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31 October 2013

Submission to EAC Inquiry: Progress on carbon budgets

The [Tyndall Centre](#) is an internationally recognised climate-change research group, bringing together scientists, economists, engineers and social scientists to develop sustainable responses to climate change. Researchers from eight UK universities, together with Fudan University, China, form the Tyndall Consortium, the headquarters of which is at the University of East Anglia.

This submission gathers input from a number of Tyndall Centre researchers based at the University of Manchester and the University of East Anglia. All views contained within are attributable to the specific section authors and do not necessarily reflect those of the other contributors, researchers from the wider Tyndall Centre or either university. With each section we have indicated the relevant lead author for clarity.

The research activity underpinning this submission has predominantly been funded by the UK Research Councils (EPSRC, ESRC and NERC), along with our host institutions and the [Sustainable Consumption Institute](#). No other interests are declared.

Sincerely,

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Summary

UK carbon budgets in the context of international commitments on 2°C

- The UK's commitments under the Climate Change Act (short-term carbon budgets and the 80% reduction pathway) are incompatible and much less challenging than the UK's explicit international commitment on 2°C. The UK has, in effect, two radically different and conflicting carbon budgets.
- The UK's national carbon budget is a highly inequitable proportion of the global budget for 2°C, and contradicts the UK's assurances of an equitable distribution of emissions under the Copenhagen Accord and similar international agreements.
- The recent global emissions trajectory is at the high end of IPCC emissions scenarios, and correlates with a central global warming projection of 4.9°C. Such a rise would exceed any warming level thought to have occurred in the past 5 million years.

UK emissions in the context of the Climate change Act (2008)

- The UK's current emission reductions targets for 2050 remain valid as a minimum requirement for the legal commitments under the 2008 Climate Change Act.
- UK emissions have remained approximately constant when UK consumption of goods and services produced elsewhere is considered; this is despite a decline in UK territorial fossil fuel emissions of 20% since 1990. In contrast, Germany's territorial and consumption emissions have both decreased by about 25% at the same time as their economy has continued to grow.
- Agricultural emissions are an example where consumption-based accounting is an important and useful complement to production-based (territorial) accounting. Direct climate impacts and global trade are especially significant in this sector and lead to this accounting vulnerability.
- Emissions from the UK's proportion of international shipping and aviation are poorly accounted for. Given that the UK has the ability to influence these sources nationally, it is prudent to incorporate aviation and shipping emissions into short-term carbon budgets as a matter of some urgency.
- Given the technical difficulty of securing large reductions in emissions from the agricultural sector, their non-CO₂ GHG emissions are set to become an increasing proportion of the UK's budgets. Greater rates and levels of decarbonisation may therefore be necessary from the UK's energy system.
- The development of further gas generation capacity cannot be reconciled with the UK's 2°C commitments and has only a very limited role in the UK's current carbon budgets. Any additional gas capacity will rapidly become a stranded asset unless retro-fitted with carbon capture and storage.
- If carbon and capture storage technologies are proven to work at scale and with high levels of capture (90% or higher), gas fired powerstations would be compatible with the UK's carbon budgets, but remain incompatible with the UK's 2°C commitments.

Question 1

In light of the current climate change assessments, whether the emissions reduction targets in the Climate Change Act (which underpin the UK Carbon Budgets) are still valid as an appropriate UK contribution to avoiding dangerous global climate change; and if not, whether the Act and/or the Carbon Budgets should be revised.

