

Building a zero-carbon economy – Call for Evidence

Background

On 15 October 2018 the governments of the UK, Scotland and Wales [asked](#) the Committee on Climate Change (CCC) to provide advice on the UK and Devolved Administrations' long-term targets for greenhouse gas emissions and the UK's transition to a net zero-carbon economy. Specifically: when the UK should reach net zero emissions of carbon dioxide and/or greenhouse gases as a contribution to global ambition under the Paris Agreement; if that target should be set now; the implications for emissions in 2050; how such reductions can be achieved; and the costs and benefits involved in comparison to existing targets.

The advice has been requested by the end of March 2019.

The UK's long-term emissions target is currently for at least an 80% reduction in greenhouse gas emissions from 1990 to 2050. It covers all sectors, including international aviation and shipping and is measured on a 'territorial' basis (i.e. based on emissions arising in the UK). On a comparable basis, emissions in 2017 were estimated to be 38% below 1990 levels.

The current target was set in 2008 based on [advice](#) from the Committee. That advice considered that to avoid the worst impacts of climate change, the central expectation of global temperature rise should be limited "to, or close to, 2°C", while the probability of crossing "the extreme danger threshold of 4°C" should be reduced to an extremely low level. That meant global emissions would roughly have to halve by 2050. The 2008 advice made the assumption that the UK should not plan to have a higher level of per capita emissions in 2050 than the global average.

The long-term target guides the setting of carbon budgets (sequential five-year caps on emissions that currently extend to 2032 and require a reduction in emissions of 57% from 1990 to 2030). Both the 2050 target and the carbon budgets guide the setting of policies to cut emissions across the economy (for example as set out most recently in the 2017 [Clean Growth Strategy](#)).

Any change to the long-term targets would therefore be expected to have significant implications, not just in the long-term but on current policies to drive the transition.

The CCC will advise based on a thorough consideration of the relevant evidence. We expect that to cover:

- The latest climate science, including as contained in the [IPCC Special Report on 1.5°C](#).
- The terms of the [Paris Agreement](#).
- Global pathways (including those reported by the IPCC) consistent with limiting global average temperature rise in line with the goals of the Paris Agreement.

- International circumstances, including existing plans and commitments to cut emissions in other countries, actions to deliver on those plans and opportunities for going further.
- An updated assessment of the current and potential options for deep emissions reductions in the UK and emissions removals from the atmosphere, including options for going beyond the current 80% target towards net zero.
- An appraisal of the costs, risks and opportunities from setting a tighter long-term target.
- The actions needed in the near term that would be consistent with achieving the long-term targets.

This Call for Evidence will contribute to that advice.

Responding to the Call for Evidence

We encourage responses that are brief and to the point (i.e. a maximum of 400 words per question, plus links to supporting evidence, answering only those questions where you have particular expertise), and may follow up for more detail where appropriate.

You do not need to answer all the questions, please answer only those questions where you have specific expertise and evidence to share. It would be useful if you could use the question and response form below and then e-mail your response to: communications@theccc.gsi.gov.uk using the subject line: 'Zero carbon economy – Call for evidence'. Alternatively, you can complete the question and answer form on the CCC website, available [here](#).

If you would prefer to post your response, please send it to:

The Committee on Climate Change – Call for Evidence
7 Holbein Place
London
SW1W 8NR

The deadline for responses is 12 noon on Friday 7 December 2018.

Confidentiality and data protection

Responses will be published on our website after the response deadline, along with a list of names or organisations that responded to the Call for Evidence.

If you want information that you provide to be treated as confidential (and not automatically published) please say so clearly in writing when you send your response to the consultation. It would be helpful if you could explain to us why you regard the information you have provided as confidential. If we receive a request for disclosure of the information we will take full account of your explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded by us as a confidentiality request.

All information provided in response to this consultation, including personal information, may be subject to publication or disclosure in accordance with the access to information legislation (primarily the Freedom of Information Act 2000, the Data Protection Act 1998 and the Environmental Information Regulations 2004).

Question and response form

When responding, please provide answers that are as specific and evidence-based as possible, providing data and references to the extent possible. Please limit your response to a maximum of 400 words per question.

Part 1: Climate Science

Question 1 (Climate Science): The IPCC's Fifth Assessment Report and the Special Report on 1.5°C will form an important part of the Committee's assessment of climate risks and global emissions pathways consistent with climate objectives. What further evidence should the Committee consider in this area?

