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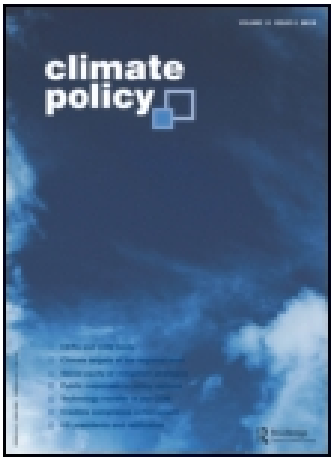

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synthesis article

Going beyond two degrees? The risks and opportunities of alternative options

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Since the mid-1990s, the aim of keeping climate change within 2 °C has become firmly entrenched in policy discourses. In the past few years, the likelihood of achieving it has been increasingly called into question. The debate around what to do with a target that seems less and less achievable is, however, only just beginning. As the UN commences a two-year review of the 2 °C target, this article moves beyond the somewhat binary debates about whether or not it should or will be met, in order to analyse more fully some of the alternative options that have been identified but not fully explored in the existing literature. For the first time, uncertainties, risks, and opportunities associated with four such options are identified and synthesized from the literature. The analysis finds that the significant risks and uncertainties associated with some options may encourage decision makers to recommit to the 2 °C target as the least unattractive course of action.

Keywords: adaptation policy; climate policy; global warming; governance; mitigation policy; post-2012 negotiations; risk governance; two degrees; UNFCCC

1. Introduction

The target to limit average global temperature rise to within 2 °C (above pre-industrial levels) is now firmly entrenched in the policy discourse and, since the 2009 United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP) in Copenhagen, the international legal regime associated with climate change. Adopted as the threshold beyond which impacts from climate change are held to be 'dangerous', it has been used to justify short- to medium-term targets (i.e. 2020–2050) for mitigation and, increasingly, informs policy making on adaptation. For the EU (Rayner & Jordan, 2013), the small island states, the Least Developed Country group, as well as many advocacy organizations, it has a near totemic status. To question this target (other than by calling for it to be

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tightened, for example to 1.5 °C; see, e.g. AOSIS, 2012) is to challenge the whole rationale for collectively addressing climate change. Others take a slightly more relaxed view, seeing it either as a 'focal point' (Jaeger & Jaeger, 2011) that guides but does not precisely determine international negotiations, or a 'boundary object' between the scientific and political realms (Randalls, 2010). For some critics, however, the setting of a global temperature target that the world should meet represents an exercise in hubris of questionable efficacy and legitimacy (Hulme, 2012), 'a stale variable which offers an illusion of control and a facade of simplicity' (Mahoney, 2013).

The target's position in international debates has evolved over the last two decades (Liverman, 2009). Initially, it was suggested in the mid-1990s as a way of adding substance to the UNFCCC's commitment in Article 2 to the 'stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. Around this time, staying within two degrees appeared challenging but eminently achievable, certainly by the EU, which strongly promoted it within and outside Europe (Jordan, Huitema, Rayner, van Asselt, & Berkhout, 2010; Rayner & Jordan, 2013). In the lead up to the Copenhagen COP to the UNFCCC, the EU managed to secure recognition of the target by the G8 (G8, 2009). In the 2010 Cancún Agreements, it was adopted for the first time by a COP: 'deep cuts in global greenhouse gas emissions are required according to the science, [...] so as to hold the increase in global average temperature below 2 °C above pre-industrial levels.'[1] However, by the time of the Durban COP in 2011, world leaders were noting 'with grave concern' the 'significant gap' between current pledges and emissions pathways consistent with the target (UNFCCC, 2011). The 'Durban Platform' duly sought to reinvigorate international negotiations on legally binding targets to limit warming to 2 °C.

Despite these recent advances in its policy reach and formal legal status, the target has never been more politically sensitive than it is now. This slightly paradoxical state of affairs was confirmed in August 2012 when the US envoy on climate change, Todd Stern, was reported as having called for its removal from international climate talks (Black, 2012). His remarks drew a fierce reaction. Tony de Brum, Minister of Assistance to the President of the Marshall Islands, claimed that '[s]uddenly abandoning our agreement to keep global warming below 2 °C is to give up the fight against climate change before it even begins' (quoted in Black, 2012).

In fairness, most of Todd Stern's comments were devoted to restating his country's well-known preference for a 'pledge and review' approach to international policy. Nevertheless, the exchange emphasized that two important changes since the mid-1990s are increasingly salient to decision makers. First, more recent research on mitigation indicates that the increasing growth in CO_2 emissions that has occurred since 2000 (Peters et al., 2013) has significantly reduced the probability of limiting warming to 2 °C (see Figure 1). Indeed, the chances are likely to diminish further as certain Annex I countries move out of recession (Meinshausen et al., 2009; UNEP, 2010). In 2011, Fatih Birol, Chief Economist of the International Energy Agency, and Lord Nicholas Stern argued that without prompt remedial action, there is a significant risk that the target would be pushed out of reach altogether: '[for] the moment our climate goals remain attainable, but the door is closing' (Birol & Stern, 2011). Others, including a former Chair of the Intergovernmental Panel on Climate Change (IPCC), have suggested that the door has effectively already closed (Ghosh, 2012); i.e. the 'emissions gap' (UNEP, 2012) can no longer be made up. By exploring *when* as opposed to *if* the temperature increase will exceed 2 °C, others are implicitly endorsing this view (Joshi, Hawkins, Sutton, Lowe, & Frame,

