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# Building a zero-carbon economy – call for evidence

## December 2018

CREDS responds to consultations and calls for evidence from government, agencies and businesses, providing insight and expertise to decision-makers.

This response was created for the Committee on Climate Change's call for evidence to support its forthcoming advice to the UK Government and the Devolved Administrations on long-term targets for greenhouse gas emissions and the UK's transition to a net zero-carbon economy. The consultation ran from 30 October–7 December 2018.

The consultation response written on behalf of CREDS by Nick Eyre (University of Oxford), Jillian Anable (University of Leeds), John Barrett (University of Leeds), Tina Fawcett (University of Oxford), Tim Foxon (University of Sussex), Tadj Oreszczyn (University College, London) and Jan Webb (University of Edinburgh).

There were 14 questions in total, and CREDS responded to 6 of them.

- Q3 – effort share
- Q6 – hard-to-reduce sectors
- Q8 – technology and innovation
- Q9 – behaviour change
- Q10 – policy
- Q13 – devolved administrations

The full consultation response, as submitted, is below.



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## Part 2: International Action

*Question 3 (Effort share): What evidence should be considered in assessing the UK's appropriate contribution to global temperature goals? Within this, how should this contribution reflect the UK's broader carbon footprint (i.e. 'consumption' emissions accounting, including emissions embodied in imports to the UK) alongside 'territorial' emissions arising in the UK?*

For the past 5 years, the UK's carbon footprint has been one of the Government's climate change indicators (BEIS, 2018). It provides a scientifically robust annual assessment of the GHG emissions, both inside and outside the UK, that are associated with UK consumption. Approximately half of the UK's GHG emissions associated with consumption occurs outside the UK, including emissions due to international aviation and shipping. This proportion will increase over time as the mitigation effort of the UK is very likely to be greater than the international efforts.

In 2013, the University of Leeds undertook modelling of future UK consumption-based emissions as part of a CCC review (Scott et al., 2013; Scott et, 2015). This projected emissions according to several detailed future mitigation scenarios (2010-2050) to establish a potential target aligned with a global 2 degree target. This proposed a 73% reduction in the UK's carbon footprint (based on 2015 levels). The same team has recently updated this analysis, in response to a UK Government request. This identifies the need for a reduction of 90% in the UK's carbon footprint by 2050 to align with global net zero emissions.

We encourage the CCC to consider the implications of a UK climate policy that would deliver net zero emissions including embodied emissions associated with UK consumption. This is for a number of important reasons. Firstly, the most recent analysis demonstrated the considerable potential of UK resource efficiency policy to deliver mitigation both inside and outside the UK (Scott et al, 2018). By taking a consumption-based perspective, it demonstrates the ability of the UK to deliver international reductions through a progressive resource efficiency package across a number of "hard to mitigate" sectors. Secondly, the UK needs to ensure that UK climate mitigation efforts do not result in the offshoring of emissions that undermines the ultimate policy goal. Examples of where this could happen are biofuels, energy intensive materials production and transport. Finally, the public is becoming increasingly aware of the need for changes in lifestyle to mitigate a number of environmental problems and a consumption-based analysis will help to translate the scale of the challenge to the public whose support for more radical policies is essential to ensure success.

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# Part 3: Reducing emissions

*Question 6 (Hard-to-reduce sectors): Previous CCC analysis has identified aviation, agriculture and industry as sectors where it will be particularly hard to reduce emissions to close to zero, potentially alongside some hard-to-treat buildings. Through both low-carbon technologies and behaviour change, how can emissions be reduced to close to zero in these sectors? What risks are there that broader technological developments or social trends act to increase emissions that are hard to eliminate?*

Hard to decarbonise sectors can be characterised as uses of energy where complete electrification is problematic. No single alternative zero carbon vector is a silver bullet. Biomass is resource constrained. District heating has some advantages with respect to access to sources of heat, but would require high capital investment. It seems likely it is technically possible to convert the gas distribution grid to hydrogen (Sadler et al. 2016). UK analysis (e.g. CCC 2016) has tended to focus on steam methane reforming with carbon capture and storage, but electrolysis may be an attractive option in a high variable renewables context (Philibert, 2017).