ANSWER:

Question 2 (CO₂ and GHGs): Carbon dioxide and other greenhouse gas gases have different effects and lifetimes in the atmosphere, which may become more important as emissions approach net-zero. In setting a net-zero target, how should the different gases be treated?

ANSWER:

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?

The UK has an opportunity to consolidate its position as a world leader on climate change and, given its historic emissions, it has a duty to do so on the basis of equity.

Analysis by Averchenkova et al. (2014) found that, with the exception of a carbon budget approach, there was no significant difference in the level of mitigation each country should undertake across different burden-sharing methodologies [1]. They recommend moving away from the idea of 'burden-sharing', because there is no methodological agreement, and towards principles of equitable access to sustainable development, the case for which was explored by Rydge et al. (2018) [23].

Holz et al. (2017) apply the principle of 'equity' to determine 'fair shares' of the global carbon budget to limit warming to 1.5°C [2, 3]. While this is a 'burden-sharing' framework, it is a useful tool for understanding the scale of support the UK should provide for sustainable development in accordance with the UK's capacity and historic responsibility.

Effort-sharing therefore has two components:

- Accounting for the UK's full carbon footprint, including monitoring of consumption emissions, although countries we import emissions from are also likely to control them through their NDCs

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- Providing support to developing countries to mitigate climate change

Analysis by Defra (2018) of the UK's consumption emissions from 1997–2015 demonstrates that the carbon footprint is larger when accounted for on a consumption rather than production basis [4]. Staffell (2017) found that emissions from electricity imported into the UK would add 5% to the sector's overall emissions [5].

Effort-sharing could be reflected in the UK's effort to engage and trade with countries that embed principles consistent with the Paris Agreement:

- By encouraging trade partners to reduce emissions through the UNFCCC ratcheting process
- By linking climate action and compliance with global rules as a condition for open economic and trade relations, as France's President Macron highlighted in September 2018 (subject to WTO compatibility) [6]
- Through the role of climate finance, particularly for low-income countries.

The UK is already a leader in sustainable finance and provides significant public and private-sector finance to developing countries. Article 2.1(c) of the Paris Agreement provides a clear mandate to make 'finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development'. As we outline in question 10, a new role for the CCC could be to take stock of the consistency of UK climate finance with temperature goals [7].

Question 4 (International collaboration): Beyond setting and meeting its own targets, how can the UK best support efforts to cut emissions elsewhere in the world through international collaboration (e.g. emissions trading schemes and other initiatives with partner countries, technology transfer, capacity building, climate finance)? What efforts are effective currently?

As the UK's position in the world is changing, it should continue to develop a competitive advantage in sustainable finance, which can ensure significant returns to UK businesses [8]. However, the Green Finance Taskforce's *Accelerating Green Finance* report identified that the UK is at risk of losing its place as a leader in sustainable finance to countries such as France and Japan who are putting forward significant and innovative green finance options. The Government should adopt the Taskforce's 30 recommendations centred on government partnership with the private sector to develop the UK's sustainable finance capacity and leadership.

The Taskforce also found that global coordination and cooperation are vital for the growth of green finance. The UK should leverage global diplomacy through forums such as the UNFCCC negotiations, G20 and others to build a coalition of developed countries focused on an equitable distribution of both public and private finance. Such a coalition may ease competition concerns arising from unilateral action.

Post-Brexit, the UK should also consider international collaboration in the design of its

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carbon price. Because the UK is a relatively small actor in the context of the EU emissions trading system (ETS), there will be a greater regulatory burden to implementing a UK ETS in isolation, and after Brexit many of the low-cost abatement opportunities, for example from eastern European countries, will no longer be available [9]. If the UK does not remain within the EU ETS, the first preference should be to maintain a UK ETS that is fully linked with the EU given the pre-existing institutional arrangements. This will allow the UK to maintain benefits resulting from effort-sharing and risk-sharing [10, 11].

The UK should also consolidate its position as a leader in international development assistance and climate finance. To ensure UK aid is climate-compatible, the UK should take the lead in developing a robust screening process of all bilateral and multilateral aid to determine a climate rationale for the allocation of all international development resources, not just those distributed through UK International Climate Finance (ICF) [12]. This process should involve an holistic, coherent approach to considering both mitigation and adaptation aspects of aid, given the scale of the impacts of climate change, and the threats they pose to development. Some climate change impacts are already observable and further warming is unavoidable. Therefore, mitigation and adaptation should be considered together and international development programmes designed, financed and allocated accordingly.