Prof C. Le Quéré: Paragraphs 1- 6

1. In spite of concerns for climate change, the global emissions of CO₂ have increased by 3.1% per year since 2000 on average, three times faster than the 1.0% per year increase observed in the 1990s (Peters et al., 2013). CO₂ emissions were 58% above 1990 levels in 2012 (Le Quéré et al., 2013). We have computed near-term projections in global CO₂ emissions using the projected World GDP from the International Monetary Fund (IMF; April 2013), and applying the mean improvements in the fossil intensity of the economy of the past decade as in Raupach and Canadell (2010) (Fig. 1, below).
2. The observed global CO₂ emissions are following the upper end of the emissions scenarios that will be used in the upcoming assessment of the Intergovernmental Panel on Climate Change (IPCC; Fig. 1). Observed emissions are increasingly diverging from the emissions required to limit global warming to the 2°C characterisation of “dangerous global climate change” (Peters et al., 2013). The emissions projections we calculated for 2012-2018 suggests that the recent trend will persist well into this decade unless improvements in energy efficiency strongly depart from the tendencies observed since 2000, or unless reductions in energy consumption occur.
3. The upper emission scenario leads to a central global warming projection of 4.9°C above pre-industrial temperatures at the end of the century (Rogelj et al., 2012), above any warming levels that is thought to have occurred on Earth in the past 5 million years. The uncertainty around this projection is large and depends on the climate sensitivity of the planet. Climate sensitivity is a measure of how much the global temperature would rise for a doubling concentration of CO₂. There is a range of climate sensitivity values based on different lines of evidence (both observations and models). However, even if the low-end of the range is chosen (i.e. 1.5°C for a doubling CO₂ concentration), this would still cause a rise in temperature of 3.5°C by 2100 under the high emissions scenario (Fig. 1). Conversely, if the climate sensitivity was at the high end of the range (i.e. of 4.5°C for a doubling of CO₂), for instance due to a strong feedback with carbon stored in the natural reservoirs (Previdi et al., 2013), warming could reach as high as 7.9°C by the end of the century. The uncertainties above the central projection are larger than those below due to the many processes that are poorly understood, but could add considerable warming to the planet if the carbon stores were destabilised (e.g. frozen soils, wetlands and gas hydrates). A range of studies suggest that the most likely value of climate sensitivity is around 3°C (Hegerl et al. 2007), even considering global temperature trends of the past 15 years, which can be accounted for by natural variability in the climate (Foster and Rahmstorf, 2011; Guemas et al., 2013).

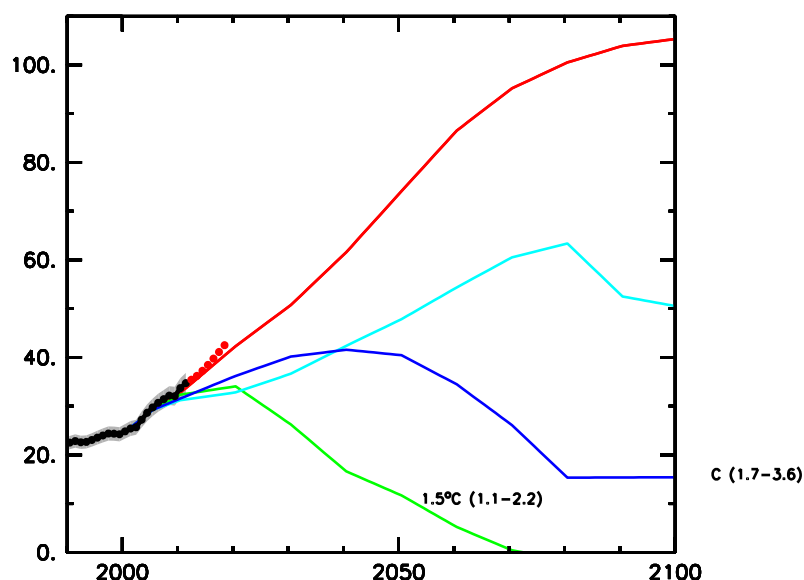


Figure 1 Global emissions of CO₂ (GtCO₂/y). The emissions computed from reported energy statistics by the Carbon Dioxide Information Analysis Centre (CDIAC) are shown in black with their uncertainty in gray (Peters et al., 2013). The red dots are projections for these emissions based on World GDP which we computed here using established methods (Raupach and Canadell, 2010). Recent and projected emissions are compared to the scenarios used to project climate change by the upcoming assessment of the Intergovernmental Panel on Climate Change (IPCC). Temperature projections in 2100 above pre-industrial levels are shown on the graph and are from Rogelj et al. (2012), including in parenthesis the range for a climate sensitivity of 1.5-4.5°C.