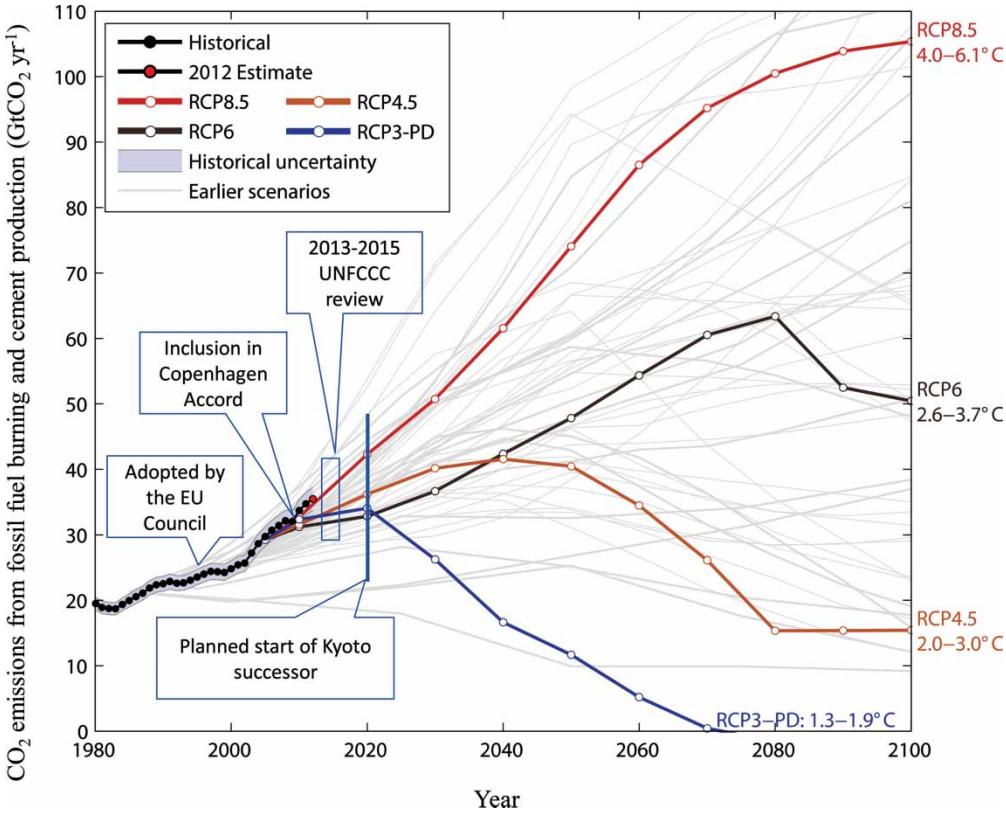

Figure 1 A comparison between the evolution of climate change policy related to the 2 °C target and global CO_2 emissions from fossil-fuel combustion and cement production.

Notes: These emissions are the largest and fastest-growing contributors to human-induced climate change. The Representative Concentration Pathways (RCPs) are the four scenarios to be used in the upcoming assessment report of the IPCC to project climate change to 2100 (Moss et al., 2010). Historical data are from Boden, Marland, and Andres (2011). Temperature projections are from Rogelj, Meinshausen, and Knutti (2012). The figure is adapted from Peters et al. (2013).

2011). Second, a substantial and diverse body of research on impacts and adaptation indicates that many ecosystems are more sensitive to impacts at 2 °C of warming than was previously thought (Smith et al., 2009; Warren et al., 2013), and many risks may amplify one another to produce cascading impacts that run through ecosystems and on into social systems (Hsiang, Burke, & Miguel, 2013).

Recent political discussions on the 2 °C target reconfirm that climate policy makers are in effect caught on the horns of a dilemma. Thus, to even mention temperatures greater than 2 °C, let alone that the target should be dropped given the increasing probability that it will be breached, could be perceived as a pernicious, self-fulfilling prophecy – a point recognized by experts (IEA, 2013), lay publics (Capstick, 2012), and of course politicians like Tony de Brum. Yet, by avoiding the matter, by 2020 the international regime could have become the victim of 'self-inflicted irrelevance' (Geden, 2012, p. 20), i.e. a situation in which 2 °C remains the cornerstone of policy, but is widely perceived

to be effectively unattainable. Any associated loss of credibility could, some claim, seriously reduce what momentum remains in international decarbonization efforts (Geden, 2012, 2013).

