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DEGROWTH AND THE CARBON BUDGET
Powerdown strategies for climate stability

> *Climate change is not 'a problem' waiting for 'a solution'. It is an environmental, cultural, and political phenomenon which is reshaping the way we think about ourselves, our societies and humanity's place on Earth.*
>
> – Mike Hulme

1. Introduction

In recent years the notion of a 'carbon budget' has entered the lexicon of climate science (e.g., IPCC, 2013; Meinshausen *et al.,* 2009). This concept refers to the estimated maximum amount of carbon emissions that can be released into the atmosphere in order to retain a reasonable chance of preventing global temperature levels from rising more than 2°C above pre-industrial levels. This is the global temperature threshold reaffirmed during the Copenhagen conference in 2009 but which many climate scientists argue should be revised downward (see, e.g., Jordan *et al.,* 2013). Although the science underpinning the carbon budget is increasingly robust (see Le Quere *et al.,* 2013), many scientists, politicians, and the broader public have been slow to recognise its radical socio-economic and political implications.

To have any hope of keeping within a 'safe' temperature threshold, deep and rapid decarbonisation is required, and yet existing trends show that global emissions are still growing rapidly. According to the recent IPCC report (2013), if the world is to have merely a 50% chance of keeping warming to less than 2°C, no more than 820-1445 billion tones of carbon dioxide and other greenhouse gases can be emitted during the rest of this century. Based on existing yearly emissions, and aiming for a 66% chance of success, this carbon budget is going to be used up by 2045. If existing trends of growth in emissions continue or accelerate, or if we demand a higher chance of success than 66%, that budget will be used up even sooner (see also, Carbon Tracker, 2013; Moriarty and Honnery, 2011). The consequences and risks of the current 'business as usual' scenario highlight the urgency with which deep decarbonisation must take place.

Given what is at stake here – the viability of the planet for human civilisation – carbon budget analyses need to become the basis for climate policies around the world, for they provide the most scientifically rigorous grounds for understanding the full extent of the climate challenge and what would constitute an appropriate response. The logic of the carbon budget numbers, however, leads to conclusions that most people, including most climate policy makers, refuse to accept, acknowledge, or understand. Most significantly, as outlined in this chapter, the carbon budget arithmetic indicates that rapid decarbonisation may well be incompatible with continuation of current global economic growth trends and paradigms. In fact, even more challengingly, carbon budget analysis seems to imply that in the most highly developed regions of the world, keeping within the carbon budget will require 'degrowth' strategies of significantly reduced energy and resource consumption. This broad line of argument has been made often by degrowth scholars in recent years, but the latest carbon budget analyses are providing the degrowth position with compelling new scientific support.

Degrowth has been defined as 'an equitable downscaling of production and consumption that increases human well-being and enhances ecological conditions' (Schneider *et al.,* 2010: 512). In a supplementary way, Serge Latouche (2014a: 211) has defined degrowth as

> a societal project of transforming industrial and market societies into socially and ecologically sustainable societies of frugal abundance. Its principle aim is to dismantle a widely shared belief in the productivist model of development – that is, the ideology of unlimited economic growth – and to reconstruct industrial societies according to the ideal of ecological democracy.

By emphasising the need for *contraction* of the economy in the most developed nations, degrowth can be understood as a transitional phase that would ultimately stabilise in a steady state economy that operates within the sustainable carrying capacity of the planet (see e.g., Daly and Farley, 2004). Within those ecological limits of significantly reduced energy and material throughput requirements, the art of living, of course, could forever improve and evolve.

Like the notion of a steady state economy, degrowth is not necessarily tied to notions of Gross Domestic Product (GDP) but is fundamentally a biophysical macroeconomic concept with profound socio-political implications, which leaves room for increased wellbeing even if GDP declines. Degrowth, therefore – which refers to *planned* economic contraction – must be distinguished from recession, which signifies *unplanned* economic contraction. From within a degrowth paradigm, there is no reason why planned reduction of energy and resource consumption cannot be associated with increased wellbeing, if the transition is negotiated wisely. This creates conceptual space for 'economic degrowth' to be contrasted with 'uneconomic growth' (see Alexander, 2012a; Kallis *et al.,* 2012; Kubiszewski, *et al.,* 2013), which is the space within which this chapter is situated.

This chapter begins by examining the key conclusions of the carbon budget research literature and unpacking some of the assumptions that frame the various decarbonisation scenarios. After doing so, the chapter builds on the work of climate scientists Kevin Anderson and Alice Bows, who have led the climate science analysis of the implications of carbon budgets on economic growth goals and policies. Although Anderson and Bows have been insightful enough to see (and brave enough to acknowledge) that meeting carbon budget targets implies a rapid shift to degrowth strategies, particularly in the most developed economies, they have not yet provided a detailed discussion of the ways in which degrowth strategies might be integrated with the broader decarbonisation policy agenda. In the final sections of this chapter, therefore, an attempt is made to contribute to this discussion by outlining the main elements of an integrated socio-economic and political strategy consistent with keeping emissions within the confines of the carbon budget.

2. The Foundations of Carbon Budget Analysis

The primary cause of greenhouse gas (GHG) emissions – especially CO_2 emissions – is burning fossil fuels. It is now scientifically accepted that when GHGs are released into the atmosphere they retain extra heat which has a warming effect on the planet (IPCC, 2013). This is the most important dynamic which explains climate change as it is unfolding today, although other factors are at play too, such as deforestation. It follows that as more GHGs are released into the atmosphere, more heat will be absorbed, leading to further rises in average global temperatures. As the scientific understanding of climatic systems has developed in recent decades, it has become possible to estimate with increasing confidence the climatic impacts of further GHG emissions. In other words, scientists are able to predict within a range of probabilities the likely temperature rise that would result from a certain amount of further GHG emissions. This is the foundation of 'carbon budget' analyses (see generally, Steffen and Hughes, 2013; Committee on Climate Change, 2013).

The size of the carbon budget depends on the parameters of the analysis. There are four main parameters that must be stipulated in order to arrive at a carbon budget: (1) the units of the analysis (i.e., what is being counted: just CO_2? Or all GHGs?); (2) the timeframe that defines the contours of the budget (i.e., from what date do we start counting emissions and what date defines the end point of the budget?); (3) what is the threshold temperature rise that we are trying to avoid? (e.g., 1°C, 1.5°C, 2°C, 4°C, etc.); and (4) what probability is considered acceptable for keeping to that temperature threshold? (e.g., 50%, 80%, 95% chance of success, etc.). Once those parameters are defined, the foundations of a carbon budget analysis are in place. (Note that the phrase 'carbon budget' is used for simplicity, but as stated above, some analyses are not limited solely to carbon dioxide emissions).

Although the parameters stated above are the main ones that shape a carbon budget, there are others that must also be considered. For example, aerosols (such as sulphur dioxide) have a cooling effect on the planet, so higher levels of aerosols (which may be harmful in other ways) have the potential to offset some of the warming effects of GHG emissions. Similarly, more CO_2 will be able to be burned if other GHG emissions are reduced faster than expected, so some informed assumptions have to be made about these relationships. Another unknown is the extent to which carbon sequestration techniques such as carbon capture and storage (CCS) will be able to reduce the level of emissions from burning fossil fuels entering the atmosphere.

As well as these issues, there are also complex questions surrounding climate sensitivity, changes in land use, and carbon cycle feedbacks, about which assumptions also have to be made, such as the extent to which emissions from CO_2 will be absorbed by the oceans or how long CO_2 will remain in the atmosphere (see Carbon Tracker and Grantham Institute, 2013). All these dynamics can increase or decrease the carbon budget, depending on the assumptions made.

Although increasing numbers of scientific articles and organisations have offered estimates of carbon budgets, the following review is limited, by way of example, to two of the most influential and frequently cited references. The first is the foundational publication by Meinshausen *et al.* (2009). This paper provides a comprehensive probabilistic analysis 'aimed at quantifying GHG emission budgets for the 2000-2050 period that would limit warming throughout the twenty-first century to below 2°C' (Meinshausen *et al.,* 2009: 1158). The authors conclude that limiting cumulative CO_2 emissions over 2000-2050 to 1000Gt of CO_2 yields a 25% probability of warming exceeding 2°C, and a limit of 1440Gt of CO_2 yields a 50% probability. Between 2000-2006 global CO_2 emissions were approximately 234Gt, which must be subtracted from those carbon budget estimates. Emissions since that time must also be subtracted. The authors note that keeping to these budgets would require leaving more than half of proven, economically recoverable fossil fuels in the ground (raising issues about 'stranded assets' to which I will return briefly later). If GHG emissions in 2020 are 25% above 2000 levels, then the analysis indicates that the probability of exceeding 2°C rises to 53-87%. We see here the types of frameworks and scenarios that can be discussed with the benefit of carbon budget analyses. It allows us to identify the level of emissions we are aiming to achieve at a particular time, and then back-cast scenarios in order to determine how to achieve the stated goal.

The more recent Carbon Tracker and the Grantham Institute analysis (2013) is based on the same models as Meinshausen *et al.* (2009) but explores some alternative assumptions. For example, this report assumes higher levels of aerosols in the atmosphere (which will offset some of the warming) and assumes greater reductions of non-CO_2 GHGs (which allows for higher CO_2 emissions but results in the same overall warming effect). Based on these alternative assumptions, the report then offers estimates of various carbon budgets for the period 2013-2049, with various temperature thresholds (1.5°, 2.5°, 3° and 4°) and two different probabilities (50% and 80%). The results are shown in Figure 1.

Maximum temperature rise (°C)	Fossil fuel carbon budget 2013-2049 ($GtCO_2$)	
Probability of not exceeding temperature threshold	50%	80%
1.5	525	-
2.0	1075	900
2.5	1275	1125
3.0	1425	1275

Figure 1: Carbon budgets for different temperature thresholds and probabilities (from Carbon Tracker and Grantham Institute, 2013: 10).

These two brief reviews of carbon budgets serve the purpose of outlining the nature of these analyses and their key conclusions. It is worth noting that this method of understanding the climate challenge has been given increased credibility in recent years with the IPCC (2013) and the International Energy Agency (2012a: 3) both now drawing on carbon budget methodologies as central tools in target-setting and policy formulation.

3. Normative Aspects of Carbon Budget Analysis

As noted above, setting different parameters to the analysis can produce higher or lower carbon budgets. The choice of different parameters, therefore, can have socio-economic and political implications, and this draws the scientific analyses into more normative, value-laden, or 'politicised' spaces. Indeed, even after a carbon budget has been determined, a critical normative question still remains about how that budget should be distributed between and within nations of the world, and what decarbonisation strategies should be adopted to keep emissions within the carbon budget. In the following sub-sections some of these normative questions are raised.

3.1. *Where should the temperature threshold be set?*

The temperature threshold is one of the most important questions to answer when framing a carbon budget analysis. The lower the threshold, the lower the carbon budget. As climate science and climate politics have developed over recent decades, a maximum 2°C temperature rise above pre-industrial levels has become entrenched in the political discourse as representing a relatively 'safe' threshold, beyond which humanity would enter increasingly 'dangerous' territory. In recent years this threshold has been continuously reaffirmed in high-level climate negotiations, including at Copenhagen (2009) and Cancun (2010). Because of this, many carbon budget analyses are framed by a 2°C temperature threshold to reflect the international consensus, such that it is.[1]

The 2°C threshold is, of course, a somewhat arbitrary threshold – why not 1.8°C or 2.2°C? It is an easily understood round number

[1] It should be noted that 2°C is not accepted as a safe threshold by many of the least developed countries or the Association of Small Island States who, at Copenhagen and elsewhere, have been pushing for reduced thresholds. See also, Spratt, 2014a; Spratt, 2014b; Spratt, 2015).

which may have served a useful political purpose when the framework for a global climate response was first being seriously negotiated in the mid-1990s. The most recent climate science evidence, however, suggests that i) many ecosystems are more sensitive to impacts at 2°C than was previously thought, and ii) many risks are self-reinforcing, threatening to produce cascading environmental impacts that would roll on to affect social systems (see Jordan *et al.,* 2013; Smith *et al.,* 2009; Mann, 2009; Lenton *et al.,* 2008). If current scientific knowledge was available in the mid-1990s, the threshold could well have been set at 1.5°C or below.

While some climate scientists, policy makers and activists argue that revising the temperature downward is a crucial step towards ensuring an appropriate alignment between scientific and policy objectives, others continue to argue that revising the threshold downward might have a negative effect if such a goal was widely perceived to be unattainable (see Jordan *et al.,* 2013). Whatever the case, if once it was thought that 2°C was the guard-rail keeping humanity 'safe', it may now be more accurate to say that it represents the bare minimum dividing line between 'dangerous' and 'extremely dangerous' climate change (Anderson, 2012; see also, Spratt, 2014a; Spratt, 2014b; Spratt, 2015).