4. The CO₂ emissions from fossil fuel combustion in the UK have decreased by 20% since 1990 when considering territorial emissions only (Fig. 2). However they have remained approximately constant when considering emissions from the consumption of goods and services produced elsewhere but consumed in the UK ((Le Quéré et al., 2013) updating the analysis of (Peters et al., 2011)). In contrast, the emissions in Germany have decreased by about 25% since 1990, for both territorial and consumption emissions, while the German economy has continued to grow. Peters et al. (2013) provide further examples of precedents in emissions reductions (consumption based) sustained over 10 years of about 4 – 5 % per year in Belgium, France and Sweden. These examples highlight the practical and economic feasibilities of transitions towards lower emissions.

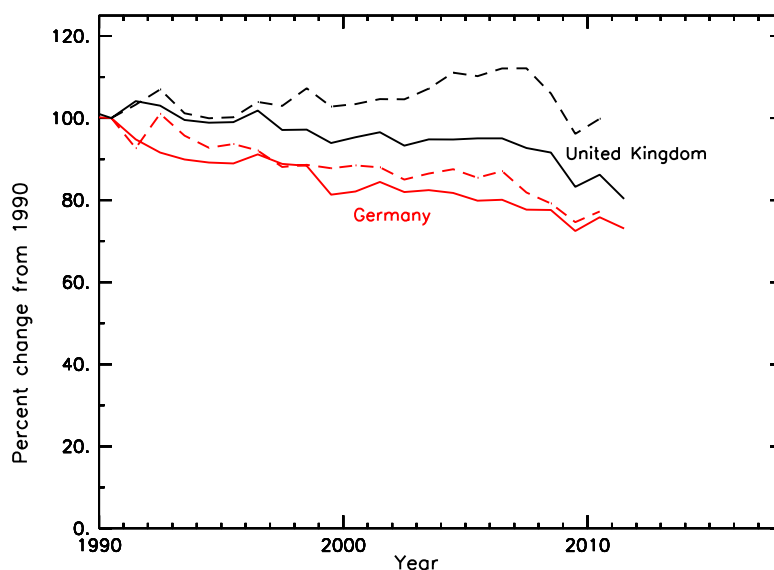


Figure 2 Change in emissions compared to year 1990 in the United Kingdom (black) and in Germany (red). Full lines show territorial emissions as reported to the UNFCCC; dashed lines show consumption emissions, which take into account the emissions from good and services produced elsewhere but consumed in the UK. The consumption CO₂ emissions are from (Le Quéré et al., 2013) updating the analysis of (Peters et al., 2011).

5. CO₂ emissions from the EU accounted for 11% of global emissions in 2012 and 24% over the period 1751-2010 (Le Quéré et al., 2013). The UK and EU need to maintain and enhance their commitments to emissions reduction in support of the successor to the Kyoto Protocol (to be decided by 2015). Any loosening of the UK commitments could be seen as a weakening of leadership and risk derailing the UNFCCC process and the credibility of the Prime Minister as Chair of the UN committee tasked with establishing the new UN Millennium Development Goals for 2015.
6. Having established the context and necessity of emissions reductions it then remains to consider the scale of UK action. There are two issues that are pivotal to an evidence-based quantification of the UK's carbon budget: 1) the 'appropriate' probability for 2°C; and 2) the 'appropriate' apportionment of the global carbon budget to the UK.

Prof K. Anderson: paragraphs 7- 19

Considering the appropriate probability for 2°C

7. From the Copenhagen Accord (2009) and subsequent COPs through to the G8 Camp David Declaration (May 2012) the UK has repeatedly committed to making its fair contribution to "hold the increase in global temperature below 2°C, and take action to meet this objective consistent with science and on the basis of equity". Moreover, much of the UK Government's domestic language has, since its 2009 Low Carbon Transition Plan (DECC 2009), been around "must rise no more than 2°C" (p. 5, emphasis added). Whilst this qualitative language of consensus around 2°C has been clear and consistent for many years ("hold below", "must not exceed", etc.) there has been no open clarification as to what quantitative probabilities such language represents. Yet, without quantified probabilities it is not possible to determine the accompanying range of twenty-first century cumulative emissions budgets from which emission pathways can be derived (Anderson & Bows, 2008).
8. In the absence of any explicit quantification, probabilities may be inferred by adopting the approach developed for the IPCC's reports, whereby a correlation is made between the language of likelihood and quantified probabilities (IPCC, 2010). Following this approach, the Accord's, EU's and UK Government's statements all clearly imply very low (0%-10%) probabilities of exceeding 2°C. Even a highly conservative judgement would suggest the statements represent no more than a 33% chance of exceeding 2°C. However in 2013, and with the UK's preferred probability density function (PDF) of temperature increase for a given trajectory (taken from Murphy et al, 2004), a 0%-10% chance of exceeding 2°C would leave almost no available carbon budget. Stretching the probabilities much further really starts to detract from any reasonable interpretation of the "must not exceed" language; though given the emissions released since 2000, it is now difficult to envisage anything much lower than 30%-40% chance of 2°C being either physically viable or deliverable in practice.
9. Set against such a quantitative backdrop, DECC's choice of a 63% chance of exceeding 2°C is clearly incompatible with the UK's repeated commitments made at various international forums (Anderson et al., 2009). Consequently, the UK has (at least - see below) two climate change targets. One with budgets related to "must not exceed" (say 0%-10% - and potentially 30%-40% chance of 2°C) and the other, with budgets accompanying a 63% of exceeding 2°C. These two budgets are associated with radically different emission pathways and hence provide fundamentally different criteria for judging the appropriateness or otherwise of alternative mitigation options – both individually and collectively.

Considering apportionment of the global carbon budget to the UK.

10. Exacerbating the UK's profoundly inconsistent domestic and international positions on climate change are issues related to how the UK chooses to apportion global emissions to

the national level. In this regard two particular issues arise; a) who is responsible for deforestation emissions; and b) how should global emissions be divided between Annex 1 and non-Annex 1 regions. Both the issues relate to the equity dimension of mitigation and against which the UK's current domestic position again conflicts with its international rhetoric.

11. *Issue a) deforestation:* The UK's budgets imply all responsibility for emissions from global deforestation accrue solely to those nations deforesting. Whilst, such a position may have merit in terms of increasing the available 'energy' budget to the Annex 1 nations such as the UK, it does so at the expense of major reductions in available 'energy' emissions space for the poorer, non-Annex 1, nations (where the deforestation is occurring). Climate change has arisen as an issue principally from the emissions of wealthier, and already deforested, Annex 1 nations (Anderson & Bows, 2011). It is therefore difficult, if not impossible, to reconcile the UK view that responsibility for current deforestation emissions belongs solely to those nations' deforesting with the explicit equity dimension of various international agreements. In response to this inequity, deforestation could be considered as a global overhead, thereby allocating emissions from deforestation amongst all nations – not only those deforesting. Such a global overhead approach would not absolve non-Annex 1 nations of responsibility for deforestation emissions, as their available budget for energy-related emissions, along with the budget for Annex 1 nations, would still be reduced as a consequence of the emissions from deforestation. Anderson and Bows further defended this position by noting how historical emissions (pre-2000) are essentially considered a global overhead that favours Annex 1 nations. Ultimately they concluded that "getting an appropriate balance of responsibilities is a matter of judgment that inevitably will not satisfy all stakeholders and certainly will be open to challenge. As it stands, the approach... in which historical and deforestation emissions are taken to be global overheads, is a pragmatic decision that, if anything, errs in favour of the Annex 1 nations."¹
12. Translating this principle into a quantitative constraint for the UK, Anderson and Bows (2008) estimated a twenty-first century budget of 266GtCO₂ from deforestation, which, disaggregated to the national level equates to about a 20% reduction in the available energy-emission space in the UK's budget. However, since Anderson and Bows first proposed the 266GtCO₂ budget, deforestation emissions have fallen sharply, with a similar method likely to almost halve the global overhead to around ~150GtCO₂.² In light of this, it is appropriate that the UK budget be reduced by approximately 7% to account for the nation's 'fair' share of global deforestation.
13. *Issue b) apportionment between nations:* A much more significant issue relates to assumptions about emissions from non-Annex 1 nations, and therefore what is a reasonable budget for Annex 1 nations, including the UK? As it stands the UK approach implies a highly inequitable division of emissions – with very little distinction drawn between the two regions. In brief, the UK choice of budgets and pathways is based on a global peak in emissions of around 2016, with non-Annex 1 nations, on average, peaking around 2 years later. As with the attribution of deforestation emissions, such a division of the global budget between Annex 1 and non-Annex 1 nations is far removed from both the wording and spirit of the equity dimensions of the various international climate change agreements.
14. Anderson and Bows (2011) took a different framing of equity than that assumed by the UK, starting with the question "what reduction profiles could non-Annex 1 nations reasonably be expected to achieve if pushed extremely hard in terms of a rapid transition away from their growing emissions, and towards absolute mitigation". They adopted a range of

