Tyndall Centre for Climate Change Research

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A response to the Draft Climate Change Bill's carbon reduction targets

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Summary

- The Government is to be congratulated for introducing its Draft Climate Change Bill
- The atmospheric concentrations implied by the logic of the Bill are upwards of 600ppmvCO_2, and could well be in excess of 750ppmvCO_2
- The targets are more likely to contribute to a world 4°C or 5°C warmer than pre-industrial, than they are to constrain warming to no more than 2°C
- The carbon reduction targets within the Draft Bill should be re-visited, be evidence based and be in keeping with the latest IPCC science on the subject
- All Government reference to targets, temperatures and concentrations should be informed by a clear understanding of the science and of the 'correlation trail' between temperature and emission pathways
- The Bill should provide joined-up climate change legislation in which emissions from *all* sectors are factored into the emission pathway. However, even with the Bill's current neglect of aviation and shipping, the emission pathway it describes correlates approximately with an 80% and 60% chance of *exceeding* 2°C and 3°C warming respectively

1. Introduction

We begin this Briefing Note by congratulating the UK Government for having the courage to propose a Climate Change Bill with specified and binding carbon reduction targets. The following and provisional analysis is not critical of the Bill itself, but is intended to inform both the forthcoming parliamentary debates on the Bill and the subsequent processes of revision. The methodology and approach are a modified and abridged form of that developed within the Tyndall Centre's energy and climate change research programme at the University of Manchester.

2. Background

Within the UK and the EU there is broad political agreement that we should make our fair contribution to *"avoiding dangerous climate change…"*.[1] In the absence of any explicit global consensus on an appropriate metric for delineating dangerous from acceptable climate change, European leaders[2] have recently reiterated their commitment to *"limiting average global temperature increases to no more than 2°C above pre-industrial levels"*.[3] Within the UK, the 2006 Climate Change Programme, the 2006 Energy Review, and the 2003 Energy White Paper, all serve to underline the UK Government's oft-cited commitment to the importance of the 2°C threshold.[4]

The 'correlation trail' (see Fig. 1) from a global temperature threshold (e.g. 2°C) through to a national carbon emission budget and carbon reduction pathway is a partially value-driven process (e.g. apportionment)

[1] Dti (2006). The Energy Challenge: Energy Review Report 2006. HMSO (Cm6887), p.10.
[2] Though the mechanism of the Council of the European Union, of which the UK Government is a full member. See Document 7224/07, 9 March 2007, section III. 27
[3] Ibid. See also Defra (2006), Climate Change: The UK Programme 2006. Defra. London, p.20, and COM (2007) Limiting global climate change to 2 degrees Celsius: the way ahead for 2020 and beyond. Final edition, Commission for the EC.
[4] For example, see Op cit 1 (p.19) and 3

complicated by a range of scientific uncertainties (e.g. climate sensitivity). However, despite these difficulties, establishing such a trail is necessary if carbon reduction strategies are to be evidence based. In brief, and using current science, a future global temperature can be 'correlated' with a range of future atmospheric carbon dioxide concentrations; these can subsequently be linked to global *cumulative* emission budgets between particular years. Having established a range of such *global* emission budgets it is necessary to apply an apportionment regime to arrive at *national* emission budgets for a given period, typically 50 to 200 years. Given a national *cumulative* emission budget, national emission pathways can be generated that initially follow actual emissions data (e.g. 2000-2006) before describing alternative future pathways, all of which must not exceed the *cumulative* emission budget. Such a 'correlation trail', in providing an explicit and sequential process, facilitates both an understanding of the pathway's constraints and allows for informed adjustment of the pathways in accordance with the evolving science of climate change.

Using the apportionment regime underpinning the 2003 Energy White Paper's long-term carbon reduction target[5], Tyndall calculated a national carbon budget for 2000-2050[6] based on an atmospheric carbon dioxide concentration of 450 parts per million by volume ($450ppmvCO_2$)[7]. Given actual UK emissions between 2000 and 2006, Tyndall proceeded to describe an emission pathway out to 2050 that stayed within the national carbon budget[8]. The pathway demonstrated that even a 30%[9] chance of not exceeding the 2°C threshold required the UK to cut its total carbon emissions by 70% by 2030 and in the region of 90% by 2050.

The purpose of this Briefing Note is to explore the concentration and temperature assumptions implicit in the Draft Climate Change Bill. The atmospheric CO_2 concentration and hence temperature can be arrived at by comparing the UK's cumulative emission budget defined by the Bill's proposed emission pathway with the UK's budget, as defined in Tyndall's earlier work. Or alternatively, by reversing the 'correlation trail', working back from the Bill's emission pathway and *national* budget to arrive at a *global* emission budget and temperature (see Fig 2). Both approaches are used here.

3. Analysis

As this is a Briefing Note, the methodology and quantitative analysis used in drawing the following sequence of interim conclusions are not outlined in detail[10]. Moreover, rather than provide unduly precise figures, the findings of this provisional analysis are given in approximate ranges. Nevertheless, a clear message emerges.

