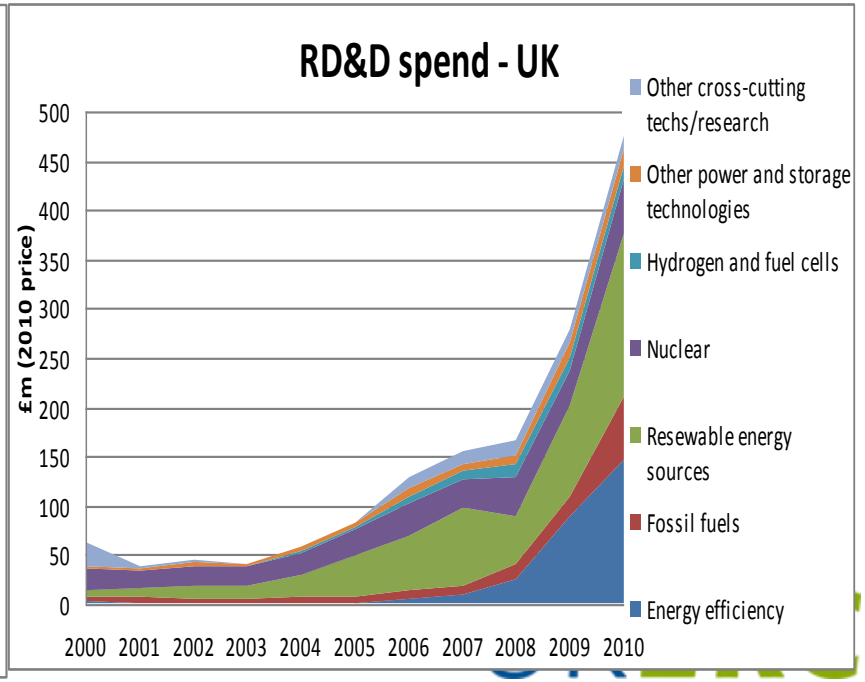
International Context: Global Trends

- In Europe, UK is an extreme case of 'stop-start', from very low base at the beginning of the 2000s to rapid acceleration from 2008 onwards





International Context: UK Performance: mixed evidence

- In FP7 Energy Programme, UK universities and research organisations have out-performed the European average in attracting support … reverse is true for private firms.
- as more consolidated and directed programmes have emerged, the UK's 'networks and collaborations' approach has led to barriers to participation
- In EU low carbon research UK share is just 11%: far behind Germany (21%) and lower than France (13%) (ERP, 2012, CCC, 2010)
- UK less effective at influencing the design of the Framework Programme for low-carbon technologies (CCC, 2010).
- UK participates in 25 IEA Implementing Agreements, well above the average.
- … but, missed opportunities (particularly outside EU), reflecting a lack of funding, low researcher awareness / time availability (RCEP, 2010)
- … now being addressed within RCEP Energy Programme recent calls

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International Context: Common Challenges

- **overall funding commitment:** global investment in energy technologies must be raised by around 25% before 2020 compared to a "business-as-usual" scenario if decarbonisation goals are to be met and 50% after 2030 IEA (2012)
- **balance between 'user-inspired' and blue skies research**: little analytical support for R&D budget allocations; budget-setting for more basic energy research remains more of an art than science
- **aligning resource spend with policy priorities**: for countries with clear resource endowments or competences (Brazil/bioenergy; Norway/oil and gas; France/nuclear), the correlations are high. For others (UK) much lower
- **avoiding fragmentation and duplication of effort:** in US, 23 agencies, 130 sub-agencies and 700 initiatives in the renewable energy field (GAO, 2012)

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Summary, Future Research

A preliminary and partial review of three related topics:

1. academic research policy debate
2. UK energy innovation public policymaking since 2000
3. wider international context and UK–international relations.

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‘Research Policy’ Research

Advocates for three distinct styles of innovation:

1. continuity-led innovation given the particular challenges of innovation in energy
2. disruptive, niche-led response given the depth and scope of the energy system transition challenge
3. centrally-planned high technology breakthrough programmes … for some, required because the scale of the challenges, and the limits of more continuity- or niche-led approaches

- Sometimes prescribed in combination, or as fundamental alternatives

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The UK Case

- a dramatic case of 'stop-start energy innovation efforts … and an *absorptive capacity* problem for UK energy innovation institutions.
- Commitments to competition and technology neutrality rather than planning and co-ordination persisted well after the re-emergence of overall energy policy ambitions for change in 2000s.
- In the early-2000s new UK energy innovation organisations and networks were created, but were essentially grafted-on: a niche-based approach
- After 2005, overall shift to larger and longer term interventions more strongly involving private sector
- From 2008 onwards: plans of real political and business consequence. The envisaged rate of energy system change now accelerated, with trajectory of public RD&D spending.
- shift from longer term / radical toward shorter-term deployability and cost reduction: to the right-hand side of the innovation chain

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International Context

- by the start of the 2010s, public energy RD&D activity had grown across the globe, recovering to levels of around those seen in the early-1980s.
- wide variety of initiatives internationally
- UK very active in many of these, but (until very recently) on an essentially bottom-up basis
- Many of the problems facing the UK – fragmentation, lack of transparent prioritisation, are repeated internationally
- Including multiple international platforms and fora

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Themes for Future Research

- balance of basic and applied research to enable short term cost reduction while maintaining long term capacity for breakthrough technologies
- recent effort to more centralised efforts in UK … possible risk of political interference … analyse merits of decentralised and more centralised innovation systems
- Implications of bigger role for the private sector, a more joined-up innovation system, but risk reduced transparency and access.
- … Need for transparency to actors within the innovation system, and wider society.
- Links to overall energy policy ambition for energy innovation spending and focus (short term concern on next Spending Review
- … pressing need to set out of an overall strategy for energy innovation, across the whole energy system and across different technologies and timescales … DECC Review, RCEP Strategy Fellowship
- with more explicit discussion of broad policy alternatives, seen in academic research policy analysis but not energy innovation policymaking.

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