The decreasing probability of staying within 2 °C, coupled with deepening concern about the shape and efficacy of future climate policy (Davis, Cao, Caldeira, & Hoffert, 2013), should encourage those concerned about climate change to take the uncomfortable step of going *beyond* current and sometimes rather binary debates about *if* and/or precisely *when* the world will cross such a threshold (Guivarch & Hallegatte, 2013; New, Liverman, Schroeder, & Anderson, 2011; Vieweg et al., 2012), to explore a much wider set alternative options than just 1.5 °C or 2 °C. One analyst suggests that rising emissions will eventually force a target modification of some kind, involving either *reinterpretation* (whereby, for example, a temporary crossing of the threshold is permitted or the probabilities of exceeding 2 °C are made more explicit) or, more radically, *revision* (either accepting a less ambitious temperature target or giving up a specific global temperature stabilization target altogether) (Geden, 2013). The opportunities and risks associated with these options (especially for the role of scientific advice in policy making) are outlined, but remain sketchy and no particular alternative is recommended. Likewise, although other commentators have implicitly conceded the need to explore alternative options (Guivarch & Hallegatte, 2013, p. 187), these nonetheless remain *terra incognita*. The debate therefore seems to have stalled.

However uncomfortable it may be to explore deeply the implications of allowing temperatures to go beyond 2 °C (Knopf, Kowarsch, Flachsland, & Edenhofer, 2012) and/or to debate alternative options, it is argued here that identifying alternative options could offer policy makers a way to grapple with the deep dilemma at the heart of climate policy. Crucially, it need not necessarily serve as a pretext for abandoning the commitment to remain within 2 °C. The international community now has a formal opportunity to debate these important issues. In response to demands from the most vulnerable states, the Copenhagen COP in 2009 committed itself to review, by 2015, 'the long term goal referencing various matters presented by the science, including in relation to temperature rises of 1.5 degrees Celsius' (UNFCCC, 2009, para. 12), as well as progress made towards it. On the basis of subsequent decisions made at Doha in 2010, this review began in 2013 (UNFCCC, 2010, para. 139(b)).

At the time of this writing, the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI) have jointly established a contact group to assist the COP in conducting the review. A structured expert dialogue to support the work of the joint contact group has been set up to enable an exchange of views, information and ideas and to ensure scientific integrity. At the first workshop, held on 5 June 2013, some scientists presented their latest research.[2] The review is to be 'guided by the principles of equity, and common but differentiated responsibilities and respective capabilities' (UNFCCC, 2010, para. 139(a)), wording that suggests that major emitting developing countries may be wary of the implications for their own mitigation commitments.

The UNFCCC review does seem to be a rather tightly drawn exercise at the moment, but it is argued here that it could, and indeed should, lead to a much more open debate on the 2 °C target and some of its potential alternatives. While the existing literature points to a number of alternative options, in this paper we select four of them and explore what they might entail in practice. Their underlying assumptions are summarized, especially in relation to issues of policy and governance, which have tended to be skirted over in many of the debates about the 2 °C target. The opportunities and risks of each option are then explored for particular actors and institutions, as well as for collective efforts to address climate

change. Finally, the main arguments are summarized and their implications discussed for both future policy and research.

2. What are the options?

There is a range of alternative options around which climate governance (broadly understood to mean institutional and policy mechanisms to steer society) (Jordan, 2008) could be organized (Aldy, Barrett, & Stavins, 2003). Although many options could be analysed, four are selected as especially worthy of initial exploration. For the sake of argument (and to keep to a manageable number), we have deliberately selected the most different, leaving out incremental alterations (e.g. loosening the existing target to 2.5 °C or 3 °C). This section briefly outlines them, beginning with the three that *differ most* in the way in which 2 °C is currently framed in policy discourse – i.e. as a target that should be met.

- *Option 1:* '*mitigate for 2 °C but adapt for 4 °C*'. Even pursuing 2 °C to the maximum does not reduce the risk of 4 °C to zero. Society should therefore 'hedge its bets' by taking steps to adapt to a much warmer world while maintaining a high level of ambition regarding mitigation.

  This option was popularized (but not coined) by former IPCC chair Sir Robert Watson, (Randerson, 2008) and more fully elaborated at a 2009 conference (New, Liverman, & Anderson, 2009).[3] Mabey, Gulledge, Finel, and Silverthorne (2011) subsequently suggested that such an approach, which they dub *ABC*, could have three elements: **A**im to stay below 2 °C; **B**uild and budget assuming 3–4 °C; **C**ontingency plan for 5–7 °C of warming. Although its advocates acknowledge the potential contradictions within the position, these are considered manageable. Given the continuing uncertainties over climate sensitivity, the eventual magnitude of climate change, and societal capacities to adapt, policy makers should step up their current efforts to mitigate. For their part, adaptation policy makers may not have to do too much differently, particularly given the difficulty of drawing a neat distinction between the actions they will need to take for a 2 °C world in 2050 and what might be required for 4 °C (although a more 'transformative' kind of adaptation might be necessary in some cases; Stafford Smith, Horrocks, Harvey, & Hamilton, 2011).
- *Option 2:* '*adopt new metrics and targets*'. Because a long-term temperature-based target appears unable to stimulate short-term policy responses and in any case does not represent current understandings of global climate system sensitivities, more specific and near-term targets should be adopted.

