# Low Carbon Innovation

## Energy and Climate Change Committee

This is an Engineering the Future response to the Energy and Climate Change Committee call for evidence on low carbon innovation.

The development of this response was led by:

- **The Institution of Mechanical Engineers**

The response has been written with the assistance of and endorsed by:

- Energy Institute
- The Institution of Engineering and Technology
- The Institution of Gas Engineers and Managers
- The Institution of Structural Engineers
- Nuclear Institute
- Royal Academy of Engineering

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*Engineering the Future is a broad alliance of engineering institutions and bodies which represent the UK's 450,000 professional engineers.*

*We are the action forum for engineering and we provide independent expert advice and promote understanding of the contribution that engineering makes to the economy, society and to the development and delivery of national policy.*

## Summary

Engineering the Future is a broad alliance of engineering institutions and bodies which represent the UK's 450,000 professional engineers.

We provide independent expert advice and promote understanding of the contribution that engineering makes to the economy, society and to the development and delivery of national policy. The development of this response was led by the Institution of Mechanical Engineers with the assistance and endorsement of The Energy Institute, The Institution of Engineering and Technology, The Institution of Gas Engineers and Managers, The Institution of Structural Engineers, Nuclear Institute and Royal Academy of Engineering.

This submission has four underlying themes:

- The UK's targets for reducing $CO_2$ emissions are very challenging and the level of effort needed to reach them should not be underestimated. The targets are unlikely to be met without a major and sustained increase in research and development resources particularly for the demonstration of new technologies at scale.

- The cost of energy obtained from low-carbon sources will in most cases remain significantly higher than the cost of burning fossil fuels for the foreseeable future. There is therefore no substantial commercial driver for private sector investment in low-carbon technologies at present energy prices without the reassurance of long-term subsidy and little incentive for innovation that would lead to significant cost-reduction in such technologies.

- To be effective in reducing $CO_2$ emissions, low carbon technologies have to be integrated into a UK energy system that includes energy storage and the necessary control systems (e.g. a smart grid) to use them efficiently.

- A societal change in attitude towards improving energy efficiency is needed in order to help make low carbon technologies affordable in the long term.

Detailed responses to the questions posed by the Committee are provided below.

Engineering the Future

**1. Will the Government's current approach towards low carbon innovation help to achieve the UK's legally binding targets at the lowest possible cost?**

1.1 Broadly speaking the Government's current approach will help to achieve the UK's targets but is unlikely to do so at lowest possible cost. Additionally, the effort needed to achieve this goal has been significantly underestimated by many politicians. The 2050 target will only be realised if there is an expanded coherent strategy which combines cross-party political will with a platform on which social change can be built.

1.2 The creation of the Energy Technologies Institute (ETI) has enabled 52 low carbon projects to be commissioned but this is a relatively small contribution to the Government's targets, and a significant amount of work must be done to achieve the ultimate goal. While the ETI has begun working on transport projects the engineering challenge of decarbonising both transport and heating must be in the vanguard of the next decade's programmes.

1.3 Low carbon innovation will be important to the future prosperity of the UK, not least through enabling low-carbon energy cost reduction, and it is easier politically to make progress in technological areas than in the social changes that also will be required. Controlling the impact of climate change by decarbonising human activity on a global basis requires a revolution in the behaviour of populations and governments. The Stern report wrote that climate change risks "major disruption to economic and social activity, later in this century and in the next, on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th century."[1] We recognise that the UK social and political landscape does not yet reflect the urgency or significance of decarbonisation and many actions that are needed for example in providing sustained R&D for the development and demonstration of new technologies at scale, are not yet politically possible.

1.4 Businesses and the research community cannot on their own deliver the level of change necessary without much stronger incentives or the direct control of Government. The current Government approach to UK low-carbon technologies essentially anticipates cost reduction to come from "on the job" learning stimulated through subsidised deployment of an existing range of technologies. Such an approach is unlikely to result in substantial innovation leading to significant cost reductions, or significant innovation of new technologies, but rather minor steps forward to enable deployments that meet the UK's short-term targets for renewables uptake.

1.5 The Government's current approach appears to be largely predicated on the notion that technological development will allow a continuation of current lifestyles but with a greatly reduced carbon impact. We do not however have sight of an affordable 'technical fix' that will allow a continuation of the UK's energy-hungry culture and a reduction in $CO_2$ emissions by 80% relative to 1990 levels by 2050. The task is made more difficult by predicted UK population growth and changing demographics. In this regard the Office of National Statistics (ONS) projects that the UK population will increase from 63.7 million to 73.3 million over the next 25 years[2], alongside a long-term trend of a reduction in average household size combined with an increase in the

[1] Nicholas Stern, *The economics of climate change*, Cambridge University Press, 2007. *Summary of Conclusions* page xv.
[2] http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2012-based-projections/index.html

number of households. Additionally, the UK's aging population will place more demands on the energy network through healthcare and heating requirement.