¹ It is worth noting that Jiankun, H., Wenying, C., Fei, T., Bin, L., 2009. Long-term climate change mitigation target and carbon permit allocation. Tsinghua University. Access date: based on analysis undertaken at Tsinghua University in Beijing, makes the case that "reasonable rights and interests should be strived for, based on the equity principle, reflected through cumulative emissions per capita". Building on this *cumulative emissions per capita* approach, the authors demonstrate how China's historical cumulative emissions are only one-tenth of the average in industrial countries and one-twentieth that of the U.S.

² This is the subject of a paper currently being developed, and is again based on FAO and other similar data.

scenarios, but suffice to say the budget remaining for the Annex 1 nations in all of these was dramatically more challenging than the proportional budget adopted by the UK government.

15. In brief, and to put some perspective on the change in the scale of the challenge, if non-Annex 1 nations can peak by 2025, and reduce emissions thereafter at around 7% p.a. (approximately twice the level Stern *et al* suggest is possible with economic growth), then there is no discernible emission space remaining for Annex 1 nations. Only if the growth to a 2025 peak in non-Annex 1 emissions is radically curtailed to just 1% p.a. and subsequently reduced at over 7% from 2025, is there any space for Annex 1 emissions – but still only if the latter’s emissions begin reducing at over 10% p.a. immediately.
16. As Anderson and Bows (2011) demonstrates, the UK’s proportion of the global carbon budget for a 63% chance of exceeding 2°C is premised on an apportionment regime that is highly partisan and certainly far removed from the UK’s explicit and international commitments on equity.

Combining probabilities and equity

17. Far from being a technical and nuanced issue, the disjuncture between the UK’s high profile and repeated commitments on 2°C and the Government’s legally binding carbon budgets is profound and with fundamental repercussions for the framing of carbon-reduction policies.
18. The legally binding budgets essentially reject 2°C in favour of maintaining some emission space out to 2050 and hence a relatively slow transition to a lower-carbon society. By contrast, taking Government international statements on 2°C as an honest reflection of commitments demands immediate behavioural adjustments alongside rapid penetration of low-carbon technologies; with complete decarbonisation of the energy system by 2030.
19. Ultimately, if the UK wants to develop a consistent and evidence-based framing of its climate change commitments, it needs to match its legally binding domestic budgets with its international rhetoric on 2°C.

Question 2

The operation and management of the Carbon Budgets, including: the accountability and governance arrangements, and the extent to which the EAC’s previous concerns and recommendations have been addresses; the effectiveness of the over all management system, including for meeting carbon budgets by sector; and the current status, operation and impact of the National Emissions Target Board.

Dr A. Bows: Paragraphs 20-25

As time goes on non-CO2 emissions will become more significant to UK budgets

20. The cumulative nature of long-lived greenhouse gases means that slow progress towards achieving a reduction in one gas must be compensated by greater cuts in another. Cutting the non-CO2 emissions associated with the agricultural sector is considered to be more challenging than mitigating CO2. Specifically, there is more uncertainty over how to significantly curb and quantify N2O emissions, particularly those associated with soil processes, than there is for the CO2 associated with energy consumption. This is exacerbated when taking into account a rising demand for food and future climatic change (Flynn et al., 2005, Popp et al., 2010, Reay et al., 2012, Smith et al., 2008, Smith and Olesen, 2010). Having separate sectoral targets, as well as an aggregated ‘carbon budget’ is therefore essential to ensure that limited progress in one sector can be compensated for by greater progress in another, when budgets are reviewed periodically. Therefore, consideration of sectoral progress should be used to maintain, weaken or strength targets in other sectors, in order to remain within the overall carbon budget associated with the 2C

target. One likely outcome of taking this approach, is that mitigation effort aimed at CO₂ will need to be strengthened in the short-term, given technical limits to N₂O emissions associated with food production over the longer term (Bows et al., 2012a).

