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.

Authors:

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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 (CO_2 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:

Due to the significantly different impacts of short- and long-lived GHGs, attempting to define 'net-zero' in the same way risks misrepresenting their contributions to future warming.

A proportion of any CO_2 emission remains in the atmosphere, and contributes to warming, for millennia. Consequently, net anthropogenic CO_2 emissions must essentially be eliminated completely to prevent further temperature increases. Other GHGs with lifetimes longer than

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the timescale of interest (e.g. nitrous oxide) also need to be reduced to zero emissions (or offset by removal of other long-lived emissions, see Q.7) to halt further warming. By contrast, emissions of methane, HFC-134a, and other short-lived pollutants (atmospheric lifespans well within a policy-relevant timeframe) do not have to reach zero emissions to stabilise temperature.

If methane's total global emissions stabilised at today's rates, methane concentrations (and its radiative forcing) would stabilise, as within decades emissions would be balanced by natural atmospheric removal (unless methane sinks substantially changed). The warming due to these continued emissions would also start to stabilise over a similar period, although there would still be a small and uncertain multi-century adjustment to past increases (see response to Q6). The metric most commonly used to place emissions of different gases on a CO_2-equivalent (CO_2e) scale, the 100-year Global Warming Potential (GWP_{100}) does not capture this stabilising behaviour; 'net-zero' emissions defined by this metric would result in different temperature outcomes for short- and long-lived gases.

A modified use of GWP, termed GWP* (Allen et al., 2018), reconciles this problem by treating sustained changes in the methane emissions rate as equivalent (in terms of impact on temperature) to single releases of long-lived pollutants. For example, using GWP*, a sustained increase in methane emission rate is equivalent to a one-off emission of a fixed number of tonnes of CO_2. GWP* retains previously tabulated values of GWP_{100} (e.g. from IPCC assessments) so does not require additional physical modelling, and incorporates the same atmospheric behaviours (e.g. radiative efficiencies, climate feedbacks). GWP* therefore provides a simple and easily-applied methodology for calculating an equivalent amount of CO_2 to describe methane (or other short-lived gases) that gives a fixed warming for every equivalent tonne of CO_2 emitted. Hence it is a much better suited than the usual application of GWP for deriving net-zero CO_2e emissions.

IPCC's 1.5°C special report reflects these principles, stating that non-CO_2 emissions do not need to reach zero emissions globally, but emissions do need to be reduced in scenarios that meet 1.5°C.

Allen, M., Shine, K., Fuglestvedt, J., Millar, R., Cain, M., Frame, D., & Macey, A. (2018). A solution to the misrepresentations of CO_2-equivalent emissions of short-lived climate pollutants under ambitious mitigation. *Npj Climate and Atmospheric Science* http://doi.org/10.1038/s41612-018-0026-8

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?

ANSWER:

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?

ANSWER:

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?

ANSWER:

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?

ANSWER:

Agriculture's climate impact is mostly from methane and N_2O emissions. As discussed in Q2, because of its short atmospheric lifespan, stable methane emissions maintain an equilibrium atmospheric concentration, leading to elevated but stable radiative forcing. If maintained, this forcing results in some continued longer-term warming because of carbon cycle feedbacks and slow (deep-ocean) temperature equilibration. As a result of this, halting temperature changes due to methane requires emissions to gradually decline, but they do not need to fall to zero.

Methane emissions that fall at a rate of approximately 0.3%/year are equivalent to net-zero CO_2 emissions, in the sense that both scenarios stabilise temperatures at some given level. This is shown in the figure, which illustrates an idealised approximation of historical global methane emissions, ramping up from zero to 300 Mt methane/year after 70 years, then held stable for 100 years (blue), or declining by 0.3%/year (orange). Calculations use the FAIR simple climate model (Smith et al., 2018); this demonstrates that a modest decline in methane emissions over time can offset the slow climate response to past methane emissions, and therefore stabilise temperature.

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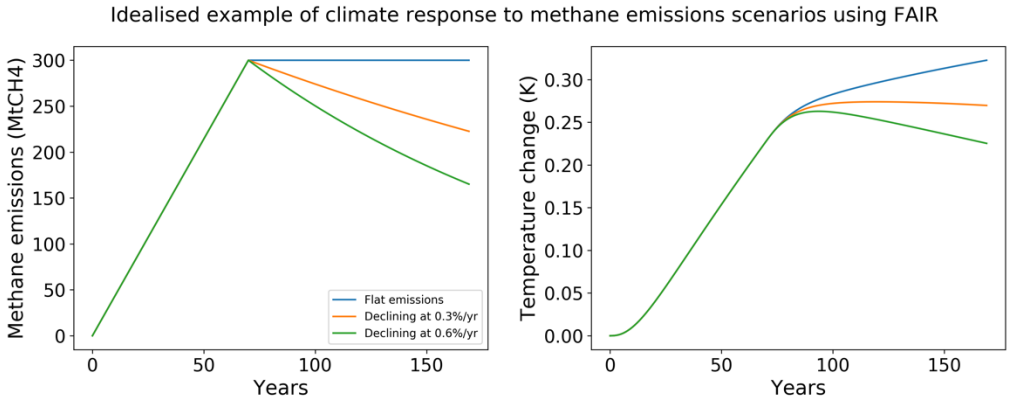

Methane emissions from the agricultural (or any other) sector present an opportunity for wider climate change mitigation if they can reduce faster than 0.3% per year. A rate of decline of 0.6%/year, for example (green line), generates a cooling response (relative to the temperature impact following peak emission rates), which could be considered as actively reversing past warming due to this gas, or as a means of offsetting unavoidable emissions of long-lived pollutants, including agricultural N_2O.