1.6 Against the background identified above, it is unlikely that the Government will manage to achieve the targets at the lowest possible cost.

**2. Does the Government have the right balance of focus between energy efficiency, renewable energy and other low carbon technologies?**

2.1 A balance between energy efficiency, renewable energy and other low carbon technologies has yet to be achieved. The Government's main drive has been to produce more energy to cope with demand by introducing more low carbon and renewable technologies, while relatively little effort has been made in dealing with the fundamental issue of domestic and commercial energy efficiency. Subsidies for loft and cavity wall insulation are not sufficient in themselves to ensure a reduction in energy usage; more effort is needed to encourage households and businesses to reduce their energy consumption.

2.2 The UK 2050 target for decarbonisation focuses on the $CO_2$ equivalent emissions from the UK while genuine decarbonisation must consider the UK's global carbon footprint. Measuring national $CO_2$ results in driving up energy cost for local manufacturing and the exporting of jobs and emissions to countries that may have more carbon intensive processes. Over time, global agreements may emerge and these anomalies removed. The innovation agenda and priorities should reflect the global nature of the task and not be constrained by local targets that are at the expense of areas that will genuinely reduce the country's global $CO_2$ footprint. Managing low carbon innovation with the resources and speed required, presents an opportunity to help rebalance the global economy but the UK cannot do this alone.

2.3 A successful outcome will require substantial effort on six fronts of the carbon reduction strategy – energy efficiency, renewables, nuclear power, energy storage, carbon capture and storage (CCS) and a smart grid to pull these together. The progress made on a new nuclear station at Hinkley Point is very welcome. However, to ensure that retired nuclear capacity is renewed and a significant proportion of the fossil fuel stations are replaced by nuclear power, the UK will need many more similar stations. In order to deliver on the Government's aspirations for future UK transport and heat energy demand to be met through electricity, then this requirement is enhanced and CCS must be included along with the maximum possible contribution from renewables, enabled through energy storage and smart grid technologies.

2.4 Without generous subsidies or draconian regulations, it is difficult (if not impossible) to meet all three objectives at the same time. The costs of renewable energy, low-carbon technologies or energy-efficiency measures, are in many instances so high that, unless energy becomes far more expensive, there are not sufficient commercial incentives to invest or innovate for cost-reduction.

**3. What outcomes, if any, are the LCICG likely to achieve? How should its forthcoming strategy drive more investment into low carbon innovation, and how should it measure success?**

3.1 Although the changes to LCICG may be positive, they are unlikely to make a significant difference to the inadequate and piecemeal funding of R&D in low-carbon energy systems. At the time the 2008 Climate Change Act was published, few recognised the enormity of the challenge it contained. The Royal Academy of Engineering subsequently studied these targets and, in a report published in March 2010,[3] wrote "Turning the theoretical emissions reduction targets into reality will require more than political will: it will require nothing short of the biggest peacetime programme of change ever seen in the UK."

3.2 The decarbonisation of Britain is a project closer in scale to the 1940s production of armaments but this has not been recognised by Government in funding terms or regulatory regimes. It is most unlikely that it will be achieved by the combination of funding mechanisms already in operation.

3.3 Significant spend has been incurred in economics research. Government often places contracts with economics consultancies on subjects such as an evaluation of revised rules for the renewables obligation.[4] Although this may give the impression of action, there has been little relative progress towards innovation in the development of affordable low carbon technology or achieving low carbon energy targets.

3.4 Although DECC may have improved the situation by re-launching the LCICG, which is welcome, they still have to work through the 16 bodies listed in the consultation as well as various Catapult organisations, EPSRC, ESRC, NERC, AHRC, IEA and many other bodies which all have some input to funding for research into low carbon, public attitudes to the technologies and the use made of them.

3.5 Most renewable energy research and innovation currently takes place in the university sector. There are 132 members of Universities UK at least half of which undertake energy research, usually as part of a consortium. EU websites on renewable energy research list many bodies involved in distribution of funding and there are dozens of organisations involved in promoting and coordinating research.[5]

3.6 As a result of this complex structure, research funding mechanisms spread resources very thinly and carry a huge administration overhead. Typically a research grant is worth £3m over 3 years and involves half a dozen institutions, allowing each to employ a couple of researchers. By way of an example it is worth comparing R&D funding for renewable energy with funding for the Trident successor. Investment in facilities at AWE is currently running at £1bn p.a.[6] In March 2013 the MOD confirmed assessment phase spending on new submarines of £2.8bn.[7] In contrast a recent press release from DECC[8] reported that "four offshore wind projects will receive a