Present producer based accounting overlooks emissions associated with imports of food

21. Given that global emissions are in line with the highest projected emission scenarios, climate change will increasingly impact on food production. However, some mid-latitude regions, such as the UK, may be able to reap greater yields for crops such as wheat, in the short- to medium-term, as temperatures rise (assuming extreme weather events do not counter this effect). If this is the case, it may be less emissions-intensive on aggregate to grow some crops in the UK than it will be to grow them elsewhere. But, under the current territorial emission accounting framework, the UK would incur greater emissions as a result of high levels of agricultural production coupled with a greater use of fertiliser to benefit from the more favourable climatic conditions (Bows et al., 2012a). Considering the consumption-based as well as the territorial emissions associated with agriculture in particular, would enable policymakers to make a more considered judgment on setting the emissions budgets for the agriculture sector.

Shipping & aviation have limited mitigation drivers and continue to be poorly accounted for

22. Difficulties remain in ascribing emissions from international aviation and shipping to nations. This, combined with the failure of the international bodies charged with mitigating international aviation and shipping emissions (International Civil Aviation Organisation (ICAO) and the International Maritime Organisation (IMO)) to put into place measures to tackle those emissions, have led the UK Government to consider international aviation and shipping within long-term targets, but omitting them from the short-term carbon budgets. Such an approach to two of the most rapidly growing sectors in terms of greenhouse gas emissions is unacceptable given the UK's broader commitment to 2°C. However, the arguments surrounding aviation and shipping are somewhat different from each other (Bows et al., 2012).
23. *Aviation*: For aviation, emissions can be apportioned to nations on the basis of departures or bunker fuels, providing a close approximation to a 'fair share' of the emissions released within international airspace. Furthermore, given the recent collapse of the carbon price governing mitigation effort within the EU ETS, the aviation sector continues to have highly limited drivers towards mitigating emissions, and urgently requires a new approach to incorporating aviation-related emissions into existing mitigation frameworks, such as the UK's carbon budgets. Thus at present, and given the known barriers to low-carbon technology unique to this sector, (Bows, 2010), aviation activity associated with UK residents or UK airlines continues with its privileged position with regard to carbon budgets, potentially jeopardising all of the UK's efforts towards a decarbonised energy system (as aviation also forms part of that system) (Woods et al., 2012)
24. *Shipping*: The problem of how to apportion the emissions associated with the shipping sector is a much greater challenge than for aviation, in the main due to shipping generally involving multiple journey legs. However, despite the methodological and data uncertainties in apportioning shipping emissions to the UK (or any nation) (Bows et al., 2012; Gilbert and Bows, 2012), the order of magnitude of emissions is known and is sufficient to at least provide a guide to the scope and scale of necessary mitigation in shipping, as well as other sectors. Nevertheless, to include shipping emissions within the existing budgets, it would be advisable not to use the sales of bunker fuels (as is used when reporting international shipping emissions to the UNFCCC), as they are a poor guide of the emissions associated with trade to and from the UK, but rather indicate that most ships choose to refuel in Rotterdam where fuel is cheap. CO₂ estimates based on bunker sales are between 20-60% lower than the estimate that "relates to the transport of passengers or goods to or from the United Kingdom", the definition given to international aviation and shipping emissions by the Committee on Climate Change. Thus consideration of one of the existing estimates

based on imports would be a reasonable starting point towards including shipping within short-term budgets (Anderson and Bows, 2012).

25. On the basis of our analysis of shipping and aviation emission apportionment, as well as how to influence these emissions (Gilbert and Bows, 2012), and given the now effectively defunct EU ETS, we would urge government to start to incorporate aviation and shipping emissions into short-term carbon budgets as a matter of some urgency.

