

The British Climate Change Act: a critical evaluation and proposed alternative approach

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Abstract

This paper evaluates the United Kingdom's Climate Change Act of 2008 in terms of the implied rates of decarbonization of the UK economy for a short-term and a long-term target established in law. The paper uses the Kaya identity to structure the evaluation, employing both a bottom up approach (based on projections of future UK population, economic growth, and technology) and a top down approach (deriving implied rates of decarbonization consistent with the targets and various rates of projected economic growth). Both approaches indicate that the UK economy would have to achieve annual rates of decarbonization in excess of 4 or 5%. To place these numbers in context, the UK would have to achieve the 2006 carbon efficiency of France by about 2015, a level of effort comparable to the building of about 30 new nuclear power plants, displacing an equivalent amount of fossil energy. The paper argues that the magnitude of the task implied by the UK Climate Change Act strongly suggests that it is on course to fail, and discusses implications.

Keywords: climate policy, decarbonization, United Kingdom, policy evaluation

1. Introduction

On November 26, 2008 the British government enacted the Climate Change Act of 2008, mandating national emissions reductions (Crown 2008). 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) (Committee on Climate Change 2008). The report argues that this amount of emissions reduction is achievable at an affordable cost of between 1 and 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. Others have argued that the targets of the Climate Change Act are problematic (Anderson *et al* 2008). An alternative

approach to climate policy focused on the long-term and incremental decarbonization of the UK economy offers greater prospects for progress toward stabilization of concentrations of atmospheric carbon dioxide at levels deemed acceptable in current climate policy proposals.

2. 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'. For carbon dioxide the relationship of forces leading to 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 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 \times per capita GDP \times energy intensity \times carbon intensity
- (2) P = total population
- (3) GDP/P = per capita GDP
 - (a) $GDP = \text{economic growth (contraction)} = P \times GDP/P = GDP$
- (4) energy intensity (EI) = $TE/GDP = \text{total energy (TE) production}/GDP$
 - (b) carbon intensity (CI) = $C/TE = \text{carbon emissions}/\text{total energy production}$
- (5) $EI \times CI = \text{'carbon intensity of the economy'} = TE/GDP \times C/TE = C/GDP$.

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 basis for evaluating 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 is 391 Mt (National Audit Office 2008).

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

3. 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 (National Statistics Online 2007). 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. It is worth emphasizing that 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 t/person. If a 2050 population of 82 million had per capita emissions of 9 t, 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 t 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)¹. 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 present global financial crisis, slowing growth. For purposes of the present discussion, let 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 1200 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 led to an accelerated decarbonization of the UK economy as compared with the following decade². 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 UK has seen

¹ <http://www.statistics.gov.uk>

² From 1992 to 1998 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 the role of gas into the electricity supply stopped growing, and coal saw a resurgence. Source: Author's calculations.

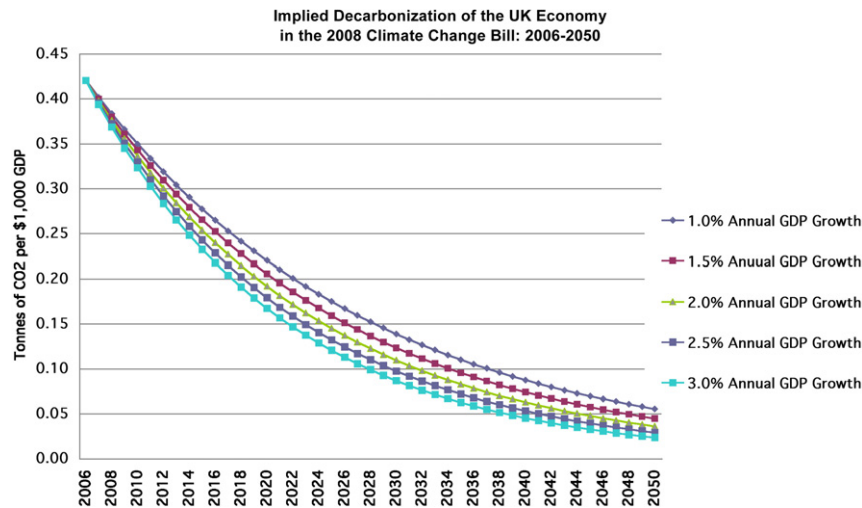


Figure 1. Implied rates of decarbonization of the United Kingdom economy for various rates of GDP growth, 2006–2050, for an 80% reduction in emissions by 2050.