[3] *Generating the Future: UK energy systems fit for 2050.* Report by the Royal Academy of Engineering, ISBN 1-903496-54-1, March 2010
[4] Pöyry Consulting: *Potential impact of revised renewables obligation technology bands – a report to the Department of Energy and Climate Change*, December 2011
[5] See, for example, European Renewable Energy Council http://www.erec.org/organisation.html
[6] http://www.lockheedmartin.co.uk/uk/news/press-releases/2012-press-releases/MoD-Announces-Investment-in-Nuclear-Facilities.html
[7] House of Common Library: *Update on the Trident Successor Programme* SN06526, 13 August 2013
[8] https://www.gov.uk/government/news/renewable-energy-delivering-green-jobs-growth-and-clean-energy

share of £2.5m Government investment under the Offshore Wind Component Technologies Scheme".

3.7 If the importance of decarbonising the UK economy is as great as described by Lord Stern and the Royal Academy of Engineering, it is surprising that there has been so little direct Government investment in research. This situation is quite different to that in many of our competitor countries, such as China, who run large-scale national research facilities and appear to make progress that we seem unable to achieve.

3.8 The private sector is unlikely to put significant resources into major R&D activity, such as CCS, nuclear or renewable energy, unless there is a clear economic case for their adoption and evidence of long-term policy continuity. At present, for renewables, the only economic case for private sector investment is based on the continuation of the current subsidy regime. Recent changes in road fuel escalator duties,[9] reductions in PV feed-in tariffs,[10] active debate over cutting green taxes,[11] and proposals to freeze energy prices[12] do not instil confidence in a continuity of policy that could justify sustained R&D investment with long payback times.

## 4. Are the Government & LCICG targeting investment towards the most effective stages of the innovation process, including over the long-term?

4.1 At present the Government and LCICG are not targeting the right stages of the innovation process. The escalation of costs as a project moves from TRL1 to TRL9 is particularly marked in low carbon technologies. These are attempting to harvest energy from very diffuse sources and thus are inevitably physically large. By their nature, they operate in aggressive environments – the windiest and most remote hillside, the fastest ocean currents, and the most exposed coastlines – and so development and demonstration at full scale becomes difficult and expensive. In the case of nuclear, prototype systems require specialist facilities with exacting regulations. Many developments flounder at this full-scale demonstration phase, between lab-based research and full-scale commercial deployment.

4.2 The costs encountered between TRL3 and TRL7 are particularly difficult for SMEs. Even if research is grant-funded, no company wants to invest the time and effort of its employees in developments that do not result in long-term profitable manufacture. The complex structure of the privatised energy industry and its multi-party supply chain can bring helpful market behaviours and independence of actions, but it also creates barriers to innovation and, coupled with a complex and changing regulatory and subsidy framework, makes it difficult for smaller companies to undertake development in this area.

4.3 It is important that Government & LCICG target investment towards the so-called "valley of death" and support demonstration of new technologies at scale. For many technologies, this is where investment of a few tens of millions of pounds is most often needed. By that stage the development typically involves a committed research establishment, developer and manufacturing partner so competition is not appropriate. Not all funding need come from government but an underwriting scheme

[9] House of Commons Library, *Taxation of road fuels,* SN824, 26 March 2013.
[10] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43085/5386-government-response-to-consultation-on-comprehensi.pdf
[11] http://www.conservativehome.com/thetorydiary/2013/10/from-harryph-what-about-some-green-tax-cuts.html
[12] http://www.theguardian.com/money/2013/nov/09/energy-prize-freeze-public-sector-ed-miliband

that leverages private investment could bring forward deployment of, for example, marine turbines and energy storage technologies by years and show whether they are commercially viable or not. A public-private long-term funding model may be less costly in the long-term than serial rounds of piecemeal public funding. The latter are often subject to political short-termism and are potentially used inefficiently due to the distraction of bidding for the next tranche of funds.

4.4 A further problem with the current approach is the political assumption that energy prices can be held at roughly current levels, and the private sector can be persuaded to invest heavily in new low-carbon generation. Recent announcements of a long-term "strike price" for Hinkley Point C of roughly twice the current wholesale price for electricity, and only slightly lower than the target price for offshore wind generation set in a May 2012 report by the Crown Estate[13] are indicative of decarbonised energy costs.

4.5 Realistically, wholesale energy prices would have to rise by a factor of at least two and possibly three for private sector investment in renewables, CCS, nuclear power and energy storage to become attractive propositions without subsidy. On the assumption that it is unrealistic to expect low-carbon generation to be heavily subsidised from general taxation far into the future, there are important welfare questions around the combination of increases to the minimum wage, personal tax allowances, social security payments, etc. that would allow energy prices to double or treble in real terms, without increasing the number of people in poverty or fomenting social unrest.