Dr P. Gilbert: Paragraphs 26-31

Chemical Industry

26. Tyndall Manchester have recently completed a report on the chemical industry in the UK considering market and climate change challenges (Gilbert et al, 2013). At the time of writing this submission, the report is not yet in the public domain. The authors will send a copy to this inquiry as soon as it is available. Key findings related to this question are as follows:

Insufficient evidence that climate policy is responsible for the loss of competitiveness in the chemical industry at present

27. Parts of the industry are shutting down in the UK and relocating to other regions due to competition and production costs. This is resulting in 'weak carbon leakage' and global greenhouse gas emissions are increasing accordingly. Although these regions typically have less stringent rules, or an absence of regulation and policies to address greenhouse gas emissions, evidence suggests that the industry is not relocating due to climate policy. However, the UK's climate change targets are challenging for the industry and the wider economy. Such targets could impose further pressure on competitiveness in the UK in future and lead to 'strong carbon leakage'. Alternatively, introduced carefully, they could drive innovative efficiency improvements that also increase resilience to fossil fuel and feedstock price volatility.

The UK's carbon footprint associated with chemicals is increasing (consumption basis)

28. Despite UK chemical industry emissions reducing by 70% from direct energy use and processes since 1990, it has not been solely the result of energy efficiency improvements. The reduction in the UK's chemical industry emissions has largely been a result of the closure of production sites and /or relocation to other nations with lower production costs and energy and feedstock costs. When examining the UK's carbon footprint from a consumption-based approach, where the UK would take account of emissions produced in other nations during the manufacturing of the goods it consumes, overall emissions associated with the consumption of chemical-derived goods and commodities are likely to be increasing (accenture, 2011; Oxford Economics, 2010; KPMG, 2011).

The chemical industry requires substantial reductions in emission intensities to satisfy UK climate targets

29. The UK chemical industry anticipates growth in the period up to 2020. Growth rates of 1-3% may lead, with no change to emission intensity or UK chemical production mix, to the chemical industry accounting for 11-25% of the total UK carbon budget in 2050. To ensure that the industry reduces its emissions by 80%, the absolute growth rates would require the emission intensity to reduce by ~2-4% p.a. Historically, technically mature industries reduce emission intensity levels by 1-1.2% p.a. This point is relevant to the majority of UK industry where growth is anticipated and the sector is required to deliver absolute savings.

Industry requires an urgent, radical rethink in how it produces chemicals

30. If the chemical industry is to step up to the challenge of meeting the UK's climate targets and maintain competitiveness, it will need to move beyond incremental energy efficiency improvements towards more radical, step changes. Although the industry could decarbonise

emissions associated with direct energy, this would return us to the argument raised above concerning non-CO₂ emissions. Process emissions from the industry should not be overlooked as they account for approximately one third of the chemical industries emissions (4.3MtCO₂e, excluding electricity use, 2010 data). Of this CO₂e, 11% is from N₂O emissions associated with nitric acid production.

31. As well as managing processes, there is a requirement to ultimately move away from fossil based hydrocarbons as feedstocks to renewable forms of fixed carbon. Nonetheless, under current emission accounting protocols, where emissions are reported on a producer basis within territorial boundaries, and coupled with issues of feedstock price and competitiveness, there is insufficient economic incentive to justify substantial investment in the new assets required to implement bio-derived product substitution. Furthermore, as fossil hydrocarbons are the primary feedstock for the chemical industry, it could be argued that their value as a fixed source of carbon is much greater than their energetic value, particularly when renewable wind, wave and solar energy could help decarbonise the energy supply. Options for decarbonised chemical feedstocks are much more limited and costly. Decisions about whether our limited use of fossil fuel emissions associated with a carbon budget should be used for the chemical industry, the transport sector (particularly aviation) or other applications are determined by the complex interplay of legislative, policy and market conditions. To date there have been few policy initiatives which have recognised the unique challenges and potential contributions from this sector; some prioritisation seems likely to be required if the UK is to achieve its carbon reduction targets and retain its valuable and strategic chemical industry.

Question 3

What the Government's response should be to the Committee on Climate Change's June 2013 assessment of emissions reduction performance, and whether the Carbon Budgets should be tightened or relaxed.

Dr A. Anger-Kraavi: Paragraphs 32-37

32. In addition to tightening the targets enshrined within the Act and Carbon Budgets, discussed above, we believe it is worth considering a policy response to the developments in the EU ETS in light of economic and industrial research. We also suggest that the committee note our previous submission to the Energy and Climate Change Committee regarding shale gas and other unconventional fossil fuels.