Despite the potential value of decreasing methane emission rates, efforts to reduce short-lived pollutant emissions which delay or come at the expense of reduction in long-lived GHG emissions such as CO_2 will result in a warmer long-term climate (Pierrehumbert, 2014). For example, a reduction in 1xGWP_{100} tonnes of methane to offset 1 tonne of CO_2 would result in short term cooling but long term warming. Any methane reduction policy should be evaluated in terms of its impact on warming (better expressed using GWP*, as noted in Q2) as opposed to its CO_2e emissions calculated using the GWP_{100}. The GWP was not designed to be a climate metric suitable for climate agreements with temperature targets, and policy strategies based on its use will give a misleading impression of the impact of reductions of short-lived pollutant emissions on temperature.

Pierrehumbert, R.(2014). Short-Lived Climate Pollution. Annual Review of Earth and Planetary Sciences http://doi.org/10.1146/annurev-earth-060313-054843

Smith, C., Forster, P., Allen, M., Leach, N., Millar, R., Passerello, G., Regayre, L. (2018). FAIR v1.3: a simple emissions-based impulse response and carbon cycle model. Geosci. Model Dev. http://doi.org/10.5194/gmd-11-2273-2018

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:

Article 4 of the Paris Agreement introduces the concept of achieving a balance of sources and sinks of greenhouse gases to achieve the temperature goal, and one-way of framing 'net-zero' emissions (Fuglestvedt et al., 2018). We briefly consider atmospheric removal of non-CO_2 gases, but focus our response removal of CO_2 to compensate for other emissions.

We are not experts in GHG removal techniques, but we point out that short-lived pollutants (e.g. methane, HFC-134a) are naturally lost from the atmosphere within decades; active removal, though still potentially beneficial, is not required to prevent the large-scale cumulative increases that occurs for sustained emissions of long-lived climate pollutants.

To address the issue of how much CO_2 removal is required to offset emissions of other gases, it is important to consider the metric used.

For long-lived gases, if zero emissions or active removal of e.g. N_2O cannot be achieved, then CO_2 removal could be used to compensate. Allen et al., (2016) show that using the 100-year Global Warming Potential, GWP_{100}, the CO_2-equivalent (CO_2e) emission of N_2O would result in equivalent warming over a 100-year period; thus GWP_{100} provides an appropriate means of deriving the required offset.

However, when GWP_{100} is applied to short lived pollutants such as methane and HFC-134a, the warming from the CO_2e emissions is not equivalent over a 100 year time period. In fact, GWP_{100} underestimates the warming from methane and HFC-134a over the short term but then significantly overestimates it in the long term (at horizons longer than 40 years after the emission). We conclude that the necessary removal of CO_2, to compensate for the longer-term impact of ongoing emissions of methane and HFC-134a on temperatures cannot be reliably calculated using the GWP_{100}. Indeed, using GWP_{100} would significantly overestimate the required amount of CO_2 removal to stabilise temperatures. Fulgestvedt et al., (2018) demonstrated this by imposing net-zero at 2100 in the RCP2.6 mitigation scenario, offsetting ongoing methane and N_2O emissions with CO_2 removals, comparing CO_2e derived using GWP_{100}, GWP* (see our response to Q.2), and other metrics and time horizons. Using GWP_{100} led to ongoing cooling because of an overestimate of the CO_2 removals that were required to balance the methane emissions on a temperature basis. The GWP* generated the best approximation of net-zero warming of all the metrics tested, hence is a superior metric to calculate the amount of CO_2 removal required to generate net-zero warming.

Allen, M., Fuglestvedt, J., Shine, K., Reisinger, A., Pierrehumbert, R., Forster, P. (2016). New use of global warming potentials to compare cumulative and short-lived climate

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pollutants. *Nature Climate Change*, http://doi.org/10.1038/nclimate2998

Fuglestvedt, J., Rogelj, J., Millar, R., Allen, M., Boucher, O., Cain, M., et al. (2018). Implications of possible interpretations of "greenhouse gas balance" in the Paris Agreement. *Phil. Trans. Roy. Soc. A:* http://doi.org/10.1098/rsta.2016.0445

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?

ANSWER:

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?

ANSWER:

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?

ANSWER:

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?

ANSWER:

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?

ANSWER:

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?
ANSWER: