The British Climate Change Act: A Critical Evaluation and Proposed Alternative Approach

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Introduction

On November 26, 2008 the British government enacted the Climate Change Act of 2008, mandating national emissions reductions.[1] In December, 2008 the United Kingdom's Committee on Climate Change (created by the Act) released a report recommending that national greenhouse gas emissions be reduced by at least 80% by 2050 and by 34% by 2022 (or 42% if an international agreement on climate change is reached).[2] The report argues that this amount of emissions reduction is achievable at an affordable cost of between 1-2% of GDP in 2050.

This paper argues that not only is the Climate Change Act all but certain to fail to achieve its ambitious emissions reduction goals in both the short and long term, but that it is fundamentally flawed in its basic conception. An alternative approach focused on the long-term and incremental decarbonization of the UK economy offers greater prospects for success.

Methodology of Evaluation

The methodology employed here draws upon Waggoner and Ausubel (2002) who argue that understanding the ability to influence environmental outcomes through policy requires "quantifying the component forces of environmental impact and integrating them."[3] For carbon dioxide emissions relationship of forces leading to carbon dioxide emissions has been called the Kaya Identity, and it can be used to decompose the factors that lead to carbon dioxide emissions from the production and use of energy in the global economy. The identity is comprised of two primary factors: economic growth (or contraction), typically represented in terms of GDP, and changes in technology, typically represented as carbon dioxide emissions per unit GDP.

Each of these two primary factors is typically broken down into a further two sub-factors. GDP growth (or contraction) is comprised of changes in *population* and in *per capita GDP*. Carbon dioxide emissions per unit GDP is represented by the product of *Energy Intensity,* which refers

[1] http://www.opsi.gov.uk/acts/acts2008/pdf/ukpga_20080027_en.pdf
[2] http://hmccc.s3.amazonaws.com/pdf/TSO-ClimateChange.pdf
[3] Waggoner, P. E. and J. H. Ausubel, 2002. A framework for sustainability science: A renovated IPAT identity, *Proceedings of the National Academy of Sciences* **99**:7860-7865.

to energy per unit of GDP and *Carbon Intensity,* which refers to the amount of carbon per unit of energy.

Together the four factors of the Kaya Identity explain the various influences that contribute to increasing atmospheric concentrations of carbon dioxide, as follows:

(1) *Carbon Dioxide Emissions= Population * Per Capita GDP * Energy Intensity * Carbon Intensity*

(2) *P = Total Population*

(3) *GDP/P = Per capita GDP*

a. *GDP = Economic Growth (Contraction) = P * GDP/P = GDP*

(4) *Energy Intensity (EI) = TE/GDP = Total Energy (TE) production/GDP*

b. *Carbon Intensity (CI) = C/TE=Carbon emissions/Total Energy Production*

(5) *EI X CI = "Carbon Intensity of the Economy" = TE/GDP * C/TE = C/GDP*

Thus, according to the logic of these relationships, carbon accumulating in the atmosphere can be reduced only by reducing (a) population, (b) per capita GDP, or (c) carbon intensity of the economy. Most proposals advanced by governments and in international negotiations focus on actions that will lead to the reduction of the carbon intensity of the economy (whether or not they are explicitly presented as such), which in this paper is referred to as "decarbonization." Policies to reduce population or that result in economic contraction are not generally considered by governments as a strategy of emissions reductions. Thus, the Kaya Identity provides a straightforward and useful way to evaluate the proposed and actual performance of policies focused on decarbonization and which are typically called mitigation policies.

The evaluation of the Climate Change Act focuses on its 2050 target of an 80% reduction in emissions below 1990 levels by 2050 and its 2022 interim target of a 34% reduction below 1990 levels by 2022. An 80% reduction in carbon dioxide emissions from 1990 levels of 593 million tonnes (mT) of carbon dioxide is 119 Mt , and a 34% reduction by 2022 to 391 Mt.[4]

The factors of the Kaya Identity can be used to evaluate these estimates in terms of what is required to achieve the identified goals. The factors can be integrated individually, in "bottom up" fashion based on independent projections for growth in population (2) and per capita GDP (3), to estimate implied rates of decarbonization (5). The overall goal can also be disaggregated in a "top down" manner, starting with overall GDP growth (a) and deriving implied rates of decarbonization (5) consistent with a specified target. The following sections

[4] http://www.nao.org.uk/publications/0708_greenhouse_gas_emissions.pdf

consider each approach from a base year of 2006, which in most cases is the latest year for which data necessary for the analysis is available.

Evaluating the UK Climate Change Act: Part 1, A Bottom Up Analysis

The first factor in the Kaya Identity is overall population, since more people means more emissions, all else equal. In 2007, the UK Office for National Statistics projected a national growth rate of 0.7% per year to 2031.[5] If this rate were to continue to 2050, then the UK would have about 82 million people, an increase of almost 22 million people from 2006. By 2022, under the same assumption, the UK is projected to have a population of more than 67 million. Population projections are notoriously uncertain, so caution should be used when using them, as actual future populations could be higher or lower.

In 2006 UK carbon dioxide emissions (as accounted under the rules of the Kyoto Protocol) were about 9 tonnes per person. If a 2050 population of 82 million had per capita emissions of 9 tonnes, then total UK emissions would be about 750 mT of carbon dioxide, far above the 80% reduction goal of 119 Mt. A 2022 population of 67 million at 9 tonnes of carbon dioxide per person would result in about 603 mT of carbon dioxide, well above the 2022 target of 391 mT. So a growing population means that the UK will have to reduce per capita emissions by as much as 85% in 2050, and by 35% in 2022, from 1990 levels.

The second factor in the Kaya identity is economic activity. All else being equal more economic activity means more emissions. From 1990 to 2007 the UK averaged 2.5% per year annual GDP growth (in constant currency, i.e., inflation adjusted).[6] If overall growth to 2050 is expected to occur at a modest 2.0% per year, and population is growing at 0.7% per year, then this implies a per capita growth rate of 1.3% per year. Of course, governments strive for higher growth rates and a vibrant economy, just as they are now doing around the world to stave off the financial crisis that grips the world, slowing growth. For purposes of the present discussion, le us assume that future per capita UK growth increases modestly at 1.3% per year. This level of growth would add another 440 mT of carbon dioxide to the 2050 total, for a total of about 1,200 mT, ten times the 2050 target. And in 2022 this rate of growth would add about another 135 mT of carbon dioxide emissions, for a total of 738 mT, approaching twice the 2022 target.

The third factor is technological change. As described above, technological change includes increased energy efficiency in the economy and in reduced carbon intensity of energy. According to data from the United States Energy Information Agency from 2000 to 2006 UK energy efficiency increased by about 2% per year, while the carbon intensity of the energy supply was largely unchanged. In the mid-1990s the so-called "dash for gas" briefly lead to an accelerated decarbonization of the UK economy as compared with the most recent 10 years.[7]

[5] http://www.statistics.gov.uk/cci/nugget.asp?id=1352
[6] http://www.statistics.gov.uk
[7] From 1992 to1998 the UK economy decarbonized at a rate of 2.3% per year, whereas from 1999 to 2006 the rate was about 1.3% per year as penetration of gas into the electricity supply reached a limit, and coal energy saw a resurgence. Source: Author's calculations, manuscript in progress.

Because the effects of technological change (including changes in the economy toward services and away from energy intensive industry) just about balanced the overall growth of the economy for the past decade, the U.K. has seen little growth in its overall carbon dioxide emissions (although the UK National Audit Office recently observed that the lack of growth in emissions is also due to accounting, as some economic activities, like air travel, are not included in official emissions numbers[8]).