3.2. *What probability of success should be assumed?*

Once a temperature threshold has been determined, a carbon budget must be framed in relation to a particular probability of success or failure. If climate systems were perfectly understood, this would be unnecessary, because scientists would be able to state with relative certainty that if x amount of CO_2 were released into the atmosphere then this would produce a temperature increase of precisely y. Needless to say, the complexity and interrelationships of climatic systems defy perfect understanding, so temperature effects from emissions can only ever be stated in terms of probability. This raises the normative question of what probability of avoiding dangerous climate change our species considers justified. The higher the probability of success, the lower the carbon budget.

In trying to arrive at an 'appropriate' probability, we need to situate this debate in the context of what is at stake if we fail. Emissions are already having an effect on climatic and broader environmental systems, with glaciers and ice caps melting, coral reefs eroding, the boundaries for vector-borne diseases expanding, and the frequency of extreme weather events increasing (see generally, IPCC, 2014). If these effects are occurring already, the question raised is: what effects will flow from a 2°C or 4°C or 6°C temperature rise? (see Potsdam, 2012; Christoff, 2013.) When the consequences of a course of action are small, the risk of failing to avoid those consequences is less important. But when consequences are potentially extremely dangerous, even catastrophic, then it is rational to expect a substantially higher probability of success (see generally, Gardiner, 2011).

The language used in the dominant political discourse about climate policy targets is quite clear. The Copenhagen Accord and Cancun Agreements both state categorically that the goal must be to 'hold the increase in global average temperature below 2°C, and to take action to meet this objective consistent with science and on the basis of equity' (UNFCCC, 2011). The European Commission (2007) is equally clear, affirming the need to '*ensure* that global average temperatures *do not* exceed preindustrial levels by more than 2°C' and states that we '*must* adopt the necessary domestic measures' to ensure this is the case (italics added). Similarly, the UK's Low Carbon Transition Plan (DECC, 2009: 5) states 'average global temperatures *must* rise no more than 2°C' (italics added; see also, Anderson, 2012).

The language does not talk of 'hoping' to avoid dangerous climate change, or that we should 'try' to avoid it, and it does not suggest that we should aim for a 50:50 chance of avoiding dangerous climate change. By using language such as 'ensure' and 'must' it can be assumed that, when framing a carbon budget analysis, the probabilities of avoiding climate change should be very high – arguably in the range of 80-95%, or higher. Not only should this follow from the scientific literature considering the potentially dire consequences of climate instability, it also follows from one of the underlying principles of the environmental movement – the 'precautionary principle'. In short, we should not gamble with the climate. This is especially so given that those who will be most affected by climate disorder – those in the poorest nations and future generations – have not been responsible for it. For these types of reasons, most carbon budget analyses have assumed a probability of success at 66% or higher, although other scenarios have explored probabilities of 50%. The choice of probability is a normative one that significantly influences any carbon budget analysis.

3.3. *How should the global carbon budget be distributed?*

Once a global carbon budget has been determined, there remains the critical question of how that budget should be distributed amongst (and within) nations. One seemingly objective and equitable way to distribute a carbon budget is to share it out equally on a per capita basis. While this approach has some intuitive plausibility, it ignores at least two critical issues. First, it ignores any 'differentiated responsibility' for the historic causes of climate change. A strong moral case can be made that those nations most responsible for historic emissions should bear the greatest responsibility for dealing with the effects of emissions, and if dealing with climate change implies hardship or burden, then again, those who caused the problem should shoulder that burden more than those least responsible. But even on this issue, we find the richest nations (which generally have the highest historic emissions) arguing that they should not be responsible for GHG emissions in historic eras when it was not understood that emissions warmed the planet. The date at which the science of climate change was sufficiently well established is a matter of some debate, although 1990 – the year the IPCC's First Assessment Report was published – is one reasonable option.

A second problem with sharing the carbon budget equally on a per capita basis flows from the fact that billions of people still live lives of material destitution. Cheap fossil fuels provide vast reserves of dense energy that could be directed toward eliminating such impoverishment. Given this humanitarian predicament – wanting to eliminate poverty but also wanting to minimise GHG emissions – a strong moral case can also be made that if the world is to continue burning fossil fuels for some time, the bulk of that fossil energy should be spent lifting the poorest people out of destitution rather than increasing the wealth of the most affluent societies. Part of the reasoning here is that energy consumption has diminishing marginal returns to wellbeing, which implies that increased energy consumption will produce more wellbeing in the poorest nations than in the richest nations (see Diffenbaugh, 2013).[2]

For these reasons, it follows that the apparent 'equity' of sharing a global carbon budget out equally on a per capita basis is in fact far from equitable. Instead, an equitable distribution would have to allow for more emissions from the poorer nations and those least responsible for historic causes of climate change, thus constraining the permissible emissions from the richest nations that are most responsible and most technologically and financially capable of dealing with the necessary societal transformation.

[2] However, as discussed briefly later in the chapter, it is critical that the carbon budget spent in the poorest nations, with the intent of lifting those nations out of poverty, avoids creating infrastructure that essentially locks them into decades of high-carbon living.

This general position, in fact, has been accepted in the international climate negotiations, which acknowledges the need for 'differentiated responsibility', even if the exact weighting of distribution remains highly contested. The Copenhagen Accord (UNFCCC, 2010) clearly distinguishes between Annex 1 nations (broadly the OECD nations) and non-Annex 1 nations (broadly the non-OECD nations), and calls for a response to climate change 'consistent with science and *on the basis of equity*' (italics added). More specifically, the Accord acknowledges that 'the time frame for peaking will be longer in developing countries' and, most significantly, that 'social and economic development and poverty eradication are the first and overriding priorities of developing countries'.

