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Reframing the policy approach to greenhouse gas removal technologies

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HIGHLIGHTS

- Greenhouse gas removal (GGR) must be decoupled from geoengineering discussions.
- GGR shares many characteristics with existing mitigation and offset measures.
- GGR brings key economic value and flexibility to mitigation efforts.
- Delaying action on GGR policy risks missing short and long term opportunities.
- The ultimate goal should be GGR “policy parity” with emissions reduction.

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ABSTRACT

Greenhouse gas removal (GGR) methods such as direct air capture, bioenergy with carbon capture and storage, biochar and enhanced weathering have recently attracted attention as “geoengineering” options to reverse the build-up of greenhouse gases in the atmosphere. Contrary to this framing, however, we argue that GGR technologies can in fact form a valuable complement to emissions control within on-going mitigation efforts. Through decoupling abatement from emissions sources, they add much-needed flexibility to the mitigation toolbox, increasing feasibility and reducing costs of meeting climate targets. Integrating GGR effectively into policy raises significant challenges relating to uncertain costs, side effects, life-cycle effectiveness and accounting. Delaying policy action until these uncertainties are resolved, however, risks missing early opportunities, suffocating innovation and locking out the long-term potential of GGR. Based on an analysis of bioenergy with carbon capture and storage, we develop four policy principles to begin unlocking the potential of GGR: (i) support further research, development and demonstration; (ii) support near-term opportunities through modifying existing policy mechanisms; (iii) commit to full GGR integration in carbon accreditation and broader climate policy frameworks in future; (iv) develop sector-specific steps that lay the groundwork for future opportunities and avoid lock-out.

1. Introduction

1.1. Background

There has been an increasing consensus in recent years that global efforts to reduce CO_2 emissions will not be sufficient to meet the widely recognised upper stabilisation limit of 450 ppmv atmospheric CO_2 concentration, the level thought to be consistent with a global average temperature rise of 2 °C (IEA, 2012). Even if all nations that have made national pledges meet their most ambitious near-term mitigation targets, an “emissions gap” of 8 gigatonnes of CO_2-equivalent per year in 2020 will still exist between projected emissions and trajectories with a 66% chance of limiting warming to 2 °C (UNEP, 2013). Similarly, latest estimates from the IPCC (2013a) suggest that humanity has used over half of the cumulative “carbon budget” associated with the same goal. Furthermore, improved understanding of climate tipping points and long-term feedbacks has led Hansen et al. (2008), among others, to suggest that 350 ppmv is in fact the upper limit for long-term climate stabilisation, a point passed in the late 1980s (IPCC, 2013a).

Such realisations have driven a surge in interest in greenhouse gas removal (GGR), also known as carbon dioxide removal (CDR) or negative emissions technologies (NETs). The term describes any method that results in long-term removal of CO_2 or other GHGs from the atmosphere either through enhancing and expanding natural sinks or creating new sinks (IPCC, 2013a).

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The concept in its current form was brought to global attention by the Royal Society (2009), which framed it as one branch of geoengineering, a “deliberate, large-scale intervention in the Earth's climate system in order to moderate warming”, in parallel to a group of techniques aiming to modify the Earth's albedo known as solar radiation management (SRM). In this view, planet-scale GGR represents a way for humanity to undo the damage caused by GHG emissions and return atmospheric concentrations to within safe limits. This initial framing, emphasising large-scale deployment, safety and regulation, has dominated early discussion of governance and policy for GGR (e.g. Bracmort et al., 2011; MacCracken et al., 2010; House of Commons, 2010).

However, recent discussion has pointed out that GGR approaches in fact have very little in common with SRM proposals. Instead they typically share much more with related emissions reduction approaches and can play a valuable role within the context of current mitigation efforts (Boucher et al., 2013; Heyward, 2013; Meadowcroft, 2013). In this view, the distinction between GGR and emissions reductions is in many ways artificial and is an unconstructive basis for developing effective policy.

The aims of this work are to evaluate the state of GGR technologies and the value they could bring to near-term and long-term efforts to tackle climate change, develop a framing of GGR that is useful for developing policy and suggest ways that policymakers can begin to make useful progress in this sector. It stresses the framing of GGR technologies as diverse and potentially valuable options of variable maturity that in many cases have much in common with “traditional” mitigation approaches. In this light, it re-examines the policy needs for effective support of GGR and the key challenges, finally recommending four classes of policy priorities that can start to take advantage of the opportunity that GGR provides.