Question 5 (Carbon credits): Is an effective global market in carbon credits likely to develop that can support action in developing countries? Subject to these developments, should credit purchase be required/expected/allowed in the UK's long-term targets?

An effective, fully integrated global market is unlikely to develop. Carbon markets are likely to emerge nationally or regionally, occasionally linked either directly or indirectly (via the joint recognition of carbon credits).

The view of the Government and CCC has always been, and should continue to be, that the UK should meet its emissions targets domestically and endeavour to meet national targets without offsets. This is particularly the case given the findings of the IPCC Special Report on 1.5°C that to ensure a realistic chance of limiting global temperature rise to below 1.5°C above pre-industrial levels, global greenhouse gas emissions will need to reach net-zero by 2050 [13]. This leaves little scope for sourcing emissions reductions internationally, as global emissions will need to reach as close to zero as possible.

However, other countries have a more open approach to international offsets. The Swedish net-zero emissions target allows for Sweden to count emissions it helps to reduce abroad towards its goal, but places a limit on this by requiring that its domestic emissions must be at least 85 per cent lower than 1990 levels [14]. Switzerland is also currently considering more stringent carbon targets supported by international offsets. These examples provides a useful model for the UK, should it consider international offsets.

International cooperation may also be required in carbon removal (negative emissions). It

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is unclear at the moment whether the UK will have a comparative advantage in negative emissions technology. So a distinction may have to be made between traditional offsets (bringing other countries' emissions closer to zero) and finding the best way, globally, of producing the negative emissions that a 1.5°C scenario requires. Depending on what that solution is, the UK may have to import negative emissions from the places best suited to produce them, while seeking not to place unsustainable pressures on international land use [15].

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?

Aviation:

Technological innovation should prioritise step changes that will have the biggest impacts on decarbonisation, including electric and hybrid aircraft. The Department for Transport has committed to supporting a roadmap to bring forward use of these technologies. This should be made a priority, as these technological step-changes will have the greatest impact on decarbonisation [16].

While these major innovations should be prioritised, in the short term research should also continue on low-carbon technologies such as switching to biofuels, operational efficiency measures (e.g. through reduced carry weight and pilot behaviour), and other incremental efficiency technologies, such as through improved aerodynamics.

Avoiding air travel is one of the most impactful actions individuals can take [17]. Accessible and acceptable solutions include greater use of video-conferencing technology in the workplace. Behavioural change in pilots can also lead to significant fuel savings [18].

Industry:

Technological innovation to decarbonise industry should again prioritise step-change innovations such as electrification and hydrogen accompanied by carbon capture and storage (CCS). This can be complemented by operational efficiencies and promoting a circular economy, including through a focus on ensuring recyclability of materials in the development and production stages.

We agree with the CCC's recommendation that the Government should set out plans in 2018 to kick-start a UK CCS industry in the 2020s to ensure it is sufficiently advanced in time to meet a net-zero target [19].

Industrial decarbonisation is unlikely to be led by consumer behaviour change, particularly where the end-product is not improved by low-carbon production. Standards will therefore have an important role to play in end-use sectors such as construction. Lessons can be learnt from fuel efficiency standards in the automotive sector [20].

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Agriculture:

The UK's withdrawal from the EU, and consequently the Common Agricultural Policy, presents an opportunity to rethink agricultural policy. A payments-for-ecosystem-services scheme could be used to encourage technological innovation and the development of nature-based negative emissions, such as afforestation [21].

Eating a plant-based diet can significantly reduce individuals' carbon footprints [17]. The public expects government to take the lead in addressing unsustainable consumption of meat. Policies could include increasing the prominence of vegetarian options, using public procurement and using price as a lever – whether through removal or subsidies or increasing the price of meat [22].

In addition to the above sectors, several others pose challenges. Analysis could be broadened to the marine sector and others covered in the Energy Transition Commission report [23]

Question 7 (Greenhouse gas removals): Not all sources of emissions can be reduced to zero. How far can greenhouse gas removal from the atmosphere, in the UK or internationally, be used to offset any remaining emissions, both prior to 2050 and beyond?

ANSWER:

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?

Climate change is a result of several market failures. A carbon price can address greenhouse gas externalities. But additional interventions are needed to address other market failures, including those related to low-carbon innovation.