4. The Radical Implications of Carbon Budget Analysis

Having outlined the foundations of carbon budget analysis along with key parameters in relation to temperature thresholds, probabilities of success, and distributional issues, we are now in a position to unpack some of the implications by considering in more detail what these numbers actually mean for emissions reduction policies and strategies. In doing so, I draw primarily on the work of climate scientists Kevin Anderson and Alice Bows, who have published a number of rigorous and influential papers on the economic policy implications of carbon budget analysis (Anderson and Bows, 2008a; Anderson and Bows, 2011; Anderson, 2012; Anderson, 2013). Although their conclusions can be seen as confronting, they in fact argue their case based on robust premises which, in ways discussed below, are actually very conservative. The numbers, in short, speak for themselves, but many find the message confronting because the numbers show that keeping temperatures below 2°C will require Annex 1 nations to immediately initiate deliberate and planned 'degrowth' strategies of reduced consumption and economic contraction. The controversy this evidence-based conclusion has provoked has prompted Anderson (2013) to note that their critics 'don't so much disagree with our conclusion, but rather they simply dislike it'. In this section their arguments are outlined and analysed.

Anderson and Bows offer their analyses on the following explicit assumptions and parameters (see especially, Anderson and Bows, 2011; Anderson, 2013):

4.1 The world should aim to keep warming below 2°C

As discussed above, 2°C used to be considered the 'safe' threshold, but more recent evidence suggests that a 2°C rise would be 'dangerous', which is why increasing numbers of scientists are questioning the 2°C threshold and considering a reduced target of 1.5°C or less (see Jordan *et al.,* 2013; Sprat, 2014a; Spratt, 2014b). By staying with the 2°C threshold, Anderson and Bows are being conservative in their assumptions and keeping in line with the *agreed goal* of mainstream international climate discourse.

4.2 The probability of exceeding 2°C is set at 50%

Although Anderson and Bows offer various scenarios based on different probabilities of exceeding 2°C, for present purposes their argument that assumes a 50% probability of exceeding 2°C is being considered. As discussed above, given the grave consequences that are likely to flow from a 2°C temperature rise or more, a 50% probability of exceeding that threshold is an extremely conservative premise. Not only does the language of the international community reflect a far lower probability (arguably in the vicinity of 1-10%), the precautionary principle would imply that a 50% chance of failure is far too risky.

4. 3 Non-Annex 1 countries peak in emissions by 2025

In order to determine how much of the global carbon budget is left for Annex 1 nations, Anderson and Bows first determine how much of the carbon budget non-Annex 1 nations will need to minimally develop their economies on the basis of equity. In making this assessment, they make what they acknowledge are 'extremely ambitious' (Anderson, 2013) assumptions with respect to the anticipated emissions peak in non-Annex 1 countries and their post-peak decarbonisation trajectory (as outlined in Anderson and Bows, 2011; Anderson and Bows, 2008a). Specifically, they assume that the non-Annex 1 nations will peak in emissions by 2025 and thereafter reduce emissions at an unprecedented 7% p.a. Note, however, that these 'extremely ambitious' assumptions are, if anything, favourable to the Annex 1 nations, since they imply less of the carbon budget is used up by the non-Annex 1 nations, leaving as much as possible for the Annex 1 nations.[3]

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[3] The other reason this premise can be considered 'favourable' to the Annex 1

4.4 Annex 1 nations must reduce emissions by 8-10% p.a

The Annex 1 carbon budget is determined by subtracting the non-Annex 1 emissions from the global carbon budget. Based on the above assumptions (all of which can be understood to leave a *favourable* carbon budget for Annex 1 nations), it follows that keeping to the carbon budget requires Annex 1 nations to decarbonise their economies by 8-10% p.a. over coming decades. Even that conclusion can be considered understated, given that the scenario was formulated in 2011 (Anderson and Bows, 2011), and since then carbon emissions globally have continued to rise (and indeed, at an increased rate). Every year emissions increase (or do not meet the 8-10% decarbonisation requirement) the decarbonisation strategies required to keep to the carbon budget become more stringent.

4.5 Emissions reductions of more than 3% or 4% p.a. are incompatible with a growing economy

Given that energy consumption and economic growth are intimately connected (Ayres and Warr, 2009), and that any significant transition to renewable and more efficient energy systems is going to take many years and probably decades to roll out (see Smil, 2014; Smil, 2010), it is widely accepted amongst orthodox economists that emissions reductions of more than 3% or 4% p.a. are incompatible with a growing economy. This view is supported by the pre-eminent climate change economist Nicholas Stern (2006), the UK's Committee on Climate Change and, as Anderson (2013) notes, 'virtually every 2°C emission scenario developed by "Integrated Assessment Modellers"'. Anderson (2013) also points out that 'if reductions of 4% each year are to occur in an economy growing at 2% each year, then the carbon intensity of the economy must continually improve at around 6% year on year'. Despite considerable engagement with the literature, Anderson admits that he has found no examples of economists suggesting that prolonged emissions reductions of 3% or 4% or more are compatible with a growing economy. On the contrary, Stern observes that annual reductions greater than 1% have 'been associated with economic

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nations is because the calculations are based on 'production-based' accounting not 'consumption-based' accounting. Given that many of the emissions in the non-Annex 1 nations are used up producing things which are ultimately consumed in the Annex 1 nations, a 'consumption-based' accounting of emissions would leave less of the carbon budget for the Annex 1 nations.

recession or upheaval' (Stern, 2006: 204). Indeed, one of the only examples of deep and prolonged emissions reductions is during the collapse of the Soviet Union, when emissions fell by approximately 5% p.a. for ten years (Anderson, 2012: 25). As the Russian economy stabilised, however, and once more began to grow, emissions again began to rise. All this firmly suggests that decarbonising an economy by 8-10% p.a. is not something that can be achieved while growing the economy in conventional GDP terms.

Admittedly, this is a point that economists, including Stern, assert without a much elaboration. It is certainly a key issue that deserves more critical attention, and obviously *planning* for decarbonisation will involve different dynamics than de-carbonisation through collapse or recession. All the same, the implicit reasoning seems relatively strong. Scaling up renewables takes many years, even decades, so does improving efficiency (Smil, 2010; Jackson, 2009). Even the theoretically 'ideal' scenarios for scaling up renewables and efficiency have to be placed in social and political context, where those 'ideal' scenarios will never be fully achieved. Therefore, one can conclude with some confidence that decarbonisation of 8-10% p.a. will never be achieved solely through a 'supply side' transition to renewables and more efficient production, especially in a growing economy. In order to achieve significant *absolute* reductions in emissions of 8-10%, the transition to renewables and more efficient processes must supplemented by planned 'demand side' reductions in energy consumption, and this energy descent requirement is what puts into question the continuation of economic growth (Ayres and Warr, 2009).