3.1. The Bill's partial emission budget

The Bill provides both 2020 and 2050 emission targets which, when allied with 2000-2006 data, permits an approximate emission pathway to be described. Such a pathway broadly equates to a UK cumulative carbon emission budget of between 5.5 and 6 billion tonnes of carbon (GtC) for the period 2000 to 2050[11]. These figures exclude emissions arising from international aviation and shipping; the Bill gives the reason for this as being because such emissions *"are not currently part of the Kyoto targets or EU ETS"*.[12] However, the global climate system does not distinguish between sources of CO_2, and consequently, as we have argued elsewhere[13], within any comprehensive and

[5] The Energy White Paper's 60% target was taken from the earlier Royal Commission on Environmental Pollution's (RCEP) 22nd report (2000). The RCEP explicitly adopted the contraction and convergence principle as the means by which global emissions were allocated to nation states. Whilst the EWP does not expressly endorse contraction and convergence, it would be, at best, disingenuous for the Government to reject the contraction and convergence apportionment principle yet enshrine the target that emerged from it.

[6] Bows A; Mander S; Starkey R; Bleda M; Anderson K. (2006), Living within a carbon budget, A report for the Co-operative bank and Friends of the Earth. http://www.tyndall.ac.uk/publications/briefing_notes/Livingwithacarbonbudget.pdf

[7] Using the same approach Tyndall also produced a national budget for $550ppmvCO_2e$.

[8] The cumulative carbon value (or budget), is equivalent to the area beneath a carbon emissions pathway.

[9] This probability is based on Meinshausen and using a concentration of $450ppmvCO_2$ ($\sim 500CO_2e$). Meinshausen M, (2006). What Does a 2°C Target Mean for Greenhouse Gas Concentrations? Published in Schellnhuber et al (2006). Avoiding Dangerous Climate Change. Cambridge University Press, p.271.

[10] As stated earlier, the approach borrows from that used within Bows et al, Op cit 6.

[11] The values of the cumulative emission range given here are for *carbon*, and equate to a *carbon dioxide* range of approximately 20 to 22 $GtCO_2$. In some respects this range could be seen to represent the flexibility available to the proposed Committee on Climate Change in developing the emission pathways, whilst still adhering to the Bills 2020 and 2050 targets.

[12] Draft Climate Change Bill 2007, p.21 footnote 19. Later on (p. 22), the reasoning is extended to include, *"[A]nd there is currently no international agreement on how to include these emissions in national inventories".*

[13] See for example: Bows, A., and Anderson K., (2007), Policy clash: Can projected aviation growth be reconciled with the UK

evidence-based Bill international emissions should be included.

3.2 The 'real' UK emission budget

To estimate the 'real' UK carbon budget between 2000 and 2050, it is necessary to estimate those emissions from international aviation and shipping for which the UK is responsible, and to add these emissions to those considered within the Bill (i.e. the 5.5-6GtC range). The commonly accepted approach to allocating aviation (and to a lesser extent shipping) emissions is the 50% apportionment principle – i.e. 50% of emissions from all arrivals and departures within the national boundary is attributable to the UK (essentially equivalent to the UK taking emissions from all incoming *or* all outgoing journeys – but *not* both).

Whilst we have an adequate quantification of international aviation and shipping emissions for the period 2000-2006, future emissions are either projected, or, within this Briefing Note, based on a 'what if' scenario. Within the scenario we have assumed optimistic low-carbon emission futures for both aviation and shipping. Current trends are assumed to continue till 2012, after which growth declines rapidly to 3% and 2% respectively, dropping to just 1% for both from 2035 onwards.

Adding the emissions accompanying this scenario to the national emission budget implied in the Bill, brings the UK's 'real' cumulative emissions to between 7 and 7.5GtC for the period 2000 and 2050.

3.3 Comparing the Bill's and Tyndall's emission budgets

Within the Tyndall work referred to earlier, and based on global cumulative emission budgets from the Hadley Centre's carbon-cycle model run for 450ppmvCO_2 (approx. 500ppmvCO_2e) and 550ppmvCO_2 (approx 600ppmvCO_2e), we estimated the UK's national budgets for 2000-2050 to be 4.5-5GtC and 6-6.5GtC respectively[14].
According to this approach, the Draft Climate Change Bill implies the UK's carbon emission budget to be, at least, 40% to 65% greater than permitted under a 450ppmvCO_2 (approx. 500ppmvCO_2e) future, and between 10% and 25% in excess of that for a 550ppmvCO_2 (approx 600ppmvCO_2e) future.

3.4 Reversing the 'correlation trail'

It is also possible to approach the analysis by reversing the 'correlation trail' outlined earlier (see Fig. 2). Here, and again assuming the apportionment regime underpinning the Government's 60% target, the analysis produces a *global* cumulative CO_2 budget of between 750 and 950GtC for 2000-2100.[15] Comparing this budget range with the Hadley Centre's global cumulative emission budgets (*with* carbon-cycle feedbacks)[16] suggests the Bill correlates with an atmospheric concentration of CO_2 of between 600 and 750ppmv (650-800ppmvCO_2e). Comparing the Bill's range with the cumulative values of the wider set of *with feedback* stabilisation studies provided by IPCC's AR4,[17] suggests that the 950GtC is not too far removed from the cumulative value at the lower end of the 1000ppmv feedback models (980GtC[18]).