  Here, Lenton's (2011a) views are taken as representative of a much larger and emerging line of thought on planetary boundaries (Rockstrom et al., 2009). Lenton (2011a) suggests that a range of potential thresholds of danger exist, not necessarily linked to global mean temperature change, but instead to (1) magnitudes of change, (2) rates of change, and (3) spatial gradients of anthropogenic radiative forcing. For example, monsoons could potentially be disrupted by localized warming altering local temperature gradients, which in turn are influenced by the uneven distribution of anthropogenic aerosols such as black carbon in the atmosphere. Future policy efforts could therefore be tailored to respond to these thresholds, rather than the 'meta' target of 2 °C of warming. Article 2 of the UNFCCC (noted above) could even be revised to make limiting anthropogenic radiative forcing the principal objective, with the stabilization of GHG concentrations as one of a number of sub-objectives. The scientific literature is already beginning to frame scenarios in

terms of radiative forcing (Moss et al., 2010). The main aim would be to prevent the crossing of large-scale thresholds in physical systems, but it could also help to address some of the other 'reasons for concern' highlighted by the IPCC (Smith et al., 2009).

- *Option 3: 'be politically more pragmatic'*. Society should accept that adopting science-informed targets such as 2 °C has failed to drive social change and governors should instead concentrate on delivering what is politically achievable in the short to medium term.

  This option emerges from a discourse that has, since the early 1990s, repeatedly expressed scepticism towards the 'hyperbolic multilateralism' of UN climate policy (Prins et al., 2010, p. 7). Proponents argue that not only has this failed to achieve significant emissions reductions, it may also have impeded potentially more effective attempts to promote investment in low-carbon technologies at more local levels (Rayner, 2010; Victor, 2011). They argue that political momentum towards a more global-scale approach is more likely to be generated by demonstrating clear economic and social benefits from mitigating in a specific number of problem areas. Therefore (and in common with advocates of Option 2), they favour rapid action on powerful short-lived forcers (Kopp & Mauzerall, 2010), the benefits of which will be more quickly apparent, as well as increased levels of investment in research and development, rather than waiting for a perfectly comprehensive global deal that may never appear. This view is associated with scepticism towards certain other kinds of universalistic thinking (Ostrom, 2010), including the UNFCCC's concept of dangerous anthropogenic interference. Pielke (2011), for example, calls for a new international convention that does not refer to 'dangerous interference' at all, but instead to the achievement of decarbonization consistent with meeting long-term targets for the stabilization of atmospheric concentrations.
- *Option 4: 'recommit to staying within 2 °C'*. The growing probability of highly risky rates of warming makes it even more important to recommit to 'low stabilisation targets' (Knopf, Luderer, & Edenhofer, 2011, p. 617).

  While accepting that it is, to some extent, a crude translation of the principle of avoiding dangerous climate change, advocates of Option 4 generally argue that the 2 °C target nonetheless provides a critical role in the international regime (Hare, Stockwell, Flachsland, & Oberthür, 2010; Jaeger & Jaeger, 2011). In view of the many uncertainties associated with climate change (and in the event that emissions are not reduced fast enough to remain within 2 °C, or climate sensitivity turns out to be at the higher end of scientific estimates), advocates of this option argue that it is preferable to recommit to the 2 °C target rather than abandon it. In which case, it may be sensible to actively remove CO_2 from the atmosphere now, e.g. by producing biochar or deploying bioenergy equipped with carbon capture and storage (CCS), although the political and technical feasibility of such strategies remains highly uncertain, particularly at the scale and within the timeframe necessary. However, in order to maximize the probability of staying within 2 °C, even more radical measures might be deemed necessary (Anderson & Bows, 2008, 2011; Swart & Marinova, 2010). To deliver drastic emission reductions of the order of 9–10% per year, some proponents are willing to contemplate limits to economic growth in the short term, particularly in the industrialized world (Jackson, 2009). Of course, much depends on precisely what probability of remaining within 2 °C is sought. This is no idle matter: the higher the probability of staying within 2 °C sought, the lower the 'budget' of cumulative emissions available for policy makers to consider and hence the more radical the policy options will have to be. Be that as it may, for advocates of this option an increasing probability that the 2 °C target will be exceeded is no reason to abandon it entirely, just as a common

tendency among some drivers to exceed a given speed limit is no argument against having and enforcing speed limits.

These four options are briefly summarized in Table 1. Each reflects a distinct line of argument (or framing) of the climate governance task in the existing literature, although there are some notable overlaps between them. When brought together and compared for the first time, it is even more apparent that they actually embody very different images or styles of governance (Hood, 1998), and hence different interpretations of the meaning and function of '2 °C'. In general, those to the left in Table 1 tend to regard it as a target that should be achieved (its role therefore being to steer social processes), while those to the right see its role in a more flexible light, focusing instead on nearer-term political and policy challenges, with the extent of warming left more 'open' (although the decision about whether and how far to adapt in the future could be considered to be correspondingly more 'closed').

In a great deal of the debate about 2 °C thus far, these underlying assumptions – whether it is a target, a focal point, or a boundary object (as well as related assumptions about the role of policy and governance therein) – have remained rather implicit and, in some contributions, entirely absent. In fact, all four options raise opportunities and risks for particular actors and institutions, as well as for collective efforts to address climate change through systems of policy and governance. It is on this basis that the options can and – this paper argues – *should* be cross-compared, a task that is addressed in the next section.