Using a bottom up analysis, the combined effects of population and per capita economic growth imply that to meet the 2022 and 2050 emissions targets the combined effects of increasing energy efficiency and reduced carbon intensity of energy would have to occur at an average annual rate of 5.4% to 2050 and 4.0% to 2022. These numbers also imply that meeting the 2022 target with a 4.0% annual rate of decarbonization implies a rate higher than 5.4% from 2022 to 2050.

Evaluating the UK Climate Change Act: Part 2, A Top Down Analysis

A top down analysis begins with assumptions of future economic growth, which integrates future population growth and per capita economic growth, and then works backwards to determine what rate of decarbonization of the economy would be necessary to meet the future emissions target. In 2006 the UK produced 0.42 tonnes of carbon dioxide for every $1,000 of GDP.[9] Figure 1 shows required rates of decarbonization of the UK economy from 2007 to 2050 (for various rates of assumed GDP growth) implied by a target of an 80% reduction in carbon dioxide emissions from 1990 levels.

The figure shows that the carbon intensity of the UK economy would have to reach a level of 0.02 to 0.05 tonnes of carbon dioxide per $1,000 of GDP by 2050, from 0.42 in 2006. Figure 2 shows the same information for 2022 implied by a target of a 34% reduction in carbon dioxide levels from 1990. The figure shows that the carbon intensity of the UK economy would have to reach a level of 0.17 to 0.24 tonnes of carbon dioxide per $1,000 of GDP by 2022, from 0.42 in 2006.

[8] http://www.nao.org.uk/publications/0708_greenhouse_gas_emissions.pdf

[9] Carbon dioxide data is available at: http://www.eia.doe.gov/pub/international/iealf/tableh1co2.xls Data on GDP, converted to 1990 Gheary-Khamis dollars (to facilitate international comparisons) is available at: http://www.ggdc.net/maddison/Historical_Statistics/vertical-file_09-2008.xls. The 1990 Gheary-Khamis dollars are the units used throughout this paper.

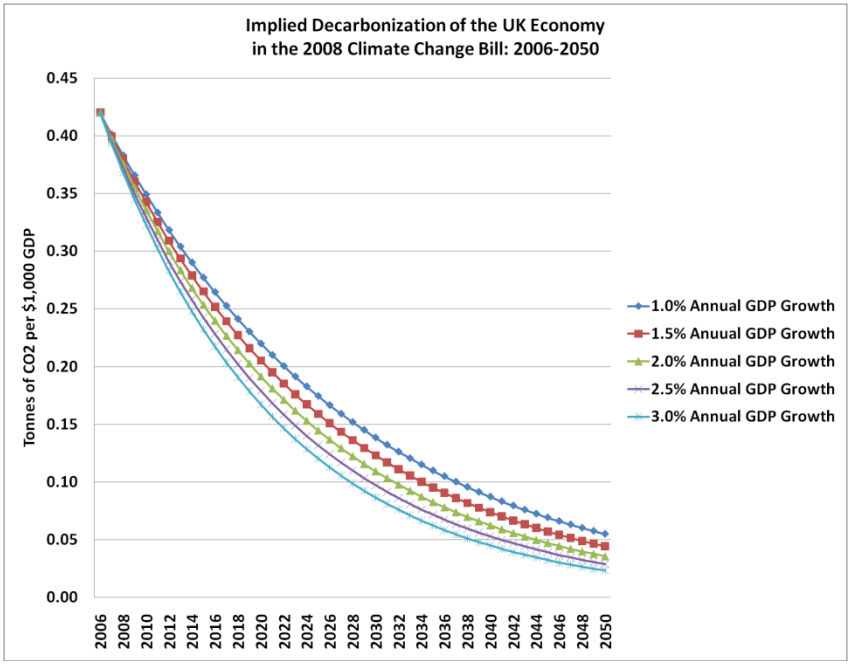

Figure 1. Implied rates of decarbonization of the United Kingdom economy for various rates of GDP growth, 2007 to 2050.

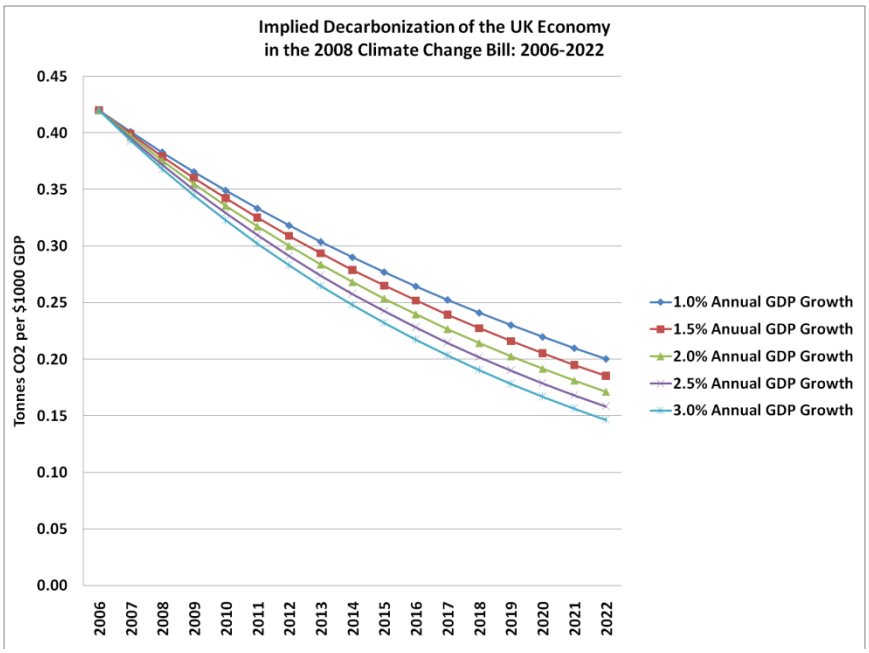

Figure 2. Implied rates of decarbonization of the United Kingdom economy for various rates of GDP growth, 2007 to 2022.

Figure 3 below shows the actual rate of decarbonization of the UK economy from 1980 to 2006 as well as the rates of decarbonization implied by the 2022 and 2050 targets assuming an average 2.0% annual GDP growth. Higher rates of future GDP growth would result in higher implied rates of decarbonization.

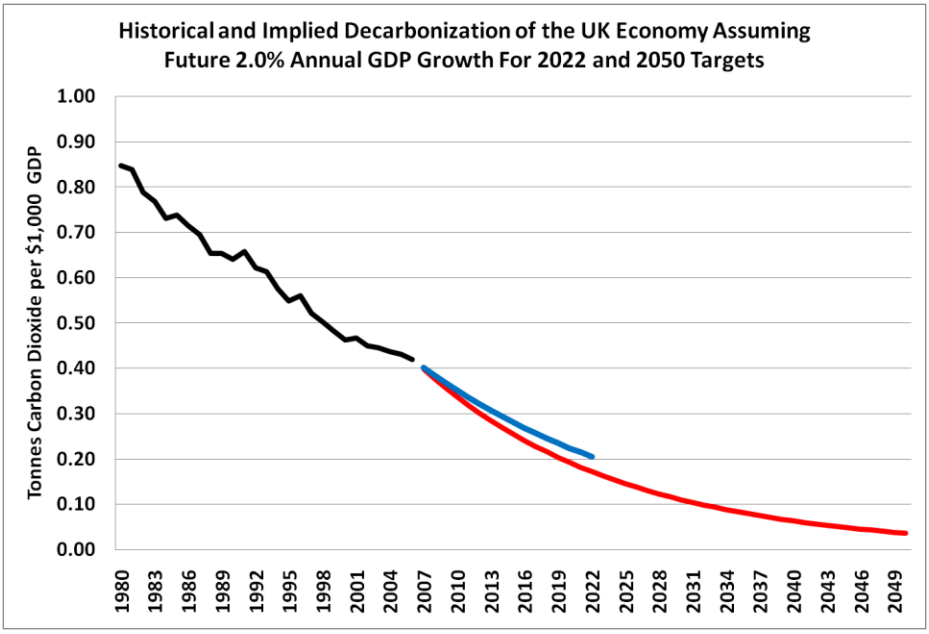

Figure 3. Past rates of decarbonization of the UK economy, 1980-2006, and implied rates of decarbonization assuming 2% annual GDP growth for the 2022 (blue) and 2050 targets (red).