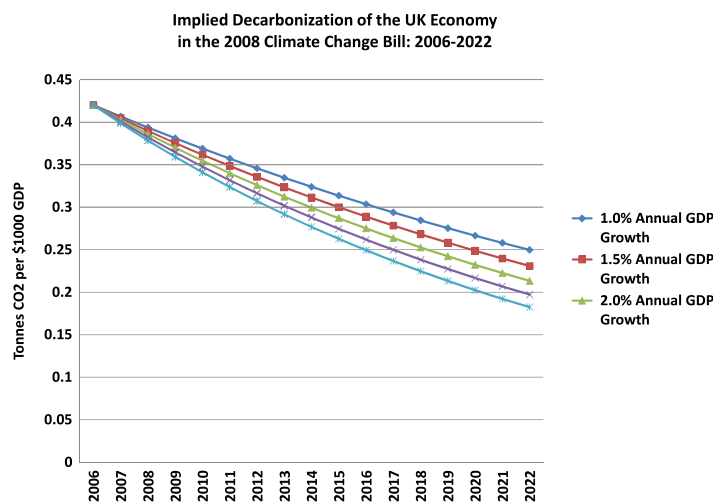


Figure 2. Implied rates of decarbonization of the United Kingdom economy for various rates of GDP growth, 2006–2022, for a 34% reduction in emissions by 2022.

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, National Audit Office 2008).

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 increasing energy efficiency and reduced carbon intensity of energy would have to occur at an average annual rate of 5.4%–2050 and 4.0%–2022. These numbers also imply that successfully meeting the 2022 target with a 4.0% annual rate of decarbonization would necessitate a rate higher than 5.4% from 2022 to 2050.

4. 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 t of carbon dioxide for every \$1000 of GDP³. 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 0.02–0.06 t of carbon dioxide per \$1000 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 0.18–0.25 tonnes of carbon dioxide per \$1000 of GDP by 2022, from 0.42 in 2006.

³ 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.ggd.net/maddison/Historical_Statistics/vertical-file_09-2008.xls. The 1990 Gheary–Khamis dollars are the units used throughout this paper.

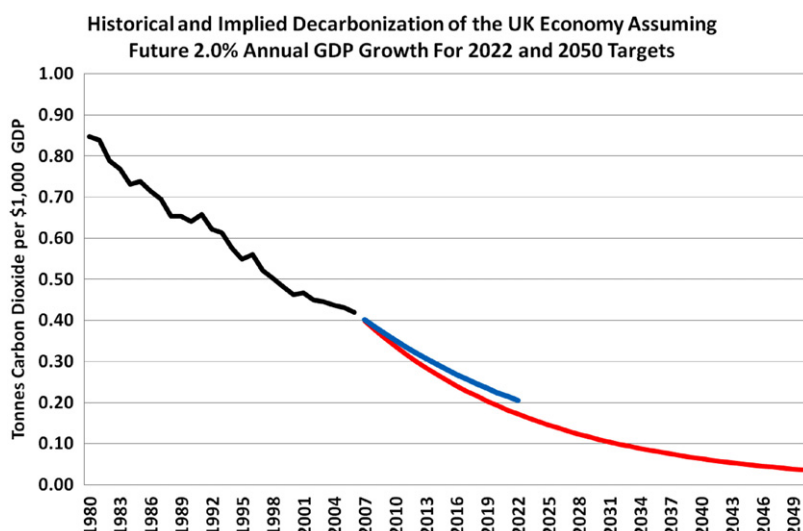


Figure 3. Past rates of decarbonization of the UK economy, 1980–2006, and implied rates of decarbonization assuming 2% annual GDP growth for the 2022 (blue) and 2050 targets (2050).