Correlating these various atmospheric concentrations of CO_2 with temperature, permits the UK carbon emission budget implied within the Draft Climate Change Bill to be compared with the UK and EU's commitment to the 2°C threshold. Using Meinshausen's concentration-temperature correlations suggests that the Bill, rather than support a 2°C warming, is, at best, more in keeping with a 50% chance of exceeding 4°C warming over the pre-industrial global temperature.[19]

Government's 60% carbon reduction target? Transport Policy, Vol 14, Issue 2, pp 103-110. Also, see Op cit 6.

[14] As stated earlier, these figures were based on an apportionment of global emission similar to that underpinning the 60% carbon reduction target within the 2003 Energy White Paper. The convergence year remains unchanged from that used in the RCEP report (Op cit 5).

[15] The extension of the period from 2050 to 2100 permits more readily available comparison with the global cumulative budgets from Hadley et al. It is assumed that beyond 2050 emissions continue declining, all-be-it at a slower rate; such an assumption is adequate for this provisional analysis.

[16] See Figure 34.5. Jones C, et al (2005). Impact of Climate-Carbon Cycle Feedback on Emissions Scenarios to Achieve Stabilisation. Published in Schellnhuber et al (Op cit 9), p.329. See also Figure 8.1. Stern N (2006). The Economics of Climate Change. Cambridge, p.222.

[17] IPCC (2007). Climate Change 2007: The Physical Science Basis, Summary for Policy Makers.

[18] Ibid p. 13.

[19] In this instance, using the Meinshausen concentration-temperature correlations does not permit other than a very approximate links to temperature. This is a consequence of Meinshausen's curves only extending to concentration values of 650ppmvCO2e, whereas the cumulative values implied by the climate change Bill suggest concentrations well in excess of this. Meinshausen Op cit 9.

4. Conclusion

This Briefing Note is intended as an early contribution to the process of converting the draft Climate Change Bill into evidence-based legislation. Within the draft Bill it is clearly stated that *"60% by 2050 and 26-32% by 2020 … are unilateral targets which we would only change in the event of significant developments in scientific knowledge about climate change or in international law or policy which made it appropriate to do so."*[20]

This Note suggests that the targets within the draft Bill are neither based on IPCC AR4 science nor can be reconciled with the UK and EU commitment/policy to make a 'fair' contribution to *"limiting average global temperature increases to no more than 2°C above pre-industrial levels"*.[21] Consequently, the Government's two criteria for revisiting the Bill's targets are already met, and hence the targets should be a legitimate subject of major reform during the passage of the Bill though Parliament.

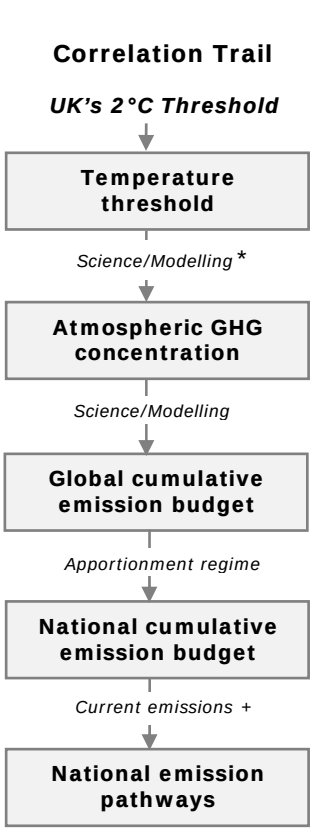

Figure 1

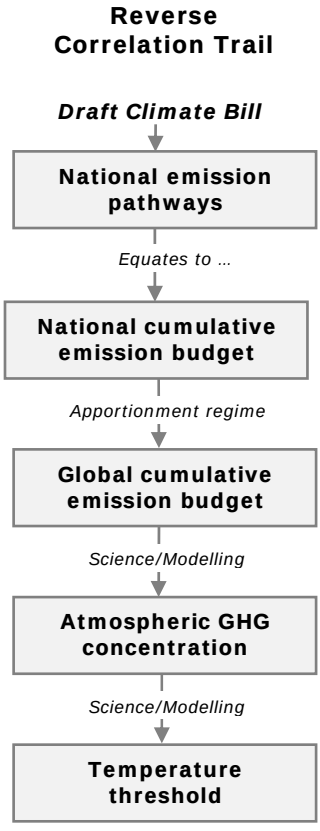

Figure 2

Figure 1. The sequence of steps from a defined temperature through to a national emission pathway. It is this sequence that essentially underpins the Government's 60% carbon-reduction target.

Figure 2. The reverse of the correlation trail; providing a means for interpreting a national emission pathway (e.g. as outlined in the Bill) in the form of a global temperature threshold.

* Climate models calculate global surface temperature from an atmospheric concentration of carbon dioxide. The resulting data can be used to correlate a given temperature with a respective concentration range.

[20] Op cit 12, p. 21. and developed slightly on p. 26.

[21] Op cit 3