The rates of decarbonization of the UK economy implied by the top down analysis are 4.4% per year for the 2022 target and 5.5% for the 2050 target. These numbers are substantially higher than the rates of decarbonization observed from 1980 to 2006 and 2001 to 2006, as summarized in the table below, along with the rates derived for the bottom up analysis.

	1980-2006	2001-2006	2007-2022	2007-2050
Actual	-1.9%	-1.3%		
Bottom Up			-4.0%	-5.4%
Top Down (at 2% GDP growth)			-4.4%	-5.5%

Table 1. Rate of decarbonization of the UK economy observed (first two columns) for 1980 to 2006 and 2001 to 2006, and implied (third and fourth columns) by the 20022 and 2050 targets under the bottom up and top down (assuming 2.0% future GDP growth) approaches.

Achieving Rapid Rates of Decarbonization

The preceding analysis shows that to achieve the ambitious for emissions reductions set forth in the Climate Change Act will require rates of decarbonization higher than 4.0% per year in the

short term and higher than 5% per year to 2050. Can the UK achieve rates of decarbonization higher than 4 or 5 percent per year? The Climate Change Committee has not addressed this question explicitly.

Cross-national comparisons can provide some sense of the magnitude of the challenge. Figure 4 shows tonnes of carbon dioxide per $1,000 of GDP for the United States, China, Germany and Japan. Figure 4 shows that the United Kingdom, at 0.42 tonnes of carbon dioxide per $1,000 of GDP in 2006, is comparable to Japan in its emissions per unit GDP. The UK is more carbon efficient than Germany, and much more so than the United States and China.

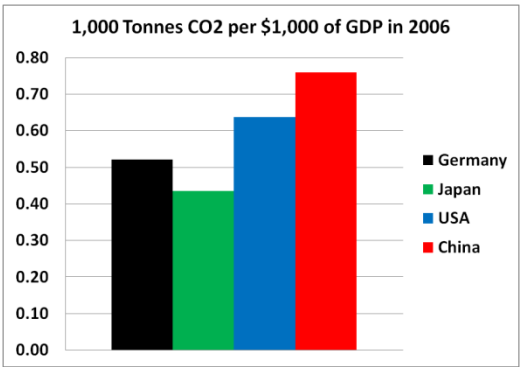

Figure 4. Tonnes of carbon dioxide per $1,000 of GDP in 2006 for Germany, Japan, United States and China.

Figure 5 below shows how each of the four economies have decarbonized from 1991 to 2006, with each country normalized to a 1991 baseline (chosen as the year of German reunification).

