

Greenhouse Gas Removal from the Atmosphere

1. Announcement of Workshop

London, 28 April 2016

The deadline for applications is 16:00 on Monday 11th April 2016.

Applications received after this time will not be considered.

The Natural Environment Research Council (NERC), Engineering and Physical Sciences Research Council (EPSRC), Economic and Social Research Council (ESRC), Science and Technology Facilities Council (STFC), Arts and Humanities Research Council (AHRC), Biotechnology and Biological Sciences Research Council (BBSRC), the Department of Energy and Climate Change (DECC) and the Met Office are inviting applications to attend a jointly organised workshop in London on 28 April 2016.

The aims will be:

- To identify the key research questions in greenhouse gas removal from the atmosphere in the remits of the organising bodies.
- To define the scope of a potential joint research programme linking together key research areas to deliver a truly integrated interdisciplinary approach.

Background

The organisers are considering the scope of a potential programme focussed on the removal of carbon dioxide (and potentially other greenhouse gases) from the atmosphere. The scientific basis for additional approaches beyond conventional mitigation is currently poorly-developed. New knowledge from research is needed to assess whether it is feasible to use greenhouse gas removal as an approach to counteract climate change at the required scale, in addition to (but not replacing) strong mitigation and adaptation, and give greater detail on what conditions might need to be met for such remedial actions to be taken and what might be the consequences of taking them. The programme's goal will be to provide the new, integrated knowledge needed to assess whether such action might, in addition to conventional mitigation, make a feasible and cost-effective contribution to avoiding dangerous climate change – thereby helping to meet commitments of the Paris Agreement. There is no intention to include research on carbon dioxide storage in this programme.

The aim of new research in this area would be to draw on expertise across a wide range of disciplines to address this issue and achieve outcomes that can have an impact on both policies and practice.

The key questions that research in this area might address are:

- i. What GHG removal options offer the most potential in terms of their scientific, economic, political and technological feasibility and expediency?
- ii. What are the economic, governance, environmental, ethical and wider societal implications of those options?

Purpose of the workshop

A very wide spectrum of biological and physico-chemical techniques could potentially be used for greenhouse gas removal, with most focussing on carbon dioxide (CO₂). However, this is a complex problem with the scientific, technical, and biogeochemical challenges being inextricably bound up with social, cultural, political and economic questions that make it difficult to provide quantitative estimates of the potential effectiveness and scalability of GHG removal techniques. A sophisticated interdisciplinary approach is therefore required that brings together all the available evidence from across the different sciences for both national climate and energy policies to determine which techniques are possible and at what scale. This will require expertise from across the research base including environmental scientists, engineers, agriculturalists, social scientists, economists, arts and humanities researchers and both academia and the private sector. Transdisciplinary discussions are needed to plan linkages between disciplines and to identify specific research priorities that are potentially tractable to multidisciplinary investigation and the range of funding bodies involved.

The workshop's outcome may inform any future calls for funding and will generate ideas for future areas of research collaboration. Participation in this workshop is **not** a pre-condition for subsequent funding, which will be based on open competition for support through any programme that might be developed in this topic area

Information about the workshop

To attend the workshop you must complete the [expression of interest form](#), following the instructions provided. The form must be submitted by 16:00 on Monday 11th April 2016. Invited participants will be notified by 15 April 2016.

In the expression of interest, applicants should provide a short summary of interests, including scope for wider collaborations (including non-UK) and indicating the main funding agency that you would expect to provide support for your work. This information, along with name, affiliation and

email address will subsequently be shared with all others expressing interest unless you indicate that you would not like this information to be circulated. The total number of participants is limited and the organisers will try to ensure a balance of disciplines/expertise and institutional representation.

The meeting is expected to be held between 10am and 4pm. There is no registration fee; travel and subsistence costs will be met by the attendee.

Contact

If you have any questions please contact Nicola Lewis – nile@nerc.ac.uk.

2. Potential research challenges

Many proposed greenhouse gas removal techniques have risks, uncertainties and knowledge gaps that hinder assessment of their effectiveness, scalability and political acceptance. The research will scrutinise and assess the feasibility of a range of removal techniques, identifying and addressing the 'weakest links' (knowledge gaps and trade-offs), that may be technical, environmental, social, economic, legal or ethical. They would include modelling and laboratory studies, with the possibility of limited field experiments to be carried out under controlled conditions and meeting all relevant regulations and guidance for such research. Specific techniques will be proposed by the research community and selected through peer review. Any field experiments would be small scale with correspondingly small impacts, phased within projects and may be required to pass stage-gates to demonstrate social and ethical acceptability. The phased approach for any fieldwork (if scientifically justified) would provide control without overly specifying the research agenda at this early stage. This approach could allow the considered inclusion of novel techniques as well as those which have already been the subject of some research. All projects will be required to comply fully with community-based guidance; e.g. [the Oxford Principles](#) and RCUK principles of Responsible Innovation. In particular, research must not only fully comply with relevant national and international legal constraints, but also be guided by recent developments in the governance of climate geoengineering research, which advocate self-regulation and strong stakeholder engagement. In keeping with the spirit of these principles and the responsible innovation framework, research must include responsible analysis of risk and regulation coupled with unbiased evaluations to inform appropriate governance.