Previous energy transitions show that supply and demand practices change together. Buildings, transport and industry will be very different after a zero carbon energy transition. This points to more emphasis on a demand-side change, an approach which we will be taking in CREDS.

Electricity is already dominant in some industrial sectors, notably aluminium and chlor-alkali manufacturing. Additional electrification is possible in low temperature processes such as drying, but similar 'easy wins' are not available in some high temperature processes, such as steel and cement. There is a growing literature on these sectors (e.g. Philibert, 2017; BZE, 2017), including Government's road maps (BEIS, 2015) and action plans (BEIS, 2017). These under-emphasise the potential for demand changes, most obviously in the oil refining sector, which could disappear in a very low carbon economy. Changes in demand for energy intensive materials should also be considered (see answer to Q3 above).

In transport, electrification of heavy road freight may not be feasible, and the most widely-researched alternative is hydrogen-powered vehicles. Shipping and aviation also remain problematic and require more research, but the technical issues associated with these are outside our areas of expertise. Again, the role of demand side change may be significant. It tends to be neglected, with Government analysis assuming growth is inevitable in freight transport. Our work in CREDS will subject this to critical review.

Heating buildings is a critical problem, largely because of its scale and seasonality. CCC has addressed options in earlier work (CCC, 2016) to which members of the CREDS consortium contributed. Complete electrification would require infeasibly large investment in generation for use at very low load factors (Eyre and Baruah, 2015). Heat pumps are not simple replacements for boilers; they require careful design and skilled installation (RAPID-HPC 2017), with major capacity building needs in the UK supply chain. Use of hydrogen might allow use of existing appliances in the short term, but is a sub-optimal long-term solution. These issues are being analysed by the CREDS Challenge on decarbonisation of heat. In the short to medium term there remains significant scope for improving the energy performance of buildings (Rosenow et al, 2018), and this should remain a key focus.

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*Question 8 (Technology and Innovation): How will global deployment of low-carbon technologies drive innovation and cost reduction? Could a tighter long-term emissions target for the UK, supported by targeted innovation policies, drive significantly increased innovation in technologies to reduce or remove emissions?*

In order to achieve the 1.5°C target, it will be necessary for innovation to drive further, and faster changes, both to reduce energy demand and to make it more flexible. This will require innovation in practices for use of energy and energy service business models, as well as innovation in low carbon technologies and vectors. There is good evidence that continuity and clarity of policies, based on strict long-term targets, can drive low-carbon innovation, but that timescales associated with invention, demonstration and deployment of new technologies are long (Gross and Watson, 2015). This supports the view that innovation on the demand side can help to meet these targets, as well as delivering reductions in the costs of energy services and other health and social benefits. For example, cost-effective investments in household energy efficiency could save around one quarter of the energy currently used, equivalent to the output of 6 nuclear power stations (Rosenow et al, 2017a).

Clear and challenging long-term targets are also needed to drive innovation in industry to enhance the capacity to deliver these types of cost-effective energy and carbon savings. For example, supply chain integration in the construction sector can help to deliver the adoption of low-carbon solutions and their integration within novel building design (Kesidou and Sorrell, 2018).

Policy mixes which are well-targeted and comprehensive are needed to drive faster adoption of energy efficiency measures. These should include high-level framework targets, such as the EU's 20% energy savings target by 2020, together with a combination of policy instruments to promote the deployment of low-cost and simple energy efficiency measures, and instruments to promote innovation and deployment of more costly and complex solutions, such as industrial process optimisation and whole-house retrofits (Rosenow et al, 2017b)

The energy transition will have different features in different places and local authorities could lead many aspects of the transition. This points to supporting innovation in devolved/ regional/local/ service delivery and policy (see out response to Q13 below).