4.6 Therefore, the Annex 1 nations must initiate a 'degrowth' strategy.

If the Annex 1 nations must reduce emissions by 8-10% p.a. over coming decades in order to keep within their carbon budget; and, if emissions reductions of more than 3% or 4% are incompatible with economic growth, it follows, as Anderson and Bows conclude, that 'for a reasonable probability of avoiding the 2°C characterisation of dangerous climate change, the wealthier (Annex 1) nations need, temporarily, to adopt a degrowth strategy' (see Anderson, 2013). Although they have not provided much detail on what they mean by 'degrowth', the clear implication is that it means giving up the conventional pursuit of economic growth and deliberately seeking an equitable reduction of energy and resource consumption as necessary to meet their 8%-10% decarbonisation requirements. While this 'radical' conclusion flows logically from the conservative assumptions outlined above, it is a conclusion that contradicts most other large scale decarbonisation proposals, which almost always assume that maintaining a safe climate is consistent with continued economic growth in both developing and the developed nations (see, e.g., Grantham, 2013; SDSN and IDDRI, 2014).

Perhaps the most compelling aspect of the argument put forward by Anderson and Bows is the cautious and moderate way in which the underlying assumptions are framed. Each of the premises could in fact be justifiably more challenging. For example, if the temperature threshold were set at 1.5°C not 2°C; or if the probability of avoiding that threshold were raised to 80% or 90% not 50%; or if less ambitious figures were given for peak emissions and decarbonisation rates for the non-Annex 1 nations; and especially if *all* of those assumptions were not so moderately stated, then the available carbon budget left for the Annex 1 nations would be hugely reduced. This would demand significantly higher decarbonisation rates for Annex 1 nations, perhaps in the vicinity of 15% or 20% p.a. Accordingly, even if critics take issue with specific assumptions (e.g., argue that the temperature threshold should be 2.5°C or that decarbonisation at 6% p.a. is compatible with growth), this would not affect the overall conclusion that keeping to the carbon budget requires degrowth in the Annex 1 nations. Nevertheless, as noted, even some of the most promising climate policy documents of recent times (e.g., SDSN and IDDRI, 2014; Grantham Institute, 2013) steadfastly refuse to accept that an adequate response to climate might require rethinking the growth paradigm.[4]

While critics will doubtless continue to object to degrowth strategies on the basis of a range of other arguments (including both socio-economic outcomes and political efficacy), when the above figures of the carbon budget are taken seriously, the case for some

[4] Two other potential responses to the argument that some form of degrowth is necessary to achieve key carbon budget targets are to point to the contribution which 'carbon capture and storage' (CCS) and geo-engineering could make to addressing climate change risks. While a full review of the rapidly expanding literature on both these options is beyond the scope of this paper, I do note the extensive range of serious ethical, governance, and technical questions which have been raised about geo-engineering (see, e.g., Hamilton, 2013). As for CCS, this, indeed, may need to play a role in reducing emissions, but the technology at present is highly undeveloped, especially in the context of a decarbonisation requirement of 8-10% p.a. that must start immediately. Even when, or if, it becomes ready, implementation will take many years, probably decades, so it is not something that affects the necessity for exploring and implementing more immediate decarbonisation strategies.

form of degrowth strategy is extremely strong on scientific grounds. In this sense the onus is on critics of the Anderson and Bows proposition to demonstrate any fundamental flaws in the key assumptions or logic of the argument. In fact, critics really need to respond to the degrowth argument based on more challenging premises and even higher decarbonisation requirements (see Spratt, 2015), given that the argument from Anderson and Bows is really too moderately stated (e.g., the probability of success should be far higher than 50%).

It should be noted also that although this argument for degrowth is based solely on carbon budget analysis, it finds much support in more general 'limits to growth' literature (see generally, Meadows *et al.,* 2004; Rockstrom *et al.,* 2009; Trainer, 2010; Turner, 2012; Hopkins and Miller, 2012; Alexander, 2014a) and, more specifically, the emerging degrowth literature (see Latouche, 2009; Latouche, 2014b; Kallis, 2011; Alexander, 2012a; Victor, 2012). These literatures argue that the developed nations (in particular) must give up the growth paradigm for various ecological and social reasons, of which climate change is only one.

5. Powerdown: Degrowth Strategies for Climate Stability

While Anderson and Bows (2011) have presented a robust case for degrowth based on climate science, the challenge that flows from this is to begin to outline the overall shape of an integrated decarbonisation policy framework consistent with the scale and speed required to stay within the constraints of carbon budget targets, and consistent with democracy, political and social stability, and equity. The following sub-sections aim to contribute to that enormous task, while acknowledging that this preliminary discussion is likely to raise as many questions as it answers.

5.1. *Strengthening public understanding of the full implications of carbon budget analysis*

In order to fully understand the necessary scale and speed of action required to significantly reduce climate change risks, citizens and governments must first understand the full extent and implications of the carbon budget challenge. This includes broadening the recognition that, even if most existing decarbonisation policies and plans were immediately implemented, they would still fail to sufficiently address the core problem (i.e., they would not keep us within the carbon budget). The economic growth implications of carbon budget analysis therefore need to become a central element in informed public debate about climate change solutions and strategies.

5.2. *Identify and adopt 'post-growth' macroeconomic indicators as a key step toward the implementation of post-growth economic paradigms and policies*

Once the case for degrowth is understood (both in terms of carbon budget analysis and the more general 'limits to growth' critique), it follows that different macroeconomic indicators will be required. Currently, growth in GDP is the most widely used measure of politico-economic success, but for decades scholars (especially ecological economists) have shown that GDP is a fundamentally inadequate measure of genuine progress (see generally, Daly and Cobb, 1989; Daly and Farley, 2004; Lawn, 2005; Stiglitz, Sen, and Fitoussi, 2010; Kubiszewski, *et al*., 2013). GDP measures the benefits of economic activity in monetary terms, but does not account for most social and ecological costs (it even treats those costs as benefits!). This can lead to 'growth' that is 'uneconomic', in the sense that the overall costs of growth outweigh the benefits (see Daly, 1999). What are needed are macroeconomic indicators such as the Genuine Progress Indicator that better account for the full social and ecological costs of economic activity. This will help explain and communicate why a post-capitalist degrowth, far from being a retrograde strategy, is actually what 'genuine progress' now looks like, at least in the most developed nations of the world. Assessing degrowth policies through the conventional lens of GDP will look absurd, whereas those same policies when seen through more inclusive indicators will look necessary and sensible, while uneconomic growth will look absurd. Although far from being a sufficient public policy innovation, post-growth indicators of progress will be a necessary part of the macroeconomic paradigm shift required.

5.3. *Introduce an appropriately robust price on carbon*

According to neoclassical economic theory, for a market economy to function in a roughly 'optimal' way, the full costs of productive activity need to be 'internalised' to the productive process, not 'externalised' to society as a whole (see generally, Clarke, 2011). While this is extremely hard to do (providing grounds for doubting purely 'economic' solutions to social or ecological problems), it makes good sense to try to ensure prices accurately reflect full social and ecological costs (including the full, long term costs of climate change and of not staying within the carbon budget). Given that currently the costs of climate change are widely 'externalised', it follows that a part of the response to climate change requires putting an appropriate price on carbon (see generally, Tietenberg, 2013). There are two main ways to do this: either through a Pigouvian 'carbon tax' or through an emissions trading scheme (ETS).[5]

The great advantage of a carbon tax is that it is relatively simple and direct, even if it is also something of a blunt instrument. By taxing emissions, the price of carbon goes up for producers, a cost that is then passed on to consumers, thus incentivising businesses and individuals to reduce carbon consumption and invest in efficiency improvements (see Meltzer, 2014). Furthermore, as noted above, by making fossil energy more expensive, renewable energy sources become more price-competitive, which would encourage fossil energy being replaced with renewable sources. The revenue from taxing 'bads' (fossil energy) can also be used to fund 'goods' (renewable energy, efficiency improvements, or assistance for low-income households).

The alleged advantage of an ETS is that it would achieve the same ends as a carbon tax, but at a reduced socio-economic cost (see generally, Betsill and Hoffmann, 2011). In theory that might be true, but the realities of ETSs have been that they are very complicated to design and operate successfully, creating much room for the schemes being abused. They can also create counter-productive incentives, as reductions in one area of society can be increased elsewhere. While a carbon tax is arguably the better mode of pricing carbon, due to its relative simplicity and directness, the main point for present purposes is that carbon has to be priced appropriately *somehow* if economies are to have price signals that incentivise reduced carbon consumption. Currently, fossil fuels are artificially cheap (due to their costs being externalised), thus leading to their overconsumption and producing a grossly sub-optimal economy. Indeed, climate change is fairly characterised as the global economy's greatest 'market failure'.

While pricing carbon is a necessary part of the preliminary transition to a low-carbon economy, it must not be assumed that it

[5] Note that calling the former policy a carbon 'tax' is actually a misuse of the term, since it is really just internalising an externality. We do not, for example, say that a company is being 'taxed' when we expect it to clean up the river it polluted. We will, however, defer to convention and use the term carbon tax to differentiate this form of pricing carbon from an emissions trading scheme.

is a sufficient policy. Both carbon taxes and ETSs are market-based mechanisms that seek to achieve decarbonisation through the incremental effects of prices. But such incremental mechanisms will be insufficient to produce deep and rapid decarbonisation of 8-10% p.a. Pricing carbon must therefore be deemed only one string on the bow of broader decarbonisation and degrowth strategies, initiating a transition that must eventually replace the destructive market forces of capitalism with an economy that exists safely within the biocapacity of the planet. Detailing the nature of that post-capitalist society is a task for another time. Presently, the focus is on some initial, although bold, policy options that can get the transition underway.

5.4. *Abolish fossil fuel subsidies and divest from the fossil fuel industry*

How we spend our private and public money is akin to voting for what kind of world we want to live in. Accordingly, if we seriously seek a low-carbon economy we must stop 'voting' for a carbon-intensive economy, and this means stopping subsidising and investing in the fossil fuel industry. The IEA (2013b: 1) notes that the 'global cost of fossil-fuel subsidies expanded to $544 billion in 2012 despite efforts at reform', adding that 'financial support to renewable sources of energy totalled $101 billion'. These figures alone show how misguided the existing climate response is. Abolishing subsidies would help 'price' fossil fuels more accurately, meaning that the price of fossil energy would increase. It would also incentivise reduced consumption (through efficiency gains and the substitution effect) and make renewables more price competitive, encouraging an investment switch. As well as abolishing subsidies, individuals, communities, financial institutions, and governments should be encouraged to progressively 'divest' their existing financial support from the fossil fuel industry and refuse to provide financial support, permits, or a 'social license', for new fossil fuel projects and infrastructure.

Promisingly, an international 'divestment' campaign is currently under way, led by 350.org (McKibben 2012) and other activist organisations (see generally, Alexander, Nicholson, and Wiseman, 2014). Notably, the fossil fuel divestment movement is founded, in large part, upon carbon budget analysis. Participants in the movement argue that approximately 80% of fossil fuels must remain in the ground if the world is to keep within the 2°C temperature threshold (similar conclusions have been reached by the IEA) (IEA, 2012a). Since all fossil fuels are currently valued as if they will all be burned, this suggests that there is a vast 'carbon bubble' which is at risk of popping and rendering most fossil fuel resource 'stranded assets' of 'unburnable carbon' (see Carbon Tracker and Grantham Institute, 2013). This provides an additional more self-interested, financial argument for divestment, adding further weight to the already compelling scientific and moral case.[6]

5.5. *Rapidly accelerate a comprehensive switch to renewable energy*

The most important corollary of the moral and financial arguments against subsidising and investing in fossil fuels is to shift that financial support toward renewable energy systems and other low-carbon technologies. Existing subsidies for fossil fuels provide significant funds to get this transformation of energy systems underway. This spending shift could be achieved without finding new investment funds, although significant additional investment funds (both public and private) will need to be reprioritised in order to fully implement the switch to renewable energy (see Wiseman, Edwards, and Luckins, 2013). It is imperative to point out, however, that renewable energy systems are not on their own a climate change silver bullet. While they are, of course, a necessary part – indeed, the foundation – of any transition to a low-carbon economy, it is a mistake to think that the world can just transition to renewable energy systems and otherwise carry on within the same growth-based, industrial paradigm.