3. The opportunities and risks of different options

3.1 Mitigate for 2 °C but adapt for 4 °C

Advocates argue that adopting Option 1 provides the opportunity to open up new ways of addressing climate change that do not rigidly separate mitigation from adaptation (Biesbroek, Swart, & van der Knaap, 2009). Adopting a twin target could help to reap synergies and lessen conflicts, especially in relation to the water–energy–food nexus (Rosenzweig & Tubiello, 2007; Secretariat of the Convention on Biological Diversity, 2009; Swart & Raes, 2007), possibly opening up additional investment in both mitigation and adaptation actions at the national level (Mabey et al., 2011). As the responsibility for leading on mitigation and adaptation may rest with different policy makers, advocates suggest that there need not necessarily be a trade-off between pursuing both to the maximum (Klein et al., 2007). More analysis and public debate on the uncertainties embedded in and possible impacts associated with all scenarios (Shaw, 2013), and especially those at the high end (of which there are relatively few at present; see Figure 1), could be a second big opportunity associated with Option 1 (Mabey et al., 2011). Conceivably, this could even lead to a greater societal effort in terms of mitigation to avoid the predicted costs.

There is, however, a significant risk that the opposite could occur. The 2 °C target has arguably sent a signal to investors, albeit a relatively weak one, that policy makers do recognize the fundamental importance of limiting warming. Explicit acknowledgement that it may not be reached risks undermining decarbonization efforts, in just the way those placing a 'taboo' (Pielke, Prins, Rayner, & Sarewitz, 2007) on discussions of adaptation originally feared. In fact, accepting that the target might not be met could mean that much higher numbers will soon be considered and possibly even accepted by policy makers and publics. This concern has recently been expressed by the International Energy

Table 1 'Going beyond' the status quo: four options

Options	4. 'Recommit to staying within 2 °C'	1. 'Mitigate for 2 °C but adapt for 4 °C'	2. 'Adopt new metrics and targets'	3. 'Be politically more pragmatic'
Headline message	*Urgent need for stringent mitigation requires a single 'meta' target to trigger social action*	*Dangerous change is likely; policy makers should place more emphasis on adaptation action*	*Global average warming is not the only kind of climate change that is dangerous*	*The 2 °C target lacks the political capacity to motivate societal change*
Implications for policy and governance	*The effects of exceeding 2 °C are serious enough to justify the short-term costs of action* *For some, this implies a fundamental questioning of current development paths*	*Mitigation and adaptation must be considered in all policy responses* *Worst-case mitigation scenarios should be considered when framing adaptation responses*	*Move away from focusing on mean global temperature, to specific/ near-term targets* *Deal with radiative-forcing agents one at a time e.g. via regional treaties*	*Focus on what is politically feasible now, e.g. (1) energy security for all; (2) viable environments protected from various forcings; and (3) ensure adaptation to climate risk*
Illustrative opportunities and risks	*Opportunity: emissions in different locations can be related to a common focal point* *Opportunity: opens up a debate about different forms of 'prosperity'* *Risk: a failure to remain within 2 °C causes maladaptation, social and environmental costs* *Opportunity/risk: opens up prospect that climate engineering will be called upon*	*Opportunity: more attention given to synergies* *Opportunity: more discussion of how to avoid worst-case scenarios becomes possible* *Risk: undermines decarbonization efforts and/or generates 'adaptive emissions'* *Risk: limits of adaptation overlooked* *Risk: liability and compensation issues become more acute*	*Opportunity: opening up discussions across multiple venues overcomes deadlock in the UNFCCC* *Risk: a more differentiated understanding of state interests blocks progress on negotiations* *Opportunity/risk: climate-engineering options have more 'fit'*	*Opportunity: opens new political 'entry points' for mitigation* *Risk: elevating political feasibility as a key criterion of decision-making risks exacerbating technological lock-ins* *Risk: action is insufficient to prevent dangerous temperature rise*

Agency (IEA, 2013, p. 9), when it underlined the importance of ensuring that 'our capacity to evaluate and quantify these impacts (from higher emissions) does not inadvertently lead to acceptance of a 4 °C scenario'. However, as noted above, a fuller analysis of what an increase of 3 °C or 4 °C by mid-century might really entail could reinforce mitigation efforts if the implications of going beyond 2 °C are better understood. Certainly, it is by no means clear that the public really understands what is at stake i.e. whether a world at 4 °C is able to support society as we currently know it.

This is not the only risk inherent in Option 1. There are several others, some of which are shared with Option 3. So, for all the reassurance that adaptation and mitigation actions can be complementary, the risk of trade-offs nonetheless remains (Pittock, 2011). Under a worst-case scenario, desalinating and transporting water (over long distances) could represent a high proportion of some countries' energy consumption, making significant mitigation considerably harder to achieve (CEC, 2009). More fundamental than the well-known issue of 'adaptive emissions', Option 1 also risks under-appreciating the barriers, limits, and uncertainties associated with adaptation (Adger & Barnett, 2009; Hall, Brown, Nicholls, Pidgeon, & Watson, 2012). Some of these relate to fundamental uncertainties in the physical science, where greater uncertainty regarding global temperature change (Meehl et al., 2007) implies even greater uncertainty in terms of regional impacts (Dessai, Hulme, Lempert, & Pielke, 2009). Many climate impacts scale nonlinearly with temperature, yet this is precisely the information that will be needed to pinpoint the key sensitivities (and thus ensure that sector-specific adaptive responses are resilient) in a 4 °C world. So, although one estimate puts the annual cost of adapting to a 2 °C rise at a minimum of US$70 billion by 2020 and up to $100 billion by 2050 (World Bank, 2010), it cannot be assumed that adapting to a rise of 4 °C will entail costs of US$140–200 billion.