Section 2 will first review the concept of GGR and a sample of proposed technologies. Section 3 reviews the strengths and limitations of how GGR has been framed in policy discussion so far and develops a new framing based on the value that GGR can bring to climate mitigation efforts. A discussion of the challenges facing attempts to integrate GGR into climate policy, and the urgency of addressing them, is presented in Section 3. Section 4 offers four broad policy recommendations for realising the potential of these technologies in the long term. Section 4 also summarises and concludes.

1.2. Greenhouse gas removal systems

1.2.1. Overview of GGR systems

There have been several excellent recent reviews of the growing range of methods for removal of GHGs from the atmosphere (see e.g. McGlashan et al., 2012; McLaren, 2012, 2011; Vaughan and Lenton, 2011) so the technologies will not be discussed in detail here. A brief description of a selection of the most widely discussed approaches is given in Table 1. Note that cost estimates should not be taken as definite, especially for less mature technologies, but simply illustrate the expected order of magnitude of abatement cost through GGR. Classification of technologies is based on McLaren (2011).

1.2.2. Policy relevant features of GGR technologies

A number of policy-relevant conclusions can be drawn from a review of the current status of GGR technologies. The following conclusions are drawn chiefly from points raised by the Royal Society (2009), Vaughan and Lenton (2011), McGlashan et al. (2012) and McLaren (2011):

1. GGR technologies are very diverse, making use of a range of capture pathways and carbon storage reservoirs. They may share nothing beyond their conceptual aim of removing atmospheric CO_2.
2. Many technologies are at an early stage of scientific and technical development, and this is reflected in often large uncertainties in estimates of their costs, effectiveness and any undesirable impacts. Ocean and soil-storage methods broadly face uncertainties surrounding underlying carbon cycling processes, quantifying storage and environmental impacts. Uncertainties in engineering-based systems such as direct air capture and bioenergy with CCS also relate to technical challenges and costs.
3. Predicted costs for some technologies overlap with those of some of today's “mitigation” options with estimated abatement costs of the order of \$10–100/tCO_2 (IPCC, 2007).
4. Some technologies may be associated with significant co-benefits or co-products, such as ecosystem services, improved agricultural yields or management of ocean acidification. These can make them worthwhile even in the absence of carbon benefits.

Bearing these characteristics in mind, we now explore the role that GGR can play in near-term and long-term climate strategy.

2. Methods

This work is a synthesis, building on the insights of a re-framing of greenhouse gas removal that is emerging in the literature with ideas developed through a series of semi-structured interviews on the specific question of combining bioenergy with carbon capture and storage conducted in 2013 (detailed in Lomax, 2013).

An extensive literature review focused on characterising the evolution of the wider discourse surrounding GGR over the last few years in order to synthesise the main themes into a new framing of GGR developed in Sections 3.1 and 3.2.

New perspectives on the role and prospects of GGR, as well as the key policy strategy recommendations presented in Section 3.3, were developed from an in-depth analysis of the example of bioenergy with carbon capture and storage, which has sometimes been characterised as the GGR technology closest to widespread deployment (McGlashan et al., 2012).

GGR approaches are very diverse, and BECCS may have few specific features in common with other options, such as ocean liming. When designing policy, it will of course be important to tailor it to the specific issues raised by particular technologies. However, BECCS shares many specific challenges with other GGR technologies that integrate bioenergy and those that integrate CCS, and raises the same high-level questions that are relevant to GGR methods considered as a group, surrounding their appropriate role and unique conceptual challenges. Therefore, it is argued that BECCS is a useful illustrative case study to develop broad principles of policy integration for GGR.

However, since BECCS is arguably most closely tied to energy system technologies and policies, more specific recommendations may not apply equally to other approaches. Where other technologies raise particular issues, or interact with other policy systems, we briefly discuss in the text.

The prospects of BECCS were explored through a series of twelve semi-structured interviews conducted over July to September 2013. The latest academic perspectives were introduced to interviewees from a range of backgrounds in order to develop new insights and derive a more balanced picture of a technology than review of academic literature alone. In order to reduce bias, representative experts and stakeholders from diverse groups, including different branches of academia, industry and related groups, NGOs and public sector policy researchers, were sought in