Table 1. Rate of decarbonization of the UK economy observed (first two columns) for 1980–2006 and 2001–2006, and implied (third and fourth columns) by the 2022 and 2050 targets under the bottom up and top down (assuming 2.0% future GDP growth) approaches.

	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%

Figure 3 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.

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 table 1, along with the rates derived for the bottom up analysis.

5. 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% 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% (or higher) per year?

The Climate Change Committee has not addressed this question explicitly. However, in an interview with a journalist (Pile 2009), Julia King, Vice Chancellor of Aston University and member of the Climate Change Committee, responded to an earlier version of this analysis by saying that in fact the

scenarios provided by the Climate Change Committee have in fact ‘been tested for do-ability’. King apparently meant technical ‘do-ability’ as she also explained that achieving the targets has both technical and political challenges, with the latter difficult to overcome:

I think you really do need to take due account of the fact that most people who are putting together targets and timetables are doing this on the basis of a lot of research into potential scenarios. It is another issue turning that into policy, for governments, and it is very easy for all of us who do not have to be elected to say ‘this is how I would do it’, and I have a lot of sympathy for our politicians, because they are dealing with extremely selfish populations.

A key aspect to effective policy implementation is that policies must meet criteria of both technical feasibility, but also social and political acceptability. Regardless of the theoretical arguments for technical ‘do-ability,’ the targets of the Climate Change Act fail the test of practical ‘do-ability’ as the following comparison shows.

Cross-national comparisons can provide some quantitative, practical sense of the magnitude of the challenge. Figure 4 shows tonnes of carbon dioxide per \$1000 of GDP for the United States, China, Germany, Japan and the United Kingdom. Figure 4 shows that the United Kingdom, at 0.42 t of carbon dioxide per \$1000 of GDP in 2006, was comparable to Japan in its emissions per unit GDP. The UK was more carbon efficient than Germany, and much more so than the United States and China.

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

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

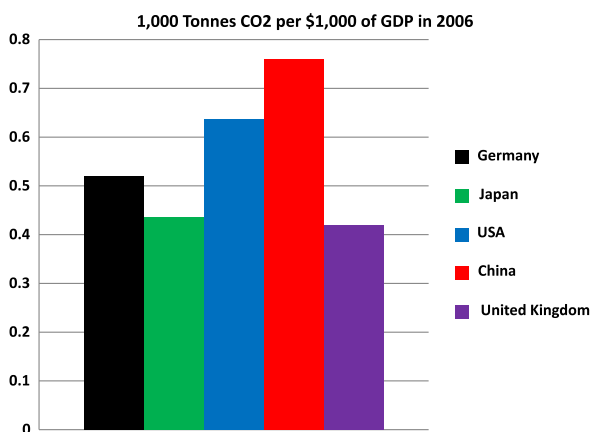


Figure 4. Tonnes of carbon dioxide per \$1000 of GDP in 2006 for Germany, Japan, United States and China.

Germany, which have had similar rates of decarbonization. One important reason for the decarbonization of the UK’s economy has been the large decrease in manufacturing as a portion of its economy, from 33% in 1970 to 13% in 2007 (Marsh 2009). 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, and based on different contributors as the sectoral shift away from manufacturing has its limits.

The developed country with a major economy with the lowest ratio of emissions to GDP is France, which emitted 0.30 t of carbon dioxide per \$1000 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. It took France about 20 years to decarbonize from 0.42 t of carbon dioxide per \$1000 GDP, the level of the UK in 2006, to 0.30 t of carbon dioxide per \$1000 GDP.

France’s decarbonization experience thus provides a useful analogue. For the UK to be on pace to achieve the targets for emissions reductions implied by the Climate Change Act its economy would have to become as carbon efficient as France by no later than 2016 (see figure 3 above and, in particular, 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 generation⁴. To meet the 2022 target the UK would then have to decarbonize by an additional 33%, i.e., from 0.30 t of carbon dioxide per \$1000 GDP, to 0.20 t. 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 (Committee on Climate Change 2008, p 197; cf Anderson *et al* 2008).