Spill-over effects from (the societal benefits of) low-carbon innovation in the energy and transport sectors are over 40% greater than for conventional technologies [24]. This means that deployment of low-carbon technology has greater potential to promote system-wide innovation and propel the shift towards a net-zero transition. However, the lack of returns from innovation poses a market failure that disincentivises R&D by the private sector [25].

A carbon price can directly drive innovation: with the introduction of the EU ETS in 2005, companies facing a price on their carbon emissions filed 30% more patents in low-carbon technologies [25]. However, the price needs to be high and firms need to expect the price to remain at a high level for the foreseeable future.

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?

A carbon price alone is not enough. In a recent report for the LSE Growth Commission, Rydge et al. recommended that the Government introduces a 'research mission', with active and coherent policymaking including levers such as:

- patient strategic finance
- institutions to take on some of the risk and uncertainty around R&D outcomes
- funding for projects slightly further along the innovation curve, to avoid the 'valley of death' [24]

Rydge et al.'s report provides useful data on innovation across various sectors in the UK and identifies sectors where there is a risk of under-provision of innovation without government intervention.

The Government can also play a key role in building and maintaining networks or consortia of researchers. The Defense Advanced Research Projects Agency (DARPA) in the US is an example of an agency that has successfully facilitated groundbreaking technology developments [27, 28]. Where possible, UK Research and Innovation should look towards DARPA for practical examples.

Reducing emissions in many of the sectors and materials that the UK relies on will require international cooperation in sectors in which other countries have a competitive advantage or supply much of the UK's materials. There is therefore a role for the UK to build sector-based partnerships and coalitions focused on fostering private sector innovation while recognising that strong regulation can also build markets.

Further evidence and recommendations on the need for a portfolio of policy levers, including innovation funding, can be found in the bibliography at: [29-32]

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?

People are more likely to change their behaviour if viable alternatives exist. Experience shows that consumers resist lifestyle changes if there is no reasonable alternative.

A study by van de Ven et al. (2018) found that behavioural change in the areas of food, transport and housing could reduce per capita carbon footprints in the EU by 6–16% [33]. The results and methodology of that study provide valuable detail that could be applied to the UK.

Wynes and Nicholas (2017) conducted a similar study, which concluded that the most impactful behavioural changes that individuals can make are: having one fewer child, living car-free, avoiding air travel and eating a plant-based diet [17]. They also recommend that adolescents should be the primary audience for behavioural change campaigns as they have not yet established lifelong behavioural patterns.

Food demand considerations were addressed in question 6 above.

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Most housing-related emissions are related to waste recycling. Individuals and local councils should be encouraged to prioritise prevention of waste and re-use of household materials where possible. A series of recommendations on how to encourage such behaviour, including through behavioural economics, were put forward by Policy Exchange (2017), which also identified a role for government in setting reporting frameworks [33]. The private sector should also focus on designing processes to enable better recycling of materials [19].

The work of the Behavioural Insights Team has been particularly ground-breaking and far-reaching in the area of influencing behavioural norms, and could be drawn upon to help implement the behavioural changes suggested by the papers cited above [35].

Behavioural change may be more effective when linked with other social considerations such as increased wellbeing. For example, promoting a plant-based diet, reduced work travel and more walking or cycling can all be touted as supporting better health outcomes in addition to emissions reductions [33].

Government policy should focus on changing the choice architecture within which people make decisions, while not removing choices.

Further useful resources on high-impact actions and mechanisms for behavioural change can be found in the bibliography at: [36, 37].

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?

1) Legislated target, backed up by policy

The Climate Change Act should be amended to replace the 80% reduction by 2050 target with a target of net-zero by around 2050, in line with net-zero commitments made by other countries. Carbon budgets should be set with significant lead times, to send strong signals to the private sector. For example, Sweden's legislated net-zero target requires it to develop a new set of policies every four years, to ensure continued responsiveness and ratcheting up of ambition [37]. A similar approach could be adapted to the UK's five-yearly carbon-budget cycles.

2) Carbon price

Dieter Helm's *Cost of Energy Review* emphasises that an economy-wide carbon price is the most efficient mechanism to reduce emissions [24, 39].

3) Standards and sustainable infrastructure

Standards can drive mitigation in hard-to-reduce sectors. Construction standards can incentivise downstream innovation and encourage sustainable infrastructure, which is key to continued economic growth [20, 24].

4) Innovation

Strategic finance accompanied by a DARPA-like network (see Q8) can drive innovation.