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*Question 9 (Behaviour change): How far can people's behaviours and decisions change over time in a way that will reduce emissions, within a supportive policy environment and sustained global effort to tackle climate change?*

Historically energy services in buildings, particularly for heating, have expanded massively due to an aging population, occupants increasingly living alone and the conditioning of whole buildings to a higher temperature. There is some evidence that these behavioural changes are saturating, for example 95% of homes now (2017) have central heating, and 24 hour mean winter temperatures in the bedroom, living room and hallway are now above 18C (DECC, 2011). Increasing fuel prices have changed behaviours in the domestic sector - estimated total UK domestic gas use has a long-run price elasticity of -0.3+/-0.1 (Elwell et al 2015), which when combined with efficiency improvements, particularly of boilers has reduced delivered energy by 20% over the last 15 years. However, warmer summers, plus increased deployment of heat pumps may increase the use of active cooling. Changing behaviours to night, rather than daytime, summer ventilation, and controlling solar gains plus reduced traffic noise due to mobility electrification could reduce the demand for active cooling.

There is still massive potential to reduce wasted energy (useful energy not used) via smart control and monitoring. This may be deployed via new business models selling energy as a service, i.e. not burdening occupants with control decisions.

For personal transport, there is evidence of substantial and sustained attitude and behaviour change among certain cohorts in certain locations towards lower car ownership and use of

private vehicles (Marsden et al, 2018). Regardless of whether or not these changes are economically driven (for which the evidence is mixed), there is significant potential to 'lock in' the lower demands by supporting car independent lifestyles. This needs to involve the support of flexible and potentially shared access to all modes of transport, including occasional car use, through much greater policy support for car clubs, smart ticketing and payment mechanisms integrated across modes and accessibility planning underpinning all new homes and land use developments.

For all personal uses of energy, better information alone has historically resulted in minimal behavioural change unless supporting regulation, fuel price rises or grants. It is especially clear that information on carbon reductions does not motivate significant individual behaviour change, though there are other co-benefits of action, for example relating to comfort, health and local pollution mitigation that can have some effect. The biggest opportunities for behaviour change probably arise from preventing new patterns of energy intensive energy consumption being widely adopted before they are appropriately controlled.

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*Question 10 (Policy): Including the role for government policy, how can the required changes be delivered to meet a net-zero target (or tightened 2050 targets) in the UK?*

Government policy can deliver significant reductions in energy demand, through three linked approaches:

1. Designing high quality, ambitious policy
2. Creating institutions and arrangements for implementation and governance
3. Expanding the ambition and reach of policy

Tightened 2050 targets will require changes in technologies, practices and choices for every household and business. We do not fully understand how to achieve these changes: experimentation and learning will be key.

### 1. Policy design

Policy is required to support low carbon innovation, installation of efficient equipment, to renovate existing buildings, develop low carbon infrastructures, and to enable sustainable use and mobility. A policy mix is needed - using a variety of instruments to overcome different 'barriers' or to support technologies at various stages of development (Rosenow et al., 2016, 2017). Regulated minimum efficiency standards, which have delivered considerable successes, will be important (Mallaburn and Eyre, 2014). Policy must reach beyond technology to address the individuals and organisations who make up (and meet) demand.

Equity and justice should be integral to policy design, for principled and pragmatic reasons (Parkhill et al., 2013). Fairness and perceptions of fairness are critical to successful policy in the UK; perceived unfairness has undermined many past policies, e.g. VAT on fuel, fuel duty escalator, FITs.

### 2. Institutions and governance

By involving multiple actors at different levels of governance, and considering new institutional arrangements, policy will be improved. More systematic, comprehensive and faster improvements in energy saving could be achieved through clearer UK and devolved national government frameworks for local authority action (Webb et al 2017). Unusually, the UK does not have an energy agency to manage the complexity of national and sub-national policy. It could create one, or alternatively adopt "hybrid" energy efficiency programmes that fuse industry-led, voluntary programmes with selective government intervention (van der Heijden, 2017).