First of all, climate change is only one environmental problem among a whole host, so decarbonising the existing economy without otherwise changing its nature would leave other significant ecological problems, such as the profound threats to biodiversity,

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[6] In an important aside, if the world decided to take climate change seriously, one of the first investment changes necessary would be to stop financing new or existing infrastructure projects aimed at producing unconventional shale oil and the tar sands, as these oils are significantly more carbon-intensive than conventional oil (Hansen and Kharecha, 2008). Nevertheless, stopping production of unconventional oils would mean global liquid fuel production would immediately peak or even be in decline, despite demand growing, which would inevitably mean significantly higher oil prices (which are already at historically high trend levels). The further challenge this would raise, however, is that expensive oil has a suffocating effect on oil-dependent economies, inhibiting growth (see Alexander, 2014b). This is not an argument in support of unconventional oil, of course; it simply provides further grounds for decarbonising our economies and moving toward a post-growth macroeconomic paradigm that is far less dependent on oil.

unresolved (see generally, Turner, 2012). Secondly, when a full lifecycle analysis of solar and wind is undertaken, they often are shown to have far lower energy returns on investment (EROIs) than previously thought (see, e.g., Pietro and Hall, 2013; Palmer, 2013), suggesting that it will be extremely difficult to run a growth-orientated industrial civilisation on renewable energy. Finally, the intermittency of most renewable energy sources means that huge amounts of expensive storage or redundant plant would be required to cover the base loads of a growing, globalised industrial economy (see Trainer, 2013a; Trainer, 2013b; Honnery and Moriarty, 2012).

Even if electricity could be provided by 100% renewable energy (or even nuclear), electricity only constitutes around 18% of global final energy consumption (IEA, 2012b: 28), leaving unresolved (among other things) the problem of replacing liquid fuels for transport and machinery, especially. This is perhaps the largest challenge to decarbonisation. While electric vehicles may go some way to mitigating this problem, the fact that there are currently about one billion fossil fuel-powered vehicles on the road suggests that any transition to an electric fleet is going to be slow, exceedingly expensive, and resource intensive. The solution, I suggest, lies not so much in running a globalised transport system on biofuels or electricity, but in driving less and in other ways reducing oil dependency (e.g., growing food organically and localising production). In short, the challenge of rapid decarbonisation cannot be solved purely from the 'supply side' (i.e., transitioning to renewable energy systems), partly because such a transition will inevitably be slow (requiring a decade or two, at least), even if undertaken with 'war mobilisation' urgency (Smil, 2010; Smil, 2014). More specifically, Annex 1 nations could not decarbonise at 8-10% p.a. purely by transitioning to renewables. In order to transition rapidly to a low-carbon economy, we must decarbonise from the 'demand side' as well, by increasing efficiency and, most importantly, by simply consuming less energy and less energy-intensive products and services. This means that any degrowth transition to a low-carbon economy means adjusting to a prolonged period of planned 'energy descent' and creatively adapting to post-consumerist, moderate-energy lifestyles (Alexander, 2013).

5.6. *Greatly increase efficiency through incentives, subsidies, regulation, and education*

There is enormous scope for significantly decarbonising and dematerialising our economies through efficiency gains (see, e.g., Weizsacker *et al.,* 2009). By exploiting the best low-carbon technologies and designs, human beings will be able to lead high quality lives at a fraction of the carbon intensity of lifestyles in developed nations today (see, e.g., Druckman and Jackson, 2010). Efficiency can be promoted through incentives (such as a carbon tax); subsidies (for such things as energy efficient fridges or bicycles); regulation (such as minimum standards for products, especially energy consuming products); and education (showing individuals and businesses the easiest ways to lower their carbon footprints). While some will argue that this process should be left to the market, given the urgency of the challenge, government policies can also play a crucial role in driving efficiency improvements. In China, for example, the government has enforced efficiency improvements in 1000 of its state-owned enterprises, contributing to a 20% improvement in efficiency in the last five years. According to *The Economist* (2013), this is 'arguably the single most important climate policy in the world'.

Once again, however, the risk of promoting efficiency as a stand-alone solution is that people can assume that efficiency will be enough to decarbonise at 8-10%p.a., without requiring deeper changes to the way we live. Efficiency gains will never decarbonise or dematerialise economic activity enough for a global population to be able to live affluent, consumer lifestyles in a growing economy (particularly an economy operating in ways consistent with carbon budget constraints). This means efficiency gains have to be complemented by lifestyle and structural changes that significantly reduce energy and resource demands compared to levels prevalent in 'developed' economies.

5.7. *Introduce diminishing resource and energy caps to contain the 'rebound effect'*

Although efficiency gains are a necessary part of any transition to a low-carbon economy, there is great risk that all or some of those efficiency gains will be lost to the 'rebound effect' unless measures are taken to contain that phenomenon (Herring and Sorrell, 2009). When efficiency is increased, this can provide more income or productive capacity that can easily be redirected back into energy or resource intensive consumption or production. In fact, as W.S. Jevons (1865) argued long ago, efficiency can actually increase overall resource or energy consumption, by making certain products cheaper and therefore more available or affordable to a wider group of people. In order to contain this well documented phenomenon, diminishing resource and energy caps – or 'impact caps' – should be introduced to ensure that efficiency gains are directed into *reducing* resource and energy consumption, not directed into consuming more stuff with the same amount of (or even increased) resources or energy (Alcott, 2010). In an age of gross ecological overshoot, what are needed are absolute energy/resource reductions (absolute decoupling), not merely decreased energy/resource costs per unit (relative decoupling) (see Jackson, 2009: Ch. 4). This could be achieved either (1) through Pigouvian taxes (such as the carbon tax discussed above), which would make carbon sufficiently expensive that sustainable levels would not be exceeded; or (2) through direct regulation, which would legally prohibit more than a set amount of fossil fuels being produced each year (Alcott, 2010). By capping impact, the rebound effect would be avoided. Whichever approach is taken, it could be introduced over a specific timeframe (say, over 10 years) to allow markets and culture to adjust, although the detailed institutional design of such policies requires careful consideration (Kallis and Martinez-Alier, 2010).