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, (The Economist 2009) 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 (though the financial crisis and subsequent economic contraction might imply a baseline lower than 2006), and even with a lower baseline will certainly require higher rates of decarbonization. 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 allowing for calculation of rates of decarbonization. It seems highly unlikely that the decarbonization of the UK economy has been occurring at a rate of 4% per year or higher.

Upon reading an early draft of this paper, Colin Challen, Member of Parliament (Labour) and chairman of its All Party Parliamentary Climate Change Group, commented to the BBC that he agrees with the analysis, making reference to

⁴ Author’s calculation based on 2005 electricity generation data from <http://www.defra.gov.uk>.

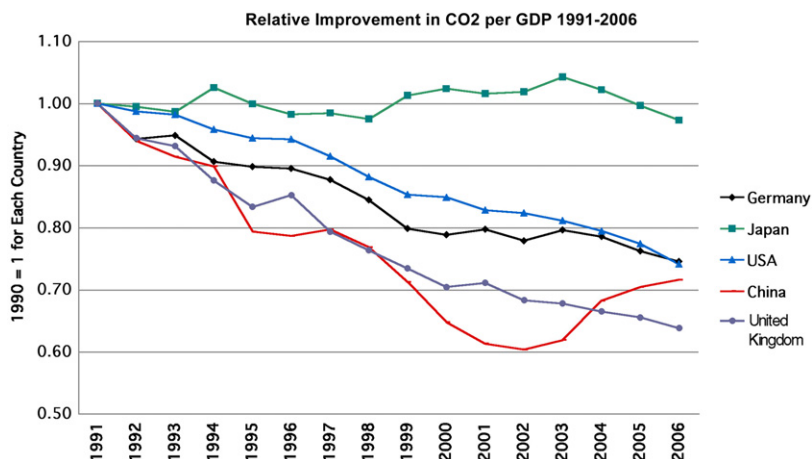


Figure 5. Relative decarbonization for Germany, Japan, United States, China, and the United Kingdom, 1991 to 2006.

the government's recent decision to expand Heathrow airport (Harrabin 2009):

This (analysis) raises questions which I do not think have been factored into the thinking behind the Climate Change Act. The task (of cutting emissions by 80% from 1990 levels by 2050) is already staggeringly huge and, as we have seen, well beyond our current political capacity to deliver. Heathrow is a prime example of ducking the responsibility. It is hard to see any tough choices being made in the current climate. A greater population implies more embedded CO₂ emissions in imported goods, but the climate change committee is only empowered to consider domestic emissions.

Given the magnitude of the challenge and the pace of action, it would not be too strong a conclusion to suggest that the Climate Change Act has failed even before it has gotten started. The Climate Change Act does have a provision for the relevant minister to amend the targets and timetable, but only for certain conditions. Failure 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.

6. 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. The uncomfortable reality is that no one knows how fast a major economy can decarbonize. 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 its economy equal to that of France in 2006 in a time period considerably 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 (cf, McGee 2009). However, as implicit in the Kaya identity, a lower GDP does very little to change the role of energy 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, a more directly useful 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 countries⁵. Because no one knows how fast a large economy can decarbonize, any policy (or policies) focused on decarbonization will have to proceed incrementally, with constant adjustment based on the proven ability to accelerate decarbonization (cf Anderson *et al* 2008). 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 rates of decarbonization higher than those of other large economies. However, in the current decade that rate has declined significantly, and because it has depended on a shift away from manufacturing, future decarbonization will require different actions than in the past. 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 t of carbon dioxide per \$1000 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 than what actually occurred. This amount of 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 decarbonization⁶.

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 \$1000 of GDP, it will first have to achieve levels observed in the UK on the way to even lower levels. Policy should focus less on targets and timetables for emissions reductions, and more on the process for achieving those goals, and the various steps along the way. Setting targets and timetables for sectoral efficiency gains and expansion of carbon-free energy supply would be a step in the right direction. Such a policy focused on incremental improvements in decarbonization, the details of which go well beyond the focus of this short paper, offers the only feasible approach to the challenge of mitigation. The failure of the UK Climate Change Act is yet to be broadly recognized, but when it is, it will provide an opportunity to recast carbon policies in a more effective manner.

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