Other barriers are likely to be of a more social and political nature. Above a certain level, adaptation may be unable to keep pace with the rate of change, or, as Tony de Brum seemed to be arguing, may only be possible at unacceptable social and environmental costs. Such a threshold could even occur at 2 °C or less in some systems, sectors, or locations. In other words, trade-offs and synergies in relation to adaptation are highly space- and time-specific, and thus harder to pinpoint and address than this option implies (Adger & Barnett, 2009). Question marks also hang over the extent to which public engagement and collective effort can be galvanized in relation to this option, and indeed also in relation to Option 3 (Shaw, 2013).

Finally, any perceived loosening of the 2 °C target risks acknowledging the need for increased financial transfers in a warmer world, thus formalizing issues of liability and compensation that developed countries have always sought to keep off the international agenda, but which resurfaced at the Doha COP (specifically in relation to the concept of 'loss and damage'). Vulnerable regions and sectors might then demand increased resources to cope with the predicted impacts, raising the fraught issue of adaptation burden-sharing (Rayner & Jordan, 2012). This may make the politics of enhanced mitigation appear comparatively simpler than at present, and further complicate international negotiations.

3.2 Adopt new metrics and targets

The first and potentially main opportunity offered by Option 2 is that by facilitating a more multilevel and multifaceted approach, with decisions made in multiple venues, it could unblock international climate discussions (Victor, House, & Joy, 2005). Negotiations on particular radiative-forcing agents

could, for example, occur in separate policy venues, i.e. regional treaties for agents with regional effects (Lenton, 2011a, 2011b). Such a concern for radiative forcing could then serve to highlight the importance of venues and decisions that are of great significance, but have not been accorded great status in the current climate regime. For example, it has been estimated that the 2008 decision of the International Maritime Organization (IMO) to limit ships' sulphur emissions, whatever its health benefits, could have an effect on radiative forcing equivalent to a doubling of the rate of global warming (Isomäki & Pettay, 2011). In turn, a shift to more venues could open up new opportunities to build on what has arguably been the most successful aspect of the UNFCCC – its 'clearing house' functions in relation to collecting and exchanging information (Yamin & Depledge, 2004). Second, being concerned with radiative forcing, rather than emissions, could create opportunities for those seeking to alter the incoming solar radiation (geoengineering), to prevent 'tipping elements' (Irvine, Lunt, Stone, & Ridgwell, 2009; MacCracken, 2006) from crossing thresholds (Caldeira & Wood, 2008). Finally (and as with Option 1), a more differentiated approach need not be at the expense of binding long-term global targets to limit GHG emissions; they could complement one another.

Risks, however, could be generated by adopting this option, from local to international scales. For example, negotiating on multiple issues across multiple venues could prove to be bureaucratically cumbersome to coordinate, especially if there is no overall objective (e.g. 2 °C) in sight. Some authors (e.g. Mabey et al., 2011) have worked on the assumption that states achieving a more differentiated understanding of the climate risks they face, informed by a range of metrics, will enable more constructive engagement in international negotiations, while others have suggested that it risks generating greater division among the main negotiating blocs (Revkin, 2011). Another risk is that metrics such as rates of change and tipping points fail to resonate any better with publics than 2 °C (Shaw, 2013; Whitmarsh, Seyfang, & O'Neill, 2011). At present, it is difficult to communicate climate-related risks, which are often 'psychologically distant' (Pidgeon & Fischhoff, 2011). Focusing on more local and near-term risks and (particularly) opportunities may be more productive, increasing individuals' sense of efficacy and motivation to act (Gifford et al., 2009; O'Neill & Nicholson-Cole, 2009). Widening them to include more socially meaningful measures, such as improved well-being, could be especially efficacious. Concerning the opportunities for advocates of geoengineering, the technical feasibility of even the most heavily studied methods of intervention is a long way from being established. Moreover, identifying when a tipping point is due to be reached, when any counter-measures should be deployed, and who would bear the costs are all highly uncertain and politically risky.

3.3 Be politically more pragmatic

Advocates of Option 3 suggest that it would ensure that the benefits from mitigation for the low-carbon economy continue to be pursued, even if the international regime embodying the 2 °C target crumbles (Geden, 2012). In this sense, its primary opportunity is, arguably, to head off that risk. Indeed, the adoption of multiple objectives for the energy system – e.g. covering access, security, and health (IEA, 2012) – could provide new opportunities (or political 'entry points') for mitigation (McCollum, Krey, & Riahi, 2011). Focusing on the long-term goal of decarbonization – perhaps indirectly as a secondary consequence of energy innovation – is presented as an easier 'sell' for politicians than tackling 'climate change', an agenda often associated with perceived sacrifice and guilt (Morton, Rabinovich, Marshall, & Bretschneider, 2011). As with Option 2, reframing climate policy could open up promising

opportunities to engage those who are particularly sceptical of the science of climate change (Bain, Hornsey, Bongiorno, & Jeffries, 2012; Nye, Whitmarsh, & Foxon, 2010). Advocates of Option 3 further claim that once attempts to define 'dangerous' levels of climate change have been dropped, adaptation can be pursued more concertedly, 'untethered' from mitigation (Pielke, 2011). The 'predict then act' approach was in any case always simplistic. Instead, adaptation could respond to interlinked vulnerabilities arising from a host of climate and 'non' climate drivers (Dessai et al., 2009).