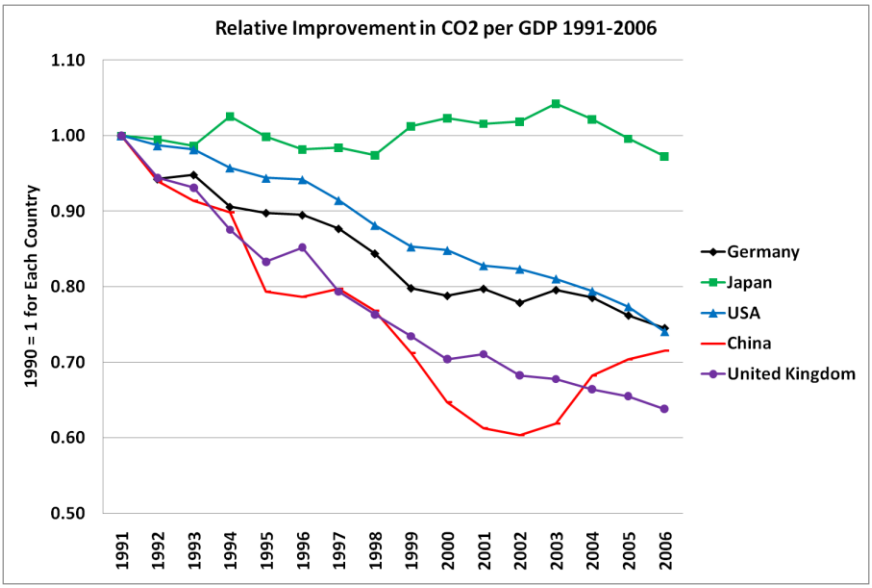

Figure 5. Relative pace of decarbonization for Germany, Japan, United States, China, and the United Kingdom, 1991 to 2006.

Figure 5 shows that the UK's rate of decarbonization has been much greater than that of Japan, which saw little change over the period, and faster than the United States or Germany, which have had similar rates of decarbonization. China saw its rapid decarbonization reversed in the early years of the decade. Thus, there is no recent precedent among developed countries with large economies for the sustained rapid rates of decarbonization implied by the Climate Change Act. Such rates necessarily must be several times greater than observed in the UK in recent decades.

The developed country with a major economy with the lowest ratio of emissions to GDP is France, which emitted 0.30 tonnes of carbon dioxide per $1,000 of GDP in 2006. France has achieved this level of decarbonization due to its reliance on nuclear power for electricity generation. France achieved an average rate of decarbonization of about 2.5% per year from 1980 to 2006, but achieved only about 1.0% per year from 1990 to 2006.

France provides a useful analogue. For the UK to be on pace to achieve the targets for emissions reductions implied by the Climate Change Act it would have to become as carbon efficient as France by no later than 2015 (see Figure 3 above and, inparticular, where the red and blue lines cross 0.30, which was the carbon efficiency of France in 2006). In practical terms this could be achieved, for example, with about 30 new nuclear plants to be built and in operation by 2015, displacing coal and gas fired electrical generation.[10] To meet the 2022 target the UK would then have to decarbonize by an additional 33%, i.e., from 0.30 tonnes of carbon dioxide per $1,000 GDP, to 0.20 tonnes. The Climate Change Committee is largely consistent with this conclusion, stating that achievement of the 2050 target would require that all UK electricity generation be completely decarbonized by 2030.[11]

The analysis presented here, however, is overly optimistic. The Climate Change Committee is not expected to present a specific policy "roadmap for decarbonizing the UK economy" until December, 2009,[12] meaning that practical action will not occur before 2010 at the earliest. The analyses presented in this paper utilize a 2006 baseline. Efforts to decarbonize beginning in 2010 will start from a possibly higher emissions baseline, and even with a lower baseline will certainly require much higher rates of decarbonization than those presented here. If the UK is making progress towards a goal of an 80% reduction in emissions we will know as data for 2007 and 2008 are released. It seems highly unlikely that the decarbonization of the economy is presently occurring at a rate of 4% per year or higher.

Given the magnitude of the challenge and the pace of action, it would not be too strong a conclusion to suggest that the UK Climate Change Act has failed even before it has gotten started. The Climate Change Act does have a provision for the Secretary of State (i.e., the "Home Secretary") to amend the targets and timetable, but only for certain conditions. Failure

[10] Author's calculation based on 2005 electricity generation data fro, http://www.defra.gov.uk
[11] P. 197, http://www.theccc.org.uk/reports/
[12] *The Economist*, January 24, 2009, p. 24.

to meet the targets is not among those conditions. It seems likely that the Climate Change Act will have to be revisited by Parliament or simply ignored by policy makers. Achievement of its targets does not appear to be a realistic option.