Stimulating innovation in the 'Traded Sector'

33. The UK's share of the EU ETS cap is represented as the 'traded sector' component of the carbon budgets (EAC, 2011). There is a concern that as the EU ETS cap is set at 20% below 1990 levels,³ and given the UK carbon budget for 2020 is tighter (34%), then the UK 'non-traded sector' will have to take on a greater burden of reductions.
34. As the 'non-traded sector' is less carbon intensive this is likely to result in emission reductions that are not economically efficient in the strict sense. Furthermore, the current low carbon price at the EU market (about €3 per tonne of CO₂e in April 2013) would allow the 'traded sector' simply to buy allowances and leave the physical domestic reductions to the 'non-traded sector'.
35. The question here is whether the UK carbon budget at least for 'non-traded sector' should be relaxed. However, as argued previously, in order to achieve climate stabilisation at or around 2°C the budgets need to be even tighter (EAC, 2011). Therefore, we propose that the

³ It would be 30% if there were to be an international agreement following Kyoto. Currently no such agreement exists and the EU ETS phase 3 has now started.

government should consider subsidising green investments in carbon intensive sectors ('traded sector'), for instance with finance from the UK Green Investment Bank⁴. Caps could then be tightened in these sectors further with a domestic commitment without detriment to competitiveness.

36. The impacts of public and private green investment would be significant (see, Barker et al., 2012). It would help industrial sectors to adopt less-carbon intensive technologies by compensating the weak price signal from the EU ETS and reduce the risk of leakage by making investments more attractive and compensating for increases in product prices. As every £1 invested is likely to result in an average of £0.60 additional investment (see, Barker et al., 2012) this policy would help to reduce unemployment and help to lift the UK economy out recession. In the longer term such support could also have a positive effect on other countries through the diffusion of low carbon technologies, and for UK industry through the growth of export markets for supported technologies.
37. However, it is worth noting that the induced investment may also generate some degree of rebound in terms of increased aggregated CO₂ emissions. At the very least, if UK 'traded sector' is 'helped' to reduce emission then it should have a negative impact on the carbon price in the EU ETS. Therefore the UK cap in the EU ETS should be tightened commensurately.

Dr J. Broderick. Paragraphs 38-41

The impact of unconventional fossil fuels on UK climate and energy policy

38. We have previously submitted evidence to the Energy and Climate Change Committee that the development of unconventional fossil fuels, indeed the expansion of fossil fuel production *per se*, is detrimental to climate change mitigation (Broderick et al, 2012).
39. Whilst gas has a lower carbon intensity per unit of energy than coal, and can be combusted in more efficient power stations, it is still a high carbon energy source (75% carbon by mass). The price effects of increased supply and hence aggregate quantity of emissions suggest that the prospect of new unconventional gas production in the USA, Canada, Australia and China will not in and of itself increase the likelihood of achieving a two degrees climate objective.
40. UK policy, and Carbon Budgets, need to be robust to these new conditions, especially with regards to the common assumption of affordable, timely, high performance, commercial scale CCS. Short term indications of a lack of commitment to decarbonisation, on the prospect of substantial indigenous shale gas production or lower global prices, may jeopardize long term investment. The DECC Gas Generation Strategy is potentially problematic in this regard; a number of the gas rich scenarios presented are incompatible with existing carbon budgets and implied climate targets.
41. Despite several clear recommendations by the Committee on Climate Change of an advisable carbon intensity of electricity sector for achieving the UK's 80% by 2050 GHG reduction target, the Energy Bill (2012) is not clear on the intended aim on decarbonisation level. A grid carbon intensity target of 50 gCO₂/kWh by 2030 is a prudent policy to assist the delivery of the carbon budgets (though it would need to be considerably tighter for UK's international commitments around 2°C). Were power sector emissions to exceed their allocation this would place greater pressure on other sectors for reductions, which, as we have outlined in a number of sections above, may be problematic.

⁴ <http://webarchive.nationalarchives.gov.uk/20121017180846/http://www.bis.gov.uk/policies/business-sectors/green-economy/gib>

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