**5. What is the impact of the short-term funding timelines on private sector investment?**

5.1 Energy systems are, by their nature, long-term investments. A nuclear power station takes 10 years to plan and build, operates for 60 years and then takes several decades to decommission. The North Sea oil industry, the national gas grid and the electricity transmission and distribution infrastructure were developed over decades. For the private sector to invest in developments and innovations that, even if completely successful are unlikely to make more than modest returns on investment, confidence in long-term market conditions and policy arrangements is required.

5.2 At present, it is far from clear whether there is a coherent national strategy that will last three years, let alone the 30 years necessary to ensure adequate returns on R&D investment. As an example, some parties have argued for the closure of the domestic gas grid and transfer of domestic heating loads to electricity whilst other parties are arguing for an expansion of "fracking" which would enshrine gas as the fuel of choice for domestic heating for many years to come.

5.3 An uncertain policy and market environment acts to discourage private sector investment. Government funding could play a role in underwriting such R&D but present short-term timelines do not provide this incentive.

[13] http://www.thecrownestate.co.uk/media/305094/Offshore%20wind%20cost%20reduction%20pathways%20study.pdf

**6. How should DECC ensure that its remaining capital allocation for low carbon innovation will be spent wisely, after two years of underspend?**

6.1 The re-launch of the LCICG will go some way to refreshing the energy efficiency and low carbon technologies schemes, however care must be taken to ensure that apathy from society and industry does not once more set in. As noted in question 1, the current Government approach to UK low-carbon technologies essentially anticipates cost reduction to come from "learning by doing" stimulated through subsidised deployment of an existing range of technologies. Such an approach is unlikely to result in any substantial innovating of the cost-out of these technologies, or significant innovation of new technologies, but rather minor steps forward to enable deployments that meet the UK's short-term targets for renewables uptake.

6.2 Given Government's long-term aspirations to stimulate an affordable, secure low-carbon supply of energy, with electricity as the energy carrier – there will have to be great improvements in cost-effective building efficiency and in energy storage, amongst other innovations. It is important that Government energy R&D policy takes each of these forward in parallel. If one area lags behind, the overall system will be far from optimum. The Government should focus strongly on finding innovative ways to fund the capital costs associated with the development of demonstration plant at full scale. DECC should work closely with BIS and the Treasury to develop such innovative Government financing arrangements, which are the key to unlocking the technical innovation that will lead to cost reduction for commercial deployment of low-carbon technologies.

6.3 Simplification of and accessibility to the schemes for domestic users, with focus on energy efficiency in the home, should also be key. Attention should be given to the Green Deal, ensuring that a substantially increased number of households can get easy access to funds to pay for energy efficient modifications to their homes.

6.4 Business would also benefit from the Green Deal but DECC should concentrate on assisting businesses to find ways to not just reduce their energy consumption but also store energy and even generate their own power using a combination of low carbon technology and energy recycling.

**7. How is the Government maximising opportunities to learn from and partner with international partners within and beyond the EU?**

7.1 The UK Government is partnering with several EU countries on Low Carbon initiatives, but it has been recognised by the International Energy Agency[14] that the UK is not participating in global initiatives at the same level.

7.2 The Government could for example work with the World Bank on the Low-Carbon Liveable Cities (LC2) Initiative, its goal to reach 300 of the world's largest developing country cities with planning and financing support over the next four years. However there are initiatives closer to home which the government could partner with that already have a global dimension. UK Universities have for many years been partnering with other international universities to work on low carbon innovation. Sussex University has been working with the African Technology Policy Studies Network to look at the adopting of low carbon technology in Kenya[15]. Additionally,

[14] Public Funding for Innovation in Low Carbon Technologies in the UK, National Audit Office, Oct 2013
[15] http://steps-centre.org/wp-content/uploads/Low-Carbon-Development-briefing.pdf

four UK universities have partnered with three Chinese universities to investigate low carbon buildings and eco-cities[16].

7.3 The UK government should take greater interest in these types of initiatives and utilise their findings to help develop policy.

[16] http://www.reading.ac.uk/CME/research/cme-InternationalResearchCentreforLowCarbonGreenBuildingandEco-Cities.aspx

## Acronyms

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| AHRC | Arts and Humanities Research Council |
| BIS | Department for Business Innovation and Skills |
| CCS | Carbon Capture and Storage |
| DECC | Department for Energy and Climate Change |
| EPSRC | Engineering and Physical Sciences Research Council |
| ESRC | Economic and Social Research Council |
| ETI | Energy Technologies Institute |
| EU | European Union |
| IEA | International Energy Agency |
| LCICG | Low Carbon Innovation Co-ordination Group |
| NERC | Natural Environment Research Council |
| SME | Small and Medium-sized Enterprises |
| TRL | Technology Readiness Level |
| UK | United Kingdom |