The most obvious risk associated with this option (and also Option 2) is that a less centrally–steered approach fails to generate the sense of common purpose and urgency deemed necessary to significantly mitigate emissions, possibly undermining emerging carbon markets and creating a 'demobilising climate of pessimism' (Guivarch & Hallegatte, 2013, p. 189). It also risks jeopardizing the development of large-scale international funding mechanisms for mitigation and adaptation activities in developing countries (Donner, Kandlikar, & Zerriffi, 2011). The concerns expressed above regarding Option 1 – that it risks impacts developing that go beyond societal capacity to adapt – apply equally if not more so to Option 3. While advocates of Option 3 recognize the need for greater North–South resource transfers to address adaptation as a 'development challenge', the precise mechanisms through which this would occur are by no means explained (Prins et al., 2010). Finally, making political pragmatism a key criterion of decision making risks exacerbating the institutional and technological lock-in of current energy-related infrastructure (Unruh, 2002). Promotion of shale gas fracking offers a pertinent present-day illustration of a technology that may facilitate short-term emission reductions, but may not deliver longer-term decarbonization (Broderick & Anderson, 2012).

3.4 Recommit to staying within 2 °C

Finally, policy makers have the option of recommitting to stay within 2 °C, or even moving the target to 1.5 °C. As noted above, the current commitment to 2 °C offers international negotiators an important focal point that, at least in principle, has some political traction and legal force. Because success is measured globally, it provides an opportunity to identify free-riders and, in theory, sanction them. Deciding at the end of the 2013–2015 review to recommit to staying within the target could allow that benefit to continue. However, as noted above, the policy and governance implications of doing so would need to be taken more seriously than they have been to date, otherwise it risks being little more than a symbolic exercise. These implications (and thus political stakes) would be much clearer if the review was more explicit about identifying a probability range for exceeding 2 °C.

The point about analyses that suggest that 2 °C is no longer attainable is that they tend to take present-day assumptions about economic growth for granted. Some, such as Lord Stern, have stressed that staying within 2 °C is the 'pro-growth strategy', while others, including at times Stern himself (see Watts, 2009), see the necessity for a much more radical reframing in the face of immutable limits (Hoffmann, 2011). Although any kind of degrowth agenda faces undeniable political feasibility constraints, advocates also stress the opportunities to develop better quality, 'post-consumerist' lifestyles (Barry, 2012). Finally, although widely associated with a radical emission reduction agenda, of the four options, Option 4 could conceivably also offer the greatest opportunities to those who advocate geoengineering as the least socially disruptive way (i.e. not requiring radical lifestyle change) to adjust the global 'thermostat'. As with Option 2, however, this would raise its own deeply challenging political and ethical questions (Barrett, 2010).

One of the main risks posed by Option 4 is that, in a (futile) attempt to stay within 2 °C, irreversible sacrifices are made across a range of environmental and social values. For example, biodiversity might be sacrificed to grow more biomass (often a key plank of low-emission scenarios), leading to it being caught in a double bind of impacts from climate change and the similarly destructive effects of mitigation, or even worse impacts from poorly understood geoengineering interventions (Secretariat of the Convention on Biological Diversity, 2009). The 'brutal arithmetic'[4] required to reduce emissions sufficiently may require that both per capita income growth in developed countries and prospects for development gains in the global South diminish, potentially cementing gross injustices (Hoffmann, 2011). Recommitting to staying within the existing target also risks delivering insufficient adaptation if policy makers refuse to acknowledge that it may not be reached, putting vulnerable regions and populations in even graver danger. Furthermore, as with Option 3, concerns about maladaptation could be realized if societies invest in activities that prove costly if a 4 °C world materializes.

These risks and opportunities, however politically difficult, would be a lot clearer if all the options, including Option 4, were explored in the context of a wider debate about what probability of remaining within 2 °C should be targeted. If the declared aim was to seek a high probability of remaining within 2 °C, some of the debates about the risks and opportunities of degrowth would be more pertinent. If, on the other hand, decision makers were only to seek a 20% or 30% chance of staying within 2 °C, the growth issue would not be nearly as problematic.

4. 'Going beyond' the 2 °C target?

More is being learnt about the probability and also the implications of 'going beyond' 2 °C, although huge uncertainties remain with respect to both these issues. Both should form an important part of the 2013–2015 review, but whether or not they do remains to be seen. Formally, the review should consider the following (UNFCCC, 2010, para. 139(a)):

1. The best available scientific knowledge, including the assessment reports of the IPCC
2. The observed impacts of climate change
3. An assessment of the overall aggregated effect of the steps taken by Parties in order to achieve the ultimate objective of the Convention
4. Consideration of strengthening the long-term global goal, referencing various matters presented by the science, including those in relation to temperature rises of 1.5 °C

However, many countries will not want to open up the debate around the fourth point too much, and some will likely try to restrict it to no more than issue 3, i.e. a report on what pledges and emission reductions have been made thus far in relation to the existing target of 2 °C.