5.8. *Rethink budget spending to facilitate low-carbon infrastructure*

If governments decide to take climate change seriously, this will require a huge investment in low-carbon technologies (especially renewable energy systems), but it will also require huge investment in 'greening' the infrastructure of our carbon-intensive urban centres. This point highlights the fact that our consumption practices do not take place in a vacuum. They take place within structures of constraint, and those structures make some lifestyle options easy or necessary, and other lifestyle options difficult or impossible. Currently many people find themselves 'locked in' to high consumption lifestyles due to the structures within which they live their lives (see Sanne, 2002). To provide one example: it is very difficult to escape a culture of driving if there is poor public transport or no bike lanes. Change the infrastructure, however, and new lifestyles would be more easily embraced. New infrastructure and systems are required to make low-impact lives easier. Given that public funding is far from limitless, this will require a significant revision of conventional spending patterns for most societies. Treating climate change as a 'security threat' and, on that basis, taking a significant portion of military spending is one path to funding low-carbon infrastructure, but deeper revisions may be needed in other places in order to fund these projects. There is no universally applicable method for determining how best to do this, and each national or local government will have to address the question in relation to their unique contexts and financial capacity. But the longer we wait before beginning this task, the harder and more urgent it becomes (see Murphy, 2012).

5.9. *Ensure an equitable pathway to global decarbonisation by resourcing transfer technologies and climate resilience strategies in non-Annex 1 nations*

While the Annex 1 developed economies must take responsibility for the majority of historic emissions it is also the case that future projections show that non-Annex 1 nations are set to become the highest overall emitters in the foreseeable future. What is necessary is that those non-Annex 1 nations are given increased support to create low-carbon economies *now*, rather than have them follow the conventional, industrialised development path which is at real risk of creating infrastructure and cultures that essentially 'lock' societies into decades of high-carbon living. Exactly how to do this, of course, is an extremely complex issue which cannot be addressed here, but one way to assist in this post-industrial development is for the Annex 1 nations to freely share their technological know-how and design methods with the non-Annex 1 nations to help them 'leap frog' an industrial phase of development and move more directly to an economy that meets basic needs for all with low-carbon emissions. This is one way the Annex 1 nations can pay back some of their 'ecological debt' (Simms, 2005) to the non-Annex 1 nations, to be supplemented by direct financial aid. A significant transfer of resources from developed to developing economies to support climate adaptation and resilience initiatives will be essential.

5.10 *Reimagine and reinvent the 'good life' beyond consumer culture*

Reimagining and reinventing the 'good life' lies at the heart of any degrowth transition to a low-carbon economy. High-consumption lifestyles simply cannot be universalised to seven, or nine, or ten billion people, while keeping within a carbon budget (to say nothing of the other limits to growth). Therefore, any sufficient response to climate change and other ecological limits requires a cultural paradigm shift that involves a significant shift away from high-consumption lifestyles toward ways of life informed by principles and practices of material sufficiency.

The 'degrowth' principles of increased frugality, moderation, and sufficiency need not necessarily be seen as principles of hardship or deprivation. A strong socio-psychological case can be made that income has diminishing marginal returns, meaning that income is very important at low levels of income, but once basic material needs have been met, priorities other than income become increasingly important (e.g., social engagement, more meaningful employment, more time for private passions). In fact, the evidence suggests that high consumption societies are widely mis-consuming, in the sense that many people could actually reduce their consumption while also increasing their wellbeing (see Alexander, 2012b; Bilancini and D'Alessandro, 2012). In this context, degrowth can be understood to mean trying to find that 'optimal' material/ energy threshold.

In much the same way that carbon budget analysis must be the basis of a pro-active education campaign, so too should support for the goal of 'voluntary simplicity' be built as an attractive alternative to consumer lifestyles. Such a campaign may need to begin at the grassroots level, where a cultural shift is initiated as more individuals and communities provide real-world examples of low consumption, high quality living. This cultural transformation also highlights the point made above: that decarbonisation cannot be achieved simply from the 'supply side' but actually requires people to reduce the consumption of resources and energy from the 'demand side' too. This might mean driving less and cycling more; growing local organic food; putting on woollen clothing rather than always turning on the heater; taking shorter showers; flying less or not at all; making and mending things rather than buying new; and in countless other ways rethinking lifestyles in ways that reduce energy and resource burdens. This is an immensely creative challenge, which finds promising movements already underway based on notions of voluntary simplicity (Alexander, 2009), permaculture (Holmgren, 2002), and Transition Towns (Hopkins, 2008). It is highly likely that these types of social movements will need to expand if the policies outlined above are to find broad social support. Indeed, to the extent that governments refuse to act decisively, it follows that the transition to a low-carbon, post-growth economy will need to be driven 'from below', without much state support (see generally, Trainer, 2010).

It is also necessary to acknowledge, in closing, that the above proposals, bold though they are, would not, in themselves, be enough to produce a just and resilient degrowth economy (Trainer, 2012). The proposals above are focused primarily on the question of decarbonisation, but given how fundamental the transition to a low-carbon economy is, a wide range of broader social, economic, and political changes will also be required. For example, a degrowth economy will require new banking and financial systems that are not so dependent on debt or the expansion of the money supply through interest-bearing loans. Similarly, providing access to cheap and affordable housing, or sufficient job security, in a degrowth economy may require a fundamental restructure of existing property and tax systems (see Alexander, 2011; Kallis *et al.,* 2012). Land use patterns will need to be revised in order to assist with decarbonisation too. This chapter has not attempted to address these or other remaining complex issues, but I note them here as issues deserving of more attention by those who see the transition to a post-growth economic paradigm as a necessary part of any low-carbon transformation. Whether 'degrowth' is the best term to describe this necessary societal transformation remains open to question. But that terminological debate is less important than the fact that this debate is occurring in recognition of the radical implications of carbon budget analysis and the broader limits to growth critique.

6. Conclusion

In order to have a reasonable chance of staying within carbon budget constraints and therefore of avoiding the most extreme global warming scenarios, this chapter has argued that an integrated matrix of decarbonisation initiatives must be implemented that aim to initiate a rapid transition to a degrowth economy. In the Annex 1 nations, this would require a systematic, planned reduction in the consumption of energy and resources. The rapid and deep reductions in emissions required if the Annex 1 nations are to decarbonise at 8-10% over coming decades cannot be achieved merely with a 'supply side' transition to renewable energy, necessary though that transition is. It must also be supplemented by a 'demand side' reduction in carbon-intensive consumption and production. That means creating a fundamentally different kind of economy – one not based on limitless growth – and embracing ways of living far less impactful than high consumption lifestyles.

While I am fully conscious of the challenges involved in building broad public support for this argument, I hope that the analysis presented here can contribute to a more informed public debate about the crucial contribution which the transition to a post-growth economic paradigm will need to make in achieving climate stability and a just and resilient future. After all, as Winston Churchill once noted: 'It is no use saying, "We are doing our best". You have got to succeed in doing what is necessary.'

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