Note – the balance of research to be undertaken within and between topics will be dependent on the balance of funding received from the different partners.

Topic 1. Options for removing greenhouse gases from the atmosphere at a climatically-relevant scale

The scientific, technical, and biogeochemical challenges of these techniques need to be carefully considered at the same time as the social, cultural, political and economic questions in terms of feasibility and viability to determine if it is possible to deploy them at a climatically-relevant scale. The IPCC emissions pathway that minimises the risk of dangerous climate change (RCP 2.6) involves assumptions about the feasibility of achieving carbon dioxide removal. However, it was acknowledged that there were many uncertainties about what may be feasible and improved quantitative understanding is therefore required of the relevant processes – not just for that technique, but for others that might also warrant serious consideration.

Research will explore the feasibility of specific GGR options to help determine if these options could be implemented at a scale that (together with conventional mitigation) could assist in avoiding dangerous climate change.

Possible techniques for removing carbon dioxide and other greenhouse gases include:

- Direct air capture with carbon capture and storage
- Enhanced weathering and other mineralised storage, on land and in the ocean
- Ocean fertilisation to increase carbon drawdown
- Impacts of different land management approaches and crop types on the storage of carbon, including afforestation and re-forestation
- Carbon sequestration in soils, including techniques such as biochar
- Bioenergy with carbon capture and storage (BECCS)
- Building with biomass
- Potentially other novel techniques.

Advances would depend on the techniques chosen, but are expected to include:

- more sophisticated global simulations of climatic benefits of greenhouse gas removal options
- identification of climatic and environmental effects of potential ‘overshoot’ in atmospheric CO₂, due to delay between emissions and carbon dioxide removal deployment
- analysis of interactions between different combinations of carbon dioxide removal
- A thorough life-cycle analysis of potential side effects (environmental, sociopolitical, economic, technical) at potential large scale uptake levels.
- improved information on feasibility of land-based options and their impacts on hydrological cycles (based on land-use and linkage to food security)
- evaluation of different metrics for climatic effectiveness of response options
- improvements in cost-effectiveness and efficiency of chemically-based CO₂ removal

- better knowledge of the rate-limiting processes for biologically-based carbon drawdown and long term retention such as implications for the soil carbon budget.

Topic 2. Economic, governance, environmental, ethical and wider societal implications of greenhouse gas removal techniques

The environmental, social and ethical impacts of GGR options need to be much better characterised, in addition to issues directly affecting their climatic effectiveness and technical feasibility. Such studies need to be carried out in partnership with stakeholders, in an international context and across a range of disciplines, to maximise societal benefits and inform governance and decision-making at a range of levels.

Advances are expected to include:

- examination and consideration of economic, societal and cultural impacts of GGR techniques
- further development of integrated assessment models that include GGR techniques, informed by field-based data and realistic social economic assessments
- new knowledge on environmental consequences of all techniques such as (but not limited to) air quality effects, biodiversity impacts, hydrological impacts, effects of changes to trade.
- factors affecting scalability, economic viability and associated governance, including legal, ethical, political and transnational issues
- integrated natural and social assessment of techniques to give overall feasibility
- consideration of risks and ethical impacts such as public consent and inter-generational and regional equity.

The programme would deliver better understanding of the biophysical, engineering, social, cultural, political and ethical processes involved in making deliberate, large scale interventions in the climate system to counteract current trajectories, thereby contributing to the evidence base on whether greenhouse gas removal can be scientifically and ethically justified.

This would meet the [UK government need](#) for “a thorough understanding of all the options available to counteract dangerous climate change and knowledge of their risks and benefits...through relevant, careful and responsible multi-disciplinary research”. In particular, a soundly-based, scientific assessment of the achievability of such options has major significance for national climate and energy policies, including mitigation goals, adaptation plans and international negotiating positions.

In particular, the programme would provide a timely UK national science contribution to quantify issues that the IPCC has identified as very uncertain, yet nevertheless are crucial to avoiding dangerous climate change. It would therefore directly support the climate policy and governance landscape by contribution to the next IPCC Assessment Report and the landscape for ongoing

negotiations of the UN Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD), and other relevant interested fora.