We argue that narrowing the scope of the review too much would be an important opportunity missed. When confronted with such a deep policy dilemma, policy makers should be as aware as possible of all the implications of pursuing alternative courses of action. In situations of high uncertainty and strong and enduring value differences, scholars of policy appraisal recommend 'opening' up policy dilemmas to wider framings and sources of expertise, rather than 'closing them down' in a valiant attempt to arrive at a scientifically precise answer regardless of whether it has societal support

(Stirling, 2008, p. 262). We suggest that the international climate regime itself faces such a high risk, posed by a growing realization that 2 °C is very probably unattainable, at least with current policy responses and current understandings of climate sensitivity (the latter issue becoming the subject of increased debate in 2013 – see for example Otto et al., 2013). For this reason, we recommend that the 2013–2015 review examine a range of alternative options. By examining (and challenging) some of these alternatives to the status quo, a wider societal debate about the ultimate objectives of climate policy could be stimulated.

As noted above, the 2013–2015 review is specifically directed to consider 'various matters presented by the science'. This paper has initiated an exploration of some of the *policy and governance* implications of adopting four very different approaches, drawing upon science *and* social science perspectives. Often, these implications have been only superficially considered in debates about 2 °C, yet history suggests these policy and governance implications are precisely the issues on which agreement at the international level has foundered. Bringing the options together proved to be very illuminating. It was shown, for example, that similar opportunities and risks apply to more than one option. This is important, because it suggests that no single option – including Option 4 – is uniformly 'better' than the rest. Indeed, future research could usefully explore the scope for combining elements of different options, as part of a more systematic comparison than space allows here, but which this journal has a record of publishing (see, e.g. Aldy et al., 2003). It has been shown that Options 2 and 4 are to some extent compatible with one another, as are Options 1 and 3.

Our key point, however, is that, as uncomfortable and threatening as it may be to sketch out and explore the risks, opportunities and uncertainties associated with alternative options, it could offer a more productive and in the longer term more politically sustainable way to grapple with the deep dilemma at the heart of contemporary climate policy. In fact, and perhaps rather ironically, it may encourage some of the more doubtful decision makers to (re-) commit to the existing 2 °C target, however demanding it may be, as the least unattractive course of action.

Nonetheless, introducing and appraising different options will serve at best to clarify, not remove, the underlying policy dilemma. Important questions would remain, e.g. concerning who would adjudicate on these matters, when decisions would need to be made, and whether sufficient agreement would be possible on key issues such as what probability of staying within 2 °C or 1.5 °C to aim for. According to decisions made at Cancun, the COP 'shall take *appropriate action* based on the [2013–2015] review' (UNFCCC, 2010, para. 139(c), emphasis added). What 'appropriate action' might involve in practice was not clarified at Doha, although it is expected to inform the negotiations of the Durban Platform. With respect to timing, would a decision either to reaffirm or replace the 2 °C target need to be made at the end of the review in 2015 or when the envisaged global deal is reached in that year? Or could it wait until 2020 when the UN hopes a successor to Kyoto will be operational? If the target were to be reaffirmed, what probability of its achievement would be required? The time that an appraisal exercise – or possibly even exercises[5] – would absorb, will of course have hugely important implications for the likelihood of limiting warming to 2 °C (Figure 1) and thus the basis on which other options are considered.

For now, the ironic prospect arises that the 2013–2015 review, initially called for as a route to *tightening* the 2 °C target, could conceivably conclude that it has, in effect, become unreachable. Then what? Institutional theory (March & Olsen, 1984; Pierson, 2004) suggests that, once adopted, targets and their associated policies attract political supporters who resist change (Young, 2010), and especially

attempts to dismantle them (Jordan, Bauer, & Green-Pedersen, 2013). This may apply in particular to perhaps the target's strongest supporter, the EU, where a danger may be perceived that member states would seize an opportunity to reopen contentious 'effort-sharing' arrangements to jockey for more favourable terms (Rayner & Jordan, 2012). Its supporters may therefore continue to support the 2 °C target as something that serves to bring together diverse interests, even though in practice it appears less and less achievable. This being the case, a 'non-decision' about 2 °C in 2015 remains a very likely but, for the reasons outlined above, politically risky prospect.

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Notes

1. *Decision 1/CP.16, The Cancún Agreements: Outcome of the Work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention* (UN Doc. FCCC/CP/2010/7/Add.1, 15 March 2011, para. 4).
2. Retrieved on August 2, 2013, from https://unfccc.int/science/workstreams/the_2013-2015_review/items/7521.php
3. *Four Degrees and Beyond. International Climate Conference*. 28–30 September 2009, Environmental Change Institute, University of Oxford. Retrieved December 5, 2012, from http://www.eci.ox.ac.uk/4degrees/
4. The phrase 'brutal arithmetic' was used by Lord Stern in an interview with the *Guardian* newspaper (Harvey, 2012).
5. A decision made at Doha suggests that the COP will '*periodically* review the adequacy of the long-term global goal' (emphasis added) (UNFCCC, 2010, para. 138).

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