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The private sector should also look beyond short-termism and consider how to cooperate with other actors to share the gains of innovation and overcome the disincentive of spill-over effects. For example, Fouquet (2017) suggests that integrating low-carbon energy with the knowledge economy could help low-carbon energy start to out-compete fossil fuels and become locked in as the knowledge economy grows [40].

5) Behavioural change

There is a role for the private sector in setting social norms to facilitate behavioural change. Individuals should also be incentivised; careful consideration of how to adopt behavioural economics is important. For example, it is often more effective not to limit consumers' choices but to increase the visibility of preferable options instead.

6) Sustainable finance

The Government can ensure that public and private sector finance is aligned to a net-zero target, in accordance with article 2.1(c) of the Paris Agreement and question 4 above, by:

- Extending the mandate of the CCC to assess and recommend measures to implement the Paris Agreement's goals, including article 2.1(c)
- Taking stock of financial flows within the UK, and between the UK and the rest of the world, to determine if these align with a net-zero pathway
- Bringing forward measures to align the UK financial system with Article 2.1(c)
- Including in regular advice to Parliament an assessment of financial consistency with net zero [7]

Part 4: Costs, risks and opportunities

Question 11 (Costs, risks and opportunities): How would the costs, risks and economic opportunities associated with cutting emissions change should tighter UK targets be set, especially where these are set at the limits of known technological achievability?

It has been known for some time that the costs of inaction are higher than those of action. A strong body of research shows that the cost of mitigating climate change would be outweighed by the cost of loss and damage caused by climate change, from the 2005 Stern Review [40] to the 2018 IPCC 1.5°C report [13], which makes clear that the risks associated with global temperature rise of more than 2°C are unacceptable.

Good climate policy can drive sustainable economic growth. The UK has grown its economy while reducing emissions, producing three times as much economic output per ton of carbon today than in 1990. Rydge et al.'s *Sustainable Growth in the UK* report emphasises the strong growth benefits of clean innovation and its impact on investment and jobs, and that the UK would benefit from investment in sustainable infrastructure, to avoid stranded assets and lock-in to high-carbon investments, but also to create networks and investments that can spur economic growth [24]. The UK's infrastructure has suffered from years of underinvestment and poor planning, so costs associated low-carbon infrastructure are outweighed by the economic benefits arising from the increased creativity, innovation and productivity that sustainable infrastructure facilitates [24].

However, as the CCC has previously highlighted (for example, in the context of CCS), there is a need to ramp up the low-carbon transition quickly if loss and damage from

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climate change are to be avoided and the economic benefits of a low-carbon economy realised [18].

Question 12 (Avoided climate costs): What evidence is there of differences in climate impacts in the UK from holding the increase in global average temperature to well below 2°C or to 1.5°C?

The appropriate metric to assess the merit of keeping warming to 1.5°C or 2°C should be the **global risks** these temperature increases entail. The UK is considering its national contribution to a global problem. The IPCC 1.5°C Report represents the best available science on the difference in global impacts between 1.5°C and 2°C and significant attention should be given to this report and its recommendations [13]. There also needs to be a view of both the direct and indirect impacts. For example, in terms of indirect impacts, the UK's best interests would be at significant risk if temperature rises increase population displacement to the extent that social conflict ensues. This risk should be assessed in the UK Government's Strategic Defence review.

The impacts of climate change on the UK are important to understand, but they are not the main driver for a net-zero target. A range of other research highlights the different impacts associated with different levels of warming in the UK. These include:

- The Met Office's recently released climate change projections which show that temperatures could rise between 0.9 and 5.4°C in summer and 0.7 and 4.2°C in winter in the UK, with an increase in hot summers ([38], although note questions over the robustness of this research by Prof David Stainforth [43]).
- The CCC's own work: the *Climate Change Risk Assessment 2017 Evidence Report*, which identifies the urgency of climate risks in the UK [44]; and work on flood risk more generally (identifying that significant additional investment and adaptation are needed to counter the increase in UK flooding projected under a 2°C rise [45]).
- Work is also soon to be forthcoming from the Grantham Research Institute linking projections of future flood risk in the UK with the impact on the finance sector.

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?

ANSWER:

Part 6: CCC Work Plan

Question 14 (Work plan): The areas of evidence the Committee intend to cover are included in the 'Background' section. Are there any other important aspects that should be covered in the Committee's work plan?

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ANSWER:

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