### 3. Expanding ambition

The limits of policy should be expanded beyond short-term, win-win options. New framings could include treating energy efficiency as a national infrastructure priority (Scottish Government, 2017), or the EU's 'energy efficiency first' approach, building on integrated resource planning. More radical approaches include sustainable prosperity in a circular economy (Jackson, 2017) or energy service sufficiency (Darby and Fawcett, 2018).

Policy boundaries should expand, for example, to encompass renovation of existing buildings. Current energy-intensive practices, such as long-distance air travel, or the growth of new energy uses, e.g. the internet of things, cooling of buildings, must be challenged.

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## Part 5: Devolved Administrations

*Question 13 (Devolved Administrations): What differences in circumstances between England, Wales, Scotland and Northern Ireland should be reflected in the Committee's advice on long-term targets for the Devolved Administrations?*

While Scottish government has made most progress in interim targets and budgets (Climate Change Act (Scotland) 2009), all Administrations need CCC advice on direct use of regulatory powers in devolved areas, notably agriculture, land use and forestry; procurement and planning; public transport and active travel; buildings and (as far as possible, since gas is reserved) heat. Targets have often assumed voluntary coordination, and progress is limited.

### Scotland

- Clean energy has been central to economic strategy, and finance under UK renewables policy has been deployed. CCC advice is now needed on support for marine and offshore resources and energy storage.
- Upgrading energy performance of buildings (Scottish Government 2018) is critical, but advice is needed on higher ambition.
    - Planned Local Heat and Energy Efficiency Strategies require investment in local governments.
    - For district heating: mandated connection requirements; data on waste heat sources and requirements to supply; fair tariffs, with open book accounting.
    - Regulation of building energy performance standards needs to be brought forward, from e.g. 2040 date for all homes to reach EPC Band C, and extended to the non-domestic sector, in order to secure net zero emissions.
    - The legislated requirement on public bodies to reduce emissions could be used to mandate collaboration in low carbon heat and in achieving the 'smarter model of local energy' (Scottish Government, 2017).
- Advice on Climate Change Plan 2018 monitoring of sectoral progress can identify policies to accelerate and scale up change.
- Advice on embedding low carbon infrastructure priorities in the planned National Infrastructure Bank.

### Wales

- Wales has fewer devolved powers, and energy is less closely allied with economic policy, perhaps related to Westminster coordination of many relevant policies. This seems to have resulted in limited renewable energy progress.
- CCC advice needs to continue to focus on setting and implementing interim targets and carbon budgets (Environment (Wales) Act 2016 specifies 80% reduction of emissions by 2050).

- Emissions from energy intensive industry requires CCC advice on action to access a greater share of England & Wales (as well as UK-wide) funding; current opportunities include E&W Heat Networks Investment Project which could build on the Flexis commitment to a demonstrator involving Tata Steel (Flexis, 2018).
- Further advice needs to support government in:
    - identifying clean technology opportunities, through e.g. UK Industrial Strategy Challenge Funds;
    - using new powers over energy infrastructure planning (up to 350MW; Wales Act 2017) to facilitate renewables investment.
- Advice is needed on accelerating progress in the Arbed housing energy efficiency programme, and its extension to heat strategy.
- Advice to support Welsh Government leading edge programme for housing will be critical to net zero buildings. The 'buildings as power stations' model sets a path with commitment to £7m investment.

### Northern Ireland

- The sectarian policy process is stalling climate progress, despite greater devolved powers, notably over energy.
- When the Administration is re-established, CCC advice needs to focus on the high share of emissions under direct control, and setting targets to secure economic benefits. Key opportunities are leadership in:
    - renewable power generation and reducing fossil fuel use
    - reducing emissions from agriculture
    - strategy for low carbon heat and energy efficiency of buildings.

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