A Focus on Decarbonization:
An Alternative Approach to Climate Change Policy in the United Kingdom

The approach to emissions reduction embodied by the Climate Change Act is exactly backwards. It begins with setting a target and then only later do policy makers ask how that target might be achieved, with no consideration for whether the target implies realistic or feasible rates of decarbonization. Both the 2022 interim and 2050 targets require rates of decarbonization far in excess of what has been observed in large economies at anytime in the past. Simply making progress to the targets requires steps of a magnitude that seem practically impossible, e.g., such as the need for the UK to achieve a carbon efficiency of the economy at a level equal to France in a time period less than a decade.

Further, the focus on emissions rather than on decarbonization means that it would be very easy for policy makers to confuse emissions reductions resulting from an economic downturn with some sort of policy success. However, as implicit in the Kaya Identity, a lower GDP does nothing to directly influence the role of technology in the economy. So during a downturn emissions may level off or even decrease as policy makers of course seek to preserve (and even accelerate) economic growth. Consequently, the proper metric for policy success for efforts to stabilize carbon dioxide concentrations in the atmosphere is the decarbonization of the economy, represented in terms of carbon dioxide emissions per unit GDP.

A focus on decarbonization as the central goal of carbon policy rather than emissions reductions means that to achieve specific stabilization targets the rate of decarbonization of the UK economy must not only exceed the rate of economic growth, but it must exceed rates of decarbonization observed historically in the UK and in other developed countries.[13] No one knows how fast a large economy can decarbonize because such policies have not been attempted. Consequently, any policy focused on decarbonization will have to proceed incrementally, with constant adjustment based on the proven ability to accelerate decarbonization. Setting targets and timetables for emissions reductions absent knowledge of the ability to decarbonize is thus just political fiction.

For the UK, the good news is that it has demonstrated sustain rates of decarbonization higher than those of other large economies. However, in the current decade that rate has declined significantly. A UK climate policy recast in terms of accelerating decarbonization has the advantage for the UK to properly claim global leadership. Consider that if the world averaged 0.42 tonnes of carbon dioxide per $1,000 of GDP, as was the case in the UK in 2006, global emissions of carbon dioxide would have been about 10,000 mT or 32% less. This amount of

[13] The December, 2008 Committee on Climate Change report mentions decarbonization in passing on p. 29, http://hmccc.s3.amazonaws.com/pdf/TSO-ClimateChange.pdf

reduction is almost 20 times the total emissions of the UK in 2006. Far more important than setting impossible national targets on timetables than cannot be met would be efforts to accelerate decarbonization in the UK to higher rates, while at the same time working internationally to assist other countries in meeting the challenge of decarbonization.[14]

If global emissions are to be reduced by 80% by mid-century, or anywhere close to this level, then the world will have to achieve rates of decarbonization that have never been achieved in large economies in recent decades. However, with the world average currently at 0.62 tonnes of carbon dioxide per $1,000 of GDP, it will first have to achieve levels observed in the UK on the way to even lower levels. Policy should focus not just on targets and timetables, but the process for achieving those goals, and the various steps along the way. A policy focused on incremental improvements in decarbonization is not only realistic, but it offers the only feasible approach to the challenge of stabilization. The failure of the UK Climate Change Act is yet to be recognized, but when it does, it will provide an opportunity to recast carbon policies in a more effective manner.

[14] There is a body of theory and experience for accelerating processes of decarbonization. See for example, H. Geller et al. 2006. Policies for increasing energy efficiency: Thirty years of experience in OECD countries, *Energy Policy* **34**:556-573; and K. Akimoto et al. 2008. Global emissions reductions through a sectoral intensity target scheme, *Climate Policy* **8**:S46-S59; and S. Baksi and C. Green, 2007. Calculating economy-wide energy intensity decline rate: The role of sectoral output and energy shares, *Energy Policy* **35**:6457-6466.